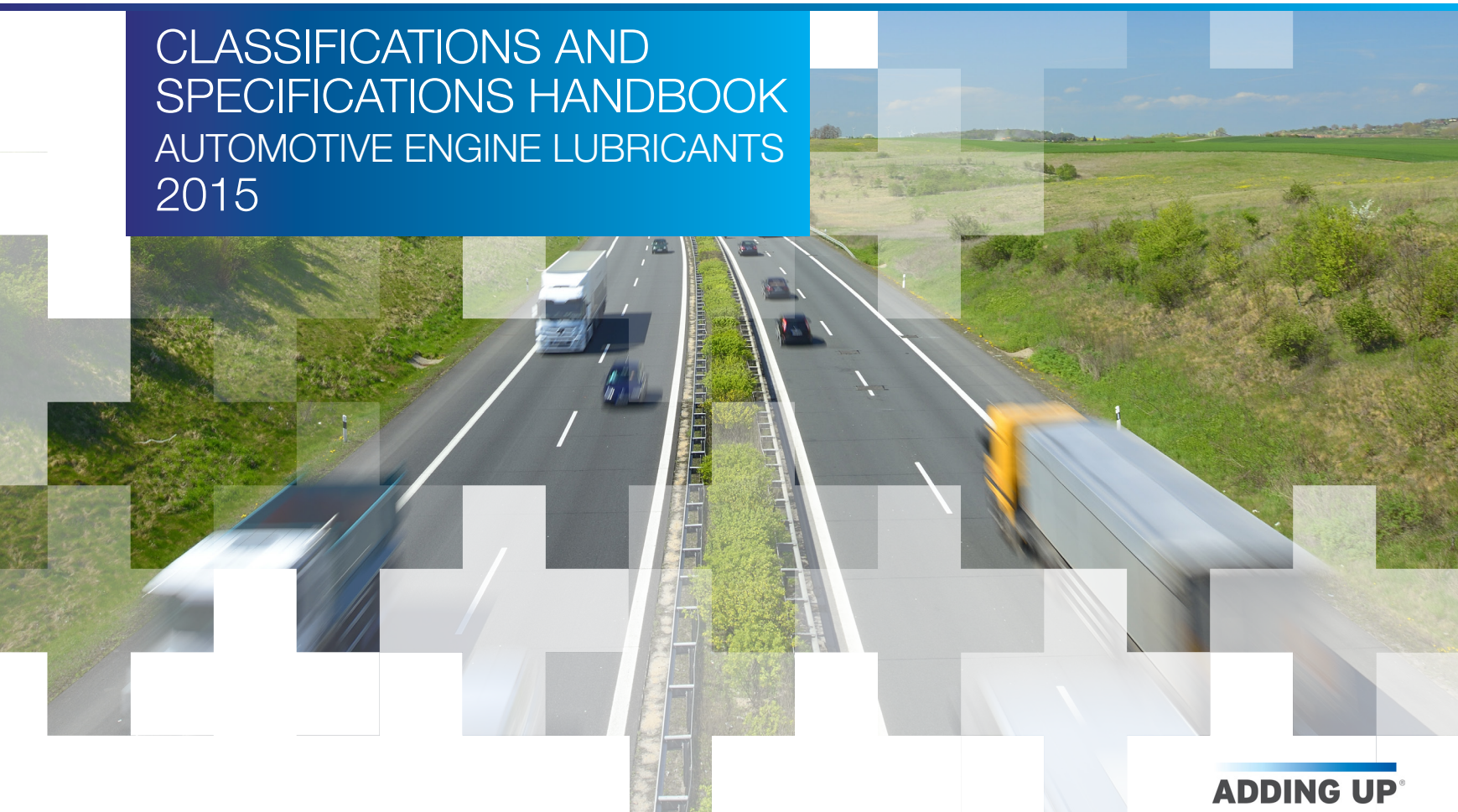




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CLASSIFICATIONS AND SPECIFICATIONS HANDBOOK AUTOMOTIVE ENGINE LUBRICANTS 2015



ADDING UP[®]

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VISCOSITY CLASSIFICATIONS - SAE J 300



SAE J300 revised January 2015 - SAE viscosity grades for engine oils^{(1) (2)}



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SAE viscosity grade	Low-temperature (°C) Cranking viscosity ⁽³⁾ (mPa.s)	Low-temperature (°C) Pumping viscosity, (mPa.s, with No Yield Stress) ⁽⁴⁾	Low-shear-rate Kinematic viscosity ⁽⁵⁾ , (mm ² /s) at 100°C	Low-shear-rate Kinematic viscosity ⁽⁵⁾ , (mm ² /s) at 100°C	High-shear-rate viscosity ⁽⁶⁾ , (mPa.s) at 150°C
	Max.	Max.	Min.	Max.	Min.
0W	6200 at -35	60 000 at -40	3.8	-	-
5W	6600 at -30	60 000 at -35	3.8	-	-
10W	7000 at -25	60 000 at -30	4.1	-	-
15W	7000 at -20	60 000 at -25	5.6	-	-
20W	9500 at -15	60 000 at -20	5.6	-	-
25W	13000 at -10	60 000 at -15	9.3	-	-
8	-	-	4.0	<6.1	1.7
12	-	-	5.0	<7.1	2.0
16	-	-	6.1	<8.2	2.3
20	-	-	6.9	<9.3	2.6
30	-	-	9.3	<12.5	2.9
40	-	-	12.5	<16.3	3.5 (0W-40, 5W-40, 10W-40)
40	-	-	12.5	<16.3	3.7 (15W-40, 20W-40, 25W-40, 40)
50	-	-	16.3	<21.9	3.7
60	-	-	21.9	<26.1	3.7

Notes:

(1) 1 mPa.s = 1 cP; 1 mm²/s = 1 cSt

(2) All values, with the exception of the low-temperature cranking viscosity, are critical specifications as defined by ASTM D3244

(3) ASTM D5293: cranking viscosity - The non-critical specification protocol in ASTM D3244 shall be applied with a P value of 0.95

(4) ASTM D4684: note that the presence of any yield stress detectable by this method constitutes a failure regardless of viscosity

(5) ASTM D445

(6) ASTM D4683, ASTM D4741, ASTM D5481, or CEC L-036-90

API and ILSAC
REQUIREMENTS
for GASOLINE and
DIESEL ENGINE OILS



API "S" and ILSAC Gasoline service categories engine and laboratory test requirement summary - Current



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API CATEGORY	SJ	SL	SM	SN	SN + RC
SAE viscosity grades	All				
L-38	X or Seq VIII	-	-	-	-
Ball rust test	X ⁽⁵⁾ or Seq IID	X ⁽⁵⁾	X ⁽⁵⁾	X ⁽⁵⁾	X ⁽⁵⁾
Sequence II	IID or BRT ⁽⁵⁾	-	-	-	-
Sequence III	IIIE or IIIF or IIIG ⁽⁶⁾ (9)	IIIF or IIIG ⁽⁹⁾	IIIG + IIIGA ⁽¹⁾	IIIG + (IIIGA or ROBO) ⁽³⁾	IIIG + IIIGB + (IIIGA or ROBO)
Sequence IV	-	IVA	IVA	IVA	IVA
Sequence V	VE or IVA + VG	VE ⁽²⁾ + VG	VG	VG ⁽⁵⁾	VG ⁽⁵⁾
Sequence VI	-	-	-	-	VID ⁽⁷⁾
Sequence VIII	X or L-38	X	X	X	X
Viscometrics	SAE J300	SAE J300	SAE J300	SAE J300	SAE J300
Volatility	X	X	X	X	X
Filterability	X	X	X	X	X
Foaming	X	X	X	X	X
Flash point	X	-	-	-	-
Homog. & Miscibility	X	X	X	X	X
TEOST	TEOST 33	TEOST MHT	TEOST MHT ⁽⁶⁾	TEOST MHT ⁽⁶⁾	TEOST 33C ⁽⁴⁾ & MHT ⁽⁶⁾
Gelation index	X	X	X	X ⁽⁶⁾	X ⁽⁵⁾
Shear stability	X	X	X	X	X
ROBO test	-	-	-	X or IIIGA ⁽³⁾	X or IIIGA
Catalyst compatibility	X	X	X	X ⁽⁶⁾	X ⁽⁶⁾
Emulsion retention	-	-	-	-	X
Elastomer compatibility	-	-	-	X	X
Phosphorus retention	-	-	-	-	X

Notes:

- (1) IIIGA required only for SAE grades 0W-20, 5W-20, 0W-30, 5W-30 and 10W30
- (2) VE not required for oils containing a minimum of 0.08% phosphorus in the form of zinc dialkyl/dithiophosphates (ZDDP)
- (3) Not required for monograde and 15W, 20W and 25W multigrade oils
- (4) Not required for 0W-20
- (5) If CI-4 and/or CJ-4 categories precede the «S» category and there is no API Certification Mark, the Sequence VG (ASTM D 6593), ball rust test (ASTM D 6557), and gelation index (ASTM D5133) tests are not required.
- (6) For all viscosity grades: if CF-4, CG-4 and/or CI-4 categories precede the 'S' category and there is no API Certification Mark, the limits

for phosphorus, sulfur and the TEOST MHT do not apply.

Note that these oils have been formulated primarily for Diesel engines and may not provide all of the performance requirements consistent with vehicle manufacturers' recommendations for Gasoline-fueled engines.

- (7) Viscosity grades are limited to 0W, 5W and 10W multigrade oils
- (8) For oils containing less than 0.08% phosphorus, in the form of ZDDP, the Sequence IIIF plus Sequence VE test is allowed as an alternative to Sequence IIIE.
- (9) For oils with ≥0.06 mass% and <0.08% phosphorus, in the form of ZDDP, the Sequence IIIG test is allowed as an alternative to Sequence IIIF plus Sequence VE.

API “S” and ILSAC Gasoline service categories engine and laboratory test requirement summary - Obsolete



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API CATEGORY	SE	SF	SG	SH
SAE viscosity grades	All			
CRC L-38	X	X	X	X or Seq VIII
Ball rust test	-	-	-	X or Seq IID
Sequence II	IID	IID	IID	IID or BRT
Sequence III	IIID	IIID	IIIE	IIIE ⁽²⁾ or IIIF ⁽²⁾ or IIIG ⁽³⁾
Sequence IV	-	-	-	-
Sequence V	VD	VD	VE	VE or IVA + VG
Sequence VI	-	-	-	-
Sequence VIII	-	-	-	X or L-38
Caterpillar	-	-	1H2	-
Ford Falcon	-	-	-	-
Viscometrics	SAE J 300	SAE J 300	SAE J 300	SAE J300
Volatility	-	-	-	X
Filterability	-	-	-	X
Foaming	-	-	-	X
Flash point	-	-	-	X
Homog. & Miscibility	-	-	-	X
TEOST	-	-	-	-
Gelation index	-	-	-	-
Shear stability	-	-	-	X
Catalyst compatibility	-	-	-	X

ILSAC STANDARD	GF-1	GF-2	GF-3	GF-4
SAE viscosity grades	0W-xx, 5W-xx, 10W-xx			
CRC L-38	X	X	-	-
Ball rust test	-	-	X	X
Sequence II	IID	IID	-	-
Sequence III	IIIE	IIIE	IIIF	IIIG + IIIGA
Sequence IV	-	-	IVA	IVA
Sequence V	VE	VE	VE ⁽¹⁾ + VG	VG
Sequence VI	VI	VIA	VIB	VIB
Sequence VIII	-	-	X	X
Caterpillar	-	-	-	-
Ford Falcon	-	-	-	-
Viscometrics	SAE J 300	SAE J 300	SAE J 300	SAE J300
Volatility	X	X	X	X
Filterability	X	X	X	X
Foaming	X	X	X	X
Flash point	X	X	-	-
Homog. & Miscibility	X	X	X	X
TEOST	-	33C	MHT	MHT
Gelation index	-	X	X	X
Shear stability	X	X	X	X
Catalyst compatibility	X	X	X	X

Notes:

(1) Not required for oils containing a minimum of 0.08% mass phosphorus in the form of Zinc dialkyl/dithiophosphates (ZDDP)

(2) For oils containing less than 0.08% phosphorus, in the form of ZDDP, the Sequence IIIF plus Sequence VE test is allowed as an alternative to Sequence IIIE

(3) For oils with ≥0.06 mass% and <0.08% phosphorus, in the form of ZDDP, the Sequence IIIG test is allowed as an alternative to Sequence IIIF plus Sequence VE

API SM, SN, SN + RC Gasoline service category laboratory test limits

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API CATEGORY	SM		SN		SN + RC
SAE viscosity grades	0W-20/30 , 5W-20/30, 10W-30	Other grades	0W-20/30 , 5W-20/30, 10W-30	Other grades	All viscosity grades
Laboratory test requirements					
ASTM D445, kinematic viscosity at 100°C, cSt.	SAE J300	SAE J300	SAE J300	SAE J300	SAE J300
ASTM D4683, HTHS viscosity, mPa.s, min.	SAE J300	SAE J300	SAE J300	SAE J300	SAE J300
ASTM D5293, low temperature cranking viscosity, cP.	SAE J300	SAE J300	SAE J300	SAE J300	SAE J300
ASTM D4684, pumpability, 60.000 cP max. / no yield stress at °C	SAE J300	SAE J300	SAE J300	SAE J300	SAE J300
ASTM D5800, volatility loss, 1 h. at 250°C, %, max.	15 ⁽¹⁾	15 ⁽¹⁾	15 ⁽¹⁾	15 ⁽¹⁾	15 ⁽¹⁾
ASTM D6417, volatility loss at 371°C, %, max.	10	10	10	10	10
Filterability, % flow reduction, max.					
ASTM D6795 (EOFT)	50	50	50	50	50
ASTM D6794 (EOWTT), with 0.6, 1.0, 2.0, 3.0% H ₂ O.	50	50	50	50	50
ASTM D4951, phosphorus, wt %, max. ^{(3) (4)}	0.08	-	0.08	-	0.08
ASTM D4951, phosphorus, wt %, min. ^{(3) (4)}	0.06	0.06	0.06	0.06	0.06
ASTM D4951 or D2622, sulfur, % m/m, max. ^{(3) (4)}	0.5 ⁽¹⁶⁾ / 0.7 ⁽¹³⁾	-	0.5 ⁽¹⁶⁾ / 0.6 ⁽¹³⁾	-	0.5 ⁽¹⁶⁾ / 0.6 ⁽¹⁷⁾
ASTM D4684, (Sequence III GA), aged oil low temperature viscosity or, ASTM D7528, (ROBO test), aged oil low temperature viscosity ^{(1) (12)}	Pass	-	Pass	Pass ⁽¹⁰⁾	Pass
ASTM D892, foaming tendency option A,					
Sequence I, ml, max., foaming/settling	10 / 0 ⁽⁵⁾	10 / 0 ⁽⁵⁾	10 / 0 ⁽⁵⁾	10 / 0 ⁽⁵⁾	10 / 0 ⁽⁵⁾
Sequence II, ml, max., foaming/settling	50 / 0 ⁽⁵⁾	50 / 0 ⁽⁵⁾	50 / 0 ⁽⁵⁾	50 / 0 ⁽⁵⁾	50 / 0 ⁽⁵⁾
Sequence III, ml, max., foaming/settling	10 / 0 ⁽⁵⁾	10 / 0 ⁽⁵⁾	10 / 0 ⁽⁵⁾	10 / 0 ⁽⁵⁾	10 / 0 ⁽⁵⁾

API SM, SN, SN + RC Gasoline service category laboratory test limits

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API CATEGORY	SM		SN		SN + RC
SAE viscosity grades	0W-20/30 , 5W-20/30, 10W-30	Other grades	0W-20/30 , 5W-20/30, 10W-30	Other grades	All viscosity grades
Laboratory test requirements					
ASTM D6082, high temperature foaming (option A), max.	100 / 0 ⁽⁶⁾	100 / 0 ⁽⁶⁾	100 / 0 ⁽⁶⁾	100 / 0 ⁽⁶⁾	100 / 0 ⁽⁶⁾
ASTM D6922, homogeneity & miscibility	Pass ⁽⁷⁾	Pass ⁽⁷⁾	Pass ⁽⁷⁾	Pass ⁽⁷⁾	Pass ⁽⁷⁾
ASTM D7097, TEOST MHT, high temperature deposits, mg deposit, max. ⁽³⁾	35	45	35	45	35
ASTM D6557, ball rust test, min.	100	100	100 ⁽¹⁴⁾	100 ⁽¹⁴⁾	100 ⁽¹⁴⁾
ASTM D7320 (Seq IIIGB), phosphorus volatility, min.	-	-	-	-	79%
ASTM D6335 , TEOST 33, total deposit weight, mg, max.	-	-	-	-	30 ⁽²⁾
ASTM D5133, gelation index, max. ⁽¹⁴⁾	12 ⁽⁸⁾	-	12 ⁽⁸⁾	-	12 ⁽⁸⁾
ASTM D6709, shear stability (Seq VIII)	Pass ⁽⁹⁾	Pass ⁽⁹⁾	Pass ⁽⁹⁾	Pass ⁽⁹⁾	Pass ⁽⁹⁾
ASTM D7563, emulsion retention: oil mixed with 10% water, 10 % E85					
0°C, 24 Hrs.	-	-	-	-	No water separation
25°C, 24 Hrs.	-	-	-	-	No water separation
ASTM D7216, elastomer compatibility ⁽¹⁵⁾	-	-	Pass	Pass	Pass

Notes:

(1) Calculated conversions specified in ASTM D5800 are allowed

(2) Not required for SAE 0W-20

(3) For all viscosity grades: if CF-4, CG-4 and/or CI-4 categories precede the "S" category and there is no API Certification Mark, the limits for phosphorus, sulfur and the TEOST MTH do not apply

Note that these oils have been formulated primarily for Diesel engines and may not provide all of the performance requirements consistent with vehicle manufacturers' recommendations for Gasoline-fueled engines.

(4) This is a non critical specification as described in ASTM D3244

(5) Settling volume determined at 10 min.

(6) Settling volume determined at 1 min.

(7) Shall remain homogenous and, when mixed with ASTM ref. oils, shall remain miscible

(8) To be evaluated from -5°C to temperature at which 40,000 cP is attained or -40°C, or 2°Celsius below the appropriate MRV TP-1

temperature (defined by SAE J 300), whichever occurs first

(9) 10 h. stripped kinematic viscosity@100°C must remain in original SAE grade

(10) Not required for monograde and 15W, 20W and 25W multigrade oils

(11) If CCS viscosity measured is less than or equal to the max. CCS viscosity specified for the original viscosity grade, run ASTM D4684 (MRV TP-1) at the MRV temperature specified in SAE J300 for the original viscosity grade

(12) If CCS viscosity measured is higher than the max. viscosity specified for the original viscosity grade in SAEJ300, run ASTM D4684 (MRV TP-1) at 5 °C higher temperature (i.e., at MRV temperature specified in SAE J300 for the next higher viscosity grade)

(13) For SAE 10W-30

(14) If CI-4 and/or CJ-4 categories precede the "S" category and there is no API Certification Mark, the Sequence VG (ASTM D 6593), ball rust test (ASTM D 6557), and gelation index (ASTM D5133) tests are not required

(15) Please refer to chapter «Elastomer compatibility» for limits

(16) For SAEs 0W-20/30 , 5W-20/30

(17) For all viscosity grades other than SAEs 0W-20/30, 5W-20

API SH, SJ and SL Gasoline service category laboratory test limits

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API CATEGORY	SH ⁽⁹⁾			SJ		SL	
SAE viscosity grades	5W-30	10W-30	15W-40	0W-20, 5W-20, 5W-30, 10W-30	Other Grades	0W-20, 0W-30, 5W-20, 5W-30, 10W-30	Other Grades
Laboratory test requirements							
ASTM D445, kinematic viscosity at 100°C, cSt	SAE J300	SAE J300	SAE J300	SAE J300	SAE J300	SAE J300	SAE J300
ASTM D4683, HTHS viscosity, mPa.s, min.	SAE J300	SAE J300	SAE J300	SAE J300	SAE J300	SAE J300	SAE J300
ASTM D5293, low temperature cranking viscosity, cP	SAE J300	SAE J300	SAE J300	SAE J300	SAE J300	SAE J300	SAE J300
ASTM D4684, pumpability, 60.000 cP max./no yield stress at °C	SAE J300	SAE J300	SAE J300	SAE J300	SAE J300	SAE J300	SAE J300
ASTM D5800, volatility loss at 250°C, %, max.	25 ⁽¹¹⁾	20 ⁽¹¹⁾	18 ⁽¹¹⁾	22 ⁽²⁾	20 ⁽¹⁾	15	15
ASTM D2887, volatility loss at 371°C, %, max.	20 ⁽¹¹⁾	17 ⁽¹¹⁾	15 ⁽¹¹⁾	-	-	-	-
ASTM D6417 or ASTM D5480, volatility loss at 371°C, %, max.	-	-	-	17 ⁽²⁾	15 ⁽¹⁾	10	10
Filterability, % flow reduction, max.							
ASTM D6795 (EOFT)	50	50	-	50	50	50	50
ASTM D6794 (EOWTT), with 0.6, 1.0, 2.0, 3.0% H ₂ O	-	-	-	Report	Report	50	50
ASTM D4951 or D5185, phosphorus, % m/m, max.	0.12	0.12	-	0.10 ⁽³⁾	-	0.10 ⁽³⁾	-
ASTM D4951 or D5185, phosphorus, % m/m, min.	0.06	0.06	0.06	0.06 ⁽¹³⁾	0.06 ⁽¹³⁾	0.06 ⁽¹³⁾	0.06 ⁽¹³⁾
ASTM D892, foaming tendency option A,							
Sequence I, ml, max., foaming/settling	10 / 0 ⁽¹²⁾	10 / 0 ⁽¹²⁾	10 / 0 ⁽¹²⁾	10 / 0 ⁽⁵⁾	10 / 0 ⁽⁵⁾	10 / 0 ⁽⁵⁾	10 / 0 ⁽⁵⁾
Sequence II, ml, max., foaming/settling	50 / 0 ⁽¹²⁾	50 / 0 ⁽¹²⁾	50 / 0 ⁽¹²⁾	50 / 0 ⁽⁵⁾	50 / 0 ⁽⁵⁾	50 / 0 ⁽⁵⁾	50 / 0 ⁽⁵⁾
Sequence III, ml, max., foaming/settling	10 / 0 ⁽¹²⁾	10 / 0 ⁽¹²⁾	10 / 0 ⁽¹²⁾	10 / 0 ⁽⁵⁾	10 / 0 ⁽⁵⁾	10 / 0 ⁽⁵⁾	10 / 0 ⁽⁵⁾

API SH, SJ and SL Gasoline service category laboratory test limits

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API CATEGORY	SH ⁽⁹⁾			SJ		SL	
SAE viscosity grades	5W-30	10W-30	15W-40	0W-20, 5W-20, 5W-30, 10W-30	Other grades	0W-20, 0W-30, 5W-20, 5W-30, 10W-30	Other grades
ASTM D6082, high temperature foaming optional blending, max.	Report ⁽⁴⁾	Report ⁽⁴⁾	Report ⁽⁴⁾	200 / 50 ⁽⁶⁾	200 / 50 ⁽⁶⁾	100 / 0 ⁽⁶⁾	100 / 0 ⁽⁶⁾
ASTM D6922, homogeneity & miscibility	Pass ⁽⁷⁾	Pass ⁽⁷⁾	Pass ⁽⁷⁾	Pass ⁽⁷⁾	Pass ⁽⁷⁾	Pass ⁽⁷⁾	Pass ⁽⁷⁾
ASTM D6335, TEOST 33, total deposit weight, mg, max.	-	-	-	60	60	-	-
ASTM D7097, TEOST MHT, high temperature deposits, mg deposit, max.	-	-	-	-	-	45	45
ASTM D5133, gelation index, max.	-	-	-	12	-	12 ⁽⁸⁾	-
ASTM D92 ⁽¹⁰⁾ , flash point, °C, min.	200	205	215	200	-	-	-
ASTM D93 ⁽¹⁰⁾ , flash point, °C, min.	185	190	200	185	-	-	-
ASTM D6557 (ball rust test), average gray value, min.	-	-	-	-	-	100	100

Notes:

(1) Only required for 15W-40 oils

(2) Meet the volatility requirement in either test method D5800, D5480, or D6417

(3) This is a non critical specification as described in ASTM D3244

(4) Report kinetic foam volume (ml), static foam volume (ml) and collapse time (s)

(5) Settling volume determined at 10 min.

(6) Settling volume determined at 1 min.

(7) Shall remain homogenous and, when mixed with ASTM ref. oils, shall remain miscible

(8) For gelation temperature at or above the W grade pumpability temperature as defined in SAE J300

(9) There are no laboratory tests and measured parameter requirements for other viscosity grades. Only the most recent edition of SAE J300 requirements have to be met on all oils

(10) Meet either test method D92 or D93 flash point requirement

(11) Meet either test method D5800 or D2887 volatility requirement

(12) Settling volume determined at 5 min.

(13) Not required if passing test method D5302 results are obtained

API "S" Gasoline service categories engine test limits

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API CATEGORY	(SE)	(SF)	(SG)	SH ⁽¹⁾ (6)	SJ ⁽¹⁾	SL	SM	SN	SN + RC		
SAE viscosity grades	All	All	All	All	All	All	All	All	xW-20	xW-30	10W-30 Other grades
CRC L-38 - ASTM D5119											
Bearing weight loss, mg, max.	40	40	40	40	40	-	-	-	-		
Piston skirt varnish, min.	-	-	9.0	-	-	-	-	-	-		
10 h. stripped viscosity	-	-	-	Stay in grade	Stay in grade	-	-	-	-		
Sequence VIII - ASTM D6709											
Bearing weight loss, mg, max.	-	-	-	26.4 ⁽⁹⁾	26.4 ⁽⁹⁾	26.4	26	26	26		
10 h. stripped viscosity	-	-	-	Stay in grade ⁽¹¹⁾	Stay in grade ⁽¹¹⁾	Stay in grade ⁽¹¹⁾	Stay in grade ⁽¹¹⁾	Stay in grade ⁽¹¹⁾	Stay in grade ⁽¹¹⁾		
Sequence IID - ASTM D5844											
Average engine rust, min.	8.5	8.5	8.5	8.5	8.5	-	-	-	-		
Lifter sticking, max.	None	None	None	None	None	-	-	-	-		

API "S" Gasoline service categories engine test limits

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Oronite

API CATEGORY	(SE)	(SF)	(SG)	SH ⁽¹⁾ (6)	SJ ⁽¹⁾	SL	SM	SN	SN + RC		
SAE viscosity grades	All	All	All	All	All	All	All	All	xW-20	xW-30	10W-30 other grades
Sequence IIID, IIIE, IIIF⁽³⁾, IIIG - ASTM D5533, D6984, D7320	IIID	IIID	IIIE	IIIE/IIIF/IIIG	IIIE/IIIF⁽³⁾/IIIG	IIIF⁽³⁾/IIIG	IIIG + IIIGA⁽⁸⁾	IIIG + IIIGA⁽⁸⁾	IIIG + IIIGA⁽⁸⁾ + IIIGB		
Viscosity increase at 40°C, %, max.	375 at 40 h.	375 at 64 h.	375 at 64 h.	-/325 ⁽¹⁰⁾ /150	-/325 ⁽¹⁰⁾ /150	275 at 80 h./150 at 100 h.	150 at 100 h.	150 at 100 h.	150 at 100 h.		
H. to 375 % viscosity inc. at 40°C, min.	-	-	-	64/-/-	64/-/-	-	-	-	-		
Average engine sludge, min.	9.2	9.2	9.2	9.2/-/-	9.2/-/-	-	-	-	-		
Average piston skirt varnish, min.	9.1	9.2	8.9	8.9/8.5 ⁽¹³⁾ /-	8.9/8.5 ⁽¹³⁾ /-	9.0 / -	-	-	-		
Average oil ring land deposits, min.	4.0	4.8	3.5	3.5/-/-	3.5/-/-	-	-	-	-		
Weighted piston deposits, min.	-	-	-	-/3.2 ⁽¹³⁾ /3.5	-/3.2 ⁽¹³⁾ /3.5	4.0 / 3.5	3.5	4.0	4.0		
Ring sticking (hot stuck)	None	None	None	None ⁽²⁾ (13)	None ⁽²⁾ (13)	None	None	None	None		
Lifter sticking	None	None	None	None/-/-	None/-/-	-	-	-	-		
Cam or lifter scuffing	None	None	None	None/-/-	None/-/-	-	-	-	-		
Maximum cam + lifter wear, µm (in.), max.	254 (0.0100)	203 (0.0080)	64 (0.0025)	64 (0.0025)/-/-	64 (0.0025)/-/-	-	-	-	-		
Average cam + lifter wear, µm (in.), max.	102 (0.0040)	102 (0.0040)	30 (0.0012)	30 (0.0012)/20 ⁽¹²⁾ /60	30 (0.0012)/20 ⁽¹²⁾ /60	20 ⁽¹²⁾ / 60	60	60	60		
Low temperature viscosity	-	-	-	-	-	Report ⁽⁴⁾ / Report ⁽⁵⁾	Pass ⁽⁵⁾	Pass ⁽⁵⁾	Pass ⁽⁵⁾		
Phosphorus retention, %, min.	-	-	-	-	-	-	-	-	79 ⁽⁷⁾		
Sequence VID - ASTM D7589											
FEI 2, %, min.	-	-	-	-	-	-	-	-	1.2	0.9	0.6
Sum of FEI, %, min.	-	-	-	-	-	-	-	-	2.6	1.9	1.5

Notes:

- (1) Alternative engine tests may be run instead of those presented as described in ASTM letter of April 28, 2000.
 Ball rust test instead of Sequence IID; Sequence IVA plus Sequence VG instead of Sequence VE; Sequence VIII instead of CRC L-38;
 Sequence IIIF as an alternative to Sequence IIIE (See ASTM D4485 -11c for limits of these alternative engine tests).
- (2) For IIIE in SH/SJ, an oil related stuck ring occurs on a piston with an individual oil ring land deposit rating < 2.6
- (3) Oil consumption is no longer a pass/fail limit. The test is invalid if oil consumption is ≥ 5.2 L and noack volatility is ≤ 15% or oil consumption is ≥ 6.5 L and noack volatility is > 15%
- (4) Evaluate the 80 h. test oil sample by ASTM test method D4684 (MRV TP-1) at the temperature indicated by the low temperature grade of oil as determined on the 80 h. sample by ASTM test method D5293 (CCS viscosity)
- (5) The ASTM test method D4684 (MRV TP-1) result on the 100 h. end of test sample must meet the requirements of the original grade or the next higher grade at the SAE J 300 temperature

- (6) API SH may only be licensed if it is preceded by a «C» category in the service symbol
- (7) API SN + resource conserving Sequence IIIGB (ASTM D7320)
- (8) A Sequence IIIGA test is identical to a Sequence IIIG test, except only low temperature viscosity performance is measured.
- (9) Alternative for CRC L-38
- (10) For IIIF in SH/SJ determine viscosity increase at 40°C at 60 h.
- (11) Data to support stay-in-grade requirement for read-across shall be supported by ASTM D 6276 (30 passes).
 The following limits for kinematic viscosity at 100°C after shear must be met:
 xW-20 ≥ 5.6 cSt / xW-30 ≥ 8.5 cSt / xW-40 ≥ 11.5 cSt / xW-50 ≥ 15.0 cSt.
- (12) Calculate by eliminating the highest and lowest cam-plus-lifter wear results and then calculating an average based on the remaining ten rating positions. For SH and SJ, determine at 80 h.
- (13) For IIIF in SH/SJ, determine at 80 h.

API "S" Gasoline service categories engine test limits

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Oronite

API CATEGORY	(SE)	(SF)	(SG)	SH ⁽¹⁾	SJ ⁽¹⁾	SL	SM	SN	SN + RC
SAE viscosity grades	All	All	All	All	All	All	All	All	All
Sequence IVA - ASTM D6891									
Cam wear average, µm, max.	-	-	-	120 ⁽⁴⁾	120 ⁽⁴⁾	120	90	90	90
Sequence V	VD	VD	VE	VE/VG⁽⁴⁾	VE/VG⁽⁴⁾	VE⁽²⁾	VG	VG	VG
Average engine sludge, min.	9.2	9.4	9.0	9.0 / 7.8	9.0 / 7.8	-	7.8	7.8	8.0
Rocker arm cover sludge, min.	-	-	7.0	7.0 / 8.0	7.0 / 8.0	-	8.0	8.0	8.3
Average piston skirt varnish, min.	6.4	6.7	6.5	6.5 / 7.5	6.5 / 7.5	-	7.5	7.5	7.5
Average engine varnish, min.	6.3	6.6	5.0	5.0 / 8.9	5.0 / 8.9	-	8.9	8.9	8.9
Oil screen debris, %, max.	-	-	-	-	-	-	Report	Report	Report
Oil screen clogging, %, max.	10.0	7.5	20	20/20	20/20	-	20	20	15
Oil ring clogging, %, max. ⁽²⁾	10.0	10.0	15	Report	Report	-	Report	Report	Report
Compression ring sticking (hot stuck)	None	None	None	None / None	None / None	-	None	None	None
Cold stuck rings	-	-	-	-	-	-	Report	Report	Report
Maximum cam wear, µm (in.), max.	Rate & Report	64 (0.0025)	380 (0.015)	380 (0.015) / -	380 (0.015) / -	380 ⁽³⁾	-	-	-
Average cam wear, µm (in.), max.	Rate & Report	25 (0.0010)	130 (0.005)	127 (0.005) / -	127 (0.005) / -	127 ⁽³⁾	-	-	-

Notes:

(1) Alternative engine tests may be run instead of those presented as described in ASTM letter of April 28, 2000. Ball rust test instead of Sequence IID; Sequence IVA plus Sequence VG instead of Sequence VE;

Sequence VIII instead of CRC L-38; Sequence IIIF as an alternative to Sequence IIIE (See ASTM D4485 -04 for limits of these alternative engine tests).

(2) Oil ring clogging as a pass criterion, suspended indefinitely by ASTM on June 1, 1994.

(3) Not required for oils containing a minimum of 0.08% mass phosphorus in the form of ZDDP

(4) Demonstrate passing performance in Sequence VE, or alternatively, in both Sequence IVA and VG

ILSAC GF-4 and GF-5 standard laboratory test limits

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Oronite

ILSAC STANDARD	GF-4	GF-5
SAE viscosity grades ⁽¹⁾	0W-xx, 5W-xx, 10W-xx	0W-xx, 5W-xx, 10W-xx
Laboratory test requirements		
ASTM D445, kinematic viscosity at 100°C, cSt	SAE J300	SAE J300
ASTM D4683, HTHS viscosity, mPa.s, min.	SAE J300	SAE J300
ASTM D5293, low temperature cranking viscosity, cP	SAE J300	SAE J300
ASTM D4684, pumpability, 60.000 cP max./no yield stress at °C	SAE J300	SAE J300
ASTM D5800, volatility loss, 1 h. at 250°C, %, max.	15 ⁽²⁾	15 ⁽²⁾
ASTM D6417, volatility loss at 371°C, %, max.	10	10
Filterability, % flow reduction, max.		
ASTM D6795 (EOTF)	50	50
ASTM D6794 (EOWTT), with 0.6, 1.0, 2.0, 3.0% H ₂ O. ⁽⁵⁾	50	50
ASTM D4951, phosphorus, % m/m, max. ⁽⁴⁾	0.08	0.08
ASTM D4951, phosphorus, % m/m, min. ⁽⁴⁾	0.06	0.06
ASTM D4951 or D2622, sulfur, % m/m, max. ⁽⁴⁾	0.5 ⁽¹¹⁾ / 0.7 ⁽¹⁵⁾	0.5 ⁽¹¹⁾ / 0.6 ⁽¹⁵⁾
ASTM D4684, (Sequence IIIGA), aged oil low temperature viscosity or, ASTM D7528, (ROBO test), aged oil low temperature viscosity	-	Pass ⁽¹²⁾ / (13)

ILSAC GF-4 and GF-5 standard laboratory test limits

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Oronite

ILSAC STANDARD	GF-4	GF-5
SAE viscosity grades ⁽¹⁾	0W-xx, 5W-xx, 10W-xx	0W-xx, 5W-xx, 10W-xx
ASTM D892, foaming tendency option A, Sequence I, ml, max.	10 / 0 ⁽⁶⁾	10 / 0 ⁽⁶⁾
Sequence II, ml, max.	50 / 0 ⁽⁶⁾	50 / 0 ⁽⁶⁾
Sequence III, ml, max.	10 / 0 ⁽⁶⁾	10 / 0 ⁽⁶⁾
ASTM D6082, high temperature foaming (option A), max.	100 / 0 ⁽⁷⁾	100 / 0 ⁽⁷⁾
ASTM D6922, homogeneity & miscibility	Pass ⁽⁸⁾	Pass ⁽⁸⁾
ASTM D7097, TEOST MHT, high temperature deposits, mg deposit, max. ⁽⁴⁾	35	35
ASTM D6557, ball rust test, min.	100	100
ASTM D7320 (Seq IIIGB), phosphorus volatility, min.	-	79%
ASTM D6335, TEOST 33, total deposit weight, mg, max.	-	30 ⁽⁹⁾
ASTM D5133, gelation index, max. ⁽⁹⁾	12 ⁽⁹⁾	12 ⁽⁹⁾
ASTM D6709, shear stability (Seq VIII)	Pass ⁽¹⁰⁾	Pass ^{(10) (14)}
ASTM D7563, emulsion retention: oil mixed with 10% water, 10% E85 0°C, 24 h.	-	No separation
25°C, 24 h.	-	No separation
ASTM D7216, elastomer compatibility ⁽¹¹⁾	-	Pass

Notes:

- (1) Please refer to chapter «Elastomer compatibility» for limits
- (2) Calculated conversions specified in ASTM D5800 are allowed
- (3) No limit for 0W-20
- (4) For all viscosity grades: if CF-4, CG-4, CH-4 and/or CI-4 categories precede the "S" category and there is no API Certification Mark, the limits for phosphorus, sulfur and the TEOST MHT do not apply. This is a non-critical specification as described in ASTM D3244. Note that these oils have been formulated primarily for Diesel engines and may not provide all of the performance requirements consistent with vehicle manufacturers' recommendations for Gasoline-fueled engines
- (5) Test formulation with highest additive (D/I/V) concentration. R/A results to all other base oil/ viscosity grade formulations using same or lower concentration of identical additive (D/I/V) combination. Each different D/I/V combination must be tested
- (6) Settling volume determined at 10 min.
- (7) Settling volume determined at 1 min.
- (8) Shall remain homogenous and, when mixed with ASTM ref. oils, shall remain miscible.
- (9) To be evaluated from -5°C to temperature at which 40,000 cP is attained or -40°C, or 2°Celsius below the appropriate MRV

TP-1 temperature (defined by SAE J 300), whichever occurs first.

(10) 10 h. stripped kinematic viscosity@100°C must remain in original SAE grade

(11) For 0W-xx, 5W-xx

(12) a) If CCS viscosity measured is less than or equal to the max. CCS viscosity specified for the original viscosity grade run ASTM D4684 (MRV TP-1) at the MRV temperature specified in SAE J300 for the original viscosity grade.

b) If CCS viscosity measured is higher than the max. viscosity specified for the original viscosity grade in SAE J300, run ASTM D4684(MRV TP-1) at 5 °C higher temperature (i.e., at MRV temperature specified in SAE J300 for the next higher viscosity grade).

(13) EOT ROBO or IIGA Sample must show no yield stress in the D4684 viscosity must be below the max. specified in SAE J300 for the original viscosity grade or the next higher viscosity grade, as outlined in (12).

(14) Data to support stay-in-grade requirement for read-across shall be supported by ASTM D 6278 (30 passes).

The following limits for kinematic viscosity at 100°C after shear must be met:

xW-20 >= 5.6 cSt / xW-30 >= 8.5 cSt / xW-40 >= 11.5 cSt / xW-50 >= 15.0 cSt.

(15) For 10W-xx

ILSAC GF-1, GF-2 and GF-3 (and GF-4) standard laboratory test limits



Oronite

ILSAC STANDARD	GF-1		GF-2	GF-3	GF-4
SAE viscosity grades ⁽¹⁾	0W-xx, 5W-xx	10W-xx	0W-xx, 5W-xx, 10W-xx	0W-xx, 5W-xx, 10W-xx	0W-xx, 5W-xx, 10W-xx
Laboratory test requirements					
ASTM D445, kinematic viscosity at 100°C, cSt	SAE J300	SAE J300	SAE J300	SAE J300	SAE J300
ASTM D4683, HTHS viscosity, mPa.s, min.	SAE J300	SAE J300	SAE J300	SAE J300	SAE J300
ASTM D5293, low temperature cranking viscosity, cP	SAE J300	SAE J300	SAE J300	SAE J300	SAE J300
ASTM D4684, pumpability, 60.000 cP max./no yield stress at °C	SAE J300	SAE J300	SAE J300	SAE J300	SAE J300
ASTM D5800 ⁽²⁾ , volatility loss at 250°C, %, max.	25 ⁽¹⁾	20 ⁽¹⁾	22	15	15
ASTM D6417 ⁽⁹⁾ , volatility loss at 371°C, %, max.	20 ⁽¹⁾	17 ⁽¹⁾	17	10	10
Filterability ⁽⁸⁾ , % flow reduction, max., ASTM D6795 (EOTF)	50	50	50	50	50
ASTM D6794 (EOWTT), with 0.6, 1.0, 2.0, 3.0% H ₂ O	-	-	Report	50	50
ASTM D4951 or D5185, phosphorus, wt %, max.	-	-	0.1	0.1	0.5 ⁽¹¹⁾ / 0.7 ⁽¹⁵⁾
ASTM D892, foaming tendency option A, Sequence I, ml, max.	10 / 0 ⁽³⁾	10 / 0 ⁽³⁾	10 / 0 ⁽⁶⁾	10 / 0 ⁽⁶⁾	10 / 0 ⁽⁶⁾
Sequence II, ml, max.	50 / 0 ⁽³⁾	50 / 0 ⁽³⁾	50 / 0 ⁽⁶⁾	50 / 0 ⁽⁶⁾	50 / 0 ⁽⁶⁾
Sequence III, ml, max.	10 / 0 ⁽³⁾	10 / 0 ⁽³⁾	10 / 0 ⁽⁶⁾	10 / 0 ⁽⁶⁾	10 / 0 ⁽⁶⁾
ASTM D6082, high temperature foaming optional blending, max.	-	-	200 / 50 ⁽⁴⁾	100 / 0 ⁽⁴⁾	100 / 0 ⁽⁴⁾
ASTM D6922, homogeneity & miscibility	Pass ⁽⁷⁾	Pass ⁽⁷⁾	Pass ⁽⁷⁾	Pass	Pass ⁽⁶⁾
ASTM D7097, TEOST MHT, high temperature deposits, mg deposit, max.	-	-	-	45	35
ASTM D5133, gelation index, max.	-	-	-	12 ⁽¹⁰⁾	12 ⁽⁹⁾
ASTM D6335, high temperature deposits (TEOST 33), mg, max.	-	-	60	-	-
ASTM D92 ⁽⁶⁾ , flash point, °C, min.	200	200	200	200	-
ASTM D93 ⁽⁶⁾ , flash point, °C, min.	185	185	185	185	-

Notes:

(1) Can run either D5800 or D6417

(2) ILSAC GF-1 requires CEC L-40-A-93 result. Test method CEC L-40-A-93 is equivalent to ASTM D5800

(3) Settling volume determined at 5 min.

(4) Settling volume determined at 1 min.

(5) Settling volume determined at 10 min.

(6) Meet either test method D92 or test method D93 flash point requirement

(7) Shall remain homogenous and, when mixed with ASTM ref. oils, shall remain miscible. Formerly «Federal Test Method 791B, Method 3470»

(8) Formerly known as GM 9099P

(9) Formerly known as D2887

(10) To be evaluated from -5°C to temperature at which 40,000 cP is attained or -40°C, or 2°Celsius below the appropriate MRV TP-1 temperature (defined by SAE J 300), whichever occurs first

ILSAC standards engine test limits

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Oronite

ILSAC STANDARD	GF-1			GF-2			GF-3			GF-4			GF-5		
SAE viscosity grades ⁽¹⁾	0W-xx	5W-xx	10W-xx	0W-20 5W-20	Other 0W-xx & 5W-xx	10W-xx	0W-20 5W-30	0W-30 5W-30	10W-xx & other Grades	0W-20 5W-20	0W-30 5W-30	10W-xx & other grades	xW-20	xW-30	10W-xx & other grades
CRC L-38 - ASTM D5119															
Bearing weight loss, mg, max.		40			40				-			-			-
Piston skirt varnish, min.		9.0			-				-			-			-
10 h. stripped viscosity		Stay in grade ⁽⁶⁾			Stay in grade ⁽⁶⁾				-			-			-
Sequence VIII - ASTM D6709															
Bearing weight loss, mg, max.		-			-			26.4			26				26
10 h. stripped viscosity		-			-			Stay in grade ⁽⁶⁾			Stay in grade ⁽⁶⁾				Stay in grade ⁽⁶⁾
Sequence IID - ASTM D5844															
Average engine rust, min.		8.5			8.5			-			-				-
Lifter sticking, max.		None			None			-			-				-
Sequence IIIE, IIIF, IIIG - ASTM D5533, D6984, D7320															
Viscosity increase at 40°C, %, max.		375 @ 64h.			-			275 @ 80h.			150 @ 100h.				150 @ 100h.
H. to 375% vis. increase at 40°C, min.		-			64			-			-				-
Average engine sludge, min.		9.2			9.2			-			-				-
Average piston skirt varnish, min.		8.9			8.9			9.0			-				-
Average oil ring land deposits, min.		3.5			3.5			-			-				-
Weighted piston deposits, min.		-			-			4.0			3.5				4.0
Ring sticking (oil related)		None ⁽²⁾			None ⁽²⁾			-			-				-
Hot stuck piston rings		-			-			None			None				None
Lifter sticking		None			-			-			-				-
Cam or lifter scuffing		None			-			-			-				-
Maximum cam + lifter wear, µm (in.), max.		64 (0.0025)			64 (0.0025)			-			-				-
Average cam + lifter wear, µm (in.), max.		30 (0.0012)			30 (0.0012)			20			60				60
Oil consumption, l., max.		5.1			5.1			5.2			-				-
Low temperature viscosity		-			-			Report ⁽³⁾			Pass ⁽⁴⁾				-

Notes:

- (1) Allowed viscosity grades for ILSAC GF-1 / GF-2 / GF-3 / GF-4 /GF-5 are limited to SAE 0W-xx, 5W-xx and 10W-xx
- (2) An oil related stuck ring occurs on a piston with an individual oil ring land deposit rating < 2.6
- (3) Evaluate the 80 h. test oil sample by ASTM test method D4684 (MRV TP-1) at the temperature indicated by the low temperature grade of oil as determined on the 80 h. sample by ASTM test method D5293 (CCS viscosity)
- (4) The ASTM test method D4684 (MRV TP-1) result on the 100 h. end of test sample must meet the requirements of

the original grade or the next higher grade at the SAE J 300 temperature.

- (5) A Sequence IIIGA test is identical to a Sequence IIIG test, except only low temperature viscosity performance is measured.
- (6) Data to support stay-in-grade requirement for read-across shall be supported by ASTM D 6278 (30 passes)
The following limits for kinematic viscosity at 100°C after shear must be met:
xW-20 >= 5.6 cSt / xW-30 >= 8.5 cSt / xW-40 >= 11.5 cSt / xW-50 >= 15.0 cSt.

ILSAC standards engine test limits

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Oronite

ILSAC STANDARD	GF-1			GF-2			GF-3			GF-4			GF-5		
SAE viscosity grades ⁽¹⁾	0W-xx	5W-xx	10W-xx	0W-20	Other 0W-xx & 5W-xx	10W-xx	0W-20	0W-30 5W-30	10W-xx & other grades	0W-20 5W-20	0W-30 5W-30	10W-xx & other grades	xW-20	xW-30	10W-xx & other grades
Sequence IVA - ASTM D6891															
Average cam wear, µm, max.	-			-			120			90			90		
Sequence VE - ASTM D5302															
Average engine sludge, min.	9.0			9.0			-								
Rocker arm cover sludge, min.	7.0			7.0			-								
Average piston skirt varnish, min.	6.5			6.5			-								
Average engine varnish, min.	5.0			5.0			-								
Piston undercrown deposits	-			To report			-								
Ring land deposits	-			To report			-			-			-		
Cylinder bore wear	-			To report			-								
Oil screen clogging, %, max.	20			20			-								
Oil ring clogging, %, max. ⁽²⁾	15			To report			-								
Compression ring sticking (hot stuck)	None			None			-								
Maximum cam wear, µm (in.), max.	380 (0.015)			380 (0.015)			380 ⁽³⁾								
Average cam wear, µm (in.), max.	130 (0.005)			127 (0.005)			127 ⁽³⁾								

Notes:

(1) Allowed viscosity grades for ILSAC GF-1 / GF-2 / GF-3 / GF-4 / GF-5 are limited to SAE 0W-xx, 5W-xx and 10W-xx

(2) Effective 8, October 1993, the oil ring clogging parameter has been suspended indefinitely as a requirement for the sequence VE

(3) Not required for oils containing a minimum of 0.08% mass phosphorus in the form of Zinc dialkyl/dithiophosphates (ZDDP)

ILSAC standards engine test limits

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Oronite

ILSAC STANDARD	GF-1			GF-2			GF-3			GF-4			GF-5		
SAE viscosity grades ⁽¹⁾	0W-xx	5W-xx	10W-xx	0W-20	Other 0W-xx & 5W-xx	10W-xx	0W-20	0W-30 5W-30	10W-xx & other grades	0W-20 5W-20	0W-30 5W-30	10W-xx & other grades	xW-20	xW-30	10W-xx & other grades
Sequence VG - ASTM D6593															
Average engine sludge, min.								7.8			7.8				8.0
Rocker arm cover sludge, min.								8.0			8.0				8.3
Average piston skirt varnish, min.								7.5			7.5				7.5
Average engine varnish, min.								8.9			8.9				8.9
Oil screen clogging, %, max.								20			20				15
Oil screen debris, %.								Rate & Report			Rate & Report				Rate & Report
Oil ring clogging, %.		-			-			Rate & Report			Rate & Report				Rate & Report
Hot stuck compression rings, max.								None			None				None
Cold stuck compression rings								Rate & Report			Rate & Report				Rate & Report
Average follower pin wear, cyl #8, µm.								-			Rate & Report				-
Average ring gap increase, cyl #1 & #8, µm.								-			Rate & Report				-
Sequence VI - ASTM RR-D:2-1204															
EFEI (fuel economy improvement), %, min.		2.7			-			-			-				-
Sequence VIA - ASTM D6202															
FEI vs. ASTM BC-2, %, min.		-		1.4 ⁽²⁾	1.1 ⁽³⁾	0.5 ⁽⁴⁾		-			-				-
Sequence VIB - ASTM D6837															
FEI relative to ref. oil BC, %, min. : FEI 1							2.0	1.6	0.9	2.3	1.8	1.1			-
FEI relative to ref. oil BC, %, min. : FEI 2							1.7	1.3	0.6	2.0	1.5	0.8			-
Sum of FEI 1 + FEI 2, min.							-	3.0	1.6	-	-	-			-
Sequence VID ASTM D7589															
FEI 2, %, min.		-			-			-			-		1.2	0.9	0.6
Sum of FEI, %, min.		-			-			-			-		2.6	1.9	1.5

Notes:

(1) Allowed viscosity grades for ILSAC GF-1 / GF-2 / GF-3 / GF-4 are limited to SAE 0W-xx, 5W-xx and 10W-xx

(2) 1.7% min. if Sequence VIB is used (calculated FEI at 16h. vs. ASTM ref. oil BC run before the candidate oil)

(3) 1.3% min. if Sequence VIB is used (calculated FEI at 16h. vs. ASTM ref. oil BC run before the candidate oil)

(4) 0.6% min. if Sequence VIB is used (calculated FEI at 16h. vs. ASTM ref. oil BC run before the candidate oil)

API "C" Diesel service categories engine and laboratory test requirement summary - Current -



Oronite

API CATEGORY	CH-4	CI-4	CI-4 PLUS	CJ-4
SAE viscosity grades	All			
Sequence IIIF or IIIG	X ⁽¹⁾	X	X	X
Caterpillar single cylinder	1P+1K	(1R or 1P) + (1K or 1N)	(1R or 1P) + (1K or 1N)	1N
Caterpillar C13	-	-	-	X
Mack T-8E ⁽²⁾	X	X	X ⁽²⁾	-
Mack T-9 ⁽³⁾	X or T-10 or T-12	-	-	-
Mack T-10 ⁽⁴⁾	-	X or T-12	X or T-12	-
Mack T-11	-	-	X	X
Mack T-12	-	-	-	X
Cummins M11/M11 EGR ⁽⁵⁾	M11 or ISM	M11-EGR or ISM	M11-EGR or ISM	-
Cummins ISM	-	-	-	X
Cummins ISB	-	-	-	X
RFWT	X	X	X	X
Navistar EOAT (HEUI)	X	X	X	X
HTHS ASTM D4683	-	X	X	X
Sheared oil stay in grade ASTM D6278 or D7109	X	X	X	X
Sooted oil MRV, ASTM D6896 Mack T-10A ⁽⁶⁾ or Mack T-11A	-	T-10A or T-12A	T-10A or T-12A	T-11A
HTCBT, ASTM D6594	X	X	X	X
ASTM D874, ASTM D4951 P and S	-	-	-	X
Volatility, ASTM D5800	X	X	X	X
Foam, ASTM D892, no option A	X	X	X	X
Elastomer compatibility	-	X	X	X

Notes:

(1) Seq IIIF 60 h. viscosity increase

(2) A passing Mack T-11 can be used in place of the T-8E

(3) The Mack T-9 and T-10 tests are no longer available to run. This requirement can be satisfied by passing a Mack T-12 against API CH-4 limits

(4) The Mack T-10 test is no longer available to run. This requirement can be satisfied by passing a Mack T-12 against API CI-4 limits

(5) The Cummins M11 and M11EGR tests are no longer available to run. This requirement can be satisfied by passing a Cummins ISM against API CH-4 or CI-4 limits

(6) A passing Mack T-12A can be used in place of the T-10A

API "C" Diesel service categories laboratory test limits - Current -

- 1 -



Oronite

API CATEGORY	CH-4		CI-4		CI-4 PLUS		CJ-4	
SAE viscosity grades	All							
ASTM D892 foaming settling								
Sequence I, ml, max.	10 / 0 ⁽¹⁾		10 / 0 ⁽¹⁾		10 / 0 ⁽¹⁾		10 / 0 ⁽¹⁾	
Sequence II, ml, max.	20 / 0 ⁽¹⁾		20 / 0 ⁽¹⁾		20 / 0 ⁽¹⁾		20 / 0 ⁽¹⁾	
Sequence III, ml, max.	10 / 0 ⁽¹⁾		10 / 0 ⁽¹⁾		10 / 0 ⁽¹⁾		10 / 0 ⁽¹⁾	
ASTM D6594 (HTCBT at 135°C)								
ppm increase, max.: Copper	20		20		20		20	
ppm increase, max.: Lead	120		120		120		120	
ppm increase, max.: Tin	Report		Report		Report		-	
Copper corrosion acc. to ASTM D130, max.	3		3		3		3	
ASTM D4683, HTHS viscosity, mPa.s, min.	SAE J300		3.5		3.5		3.5	
ASTM D445, kinematic viscosity at 100°C, cSt.	SAE J300		SAE J300		SAE J300		SAE J300	
ASTM D5293, low temperature cranking viscosity, cP at -xx°C	SAE J300		SAE J300		SAE J300		SAE J300	
ASTM D4684, pumpability, 60.000 cP max. at -xx°C	SAE J300		SAE J300		SAE J300		SAE J300	
ASTM D5800, volatility loss at 250°C	10W-30	15W-40					Not 10W30	For 10W30
% loss at 250°C, max.	20	18	15		15		13	15
ASTM D6417, volatility, % loss at 371 °C, max.	17	15	-		-		-	
ASTM D6278, kinematic viscosity after shearing	xW30	xW40	xW30	xW40	xW30	xW40		
Kinematic viscosity. at 100°C after 30 cycles Bosch shearing, cSt, min.	9.3	12.5	9.3	12.5	9.3	12.5	-	
ASTM D7109							xW-30	xW-40
Kinematic viscosity at 100°C after 90 cycles Bosch shearing, cSt, min.	-		-		-		9.3	12.5

API "C" Diesel service categories laboratory test limits - Current -

- 2 -



Oronite

API CATEGORY	CH-4	CI-4	CI-4 PLUS	CJ-4
SAE viscosity grades	All			
Elastomer compatibility, ASTM D7216⁽²⁾				
Nitrile NBR		Pass	Pass	Pass
Silicone VMQ	-	Pass	Pass	Pass
Polyacrylate ACM		Pass	Pass	Pass
Fluorelastomer FKM		Pass	Pass	Pass
Vamac G		-	-	Pass
ASTM D4684 (MRV TP-1)				
Viscosity of the 180 h. used oil drain sample from a T-11 test ⁽³⁾ , tested at -20°C, mPa.s, max.	-	25000	25000	-
If yield stress is detected, use the modified test method (external preheat), then measure the viscosity, mPa.s, max.		25000	25000	
Measure the yield stress, Pa.		< 35	< 35	
ASTM D6896 (MRV TP-1)				
Viscosity of the 180 h. used oil drain sample from a T-11 test, tested at -20°C, mPa.s, max.	-	-	-	25000
If yield stress is detected, use the modified test method (external preheat), then measure the viscosity, mPa.s, max.				25000
Measure the yield stress, Pa.				< 35
ASTM D874, mass fraction, sulfated ash, %, max.	-	-	-	1.0
ASTM D4951				
Phosphorus, % m/m, max. (non critical)	-	-	-	0.12
Sulfur, % m/m, max. (non critical)				0.4

Notes:

(1) 10 min. settling

(2) Please refer to chapter «Elastomer compatibility» for limits

(3) Results from T10A (or T12A if established and accepted by ASTM) can be used as an alternative to T11A results

API "C" Diesel service categories engine test limits - Current -

- 1 -



Oronite

API CATEGORY	CH-4	CI-4	CI-4 PLUS	CJ-4
SAE viscosity grades	All			
Sequence IIIF, IIIG - ASTM D6984, D7320	IIIF (60h) or IIIG	IIIF or IIIG	IIIF or IIIG	IIIF or IIIG
Run number	1 - 2 - 3	1 - 2 - 3	1 - 2 - 3	1 - 2 - 3
Viscosity (at 40°C), increase from 10 min. sample, %, max. (IIIF)	295 - 295 - 295 (MTAC) ⁽¹⁾	275 - 275 - 275 (MTAC)	275 - 275 - 275 (MTAC)	275 - 275 - 275 (MTAC)
Kinematic viscosity, % increase at 40°C, max. (IIIG)	150 - 150 - 150 (MTAC)	150 - 150 - 150 (MTAC)	150 - 150 - 150 (MTAC)	150 - 150 - 150 (MTAC)
Caterpillar single cylinder 1K, 1N - ASTM D6750	1K	1K⁽²⁾	1K⁽²⁾	1N
Run number	1 - 2 - 3	1 - 2 - 3	1 - 2 - 3	1 - 2 - 3
Top groove fill (TGF), %, max.	24 - 27 - 29	24 - 27 - 29	24 - 27 - 29	20 - 23 - 25
Weighted total demerit (WD), max.	332 - 347 - 353	332 - 347 - 353	332 - 347 - 353	286.2 - 311.7 - 323.0
Top land heavy carbon (TLHC), %, max.	4 - 5 - 5	4 - 5 - 5	4 - 5 - 5	3 - 4 - 5
Piston, ring and liner scuffing	None	None	None	None
Ring sticking	-	-	-	None
Average oil consumption, g/kWh max., 0-252 h.	0.5	0.5	0.5	0.5
Caterpillar single cylinder 1P, 1R - ASTM D6681, D6923	1P	1R⁽³⁾	1R⁽³⁾	
Run number	1 - 2 - 3	1 - 2 - 3	1 - 2 - 3	
Top groove carbon fill (TGC), %, max.	36 - 39 - 41	52 - 57 - 59	52 - 57 - 59	
Weighted total demerit (WD), max.	350 - 378 - 390	382 - 396 - 402	382 - 396 - 402	
Top land carbon (TLC), %, max.	40 - 46 - 49	31 - 35 - 36	31 - 35 - 36	
Piston, ring and liner scuffing	None	None	None	-
Ring sticking	-	None	None	
Average oil consumption, g/h, max., 0-360 h.	12.4	-	-	
Initial oil consumption, g/h, max., 0-252 h.	-	13.1	13.1	
Final oil consumption, g/h, max., 432-504 h.	-	Initial + 1.8	Initial + 1.8	
Final oil consumption, g/h, max., 312-360 h.	14.6	-	-	

Notes:

(1) MTAC - use method without transformations

(2) Alternatively, test method D6750 (1N) can be used; if this test method is used, the measured parameters and primary performance criteria are the same as those shown for test method D6750 (1N) in the CJ-4 category, except that oil consumption, max., is 0.5g/kWh

(3) Oils shall pass either Cat 1P or Cat 1R. Cat 1P limits are those required for API CH-4

API "C" Diesel service categories engine test limits - Current -

- 2 -



Oronite

API CATEGORY	CH-4	CI-4	CI-4 PLUS	CJ-4
SAE viscosity grades	All			
Cummins M11/M11-EGR⁽¹⁾	M11	M11 EGR	M11 EGR	
Run number	1 - 2 - 3	1 - 2 - 3	1 - 2 - 3	
Rocker pad average weight loss norm. to 4.5% soot, µm, max.	6.5 - 7.5 - 8.0	-	-	
Average crosshead weight loss, mg, max.	-	20.0 - 21.8 - 22.6	20.0 - 21.8 - 22.6	-
Oil filter P at EOT, kPa, max.	79 - 93 - 100	275 - 320 - 341	275 - 320 - 341	
Average engine sludge, CRC merit at EOT, min.	8.7 - 8.6 - 8.5	7.8 - 7.6 - 7.5	7.8 - 7.6 - 7.5	
Average top ring weight loss, mg, max.	-	Report	Report	
Cummins ISM⁽¹⁾				
Run number	1 - 2 - 3	1 - 2 - 3	1 - 2 - 3	1 - 2 - 3
Merit rating, min.	-	-	-	1000 - 1000 - 1000
Top ring weight loss, mg, max.	-	-	-	100 - 100 - 100
Crosshead wear, mg, max. (anchor)	7.5 - 7.8 - 7.9	7.5 - 7.8 - 7.9	7.5 - 7.8 - 7.9	7.1 (5.7)
Oil filter Δ P at 150 h., kPa, max. (anchor)	79 - 95 - 103	55 - 67 - 74	55 - 67 - 74	19 (13)
Valve adj. screw mass loss, mg, max. (anchor)	-	-	-	49 (27)
Engine sludge, CRC merit at EOT, min. (anchor)	8.1 - 8.0 - 8.0	8.1 - 8.0 - 8.0	8.1 - 8.0 - 8.0	8.7 (9.0)
Roller Follower Wear Test (RFWT)				
Run number	1 - 2 - 3	1 - 2 - 3	1 - 2 - 3	1 - 2 - 3
Average pin wear, mils, max.	0.30 - 0.33 - 0.36	0.30 - 0.33 - 0.36	0.30 - 0.33 - 0.36	0.30 - 0.33 - 0.36
Average pin wear, (µm), max.	(7.6 - 8.4 - 9.1)	(7.6 - 8.4 - 9.1)	(7.6 - 8.4 - 9.1)	(7.6 - 8.4 - 9.1)
Engine Oil Aeration Test (EOAT)				
Run number	1 - 2 - 3	1 - 2 - 3	1 - 2 - 3	1 - 2 - 3
Oil aeration at 20 h., %, max.	8.0 - 8.0 - 8.0 (MTAC) ⁽²⁾	8.0 - 8.0 - 8.0 (MTAC) ⁽²⁾	8.0 - 8.0 - 8.0 (MTAC) ⁽²⁾	8.0 - 8.0 - 8.0 (MTAC) ⁽²⁾

Notes:

(1) A Cummins ISM test and its limits can be used as an alternative for the Cummins M11/ M11-EGR test

(2) MTAC - use method without transformations

API "C" Diesel service categories engine test limits - Current -

- 3 -



Oronite

API CATEGORY	CH-4	CI-4	CI-4 PLUS	CJ-4
SAE viscosity grades	All			
Caterpillar C13				-
Run number				1 - 2 - 3
Merit rating, min.				1000 - 1000 - 1000
Oil consumption, g/h, max. (anchor)	-	-	-	31 (25)
Top land carbon average, max., %. (anchor)				35 (30)
Top groove carbon average, max., %. (anchor)				53 (46)
Second ring top carbon, max., %. (anchor)				33 (22)
Hot stuck piston ring				None
Mack T-8E⁽¹⁾				
Run number	1 - 2 - 3	1 - 2 - 3	1 - 2 - 3	-
Relative viscosity at 100°C at 4.8% soot, max.	2.1 - 2.2 - 2.3 ⁽²⁾	1.8 - 1.9 - 2.0 ⁽³⁾	1.8 - 1.9 - 2.0 ⁽³⁾	
Viscosity Inc. at 100°C at 3.8% soot, cSt, max.	11.5 - 12.5 - 13	-	-	
Mack T-11⁽¹⁾				
Run number			1 - 2 - 3	1 - 2 - 3
Minimum % TGA soot at 4.0 cSt increase at 100°C	-	-	-	3.5 - 3.4 - 3.3
Minimum % TGA soot at 12.0 cSt increase at 100°C			6.00 - 5.89 - 5.85	6.0 - 5.9 - 5.9
Minimum % TGA soot at 15.0 cSt increase at 100°C			-	6.7 - 6.6 - 6.5
Cummins ISB				
Run number				1 - 2 - 3
Slider tappet weight loss, mg , average, max.	-	-	-	100 - 108 - 112
Cam lobe wear, µm, average, max.				55 - 59 - 61
Crosshead weight loss, mg, average				Report

Notes:

(1) A Mack T-11 test and its limits can be used as an alternative for the Mack T8-E test in the applicable categories

(2) Relative viscosity: viscosity at 4.8% soot / (viscosity of new oil - 50% of viscosity loss by ASTM D3945)

(3) Relative viscosity: viscosity at 4.8 % soot / viscosity of new oil sheared in ASTM D6278

API "C" Diesel service categories engine test limits - Current -

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Oronite

API CATEGORY	CH-4	CI-4	CI-4 PLUS	CJ-4
SAE viscosity grades	All			
Mack T-9⁽¹⁾				
Run number	1 - 2 - 3			
Average liner wear norm. to 1.75% soot, µm, max.	25.4 - 26.6 - 27.1	-	-	-
Average top ring weight loss, mg, max.	120 - 136 - 144			
Lead increase, ppm, max.	25 - 32 - 36			
Mack T-10⁽²⁾				
Run number	1 - 2 - 3	1 - 2 - 3	1 - 2 - 3	
Merit rating, min.	-	1000 - 1000 - 1000	1000 - 1000 - 1000	
Liner wear, µm, max. (anchor)	32 - 34 - 35	32.0 (30)	32.0 (30)	-
Ring wear, mg, max. (anchor)	150 - 159 - 163	158 (140)	158 (140)	
Lead content at EOT mg/kg, max. (anchor)	50 - 56 - 59	35 (30)	35 (30)	
Lead content 250-300 h., mg/kg, max. (anchor)	-	14 (10)	14 (10)	
Used oil pumpability at 75 h., MRV at -20°C, cP., max. ⁽³⁾	-	25000 (NYS) ⁽⁴⁾	25000 (NYS) ⁽⁴⁾	
Mack T-12				
Run number	1 - 2 - 3	1 - 2 - 3	1 - 2 - 3	1 - 2 - 3
Merit rating, min.	-	1000 - 1000 - 1000	1000 - 1000 - 1000	1000 - 1000 - 1000
Liner wear, µm, max. (anchor)	30.0 - 30.8 - 31.1	26 (23)	26 (23)	24 (20)
Top ring wt. loss, mg, max. (anchor)	120 - 132 - 137	117 (82)	117 (82)	105 (70)
Oil consumption, g/h, max. (anchor)	-	95 (82)	95 (82)	85 (65)
Lead content at EOT, mg/kg, max. (anchor)	65 - 75 - 79	42 (35)	42 (35)	35 (25)
Lead content 250-300 h., mg/kg, max. (anchor)	-	18 (13)	18 (13)	15 (10)
Used oil pumpability at 75 h., MRV at -20°C, cP., max. ⁽³⁾	-	25000 (NYS) ⁽⁴⁾	25000 (NYS) ⁽⁴⁾	25000 (NYS) ⁽⁴⁾

Notes:

(1) A Mack T-12 or Mack T-10 test and its limits can be used as an alternative for the Mack T-9 test

(2) A Mack T-12 test and its limits can be used as an alternative for the Mack T-10 test

(3) Sample to test can also be from a Mack T-10A test or a Mack T-12A test to generate the sample for ASTM D4684 as used to measure this parameter. (Mack T-10A is the name given to a Mack T-10 test run for 75 h.

Mack T-12A is the name given to a Mack T-12 test run for 100 h.)

(4) If yield stress is detected, use modified ASTM D4684 (external preheat); then limits become viscosity: 25.000 cP max. and yield stress, < 35 Pa

API "C" Diesel service categories engine and laboratory test requirements summary - Obsolete -



Oronite

API CATEGORY	CC	CD	CD-II	CE	CF	CF-2	CF-4	CG-4
SAE viscosity grades	All							
Sequence VIII (or CRC L-38)⁽¹⁾	X	X	X	X	X	X	X	X
Sequence III	-	-	-	-	-	-	-	III F or III G
Caterpillar	1H/1H2	1G2	1G2	1G2	1M-PC	1M-PC	1K	1N
DD6V-53T	-	-	X	-	-	-	-	-
DD6V-92TA	-	-	-	-	-	X	-	-
Mack T-6	-	-	-	X	-	-	X or T-9 or T10	-
Mack T-7	-	-	-	X	-	-	X or T-8A	-
Mack T-8 / T-8 ^E	-	-	-	-	-	-	-	T-8
Cummins NTC-400 ⁽¹⁾	-	-	-	X	-	-	X ⁽²⁾	-
RFWT	-	-	-	-	-	-	-	X
EOAT Aeration Navistar	-	-	-	-	-	-	-	X
Visco., HTHS, pumpab								
Cummins corrosion	-	-	-	-	-	X	X	-
Metals, AN, BN	-	-	-	-	X	X	X	X

Notes:

(1) Test no longer available

(2) Cummins NTC 400 can be replaced by one additional Cat 1K, meeting CF-4 limits

API "C" Diesel service categories engine test limits - Obsolete -

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Oronite

API CATEGORY	CC	CD	CD-II	CE	CF	CF-2	CF-4	CG-4
SAE viscosity grades	All							
CRC L-38								
Bearing weight loss, mg, max.	50	50	50	50	-	-	-	-
Piston skirt varnish, min.	9.0	9.0	9.0	-				
Sequence VIII⁽⁹⁾								
Run number	-	-	-	-	1 - 2 - 3	1 - 2 - 3	-	1 - 2 - 3
Bearing weight loss, mg, max.					29.3 - 31.9 - 33.0	29.3 - 31.9 - 33.0	33.0	29.3 - 31.9 - 33.0
Used oil viscosity, cSt > SAE grade limit, min.					-	-	-	0.5 ⁽²⁾ (4)
Sequence III								
Run number	-	-	-	-	-	-	-	IIIF or IIIG
60 h. viscosity (at 40°C), increase from 10 min. sample, %, max. (IIIF)								1 - 2 - 3
Kinematic viscosity, % increase at 40°C, max. (IIIG)								325 - 349 - 360
								150 - 173 - 184
Caterpillar	1H2	1G2	1G2	1G2	1M-PC	1M-PC	1K	1N
Run number	-	-	-	-	-	-	1 - 2 - 3	1 - 2 - 3
Top groove fill, %, max.	45	80	80	80	70	-	24 - 26 - 27	20 - 23 - 25
Weighted total demerit, max.	140	300	300	300	240	100 ⁽⁹⁾	332 - 339 - 342	286.2 - 311.7 - 323.0
Top land heavy carbon (TLHC), %, max.	0.013	0.013	0.013	0.013 (0.0005)	-	-	4 - 4 - 5	3 - 4 - 5
Piston, ring and liner scuffing	-	-	-	-	None	-	None	None
Ring sticking	-	-	-	-	None	-	None	None
Average oil consumption, g/kWh max., 0-252 h.	-	-	-	-	-	-	0.139	0.139
Average oil consumption, g/kWh max., 228-252 h.	-	-	-	-	-	-	0.075	-

API "C" Diesel service categories engine test limits - Obsolete -

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Oronite

API CATEGORY	CC	CD	CD-II	CE	CF	CF-2	CF-4	CG-4
SAE viscosity grades	All							
Cummins NTC 400							(8)	
Oil consumption (2 nd order regression)				< ref. oil + 1std. dev.			<ref. oil	
Cam follower pin wear, in., max.	-	-	-	0.002	-	-	0.002	-
Crownland heavy carbon, %, max.				15			15	
Piston deposits, third ring land, total CRC demerits for all 6 pistons, max.				40			-	
Detroit Diesel			DD6V53T			DD6V92TA		
Run number						1 - 2 - 3		
Weighted total demerit, average, max.			400			-		
Hot stuck rings			None			-		
Liner distress, average, % area, max.			12.0			-		
Valve distress	-	-	None	-	-	-	-	-
Piston rings face distr. fire ring, demerit, max.			-			0.23 - 0.24 - 0.26		
Piston rings face distr., average 2 nd +3 rd ring, demerit, max.			13.0			0.20 - 0.21 - 0.22		
Cylinder liner scuffing, area %, max.			-			45 - 48 - 50		
Cylinder liner port plugging area, average, %, max.			-			2 - 2 - 2		
Cylinder liner port plugging area, single cylinder, %, max.			-			5 - 5 - 5		
Roller Follower Wear Test (RFWT)								
Run number	-	-	-	-	-	-	-	1 - 2 - 3
Average pin wear, mils, max.								0.45 - 0.49 - 0.50
Average pin wear, (µm), max.								(11.4 - 12.4 - 12.7)
Engine Oil Aeration Test (EOAT)								
Oil aeration at 20 h., %, max.	-	-	-	-	-	-	-	10.0

API "C" Diesel service categories engine test limits - Obsolete -

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Oronite

API CATEGORY	CC	CD	CD-II	CE	CF	CF-2	CF-4	CG-4
SAE viscosity grades	All							
Mack T-6 Merit rating, min.	-	-	-	⁽¹⁾ 90 ⁽²⁾	-	-	^{(1) (6)} 90 ⁽²⁾	-
Mack T-7 Average rate of viscosity increase at 100°C/h. for last 50 h., cSt/h, max.	-	-	-	0.40	-	-	0.04 ⁽⁷⁾	-
Mack T-8 / T-8A Run number 100-150 h. average rate of viscosity Inc. at 100°C/h, cSt/h, max. Relative viscosity at 100°C at 4.8% soot, max. Viscosity increase at 100°C at 3.8% soot, cSt, max. Filter plugging, diff. press., Kpa (psi), max. Oil consumption, average lb/bhp-h(g/kWh), max.	-	-	-	-	-	-	T-8A⁽⁷⁾ - 0.20 - - - -	T-8 1 - 2 - 3 - - 11.5 - 12.5 - 13.0 138 (20) 0.0005 (0.304)
Mack T-9 Average liner wear norm. to 1.75% soot, µm, max. Average top ring weight loss, mg, max. Lead increase, ppm, max.	-	-	-	-	-	-	⁽⁶⁾ 40 150 -	-

- Notes:**
- (1) 151 mg or greater gives 0 Mack merit
 - (2) All individual ratings must be greater than 0
 - (3) ASTM D4485-5a issue shows that a Sequence VIII is required to meet API CF, API CF-2, API CF-4 and API CG-4. Sequence VIII has been shown to correlate with CRC L-38, now no more available.
 - (4) Limit do not apply to monograde oils
 - (5) Rating of top and 2nd groove carbon and land carbon
 - (6) A Mack T-9 test and its limits (as reported in CF-4 above) can be used as an alternate for the Mack T-6 test
 - (7) A Mack T-8A test version and its limits (as reported in CF-4 above) can be used as an alternate for the Mack T-7 test
 - (8) Cummins NTC 400 is no longer available and can be replaced by one additional Caterpillar 1K and ASTM D5968 CBT at copper

ACEA SEQUENCES for GASOLINE and DIESEL ENGINE OILS



ACEA sequences - Overview of validity periods



Oronite

Issue year of full document	First allowable use	Mandatory for new claims	Oils with this claim may be marketed until
1996	January 1, 1996	March 1, 1997	March 1, 2000
1998	March 1, 1998	March 1, 1999	March 1, 2002
1999	September 1, 1999	September 1, 2000	February 1, 2004
2002	February 1, 2002	February 1, 2003	November 1, 2006
2004	November 1, 2004	November 1, 2005	December 31, 2009
2007	February 1, 2007	February 1, 2008	December 23, 2010
2008	December 22, 2008	December 22, 2009	December 22, 2012
2010	December 22, 2010	December 22, 2011	December 22, 2014
2012	December 14, 2012	December 14, 2013	...

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			
				A1/B1-12	A3/B3-12	A3/B4-12	A5/B5-12
1. Laboratory tests							
1.1 Viscosity grades		SAE J300 Latest active issue		No restriction except as defined by shear stability and HTHS requirements. Manufacturers may indicate specific viscosity requirements related to ambient temperature.			
1.2 Shear stability ⁽¹⁾	CEC-L-014-93 (Bosch injector) or ASTM D6278	Viscosity after 30 cycles measured at 100°C	mm²/s	xW-20 : ≥ 5.6 xW-30 ≥ 9.3 xW-40 ≥ 12.0	All grades to stay in grade		
1.3 Viscosity at high temperature & high shear rate	CEC-L-036-90 (2 nd edition)	Viscosity at 150°C and 10 ⁶ s ⁻¹ shear rate	mPa.s	≥ 2.9 and ≤ 3.5 xW-20: 2.6 min.	≥ 3.5		≥ 2.9 and ≤ 3.5
1.4 Evaporative loss	CEC-L-040-93 (Noack)	Max. weight loss after 1 h. at 250°C	%	≤ 13			
1.5 TBN	ASTM D2896		mg KOH/g	≥ 8.0	≥ 8.0	≥ 10.0	≥ 8.0
1.6 Sulphur ⁽¹⁾	ASTM D5185		% m/m	Report			
1.7 Phosphorus ⁽¹⁾	ASTM D5185		% m/m	Report			
1.8 Sulfated ash ⁽¹⁾	ASTM D874		% m/m	≤ 1.3	≥ 0.9 ≤ 1.5	≥ 1.0 ≤ 1.6	≤ 1.6
1.9 Chlorine	ASTM 6443		% m/m	Report			

ACEA	ACEA 2012 EUROPEAN OIL SEQUENCE FOR SERVICE-FILL OILS FOR GASOLINE AND DIESEL ENGINES	Dec. 2012
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This sequence defines the minimum quality level of a product for self-certification to EELQMS and for presentation to ACEA members

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

Requirements	Test method	Properties	Unit	Limits				
				A1/B1-12	A3/B3-12	A3/B4-12	A5/B5-12	
1. Laboratory tests								
1.10 Oil/Elastomer compatibility ⁽¹⁾	CEC-L-039-96 ⁽³⁾	Max. variation of characteristics after immersion for 7 days in fresh oil without pre-ageing		Elastomer type				
			Points	RE1 FLUORO -1 / +5	RE2-99 ACM -5 / +8	RE3-04 SILICONE - 22 / +1	RE4 NBR -5 /+ 5	DBL-AEM +5 / +10
		%	-40 / +10	-15 / +18	-30 / +10	-20 / +10	-35 / -	
		%	-50 / +10	-35 / +10	-20 / +10	-50 / +10	-50 / -	
		%	-1 / +5	-7 / +5	-1 / +22	-5 / +5	-5 / +15	
1.11 Foaming tendency	ASTM D892 without option A	Tendency – stability	ml	Sequence I (24°C) 10 – nil Sequence II (94°C) 50 – nil Sequence III (24°C) 10 – nil				
1.12 High temperature foaming tendency	ASTM D6082 High temperature foam test	Tendency – stability	ml	Sequence IV (150°C) 100 – nil				

ACEA	ACEA 2012 EUROPEAN OIL SEQUENCE FOR SERVICE-FILL OILS FOR GASOLINE AND DIESEL ENGINES	Dec. 2012
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This sequence defines the minimum quality level of a product for self-certification to EELQMS and for presentation to ACEA members

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

Requirements	Test method	Properties	Unit	Limits			
				A1/B1-12	A3/B3-12	A3/B4-12	A5/B5-12
1. Laboratory tests							
1.13 Oxidation in presence of biodiesel ⁽¹⁾	GFC-Lu-43A-11	Catalysed ageing test until 144 h.	%				
		at 170°C & with air bubbling:					
		1. on pure oil					
		2. with B10 added (B71 1892 GO B10 LUB)					
		PAI at 144 h.					
Kinematic viscosity at 100°C variation:	cST & %	Report					
- at 72 h.	cST & %		Report				
- at 96 h.	cST & %		Report				
- at 120 h.	cST & %		Report				
- at 144 h.	cST & %		Report & at 144 h.: < +200% (no solidification)				
1.14 Low-temperature pumpability	CEC L-105	After 150°C, 72 h. with 5% B100, MRV at SAE J300 temperatures applicable for fresh oil viscosity grade	mPa.s Pa	Acc to SAE J300 for fresh oil		Acc to SAE J300 for fresh oil	
		Viscosity Yield stress					

Notes:

(1) Additional information is given as footnotes underneath the table for the C-categories

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			
				A1/B1-12	A3/B3-12	A3/B4-12	A5/B5-12
2. Engine tests							
2.1 High temperature deposits ring sticking oil thickening	CEC-L-088-02 (TU5JP-L4) 72 h. test	Ring sticking (each part)	Merit	≥ 9.0			
		Piston varnish (6 elements, average of 4 pistons)	Merit	≥ RL 216			
		Absolute viscosity increase at 40°C between min. and max. values during test	mm²/s	≤ 0.8 x RL 216			
		Oil consumption	kg/test	Report			
2.2 Low temperature sludge ⁽¹⁾	ASTM D6593-00 (Sequence VG)	Average engine sludge	Merit	≥ 7.8			
		Rocker cover sludge	Merit	≥ 8.0			
		Average piston skirt varnish	Merit	≥ 7.5			
		Average engine varnish	Merit	≥ 8.9			
	Under protocol & requirements for API	Comp. ring (hot stuck)		None			
		Oil screen clogging	%	≤ 20			
2.3 Valve train scuffing wear	CEC-L-038-94 (TU3M)	Cam wear, average	µm	≤ 10			
		Cam wear, max.	µm	≤ 15			
		Pad merit (average of 8 pads)	Merit	≥ 7.5			
2.4 Black sludge ⁽¹⁾		Engine sludge, average	Merit	≥ RL140 + 4σ			
2.5 Fuel economy ⁽¹⁾	CEC-L-054-96 (M111)	Fuel economy improvement vs ref. oil RL 191 (15W40)	%	≥ 2.5	—		≥ 2.5
2.6 Medium temperature dispersivity	CEC-L-093-04 (DV4TD) ⁽²⁾ To be replaced by DV6C	Absolute viscosity increase at 100°C and 6% soot	mm²/s	≤ 0.60 × RL 223 result			
		Piston merit	Merit	≥ (RL 223 minus 2.5 points)			

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			
				A1/B1-12	A3/B3-12	A3/B4-12	A5/B5-12
2. Engine tests							
2.7 DV6C oil dispersion at medium temperature for passenger car direct injection Diesel engines ⁽¹⁾	CEC L-106 (DV6C)	Absolute viscosity increase at 100°C and 6% soot	mm²/s	Limits to defined			
		Piston merit	Merit				
2.8 Wear ⁽¹⁾	CEC-L-099-08 (OM646LA)	Cam wear outlet (average max. wear 8 cams)	µm	≤ 120	≤ 140	≤ 120	
		Cam wear inlet (average max. 8 cams)	µm	≤ 110	≤ 110	≤ 100	
		Cylinder wear (average 4 cyl.)	µm	≤ 5.0	≤ 5.0	≤ 5.0	
		Bore polishing (13mm) (max. of 4 cyl.)	%	≤ 3.5	≤ 3.5	≤ 3.0	
		Tappet wear inlet (average max. wear 8 cams)	µm	Report	Report	Report	
		Tappet outlet wear (average max..wear 8 cams)	µm	Report	Report	Report	
		Piston cleanliness (average 4 pistons)	Merit	Report	Report	≥ 12	
		Engine sludge average	Merit	Report	Report	≥ 8.8	
2.9 DI Diesel piston cleanliness & ring sticking ⁽¹⁾	CEC-L-078-99 (VW DI)	Piston cleanliness	Merit	≥ RL 206	≥ RL 206 minus 4 points	≥ RL 206	≥ RL 206
		Ring sticking (rings 1 & 2)					
		Average of all 8 rings	ASF	≤ 1.0	≤ 1.2	≤ 1.0	≤ 1.0
		Max. for any 1 st ring	ASF	≤ 1.0	≤ 2.5	≤ 1.0	≤ 1.0
		Max. for any 2 nd ring	ASF	0.0	0.0	0.0	0.0
		EOT TBN (ISO 3771)	mg KOH/g	≥ 4.0	≥ 4.0	≥ 6.0	≥ 4.0
		EOT TAN (ASTM D664)	mg KOH/g	Report	Report	Report	Report
2.10 Effects of biodiesel ⁽¹⁾	CEC-L-104	Piston cleanliness	Merit			Report	
		Ring sticking	ASF			Report	
		Sludge	Merit			Report	

Notes:

(1) Additional information is given as footnotes underneath the table for the C-categories

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			
				C1-12	C2-12	C3-12	C4-12
1. Laboratory tests							
1.1 Viscosity grades		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 ⁽¹⁾	CEC-L-014-93 or ASTM D6278	Viscosity after 30 cycles measured at 100°C	mm²/s	All grades to stay in grade			
1.3 Viscosity at high temperature & high shear rate	CEC-L-036-90	Viscosity at 150°C and 10 ⁶ s ⁻¹ shear rate	mPa.s	≥ 2.9		≥ 3.5	
1.4 Evaporative loss	CEC-L-040-93 (Noack)	Max. weight loss after 1 h. at 250°C	%	≤ 13			≤ 11
1.5 TBN	ASTM D2896		mg KOH/g			≥ 6.0	
1.6 Sulphur ⁽¹⁾	ASTM D5185		% m/m	≤ 0.2	≤ 0.3		≤ 0.2
1.7 Phosphorus ⁽¹⁾	ASTM D5185		% m/m	≤ 0.5	≤ 0.090	≥ 0.070 ≤ 0.090	≤ 0.090
1.8 Sulfated ash ⁽¹⁾	ASTM D6443		% m/m	≤ 0.5	≤ 0.8		≤ 0.5
1.9 Chlorine	ASTM 6443		ppm m/m	Report			

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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

Requirements	Test method	Properties	Unit	Limits				
				C1-12	C2-12	C3-12	C4-12	
1. Laboratory tests								
1.10 Oil/Elastomer compatibility	CEC-L-039-96	Max. variation of characteristics after immersion for 7 days in fresh oil without pre-ageing		Elastomer type				
				RE1 FLUORO	RE2-99 ACM	RE3-04 SILICONE	RE4 NBR	DBL-AEM
		Hardness DIDC	Points	-1 / +5	-5 / +8	- 22 / +1	-5 /+ 5	+5 / +10
		Tensile strength	%	-40 / +10	-15 / +18	-30 / +10	-20 / +10	-35 / -
		Elongation at rupture	%	-50 / +10	-35 / +10	-20 / +10	-50 / +10	-50 / -
		Volume variation	%	-1 / +5	-7 / +5	-1 / +22	-5 / +5	-5 / +15
1.11 Foaming tendency	ASTM D892 without option A	Tendency – stability	ml	Sequence I (24°C) 10 – nil Sequence II (94°C) 50 – nil Sequence III (24°C) 10 – nil				
1.12 High temperature foaming tendency	ASTM D6082 High temperature foam test	Tendency – stability	ml	Sequence IV (150°C) 100 – nil				

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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

Requirements	Test method	Properties	Unit	Limits			
				C1-12	C2-12	C3-12	C4-12
1. Laboratory tests							
1.13 Oxidation in presence of biodiesel ⁽¹⁾	GFC-Lu-43A-11	Catalysed ageing test until 144 h. at 170°C & with air bubbling:	%	Report			
		1. on pure oil					
		2. with B10 added (B71 1892 G0 B10 LUB)					
		PAI at 144h.					
		Kinematic viscosity at 100°C variation:					
		- at 72 h.					
- at 96 h.	cST & %	Report					
- at 120 h.	cST & %	Report					
- at 144 h.	cST & %	Report					
				Report and at 144 h.: < +200% (no solidification)			
1.14 Low-temperature pumpability	CEC L-105	After 150°C, 72 h. with 5% B100, MRV at SAE J300 temperatures applicable for fresh oil viscosity grade	mPa.s Pa	Acc to SAE J300 for fresh oil			
		Viscosity					
		Yield stress					
1.12 High temperature foaming tendency	ASTM D6082 High temperature foam test	Tendency – stability	ml	Sequence IV (150°C) 100 – nil			

Notes:

(1) Additional information is given as footnotes underneath the table for the C-categories

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			
				C1-12	C2-12	C3-12	C4-12
2. Engine tests							
2.1 High temperature deposits ring sticking oil thickening	CEC-L-088-02 (TU5JP-L4) 72 h. test	Ring sticking (each part)	Merit	≥ 9.0			
		Piston varnish (6 elements, average of 4 pistons)	Merit	≥ RL 216			
		Absolute viscosity increase at 40°C between min. and max. values during test	mm²/s	≤ 0.8 x RL 216			
		Oil consumption	kg/test	Report			
2.2 Low temperature sludge ⁽¹⁾	ASTM D6593-00 (Sequence VG) Under protocol & requirements for API	Average engine sludge	Merit	≥ 7.8			
		Rocker cover sludge	Merit	≥ 8.0			
		Average piston skirt varnish	Merit	≥ 7.5			
		Average engine varnish	Merit	≥ 8.9			
		Comp. ring (hot stuck)		None			
		Oil screen clogging	%	≤ 20			
2.3 Valve train scuffing wear	CEC-L-038-94 (TU3M)	Cam wear, average	µm	≤ 10			
		Cam wear, max.	µm	≤ 15			
		Pad merit (average of 8 pads)	Merit	≥ 7.5			
2.4 Black sludge ⁽¹⁾		Engine sludge, average	Merit	≥ RL140 + 4σ			
2.5 Fuel economy ⁽¹⁾	CEC-L-054-96 (M111)	Fuel economy improvement vs.ref. oil RL 191 (15W40)	%	≥ 3.0	≥ 2.5	≥ 1.0 (for xW-30 grades)	
2.6 Medium temperature dispersivity	CEC-L-093-04 (DV4TD) ⁽²⁾ To be replaced by DV6C	Absolute viscosity increase at 100°C and 6% soot	mm²/s	≤ 0.60 × RL 223 result			
		Piston merit	Merit	≥ (RL 223 minus 2.5 points)			

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			
				C1-12	C2-12	C3-12	C4-12
2. Engine tests							
2.7 DV6C oil dispersion at medium temperature for passenger car direct injection Diesel engines ⁽¹⁾	CEC L-106 (DV6C)	Absolute viscosity increase at 100°C & 6% soot	mm²/s	Limits to defined			
		Piston merit	Merit				
2.8 Wear ⁽¹⁾	CEC-L-099-08 (OM646LA)	Cam wear outlet (average max. wear 8 cams)	µm	≤ 120	≤ 120	≤ 120	
		Cam wear inlet (average max. 8 cams)	µm	≤ 100	Report	≤ 100	
		Cylinder wear (average 4 cyl.)	µm	≤ 5.0	≤ 5.0	≤ 5.0	
		Bore polishing (13mm) (max. of 4 cyl.)	%	≤ 3.0	≤ 3.0	≤ 3.0	
		Tappet wear inlet (average max. wear 8 cams)	µm	Report	Report	Report	
		Tappet outlet wear (average max..wear 8 cams)	µm	Report	Report	Report	
		Piston cleanliness (average 4 pistons)	Merit	Report	Report	≥ 12	
		Engine sludge average	Merit	Report	Report	≥ 8.8	
2.9 DI Diesel piston cleanliness & ring sticking ⁽¹⁾	CEC-L-078-99 (VW DI)	Piston cleanliness	Merit	≥ RL 206	≥ RL 206	≥ RL 206	
		Ring sticking (rings 1 & 2)					
		Average of all 8 rings	ASF	≤ 1.0	≤ 1.2	≤ 1.0	
		Max. for any 1 st ring	ASF	≤ 1.0	≤ 2.5	≤ 1.0	
		Max. for any 2 nd ring	ASF	0.0	0.0	0.0	
		EOT TBN (ISO 3771)	mg KOH/g	Report	Report	Report	
		EOT TAN (ASTM D664)	mg KOH/g	Report	Report	Report	
2.10 Effects of biodiesel ⁽¹⁾	CEC-L-104	Piston cleanliness	Merit	Report Report Report			
		Ring sticking	ASF				
		Sludge	Merit				

Notes:

(1) Footnotes referring to the following requirements in the A/B- and C-Classes:

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

No. 1.6; 1.7; 1.8: max. limits, Values take into account method and production tolerances

No. 1.6; 1.7: internal standard method has to be used.

No. 1.10: all reference materials and limits for RE1, RE2, RE3, RE4 and DBL-AEM can be used until acceptable new reference materials (proposed from CEC L-039-96) are available and appropriate limits have been set.

The Daimler requirements for DBL-AEM D (proposed from CEC L-039-96) are available and appropriate limits have been set.

The Daimler requirements for DBL-AEM D 8948/200 are VDA 675301, 7 days $\pm$ 2 h., 150°C $\pm$ 2°C, closed cup test.

RE-1, RE-2, RE-3, RE-4 based on CEC and DBL-AEM based on Daimler AG data may continue to be used "grandfathered" for the lifetime of the ACEA 2012 sequences.»

No. 1.13: until a CEC test method is developed, the oxidation behavior of engine oil formulations must be proved by GFC-Lu-43A-11.

Test results obtained by this procedure will be accepted under the condition that they come from labs having participated to the official round robin and comply with the quality criteria of GFC.

No. 2.2: the limits shown are based on those applied in U.S. market requirements. ACEA will continuously review the situation to ensure that these limits are appropriate for European vehicles and lubricants.

No. 2.4: until a new CEC test method is developed, the Gasoline sludge protection performance of engine oil formulations must be proved by the M 271 sludge test procedure as described by Daimler AG.

Test results obtained by the M 271 procedure will be accepted under the condition that they come from test rigs being referenced and quality controlled by Daimler AG.

Limits are based on the same reference oil as with the old M111 sludge test.

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

No. 2.7: may be performed as soon as it becomes available as an alternative to the DV4 test. ACEA will decide when the DV4 test will be finally deleted from this specification.

CEC-L-093-04 (DV4 test) test results obtained in accordance with the ATIEL guidelines may be used by a grandfathering process also after this test has become unavailable to run and is replaced by the CEC-L-106 (DV6 test) procedure.

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

No. 2.9: test report has to give measured values before & after the test, all measurements to be taken in the same lab.

Note: TAN is considered to become performance criteria in the future. Not all parameters are yet official CEC parameters.

No. 2.10: test is still under development at the time of publishing of this specification.

Test has to be performed for all qualifications against 2012 Oil Sequences from the time the test is officially released by CEC (running programs only).

All test criteria is rate and report.

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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

Requirements	Test method	Properties	Unit	Limits			
				E4-12	E6-12	E7-12	E9-12
1. Laboratory tests							
1.1 Viscosity grades		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-014-93 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 Viscosity at high temperature & high shear rate	CEC-L-036-90 (2 nd edition)	Viscosity at 150°C and 10 ⁶ s ⁻¹ shear rate	mPa.s	≥ 3.5			
1.4 Evaporative loss	CEC-L-040-93 (Noack)	Max. weight loss after 1 h. at 250°C	%	≤ 13			
1.5 Sulfated ash	ASTM D874		% m/m	≤ 2.0	≤ 1.0	≤ 2.0	≤ 1.0
1.6 Phosphorus ⁽¹⁾	ASTM D5185		% m/m		≤ 0.08		≤ 0.12
1.7 Sulphur ⁽¹⁾	ASTM D5185		% m/m		≤ 0.3		≤ 0.4

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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

Requirements	Test method	Properties	Unit	Limits				
				E4-12	E6-12	E7-12	E9-12	
1. Laboratory tests								
1.8 Oil/Elastomer compatibility ⁽¹⁾	CEC-L-039-96	Max. variation of characteristics after immersion for 7 days in fresh oil without pre-ageing		Elastomer type				
				RE1 FLUORO	RE2-99 ACM	RE3-04 SILICONE	RE4 NBR	DBL-AEM
		Hardness DIDC	Points	-1 / +5	-5 / +8	- 22 / +1	-5 /+ 5	-5 / +10
		Tensile strength	%	-40 / +10	-15 / +18	-30 / +10	-20 / +10	-35 / -
		Elongation at rupture	%	-50 / +10	-35 / +10	-20 / +10	-50 / +10	-50 / -
		Volume variation	%	-1 / +5	-7 / +5	-1 / +22	-5 / +5	-5 / +15
1.9 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 Seq I 10/0 Seq II 20/0 Seq III 10/0				
1.10 High temperature foaming tendency	ASTM D6082	Tendency – stability	ml	Sequence IV (150°C) 200 – 50				
1.11 Oxidation	CEC-L-085-99 (PDSC)	Oxidation induction time	min.	R & R		≥ 65		
1.12 Corrosion	ASTM D6594 (HTCBT)	Copper increase Lead increase Copper strip rating	ppm ppm max.	R & R R & R R & R		R & R ≤ 100 R & R	≤ 20 ≤ 100 3	
1.13 TBN ⁽¹⁾	ASTM D2896		mg KOH/g	≥ 12	≥ 7	≥ 9	≥ 7	
1.14 Low-temperature pumpability	CEC L-105	After 150°C, 72h. with 5% B100, MRV at SAE J300 temperatures applicable for fresh oil viscosity grade Viscosity Yield stress	mPa.s Pa	Acc to SAE J300 for fresh oil				

Notes:

(1) Additional information is given as footnotes underneath the table for the C-categories

This sequence defines the minimum quality level of a product for self-certification to EELQMS and for presentation to ACEA members

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

Requirements	Test method	Properties	Unit	Limits			
				E4-12	E6-12	E7-12	E9-12
2. Engine tests							
2.1 Wear ⁽¹⁾	CEC L-099-08 (OM646LA)	Cam wear outlet (average max. wear 8 cams)	µm	≤ 140	≤ 140	≤ 155	≤ 155
2.2 Soot in oil ⁽¹⁾	ASTM D5967 (Mack T-8E)	Test duration 300 h. Relative viscosity at 4.8% soot 1 test/2 test average/3 test average	mm²/s	≤ 2.1 / 2.2 / 2.3	≤ 2.1 / 2.2 / 2.3	≤ 2.1 / 2.2 / 2.3	
2.3 Soot in oil	Mack T-11 (ASTM D7156)	Min TGA soot @ 4.0 cSt (100°C) Min TGA soot @ 12.0 cSt (100°C) Min TGA soot @ 15.0 cSt (100°C)	% % %				3.5 / 3.4 / 3.3 6.0 / 5.9 / 5.9 6.7 / 6.6 / 6.5
2.4 Bore polishing piston cleanliness ⁽¹⁾	CEC L-101-08 (OM501LA)	Bore polishing, average Piston cleanliness, average Oil consumption Engine sludge, average	% Merit kg/test Merit	≤ 1.0 ≥ 26 ≤ 9 R & R	≤ 1.0 ≥ 26 ≤ 9 R & R	≤ 2.0 ≥ 17 ≤ 9 R & R	≤ 2.0 ≥ 17 ≤ 9 R & R
2.5 Soot-induced wear ⁽¹⁾	Cummins ISM (ASTM D7468)	Merit Rocker pad avg. weight loss at 3.9% soot 1 test/2 test average/3 test average oil filter diff.press EOT 1 test/2 test average/3 test average engine sludge 1 test/2 test average/3 test average adj. screw weight loss	mg kPa Merit mg			≤ 7.5 / 7.8 / 7.9 ≤ 55 / 67 / 74 ≥ 8.1 / 8.0 / 8.0	≥ 1000 ≤ 7.1 ≤ 19 ≥ 8.7 ≤ 49
2.6 Wear (liner-ring- bearings) ⁽¹⁾	Mack T-12 (ASTM D7422)	Merit Average liner wear Average top ring weight loss End of test lead Delta lead 250-300 h. Oil consumption (phase II)	µm mg ppm ppm g/hr		≥ 1000 ≤ 26 ≤ 117 ≤ 42 ≤ 18 ≤ 95	≥ 1000 ≤ 26 ≤ 117 ≤ 42 ≤ 18 ≤ 95	≥ 1000 ≤ 24 ≤ 105 ≤ 35 ≤ 15 ≤ 85

Notes:

(1) Footnotes referring to the following requirements in the E-Class:

No. 1.6; 1.7: internal standard method has to be used.

No. 1.8: all reference materials and limits for RE1, RE2, RE3, RE4 and DBL-AEM can be used until acceptable new reference materials (proposed from CEC L-039-96) are available and appropriate limits have been set.

The Daimler requirements for DBL-AEM D (proposed from CEC L-039-96) are available and appropriate limits have been set.

The Daimler requirements for DBL-AEM D 8948/200 are VDA 675301, 7 days $\pm$ 2 h., 150°C $\pm$ 2°C, closed cup test.

RE-1, RE-2, RE-3, RE-4 based on CEC and DBL-AEM based on Daimler AG data may continue to be used "grandfathered" for the lifetime of the ACEA 2012 sequences.

No. 1.13: for E7, values < 9.00 are not accepted.

No. 2.1: OM602A data can be used instead of OM646LA data providing it meets the requirements as specified in the 2007 ACEA sequences.

Additional parameters may be included once approved by CEC.»

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

No. 2.4: bore polish, oil consumption and engine sludge are non-approved CEC parameters.

OM441LA data can be used instead of OM501LA data providing it meets the requirements as specified in the 2007 ACEA sequences.

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

No. 2.6: for E6 & E7 merit number shall be calculated according to the API CI-4 specification.

For E6 & E7 Mack T10 results obtained as part of an API CI-4 or CI-4 plus approval program, can be used in place of Mack T12.

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			
				A1/B1-10	A3/B3-10	A3/B4-10	A5/B5-10
1. Laboratory tests							
1.1 Viscosity grades		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-014-93 (Bosch injector) or ASTM D6278	Viscosity after 30 cycles measured at 100°C	mm²/s	xW-20: stay in grade xW-30 ≥ 9.3 xW-40 ≥ 12.0	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 temperature & high shear rate	CEC-L-036-90 (2 nd edition) (Ravenfield)	Viscosity at 150°C and 10 ⁶ s ⁻¹ shear rate	mPa.s	≥ 2.9 and ≤ 3.5 xW-20: 2.6 min.	≥ 3.5	≥ 3.5	≥ 2.9 and ≤ 3.5
1.4 Evaporative loss	CEC-L-040-93 (Noack)	Max. weight loss after 1 h. at 250°C	%	≤ 15	≤ 13	≤ 13	≤ 13
1.5 TBN	ASTM D2896		mg KOH/g	≥ 8.0	≥ 8.0	≥ 8.0	≥ 8.0
1.6 Sulfated ash	ASTM D874		% m/m	≤ 1.3 ⁽²⁾	≤ 1.5 ⁽²⁾	≤ 1.6 ⁽²⁾	≤ 1.6 ⁽²⁾
				Note: the following sections apply to all sequences			
1.7 Sulphur ⁽¹⁾	ASTM D5185		% m/m	Report			
1.8 Phosphorus ⁽¹⁾	ASTM D5185		% m/m	Report			
1.9 Chlorine	ASTM D6443		% m/m	Report			

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				
				A1/B1-10	A3/B3-10	A3/B4-10	A5/B5-10	
1. Laboratory tests								
1.10 Oil/Elastomer compatibility	CEC-L-039-96 ⁽³⁾	Max. variation of characteristics after immersion for 7 days in fresh oil without pre-ageing		Elastomer type				
				RE1 FLUORO	RE2-99 ACM	RE3-04 SILICONE	RE4 NBR	EAM (VAMAC)
			Points	-1 / +5	-5 / +8	- 22 / +1	-5 /+ 5	As per Daimler
			%	-40 / +10	-15 / +18	-30 / +10	-20 / +10	
			%	-50 / +10	-35 / +10	-20 / +10	-50 / +10	
			%	-1 / +5	-7 / +5	-1 / +22	-5 / +5	
1.11 Foaming tendency	ASTM D892 without option A	Tendency – stability	ml	Sequence I (24°C) 10 – nil				
				Sequence II (94°C) 50 – nil				
				Sequence III (24°C) 10 – nil				
1.12 High temperature foaming tendency	ASTM D6082 High temperature foam test	Tendency – stability	ml	Sequence IV (150°C) 100 – nil				

Notes:

(1) The internal standard method has to be used

(2) Maximum limits, values take into account method and production's tolerances

(3) Use either complete Daimler requirements (VDA 675301, 7 days +/- 2 h., 4 materials (NBR: NBR34 DIN 53538 T3 (100 °C +/- 2°C); FPM: AK6 (150 °C +/- 2°C); ACM: E7503 (150 °C +/- 2°C); AEM: D 8948/200.1 (150 °C +/- 2°C)) + RE3, or complete requirements according to 1.10 above + DC requirements for AEM.

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			
				A1/B1-10	A3/B3-10	A3/B4-10	A5/B5-10
2. Engine tests							
2.1 High temperature deposits ring sticking oil thickening	CEC-L-088-02 (TU5JP-L4) 72 h. test	Ring sticking (each part)	Merit	≥ 9.0	≥ 9.0	≥ 9.0	≥ 9.0
		Piston varnish (6 elements, average of 4 pistons)	Merit	≥ RL 216	≥ RL 216	≥ RL 216	≥ RL 216
		Absolute viscosity increase at 40°C between min. and max. values during test	mm²/s	≤ 0.8 x RL 216	≤ 0.8 x RL 216	≤ 0.8 x RL 216	≤ 0.8 x RL 216
		Oil consumption	kg/test	Report	Report	Report	Report
2.2 Low temperature sludge	ASTM D6593-00 (Sequence VG) Under protocol & requirements for API ⁽⁴⁾	Average engine sludge	Merit	≥ 7.8	7.8 ⁽³⁾	7.8 ⁽³⁾	7.8 ⁽³⁾
		Rocker cover sludge	Merit	≥ 8.0	8.0 ⁽³⁾	8.0 ⁽³⁾	8.0 ⁽³⁾
		Average piston skirt varnish	Merit	≥ 7.5	7.5 ⁽³⁾	7.5 ⁽³⁾	7.5 ⁽³⁾
		Average engine varnish	Merit	≥ 8.9	8.9 ⁽³⁾	8.9 ⁽³⁾	8.9 ⁽³⁾
		Comp. ring (hot stuck)		None	None	None	None
		Oil screen clogging	%	≤ 20	≤ 20	≤ 20	≤ 20
2.3 Valve train scuffing wear	CEC-L-038-94 (TU3M)	Cam wear, average	µm	≤ 10	≤ 10	≤ 10	≤ 10
		Cam wear, max.	µm	≤ 15	≤ 15	≤ 15	≤ 15
		Pad merit (average of 8 pads)	Merit	≥ 7.5	≥ 7.5	≥ 7.5	≥ 7.5
2.4 Black sludge	CEC-L-053-95 (M111)	Engine sludge, average	Merit	≥ RL140	≥ RL140 + 4σ or ≥ 9.0	≥ RL140 + 4σ or ≥ 9.0	≥ RL140 + 4σ or ≥ 9.0
2.5 Fuel economy ⁽⁵⁾	CEC-L-054-96 (M111)	Fuel economy improvement vs ref. oil RL 191 (15W40)	%	≥ 2.5	—	—	≥ 2.5
2.6 Medium temperature dispersivity	CEC-L-093-04 (DV4TD) ⁽⁷⁾	Absolute viscosity increase at 100°C & 6% soot	mm²/s	≤ 0.60 × RL 223 result	≤ 0.60 × RL 223 result	≤ 0.60 × RL 223 result	≤ 0.60 × RL 223 result
		Piston merit	Merit	≥ (RL 223 minus 2.5 points)	≥ (RL 223 minus 2.5 points)	≥ (RL 223 minus 2.5 points)	≥ (RL 223 minus 2.5 points)

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			
				A1/B1-08	A3/B3-08	A3/B4-08	A5/B5-08
2. Engine tests							
2.7 Wear ⁽⁶⁾	CEC-L-099-08 (OM646LA)	Cam wear outlet (average max. wear 8 cams)	µm	≤ 140	≤ 140	≤ 120	≤ 120
		Cam wear inlet (average max. 8 cams) ⁽⁶⁾	µm	≤ 110	≤ 110	≤ 100	≤ 100
		Cylinder wear (average 4 cyl.) ⁽⁶⁾	µm	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5.0
		Bore polishing (13mm) (max. of 4 cyl.) ⁽⁶⁾	%	≤ 3.5	≤ 3.5	≤ 3.0	≤ 3.0
		Tappet wear inlet (average max. wear 8 cams)	µm	Report	Report	Report	Report
		Tappet outlet wear (average max. wear 8 cams)	µm	Report	Report	Report	Report
		Piston cleanliness (average 4 pistons)	Merit	Report	Report	Report	Report
		Engine sludge average	Merit	Report	Report	Report	Report
2.8 DI Diesel piston cleanliness & ring sticking ⁽⁹⁾	CEC-L-078-99 (VW DI)	Piston cleanliness	Merit	≥ RL 206 minus 4 points	≥ RL 206 minus 4 points	≥ RL 206	≥ RL 206
		Ring sticking (rings 1 & 2)					
		Average of all 8 rings	ASF	≤ 1.2	≤ 1.2	≤ 1.0	≤ 1.0
		Max. for any 1 st ring	ASF	≤ 2.5	≤ 2.5	≤ 1.0	≤ 1.0
		Max. for any 2 nd ring	ASF	0.0	0.0	0.0	0.0
		EOT TBN (ISO 3771) ^{(7) (8)}	mg KOH/g	≥ 4.0	≥ 4.0	≥ 4.0	≥ 4.0
		EOT TAN (ASTM D664) ⁽⁷⁾	mg KOH/g	Report	Report	Report	Report

Notes:

(4) The limits shown are based upon those applied in U.S. market requirements. ACEA will continuously review the situation to ensure that these limits are appropriate for European vehicles and lubricants.

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

(6) For A1/B1 claims OM 602A passing results obtained before the end 2008 can be used instead of OM 646LA results

(7) Test report has to give measured values before & after the test, all measurements to be taken in the same lab.

(8) These parameters are not yet official CEC parameters

(9) Test results from tests performed before the publishing of the 2008 ACEA oil sequences are allowed to be used without passing the EOT TBN criteria and reporting EOT TAN values

(10) Until a new CEC test method is developed, the Gasoline sludge protection performance of engine oil formulations must be proofed by the M 271 sludge test procedure as described by Daimler AG.

Test results obtained by the M 271 procedure will be accepted under the condition that they come from test rigs being referenced and quality controlled by Daimler AG.

Limits are based on the same reference oil as with the old M111 sludge test.

(11) Existing results from tests with CEC-L-053 may be used where applicable. In this case limits for all ACEA A/B categories (including A1/B1) are: ≥ RL140 + 4σ or ≥ 9.0

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			
				C1-10	C2-10	C3-10	C4-10
1. Laboratory tests							
1.1 Viscosity grades		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-014-93 or ASTM D7109	Viscosity after 30 cycles measured at 100°C	mm²/s	All grades to stay in grade	All grades to stay in grade	All grades to stay in grade	All grades to stay in grade
1.3 Viscosity at high temperature & high shear rate	CEC-L-036-90 (2 nd edition) (Ravenfield)	Viscosity at 150°C and 10 ⁶ s ⁻¹ shear rate	mPa.s	≥ 2.9	≥ 2.9	≥ 3.5	≥ 3.5
1.4 Evaporative loss	CEC-L-040-93 (Noack)	Max. weight loss after 1 h. at 250°C	%	≤ 13	≤ 13	≤ 13	≤ 11
1.5 Sulphur	ASTM D5185	(1)	% m/m	≤ 0.2	≤ 0.3	≤ 0.3	≤ 0.2
1.6 Phosphorus	ASTM D5185	(1)	% m/m	≤ 0.05(2)	≥ 0.070 ≤ 0.090(2)	≥ 0.070 ≤ 0.090(2)	≤ 0.090(2)
1.7 Sulfated ash	ASTM D874		% m/m	≤ 0.5(2)	≤ 0.8(2)	≤ 0.8(2)	≤ 0.5(2)
1.8 Chlorine	ASTM D6443		ppm m/m	Report	Report	Report	Report
1.9 TBN	ASTM D2896		mg KOH/g	-	-	≥ 6.0	≥ 6.0

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				
				C1-10	C2-10	C3-10	C4-10	
1. Laboratory tests								
				Note: the following sections apply to all sequences				
1.10 Oil/Elastomer compatibility	CEC-L-039-96 ⁽³⁾	Max. variation of characteristics after immersion for 7 days in fresh oil without pre-ageing		Elastomer type				
				RE1 FLUORO	RE2-99 ACM	RE3-04 SILICONE	RE4 NBR	EAM (VAMAC)
			Points	-1 / +5	-5 / +8	- 22 / +1	-5 /+ 5	As per
			Tensile strength					
			%	-40 / +10	-15 / +18	-30 / +10	-20 / +10	Daimler
		Elongation at rupture	%	-50 / +10	-35 / +10	-20 / +10	-50 / +10	
		Volume variation	%	-1 / +5	-7 / +5	-1 / +22	-5 / +5	
1.11 Foaming tendency	ASTM D892 without option A	Tendency – stability	ml	Sequence I (24°C) 10 – nil Sequence II (94°C) 50 – nil Sequence III (24°C) 10 – nil				
1.12 High temperature foaming tendency	ASTM D6082 High temperature foam test	Tendency – stability	ml	Sequence IV (150°C) 100 – nil				

Notes:

(1) The internal standard method has to be used

(2) Maximum limits, values take into account method and production's tolerances

(3) Use either complete Daimler requirements (VDA 675301, 7 days +/- 2 h., 4 materials (NBR: NBR 34 DIN 51538 T3 (100°C +/- 2°C); FPM: AK6 (150°C +/- 2°C); ACM: E7503 (150°C +/- 2°C); AEM: D8948/200.1 (150°C +/- 2°C)) + RE3, or complete requirements according to 1.10 above + Daimler requirements for AEM.

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			
				C1-10	C2-10	C3-10	C4-10
2. Engine tests							
2.1 High temperature deposits ring sticking oil thickening	CEC-L-088-02 (TU5JP-L4) 72 h. test	Ring sticking (each part)	Merit	≥ 9.0	≥ 9.0	≥ 9.0	≥ 9.0
		Piston varnish (6 elements, average of 4 pistons)	Merit	≥ RL 216	≥ RL 216	≥ RL 216	≥ RL 216
		Absolute viscosity increase at 40°C between min. and max. values during test	mm²/s	≤ 0.8 x RL 216	≤ 0.8 x RL 216	≤ 0.8 x RL 216	≤ 0.8 x RL 216
		Oil consumption	kg/test	Report	Report	Report	Report
2.2 Low temperature sludge	ASTM D6593-00 (Sequence VG) Under protocol & requirements for API ⁽⁴⁾	Average engine sludge	Merit	≥ 7.8	≥ 7.8	≥ 7.8	≥ 7.8
		Rocker cover sludge	Merit	≥ 8.0	≥ 8.0	≥ 8.0	≥ 8.0
		Average piston skirt varnish	Merit	≥ 7.5	≥ 7.5	≥ 7.5	≥ 7.5
		Average engine varnish	Merit	≥ 8.9	≥ 8.9	≥ 8.9	≥ 8.9
		Comp. ring (hot stuck)		None	None	None	None
		Oil screen clogging	%	≤ 20	≤ 20	≤ 20	≤ 20
2.3 Valve train scuffing wear	CEC-L-038-94 (TU3M)	Cam wear, average	µm	≤ 10	≤ 10	≤ 10	≤ 10
		Cam wear, max.	µm	≤ 15	≤ 15	≤ 15	≤ 15
		Pad merit (average of 8 pads)	Merit	≥ 7.5	≥ 7.5	≥ 7.5	≥ 7.5
2.4 Black sludge	CEC-L-053-95 (M111)	Engine sludge, average	Merit	≥ RL140 + 4σ or ≥ 9.0	≥ RL140 + 4σ or ≥ 9.0	≥ RL140 + 4σ or ≥ 9.0	≥ RL140 + 4σ or ≥ 9.0
2.5 Fuel economy ⁽⁵⁾	CEC-L-054-96 (M111)	Fuel economy improvement vs ref. oil RL 191 (15W-40)	%	≥ 3.0	≥ 2.5	≥ 1.0 (for xW30 grades)	≥ 1.0 (for xW30 grades)
2.6 Medium temperature dispersivity	CEC-L-093-04 (DV4TD) ⁽⁷⁾	Absolute viscosity increase at 100°C and 6% soot	mm²/s	≤ 0.60 × RL 223 result	≤ 0.60 × RL 223 result	≤ 0.60 × RL 223 result	≤ 0.60 × RL 223 result
		Piston merit	Merit	≥ (RL 223 minus 2.5 points)	≥ (RL 223 minus 2.5 points)	≥ (RL 223 minus 2.5 points)	≥ (RL 223 minus 2.5 points)

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			
				C1-10	C2-10	C3-10	C4-10
2. Engine tests							
2.7 Wear ⁽⁶⁾	CEC-L-099-08 (OM646LA)	Cam wear outlet (average max. wear 8 cams)	µm	≤ 120	≤ 120	≤ 120	≤ 120
		Cam wear inlet (average max. 8 cams) ⁽⁸⁾	µm	≤ 100	Report ⁽⁹⁾	≤ 100	≤ 100
		Cylinder wear (average 4 cyl.) ⁽⁸⁾	µm	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5.0
		Bore polishing (13mm) (max. of 4 cyl.) ⁽⁸⁾	%	≤ 3.0	≤ 3.0	≤ 3.0	≤ 3.0
		Tappet wear inlet (average max. wear 8 cams)	µm	Report	Report	Report	Report
		Tappet outlet wear (average max. wear 8 cams)	µm	Report	Report	Report	Report
		Piston cleanliness (average 4 pistons)	Merit	Report	Report	Report	Report
		Engine sludge average	Merit	Report	Report	Report	Report
2.8 DI Diesel piston cleanliness & ring sticking ⁽¹⁰⁾	CEC-L-078-99 (VW DI)	Piston cleanliness	Merit	≥ RL 206	≥ RL 206	≥ RL 206	≥ RL 206
		Ring sticking (rings 1 & 2)					
		Average of all 8 rings	ASF	≤ 1.0	≤ 1.2	≤ 1.0	≤ 1.0
		Max. for any 1 st ring	ASF	≤ 1.0	≤ 2.5	≤ 1.0	≤ 1.0
		Max. for any 2 nd ring	ASF	0.0	0.0	0.0	0.0
		EOT TBN (ISO 3771) ⁽⁷⁾	mg KOH/g	Report	Report	Report	Report
		EOT TAN (ASTM D664) ⁽⁷⁾	mg KOH/g	Report	Report	Report	Report

Notes:

(4) The limits shown are based upon those applied in U.S. market requirements. ACEA will continuously review the situation to ensure that these limits are appropriate for European vehicles and lubricants.

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

(6) Limits for C1 might be revised if needed. For C1 claims OM 602A passing results obtained before the end of 2008 can be used instead of OM 646LA results.

(7) Test report has to give measured values before & after the test, all measurements to be taken in the same lab

(8) Limit under definition

(9) These parameters are not yet official CEC parameters

(10) Test results from tests performed before the publishing of the 2008 ACEA oil sequences are allowed to be used without reporting EOT TBN & TAN

(11) Until a new CEC test method is developed, the Gasoline sludge protection performance of engine oil formulations must be proofed by the M 271 sludge test procedure as described by Daimler AG.

Test results obtained by the M 271 procedure will be accepted under the condition that they come from test rigs being referenced and quality controlled by Daimler AG.

Limits are based on the same reference oil as with the old M111 sludge test

(12) Existing results from tests with CEC-L-053 may be used where applicable. In this case limits for all ACEA A/B categories (including A1/B1) are: ≥ RL140 + 4σ or ≥ 9.0

This sequence defines the minimum quality level of a product for self-certification to EELQMS and for presentation to ACEA members

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

Requirements	Test method	Properties	Unit	Limits			
				E4-08 Issue 2	E6-08 Issue 2	E7-08 Issue 2	E9-08 Issue 2
1. Laboratory tests							
1.1 Viscosity grades		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-014-93 (Bosch injector) or ASTM D7109	Viscosity after 30 cycles measured at 100°C	mm²/s	Stay in grade	Stay in grade		
	ASTM D7109	Viscosity after 90 cycles measured at 100°C	mm²/s				
1.3 Viscosity at high temperature & high shear rate	CEC-L-036-90 (2 nd edition) (Ravenfield)	Viscosity at 150°C and 10 ⁶ s ⁻¹ shear rate	mPa.s	≥ 3.5	≥ 3.5	≥ 3.5	≥ 3.5
1.4 Evaporative loss	CEC-L-040-93 (Noack)	Max. weight loss after 1 h. at 250°C	%	≤ 13	≤ 13	≤ 13	≤ 13
1.5 Sulfated ash	ASTM D874		% m/m	≤ 2.0	≤ 1.0	≤ 2.0	≤ 1.0
1.6 Phosphorus ⁽¹⁾	ASTM D5185		% m/m		≤ 0.08		≤ 0.12
1.7 Sulphur ⁽¹⁾	ASTM D5185		% m/m		≤ 0.3		≤ 0.4

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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

Requirements	Test method	Properties	Unit	Limits				
				E4-08 Issue 2	E6-08 Issue 2	E7-08 Issue 2	E9-08 Issue 2	
1. Laboratory tests								
1.8 Oil/Elastomer compatibility ⁽²⁾	CEC-L-039-96	Max. variation of characteristics after immersion for 7 days in fresh oil without pre-ageing		Elastomer type				
				RE1 FLUORO	RE2-99 ACM	RE3-04 SILICONE	RE4 NBR	EAM (VAMAC)
			Points	-1 / +5	-5 / +8	- 25 / +1	-5 /+ 5	As per
			%	-50 / +10	-15 / +18	-45 / +10	-20 / +10	Daimler
			%	-60 / +10	-35 / +10	-20 / +10	-50 / +10	
			%	-1 / +5	-7 / +5	-1 / +30	-5 / +5	
1.9 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				Seq I 10/0 Seq II 20/0 Seq III 10/0
1.10 High temperature foaming tendency	ASTM D6082	Tendency – stability	ml	Sequence IV (150°C) 200 – 50				
1.11 Oxidation	CEC-L-085-99 (PDSC)	Oxidation induction time	min.	R & R	R & R	≥ 65	≥ 65	
1.12 Corrosion	ASTM D6594 (HTCBT)	Copper increase	ppm	R & R	R & R	R & R	≤ 20	
		Lead increase	ppm	R & R	R & R	≤ 100	≤ 100	
		Copper strip rating	max.	R & R	R & R	R & R	3	
1.13 Turbocharger performance ⁽³⁾								
1.14 TBN	ASTM D2896		mg KOH/g	≥ 12	≥ 7	≥ 9 ⁽⁴⁾	≥ 7	

Notes:

(1) The internal standard method has to be used

(2) Use either the most recent complete Daimler requirements (VDA 675301, 7 days, 4 materials (NBR: NBR 34 DIN 53538 T3 (100°C); FPM: AK6 (150°C); ACM: E7503 (150°C); AEM: D8948/200.1 (150°C)) + RE3 according to requirement 1.8 above, or complete requirements according to 1.8 above + Daimler requirements for AEM.

(3) Should a test become available before the next document update, ACEA reserves the right to set performance limits providing adequate data is available

(4) Values < 9.00 are not accepted

This sequence defines the minimum quality level of a product for self-certification to EELQMS and for presentation to ACEA members

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

Requirements	Test method	Properties	Unit	Limits			
				E4-08 Issue 2	E6-08 Issue 2	E7-08 Issue 2	E9-08 Issue 2
2. Engine tests							
2.1 Wear	CEC L-099-08 (OM646LA)	Cam wear outlet (average max. wear 8 cams)	µm	≤ 140 ^{(5) (6)}	≤ 140 ^{(5) (6)}	≤ 155 ^{(5) (6)}	≤ 155 ^{(5) (6)}
2.2 Soot in oil ⁽⁷⁾	ASTM D5967 (Mack T-8E)	Test duration 300 h. Relative viscosity at 4.8% soot 1 test/2 test average/3 test average	mm²/s	≤ 2.1 / 2.2 / 2.3	≤ 2.1 / 2.2 / 2.3	≤ 2.1 / 2.2 / 2.3	
2.3 Soot in oil	Mack T-11 (ASTM D7156)	Min. TGA soot @ 4.0 cSt (100°C) Min. TGA soot @ 12.0 cSt (100°C) Min. TGA soot @ 15.0 cSt (100°C)	% % %				3.5 / 3.4 / 3.3 6.0 / 5.9 / 5.9 6.7 / 6.6 / 6.5
2.4 Bore polishing piston cleanliness	CEC L-101-08 (OM501LA)	Bore polishing, average	%	≤ 1.0	≤ 1.0	≤ 2.0	≤ 2.0
		Piston cleanliness, average	Merit	≥ 26	≥ 26	≥ 17	≥ 17
		Oil consumption	kg/test	≤ 9	≤ 9	≤ 9	≤ 9
		Engine sludge, average ⁽⁸⁾	Merit	R & R ^{(9) (10)}	R & R ^{(9) (10)}	R & R ^{(9) (10)}	R & R ^{(9) (10)}
2.5 Soot-induced wear	Cummins ISM (ASTM D7468)	Merit					≥ 1000
		Rocker pad avg. weight loss at 3.9% soot	mg				≤ 7.1
		1 test/2 test average/3 test average oil filter diff.press EOT	kPa			≤ 55 / 67 / 74	≤ 19
		1 test/2 test average/3 test average engine sludge	Merit			≥ 8.1 / 8.0 / 8.0 ⁽¹¹⁾	≥ 8.7
		1 test/2 test average/3 test average adj. screw weight loss	mg				≤ 49
2.6 Wear (liner-ring- bearings)	Mack T-12 (ASTM D7422)	Merit			≥ 1000	≥ 1000	≥ 1000
		Average liner wear	µm		≤ 26	≤ 26	≤ 24
		Average top ring weight loss	mg		≤ 117	≤ 117	≤ 105
		End of test lead	ppm		≤ 42	≤ 42	≤ 35
		Delta lead 250-300 h.	ppm		≤ 18	≤ 18	≤ 15
		Oil consumption (phase II)	g/hr		≤ 95 ^{(12) (13)}	≤ 95 ^{(12) (13)}	≤ 85

Notes:

(5) OM602A data can be used instead of OM646LA data providing it meets the requirements as specified in the 2007 ACEA sequences

(6) Additional parameters may be included once approved by CEC

(7) Mack T-11 results obtained as part of an API CI-4, CI-4 Plus or API CJ-4 approval program, can be used in place of Mack T-8E

(8) Bore polish, oil consumption and engine sludge are non-approved CEC parameters

(9) OM441LA data can be used instead of OM501LA data providing it meets the requirements as specified in the 2007 ACEA sequences

(10) Limits for sludge parameter may be reconsidered when more data becomes available

(11) Results from Cummins M11 HST (ASTM D6838) at API CH-4 or M11 EGR test (ASTM D6975) at API CI-4 or CI-4 Plus can be used in place of the Cummins ISM test

(12) Merit number shall be calculated according to the API CI-4 specification

(13) 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.

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			
				A1/B1-08	A3/B3-08	A3/B4-08	A5/B5-08
1. Laboratory tests							
1.1 Viscosity grades		SAE J300 Latest active issue		No restriction except as defined by shear stability and HT/HS requirements. Manufacturers may indicate specific viscosity requirements related to ambient temperature.			
1.2 Shear stability	CEC-L-014-93 (Bosch injector) or ASTM D7109	Viscosity after 30 cycles measured at 100°C	mm²/s	xW-20: stay in grade xW-30 ≥ 9.3 xW-40 ≥ 12.0	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 temperature & high shear rate	CEC-L-036-90 (2 nd edition) (Ravenfield)	Viscosity at 150°C and 10 ⁶ s ⁻¹ shear rate	mPa.s	≥ 2.9 and ≤ 3.5 xW-20: 2.6 min.	≥ 3.5	≥ 3.5	≥ 2.9 and ≤ 3.5
1.4 Evaporative loss	CEC-L-040-93 (Noack)	Max. weight loss after 1 h. at 250°C	%	≤ 15	≤ 13	≤ 13	≤ 13
1.5 TBN	ASTM D2896		mg KOH/g	≥ 8.0	≥ 8.0	≥ 8.0	≥ 8.0
1.6 Sulfated ash	ASTM D874		% m/m	≤ 1.3 ⁽²⁾	≤ 1.5 ⁽²⁾	≤ 1.6 ⁽²⁾	≤ 1.6 ⁽²⁾
				NOTE: the following sections apply to all sequences			
1.7 Sulphur ⁽¹⁾	ASTM D5185		% m/m	Report			
1.8 Phosphorus ⁽¹⁾	ASTM D5185		% m/m	Report			
1.9 Chlorine	ASTM D6443		% m/m	Report			

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						
				A1/B1-08	A3/B3-08	A3/B4-08	A5/B5-08			
1. Laboratory tests										
1.10 Oil/Elastomer compatibility	CEC-L-039-96 ⁽³⁾	Max. variation of characteristics after immersion for 7 days in fresh oil without pre-ageing	Points	Elastomer type						
				RE1 FLUORO	RE2-99 ACM	RE3-04 SILICONE	RE4 NBR	EAM (VAMAC)		
				Hardness DIDC	-1 / +5	-5 / +8	-22 / +1	-5 /+ 5	As per	
				Tensile strength	%	-40 / +10	-15 / +18	-30 / +10	-20 / +10	Daimler
				Elongation at rupture	%	-50 / +10	-35 / +10	-20 / +10	-50 / +10	
				Volume variation	%	-1 / +5	-7 / +5	-1 / +22	-5 / +5	
1.11 Foaming tendency	ASTM D892 without option A	Tendency – stability	ml	Sequence I (24°C) 10 – nil Sequence II (94°C) 50 – nil Sequence III (24°C) 10 – nil						
1.12 High temperature foaming tendency	ASTM D6082 High temperature foam test	Tendency – stability	ml	Sequence IV (150°C) 100 – nil						

- Notes:**
- (1) The internal standard method has to be used
- (2) Maximum limits, values take into account method and production's tolerances.
- (3) Use either complete Daimler requirements (VDA 675301, 7 days +/- 2 h., 4 materials (NBR: NBR34 DIN 53538 T3 (100 °C +/- 2°C); FPM: AK6 (150 °C +/- 2°C); ACM: E7503 (150 °C +/- 2°C); AEM: D 8948/200.1 (150 °C +/- 2°C) + RE3, or complete requirements according to 1.10 above + DC requirements for AEM

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			
				A1/B1-08	A3/B3-08	A3/B4-08	A5/B5-08
2. Engine tests							
2.1 High temperature deposits ring sticking oil thickening	CEC-L-088-02 (TU5JP-L4) 72 h. test	Ring sticking (each part)	Merit	≥ 9.0	≥ 9.0	≥ 9.0	≥ 9.0
		Piston varnish (6 elements, average of 4 pistons)	Merit	≥ RL 216	≥ RL 216	≥ RL 216	≥ RL 216
		Absolute viscosity increase at 40°C between min. and max. values during test	mm²/s	≤ 0.8 x RL 216	≤ 0.8 x RL 216	≤ 0.8 x RL 216	≤ 0.8 x RL 216
		Oil consumption	kg/test	Report	Report	Report	Report
2.2 Low temperature sludge	ASTM D6593-00 (Sequence VG) Under protocol & requirements for API ⁽⁴⁾	Average engine sludge	Merit	≥ 7.8	≥ 7.8	≥ 7.8	≥ 7.8
		Rocker cover sludge	Merit	≥ 8.0	≥ 8.0	≥ 8.0	≥ 8.0
		Average piston skirt varnish	Merit	≥ 7.5	≥ 7.5	≥ 7.5	≥ 7.5
		Average engine varnish	Merit	≥ 8.9	≥ 8.9	≥ 8.9	≥ 8.9
		Comp. ring (hot stuck)		None	None	None	None
		Oil screen clogging	%	≤ 20	≤ 20	≤ 20	≤ 20
2.3 Valve train scuffing wear	CEC-L-038-94 (TU3M)	Cam wear, average	µm	≤ 10	≤ 10	≤ 10	≤ 10
		Cam wear, max.	µm	≤ 15	≤ 15	≤ 15	≤ 15
		Pad merit (average of 8 pads)	Merit	≥ 7.5	≥ 7.5	≥ 7.5	≥ 7.5
2.4 Black sludge	CEC-L-053-95 (M111)	Engine sludge, average	Merit	≥ RL140	≥ RL140 + 4σ or ≥ 9.0	≥ RL140 + 4σ or ≥ 9.0	≥ RL140 + 4σ or ≥ 9.0
2.5 Fuel economy ⁽⁵⁾	CEC-L-054-96 (M111)	Fuel economy improvement vs ref. oil RL 191 (15W40)	%	≥ 2.5	—	—	≥ 2.5
2.6 Medium temperature dispersivity	CEC-L-093-04 (DV4TD) ⁽⁷⁾	Absolute viscosity increase at 100°C and 6% soot	mm²/s	≤ 0.60 × RL 223 result	≤ 0.60 × RL 223 result	≤ 0.60 × RL 223 result	≤ 0.60 × RL 223 result
		Piston merit	Merit	≥ (RL 223 minus 2.5 points)	≥ (RL 223 minus 2.5 points)	≥ (RL 223 minus 2.5 points)	≥ (RL 223 minus 2.5 points)

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			
				A1/B1-08	A3/B3-08	A3/B4-08	A5/B5-08
2. Engine tests							
2.7 Wear ⁽⁶⁾	CEC-L-099-08 (OM646LA)	Cam wear outlet (average max. wear 8 cams)	µm	≤ 140	≤ 140	≤ 140	≤ 140
		Cam wear inlet (average max. 8 cams) ⁽⁸⁾	µm	≤ 110	≤ 110	≤ 100	≤ 100
		Cylinder wear (average 4 cyl.) ⁽⁸⁾	µm	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5.0
		Bore polishing (13mm) (max. of 4 cyl.) ⁽⁸⁾	%	≤ 3.5	≤ 3.5	≤ 3.0	≤ 3.0
		Tappet wear inlet (average max. wear 8 cams)	µm	Report	Report	Report	Report
		Tappet outlet wear (average max.wear 8 cams)	µm	Report	Report	Report	Report
		Piston cleanliness (average 4 pistons)	Merit	Report	Report	Report	Report
		Engine sludge average	Merit	Report	Report	Report	Report
2.8 DI Diesel piston cleanliness & ring sticking ⁽⁹⁾	CEC-L-078-99 (VW DI)	Piston cleanliness	Merit	≥ RL 206 minus 4 points	≥ RL 206 minus 4 points	≥ RL 206	≥ RL 206
		Ring sticking (rings 1 & 2)					
		Average of all 8 rings	ASF	≤ 1.2	≤ 1.2	≤ 1.0	≤ 1.0
		Max. for any 1 st ring	ASF	≤ 2.5	≤ 2.5	≤ 1.0	≤ 1.0
		Max. for any 2 nd ring	ASF	0.0	0.0	0.0	0.0
		EOT TBN (ISO 3771) ^{(7) (8)}	mg KOH/g	≥ 4.0	≥ 4.0	≥ 4.0	≥ 4.0
		EOT TAN (ASTM D664) ⁽⁷⁾	mg KOH/g	Report	Report	Report	Report

Notes:

(4) The limits shown are based upon those applied in U.S. market requirements. ACEA will continuously review the situation to ensure that these limits are appropriate for European vehicles and lubricants.

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

(6) For A1/B1 claims OM 602A passing results obtained before the end 2008 can be used instead of OM 646LA results

(7) Test report has to give measured values before & after the test, all measurements to be taken in the same lab

(8) These parameters are not yet official CEC parameters

(9) Test results from tests performed before the publishing of the 2008 ACEA oil sequences are allowed to be used without passing the EOT TBN criteria and reporting EOT TAN values

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			
				C1-08	C2-08	C3-08	C4-08
1. Laboratory tests							
1.1 Viscosity grades		SAE J300 Latest active issue		No restriction except as defined by shear stability and HT/HS requirements. Manufacturers may indicate specific viscosity requirements related to ambient temperature.			
1.2 Shear stability	CEC-L-014-93 or ASTM D6278	Viscosity after 30 cycles measured at 100°C	mm²/s	All grades to be stay in grade	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 temperature & high shear rate	CEC-L-036-90 (2 nd edition) (Ravenfield)	Viscosity at 150°C and 10 ⁶ s ⁻¹ shear rate	mPa.s	≥ 2.9	≥ 2.9	≥ 3.5	≥ 3.5
1.4 Evaporative loss	CEC-L-040-93 (Noack)	Max. weight loss after 1 h. at 250°C	%	≤ 13	≤ 13	≤ 13	≤ 11
1.5 Sulphur	ASTM D5185	(1)	% m/m	≤ 0.2	≤ 0.3	≤ 0.3	≤ 0.2
1.6 Phosphorus	ASTM D5185	(1)	% m/m	≤ 0.05 ⁽²⁾	≥ 0.070 ≤ 0.090 ⁽²⁾	≥ 0.070 ≤ 0.090 ⁽²⁾	≤ 0.090 ⁽²⁾
1.7 Sulfated ash	ASTM D874		% m/m	≤ 0.5 ⁽²⁾	≤ 0.8 ⁽²⁾	≤ 0.8 ⁽²⁾	≤ 0.5 ⁽²⁾
1.8 Chlorine	ASTM D6443		ppm m/m	Report	Report	Report	Report
1.9 TBN	ASTM D2896		mg KOH/g	-	-	≥ 6.0	≥ 6.0

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				
				C1-08	C2-08	C3-08	C4-08	
1. Laboratory tests								
				NOTE: the following sections apply to all sequences				
1.10 Oil/Elastomer compatibility	CEC-L-039-96 ⁽³⁾	Max. variation of characteristics after immersion for 7 days in fresh oil without pre-ageing		Elastomer type				
				RE1 FLUORO	RE2-99 ACM	RE3-04 SILICONE	RE4 NBR	EAM (VAMAC)
			Points	-1 / +5	-5 / +8	- 22 / +1	-5 /+ 5	As per
			Tensile strength					
			%	-40 / +10	-15 / +18	-30 / +10	-20 / +10	Daimler
			%	-50 / +10	-35 / +10	-20 / +10	-50 / +10	
			%	-1 / +5	-7 / +5	-1 / +22	-5 / +5	
1.11 Foaming tendency	ASTM D892 without option A	Tendency – stability	ml	Sequence I (24°C) 10 – nil Sequence II (94°C) 50 – nil Sequence III (24°C) 10 – nil				
1.12 High temperature foaming tendency	ASTM D6082 High temperature foam test	Tendency – stability	ml	Sequence IV (150°C) 100 – nil				

Notes:

(1) The internal standard method has to be used

(2) Maximum limits, values take into account method and production's tolerances

(3) Use either complete Daimler requirements (VDA 675301, 7 days +/- 2 h., 4 materials (NBR: NBR 34 DIN 51538 T3 (100°C +/- 2°C); FPM: AK6 (150°C +/- 2°C); ACM: E7503 (150°C +/- 2°C); AEM: D8948/200.1 (150°C +/- 2°C)) + RE3, or complete requirements according to 1.10 above + Daimler requirements for AEM.

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			
				C1-08	C2-08	C3-08	C4-08
2. Engine tests							
2.1 High temperature deposits ring sticking oil thickening	CEC-L-088-02 (TU5JP-L4) 72 h. test	Ring sticking (each part)	Merit	≥ 9.0	≥ 9.0	≥ 9.0	≥ 9.0
		Piston varnish (6 elements, average of 4 pistons)	Merit	≥ RL 216	≥ RL 216	≥ RL 216	≥ RL 216
		Absolute viscosity increase at 40°C between min. and max. values during test	mm²/s	≤ 0.8 x RL 216	≤ 0.8 x RL 216	≤ 0.8 x RL 216	≤ 0.8 x RL 216
		Oil consumption	kg/test	Report	Report	Report	Report
2.2 Low temperature sludge	ASTM D6593-00 (Sequence VG) Under protocol & requirements for API ⁽⁴⁾	Average engine sludge	Merit	≥ 7.8	≥ 7.8	≥ 7.8	≥ 7.8
		Rocker cover sludge	Merit	≥ 8.0	≥ 8.0	≥ 8.0	≥ 8.0
		Average piston skirt varnish	Merit	≥ 7.5	≥ 7.5	≥ 7.5	≥ 7.5
		Average engine varnish	Merit	≥ 8.9	≥ 8.9	≥ 8.9	≥ 8.9
		Comp. ring (hot stuck)		None	None	None	None
		Oil screen clogging	%	≤ 20	≤ 20	≤ 20	≤ 20
2.3 Valve train scuffing wear	CEC-L-038-94 (TU3M)	Cam wear, average	µm	≤ 10	≤ 10	≤ 10	≤ 10
		Cam wear, max.	µm	≤ 15	≤ 15	≤ 15	≤ 15
		Pad merit (average of 8 pads)	Merit	≥ 7.5	≥ 7.5	≥ 7.5	≥ 7.5
2.4 Black sludge	CEC-L-053-95 (M111)	Engine sludge, average	Merit	≥ RL140 + 4σ or ≥ 9.0	≥ RL140 + 4σ or ≥ 9.0	≥ RL140 + 4σ or ≥ 9.0	≥ RL140 + 4σ or ≥ 9.0
2.5 Fuel economy ⁽⁵⁾	CEC-L-054-96 (M111)	Fuel economy improvement vs ref. oil RL 191 (15W-40)	%	≥ 3.0	≥ 2.5	≥ 1.0 (for xW30 grades)	≥ 1.0 (for xW30 grades)
2.6 Medium temperature dispersivity	CEC-L-093-04 (DV4TD) ⁽⁷⁾	Absolute viscosity increase at 100°C and 6% soot	mm²/s	≤ 0.60 × RL 223 result	≤ 0.60 × RL 223 result	≤ 0.60 × RL 223 result	≤ 0.60 × RL 223 result
		Piston merit	Merit	≥ (RL 223 minus 2.5 points)	≥ (RL 223 minus 2.5 points)	≥ (RL 223 minus 2.5 points)	≥ (RL 223 minus 2.5 points)

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			
				C1-08	C2-08	C3-08	C4-08
2. Engine tests							
2.7 Wear ⁽⁶⁾	CEC-L-099-08 (OM646LA)	Cam wear outlet (average max. wear 8 cams)	µm	≤ 120	≤ 120	≤ 120	≤ 120
		Cam wear inlet (average max. 8 cams) ⁽⁹⁾	µm	≤ 100	Report ⁽⁶⁾	≤ 100	≤ 100
		Cylinder wear (average 4 cyl.) ⁽⁸⁾	µm	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5.0
		Bore polishing (13mm) (max. of 4 cyl.) ⁽⁸⁾	%	≤ 3.0	≤ 3.0	≤ 3.0	≤ 3.0
		Tappet wear inlet (average max. wear 8 cams)	µm	Report	Report	Report	Report
		Tappet outlet wear (average max.wear 8 cams)	µm	Report	Report	Report	Report
		Piston cleanliness (average 4 pistons)	Merit	Report	Report	Report	Report
		Engine sludge average	Merit	Report	Report	Report	Report
2.8 DI Diesel piston cleanliness & ring sticking ⁽¹⁰⁾	CEC-L-078-99 (VW DI)	Piston cleanliness	Merit	≥ RL 206	≥ RL 206	≥ RL 206	≥ RL 206
		Ring sticking (rings 1 & 2)					
		Average of all 8 rings	ASF	≤ 1.0	≤ 1.2	≤ 1.0	≤ 1.0
		Max. for any 1 st ring	ASF	≤ 1.0	≤ 2.5	≤ 1.0	≤ 1.0
		Max. for any 2 nd ring	ASF	0.0	0.0	0.0	0.0
		EOT TBN (ISO 3771) ^{(7) (8)}	mg KOH/g	Report	Report	Report	Report
		EOT TAN (ASTM D664) ⁽⁷⁾	mg KOH/g	Report	Report	Report	Report

Notes:

(4) The limits shown are based upon those applied in U.S. market requirements. ACEA will continuously review the situation to ensure that these limits are appropriate for European vehicles and lubricants.

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

(6) Limits for C1 might be revised if needed. For C1 claims OM 602A passing results obtained before the end of 2008 can be used instead of OM 646LA results.

(7) Test report has to give measured values before & after the test, all measurements to be taken in the same lab.

(8) Limit under definition

(9) These parameters are not yet official CEC parameters

(10) Test results from tests performed before the publishing of the 2008 ACEA oil sequences are allowed to be used without reporting EOT TBN & TAN

This sequence defines the minimum quality level of a product for self-certification to EELQMS and for presentation to ACEA members

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

Requirements	Test method	Properties	Unit	Limits			
				E4-08	E6-08	E7-08	E9-08
1. Laboratory tests							
1.1 Viscosity grades		SAE J300 Latest active issue		No restriction except as defined by shear stability and HT/HS requirements. Manufacturers may indicate specific viscosity requirements related to ambient temperature.			
1.2 Shear stability	CEC-L-014-93 (Bosch injector) or ASTM D6278	Viscosity after 30 cycles measured at 100°C	mm²/s	Stay in grade			
	ASTM D6278	Viscosity after 90 cycles measured at 100°C	mm²/s		Stay in grade		
1.3 Viscosity at high temperature & high shear rate	CEC-L-036-90 (2 nd edition) (Ravenfield)	Viscosity at 150°C & 10 ⁶ s ⁻¹ shear rate	mPa.s	≥ 3.5	≥ 3.5	≥ 3.5	≥ 3.5
1.4 Evaporative loss	CEC-L-040-93 (Noack)	Max. weight loss after 1 h. at 250°C	%	≤ 13	≤ 13	≤ 13	≤ 13
1.5 Sulfated ash	ASTM D874		% m/m	≤ 2.0	≤ 1.0	≤ 2.0	≤ 1.0
1.6 Phosphorus ⁽¹⁾	ASTM D5185		% m/m		≤ 0.08		≤ 0.12
1.7 Sulphur ⁽¹⁾	ASTM D5185		% m/m		≤ 0.3		≤ 0.4

This sequence defines the minimum quality level of a product for self-certification to EELQMS and for presentation to ACEA members

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

Requirements	Test method	Properties	Unit	Limits				
				E4-08	E6-08	E7-08	E9-08	
1. Laboratory tests								
1.8 Oil/Elastomer compatibility ⁽²⁾	CEC-L-039-96	Max. variation of characteristics after immersion for 7 days in fresh oil without pre-ageing	Points	Elastomer type				
				RE1 FLUORO	RE2-99 ACM	RE3-04 SILICONE	RE4 NBR	EAM (VAMAC)
				-1 / +5	-5 / +8	- 22 / +1	-5 /+ 5	As per
				-40 / +10	-15 / +18	-30 / +10	-20 / +10	Daimler
				-50 / +10	-35 / +10	-20 / +10	-50 / +10	

Notes:

(1) The internal standard method has to be used

(2) Use either the most recent complete Daimler requirements (VDA 675301, 7 days, 4 materials (NBR: NBR 34 DIN 53538 T3 (100°C); FPM: AK6 (150°C); ACM: E7503 (150°C); AEM: D8948/200.1 (150°C)) + RE3 according to requirement 1.8 above, or complete requirements according to 1.8 above + Daimler requirements for AEM.

(3) Should a test become available before the next document update, ACEA reserves the right to set performance limits providing adequate data is available.

(4) Values < 9.00 are not accepted

This sequence defines the minimum quality level of a product for self-certification to EELQMS and for presentation to ACEA members

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

Requirements	Test method	Properties	Unit	Limits			
				E4-08	E6-08	E7-08	E9-08
2. Engine tests							
2.1 Wear	CEC L-099-08 (OM646LA)	Cam wear outlet (average max. wear 8 cams)	µm	≤ 140 ^{(5) (6)}	≤ 140 ^{(5) (6)}	≤ 155 ^{(5) (6)}	≤ 155 ^{(5) (6)}
2.2 Soot in oil ⁽⁷⁾	ASTM D5967 (Mack T-8E)	Test duration 300 h. Relative viscosity at 4.8% soot 1 test/2 test average/3 test average	mm²/s	≤ 2.1 / 2.2 / 2.3	≤ 2.1 / 2.2 / 2.3	≤ 2.1 / 2.2 / 2.3	
2.3 Soot in oil	Mack T-11 (ASTM D7156)	Min. TGA soot @ 4.0 cSt (100°C) Min. TGA soot @ 12.0 cSt (100°C) Min. TGA soot @ 15.0 cSt (100°C)	% % %				3.5 / 3.4 / 3.3 6.0 / 5.9 / 5.9 6.7 / 6.6 / 6.5
2.4 Bore polishing piston cleanliness	CEC L-101-08 (OM501LA)	Bore polishing, average	%	≤ 1.0	≤ 1.0	≤ 2.0	≤ 2.0
		Piston cleanliness, average	Merit	≥ 26	≥ 26	≥ 17	≥ 17
		Oil consumption	kg/test	≤ 9	≤ 9	≤ 9	≤ 9
		Engine sludge, average ⁽⁸⁾	Merit	R & R ^{(9) (10)}	R & R ^{(9) (10)}	R & R ^{(9) (10)}	R & R ^{(9) (10)}
2.5 Soot-induced wear	Cummins ISM (ASTM D7468)	Merit					≥ 1000
		Rocker pad avg. weight loss at 3.9% soot	mg				≤ 7.1
		1 test/2 test average/3 test average oil filter diff.press EOT	kPa			≤ 55 / 67 / 74	≤ 19
		1 test/2 test average/3 test average engine sludge	merit			≥ 8.1 / 8.0 / 8.0 ⁽¹¹⁾	≥ 8.7
2.6 Wear (liner-ring- bearings)	Mack T-12 (ASTM D7422)	1 test/2 test average/3 test average adj. screw weight loss	mg				≤ 49
2.6 Wear (liner-ring- bearings)	Mack T-12 (ASTM D7422)	Merit			≥ 1000	≥ 1000	≥ 1000
		Average liner wear	µm		≤ 26	≤ 26	≤ 24
		Average top ring weight loss	mg		≤ 117	≤ 117	≤ 105
		End of test lead	ppm		≤ 42	≤ 42	≤ 35
		Delta lead 250-300 h.	ppm		≤ 18	≤ 18	≤ 15
		Oil consumption (phase II)	g/hr		≤ 95 ^{(12) (13)}	≤ 95 ^{(12) (13)}	≤ 85

Notes:

(5) OM602A data can be used instead of OM646LA data providing it meets the requirements as specified in the 2007 ACEA sequences

(6) Additional parameters may be included once approved by CEC

(7) Mack T-11 results obtained as part of an API CI-4, CI-4 Plus or API CJ-4 approval program, can be used in place of Mack T-8E.

(8) Bore polish, oil consumption and engine sludge are non-approved CEC parameters

(9) OM441LA data can be used instead of OM501LA data providing it meets the requirements as specified in the 2007 ACEA sequences

(10) Limits for sludge parameter may be reconsidered when more data becomes available

(11) Results from Cummins M11 HST (ASTM D6838) at API CH-4 or M11 EGR test (ASTM D6975) at API CI-4 or CI-4 Plus can be used in place of the Cummins ISM test.

(12) Merit number shall be calculated according to the API CI-4 specification

(13) 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.

GLOBAL DHD-1,
JASO DH/DL
and U.S. MILITARY
REQUIREMENTS
for DIESEL
ENGINE OILS



GLOBAL DHD-1- specification

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Oronite

Laboratory tests	Limits
Foaming tendency, ASTM D892, no option A Sequence I, max. Sequence II, max. Sequence III, max. High temperature foaming, ASTM D6082, ml, max.	10 / 0 ⁽¹⁾ 50 / 0 ⁽¹⁾ 10 / 0 ⁽¹⁾ 100 / 0 ⁽¹⁾
Sulfated Ash, ASTM D874, mass%, max.	2.0
Base Number, ASTM D4739, mg KOH/g, min.	10
Corrosion tendency, HTCBT, ASTM D6594 Copper, ppm, max. Lead, ppm, max. Tin, ppm, max.	20 120 50
High shear rate viscosity, ASTM D4683, mPa.s, min.	3.5
Kinematic viscosity, ASTM D445, mm²/s	SAE J300
Low temperature cranking viscosity, ASTM D5293, mPa.s	SAE J300
Low temperature pumping viscosity, ASTM D4684, mPa.s	SAE J300
Evaporation loss, Noack, ASTM D5800 or CEC L-40-93, % loss, max.	15
Shear stability, ASTM D3945 or CEC L-14-A-93 Kinematic viscosity at 100°C after 30 cycles Bosch shearing, cSt, min.	Stay in grade
Oxidation induction time, PDSC, CEC-L-085-99, Min, min.	35
Elastomer compatibility, CEC-L-039-96⁽²⁾	Pass

Notes:

(1) After 1 min. settling

(2) Please refer to chapter «Elastomer compatibility» for limits

GLOBAL DHD-1 - specification

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Oronite

Engine tests	Limits
Run number	1 / 2 / 3
ASTM RR D02-1379, Engine Oil Aeration Test (EOAT) Oil aeration at 20 h., %, max.	8.0
CEC L-52-T-97, OM441LA Bore polish, %, max. Piston cleanliness, merit, min. Boost pressure loss at 400 h., %, max. Oil consumption, kg/test, max.	2.0 25.0 4 40
ASTM D6483, corrosion, Mack T-9 Used oil lead, ppm, max. Average wear, normalized to 1.75% soot, liner wear, µm, max. Average wear, normalized to 1.75% soot, top ring weight loss, mg, max. TAN increase at EOT, max.	15 ⁽³⁾ 25.4 / 26.6 / 27.1 120 / 136 / 144 2.0
ASTM RR D02-1440, filter plugging, Cummins M11 HST Engine sludge, EC merits, min. Rocker pad average weight loss, normalized to 4.5% soot, mg, max. Oil filter diff.press, kPa, max.	8.7 / 8.6 / 8.5 6.5 / 7.5 / 8.0 79 / 93 / 100
ASTM D6975, piston cleanliness, Caterpillar 1R⁽⁴⁾ Top groove carbon fill (TGC), % max. Weighted total demerit (WD), max. Top land carbon (TLC), % max. Initial oil consumption g/h., max., 0-252 h. Final oil consumption g/h., max., 432-504 h.	40 / 42 / 44 397 / 416 / 440 37 / 42 / 46 13.1 1.5X Initial
ASTM D6984, sequence IIIF, 60 h., KV100 viscosity increase, %, max.⁽⁵⁾	200
ASTM D5967, Mack T-8E, relative viscosity at 4.8% soot, %, max.	2.1 / 2.2 / 2.3
JASO M354-1999, Mitsubishi 4D34T4, average cam lobe wear, µm, max.	95.0
ASTM D5966-96, roller follower wear test, pin wear, µm, max.	7.6 / 8.4 / 9.1

Notes:

(3) Lead max. 25 ppm, if fresh oil has TBN (ASTM D4739) greater than 10.

(4) The Caterpillar 1R requirements may be satisfied with a passing API CH-4 test result in the Caterpillar 1P

(5) The Sequence IIIF oxidation requirements may be satisfied with a passing API CH-4 test result in the Sequence IIIE

MIL-PRF-2104H specification⁽²⁾

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Oronite

Laboratory tests	Limits		
SAE viscosity grades	40	15W-40	5W-40
ASTM D892, foaming tendency w/o option A, Sequence I, ml, max. Sequence II, ml, max. Sequence III, ml, max.	10 / 0 ⁽¹⁾ 50 / 0 ⁽¹⁾ 10 / 0 ⁽¹⁾	10 / 0 ⁽¹⁾ 50 / 0 ⁽¹⁾ 10 / 0 ⁽¹⁾	10 / 0 ⁽¹⁾ 50 / 0 ⁽¹⁾ 10 / 0 ⁽¹⁾
ASTM D874, sulfated ash, % m/m, max.	1.5	1.5	1.5
ASTM D6594 (HTCBT @ 135°C), ppm increase, max. Copper Lead Tin Copper corrosion acc. to ASTM D130, max.	20 120 50 3	20 120 50 3	20 120 50 3
ASTM D4683, HTHS viscosity, mPa.s, min.	-	3.7	3.7
ASTM D445, kinematic viscosity @ 100°C, cSt	SAE J300	SAE J300	SAE J300
ASTM D5293, low temperature cranking viscosity, cP at -xx°C	-	SAE J300	SAE J300
ASTM D4684, pumpability, 60.000 cP max. at -xx°C	-	SAE J300	SAE J300
ASTM D5800 or CEC L-40-93, volatility NOACK % loss at 250°C, max.	-	15	15
ASTM D3945 or CEC L-14-A-93 shear stability Kinematic viscosity at 100°C after 30 cycles Bosch shearing, cSt, min.	-	Stay in grade	Stay in grade
ASTM D92, flash point, °C, min.	225	215	210
ASTM D97 or D5950, pour point, °C, min.	-15	-25	-40
GMN10055, Allison C-4 elastomer compatibility⁽²⁾	Pass	Pass	Pass

MIL-PRF-2104H specification⁽²⁾

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Oronite

Laboratory tests	Limits		
SAE viscosity grades	40	15W-40	5W-40
Allison C-4 graphite and paper friction Mid-point dynamic friction Slip time	≥ qualified batch sample mean mid-point friction coefficient minus 0.012 ≤ max. acceptable slip time criteria		
Caterpillar TO-4/TO-4M, SEQ1220 Average dynamic coefficient, % Average static coefficient, % Disc wear, mm, max. Energy limit, m/s, min.	90.0 - 140.0 91.0 - 127.0 0.04 25		
Caterpillar TO-4/TO-4M, SEQFRRET Average dynamic coefficient, % at 3000 cycles at 8000 cycles at 15000 cycles at 25000 cycles	85.0 - 130.0 90.0 - 125.0 90.0 - 125.0 95.0 - 125.0		
Caterpillar TO-4M, EHD film-forming % of elastohydrodynamic (EHD) reference film thickness at 2 m/s at 70°C at 100°C at 130°C	- - -	≥ 90 ≥ 96 ≥ 98	
ASTM D6922, homogeneity and miscibility	Pass ⁽³⁾	Pass ⁽³⁾	Pass ⁽³⁾

Notes:

(1) After 1 min. settling

(2) Specification covers engine oils suitable for lubrication of reciprocating compression-ignition internal combustion engines and for power transmission fluid applications

(3) Shall remain homogenous and, when mixed with ASTM ref. oils, shall remain miscible.

MIL-PRF-2104H specification⁽²⁾

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Oronite

Engine tests	Limits
SAE viscosity grades	All
ASTM RR D02-1379, Engine Oil Aeration Test (EOAT) Oil aeration at 20 h., %, max.	8.0
ASTM D6750, Caterpillar single cylinder 1K Run number Top groove fill (TGF), % max. Weighted total demerit (WD), max. Top land heavy carbon (TLHC), % max. Piston, ring and liner scuffing Average oil consumption, g/kWh max., 0-250 h.	1 - 2 - 3 24 - 27 - 29 332 - 347 - 353 4 - 5 - 5 None 0.5 - 0.5 - 0.5
ASTM D6684, Caterpillar single cylinder 1P Run number Top groove carbon fill (TGC), % max. Weighted total demerit (WD), max. Top land carbon (TLC), % max. Piston, ring and liner scuffing Average oil consumption, g/h., max., 0-360 h. Final oil consumption, g/h., max., 312-360 h.	1 - 2 - 3 36 - 39 - 41 350 - 378 - 390 40 - 46 - 49 None 12.4 14.6
ASTM D6975, Cummins M11-EGR Run number Crosshead total wt. loss norm. to 4.6% soot, µm, max. Oil filter ΔP at EOT, kPa, max. Engine sludge, CRC merit at EOT, min. Top ring weight loss, mg, max.	1 - 2 - 3 20.0 - 21.8 - 22.6 275 - 320 - 341 7.8 - 7.6 - 7.5 175 - 186 - 191
ASTM D5967, Mack T-8E Run number Relative viscosity at 100°C at 4.8% soot, max.	1 - 2 - 3 1.8 - 1.9 - 2.0

MIL-PRF-2104H specification⁽²⁾

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Oronite

Engine tests	Limits
SAE viscosity grades	All
ASTM D6987, Mack T-10 Merit rating, min. Used oil pumpability at 75 h., MRV @ -20°C, cP, max. ⁽³⁾	1000 25.000 (NYS)
ASTM D5862, Detroit Diesel⁽¹⁾ Run number Broken rings Liner distress, average % area, max. Piston rings face distr. fire ring, demerit, max. Piston rings face distr., average 2 nd +3 rd ring, demerit, max. Cylinder liner port plugging area, average, %, max. Cylinder liner port plugging area, single cylinder, %, max.	DD6V92TA 1 - 2 - 3 None 60.0 - 63.5 - 65.0 0.33 - 0.34 - 0.36 0.28 - 0.29 - 0.30 2 - 2 - 2 5 - 5 - 5
ASTM D5966, Roller Follower Wear Test (RFWT) Run number Average pin wear, (µm) max.	1 - 2 - 3 7.6 - 8.4 - 9.1
ASTM D6984, Sequence IIIF Viscosity (at 40°C), increase from 10 min. sample, % max. (IIIF)	275 (MTAC)

Notes:

(1) Per ASTM D5862, with the exception that ratings from any five of the six cylinders shall be averaged.

(2) Specification covers engine oils suitable for lubrication of reciprocating compression-ignition internal combustion engines and for power transmission fluid applications

(3) If yieldstress is detected, modified ASTM D4684 can be used.

JASO DH-1, DH-2, DL-1 specifications

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Oronite

Specification	DH-1-05 DH-1-14 DH-1-15	DH-2-08 DH-2-14 DH-2-15	DL-1-08 DL-1-14 DL-1-15
Laboratory tests	Limits		
ASTM D892, foaming tendency w/o option A,			
Sequence I, ml, max.	10 / 0	10 / 0	10 / 0
Sequence II, ml, max.	50 / 0	50 / 0	50 / 0
Sequence III, ml, max.	10 / 0	10 / 0	10 / 0
ASTM D6082, high temperature foaming, max.	-	-	100 / 0
ASTM D874, sulfated ash, % m/m, max.	Report	1.0 ± 0.1	0.6
ASTM D4739, TBN, mg KOH/g, min.	10.0	Report	Report
JIS K2501-2003 8. base number, mg KOH/g, min.	10.0	5.5	Report
ASTM D6594, (HTCBT at 135°C), ppm increase, max.			
Copper	20	20	20
Lead	120	100	120
Tin	50	50	50
Copper strip rating (acc. to ASTM D130), max.	3	3	3
ASTM D4683, HTHS viscosity, mPa.s, min.	SAE J300	SAE J300	SAE J300
ASTM D445, kinematic viscosity at 100°C, cSt	SAE J300	SAE J300	SAE J300
ASTM D5293, low temperature cranking viscosity, cP at -xx°C	SAE J300	SAE J300	SAE J300
ASTM D4684, pumpability, 60.000 cP max. at -xx°C	SAE J300	SAE J300	SAE J300
ASTM D5800, NOACK volatility, % loss at 250°C, max.	18.0	18.0	15
ASTM D6278, shear stability			
Kinematic viscosity. at 100°C after 30 cycles Bosch shearing, cSt, min.	SAE J300 ⁽¹⁾	SAE J300 ⁽¹⁾	xW-30: 8.6 xW-20: SAE J300
JPI-5S-55-99, hot surface deposit control at 280°C, merit, min.	7.0	7.0	7.0
CEC-L-39-T-96, elastomer compatibility⁽²⁾	Pass	Pass	Pass
ASTM D5185, phosphorus, % m/m, max.	Report	0.12	0.10
ASTM D5185, sulfur, % m/m, max.	Report	0.5	0.5
ASTM D6443, chlorine, ppm, max.	Report	150	150

Notes:

(1) Only for multi grade oils

(2) Please refer to chapter «Elastomer compatibility» for limits

JASO DH-1, DH-2, DL-1 specifications

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Oronite

Specification	DH-1-05 DH-2-08	DL-1-08	DH-1-14 DH-2-14	DL-1-14	DH-1-15 DH-2-15	DL-1-15
Laboratory tests	Limits					
Piston detergency test, M336, 1998, Nissan TD25⁽¹⁾ Top groove filling, %, max. Deposits on ring lands, merit. Piston ring sticking	60.0 Report All free	60.0 Report All free				
Piston detergency test, M336:2014, Hino N04C Weighted Total Demerit, max. Top groove filling, %, max. Deposits on ring lands, merit. Piston ring sticking			740 Report Report All free	740 Report Report All free	740 Report Report All free	740 Report Report All free
Valve train wear test, M354:2006, Mitsubishi 4D34T4 Average cam diameter loss, µm, max. ⁽²⁾ Max. cam diameter loss, µm, max. ⁽²⁾ Cam surface wear	95.0 210 No pitting	95.0 210 No pitting	95.0 210 No pitting	95.0 210 No pitting		
Valve train wear test, M354:2015, Hino N04C Tappet Wear, µm, max.					11.3	11.3
Mack T-8A⁽³⁾, ASTM D5967 Viscosity increase (100 to 150 h.) at 100°C, mm²/s/h., max.	0.2	0.2	0.2	0.2	0.2	0.2
or Mack T-8E⁽³⁾, ASTM D5967 Run number Relative viscosity at 100°C at 4.8% soot, max.	1 - 2 - 3 2.1 - 2.2 - 2.3	1 - 2 - 3 2.1 - 2.2 - 2.3	1 - 2 - 3 2.1 - 2.2 - 2.3	1 - 2 - 3 2.1 - 2.2 - 2.3	1 - 2 - 3 2.1 - 2.2 - 2.3	1 - 2 - 3 2.1 - 2.2 - 2.3
or Mack T-11⁽³⁾, ASTM D7156 Run number Min. % TGA soot at 4.0 cSt increase at 100°C Min. % TGA soot at 12.0 cSt increase at 100°C Min. % TGA soot at 15.0 cSt increase at 100°C	1 - 2 - 3 3.5 - 3.4 - 3.3 6.0 - 5.9 - 5.9 6.7 - 6.6 - 6.5	1 - 2 - 3 3.5 - 3.4 - 3.3 6.0 - 5.9 - 5.9 6.7 - 6.6 - 6.5	1 - 2 - 3 3.5 - 3.4 - 3.3 6.0 - 5.9 - 5.9 6.7 - 6.6 - 6.5	1 - 2 - 3 3.5 - 3.4 - 3.3 6.0 - 5.9 - 5.9 6.7 - 6.6 - 6.5	1 - 2 - 3 3.5 - 3.4 - 3.3 6.0 - 5.9 - 5.9 6.7 - 6.6 - 6.5	1 - 2 - 3 3.5 - 3.4 - 3.3 6.0 - 5.9 - 5.9 6.7 - 6.6 - 6.5
SEQUENCE IIIE, ASTM D5533, or SEQUENCE IIIF, ASTM D6984, or SEQUENCE IIIG, ASTM D7320⁽⁴⁾ Viscosity increase at 40°C, increase after 64 h., %, max. (IIIE) Viscosity increase at 40°C, increase after 60 h., %, max. (IIIF) Viscosity increase at 40°C, increase after 100 h., %, max. (IIIG)	IIIE, or IIIF, or IIIG 200 295 150	IIIF, or IIIG - 275 (after 80 h.) 150	IIIE, or IIIF, or IIIG 200 295 150	IIIF, or IIIG - 275 (after 80 h.) 150	IIIE, or IIIF, or IIIG 200 295 150	IIIF, or IIIG - 275 (after 80 h.) 150
CEC L-54-T-96, M111 fuel economy test⁽⁵⁾ Fuel economy improvement, %, min.	-	2.5	-	2.5	-	2.5

Notes:

(1) TD25 engine are no longer supplied since March 2009. Alternative detergency tests for DH-1-05 and DH-2-08 are: Caterpillar 1K (ASTM D6750), Caterpillar 1N (ASTM D6750), Caterpillar 1P (ASTM D6681), Caterpillar 1R (ASTM D6923), Caterpillar C13 (ASTM D7549) according to the limits of API CH-4, CI-4 and CJ-4. Alternative detergency test for DL-1-08 is: WTTD2 (CEC-L-78-T-99) according to the limits of ACEA C2-08.

(2) Normalized at 4.5 mass % carbon residue increase

(3) Only one of the Mack tests has to be run

(4) Only one of the Sequence III tests has to be run

(5) Not required for 10W-30



OEM REQUIREMENTS for GASOLINE and DIESEL ENGINE OILS

BMW long life specification overview



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BMW Specification	LL-01	LL-01 FE	LL-04	LL-12 FE	LL-14 FE+
Application:	Minimum level for Gasoline from MY2002 Minimum level for Diesels excluding DPF from MY2003 OK for older engines Not allowed for M engines in general, only for new S55- and S63-M-engines	All Gasoline engines from MY 2005 OK for older Gasoline engines with Valvetronic Not allowed for Diesel engines Not allowed for M engines in general, only for new S55- and S63-M-engines	Mandatory for DPF Diesels OK for other Diesels OK for Gasoline from MY 2002 <u>in EU only</u> Not allowed for M engines in general, only for new S55- and S63-M-engines	Standard BMW Diesels from MY 2013 onwards. (not backward compatible) Not allowed for high power Diesels, check manual for details. (rule of thumb: multiple turbos) OK for Gasoline from MY 2002 <u>in EU only</u> Not allowed for M engines in general, only for new S55- and S63-M-engines	ONLY for EU and USA! Gasoline from MY 2013 with N20 and «Baukasten» engines. Not allowed for other engines. Not allowed for M engines in general, only for new S55- and S63-M-engines.
ACEA basis	A3/B4 ¹²	A5/B5 ¹²	C3 ¹² excl, P limit	C2 ¹²	A1/B1 ¹²
SAE viscosity grade	0/5W-30/40	xW-30	0/5W-30/40	xW-30 & 5W-20	xW-20
HTHS viscosity , CEC L-036-90, mPa.s, min.	3.5	3.0	3.5	2.9	2.6
Kin. viscosity at 100 °C, mm ² /s	SAE J300	≥ 10.0	SAE J300	≥ 8.8	≥ 7.8 & < 9.3
Noack , ASTM D5800, %	ACEA	ACEA	ACEA	ACEA	ACEA
TBN , ASTM D2896, mg KOH/g, min.	10	10	6	6	9.5
Sulfated ash , ASTM D874, % m/m	≥ 1.0 & ≤ 1.6	≤ 1.6	≤ 0.8	≤ 0.8	≤ 1.3
Required BMW engine tests:					
N20 Performance	Pass	Pass	Pass	Pass	Pass
N20 Aeration	Pass	Pass	Pass	Pass	Pass
N42 Valvetronic RNT	Pass	Pass	Pass	Pass	Pass
N20 Gasoline fuel economy	-	Pass ⁽¹⁾	-	Pass ⁽¹⁾	Pass ⁽²⁾
N47 Diesel fuel economy	-	-	-	Pass ⁽³⁾	-
N47 Diesel turbo charger deposits test	-	-	-	Pass	-

Notes:

(1) Limit ≥ -1,2 % vs 0W-20 ref. oil

(2) Limit ≥ 0,0 % vs 0W-20 ref. oil

(3) Limit ≥ -0,5% vs 0W-30 ref. oil

CATERPILLAR Engine Crankcase Fluid (ECF) recommendations

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	Model year 2007 ⁽¹⁾	Pre-model year 2007 ⁽¹⁾
Viscosity grades (SAE J300)	10W-30, 15W-40	
Preferred	Cat DEO-ULS Cat DEO and Cat DEO-ULS require in addition to the tests required for Cat ECF classifications, pass results in a number of Cat Proprietary multi-cylinder endurance tests, field tests and a variety of quality assurance tests.	Cat DEO-ULS Cat DEO
Commercial lubricants	Cat ECF-3 / API CJ-4 ⁽²⁾	Cat ECF-3 / API CJ-4 Cat ECF-2 Cat ECF-1-a

Notes:

(1) The oils are listed in order of preference

(2) Cat ECF-2 oils of ≤ 1 percent ash content are also allowed

Caterpillar specification	Application	Caterpillar ECF specifications requirements
Cat ECF-3	- Caterpillar 2007 model year on-highway Diesel engines - Also highly recommended for other Caterpillar engines in on-highway applications - Cat 3500 series and smaller machine & commercial Diesel engines	API CJ-4
Cat ECF-2	- All 2006 model year & older Caterpillar on-highway Diesel engines & Cat 3500 Series and smaller commercial and machine Diesel engines <u>Not</u> applicable to Cat engines equipped with Diesel Particulate Filters (DPF)	- API CI-4 / CI-4 PLUS - Cat C13 500 h. engine test as defined in the API CJ-4 oil category. requirements and 2- Oils of sulfated ash $> 1.50\%$ are not allowed - Sulfated ash ≤ 1.50 wt% - API oil categories older than API CI-4 may not claim to meet the Cat ECF-2 specification
Cat ECF-1-a	- All 2006 model year & older Cat on-highway Diesel engines & Cat 3500 series & smaller commercial and machine Diesel engines <u>Not</u> applicable to Cat model year 2007 and newer on-highway engine models <u>Not</u> applicable to Cat engines equipped with Diesel Particulate Filters (DPF)	- API CH-4 - Cat 1P SCOTE⁽¹⁾ test (ASTM D6681) - Sulfated ash ≤ 1.30 wt% - If $1.30 < \text{sulfated ash} \leq 1.50$ wt%, two passing Cat 1P tests (ASTM D 4485) at the single pass limits - API oil categories older than API CI-4 may not claim to meet the Cat ECF-1-a specification

Note:

(1) SCOTE Single Cylinder Oil Test Engine

CATERPILLAR Engine Crankcase Fluid (ECF) recommendations

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Oronite

Fuel sulfur level (ppm)	Cat engine oils	TBN of commercial engine oils
≤ 500	Cat DEO-ULS, Cat DEO	≥ 7
500 - 1000	Cat DEO-ULS, Cat DEO	≥ 7
> 1000	Cat DEO	≥ 10

CHRYSLER GROUP LLC requirements – MS-6395 specification



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Specifications	MS-6395
Laboratory test requirements and limits	According to ILSAC GF-5
Engine test requirements and limits	According to ILSAC GF-5
Chrysler field test Chrysler vehicles for 100000 miles in taxicabs in Las Vegas over two summers and one winter	Pass

Cummins engineering standards (CES)

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Oronite

CES number	20071	20072	20076	20077	20078	20081
Viscosity grades (SAE J300)	xW-30, xW-40	10W-30, 10W-40, 15W-40	xW-30, xW-40	10W-30, 10W-40, 15W-40	xW-30, xW-40	xW-30, xW-40
API / ACEA performance level	API CH-4/SJ, Global DHD-1	API-CH-4, ACEA E3, Global DHD-1	API CH-4 ⁽¹⁾ , ACEA E5, Global DHD-1	API CH-4 ⁽¹⁾ , ACEA E5, Global DHD-1	API CI-4, ACEA E7	API CJ-4 , ACEA E9, JASO DH-2
Laboratory tests						
Viscosity at 40°C (ASTM D445) at 100°C	Report Per SAE J300	Report Per SAE J300	Report Per SAE J300	Report Per SAE J300	Report Report	Report Report
Shear stability , ASTM D3945, D6278, CEC L-14-A-96 Viscosity after 30 cycles at 100°C, mm²/s, min.	xW-30: 9.5, xW-40: 12.5	9.0	xW-30: 9.5, xW-40: 12.5	Stay in grade	xW-30: 9.3, xW-40: 12.5	xW-30: 9.3, xW-40: 12.5
Low temperature cranking and pumping viscosity CCS (ASTM D5293), mPa.s, max. MRV (ASTM D4684), mPa.s, max.	Per SAE J300 Per SAE J300	Per SAE J300 Per SAE J300	Per SAE J300 Per SAE J300	Per SAE J300 Per SAE J300	Report Report	Report Report
HTHS viscosity , ASTM D4683, CEC L-036-90, mPa.s, min.	3.7	Per SAE J300	3.7	Per SAE J300	3.5	3.5
Gelation index , ASTM D5133, max.	12	-	12	-	12	12
Evaporative loss , Noack, ASTM D5800, %, max. CEC L-40-A-93, %, max.	xW-30: 20, xW-40: 18 -	- 13	xW-30: 20, xW-40: 18 -	- 12	15 -	xW-30: 15, xW-40: 13 -
TBN , ASTM D4739, mg KOH/g, min.	Report	Report	Report	Report	10.0	Report
TAN , ASTM D664, mg KOH/g	Report	Report	Report	Report	Report	Report
Sulfated ash , ASTM D874, % m/m, max.	1.85	1.85	1.85	1.85	1.85	1.00
Ba, Bo, Ca, Mg, Mo, Si, Na, Zn (ICP)	Report	Report	Report	Report	Report	Report
Phosphorus , ASTM D4951, % m/m, max.	Report	Report	Report	Report	Report	0.12
Sulfur , ASTM 4951, % m/m, max.	Report	Report	Report	Report	Report	0.4
Nitrogen , ASTM D4629, % m/m	Report	Report	Report	Report	Report	Report

Cummins engineering standards (CES)

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Oronite

CES number	20071	20072	20076	20077	20078	20081
Foaming tendency , ASTM D6082, no option A Sequence I (24°C), II (94°C), III (24°C), ml, max. Sequence IV (150°C), ASTM D6082 ml, max.	10 / 0, 20 / 0, 10 / 0 -	10 / 0, 50 / 0, 10 / 0 -	10 / 0, 50 / 0, 10 / 0 -	10 / 0, 20 / 0, 10 / 0 200 / 50	10 / 0, 20 / 0, 10 / 0 -	10 / 0, 20 / 0, 10 / 0 -
High temperature foaming tendency , ASTM D6082), ml, max.	-	100 / 0	-	200 / 50	-	-
Low temperature pumping viscosity (75/180 h. T10(A)/T11(A)) (ASTM D4684) MRV viscosity at -20°C, mPa.s, max. MRV yield stress, Pa, max.	- -	- -	- -	- -	25000 35	25000 35
Oxidation induction time , PDSC, CEC-L-85-T-99, min., min.	-	-	-	35	-	-
Elastomer compatibility , CEC-L-039-96, ASTM D7216 [®] RE1, Nitrile NBR RE2-99, Silicone VMQ RE3-04, Polyacrylate ACM RE4, Fluorelastomer FKM Vamac G	Pass Pass Pass Pass -	Pass Pass Pass Pass -	Pass Pass Pass Pass -	Pass Pass Pass Pass -	Pass Pass Pass Pass -	Pass Pass Pass Pass Pass
Corrosion tendency , HTCBT, ASTM D6594 Copper increase, ppm, max. Lead increase, ppm, max. Tin increase, ppm, max. Copper strip rating (ASTM D130), max.	D5968 20 120 50 3	D5968 20 120 50 -	D5968 20 120 50 3	D5968 20 100 100 -	D6594 20 120 50 3	D6594 20 120 50 3

Cummins engineering standards (CES)

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Oronite

CES number	20071	20072	20076	20077	20078	20081
Engine tests						
Caterpillar 1P , ASTM D6681	Run number	1 / 2 / 3	1 / 2 / 3			
Weighted total demerit	350 / 378 / 390	350 / 378 / 390	Report	-	-	-
Top groove carbon fill, %	36 / 39 / 41	36 / 39 / 41	Report	-	-	-
Top land heavy carbon, %	40 / 46 / 49	40 / 46 / 49	Report	-	-	-
Average oil consumption, 0-360 h., g/h	12.4	12.4	Report	-	-	-
Final oil consumption, 336-360 h., g/h	14.6	14.6	Report	-	-	-
Piston ring and liner scuffing	Report	Report	Report	-	-	-
Caterpillar 1R , ASTM D6923						
Weighted total demerit, max.	-	-	-	-	382	-
Top groove carbon fill, %, max.	-	-	-	-	52	-
Top land carbon, %, max.	-	-	-	-	31	-
Average initial oil consumption, 0-252 h., g/h, max.	-	-	-	-	13.1	-
Average final oil consumption, 432-504 h., g/h, max.	-	-	-	-	Initial + 1.8	-
Piston ring sticking and liner scuffing	-	-	-	-	None	-
Caterpillar 1K , ASTM D6750 ⁽⁴⁾	Run number	1 / 2 / 3	1 / 2 / 3			
Weighted total demerit, max.	332 / 347 / 353	332 / 347 / 353	332 / 347 / 353	-	332	-
Top groove carbon fill, %, max.	24 / 27 / 29	24 / 27 / 29	24 / 27 / 29	-	24	-
Top land heavy carbon, %, max.	4 / 5 / 5	4 / 5 / 5	4 / 5 / 5	-	4	-
Oil consumption, gbhp-h, g/kWh, max.	0.5	0.5	0.5	-	0.5	-
Piston ring sticking and liner scuffing	None	None	None	-	None	-
Caterpillar 1N , ASTM D6750 ⁽⁴⁾						
Weighted total demerit, max.	-	-	-	-	286.2	286.2
Top groove carbon fill, %, max.	-	-	-	-	20	20
Top land heavy carbon, %, max.	-	-	-	-	3	3
Oil consumption, g/kWh, max.	-	-	-	-	0.5	0.5
Piston ring sticking and liner scuffing	-	-	-	-	None	None

Cummins engineering standards (CES)

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Oronite

CES number	20071	20072	20076	20077	20078	20081
Caterpillar C13 , ASTM D7484						
Merit rating, min.	-	-	-	-	-	Report
Hot stuck piston ring	-	-	-	-	-	Report
Oil consumption, g/h, max.	-	-	-	-	-	Report
TLC, %, max.	-	-	-	-	-	Report
TGC, %, max.	-	-	-	-	-	Report
Carbon ring 2, %, max.	-	-	-	-	-	Report
Cummins ISB , ASTM D7549						
Run number						1 / 2 / 3
Slider tappet weight loss, average, mg, max.	-	-	-	-	-	100 / 108 / 112
Cam lobe wear, average, µm, max.	-	-	-	-	-	50 / 53 / 55
Crosshead weight loss, average, mg	-	-	-	-	-	Report
Cummins M11 , 300 h. extended test, ASTM RR:D02-1440						
Run number	1 / 2 / 3	1 / 2 / 3	1 / 2 / 3	1 / 2 / 3		
Rocker pad total weight loss at 4.5% soot, mg, max.	6.5 / 7.5 / 8.0	6.5 / 7.5 / 8.0	-	-	-	-
Crosshead wear weight loss at 6.5% soot, average, mg, max.	-	-	12.0	12.0	-	-
Engine sludge at 200 h., CRC merit, min.	8.7 / 8.6 / 8.5	8.7 / 8.6 / 8.5	8.7 / 8.6 / 8.5	8.7 / 8.6 / 8.5	-	-
Oil filter ΔP at 200 h., kPa, max.	79 / 93 / 100	79 / 93 / 100	79 / 93 / 100	79 / 93 / 100	-	-
Cummins M11 EGR , ASTM D6975						
Crosshead total weight loss at 4.6% average soot, mg, max.	-	-	-	-	20.0	-
Top ring weight loss, mg, max.	-	-	-	-	175.0	-
Engine sludge at end-of-test, CRC merit, min.	-	-	-	-	7.80	-
Oil filter ΔP at 250 h., kPa, max.	-	-	-	-	275.0	-

Cummins engineering standards (CES)

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Oronite

CES number	20071	20072	20076	20077	20078	20081
Cummins ISM , ASTM D7468	Run number					
Merit rating, min.	-	-	-	-	-	1000
Crosshead total weight loss at 3.9% average soot, mg	-	-	-	-	-	7.1
Diff. pressure across oil filter after 150 h., kPa, max.	-	-	-	-	-	19
Adjusting screw weight loss, mg, max.	-	-	-	-	-	45
Average engine sludge CRC merits at EOT, min.	-	-	-	-	-	8.7
Mack T-8 , 250 h., ASTM D5967	Run number	1 / 2 / 3				
Viscosity increase at 3.8% soot, mm ² /s, max.	-	11.5 / 12.5 / 13.0	-	-	-	-
Oil filter ΔP, kPa, max.	-	138	-	-	-	-
Oil consumption, g/kWh, max.	-	0.304	-	-	-	-
Mack T-8E , 300 h. extended test, ASTM D5967	Run number	1 / 2 / 3	1 / 2 / 3	1 / 2 / 3		
Relative viscosity at 4.8% soot TGA, max. ⁽⁶⁾	2.1 / 2.2 / 2.3	2.1 / 2.2 / 2.3	1.8 / 1.9 / 2.0	1.8 / 1.9 / 2.0	1.8	-
Viscosity increase at 100°C at 3.8% soot, cSt, max.	11.5 / 12.5 / 13.0	11.5 / 12.5 / 13.0	11.5 / 12.5 / 13.0	11.5 / 12.5 / 13.0	Report	-
Oil filter ΔP, kPa, max.	-	-	-	138	-	-
Oil consumption, g/kWh, max.	-	-	-	0.304	-	-
Mack T-9 , ASTM D6483	Run number	1 / 2 / 3	1 / 2 / 3	1 / 2 / 3		
Average liner wear at 1.75% soot, μm, max.	25.4 / 26.6 / 27.1	25.4 / 26.6 / 27.1	25.4 / 26.6 / 27.1	25.4 / 26.6 / 27.1	-	-
Top ring weight loss, mg, max.	120 / 136 / 144	120 / 136 / 144	120 / 136 / 144	120 / 136 / 144	-	-
Used oil lead increase, ppm, max.	25/32/36	25/32/36	20 / 27 / 31	25 / 32 / 36	-	-
Lead increase from 400 to 500 h., ppm, max.	-	-	10	-	-	-
Mack T-10 , ASTM D6987						
Merit rating, min.	-	-	-	-	1000	-
Average liner wear, μm, max.	-	-	-	-	32	-
Average top ring weight loss, mg, max.	-	-	-	-	158	-
Lead increase from 0 to 300 h., ppm, max.	-	-	-	-	35	-
Lead increase from 250 to 300 h., ppm, max.	-	-	-	-	14	-
Oil consumption, average, g/h, max.	-	-	-	-	65	-
Mack T-11 , ASTM D7156						
Minimum % TGA soot at 4.0 mm ² /s increase at 100°C	-	-	-	-	-	3.5
Minimum % TGA soot at 12.0 mm ² /s increase at 100°C	-	-	-	-	-	6.0
Minimum % TGA soot at 15.0 mm ² /s increase at 100°C	-	-	-	-	-	6.7

Cummins engineering standards (CES)

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Oronite

CES number	20071	20072	20076	20077	20078	20081
Mack T-12 , ASTM D7422						
Merit rating, min.	-	-	-	-	-	1000
Liner wear, μm , max.	-	-	-	-	-	20
Top ring weight loss, mg, max.	-	-	-	-	-	50
EOT used oil lead/new oil lead content, ppm, max.	-	-	-	-	-	20
Lead increase from 250 h. to 300 h., mg/kg, max.	-	-	-	-	-	7
Oil consumption, average, g/h, max.	-	-	-	-	-	60
Roller Follower Wear Test (RFWT) , ASTM D5966	Run number	1 / 2 / 3	1 / 2 / 3	1 / 2 / 3		
Pin wear, mils max.	0.30 / 0.33 / 0.36	0.30 / 0.33 / 0.36	0.30 / 0.33 / 0.36	-	-	-
μm , max.	7.6 / 8.4 / 9.1	7.6 / 8.4 / 9.1	7.6 / 8.4 / 9.1	-	7.6	7.6
Mitsubishi 4D34T , JASO M354-2000						
Cam lobe wear, μm ., max.	-	-	-	-	95.0	-
Engine oil aeration test , International 7.3L. DIT, ASTM D6894						
Aeration volume at 20 h., %, max.	8.0	8.0	8.0	-	8.0	8.0
Sequence IIIE , ASTM D5533						
Viscosity increase at 64 h. at 40°C from 10 min. sample, %, max.	200	-	100	-	-	-
Sequence IIIF , ASTM D6984/ Sequence IIIG , ASTM D7320						
Cam and tappet wear, μm , max.	-	-	-	-	IIIF 20.0	IIIF (IIIG) -
Viscosity increase at EOT at 40°C, %, max.	-	295	-	-	275	275 (150)
Oil consumption, L, max.	-	-	-	-	5.2	-
OM 364 LA , CEC L-42-T-99						
Bore polishing, average, %, max.	-	1.0	-	-	-	-
Piston cleanliness, average, merit, min.	-	45.0	-	-	-	-
Cylinder wear (average 4 cyl.), μm , max.	-	3.0	-	-	-	-
Engine sludge, merit, min.	-	9.5	-	-	-	-
Oil consumption, kg/test, max.	-	12	-	-	-	-
OM 441 LA , CEC L-52-T-97						
Bore polishing, average, %, max.	-	-	-	2	-	-
Piston cleanliness, average, merit, min.	-	-	-	25	-	-
Boost pressure loss at 400 h., %, max.	-	-	-	4	-	-
Oil consumption, kg/test, max.	-	-	-	40	-	-

Cummins engineering standards (CES)

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Oronite

CES number	20071	20072	20076	20077	20078	20081
OM 602A, CEC-L-51-A-97						
Viscosity increase at 40°C, %, max.	-	RL 148	-	90	-	-
Cam wear, average, µm, max.	-	-	-	45.0	-	-
Cylinder wear (average 4 cyl.), µm, max.	-	Report	-	20.0	-	-
Bore polishing, %, max.	-	Report	-	7.0	-	-
Oil consumption, kg/test, max.	-	Report	-	10	-	-
Piston cleanliness, average, merit, min.	-	Report	-	Report	-	-
Engine sludge, average, merit	-	-	-	Report	-	-

Notes:

- (1) CES 20076 adds the requirement of a 300 h. Cummins M11 test to API CH-4
- (2) CES 20077 adds the requirement of a 300 h. Cummins M11 test to ACEA E5
- (3) Please refer to chapter «Elastomer compatibility» and ACEA Sequence E for limits
- (4) For CES 20078, oil shall pass either Caterpillar 1K or Caterpillar 1N
- (5) New oil viscosity minus 50% of ASTM D6278 viscosity loss as denominator

DAF engine oil requirements and oil drain intervals



Oronite

Engine	Engine oil recommendation	Oil drain interval
Euro V / EEV		
Paccar PR	ACEA E6 / xW-40	Standard drain: 75,000 km Extended drain ¹⁾ : 100,000 km
Paccar MX	ACEA E6 or E9 / xW-30, xW-40	Standard drain: 90,000 km Extended drain ²⁾ : 150,000 km only with ACEA E6
Euro VI		
Paccar PX-5, PX-7	ACEA E9 + CES 20081 / 10W-30	Standard drain: 60,000 km
Paccar MX-11	ACEA E6 or E9 / xW-30, xW-40	Standard drain: 90,000 km Extended drain ²⁾ : 125,000 km only with ACEA E6
Paccar MX-13	ACEA E6 or E9 / xW-30, xW-40	Standard drain: 90,000 km Extended drain ²⁾ : 150,000 km only with ACEA E6
EPA10		
Paccar MX ³⁾	API CJ-4 / xW-40	Severe duty / Vocational ⁴⁾ : 25,000 miles Normal duty / Line haul ⁵⁾ : 40,000 miles
EPA13		
Paccar MX-13 ³⁾	API CJ-4 / xW-30, xW-40	Severe duty / Vocational ⁴⁾ : 25,000 miles Normal duty / Line haul ⁵⁾ : 60,000 miles

Notes:

- 1) DAF Service Rapido system: oil filter with larger filtering capacity and centrifugal oil filter
- 2) DAF Service Rapido system: double fuel filter and centrifugal oil filter; MX-13 engine has 6 L larger sump
- 3) Standard with extended drain package
- 4) Fuel consumption: <2.5 km/L (<6 MPG); Gross vehicle weight: >36,300 kg (>80,000 lb)
- 5) Fuel consumption: >2.5 km/L (>6 MPG); Gross vehicle weight: <36,300 kg (<80,000 lb)
- 6) Max. allowed idle time is 20% or less, based on idle timer percentage within DAVIE report

DETROIT DIESEL CORPORATION

Power Guard Oil Specifications (PGOS) - 1 -



Oronite

Specifications	93K214	93K215	93K218
Description	Engine oil for Series 50, Series 60, MBE 4000 and MBE 900 engines	Non-EGR engine oil for Series 50, Series 60, MBE 4000 and MBE 900 engines	Engine oil for DD-13, DD-15, Series 60, Series 50, MBE 4000 and MBE 90 engines
Viscosity grades (SAE J300)	-	-	xW-40
API performance level			CJ-4
Laboratory tests			
Sulphated ash , ASTM D874, % m/m, max.	2.0	2.0	1.0
Phosphorus , ASTM D4951, ASTM D5185, % m/m, max.	-	-	0.12
Sulphur , ASTM D4951, ASTM D2622, % m/m, max.	-	-	0.4
HTHS viscosity , ASTM D4683, mPa.s, min.	4.2	3.5	xW-30: 3.5; xW-40: Report
Shear stability , ASTM D6278/D7109			
Viscosity at 100°C after 30 cycles shear (ASTM D445), mm ² /s, min.	-	12.5	-
Viscosity at 100°C after 90 cycles shear (ASTM D445), mm ² /s, min.	12.5	-	xW-30: 9.3; xW-40: 12.5
HTHS viscosity after 90 cycles shear (ASTM4683), mPa.s, min.	3.9	-	xW-30: Report; xW-40: 3.9
Evaporative loss , Noack, ASTM D5800, % loss, max.	13	18	13
ASTM D5480, % loss, max.	-	15	-
Pour point , ASTM D97, °C, max.	-25	-25	-27
Foaming tendency , ASTM D892, no option A			
Sequence I, II, III, ml, max.	10 / 0, 20 / 0, 10 / 0	10 / 0, 20 / 0, 10 / 0	10 / 0, 20 / 0, 10 / 0 ⁽⁴⁾
Corrosion tendency , HTCBT, ASTM D6594			
Copper increase, ppm, max.	20	20	20
Lead increase, ppm, max.	120	120	120
Tin increase, ppm, max.	50	50	-
Copper strip rating (ASTM D130), max.	3	3	3
Low temperature pumpability of sooted oil , ASTM D4684/D7110			
MRV viscosity at -20°C of 75 h. oil from Mack T-10, T-10A or T-11 test at 5% soot, mPa.s, max.	25000	-	-
MRV viscosity at -20°C of 180 h. oil from Mack T-11 or T-11A test, mPa.s, max.	-	-	18000
Yield stress, Pa, max.	35	-	35

DETROIT DIESEL CORPORATION

Power Guard Oil Specifications (PGOS) - 2 -



Oronite

Specifications	93K214	93K215	93K218
Laboratory tests			
Elastomer compatibility , ASTM D7216/CEC L-039-96 ⁽¹⁾			
Nitrile (NBR)	Pass ⁽²⁾	Pass ⁽³⁾	Pass ⁽²⁾
Silicone (VMQ)	Pass ⁽²⁾	-	Pass ⁽²⁾
Polyacrylate (ACM)	Pass ⁽²⁾	Pass ⁽³⁾	Pass ⁽²⁾
Fluorelastomer (FKM)	Pass ⁽²⁾	Pass ⁽³⁾	Pass ⁽²⁾
Vamac G	Rate & Report ⁽³⁾	Pass ⁽³⁾	Pass ⁽²⁾
Engine tests			
Sequence IIIF , ASTM D6984			
Viscosity increase at 80 h. at 40°C, %, max.	275	295	275 (MTAC) ⁽⁶⁾
Oil consumption, L, max.	5.2	-	-
Sequence IIIG , ASTM D7320, alternative to IIIF			
EOT viscosity increase at 40°C, %, max.			150 (MTAC) ⁽⁶⁾
Roller Follower Wear Test (RFWT) , ASTM D5966			
Run number	0.30	1 / 2 / 3 0.30 / 0.33 / 0.36	1 / 2 / 3 0.30 / 0.33 / 0.36
Average pin wear, mils, max. or µm, max.	7.6	7.6 / 8.4 / 9.1	7.6 / 8.4 / 9.1
Engine Oil Aeration Test (EOAT) , ASTM D6894			
Aeration, vol %, max.	-	8.0	8.0 (MTAC)
Mitsubishi 4D34T4 , JASO M 354			
Valve train wear, cam lobe wear, µm, max.	-	95	-
OM 441 LA , CEC L-52-T-97 ⁽⁶⁾			
Bore polishing, average, %, max.	2.0	2.0	2.0
Piston deposits, average, merit, min.	25.0	25.0	25.0
Boost pressure loss at 400 h., %, max.	4	4	4
Specific oil consumption, kg/test, max.	40	40	40

DETROIT DIESEL CORPORATION

Power Guard Oil Specifications (PGOS) - 3 -



Oronite

Specifications	93K214	93K215	93K218
Engine tests			
OM 501 LA, CEC L-101-09⁽⁷⁾			
Piston cleanliness average, merit, min.	-	-	19.0
Ring sticking 2 nd ring, ASF, max.	-	-	1.0
Engine sludge average, merit, min.	-	-	9.0
General engine deposits average, demerit, max.	-	-	2.0
Wear rating (visual) average, demerit, max.	-	-	3.0
Bore polishing average, %, max.	-	-	2.0
Cylinder wear average, mm, max.	-	-	0.008
Turbocharger deposits, demerit, max.	-	-	2.0
TBN (ASTM D4739) at end of test, mg KOH/g	-	-	Rate & Report
TAN (ASTM D664) at end of test, mg KOH/g	-	-	Rate & Report
Specific oil consumption, g/h, max.	-	-	30.0
OM 646 DE22LA wear test, CEC L-099-08⁽⁷⁾			
Cam wear inlet/outlet valve (average wear 8 cams), µm, max.	-	-	100 / 130
Cylinder wear (average 4 cylinders), µm, max.	-	-	5.0
Bore polishing (13 mm), %, max. value of 4 cylinders	-	-	3.5
Piston cleanliness (average 4 pistons), merit, min.	-	-	12.0
Engine sludge average, merit, min.	-	-	8.8
Ring sticking	-	-	No
Tappet wear inlet (average wear 8 cams), µm	-	-	Rate & Report
Tappet wear outlet (average wear 8 cams), µm	-	-	Rate & Report
Bearing wear main/con rod bearing, µm, max. ⁽⁹⁾	-	-	2.1 / 2.1
Piston ring wear axial at ring 1/ring 2/ring 3, µm, max. ⁽⁹⁾	-	-	10.4 / 6.0 / 5.0
Piston ring wear radial at ring 1/ring 2/ring 3, µm, max. ⁽⁹⁾	-	-	10.0 / 12.0 / 8.0
Timing chain wear (elongation), %, max.	-	-	0.4
Oil consumption, g/test, max.	-	-	7000
Soot, %, max.	-	-	4.0 - 7.0
Viscosity increase at 100°C, %, max.	-	-	100

DETROIT DIESEL CORPORATION

Power Guard Oil Specifications (PGOS) - 4 -



Oronite

Specifications		93K214	93K215	93K218
Engine tests				
Caterpillar 1K or 1N , ASTM D6750	Run number	1K (1N)⁽¹⁰⁾	1K	1N
Weighted total demerits (WDN), max.		332 (286)	1 / 2 / 3 332 / 347 / 353	1 / 2 / 3 286.2 / 311.7 / 323.0
Top groove fill (TGF), %, max.		24 (20)	24 / 27 / 29	20 / 23 / 25
Top land heavy carbon (TLHC), %, max.		4 (3)	4 / 5 / 5	3 / 4 / 5
Oil consumption, 0-250 h., average, g/kWh, max.		0.5 (0.5)	0.5 / 0.5 / 0.5	0.5 / 0.5 / 0.5
Piston ring sticking and liner scuffing		None (None)	None	None
Caterpillar 1R , ASTM D6923, 1P , ASTM D6681	Run number	1R	1P	
Weighted total demerits (WDR), max.		382	1 / 2 / 3 350 / 378 / 390	-
Top groove carbon fill (TGC), %, max.		52	36 / 39 / 41	-
Top land carbon (TLC), %, max.		31	40 / 46 / 49	-
Oil consumption		-	14.4 / 14.6 / 14.6	-
Initial, 0-252 h., g/h, max.		13.1	-	-
Final, 432-504 h., g/h, max.		Initial + 1.8	-	-
Piston ring and liner scuffing		None	None	-
Caterpillar C13 , ASTM D7484				
Merit rating, min.		-	-	1000
Hot stuck piston rings		-	-	None
Top land carbon (TLC)		-	-	Rate & Report
Top groove carbon (TGC)		-	-	Rate & Report
Cummins M11 EGR , ASTM D6975 ⁽¹¹⁾				
Crosshead total weight loss at 4.6% average soot, mg, max.		20.0	-	-
Top ring weight loss, mg, max.		175	-	-
Oil filter ΔP at 250 h., kPa, max.		275	-	-
Engine sludge, average, CRC merits, min.		7.80	-	-
Cummins M11 , ASTM RR: D02 1439	Run number		1 / 2 / 3	
Crosshead weight loss, mg, max.		-	6.5 / 7.5 / 8.0	-
Oil filter ΔP at end-of-test, kPa, max.		-	79 / 93 / 100	-
Sludge rating, merits, min.		-	8.7 / 8.6 / 8.5	-

DETROIT DIESEL CORPORATION

Power Guard Oil Specifications (PGOS) - 5 -



Oronite

Specifications	93K214	93K215	93K218
Engine tests			
Cummins ISM , ASTM D7468	Run number		1 / 2 / 3
Merit rating, min.	-	-	1000
Top ring weight loss, mg, max.	-	-	100 / 100 / 100
Crosshead weight loss, average, mg	-	-	Rate & Report
Cummins ISB , ASTM D7549	Run number		1 / 2 / 3
Slider tappet weight loss, mg, average, max.	-	-	100 / 108 / 112
Cam lobe wear, µm, average, max.	-	-	55 / 59 / 61
Crosshead weight loss, average, mg	-	-	Rate & Report
Mack T-8E , ASTM D5967	Run number	1 / 2 / 3	
Relative viscosity at 100°C at 4.8% soot, max. ⁽¹²⁾	-	2.1 / 2.2 / 2.3	-
Viscosity increase at 100°C at 3.8% soot, mm ² /s, max.	-	11.5 / 12.5 / 13	-
Mack T-10 , ASTM D6987	Run number	1 / 2 / 3	
Merit rating, min.	1000	1000	-
Liner wear, average, µm, max.	32	32 / 34 / 35	-
Top ring weight loss, average, mg, max.	158	150 / 159 / 163	-
EOT used oil/new oil lead content, ppm, max.	35	50 / 56 / 59	-
Lead increase from 250 to 300 h., ppm, max.	14	-	-
Oil consumption, average, g/h, max.	65	65	-
Mack T-11 , ASTM D7156	Run number		1 / 2 / 3
Soot at 12.0 cSt increase at 100°C from 90 pass sheared (ASTM D6278 mod.) new oil as interpolated from 2 data points, %, min.	6.00	-	-
TGA soot at 4.0 mm ² /s increase at 100°C, %, min.	-	-	3.5 / 3.4 / 3.3
TGA soot at 12.0 mm ² /s increase at 100°C, %, min.	-	-	6.0 / 5.9 / 5.9
TGA soot at 15.0 mm ² /s increase at 100°C, %, min.	-	-	6.7 / 6.6 / 6.5
Mack T-12 , ASTM D7422			
Merit rating, min.	-	-	1000

Notes:

(1) Please refer to chapter «Elastomer compatibility» for limits

(2) According to ASTM D7216

(3) According to CEC L-039-96

(4) Option A is allowed

(5) Either the Sequence IIIF of Sequence IIIG requirement shall be met

(6) Requirement can be satisfied by submitting MB 228.3 approval documentation and information relating the candidate formulation and that tested

(7) Requirements for the OM 501 LA and/or the OM646DE22LA engine tests may be satisfied by a MB trading approval for MB 228.31

or 228.51 on the candidate formulation

(8) Only for xW-30 or OW-40: evaluation of bearing wear in an OM 501 LA engine with new crankshaft and premeasured bearings is required. Rerating by Daimler at TP/PHC

(9) The worst result (outlier result) will be replaced by the second worst to calculate the average to control outliers

(10) Requirement can be satisfied with passing result from either Caterpillar 1K or 1N test

(11) M11 EGR tests ending after March 1, 2003 may not be used to satisfy this requirement. The Mack T10 (ASTM D6981) Top Ring Weight Loss max. limit of 140 mg then applies

(12) Relative viscosity = viscosity at 4.8 % soot / viscosity of new oil sheared in ASTM D6278

DEUTZ lubricating oil Quality Classes (DQC)

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Oronite

Specifications	DQC I-02	DQC II-10	DQC II-10 LA
Viscosity grades (SAE J300)	xW-30, xW-40, 15W-50, 20W-50 (x = 0, 5, 10, 15)		
ACEA / API performance level	ACEA E2-96, API CF, CF-4	ACEA E3-96, E4-08, E5-02, E7-08, API CG-4, CH-4, CI-4, CI-4 PLUS, DHD-1	ACEA E6-08, E9-08, API CJ-4

DEUTZ lubricating oil Quality Classes (DQC)

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Oronite

Specifications	DQC III-10	DQC III-10 LA	DQC IV-10	DQC IV-10 LA
Viscosity grades (SAE J300)	xW-30, xW-40, 10W-40 (x = 0, 5) ⁽¹⁾		xW-30, xW-40, 10W-40 (x = 0, 5) ⁽¹⁾	
ACEA	ACEA E7-08 ⁽²⁾	ACEA E9-08 ⁽²⁾	ACEA E7-08, E4-08 ⁽²⁾	ACEA E9-08, E6-08 ⁽²⁾
Laboratory tests				
Density at 15°C, DIN ISO EN 12185, DIN 51757, ASTM D4052	Report		Report	
Viscosity at 40°C, DIN EN ISO 3104, DIN 51562-1, ASTM D445, mm²/s at 100°C	Report Report		Report Report	
Viscosity index , VI, DIN ISO 2209, ASTM D2270	Report		Report	
Shear stability , CEC L-014-93, ASTM D6278 Viscosity at 100°C after 30 cycles, mm²/s Viscosity at 100°C after 90 cycles, mm²/s	Stay in grade Stay in grade		Stay in grade Stay in grade	
Low temperature cranking viscosity , DIN 51377, ASTM D5293, mPa.s	Report		Report	
HTHS viscosity , CEC L-036-90, mPa.s, min.	3.5		3.5	
Evaporative loss , Noack, CEC L-040-93, DIN 51581-13, %, max.	12		11	
TAN , DIN EN 12634, ASTM D664, mg/KOH/g	Report		Report	
TBN , ASTM D2896, mg KOH/g, min.	9	7	12	7
Sulfated ash , ASTM D874, % m/m, max.	2.0	1.0	2.0	1.0
Ca, Mg, Zn, Mo, Bo, Na, Si , DIN 51391-2, -3, 51399-1, -2, ASTM D4951	Report		Report	
Phosphorus , DIN 51399-1, -2, ASTM D4951, % m/m, max.	Report	0.12	Report	0.08
Sulfur , DIN 51399-1, -2, ASTM D4951, % m/m, max.	Report	0.4	Report	0.4
Flash point , COC, DIN EN ISO 2592, ASTM D92, °C, min.	Report		Report	

DEUTZ lubricating oil Quality Classes (DQC)

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Oronite

Specifications	DQC III-10	DQC III-10 LA	DQC IV-10	DQC IV-10 LA
Pourpoint , DIN ISO 3016, ASTM D97, °C, max.	Report		Report	
Oxidation induction time , PDSC, CEC L-085-99, min., min.	70		110	
Corrosion , HTCBT, ASTM D6594				
Copper, ppm increase, max.	20		20	
Lead, ppm increase, max.	90		70	
Copper strip rating (ASTM D130), max.	3		3	
Elastomer compatibility , CEC-L-039-96 ⁽³⁾ ⁽⁴⁾	as ACEA		as ACEA	
Foaming tendency , ASTM D892, no option A, ml, max.	as ACEA		as ACEA	
High temp foaming tendency , ASTM D6082, ml, max.	as ACEA		as ACEA	
Turbocharger deposits , MTV 5040, DIN 51535, mg, max.	110	110	80 ⁽⁵⁾	90 ⁽⁵⁾
Engine tests				
OM 646 LA , CEC L-099-08				
Cam wear outlet (average max. wear 8 cams), µm, max.	140	140	120	120
Cam wear inlet (average max. 8 cams), µm, max.	110	110	100	100
Cylinder wear (average 4 cyl.), µm, max.	5.0	5.0	5.0	5.0
Bore polishing (13 mm) (max. of 4 cyl.), %, max.	3.5	3.5	3.0	3.0
Tappet wear inlet (average max. wear 8 cams), µm, max.	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Tappet outlet wear (average max. wear 8 cams), µm, max.	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Viscosity increase at 100°C, %, max.	100	100	100	100
Oil consumption, kg/test, target value, max.	7	7	7	7

DEUTZ lubricating oil Quality Classes (DQC)

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Oronite

Specifications	DQC III-10	DQC III-10 LA	DQC IV-10	DQC IV-10 LA
OM 602 A , CEC-L-51-A-97, alternative to OM 646 LA				
Viscosity increase at 40°C, %, max.	90	90	90	90
Cam wear, average, µm, max.	50.0	50.0	50.0	50.0
Cylinder wear (average 4 cyl.), µm, max.	20.0	20.0	20.0	20.0
Bore polishing, %, max.	7.0	7.0	7.0	7.0
Oil consumption, kg/test, max.	10	10	10	10
Piston cleanliness, average, merit	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Sludge, merit	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Mack T-11 , ASTM D7156				
Minimum TGA soot at 4.0 mm²/s increase at 100°C, %, max.	-	3.5 / 3.4 / 3.3	-	-
Minimum TGA soot at 12.0 mm²/s increase at 100°C, %, max.	6.0 / 5.9 / 5.9	6.0 / 5.9 / 5.9	6.0 / 5.9 / 5.9	6.0 / 5.9 / 5.9
Minimum TGA soot at 15.0 mm²/s increase at 100°C, %, max.	-	6.7 / 6.6 / 6.5	-	-
Mack T-8E , ASTM D5967, alternative to Mack T-11	1 / 2 / 3		1 / 2 / 3	
Relative viscosity at 4.8% soot (300 h.), %, max.	2.1 / 2.2 / 2.3	-	2.1 / 2.2 / 2.3	-
OM 501 LA , CEC L-101-08				
Bore polishing, average, %, max.	2.0	2.0	1.0	1.0
Piston cleanliness, average, merit, min.	17	17	26	26
Specific oil consumption, g/test, max.	9	9	9	9
Engine sludge, average, merit, min.	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Wear rating (visual), average, demerit, max.	Rate & Report	Rate & Report	Rate & Report	Rate & Report
General engine deposits, average, demerit, max.	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Cylinder wear, average, µm, max.	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Ring sticking piston ring 2, ASF, max.	Rate & Report	Rate & Report	Rate & Report	Rate & Report
OM 441 LA , CEC L-52-T-97, alternative to OM 501 LA				
Bore polishing, average, %, max.	2.0	2.0	2.0	2.0
Piston cleanliness, average, merit, min.	25	25	40	40
Boost pressure loss, 400 h., %, max.	3	3	2	2
Specific oil consumption, kg/test, max.	40	40	40	40
Engine sludge, average, merit, min.	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Wear rating (visual), average, demerit, max.	Rate & Report	Rate & Report	Rate & Report	Rate & Report
General engine deposits, average, demerit, max.	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Cylinder wear, average, µm, max.	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Ring sticking piston ring 2, ASF, max.	Rate & Report	Rate & Report	Rate & Report	Rate & Report

DEUTZ lubricating oil Quality Classes (DQC)

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Oronite

Specifications	DQC III-10	DQC III-10 LA	DQC IV-10	DQC IV-10 LA
Cummins ISM , ASTM D7468				
Rocker pad weight loss at 3.9% soot, average, mg, max.	7.5	7.1	7.5	7.1
Oil filter ΔP at 150 h., kPa, max.	55	19	55	19
Engine sludge, CRC merit at EOT, min.	8.1	8.7	8.1	8.7
Adjusting screw weight loss, mg, max.	-	49	-	49
Cummins M11 EGR , ASTM D6975, alternative to Cummins ISM				
Rocker pad weight loss, average, mg, max.	20.0	-	20.0	-
Top ring weight loss, average, mg, max.	Rate & Report	-	Rate & Report	-
Oil filter ΔP at 250 h., kPa, max.	275	-	275	-
Engine sludge, CRC merit at EOT, min.	7.8	-	7.8	-
Cummins M11 , ASTM D6838, alternative to Cummins M11 EGR				
Rocker pad weight loss at 4.5% soot, average, mg, max.	6.5	-	6.5	-
Oil filter ΔP at end-of-test, kPa, max.	79	-	79	-
Engine sludge, average, merit, min.	8.7	-	8.7	-
Mack T-12 , ASTM D7422				
Merit rating, min.	1150 ⁽⁷⁾	1150 ⁽⁷⁾ / 1200 ⁽⁶⁾	1300 ⁽⁶⁾	1300 ⁽⁷⁾ / 1400 ⁽⁶⁾
Liner wear, μm, max.	26	24	26	24
Top ring weight loss, mg, max.	117	105	117	105
Lead end-of-test, mg/kg, max.	42	35	42	35
Delta lead 250-300 h., mg/kg, max.	18	15	18	15
Oil consumption (phase II), g/h, max.	95	85	95	85
Mack T-10 , ASTM D6987, alternative to Mack T-12				
Merit rating, min.	1150	-	1400	-
Liner wear, μm, max.	32	-	32	-
Top ring weight loss, mg, max.	158	-	158	-
Lead end-of-test, mg/kg, max.	35	-	35	-
Delta lead 250-300 h., mg/kg, max.	14	-	14	-
Oil consumption (phase II), g/h, max.	65	-	65	-

Notes:

(1) SAE classes 10W-30, 15W-30 and 15W-40 will also be accepted when the specified limit values are fulfilled

(2) Requirements for Deutz specifications may be higher than ACEA

(3) Use either the most recent complete Daimler requirements + RE3, or complete requirements + Daimler requirements for AEM

(4) Please refer to chapter «Elastomer compatibility» for limits

(5) Variation of DIN 51535: calibration with RL 206 and FES T-XH5-12

(6) Merit calculation as per API CI-4

(7) Merit calculation as per API CJ-4

FORD MOTOR COMPANY active Ford engine oil specifications

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Oronite

WSS FORD specification	M2C171-E	M2C913-C	M2C913-D	M2C917-A	M2C925-B	M2C929-A (5W-30) M2C930-A (5W-20)	M2C945-A (5W-20) M2C946-A (5W-30) M2C947-A (0W-20)	M2C948-B	M2C950-A
Fill type	Initial / Service	Service	Initial for Diesels / Service	Initial / Service	Initial / Service	929 = service/ 930 = initial	Initial / Service	Service ⁽⁹⁾	Initial / Service
Application	Diesel	All Diesels worldwide where fuel Sulfur level is ≤ 300 ppm ⁽¹⁾ . Allowed for Gasoline in some markets ⁽¹⁾	All Diesels worldwide. Allowed for Gasoline in some markets	Ford Ka, consult Ford for requirements	Gasoline (fuel economy)	Gasoline	Gasoline	Gasoline worldwide excl. North America	New MY 2015 Mondeo and Focus with new 2.0 Diesel engine
Fuel type	Diesel	Diesel & Gasoline (max. 300 ppm S)	Diesel & Gasoline	Diesel & Gasoline	Gasoline	Gasoline	Gasoline	Gasoline	Diesel & Gasoline
Main region	US	Worldwide, excl. North America	Worldwide, excl. North America	Europe	Scheduled to be phased out	Scheduled to be phased out	US + Mexico + Latin America + China	Worldwide, excl. North America	Europe
ILSAC or API and ACEA required level	API CJ-4	A5/B5 ⁻⁰⁸	A5/B5 ⁻¹⁰	C3 ⁻⁰⁸	A5/B5 ^{-08 (2)}	GF-4	GF-5	C2 ⁻¹² without M111FE	C2 ⁻¹² without M111FE
Acceptable SAE grades	According API CJ-4	5W-30	5W-30	5W-40	5W-20	5W-30 / 5W-20	5W-30 / 5W-20	5W-20	0W-30
HTHS viscosity , CEC L-036-90, mPa.s	-	≥ 2.9 & < 3.5	≥ 2.9 & < 3.5	-	≥ 2.9 & < 3.5	-	According SAE J300	≥ 2.6 & < 2.9	≥ 2.9 & < 3.5
HTHS viscosity , CEC L-036-90 after CEC L-014-88 or ASTM D6278, mPa.s, min.	-	2.9	2.9	2.9	2.6	-	-	2.6	2.6
Shear stability , CEC L-014-93 or ASTM D6278, Kin. viscosity, mm ² /s	-	9.3 - < 12.5	9.3 - < 12.5	-	≥ 6.8 - < 9.3	-	-	≥ 6.8 - < 9.3	Stay in grade
Noack , ASTM D5800, %, max.	-	13	13	13	13	15	15	13	13
Sulfated ash , ASTM D874, % m/m, max.	-	1.3	1.3	-	1.3	-	-	0.8	0.8
Phosphorus , ASTM D4951, % m/m	-	≤ 0.1	≤ 0.1	-	≤ 0.1	≤ 0.08	≥ 0.06 & ≤ 0.08	≥ 0.06 & ≤ 0.08	≥ 0.06 & ≤ 0.09

FORD MOTOR COMPANY active Ford engine oil specifications

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Oronite

WSS FORD specification	M2C171-E	M2C913-C	M2C913-D	M2C917-A	M2C925-B	M2C929-A (5W-30) M2C930-A (5W-20)	M2C945-A (5W-20) M2C946-A (5W-30) M2C947-A (0W-20)	M2C948-B	M2C950-A
Sulfur , ASTM D4951, or ASTM D5453, max.	-	Rate & Report	Rate & Report	-	Rate & Report	0.50	0.50	0.3	0.3
TBN , ASTM D2896, mg KOH/g, min.	-	8.0	10.0	-	8.5	-	-	7.5	7.0
Copper corrosion , ASTM D130, rating, max.	-	1b	1b	-	1b	1b	1b	1b	1b
Gelation index , ASTM D5133, max.	-	12	12	-	12	12	12	12	12
TEOST MHT4 , ASTM D7097, high temp. dep., mg, max.	-	35	35	-	35	30	35	35	35
Ball rust test , ASTM D6557, average grey value, min.	-	100	100	-	100	100	100	100	100
Daimler biodiesel oxidation test , average of 3 runs, A/cm, max.	-	-	50	-	-	-	-	-	35
Aged oil low temperature viscosity , Seq. IIIGA or ROBO, ASTM D7528 or D7320, mPa.s	-	-	EOT sample must show no yield stress. D4684 below SAE J300. If CCS used ≤ CCS grade then run MRV TP-1 @ original grade if CCS used ≥ max. original grade then run MRV TP-1 @ next higher grade.	-	-	-	-	≤ 60.000	≤ 60.000
Ford timing belt compatibility , CEC-L-039-96 procedure	-	-	Pass ⁽⁴⁾	-	-	-	-	Pass ⁽⁴⁾	Pass ⁽⁴⁾

FORD MOTOR COMPANY active Ford engine oil specifications

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Oronite

WSS FORD specification	M2C171-E	M2C913-C	M2C913-D	M2C917-A	M2C925-B	M2C929-A (5W-30) M2C930-A (5W-20)	M2C945-A (5W-20) M2C946-A (5W-30) M2C947-A (0W-20)	M2C948-B	M2C950-A
M111 fuel economy , CEC L-054-96, average of 3 tests, %	-	≥ 3.0	≥ 3.0	-	≥ 3.3	-	-	-	-
Ford Gasoline fuel economy test @ ISP, %	-	-	-	-	-	-	-	> 0.6% vs 5W-20 WSS M2C925-B ref. oil	> 0.6% vs 5W-20 WSS M2C925-B ref. oil
Ford Diesel fuel economy test @ ISP, %	-	-	-	-	-	-	-	-	> 0.75% vs 5W-30 WSS M2C913-D ref. oil
Ford Gasoline durability test @ ISP	-	-	-	-	-	-	-	Pass	-
Ford Diesel test for chain wear @ ISP	-	-	Pass	-	-	-	-	-	Pass

Notes:

- (1) Can be used in regions with higher S fuel levels up to 3000 ppm, but with reduced drain interval
- (2) ACEA A5/B5 quality, but in 5W-20 viscosity grade
- (3) For Initial Fill M2C948-A is used. This spec has the Seq. VID added
- (4) Please refer to chapter «Elastomer compatibility» for limits

GM engine oil specifications

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Oronite

Specification	dexos 1™	dexos 2™
Application	Factory fill: Gasoline Worldwide (incl. E85, CNG, LPG) Service fill: Gasoline excluding European region	Factory fill: Diesel worldwide Service fill: Diesel and Gasoline in European region
Laboratory tests		
SAE viscosity grade, service Fill , SAE J300	0/5W-20/30	0/5W-30/40
SAE viscosity grade, factory Fill , SAE J300	0/5W-20/30	5W-30, 0W-40
HTHS viscosity , CEC L-36-A-90 or ASTM D4741, mPa*s, min.	2.9	3.5
Noack volatility , CEC L-40-A-93, % loss (B method), max.	13.0%	13.0%
Sulfated ash , ASTM D874, % m/m, max.	1.0	0.8
TBN , ASTM D2896, mg KOH/g, min.	6.0	6.0
Chlorine , ISO 15597, mg/kg, max.	150	150
Phosphorus , DIN 51363 -2/-3 or ASTM D4951, mg/kg	≤ 850	≥ 700 & ≤ 900
Sulfur , DIN ISO 14596 or ASTM D2622, mg/kg, max.	4500	3500
Ball rust test , TM D6557, average grey value, min.	100	100
Corrosion performance GMW16073, max.	0 (no corrosion) ⁽¹⁾	0 (no corrosion) ⁽¹⁾
Foaming tendency		
Sequence I (24°C) ASTM D892 w/option A, ml. max.	10 / 0	10 / 0
Sequence II (94°C) ASTM D892 w/option A, ml. max.	50 / 0	50 / 0
Sequence III (24°C) ASTM D892 w/option A, ml. max.	10 / 0	10 / 0
Sequence IV (150°C) ASTM D6082, ml. max.	100 / 0	100 / 0
Elastomer compatibility⁽²⁾	Elastomer type: RE-1, RE-4 AEM SAE J2643: ACM-1, HNBR-1, VMQ-1	Elastomer type: RE-1, RE-4 AEM SAE J2643: ACM-1, HNBR-1, VMQ-1

Notes:

(1) For factory fill only

(2) Please refer to chapter «Elastomer compatibility» for limits

GM engine oil specifications

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Oronite

Requirements	dexos 1™	dexos 2™
Engine tests, ACEA		
High temperature deposits, ring sticking, oil thickening, TU5JP-L4, CEC-L-088-02		
Ring sticking (each part), merit, min.	9.0	9.0
Piston varnish (6 elements, average of 4 pistons), merit, min.	RL 216	RL 216
Absolute viscosity increase at 40°C between min. and max. values during test, mm²/s, max.	0.8 x RL 216	0.8 x RL 216
Oil consumption, kg/test	Rate & Report	Rate & Report
Low temperature sludge, Sequence VG, ASTM D6593-00		
Average engine sludge, merit, min.	8.3	8.3
Rocker cover sludge, merit, min.	8.5	8.5
Average piston skirt varnish, merit, min.	7.5	7.5
Average engine varnish, merit, min.	8.9	8.9
Compression ring (hot stuck)	None	None
Oil screen clogging, %, max.	10	10
Valve train scuffing wear, TU3M, CEC-L-038-94		
Cam wear, average, mm., max.	10	10
Cam wear, max., mm, max.	15	15
Pad merit (average of 8 pads), merit, min.	7.5	7.5
Black sludge, M271, MB method		
Engine sludge, average, merit, min.	RL140 + 4σ	RL140 + 4σ
Fuel economy, M111, CEC-L-054-96		
Fuel economy improvement vs ref. oil RL 191 (15W40), %, min.	-	2%
Medium temperature dispersivity, DV4TD, CEC-L-093-04		
Absolute viscosity increase at 100°C and 6% soot, mm²/s, min.	-	0.6 x RL 223 result

GM engine oil specifications

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Oronite

Requirements	dexos 1™	dexos 2™
Engine tests, ACEA		
Wear, OM646LA, CEC-L-099-08		
Cam wear outlet (average max. wear 8 cams), mm, max.	-	120
Cam wear inlet (average max. 8 cams), µm, max.	-	100
Cylinder wear (average 4 cyl.), µm, max.	-	5.0
Bore polishing (13mm) (max. of 4 cyl.) , %, max.	-	3
Tappet wear inlet (average max. wear 8 cams) , mm.	-	Rate & Report
Tappet outlet wear (average max. wear 8 cams), mm.	-	Rate & Report
Piston cleanliness (average 4 pistons), merit.	-	Rate & Report
Oil consumption, kg/test	-	Rate & Report
Engine sludge average, merit.	-	Rate & Report
DI Diesel piston cleanliness & ring sticking, VW TDI, CEC-L-078-99		
Piston deposits, merit, min.	-	> RL 206 + Std dev
Ring sticking. average 1 st grade, ASF, max.	-	1.0
Ring sticking. Max. 1 st /2 nd grade, ASF, max.	-	1 / 0
End of test TBN, DIN 51639-1, mgKOH/g, min.	-	Rate & Report
End of test TAN, ASTM D 664, max.	-	Rate & Report

Notes:

(1) M271 Sludge can be used instead of M111SL as approved by ACEA

(2) OM 602A (CEC-L-51-A-98) can be used instead of OM 646LA results, but only until OM 646LA (CEC L-099-08) becomes available

GM engine oil specifications

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Oronite

Requirements	dexos 1™	dexos 2™	dexos 2™
Engine tests, API and GM			
High temperature deposits, ring sticking, oil thickening⁽³⁾ Seq. I/II/III/IV, ASTM D7320 Viscosity increase at 40°C, %, max. Weighted piston deposits, merit, min. Ring sticking (hot stuck) Average cam + lifter wear, µm, max. Oil consumption, l. Aged oil low temperature pumping viscosity, ASTM D4684, mPa*s	150 4.5 None 60 Rate & Report Pass equal or next higher grade		150 4.5 None 60 Rate & Report Pass equal or next higher grade
Bearing corrosion , Sequence VIII, ASTM D6709 Bearing weight loss, mg, max. 10h. stripped viscosity, mm²/s	26 Stay in grade		26 Stay in grade
Fuel economy , Sequence VID, ASTM D7589 FEI 2, %, min. Sum of FEI, %, min.	0W-20 1.2 2.6	0W-30 0.9 1.9	- - -
Aeration test , GMPT-T MEC024 Aeration rate of candidate vs ref. oil Max. difference in aeration of aged candidate vs ref. oil	Candidate ≥ ref. oil EOT candidate oil - Fresh reference oil < +2		Candidate ≥ ref. oil EOT candidate oil - Fresh reference oil < +2
Valve-train wear test , GMPT-T DUR021, RNT method Cam wear max., nm/h, max. Tappet wear max. nm/h, max.	5 2		5 2
Oil release test (Gasoline) , OP1, GMPT-T DUR020 Function test, oil pressure, bar Run-in oil consumption, g/h Viscosity increase at 40°C, %, max. TAN at EOT, mg KOH/g, max. Nitration at EOT, A/cm, max.	Pass 15 - 39 130 8.0 30		Pass 15 - 39 130 8.0 30

Notes:

(3) GM does NOT accept the ROBO test as replacement for the oil aging phase for the Sequence I/II/III/IV test

GM engine oil specifications

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Oronite

Requirements	dexos 1™	dexos 2™
Engine tests, API and GM		
Oil release test (Diesel), GMPTE-T DUR019		
Piston ring clearance 1 st ring (average), mm, max.	-	0.05
Piston ring clearance 2 nd ring (average), mm, max.	-	0.15
Piston ring clearance 3 rd ring (average), mm, max.	-	0.08
Connecting rod bearing wear, µm, max.	-	3
Main bearing wear (average), µm, max.	-	3
Camshaft wear (average) µm, max.	-	10
Timing chain elongation, mm, max.	-	0.8
Duplex chain elongation, mm, max.	-	0.7
Balancer chain elongation, mm, max.	-	1.5
Piston cleanliness, merit	-	Rate & Report
Oil consumption, g/h, max.	-	15
Blow-by (max.), l/min., max.	-	50
Viscosity increase at 100°C and 2.5 wt% soot, mm ² /s, max.	-	6.0

IVECO engine oil requirements



Oronite

Engine family	Oil specification	Preferred viscosity	Oil drain interval
Family 1 (Daily) 2.3 l - 3.0 L	ACEA B5 ACEA C2 ACEA E7 ⁽¹⁾	5W-30 5W-30 15W-40	40000 km 40000 km 40000 km
Tector (Eurocargo) 3.9 L - 5.8 L	ACEA E2 ACEA E7 ACEA E4 Euro VI ACEA E9 Euro VI ACEA E6	15W-40 15W-40 5W-30 10W-40 5W-30	20000 - 40000 km 30000 - 60000 km 40000 - 80000 km 40000 - 80000 km 40000 - 80000 km
Cursor 8, 10, 13 (Stralis) 7.8 L, 10.3 L, 12.9 L	ACEA E2 ACEA E7 ACEA E4 Euro VI ACEA E9 Euro VI ACEA E6	15W-40 15W-40 5W-30 10W-40 5W-30	40000 - 50000 km 80000 - 100000 km 100000 - 150000 km 100000 km 150000 km
Tector / Cursor (CNH) 4.5 L, 6.7 L / 8.7 L, 10.3 L, 12.9 L	API CH-4 API CI-4	15W-40 15W-40	600 h 600 h

Notes:

(1) Not for engines with VGT

MACK TRUCKS general engineering specifications

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Oronite

Specifications	EO-N (VDS-3)	EO-N PREMIUM PLUS	EO-O PREMIUM PLUS (VDS-4)
ACEA/API performance level	ACEA E7 and API CI-4	-	-
Viscosity grades (SAE J300)	xW-30, xW-40	xW-40	xW-30, xW-40 (x = 5, 10, 15)
Laboratory tests			
Density , ASTM D1298, kg/m ³	Report	-	Report
Flash point , COC, ASTM D92, °C	Report	-	Report
Pour point , ASTM D97, °C	Report	-	Report
Viscosity , ASTM D445 at 40°C, mm ² /s at 100°C, mm ² /s	Report xW-30: 9.3 - 12.5; xW-40: 12.5 - 16.3	- -	Report xW-30: 9.3 - 12.5; xW-40: 12.5 - 16.3
HTHS viscosity , ASTM D4683, mPa.s, min.	Report	4.2	Report
Shear stability , ASTM D6278, D7109 Viscosity at 100°C after 90 cycles shear, ASTM D445, mm ² /s, min. HTHS viscosity after 90 cycles shear, ASTM D4683, mPa.s, min.	xW-30: 9.3; xW-40: 12.5 xW-30: 3.4; xW-40: 3.7	12.5 3.9	xW-30: 9.3; xW-40: 12.5 xW-30: 3.4; xW-40: 3.9
TBN , ASTM D4739, mg KOH/g, min.	-	10	-
Low temperature cranking viscosity CCS, ASTM D5293, mPa.s, max. MRV, ASTM D4684, mPa.s, max.	Acc. to SAE J300 Acc. to SAE J300	- -	7000 (10W-x at -25°C; 15W-x at -20°C) 60000 (10W-x at -30°C; 15W-x at -25°C)
Base oil viscosity at 100°C , ASTM D445, mm ² /s, min. ⁽¹⁾	Report ⁽¹⁾	6.8 ^{(2) (3)}	xW-30: 6.2; xW-40: 6.5 ⁽¹⁾
Evaporative loss , Noack, ASTM D5800 or CEC L-040-93, %, max	13	13	13
Sulfated ash , ASTM D874, %m/m, max.	-	-	1.0
Phosphorus , ASTM D4951, % m/m, max.	-	-	0.12
Sulfur , phosphorus, sulfur and foaming tendency after evaporative loss.	-	-	0.4
Foaming tendency , ASTM D892 Sequence I, II, III, ml, max.	10 / 0, 20 / 0, 10 / 0	10 / 0, 20 / 0, 10 / 0	10 / 0, 20 / 0, 10 / 0
Corrosion tendency , HTCBT, ASTM D6594 Copper, ppm increase, max. Lead, ppm increase, max. Tin, ppm increase, max. Copper strip rating, max.	20 120 - 3	20 120 50 3	20 120 - 3

MACK TRUCKS general engineering specifications

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Oronite

Specifications	EO-N (VDS-3)	EO-N PREMIUM PLUS	EO-O PREMIUM PLUS (VDS-4)
Laboratory tests			
Hot surface oxidation , PDSC, CEC L-085-99 Oxidation induction time, min., min.	65	-	-
Low temperature pumping viscosity , 180 h. T-11 (A), ASTM D 4684 MRV viscosity at -20°C, mPa.s, max. MRV yield stress, Pa, max.	25000 35	18000	18000 35
Elastomer compatibility , ASTM D7216 ⁽⁹⁾ Nitrile Silicone Polyacrylate FKM Vamac G	Pass Pass Pass Pass Pass	Pass Pass Pass Pass Pass	Pass Pass Pass Pass -
HFRR boundary film ⁽⁶⁾ % film of 3 tests vs reference oil Wear scar diameter of 3 tests vs reference oil	- -	Report Report	- -
Engine tests			
Mack T-11A used oil MRV TP-1 , ASTM D6896 180 h drain MRV viscosity, mPa.s, max MRV yield stress, Pa, max.	25000 ⁽⁷⁾ 35	- -	18000 35
Cummins M11 EGR , ASTM D6975 ⁽⁸⁾ Run number Top ring weight loss, mg, max. Crosshead weight loss at 3.9% soot, average, mg, max. Crosshead weight loss (raw data), average, mg, max. Oil filter ΔP at 250 h., kPa, max. Engine sludge at EOT, average, CRC merit, min.	1 / 2 / 3 - 20.0 / 21.8 / 22.6 at 3.9% soot - 275 / 320 / 341 7.8 / 7.6 / 7.5	175 12 at 4.6% soot Report 275 7.8	- - - - -
Cummins ISM EGR , ASTM D7468 Run number Merit rating, min. Crosshead weight loss at 3.9% soot, mg, max. Oil filter DP at 150 h., kPa, max. Engine sludge, average, merit, min. VAS weight loss at 3.9% soot, average, mg, max.	1 / 2 / 3 - 7.5 / 7.8 / 7.9 55 / 67 / 74 8.1 / 8.0 / 8.0 -	- - - - -	1000 7.1 19 8.7 45

MACK TRUCKS general engineering specifications

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Oronite

Specifications		EO-N (VDS-3)	EO-N PREMIUM PLUS	EO-O PREMIUM PLUS (VDS-4)
Cummins ISB EGR , ASTM D7484	Run number	1 / 2 / 3		1 / 2 / 3
Slider tappet weight loss, average, max.		100 / 108 / 112	-	100 / 108 / 112
Cam lobe wear, average, max.		50 / 53 / 55	-	50 / 53 / 55
Crosshead weight loss, average		Report	-	Report
Mack T8-E , ASTM D5967 ⁽⁹⁾	Run number	1 / 2 / 3		
Relative viscosity at 4.8% soot, max.		1.8 / 1.9 / 2.0	-	-
Slope at 275 h. or 5.8% soot (if reached before 275 h.), max. ⁽¹⁰⁾		0.75	-	-
Mack T11 , ASTM D7156	Run number	1 / 2 / 3		1 / 2 / 3
TGA soot at 4.0 mm ² /s increase, %, min.		3.5 / 3.4 / 3.3	-	3.5 / 3.4 / 3.3
TGA soot at 12.0 mm ² /s increase, %, min.		6.0 / 5.9 / 5.9	6.0	6.0 / 5.9 / 5.9
TGA soot at 15.0 mm ² /s increase, %, min.		6.7 / 6.6 / 6.5	-	6.7 / 6.6 / 6.5
Mack T10 , ASTM D6987/ Mack T12 , ASTM D7422		T10 / T12 ⁽¹¹⁾	T10	T12
Merit rating, min.		1250 / 1250	1500	1300
Cylinder liner wear, µm, max.		32 / 26	26 ⁽¹²⁾	21
Top ring weight loss, mg, max.		158 / 117	120	105
Δ lead 0 - 300 h., ppm, max.		35 / 42	-	30
Δ lead 200 - 300 h., ppm, max.			10	
Δ lead 250 - 300 h., ppm, max.		14 / 18	5	12
Oil consumption, g/h, max.		65 / 95	45	80
OM 501 LA , CEC L-101-08 ⁽¹³⁾				
Piston deposits, average, merit, min.		17	-	-
Bore polishing, average, %, max.		2	-	-
Oil consumption, kg/test, max.		9	-	-
Engine sludge, average, merit		Report	-	-

MACK TRUCKS general engineering specifications

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Oronite

Specifications	EO-N (VDS-3)	EO-N PREMIUM PLUS	EO-O PREMIUM PLUS (VDS-4)
Caterpillar 1R , ASTM D6923			
Weighted total demerit (WDR), max.	-	382	-
Top groove carbon fill, %, max.	-	52	-
Top land carbon, %, max.	-	31	-
Initial average oil consumption, g/h., max.	-	12.1	-
Final average oil consumption, g/h., max.	-	Initial + 1.8	-
Ring and liner scuffing	-	None	-
Caterpillar C13 , ASTM D7484			
Merit rating, min.	-	-	1000
D oil consumption, g/h, max.	-	-	31
TLC, average, demerit, max.	-	-	35
TGC, average, demerit, max.	-	-	53
2 nd ring top face carbon, demerit, max.	-	-	33
Sequence IIIF , ASTM D 6984 / Sequence IIIG , ASTM D7320	IIIF	IIIF	IIIG
EOT viscosity increase at 40°C (adjusted), %, max.	-	80	150
Viscosity increase at 40°C at 100 h. (unadjusted), % [B]	-	25	Report
Viscosity increase at 40°C at 80 h. (unadjusted), % [C]	275	-	Report
Viscosity increase at 40°C at 60 h. (unadjusted), % [D]	-	-	Report
EOT Ratio [(B-C)/(C-D)], max.	-	-	2.5
Roller Follower Wear Test (RWFT) , ASTM D5966 Run number	-		1 / 2 / 3
Pin wear, average, µm, max.		7.6	7.6 / 8.4 / 9.1
Engine Oil Aeration Test (EOAT) , ASTM D6894, %vol, max.	-	8.0	8.0
Turbocharger deposits , CEC ⁽¹⁴⁾			
Boost pressure loss and/or, %, max.	-	-	TBD
Deposit weight, mg, max.	-	-	TBD

MACK TRUCKS general engineering specifications

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Specifications	EO-N (VDS-3)	EO-N PREMIUM PLUS	EO-O PREMIUM PLUS (VDS-4)
Volvo D12D460, TC 415⁽¹⁵⁾		-	
Piston deposits, merit, min.	40	-	40
Ring riding, %, max.	50	-	50
Bore polishing, cm ² , max.	150	-	150
Oil consumption (400 h.), g/h, max.	35	-	35
Oil consumption (final 100 h.), g/h, max.	35	-	35
VDS-3 approval field tests, PK 317E, issue 03	-	Pass	-
Fuel economy D12D460⁽¹⁶⁾, ESC 13 mode, flat and hilly⁽¹⁷⁾, g/kWh, min.	-	-	xW-30: p/n 8715091

Notes:

- (1) If the base oil viscosity is lower than the indicated limits, Mack T10/T12, Cummins ISB and Cummins M11-EGR/ISM test results must be obtained on a formulation with the actual or lower base oil viscosity.
- (2) No base stock substitutions may be made from the approved product to the marketed product without Mack / Volvo Powertrain North America approval. Documentation on oil/additive formulation meeting the requirements must be submitted to Mack / Volvo Powertrain North America. Oil company must agree to participate in Mack Monitoring Program. Monitoring program will be administered by Test Engineering Inc. San Antonio, TX.
- (3) If Base Oil Viscosity (BOV) is not ≥ 6.8 cSt you must provide EHD lubricant film thickness data at 120°C, 30 N load, 1.0-3.0 m/s speed. You will at the same time and on the same equipment test a reference oil supplied by Mack. If candidate oil is equal to or higher in film thickness compared to the reference oil and has a BSV of 6.3 mm²/s or higher, it is approved.
- (4) Please refer to chapter «Elastomer compatibility» for limits
- (5) Additional requirements may be required for factory fill and Volvo Group branded products. Results according to ASTM D7216 or CEC L-039-96 are required. However, results for VAMAC G material according to ASTM D7216 are always required.
- (6) Test to be run at SWRI, test procedure and reference oil provided by Mack Powertrain.
- (7) Results from T10A (or T12A if established and accepted by ASTM) can be used as an alternative to T11A results. Limits as for API CI-4 or CI-4 Plus apply.
- (8) Results from Cummins M11-EGR or Cummins ISM can be used.
- (9) Mack T-11 (ASTM D7156) results obtained as part of API CI-4, CI-4 Plus or CJ-4 approval programs can be used.
- (10) Slope is calculated using derivative of a 3rd order polynomial regression fit of soot vs relative viscosity using the last seven data points (150-300 h).
- (11) Mack T10 or Mack T12 results can be used.
- (12) If measured by Talsurf, PDI measurements are required.
- (13) OM 441LA data can be used. Limits according to ACEA E7-04 Issue 2 apply.
- (14) Test to be developed by CEC. Requirement will be added when test is available.
- (15) Test code Volvo Powertrain Corp.
- (16) Applies only for factory fill and Volvo Group branded products.
- (17) According to Volvo Powertrain Corp. weighting factors.

MAN works standards

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Oronite

Specifications	M3275-1 / 2	M3277 ⁽¹⁾	M3377	M3477	M3575	M3677
ACEA / API performance level	ACEA E7-08 (Issue 2)	ACEA E4-08 (Issue 2)	ACEA E4-12	ACEA E6-12	ACEA E9-08 and API CJ-4	ACEA E6-12
Viscosity grades (SAE J300)	M 3275-1: 5W-x, 10W-x, 15W-x, M 3275-2: 30, 40, 50	0W-x, 5W-x, 10W-x	0W-x, 5W-x, 10W-x	0W-x, 5W-x, 10W-x	xW-30, xW-40	0W-30, 5W-30, 10W-30

Laboratory tests

Density at 15°C, DIN 51757, g/ml	Report	Report	Report	Report	Report	Report
Viscosity at 40°C, DIN 51562-1 at 100°C	Report In acc. with DIN 51511	Report In acc. with DIN 51511	Report In acc. with DIN 51511	Report In acc. with DIN 51511	Report In acc. with DIN 51511	Report In acc. with DIN 51511
Viscosity index , DIN ISO 2909	-	Report	Report	Report	Report	Report
HTHS viscosity , CEC L-36-A-90, mPa.s, min.	3.5	3.5	3.5	3.5	3.5	3.5
Shear stability , DIN EN ISO 20844 Viscosity at 100°C after 90 cycles shear (DIN 51562-1), mm²/s, min.	xW-30: 9; xW-40: 12 30, 40, 50: stay in grade	xW-30: 9; xW-40: 12	xW-30: 9; xW-40: 12	xW-30: 9; xW-40: 12	xW-30: 9; xW-40: 12	Stay in grade
Evaporative loss , NOACK, DIN 51581-1, %, max.	13	12	12	12	13	12
Flash point , COC, DIN EN ISO 2592, °C, min.	215	215	215	215	215	215
Pour point , DIN ISO 3016, °C, max.	5W-x: -40 10W-x: -30 15W-x: -27 30, 40, 50: -	0W-x, 5W-x: -40 10W-x: -30	0W-x, 5W-x: -40 10W-x: -30	0W-x, 5W-x: -40 10W-x: -30	xW-30: -27 xW-40: -30	10W-30: -30 0W-30, 5W-30: -40
TBN , DIN ISO 3771, mg KOH/g, min.	Report	Report	Report	10	Report	10
TAN , ASTM D664, mg KOH/g, min.	Report	Report	Report	Report	Report	Report
Metallic constituents (calcium, magnesium, others), DIN 51399-1	Report	Report	Report	Report	Report	Report
Zinc , DIN 51399-1, % m/m, min.	0.08	Report	Report	Report	Report	Report
Phosphorus , DIN 51399-1, % m/m, max.	Report	Report	0.11	0.08	0.12	0.08
Boron , DIN 51399-1, % m/m	Report	Report	-	Report	Report	Report
Nitrogen (additive) (calculated), % m/m	Report	Report	Report	Report	Report	Report
Sulfated ash , DIN 51575, % m/m, max.	2.0	2.0	1.2 - 1.5	1.0	1.0	1.0
Sulfur in finished oil , DIN EN ISO 14596, (as additive only), % m/m, max.	-	-	0.3	0.3	0.4	0.3

MAN works standards

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Oronite

Specifications	M3275-1 / 2	M3277 ⁽¹⁾	M3377	M3477	M3575	M3677
Laboratory tests						
Ethylen glycol , DIN 51375-2, % m/m, max.	0.05	0.05	0.05	Report	0.05	Report
Turbocharger and intercooler deposits , MTV 5040, DIN 51535, mg, max.	Report	120	120	100	Report	100
Oxidation stability , PDSC, CEC L-085-99, min., min.	-	-	100	100	-	100
Foaming tendency , ASTM D892, (no option A) Sequence I, II, III, ml, max.	10 / 0, 50 / 0, 10 / 0	10 / 0, 50 / 0, 10 / 0	10 / 0, 50 / 0, 10 / 0	10 / 0, 50 / 0, 10 / 0	10 / 0, 50 / 0, 10 / 0	10 / 0, 50 / 0, 10 / 0
Elastomer compatibility , VDA 675 301, M 3273 ⁽⁵⁾	Pass	Pass	Pass	Pass	Pass	Pass
Pass blend analysis , M3353	Pass	Pass	Pass	Pass	Pass	Pass

MAN works standards

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Oronite

Specifications	M3275-1	M3277 ⁽¹⁾	M3377	M3477	M3575	M3677
Engine tests						
OM 501 LA, CEC L-101-08⁽²⁾						
Piston merit, average, merit, min.	17.0	26.0	26.0	-	17.0	26.0
Wear rating (visual), average, demerit, max.	3.0	2.0	2.0	-	3.0	2.0
Bore polishing, average, %, max.	2.0	1.0	1.0	-	2.0	1.0
General engine deposits, average, demerit, max.	2.0	2.0	2.0	-	2.0	2.0
Cylinder wear, average, mm, max.	0.008	0.008	0.008	-	0.008	0.008
Ring sticking, piston ring 2, ASF, max.	1.0	1.0	1.0	-	1.0	1.0
Turbocharger deposits, demerit, max.	2.0	2.0	2.0	-	2.0	2.0
Engine sludge, average, merit, min.	9.0	9.4	9.4	-	9.0	9.4
Specific oil consumption, kg/test, max.	9	9	9	-	9	9
TBN at end-of-test, mg KOH/g	Rate & Report	Rate & Report	Rate & Report	-	Rate & Report	Rate & Report
TAN at end-of-test, mg KOH/g	Rate & Report	Rate & Report	Rate & Report	-	Rate & Report	Rate & Report
OM 646 LA, CEC L-099-08^{(3) (4)}						
Cam wear inlet (average max. 8 cams), µm, max.	110	100	100	-	110	100
Cam wear outlet (average max. wear 8 cams), µm, max.	140	120	120	-	140	120
Cylinder wear (average 4 cyl.), µm, max.	5.0	5.0	5.0	-	5.0	5.0
Bore polishing (13 mm) (max. of 4 cyl.), %, max.	3.5	3.0	3.0	-	3.5	3.0
Tappet wear inlet (average max. wear 8 cams), µm, max.	Rate & Report	Rate & Report	Rate & Report	-	Rate & Report	Rate & Report
Tappet outlet wear (average max. wear 8 cams), µm, max.	Rate & Report	Rate & Report	Rate & Report	-	Rate & Report	Rate & Report
Viscosity increase @ 100°C, %, max.	100	90	90	-	100	90
Oil consumption, kg/test, target value, max.	7	7	7	-	7	7

MAN works standards

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Oronite

Specifications	M3275-1	M3277 ⁽¹⁾	M3377	M3477	M3575	M3677
Engine tests						
MAN in-house test in the D2786 LF04 test engine⁽²⁾						
Engine cleanliness, sludge merit, min.	-	9.0	-	9.0	-	-
Piston cleanliness, merit, min.	-	51.6	-	51.6	-	-
Piston ring wear	-	Rate & Report	-	Rate & Report	-	-
Ring sticking, merit, min.	-	9.7	-	9.7	-	-
Bore polishing, average, %	-	Rate & Report	-	Rate & Report	-	-
Cylinder wear, average, µm, max.	-	2.1	-	2.1	-	-
Rocker arm, tappet, camshaft wear, demerit	-	Rate & Report	-	Rate & Report	-	-
Outlet rocker arm axis wear, µm, max.	-	2.2	-	2.2	-	-
Inlet / outlet valve bridge wear, µm, max.	-	7.3 / 6.4	-	7.3 / 6.4	-	-
Bearings and oil pump	-	Rate & Report	-	Rate & Report	-	-
Total engine deposit, demerit, max.	-	3.0	-	3.0	-	-
Viscosity increase at 4% soot, %, max.	-	45	-	45	-	-
Iron content at 4% soot, mg/kg, max.	-	180	-	180	-	-
Oil consumption, kg in 400 h, max.	-	34.5	-	34.5	-	-
Field test, M 3554						
Field test with three D26 engines rated 440 or 480 hp over 2 x 120,000 km oil drain intervals	-	-	-	-	-	Pass

Notes:

(1) Approval of engine oils and additive packages will be dependent on the results in the test engines OM501LA and OM646LA. Alternatively, these two CEC tests may be replaced with the 400 h test in the MAN D2876 LF04 engine.

(2) Please refer to chapter « Elastomer compatibility » for limits

(3) Test fuel in accordance with EN 590, but with a sulphur content <10 mg/kg and without addition of FAME

MERCEDES-BENZ specifications for heavy duty (service fill) V2012.2

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MB sheet no. ⁽¹⁾	226.9	228.0/1	228.2/3	228.31	228.5	228.51
Mono- / multigrade viscosities	Multi	Mono / multi	Mono / multi	Multi	Multi	Multi
Viscosity grades (SAE J300)	acc. ACEA	acc. ACEA	acc. ACEA	acc. ACEA	acc. ACEA	acc. ACEA
SAE xW-30 and OW-40	No	Yes ⁽⁴⁾	Yes ⁽⁴⁾	Yes ⁽⁴⁾	Yes ⁽⁴⁾	Yes ⁽⁴⁾
Read across guidelines						
MB read across ⁽⁷⁾	No	Yes	Yes	Yes	Yes	Yes
Package pass ⁽⁷⁾	Yes	Yes	Yes	Yes	No	No
ACEA oil sequences required	When any ACEA Ax, Bx, Cx or Ex oil sequence is claimed, then all tests within this oil sequence are mandatory					
API oil categories required, min.	-	-	-	API CJ-4	-	-
DDC oil specification level	-	-	-	93K218	-	-
Laboratory tests						
Sulphated ash , DIN 51575 or ASTM D874, % m/m	≤ 1.0	≤ 2.0	> 1.0 and ≤ 2.0	≤ 1.0	> 1.0 and ≤ 2.0	≤ 1.0
TBN , ISO 3771, ASTM D2896, fresh oil, mg KOH/g, min.	-	6.0	8.0	7.0	12.0	7.0
TBN , ASTM D4739, fresh oil, mg KOH/g, min.	-	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Pour point , ISO 3016, ASTM D97, °C, max.	-27	R & R / -27	R & R / -27	-27	-27	-27
Evaporative loss , Noack, CEC L-040-93, ASTM 5800, %, max.	13	13	13	13	13	12
HTHS viscosity , CEC L-036-90, mPa.s, min.	3.5	3.5	3.5	3.5	3.5	3.5
Zinc , DIN 51391 -2/-3, ASTM D5185/6443, % m/m, min.	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Sulphur , DIN EN ISO 14596, ASTM D5185/2622, % m/m, max.	Rate & Report	Rate & Report	Rate & Report	0.4	Rate & Report	0.3
Phosphorus , DIN 51363 -2/-3, ASTM D5185/4951, % m/m, max.	Rate & Report	Rate & Report	Rate & Report	0.12	Rate & Report	0.08
Chlorine , DIN ISO 51577, ASTM D6443, % m/m, max.	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	0.0150
Daimler oxidation test - Fresh oil , Daimler procedure ⁽⁹⁾	-	-	Pass	Pass	Pass	Pass
Kinematic viscosity at 100°C at EOT 168 h., average 3 runs, mm²/s, max.	-	-	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Oxidation DIN 51453 at EOT 168 h., average 3 runs, A/cm, max.	-	-	60	60	25	25
Δ kinematic viscosity at 100°C, average of 3 runs - absolute, mm²/s, max.	-	-	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Δ kinematic viscosity at 100°C, average of 3 runs - relative, %, max.	-	-	Rate & Report	Rate & Report	Rate & Report	Rate & Report

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Oronite

MB sheet no. ⁽¹⁾	226.9	228.0/1	228.2/3	228.31	228.5	228.51
Daimler oxidation test - with fuel dilution 5% B100 (FAME from OM 646 biodiesel test) (Daimler procedure) ⁽³⁾	-	-	Pass	Pass	Pass	Pass
Kinematic viscosity at 100°C at EOT (168 h.), average 3 runs, mm ² /s, max.	-	-	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Oxidation DIN 51453 at EOT (168 h.), average 3 runs, A/cm, max.	-	-	120	120	90	90
Δ kinematic viscosity at 100°C, average of 3 runs - absolute, mm ² /s, max.	-	-	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Δ kinematic viscosity at 100°C, average of 3 runs - relative, %, max.	-	-	Rate & Report	Rate & Report	Rate & Report	Rate & Report
CEC low temperature pumping test , CEC TDG-L-105 ⁽³⁾	Pass	Pass	Pass	Pass	Pass	Pass
MRV at SAE J300 fresh oil temperature, mPa.s	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
MRV at SAE J300 fresh oil temperature + 5°C, mPa.s	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Yield stress, Pa	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Deposit test , MTU, DIN 51535, mg	-	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Sooted oil MRV T-11/T-11A , ASTM D6896	-	-	-	Pass	-	-
180 h. sample T-11/T-11A drain MRV, mPa.s, max.	-	-	-	18000	-	-
Yield stress, Pa, max.	-	-	-	35	-	-
High Temperature Corrosion Bench Test , HTCBT, modified ASTM D6594 @ 135°C ⁽³⁾		-	Pass	Pass	Pass	Pass
Cu increase - without/with 10% B100*, ppm, max.	-	-	R & R / R & R	20 / R & R	R & R / R & R	R & R / R & R
Pb increase - without/with 10% B100*, ppm, max.	-	-	100 / R & R	120 / R & R	R & R / R & R	R & R / R & R
Copper strip rating - without/with 10% B100*, max.	-	-	R & R / R & R	3 / R & R	R & R / R & R	R & R / R & R
* Ref. fuel B100 (80/20 RME/SME from OM 646 TDG-L-104)						
Shear stability , CEC L-14-93, ASTM D6278 / D7109	Pass @ 30 cycles	Pass @ 30 cycles	Pass @ 30 cycles	Pass @ 90 cycles	Pass @ 90 cycles	Pass @ 90 cycles
Kinematic viscosity at 100°C after 30/90 cycles shearing, mm ² /s	Stay in grade	Stay in grade	Stay in grade	Stay in grade	Stay in grade	Stay in grade
Foaming tendency , ASTM D892	Pass	Pass	Pass	Pass	Pass	Pass
Sequence I, 24°C, ASTM D892 w/o option A, ml, max.	10 / 0	10 / 0	10 / 0	10 / 0	10 / 0	10 / 0
Sequence II, 94°C, ASTM D892 w/o option A, ml, max.	50 / 0	50 / 0	20 / 0	20 / 0	20 / 0	20 / 0
Sequence III, 24°C, ASTM D892 w/o option A, ml, max.	10 / 0	10 / 0	10 / 0	10 / 0	10 / 0	10 / 0
Sequence IV, 150°C, ASTM D6082, after 1 min. settling period, ml	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Elastomer compatibility , CEC L-39-96 ⁽²⁾	ACEA E9	ACEA E7	ACEA E7	ACEA E9	ACEA E4	ACEA E6
Related Daimler Liefervorschrift (DBL)	6610	6610	6610	6610	6610	6610

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MB sheet no. ⁽¹⁾	226.9	228.0/1	228.2/3	228.31	228.5	228.51
Engine tests						
OM 646 DE22LA biodiesel test , CEC TDG-L-104, when ready at CEC	-	Pass	Pass	Pass	Pass	Pass
OM 646 DE22LA wear test , CEC L-099-08 ⁽³⁾	-	Pass	Pass	Pass	Pass	Pass
Cam wear inlet/outlet valve (average wear 8 cams), µm, max.	-	120 / 155	100 / 130	100 / 130	90 / 110	90 / 110
Cylinder wear (average 4 cylinders), µm, max.	-	5.0	5.0	5.0	5.0	5.0
Bore polishing (13 mm), %, max. value of 4 cylinders	-	4.0	3.5	3.5	3.0	3.0
Piston cleanliness (average 4 pistons), merit, min.	-	10.0	12.0	12.0	14.0	14.0
Engine sludge average, merit, min.	-	8.6	8.8	8.8	9.1	9.1
Ring sticking	-	No	No	No	No	No
Tappet wear inlet (average wear 8 cams), µm	-	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Tappet wear outlet (average wear 8 cams), µm	-	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Bearing wear main/con rod bearing, µm, max. ⁽⁵⁾	-	2.1 / 2.1	2.1 / 2.1	2.1 / 2.1	2.1 / 2.1	2.1 / 2.1
Piston ring wear axial at ring 1/ring 2/ring 3, µm, max. ⁽⁵⁾	-	10.4 / 6.0 / 5.0	10.4 / 6.0 / 5.0	10.4 / 6.0 / 5.0	8.7 / 4.0 / 3.0	8.7 / 4.0 / 3.0
Piston ring wear radial at ring 1/ring 2/ring 3, µm, max. ⁽⁵⁾	-	10.0 / 12.0 / 8.0	10.0 / 12.0 / 8.0	10.0 / 12.0 / 8.0	10.0 / 12.0 / 8.0	10.0 / 12.0 / 8.0
Timing chain wear (elongation), %, max.	-	0.4	0.4	0.4	0.4	0.4
Oil consumption, g/test, max.	-	7000	7000	7000	7000	7000
Soot, %, max.	-	4.0 - 7.0	4.0 - 7.0	4.0 - 7.0	4.0 - 7.0	4.0 - 7.0
Viscosity increase at 100°C, %, max.	-	100	100	100	90	90
OM 501 LA Euro 5 , CEC L-101-08 ⁽⁴⁾	-	Pass	Pass	Pass	Pass	Pass
Piston cleanliness average, merit, min.	-	16.0	19.0	19.0	28.0	28.0
Ring sticking 2 nd ring, ASF, max.	-	1.0	1.0	1.0	1.0	1.0
Engine sludge average, merit, min.	-	9.0	9.0	9.0	9.4	9.4
General engine deposits average, demerit, max.	-	3.0	2.0	2.0	2.0	2.0
Wear rating (visual) average, demerit, max.	-	3.0	3.0	3.0	2.0	2.0
Bore polishing average, %, max.	-	3.0	2.0	2.0	1.0	1.0
Cylinder wear average, mm, max.	-	0.008	0.008	0.008	0.008	0.008
Turbocharger deposits, demerit, max.	-	3.0	2.0	2.0	2.0	2.0
TBN, ASTM D4739, at end of test, mg KOH/g	-	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
TAN, ASTM D664, at end of test, mg KOH/g	-	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Specific oil consumption, g/h, max.	-	50.0	30.0	30.0	30.0	30.0

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MB sheet no. ⁽¹⁾	226.9	228.0/1	228.2/3	228.31	228.5	228.51
OM 501 LA Euro 5 fuel economy test (Daimler inhouse test, WHTC, FE vs. MB RL003, 10W-40 ⁽³⁾)			Pass	Pass	Pass	Pass
FE benefit vs. MB RL003 - only required for xW-30, %	-	-	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Mack T-12 EGR , ASTM D7422 ⁽⁸⁾	-	-	-	Pass	-	-
Mack merit rating, min.	-	-	-	1000	-	-
Mack T-11 , ASTM D7156	-	-	-	Pass	-	-
Min. TGA % soot at 4.0 mm ² /s increase at 100°C, %, min.	-	-	-	3.5 / 3.4 / 3.3	-	-
Min. TGA % Soot at 12.0 mm ² /s increase at 100°C, %, min.	-	-	-	6.0 / 5.9 / 5.9	-	-
Min. TGA % Soot at 15.0 mm ² /s increase at 100°C, %, min.	-	-	-	6.7 / 6.6 / 6.5	-	-
Cummins ISM EGR , ASTM D7468 ⁽⁹⁾	-	-	-	Pass	-	-
Cummins merit rating, min.	-	-	-	1000	-	-
Top ring weight loss, mg, max.	-	-	-	100 / 100 / 100	-	-
Cummins ISB EGR , ASTM D7549	-	-	-	Pass	-	-
Slider tappet weight loss, average, mg, max.	-	-	-	100 / 108 / 112	-	-
Cam lobe wear, max. 55, average, µm, max.	-	-	-	55 / 59 / 61	-	-
Crosshead weight loss, mg	-	-	-	Rate & Report	-	-
Caterpillar C13 , ASTM D7484 ⁽⁸⁾	-	-	-	Pass	-	-
CAT merit rating, min.	-	-	-	1000	-	-
Hot-stuck piston ring	-	-	-	None	-	-

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MB sheet no. ⁽¹⁾	226.9	228.0/1	228.2/3	228.31	228.5	228.51
Caterpillar 1N , ASTM D6750	-	-	-	Pass	-	-
Weighted demerits, max.	-	-	-	286.2 / 311.7 / 323.0	-	-
Top groove fill, %, max.	-	-	-	20 / 23 / 25	-	-
Top land heavy carbon, %, max.	-	-	-	3 / 4 / 5	-	-
Oil consumption (0-252 h.), g/kWh, max.	-	-	-	0.5	-	-
Piston/ring/liner scuffing	-	-	-	None	-	-
Piston ring sticking	-	-	-	None	-	-
Sequence IIIF , ASTM D6984	-	-	-	Pass	-	-
EOT kinematic viscosity increase at 40°C, %, max.	-	-	-	275 (MTAC)	-	-
Sequence IIIG , ASTM D7320, (alternative to IIIF)	-	-	-	Pass	-	-
EOT kinematic viscosity increase at 40°C, %, max.	-	-	-	150 (MTAC)	-	-
Roller Follower Wear Test (RFWT) , ASTM D5596	-	-	-	Pass	-	-
Pin wear, average, mils, max.	-	-	-	0.30 / 0.33 / 0.36	-	-
or µm, max.	-	-	-	7.6 / 8.4 / 9.1	-	-
Engine Oil Aeration Test (EOAT) , ASTM D6894	-	-	-	Pass	-	-
Oil aeration volume, %, max. (MTAC)	-	-	-	8.0	-	-

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Notes:

- (1) All required data have to be measured, calculated values are not accepted.
- (2) Elastomer compatibility tests according to VDA 675301 and DBL 6674 / 6610 / 6615 with materials NBR34, AK6, ACM E7503, VMQ RE3-04 and EAM D8948-200.1. Limits according to DBL 6610 / 6615.
- (3) Rerating by Daimler at EP/MOR for all related engine parts
- (4) Only for xW-30 or OW-40: evaluation of bearing wear in a OM501LA engine with new crankshaft and premeasured bearings. Rerating by Daimler at TP/PHC.
- (5) The worst result (outlier result) will be replaced by the second worst to calculate the average to control outliers
- (6) Approval conditions for engine oils for natural gas (CNG) engines: positive field test with MB CNG busses or a pass result in a 500 h CNG engine test by MB do Brazil or read across from MAN M 3271 approval.
- (7) Read across only according to MB Read Across Guidelines for engine tests (based on the latest ATC and ATIEL Code of Practice). MB Package Pass only for Mineral Oils (SN, ATIEL Grp. I & II) and for SAE 15W-40, 20W-40, 15W-50, 20W-50.
- (8) Detailed rating for Mack T-12, Cummins ISM and Cat C-13 according to API CJ-4 merit systems.

Conditions for approvals and the use of performance claims (MB sheets) against MB oil specifications

MB requires that any claims for oil performance to meet the mentioned MB specifications 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 MB oil specifications must be generated according to the MB Read Across Guidelines and the European Engine Lubricants Quality Management System (EELQMS).

MB Approval for each new oil formulation is valid for 5 years.

The runtime of rebrands and rebLENds is limited by the runtime of the original and therefore limited to max. 5 years.

From the introduction date of a new version of the MB Specification the previous version is still valid one year.

For this time-period both specification versions are valid for approvals.

Package Pass approvals: for every treat rate a trading approval is required. The trading approvals are handled like approvals for new oil formulations.

As a consequence the following timeline is valid from now on:

MB Specification - Issue (version with year spec. no.)	First allowable use	New approvals by at the latest
MB Specification V2004.2	26.10.2004	18.03.2006
MB Specification V2005.1	18.03.2005	22.09.2007
MB Specification V2006.1	22.09.2006	01.12.2008
MB Specification V2007.1	01.12.2007	16.03.2010
MB Specification V2009.1	16.03.2009	21.03.2013
MB Specification V2012.1	21.03.2012	substituted by MB Specification V2012.2 on 01.10.2012
MB Specification V2012.2	01.10.2012	

First allowable use means that approvals and claims cannot be made against the specification before the date indicated.

New approvals by means that from this date all approvals for new oil formulations must be according to the latest MB specification release.

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MB sheet no. ⁽¹⁾	226.5	226.51	229.1	229.3	229.31	229.5	229.51	229.52
Mono- / multigrade viscosities	Multi	Multi	Multi	Multi	Multi	Multi	Multi	Multi
Viscosity grades (SAE J300)	0/5W30/40, 10W-40	0/5W-30/40	acc, ACEA	0W-, 5W-, 10W-x	0W-, 5W-, 10W-x	0W-, 5W-, 10W-x	0W-, 5W-, 10W-x	0W-, 5W-x
Read across guidelines								
MB read across ⁽⁵⁾	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Package pass ⁽⁵⁾	No	No	No	No	No	No	No	No
ACEA oil sequences required	When any ACEA Ax, Bx, Cx, or Ex oil sequence is claimed, then all tests within this oil sequence are mandatory							
RN oil specification	RN0710	RN0720						
Laboratory tests								
Sulphated ash , DIN 51575, ASTM D874, % m/m	≥ 0.8 & ≤ 1.5	≤ 0.5	> 0.8 & ≤ 1.5	> 0.8 & ≤ 1.5	≤ 0.8	> 0.8 & ≤ 1.5	≤ 0.8	≤ 0.8
TBN , ISO 3771, ASTM D2896 fresh oil, mg KOH/g, min.	8.0	6.0	6.0	7.0	6.0	8.0	6.0	6.0
TBN , ASTM D4739 fresh oil, mg KOH/g, min.	-	-	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Pour point , ISO 3016, ASTM D97, °C, max.	Rate & Report	Rate & Report	-27	-27	-27	-27	-27	-36
Evaporative loss , Noack, CEC L-40-A-93, ASTM 5800, %, max.	12	11	13	13	12	10	10	10
HTHS viscosity , CEC L-036-90, i3 2 nd edition, mPa.s, min.	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Zinc , DIN 51391 -2/-3, ASTM D5185/6443, % m/m, min.	Rate & Report	Rate & Report	0.04	0.04	0.04	0.04	0.04	0.04
Sulphur , DIN EN ISO 14596, ASTM D5185/2622, % m/m, max.	Rate & Report	0.2	Rate & Report	0.5	0.3	0.5	0.3	0.3
Phosphorus , DIN 51363 -2/-3, ASTM D5185/4951, % m/m, max.	Rate & Report	0.9	Rate & Report	0.05-0.11	0.05-0.09	0.05-0.11	0.05-0.09	0.05-0.09
Chlorine , DIN 51577: 2006-01 ASTM D6443, % m/m, max.	Rate & Report	Rate & Report	Rate & Report	0.015	0.015	0.015	0.015	0.010
Daimler oxidation test - fresh oil (Daimler oxidation test procedure) ⁽⁹⁾	-	-						
Kinematic viscosity at 100°C, EOT 168 h., average of 3 runs, mm²/s, max.	-	-	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Oxidation DIN 51453 at EOT 168 h., average of 3 runs, A/cm, max.	-	-	Rate & Report	60	60	25	25	20
Δ Kinematic viscosity at 100°C, average of 3 runs - absolute, mm²/s, max.	-	-	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Δ Kinematic viscosity at 100°C, average of 3 runs - relative, %, max.	-	-	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	50

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MB sheet no. ⁽¹⁾	226.5	226.51	229.1	229.3	229.31	229.5	229.51	229.52
Daimler oxidation test - with fuel dilution 5% B100⁽³⁾ (FAME from OM646 biodiesel test) Kinematic viscosity at 100°C, EOT 168 h., average of 3 runs, mm ² /s, max. Oxidation DIN 51453 at EOT 168 h., average of 3 runs, A/cm, max. Δ Kinematic viscosity at 100°C, average of 3 runs - absolute, mm ² /s, max. Δ Kinematic viscosity at 100°C, average of 3 runs - relative, %, max.	- - - -	- - - -	Rate & Report Rate & Report Rate & Report Rate & Report	Rate & Report 120 Rate & Report Rate & Report	Rate & Report 120 Rate & Report Rate & Report	Rate & Report 80 Rate & Report Rate & Report	Rate & Report 80 Rate & Report Rate & Report	Rate & Report 40 Rate & Report 50
TOC oxidation test, D55 3099 TAN, mgKOH/g, R & R at 80 h. PAI CO, max. Variation of viscosity at 40°C at 96 h., % max. Variation of viscosity at 100°C, % max.	R & R at 80h. 400 at 80h. 200 R & R at 80h.	R & R at 96h. 400 at 96h. 200 R & R at 96h.						
MCT cokefaction test, GFC Lu 27, merit cot.1, min.	7.0	7.0						
SRV (Schwing Reib Verschleiß) test, MBN 10474⁽³⁾ Load carrying capacity, average of 5 runs - fresh oil, N, min. Coefficient of friction, μr, average of 5 runs - fresh oil, max. Load carrying capacity, average of 5 runs - aged oil, N, min. Coefficient of friction, μr, average of 5 runs - aged oil, max.	- - - -	- - - -	100 Rate & Report Rate & Report Rate & Report	100 Rate & Report Rate & Report Rate & Report	100 Rate & Report Rate & Report Rate & Report	100 Rate & Report Rate & Report Rate & Report	100 Rate & Report Rate & Report Rate & Report	100 Rate & Report Rate & Report Rate & Report
CEC low temperature pumping test, CEC TDG-L105⁽³⁾ MRV at SAE J300 fresh oil temperature, mPa s, max. MRV at SAE J300 fresh oil temperature + 5°C, mPa s, max. Yield stress, Pa, max.	- - - -	- - - -	Rate & Report Rate & Report Rate & Report	Rate & Report Rate & Report Rate & Report	Rate & Report Rate & Report Rate & Report	Rate & Report Rate & Report Rate & Report	Rate & Report Rate & Report Rate & Report	Rate & Report Rate & Report Rate & Report
High temperature corrosion bench test HTCBT (modified ASTM D6594 at 135°C) ⁽³⁾ Cu increase - without / with 10% m/m B100*, ppm, max. Pb increase - without / with 10% m/m B100*, ppm, max.	- -	- -	- -	Rate & Report / - Rate & Report	Rate & Report / - Rate & Report	Rate & Report / - Rate & Report	Rate & Report / - Rate & Report	Rate & Report / - Rate & Report

* Ref. fuel B100 (80% RME + 20% SME) from OM 646 TDG-L104

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MB sheet no. ⁽¹⁾	226.5	226.51	229.1	229.3	229.31	229.5	229.51	229.52
Shear stability , CEC L-014-93, ASTM D6278/D7109	Pass @ 30 cycles	Pass @ 30 cycles	Pass @ 30 cycles	Pass @ 30 cycles	Pass @ 30 cycles	Pass @ 90 cycles	Pass @ 90 cycles	Pass @ 90 cycles
Kinematic viscosity after 30 or 90 cycles shearing at 100°C, mm²/s	Stay in grade	Stay in grade	Stay in grade	Stay in grade	Stay in grade	Stay in grade	Stay in grade	Stay in grade
Foaming tendency , ASTM D892								
Sequence I, 24°C, ASTM D892 w/o option A, ml, max.	10 / 0	10 / 0	10 / 0	10 / 0	10 / 0	10 / 0	10 / 0	10 / 0
Sequence II, 94°C, ASTM D892 w/o option A, ml, max.	10 / 0	10 / 0	50 / 0	20 / 0	20 / 0	20 / 0	20 / 0	20 / 0
Sequence III, 24°C, ASTM D892 w/o option A, ml, max.	10 / 0	10 / 0	10 / 0	10 / 0	10 / 0	10 / 0	10 / 0	10 / 0
Sequence IV, 150°C, ASTM D6082, ml	100 / 0	100 / 0	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Elastomer compatibility - CEC L-39-96 ⁽⁶⁾	ACEA A3/B3	ACEA C4	ACEA A3/B4	ACEA A3/B4	ACEA C3	ACEA A3/B4	ACEA C3	ACEA C3
Related Daimler Liefervorschrift (DBL)			6615	6615	6615	6615	6615	6615
Engine tests								
M271 sludge test , M271 classic sludge DL, until M271 EVO sludge (CEC TDG-L107) is ready at CEC ⁽³⁾								
Engine sludge average, merit, min.	RL140 + 4σ	RL140 + 4σ	8.5	8.8	8.8	9.1	9.1	9.1
M271 EVO sludge test when CEC TDG-L107 is ready at CEC ⁽³⁾								
Engine sludge average, merit, min.			8.5	8.8	8.8	9.1	9.1	9.1
M271 wear test , MB DL, wear, 250 h. ⁽³⁾	-	-						
Cam wear inlet/outlet valve (average wear 8 cams), μm, max.	-	-	5.0 / 5.0	5.0 / 5.0	5.0 / 5.0	5.0 / 5.0	5.0 / 5.0	5.0 / 5.0
Piston ring wear radial at ring 1/ring 2 (average), μm, max. ⁽⁴⁾	-	-	5.0 / 12.0	5.0 / 12.0	5.0 / 12.0	5.0 / 12.0	5.0 / 12.0	5.0 / 12.0
Piston ring wear axial at ring 1/groove 1 (average), μm, max. ⁽⁴⁾	-	-	5.0 / 15.0	5.0 / 15.0	5.0 / 15.0	5.0 / 15.0	5.0 / 15.0	5.0 / 15.0
Ring sticking	-	-	No	No	No	No	No	No
Main bearing wear (average), μm, max. ⁽⁴⁾	-	-	1.5 / 3.5	1.5 / 3.5	1.5 / 3.5	1.5 / 3.5	1.5 / 3.5	1.5 / 3.5
Conrod bearing wear (average), μm, max. ⁽⁴⁾	-	-	1.5 / 3.5	1.5 / 3.5	1.5 / 3.5	1.5 / 3.5	1.5 / 3.5	1.5 / 3.5
Timing chain wear (elongation), %, max.	-	-	0.25	0.25	0.25	0.25	0.25	0.25
Timing chain wear (single chain link), %, max.	-	-	1.0	1.0	1.0	1.0	1.0	1.0
Bore polishing (xmm) - max. value of 4 cylinders, %, max.	-	-	TBD	TBD	TBD	TBD	TBD	TBD

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MB sheet no. ⁽¹⁾	226.5	226.51	229.1	229.3	229.31	229.5	229.51	229.52
Engine tests								
M111 Fuel economy, CEC L-054-96⁽³⁾			-					
Fuel economy improvement vs RL191 (15W-40), %, min.	1.0 (for xW-30 C3)	1.0 (for xW-30)		1.0	1.0	1.7	1.7	1.7
MB fuel economy tests - FE benefit in NEDC (PC chassis dyno-meter test) for 0W/-40 and 5W-3/-40 vs MB RL001 Otto & MB RL002 Diesel⁽³⁾			-					
Chassis: W204 C250CDI/engine: OM651 vs MB RL002, %, min.	-	-		Rate & Report	Rate & Report	Rate & Report	Rate & Report	1.0
Chassis: W204 C320CDI/engine: OM642 vs MB RL002, %, min.	-	-		Rate & Report	Rate & Report	Rate & Report	Rate & Report	1.0
Chassis: W204 C200K/engine: M271 ML18 vs MB RL001, %, min.	-	-		Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Chassis: W204 C350CGI/engine: M272 DE35 vs MB RL001, %, min.	-	-		Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
OM 646 DE22LA biodiesel test, CEC TDG-L104, when ready	-	-						
Piston cleanliness (average 4 pistons), merit, min.	-	-	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Engine sludge average, merit, min.	-	-	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Ring sticking, yes / no	-	-	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
TBN, ASTM D4739, at end of test, mgKOH/g, min.	-	-	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
TAN, ASTM D664, at end of test, mgKOH/g, max.	-	-	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Oil consumption, g/test, max.	-	-	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Soot, %, max.	-	-	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Viscosity increase at 100°C, %, max.	-	-	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
VW TDI, CEC L-078-99	-	-						
Piston cleanliness, average, merit, min.	RL206	RL206	RL206 - 4	RL206	RL206	RL206	RL206	RL206
All other requirements as listed in ACEA 2010	A5/B5 - 10	C4 - 10	A3/B3 -10	A3/B3 -10	C3 - 10	A3/B3 - 10	C3 - 10	C3 - 10
VW T4, VW PV 1449	-	-						
All test parameters from VW 502.00	-	-	-	Pass	-	Pass	-	-
MB Sheet No. (1)	226.5	226.51	229.1	229.3	229.31	229.5	229.51	229.52

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MB sheet no. ⁽¹⁾	226.5	226.51	229.1	229.3	229.31	229.5	229.51	229.52
Engine tests								
OM 646 DE22LA, CEC L-099-08⁽³⁾								
Cam wear inlet/outlet valve (average wear 8 cams), µm, max.	100	100	120 / 155	100 / 130	100 / 130	90 / 110	90 / 110	90 / 110
Cylinder wear (average 4 cylinders), µm, max.	120	120	5.0	5.0	5.0	5.0	5.0	5.0
Bore polishing (13 mm), %, max. value of 4 cylinders	5.0	5.0	4.0	3.5	3.5	3.0	3.0	3.0
Piston cleanliness (average 4 pistons), merit, min.	3.0	3.0	10.0	12.0	12.0	14.0	14.0	14.0
Engine sludge average, merit, min.	Rate & Report	Rate & Report	8.6	8.8	8.8	9.1	9.1	9.1
Ring sticking	Rate & Report	Rate & Report	No	No	No	No	No	No
Tappet wear inlet (average wear 8 cams), µm	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Tappet wear outlet (average wear 8 cams), µm	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Bearing wear main/con rod bearing, µm, max. ⁽⁵⁾	Rate & Report	Rate & Report	2.1 / 2.1	2.1 / 2.1	2.1 / 2.1	2.1 / 2.1	2.1 / 2.1	2.1 / 2.1
Piston ring wear axial at ring 1/ring 2/ring 3, µm, max. ⁽⁵⁾	Rate & Report	Rate & Report	10.4 / 6.0 / 5.0	10.4 / 6.0 / 5.0	10.4 / 6.0 / 5.0	8.7 / 4.0 / 3.0	8.7 / 4.0 / 3.0	8.7 / 4.0 / 3.0
Piston ring wear radial at ring 1/ring 2/ring 3, µm, max. ⁽⁵⁾	Rate & Report	Rate & Report	10.0 / 12.0 / 8.0	10.0 / 12.0 / 8.0	10.0 / 12.0 / 8.0	10.0 / 12.0 / 8.0	10.0 / 12.0 / 8.0	10.0 / 12.0 / 8.0
Timing chain wear (elongation), %, max.	Rate & Report	Rate & Report	0.4	0.4	0.4	0.4	0.4	0.4
Oil consumption, g/test, max.	Rate & Report	Rate & Report	7000	7000	7000	7000	7000	7000
Soot, %, max.	Rate & Report	Rate & Report	4.0 - 7.0	4.0 - 7.0	4.0 - 7.0	4.0 - 7.0	4.0 - 7.0	4.0 - 7.0
Viscosity increase at 100°C, %, max.	Rate & Report	Rate & Report	100	100	100	90	90	90
LLR Renault in-house test								
PAI CO at end of test, max.	-	200.0	-	-	-	-	-	-
Viscosity increase at 40°C at end of test, %, max.	-	100.0	-	-	-	-	-	-
Oil consumption, g/h.	-	Report	-	-	-	-	-	-
Piston deposits (cotation), merit, min.	-	5.0	-	-	-	-	-	-
Ring sticking (all rings)	-	No	-	-	-	-	-	-

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Notes:

- (1) All required data have to be measured, calculated values are not accepted
- (2) Elastomer compatibility tests & limits according to DBL 6674 / 6610 / 6615 - will be replaced by new requirements as listed in ACEA oil test sequences 2014. with materials.
- (3) Complete test report is required. Additional for MB engine tests: rerating at RD/PDI for all related engine parts
- (4) The worst result (outlier result) will be replaced by the second worst to calculate the average to control outliers
- (5) Read across only according to MB Read Across Guidelines for engine tests (based on the latest ATC and ATIEL Code of Practice), MB Package Pass only for Mineral Oils (SN, ATIEL Grp. I & II) and for SAE 15W-40, 20W-40, 15W-50, 20W-50.
- (6) Please refer to chapter «Elastomer compatibility» for limits

Conditions for approvals and the use of performance claims (MB sheets) against MB oil specifications

MB requires that any claims for oil performance to meet the mentioned MB specifications 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 MB oil specifications must be generated according to the MB Read Across Guidelines and the European Engine Lubricants Quality Management System (EELQMS)

MB Approval for each new oil formulation is valid for 5 years.

The runtime of rebrands and rebLENds is limited by the runtime of the original and therefore limited to max. 5 years.

From the introduction date of a new version of the MB Specification the previous version is still valid one year. For this time-period both specification versions are valid for approvals.

Package Pass approvals: For every treat rate a trading approval is required. The trading approvals are handled like approvals for new oil formulations.

As a consequence the following timeline is valid from now on:

MB Specification - Issue (version with year spec. no.)	First allowable use	New approvals by at the latest
MB Specification V2004.2	26.10.2004	18.03.2006
MB Specification V2005.1	18.03.2005	22.09.2007
MB Specification V2006.1	22.09.2006	01.12.2008
MB Specification V2007.1	01.12.2007	16.03.2010
MB Specification V2009.1	16.03.2009	21.03.2013
MB Specification V2012.1	21.03.2012	substituted by MB specification V2012.2 on 01.10.2012
MB Specification V2012.2	01.10.2012	

First allowable use means that approvals and claims cannot be made against the specification before the date indicated.

New approvals by means that from this date all approvals for new oil formulations must be according to the latest MB specification release.

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- Oil category 1: normal quality (generally corresponds to API-CF, CG-4, CH-4, or ACEA E2-96)
- Oil category 2: higher quality level (corresponds to SHPD = Super High Performance Diesel, or ACEA E7-08)
- Oil category 2.1: higher quality with low ash-forming additive content (low SAPS) (API CJ-4, ACEA E9-08)
- Oil category 3: high performance Diesel engine oil (quality level above ACEA E4-99, E5-08)
- Oil category 3.1: high performance Diesel engine oil with low ash-forming additive content (low SAPS) (ACEA E6-08)

Oil category	-	-	1, 2, 2.1, 3		3.1
Viscosity grades (SAE J300)	30	40	5W-30, 10W-30	5W-40, 10W-40, 15W-40	5W-30, 10W-40
Laboratory tests					
Density at 15°C, DIN51757, ASTM D1298, g/ml	Report		Report		
Viscosity at 40°C, DIN 51562-1, ASTM D445, mm²/s at 100°C	Report 9.3 - 12.5	Report 12.5 - 16.3	Report 9.3 - 12.5	Report 12.5 - 16.3	Report 12.5 - 16.3
HTHS viscosity , CEC L-036-90, mPa.s, min.	-		3.5		
Shear stability , DIN 51382, CEC L-014-93, ASTM D6278, D7109 Viscosity after 30 cycles shear (DIN 51562-1, ASTM D445), mm²/s Viscosity after 90 cycles shear (DIN 51562-1, ASTM D445), mm²/s	- -		Oil category 1, 2: stay in grade Oil category 2.1, 3, 3.1: stay in grade		
Viscosity index , DIN ISO 2209, ASTM D2270	Report		Report		
Pour point , DIN ISO 3016, ASTM D97, °C	Report		Report		
Flash point COC, DIN EN ISO 2592, ASTM D92, °C, min. PM, DIN EN ISO 2719 °C	215 Report		215 Report		
Evaporative loss , Noack, DIN 51581, CEC L-040-93, %, max.	10		13		12
TBN , ISO 3771, ASTM D2896, mg KOH/g, min.	8		Oil category 1, 2: 8.0; 2.1: 7.0; 3: 12.0		7.0
TAN , ASTM D664, mg KOH/g	Report		Report		
Sulfated ash , DIN 51575, ASTM D874, % m/m, max.	1.0 - 2.0		1.0 - 2.0; Oil category 2.1: 1.0		1.0
Mg, Ca, Ba, Mo, Na, K , DIN 51391-3	Report		Report		

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Oil category	-	-	1, 2, 2.1, 3	3.1
Chlorine , DIN 15597, mg/kg, max.	150		150	
Phosphorus , DIN 51363-2/-3, % m/m, max.	Report		Report / oil category 2.1: 0.12	0.08
Sulfur , DIN 51400-1, DIN EN ISO 14596, % m/m, max.	Report		Report / oil category 2.1: 0.4	0.3
Zinc , DIN 51391-3, % m/m, min.	0.035		0.035	
Nitrogen , ASTM D3228, D5762, % m/m	Report		Report	
Further additive elements > 0.01 % m/m	Report		Report	
Elastomer compatibility , DIN 53521, SRE NBR 28, FPM AK6 ⁽¹⁾	Pass		Pass	
FZG gear rig , DIN 51354-2, CEC L-07-A-95, damage force stage, min.	11		11	
Foaming tendency , ASTM D6082, ml, max.	200 - 50		200 - 50	
Turbocharger deposits , MTV 5040, DIN 51535, mg, max.	-		120	
PDSC oxidation test , CEC L-85-99, min.	Report		Report	

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Oil category	1	2, 2.1	3, 3.1
Engine tests			
OM 441 LA, CEC L-52-T-97			
Bore polishing, average, %, max.	3.0		
Piston cleanliness, average, merit, min.	22		
Cylinder wear, average, µm, max.	8.0		
Engine sludge, average, merit, min.	9.0		
Specific oil consumption, g/h, max.	100	-	-
Viscosity increase at 40°C, %, max.	-		
Wear rating, demerit, max.	2.5		
General engine deposits, demerit, max.	3.0		
Oil drain interval, h.	200		
OM 501 LA, CEC L-101-09			
Piston cleanliness, average, merit, min.	16	19	28
Ring sticking piston ring 2, ASF, max.	1	1	1
Engine sludge, average, merit, min.	9.0	9.0	9.4
General engine deposits, average, demerit, max.	3.0	2.0	2.0
Wear rating, average, demerit, max.	3.0	3.0	2.0
Bore polishing, average, %, max.	3.0	2.0	1.0
Cylinder wear, average, µm, max.	8	8	8
Turbocharger deposits, demerit, max.	3.0	2.0	2.0
TBN, ASTM D 4739, at end of test, mg KOH/g	Report	Report	Report
TAN, ASTM D 664, at end of test, mg KOH/g	Report	Report	Report
Oil consumption, g/h, max.	50.0	30.0	30.0

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Oil category	1	2, 2.1	3, 3.1
OM 611 , Mercedes-Benz 300 h. test			
Bore polishing, max. value of 4 cylinders	4.0		
Piston cleanliness, average, merit, min.	23		
Cylinder wear, average, µm, max.	7.0		
Cam wear inlet / outlet valve, average, µm, max.	140 / 155	-	-
Engine sludge, average, merit, min.	8.0		
Oil consumption, g/test, max.	6000		
Viscosity increase at 40°C, %, max.	100		
OM 646 DE22LA , CEC L-099-08			
Cam wear inlet/outlet valve, average, µm, max.	120 / 155	100 / 130	90 / 110
Cylinder wear, average, µm, max.	5	5	5
Bore polishing (13 mm), max. value of 4 cylinders	4.0	3.5	3.0
Piston cleanliness, average, merit, min.	10	12	14
Engine sludge, average, merit, min.	8.6	8.8	9.1
Ring sticking, yes/no	No	No	No
Tappet wear inlet/outlet, average, µm, max.	Rate & Report	Rate & Report	Rate & Report
Bearing wear main/con rod bearing, µm, max.	2.1 / 2.1	2.1 / 2.1	2.1 / 2.1
Piston ring wear axial at ring 1/ring 2/ring 3, µm, max.	10.4 / 6.0 / 5.0	10.4 / 6.0 / 5.0	8.7 / 4.0 / 3.0
Piston ring wear radial at ring 1/ring 2/ring 3, µm, max.	10.0 / 12.0 / 8.0	10.0 / 12.0 / 8.0	10.0 / 12.0 / 8.0
Timing chain wear (elongation), %, max.	0.4	0.4	0.4
Oil consumption, g/test, max.	7000	7000	7000
Soot, %, max.	4.0 - 7.0	4.0 - 7.0	4.0 - 7.0
Viscosity increase at 100°C, %, max.	100	100	90
Mack T-8E , ASTM D5967, oil category 2, 3, 3.1	Run number	1 / 2 / 3	1 / 2 / 3
Relative viscosity at 100°C at 4.8% soot, max.		2.1 / 2.2 / 2.3	2.1 / 2.2 / 2.3
Mack T-11 , ASTM D7156, oil category 2.1	Run number	1 / 2 / 3	
TGA soot at 4.0 mm²/s increase at 100°C, %, min.		3.5 / 3.4 / 3.3	
TGA soot at 12.0 mm²/s increase at 100°C, %, min.		6.0 / 5.9 / 5.9	
TGA soot at 15.0 mm²/s increase at 100°C, %, min.		6.7 / 6.6 / 6.5	

Notes:

(1) Please refer to chapter « Elastomer compatibility » for limits

PORSCHE engine oil requirements



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Specifications	Porsche A40	Porsche C30
Performance requirements:		
HTHS, CEC L-36-A-90, mPa.s, min.	3.5	3.5
ACEA level	A3/B3-12, A3/B4-12 or C3-12	-
Volkswagen approval	-	VW 504.00 / 507.00
VW T4 , PV 1449		
Viscosity at 40°C at end of test, mm²/s, max.	200 +/- test stand severity	200 +/- test stand severity
Viscosity increase at 40°C, %, max.	130 +/- test stand severity	130 +/- test stand severity
TBN end of test, DIN 51639-1, mg KOH/g, min.	5 +/- test stand severity	5 +/- test stand severity
Piston merit, 5 parts, min.	1.0	None
Ring sticking, ASF, max.	None	
Porsche durability , 9A1, 3.6 l, 360 kW B6 engine, 163.7 h. cycling test:	Pass	-
Sludge rating, merit, min.	9.5	-
Turbo deposits, merit, min.	6.0	
Turbo feed pipe deposits, merit, min.	7.4	
Turbo charger sealing ring sticking	none	-
Piston ring groove fill % max., Porsche method	100	-
Piston ring sticking	none	-
Cam wear, µm, average, max.	above 8-10	none
Cylinder liner wear: washboard	none	-
Cam wear, µm, max.	9 - 12	-
Tappet wear, µm, avg.	3 - 10	-
Tappet wear, µm, max.	5 - 13	-
Thrust curve	as reference oil or better	-
Engine description and allowed viscosity:		
Porsche sports cars, Panamera (V6), Panamera S & Turbo, Cayenne S/Turbo/GTS	0W-40, 5W-40, 5W-50	Not allowed
Porsche Panamera S Hybrid	0/5W-40 (not for long drain)	5W-30 (not for China)
Porsche Cayenne (V6) and S Hybrid	0/5W-40 (not for long drain)	5W-30 (not for China)
Porsche Cayenne Diesel	Not allowed	5W-30 (not for China)

PSA service fill level	PSA level 1	PSA level 2 based on A3/B3	PSA level 2 based on A3/B4	PSA level 3	PSA mid ash C3	PSA mid ash C2	PSA low ash 0W-30	PSA xW-20 (NOT for service fill)	Factory and service fill China	Factory and service fill outside Europe
PSA lubricant specification	B71 2295	B71 2294	B71 2300	B71 2296	B71 2297	B71 2290	B71 2312	B71 2216	B71 2301	B71 2302
Last version date	May 24 th 2012	March 29 th 2012	April 4 th 2012	April 2 nd 2012	April 2 nd 2012	March 28 th 2012	March 28 th 2012	Jan 13 th 2012	Jan 18 th 2012	March 4 th 2013
Service fill	Not to be used as service fill for todays generation of PSA engines. Only for engines outside Europe. To be used for older Gasoline and Diesel engines. Diesel engines only if biodiesel content is not used (B0 only).	PSA level 2 based on A3/B3: not to be used for todays generation of PSA engines.	PSA level 2 based on A3/B4: minimum service level inside Europe for todays generation engines.	PSA level 3: can be used in all countries for engines where low SAPS is not required.	ACEA C3 based service fill for PSA Engines.	ACEA C2 based service fill for PSA Engines	ACEA low ash based service fill for PSA Engines	Factory fill: xW-20 for selected engines only. Not allowed as service fill	Gasoline factory and service fill China	Gasoline factory and service fill outside Europe
Allowed SAE viscosity grade	xW- 30/40/50	xW- 30/40/50	xW- 30/40/50	5W-30/40	xW-40	xW-30	0W-30	xW-20	0/5W-30	0W-30
ACEA basis⁽¹⁾	A1/B1-10 or A3/B3-10 (A2/B2 not allowed)	A3/B3-10	A3/B4-10	A3/B4-10 or A5/B5-10	C3-10	C2-10	C1-10 or C2-10 excl. chemical limits	ACEA A1/B1-10 + API SN	A5/B5-10	A5/B5-10
HTHS , CEC L-36-A-90, mPa.s, min.	A1/B1: ≥ 2.9 & ≤ 3.5 / A3/B3 > 3.5	3.5	3.5	A3/B4: > 3.5 / A5/B5: > 2.90	3.5	2.9	2.9	2.60	2.90	2.90
Shear stability CEC L-14-A-93 , 30 cycles, KV 100, mm ² /s , min.	xW-30:9.3 / xW-40:12 / xW-50:15	10	Stay in grade	10	10	10	9.3	5.0 calculated @ 125°C	9.3	9.3
Noack volatility , CEC L-40-A-93, loss (B method), % m/m, max.	A1/B1: 15%, Others: 13%	13%	13%	13%	13%	13%	13%	13%	13%	13%
Sulfated ash , ASTM D874, % m/m, max.	1.5	1.5	1.6	1.6	0.8	0.8	0.6	1.2	1.6	1.6

PSA service fill level	PSA level 1	PSA level 2 based on A3/B3	PSA level 2 based on A3/B4	PSA level 3	PSA mid ash C3	PSA mid ash C2	PSA low ash 0W-30	PSA xW-20 (NOT for service fill)	Factory and service fill China	Factory and service fill outside Europe
PSA lubricant specification	B71 2295	B71 2294	B71 2300	B71 2296	B71 2297	B71 2290	B71 2312	B71 2216	B71 2301	B71 2302
Phosphorus , D50 5483, wt%, max.	-	-	-	-	≥ 0.07 & ≤ 0.090	0.090	0.0650	≥ 0.065 & ≤ 0.080	-	-
Sulphur , wt%, max.	-	-	-	-	0.3	0.3	0.3	0.3	-	-
TBN , ASTM D2896, mg KOH/g, min.	8	Outside Europe only: 10	Outside Europe only: 10	Outside Europe only: 10	6	6	6	6	-	-
TBN , ASTM D4739, min.	-	Europe only : 8	Europe only : 8	Europe only : 8	3	3	3	3	3	3
Flash point , ISO 2592, °C , min.	210 °C	210 °C	210 °C	210 °C	210 °C	210 °C	210 °C	210 °C	210 °C	210 °C
Pour Point NF T60-105, °C, max.	-	- 35 °C	- 35 °C	- 35 °C	- 35 °C	- 35 °C	- 40 °C	- 35 °C	-35 °C	-35 °C
Particular contamination ISO 4426	-	17/11	17/11 - 17/14	17/11 - 17/14	17/11	17/11	17/11 - 17/14	17/11	17/11 - 17/14	17/11 - 17/14
Elastomer compatibility	According ACEA 2010	According ACEA 2010	According ACEA 2010	According ACEA 2010	According ACEA 2010	According ACEA 2010	According ACEA 2010	According ACEA 2010	According ACEA 2010	According ACEA 2010
TEOST 33C , ASTM D6335 or MHT 4 , ASTM D7097	-	-	-	-	-	-	-	Rate & Report	-	-
Copper strip method	-	-	-	-	-	-	-	Rate & Report @ 3 h., 150 °C	-	-
Anti-corrosion (acid:1 max., salted water: 2 max., wet air: 0 max.)	-	-	-	-	-	-	-	Pass	-	-
PSA tests										
Air entrapment	Time & curve of de-airation	Time & curve of de-airation	Time & curve of de-airation	Time & curve of de-airation	Time & curve of de-airation	Time & curve of de-airation	Time & curve of de-airation	Time & curve of de-airation	Time & curve of de-airation	Time & curve of de-airation
Coking , D57 5177, panel coker test, 24h @ 288C, merit, min.	8	8	8	8	8	8	8	8	8	8
Coking , D57 5177, panel coker test + 8% added E10 Ethanol fuel, 24h @ 288C, merit, min.	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Coking , D57 5177, panel coker test, 24h @ 305C, merit	-	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report

PSA service fill level	PSA level 1	PSA level 2 based on A3/B3	PSA level 2 based on A3/B4	PSA level 3	PSA mid ash C3	PSA mid ash C2	PSA low ash 0W-30	PSA xW-20 (NOT for service fill)	Factory and service fill China	Factory and service fill outside Europe
PSA tests										
PSA lubricant specification	B71 2295	B71 2294	B71 2300	B71 2296	B71 2297	B71 2290	B71 2312	B71 2216	B71 2301	B71 2302
4 ball test										
Antiwear, D55 1078, 60 min. @ 1500 rpm and 40 Kg pressure, scar mm, max.	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Extreme pressure, D55 1136, 1 min. @ 1500 rpm	Load before seizure: ≥ 100 Kg, max. 0.55 scar	Load before seizure: ≥ 100 Kg, max. 0.55 scar	Load before seizure: ≥ 100 Kg, max. 0.55 scar	Load before seizure: ≥ 100 Kg, max. 0.55 scar	Load before seizure: ≥ 100 Kg, max. 0.55 scar	Load before seizure: ≥ 100 Kg, max. 0.55 scar	Load before seizure: ≥ 100 Kg, max. 0.55 scar	Load before seizure: ≥ 100 Kg, max. 0.55 scar	Load before seizure: ≥ 100 Kg, max. 0.55 scar	Load before seizure: ≥ 100 Kg, max. 0.55 scar
TOC oxidation stability test, 01563_11_00047, with 100 ppm Fe @ 170 °C										
Change in KV100 @ 72 h.	+/- 20% & ≤ max. of grade	-	-	-	-	-	-	-	-	-
Change in KV100 @ 96 h.	Rate & Report	+/- 20% & ≤ max. of grade	+/- 20% & ≤ max. of grade	Grade 30 : > -20%, Grade 40 : > 9.3 cSt	> -20%	> -20%	> -20% AND > 9.3 cSt	> -20%	> -20%	> -20%
Change in KV100 @ 120 h.	-	-	Max.: + 200%	Max. + 20% & ≤ max. of grade	Max. + 20% & ≤ 16,3 cSt	Max. + 20% & ≤ 12,5 cSt	Max. + 20% & ≤ 12,5 cSt	Max. + 20% & ≤ 12,5 cSt	Max. + 20% & ≤ max. of grade	Max. + 20% & ≤ max. of grade
Change in KV100 @ 144 h.	-	-	-	Max.: + 200%	Max.: + 200%	Max.: + 200%	Max.: + 200%	Max.: + 200%	Max.: + 200%	Max.: + 200%
TAN and PAI @ 48,72 & 96 h.	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Insoluble's in suspension at end of test, %, max.	0.05%	0.05%	0.05%	0.05%	0.05%	0.05%	0.05%	0.05%	0.05%	0.05%
TOC oxidation stability with 1% added EHN1 (nitration)	Pass same limits as standard TOC test	Pass same limits as standard TOC test	Pass same limits as standard TOC test	Pass same limits as standard TOC test	Pass same limits as standard TOC test	Pass same limits as standard TOC test	Pass same limits as standard TOC test	Pass same limits as standard TOC test	Pass same limits as standard TOC test	Pass same limits as standard TOC test
TOC oxidation stability with 8% added E10 (ethanol fuel)	Pass same limits as standard TOC test	Pass same limits as standard TOC test	Pass same limits as standard TOC test	Pass same limits as standard TOC test	Pass same limits as standard TOC test	Pass same limits as standard TOC test	Pass same limits as standard TOC test	Pass same limits as standard TOC test	-	Pass same limits as standard TOC test
TOC oxidation stability with 8% added China E10 (ethanol fuel)	-	-	-	-	-	-	-	-	Pass same limits as standard TOC test	For China: pass at limits standard TOC test

PSA service fill level	PSA level 1	PSA level 2 based on A3/B3	PSA level 2 based on A3/B4	PSA level 3	PSA mid ash C3	PSA mid ash C2	PSA low ash 0W-30	PSA xW-20 (NOT for service fill)	Factory and service fill China	Factory and service fill outside Europe
PSA TESTS										
PSA lubricant specification	B71 2295	B71 2294	B71 2300	B71 2296	B71 2297	B71 2290	B71 2312	B71 2216	B71 2301	B71 2302
TOC oxidation stability with added local fuel (China, Brasil or other)	-	-	-	-	-	-	-	-	-	Depends per targetted region
TOC oxidation stability with 10% added B10 (GOPSA Biodiesel)	Not required								Not required	Not required
Change in KV100 @ 96 h.	-	+/- 20% & ≤ max. of grade	+/- 20% & ≤ max. of grade	-	-	-	-	> -20%		
Change in KV100 @ 120 h.	-	Rate & Report	Rate & Report	Grade 30 : > -20%, Grade 40 : > 9.3 cSt	+/- 20% & ≤ 16.3 cSt	+/- 20% & ≤ 12.5 cSt	+/- 20% & ≤ 9.3 cSt	Max +20% & > 12.5 cSt		
Change in KV100 @ 120 h.	-	-	-	Max. + 20% & ≤ max. of grade	-	-	-	-		
Change in KV100 @ 144 h.	-	-	-	Max.: + 200%	Max.: + 200%	Max.: + 200%	Max.: + 200%	Max.: + 200%		
TAN and PAI @ 48,72 & 96 h.	-	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report		
Insoluble's in suspension at end of test, %, max.	-	0.05%	0.05%	0.05%	0.05%	0.05%	0.05%	0.05%		
DW10C engine endurance test @ IFP	-	-	Pass (contact PSA for details)	Pass (contact PSA for details)	Pass (contact PSA for details)	Pass (contact PSA for details)	Pass (contact PSA for details)	-	-	-
DW10B engine lash adjuster wear test @ APL	-	Merit > Low ref. oil	Merit > Low ref. oil	Merit > Low ref. oil	Merit > Low ref. oil	Merit > Low ref. oil	Merit > Low ref. oil	Merit > Low ref. oil	Merit > Low ref. oil	Merit > Low ref. oil
EP6CDT engine endurance test @ ISP	-	Pass (contact PSA for details)	Pass (contact PSA for details)	Pass (contact PSA for details)	Pass (contact PSA for details)	Pass (contact PSA for details)	Pass (contact PSA for details)	Pass (contact PSA for details)	Pass (contact PSA for details)	Pass on local fuel (contact PSA for details)
Fuel economy , internal PSA FE test, EP6 engine	-	-	-	-	-	-	-	-	> 0,2% vs MA4 5W-30 Ref. oil	≥ vs MA6 0W-30 Ref. oil

Note:

(1) ACEA TU5JP, TU3M & DV4TD tests reports needs to be send for approval, other test reports have to be available on demand.

RENAULT passenger car engine oil requirements

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Oronite

Specifications	RN0700	RN0710	RN0720
Application	Gasoline engines	Turbocharger Gasoline & Diesel engines without DPF	Diesels with DPF
ACEA basis⁽¹⁾	A3/B4-08 or A5/B5-08	A3/B4-08	C4-08
SAE viscosity grade	0/5W-30 & 0/5/10W-40	0/5W-30 & 0/5/10W-40	0/5W-30 & 0/5W-40
HTHS , CEC L-36-A-90, mPa.s, min.	2.9	3.5	3.5
Noack volatility , CEC L-40-A-93, loss (B method), max.	13.0	12.0	11.0
Sulfated ash , ASTM D874, % m/m	> 0.8 & ≤ 1.5	> 0.8 & ≤ 1.5	< 0.50
Phosphorus , ASTM D5185, % m/m, max.	Rate & Report	Rate & Report	0.09
Sulfur , ASTM D4951, or ASTM D5453, % m/m, max.	Rate & Report	Rate & Report	0.2
TBN , ASTM D2896, mg KOH/g, min.	8	8	6
TAN , ASTM D 664, mg KOH/g, max.	Rate & Report	Rate & Report	Rate & Report
Low temperature pumpability viscosity , ASTM D4684, mPa.s	According SAE J300	According SAE J300	According SAE J300
Density , ISO 12185/NFT 601172, kg/m ³	Rate & Report	Rate & Report	Rate & Report
Flash point , ISO 2592, °C, min.	200	200	200
Pour point , ISO 3016, °C	Rate & Report	Rate & Report	Rate & Report
Copper corrosion ISO 2160, (3 h. @ 150 ° C), rating	1a	1a	1a
Anti-wear properties ISO 2160, (60 min. - 40daN, Avg diameter), mm, max.	0.5	0.5	0.5
De-airing at 40 °C , ISO 9120, min., max.	35	35	35
Water content , D50 1622 / D50 1623, %, max.	0.05	0.05	0.05

RENAULT passenger car engine oil requirements

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Oronite

Specifications	RN0700	RN0710	RN0720
Oxidation test TOC , D55 3099, Big tube (150g), 170°C, 360 mg/kg of iron, 10l/h air. Samples at 0, 8, 80, 96, 140 h. (TAN, PAI CO, viscosity) TAN, ASTM D 664, mg KOH/g, max. PAI CO, max. Variation of viscosity at 40°C, %, max. Variation of viscosity at 100°C, %, max.	Report @ 80 h. 400 @ 80 h. 200% @ 80 h. Report @ 80 h.	Report @ 80 h. 400 @ 80 h. 200% @ 80 h. Report @ 80 h.	Report @ 96 h. 400 @ 96 h. 200% @ 96 h. Report @ 96 h.
MCT (cokefaction test) , GFC Lu 27, merit, min.	6.0	7.0	7.0
Auto-ignition temperature , ASTM D659, °C	Rate & Report	Rate & Report	Rate & Report
Storage stability test ⁽²⁾ , Renault in-house test method	See spec for details	See spec for details	See spec for details
Compatibility test first fill oils ⁽²⁾ , Renault in-house test method	See spec for details	See spec for details	See spec for details
Compatibility with plastics ⁽²⁾ , Renault in-house test method	See spec for details	See spec for details	See spec for details
Particular contamination ⁽²⁾ , ISO 4426	16 / 13	16 / 13	16 / 13
Filterability ⁽²⁾ , ME 64120 A 014/--B, Delta P (bar) with KN filter After 5 min., bar, max. After 50 min., bar, max. FMA, micron, max.	0.05 0.2 12	0.05 0.2 12	0.05 0.2 12
LLR Durability , Renault engine durability test @ IFP, Renault in-house test method Viscosity increase at 40°C (PAI CO), %, max. Oil consumption, g/h, max. Piston deposits, merit, min. Ring sticking, max.	- - - -	- - - -	100 Rate & Report 5 None (for all rings)

Notes:

(1) Renault does not require official ACEA approval, only tests mentioned in their specs. These are based on ACEA 2008 tests and limits.

(2) For Factory Fill only

RENAULT TRUCKS engine oil recommendations



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OLD Renault Specification	NEW Renault Specification
RD	RLD-2
RD-2	RLD-2
RLD	RLD-2
RLD-2	VDS-3 417-0002 ⁽¹⁾
RLD-3	VDS-4 417-0001 ⁽¹⁾
RGD	ACEA E6 + RLD-2
RXD	ACEA E6 + RLD-2

Note:

(1) No separate approvals for RLD-x; in 417-000x approval documents, the wording «Renault VI RLD-x compliance» will be changed into «Renault VI RLD-x approval».

SCANIA Long Drain Field (LDF) test requirements



Oronite

- Scania LDF, LDF-2, LDF-3, Low Ash, LA-2, LA-2 FS and LDF-3 FS approvals specify qualification in Long Drain Field tests.
- Test oil quality must pass one or more of following specifications: ACEA E4, E6, E7, E9, API CJ-4⁽¹⁾.
- Engine types: DC13 109, DC13 110, DC13 115, DC13 124, DC13 125 and DC13 147, all Euro VI.
- Minimum three vehicles with candidate oil to complete the field test
- Test distance
 - 2 x 150000 km if fuel consumption is 2.6 - 2.79 L/10 km (not for FS)
 - 2 x 130000 km if fuel consumption is 2.8 - 2.89 L/10 km (not for FS)
 - 2 x 120000 km if fuel consumption is 2.9 - 3.29 L/10 km (not for FS)
 - 3 x 90000 km if fuel consumption is 3.3 - 3.8 L/10 km
 - Scania LDF-3 FS and Scania LA-2 FS candidates should be run in haulage applications with fuel consumption > 3.5 L/100 km.
- Operating conditions and engine types to be checked and validated by Scania before start of test
- The overall total impression of the engine is the base for acceptance/refusal
- No read across to not-tested formulations

Possible approval level	LDF	LDF-2	LDF-3 (FS)	Low Ash	LA-2 (FS)
ACEA / API performance level	ACEA E4, E6, E7, E9, API CJ-4 ⁽¹⁾				

Laboratory tests

Viscosity @ 40°C and 100°C , ASTM D 445, mm ² /s	Must not fall / exceed the original value by more than 20% at drain				
HTHS , CEC L-036-90, m.Pa.s	> 3.5	> 3.5	LDF-3: > 3.5 LDF-3FS: < 3.2 ⁽²⁾	> 3.5	LA-2: > 3.5 LA-2FS: < 3.2 ⁽²⁾
Sulfated ash , ASTM D874, % m/m	< 2	1 - 2	1 - 2	< 1	< 1
Sulfur , ASTM D5185, % m/m, max.	-	-	0.4	0.4	0.3
Phosphorus , ASTM D5185, % m/m, max.	-	-	0.12	0.12	0.08
Oxidation , DIN51453, A/cm, max.	-	-	-	-	10

Field tests

Piston cleanliness , average, merit, min.	30	35	35	30	40
TBN , ASTM D4739, lowest level during test, mg KOH/g, min.	3.5	7.0	7.0	-	-
Fe , ASTM D5185, mg/kg, max.	10 x oil age [10000km] + 10 ⁽³⁾				
Pb , ASTM D5185, mg/kg, max.	25e ^{0.16 x oil age [10000km]}			25 + 25e ^{0.32 x oil age [10000km]}	
				10	

Notes:

(1) Deviations are permitted, but must be agreed with Scania in each case

(2) Used oil HTHS for FS oils need to be <3.2 m.Pa.s at end of drain

(3) For Scania Low Ash oils the limiting sector for Iron is only defined up to oil age 60.000 km and not at maximum oil age as for other specifications

VOLVO CAR corporation engine oil specifications

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Oronite

Volvo car specification	VCC RBS0-2AE 0W-20	95200356	95200377
Lastest version date	Sept 10 th 2014	Sept 10 th 2014	Sept 10 th 2014
Application	Volvo car 0W-20 low ash, long drain, high fuel economy oil, Suitable only for HTHS 2.6 capable Volvo engines starting with the Volvo Engine Architecture (VEA) Diesel and Gasoline engine platform, Not backward compatible.	Volvo car high ash standard service fill oil suitable for all Gasoline and Diesel engines.	Volvo car high ash, fuel economy, service fill oil suitable for all Gasoline and Diesel engines.
Main region	Europe & US	China	Worldwide
ACEA level	C2-12 Unless otherwise stated per test	A3/B4-12	A5/B5-12
Acceptable SAE grades	0W-20	0W-30	0W-30
KV 150 , ASTM D445, mm ² /s, min.	3.6	Rate & Report	Rate & Report
KV 100 , ASTM D445, mm ² /s, min.	≥ 7.0 & ≤ 9.3	≥ 11.5 & ≤ 12.5	≥ 9.3 & ≤ 12.6
Shear stability KV100 , CEC L-014-93 or ASTM D6278, Kin. Viscosity, mm ² /s	≥ 7.0 & ≤ 9.3	≥ 9.3 & ≤ 12.5	≥ 9.3 & ≤ 12.6
HTHS viscosity , CEC L-036-90, mPa.s, min.	2.75	3.5	≥ 2.9 & < 3.5
Shear stability HTHS , CEC L-014-93 or ASTM D6278, HTHS, mPa.s, min.	2.75	3.5	≥ 2.9 & < 3.5
Noack , ASTM D5800, %, max.	13	13	13
Sulfated ash , ASTM D874, % m/m, max.	0.9	≥ 1.0 & ≤ 1.6	≤ 1.6
Phosphorus , ASTM D5185, % m/m	≥ 0.07 & ≤ 0.09	Rate & Report	Rate & Report
Sulfur , ASTM D4951, or ASTM D5453, max.	0.3	Rate & Report	Rate & Report
TBN , ASTM D2896, mg KOH/g, min.	7.5	10.0	8.0
Pour point , ASTM D97, °C, max.	-48	Rate & Report	-
Copper corrosion , ASTM D130 or ISO2160, rating, max.	1b	1b	1b
Gelation index , ASTM D5133, max.	8.5	-	-
Flash point , ASTM D93, °C, min.	185	Rate & Report	230
Foaming high temperature , ASTM D6082, ml, max.	100/0	100/0	50/0
M111 fuel economy , CEC L-054-96, %, min.	3.4% (average of 3 tests)	-	2.5%
VW TDI, PV 1452			

VOLVO CAR corporation engine oil specifications

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Oronite

Volvo car specification	VCC RBS0-2AE 0W-20	95200356	95200377
VW TDI , PV 1452			
Piston deposits, merit, min.	> RL 206 + Std Dev	RL 206 + Std Dev	> RL 206 + Std Dev
Ring sticking. Average 1 st grade, ASF, max.	1.0	1.0	1,0
Ring sticking. Max. 1 st /2 nd grade, ASF, max.	1 / 0	1 / 0	1 / 0
End of test TBN, DIN 51639-1, mgKOH/g, min.	4.0	4.0	4.0
End of test TAN, ASTM D 664, max.	Rate & Report	Rate & Report	Rate & Report
OM 646 DE22LA wear , CEC L-099-08			
Cam wear inlet/outlet valve (average wear 8 cams), µm, max.	100 / 120	100 / 120	100 / 120
Cylinder wear (average 4 cylinders), µm, max.	5.0	5.0	5.0
Bore polishing (13 cm), max. value of 4 cylinders, %, max.	3.0	3.0	3.0
Tappet wear inlet/outlet (average wear 8 cams), µm	Rate & Report	Rate & Report	Rate & Report
Piston cleanliness (average 4 pistons), merit, min.	Rate & Report	Rate & Report	Rate & Report
Engine sludge average, merit, min.	Rate & Report	Rate & Report	Rate & Report

VOLVO trucks VDS-3 and VDS-4 Standards

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Oronite

Engine oil	VDS-3 STD 417-0002	VDS-4 STD 417-0001
Viscosity grades (SAE J300)	xW-30, xW-40	xW-30, xW-40 (x = 5, 10, 15)
ACEA / API performance level	ACEA E7 and API CI-4	
Other OEM approvals	Mack EO-N, Renault trucks RLD-2	Mack EO-0 Premium Plus, Renault Trucks RLD-3
Laboratory tests		
Density , ASTM D1298, kg/m ³	Report	Report
Flash point COC, ASTM D92, °C	Report	Report
Pour point , ASTM D97, °C	Report	Report
Viscosity at 40°C, ASTM D445, mm ² /s at 100°C, mm ² /s	Report xW-30: 9.3 - 12.5; xW-40: 12.5 - 16.3	Report xW-30: 9.3 - 12.5; xW-40: 12.5 - 16.3
HTHS viscosity , ASTM D4683, CEC L-036-90	Report	Report
Shear stability , ASTM D7109 Viscosity at 100°C after 90 cycles shear (ASTM D445), mm ² /s, min. HTHS viscosity after 90 cycles shear (ASTM D4683, CEC L-036-90), mPa.s, min.	xW-30: 9.3; xW-40: 12.5 xW-30: 3.4; xW-40: 3.7	xW-30: 9.3; xW-40: 12.5 xW-30: 3.4; xW-40: 3.9
Low temperature cranking and pumping viscosity Low Temperature Cranking Viscosity, CCS, ASTM D5293, mPa.s, max. Low Temperature Pumping Viscosity, MRV, ASTM D4684, mPa.s, max.	Acc. to SAE J300 Acc. to SAE J300	7000 (10W-x at -25°C; 15W-x at -20°C) 60000 (10W-x at -30°C; 15W-x at -25°C)
Base oil viscosity at 100°C , ASTM D445, mm ² /s ⁽¹⁾	Report	xW-30: 6.2; xW-40: 6.5
Evaporative loss , Noack, ASTM D5800 or CEC L-040-93, %, max.	13	13
Sulfated ash , ASTM D874, % m/m, max.	-	1.0
Phosphorus , ASTM D4951, % m/m, max.	-	0.12
Sulfur , ASTM D4951, % m/m, max.	-	0.4
Foaming tendency , ASTM D892 Sequence I, II, III, ml, max.	10 / 0, 20 / 0, 10 / 0	10 / 0, 20 / 0, 10 / 0
Corrosion tendency , ASTM D6594 Copper increase, ppm, max. Lead increase, ppm, max. Copper strip rating (ASTM D130), max.	20 120 3	20 120 3

VOLVO trucks VDS-3 and VDS-4 Standards

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Oronite

Engine oil	VDS-3 STD 417-0002	VDS-4 STD 417-0001
Hot surface oxidation , PDSC, CEC L-085-99 Oxidation induction time, min.	65	-
Seal compatibility ⁽³⁾		
Nitrile	Pass	Pass
Silicone	Pass	Pass
Polyacrylate	Pass	Pass
FKM	Pass	Pass
Vamac G	Pass	Pass
Engine tests		
Mack T-11 or T-11A used oil MRV , ASTM D6896 ⁽²⁾ 180 h. drain MRV viscosity, mPa.s, max. MRV yield stress, Pa, max.	25000 35	18000 35
Cummins M11 EGR , ASTM D6975 ⁽⁴⁾ Run number Crosshead weight loss at 3.9% soot, mg, max. Oil filter Δ P at 250 h., kPa, max. Engine sludge, average, merit, min.	1 / 2 / 3 20.0 / 21.8 / 22.6 275 / 320 / 341 7.8 / 7.6 / 7.5	- - - -
Cummins ISM EGR , ASTM D7468 Run number Merit rating, min. Crosshead weight loss at 3.9% soot, mg, max. Oil filter Δ P at 150 h., kPa, max. Engine sludge, average, merit, min. VAS weight loss at 3.9% soot, average, mg, max.	1 / 2 / 3 - 7.5 / 7.8 / 7.9 55 / 67 / 74 8.1 / 8.0 / 8.0 -	1000 7.1 19 8.7 45
Cummins ISB EGR , ASTM D7484 Run number Slider tappet weight loss, average, max. Cam lobe wear, average, max. Crosshead weight loss, average	1 / 2 / 3 100 / 108 / 112 50 / 53 / 55 Report	1 / 2 / 3 100 / 108 / 112 50 / 53 / 55 Report
Mack T-8E , ASTM D5967 ⁽⁵⁾ Run number Relative viscosity at 4.8% soot, max. Slope at 275 h. or 5.8% soot (if reached before 275 h.), max. ⁽⁶⁾	1 / 2 / 3 1.8 / 1.9 / 2.0 0.75	- - -
Mack T-11 , ASTM D7156 Run number TGA soot at 4.0 mm ² /s increase, %, min. TGA soot at 12.0 mm ² /s increase, %, min. TGA soot at 15.0 mm ² /s increase, %, min.	1 / 2 / 3 3.5 / 3.4 / 3.3 6.0 / 5.9 / 5.9 6.7 / 6.6 / 6.5	1 / 2 / 3 3.5 / 3.4 / 3.3 6.0 / 5.9 / 5.9 6.7 / 6.6 / 6.5

VOLVO trucks VDS-3 and VDS-4 Standards

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Oronite

Engine oil	VDS-3 STD 417-0002	VDS-4 STD 417-0001
Mack T-10, ASTM D6987/Mack T-12, ASTM D7422	T-10 / T-12^m	T-12
Merit rating, min.	1250 / 1250	1300
Cylinder liner wear, µm, max.	32 / 26	21
Top ring weight loss, mg, max.	158 / 117	105
Δ lead 0 - 300 h., ppm, max.	35 / 42	30
Δ lead 250 - 300 h., ppm, max.	14 / 18	12
Oil consumption, g/h, max.	65 / 95	80
OM 501 LA, CEC L-101-08[®]		
Piston deposits, average, merit, min.	17	-
Bore polishing, average, %, max.	2	-
Oil consumption, kg/test, max.	9	-
Engine sludge, average, merit	Report	-
Caterpillar C13, ASTM D7484		
Merit rating, min.		1000
Δ oil consumption, g/h, max.		31
TLC, average, demerit, max.		35
TGC, average, demerit, max.		53
2 nd ring top face carbon, demerit, max.	-	33
Sequence IIIF, ASTM D6984/Sequence IIIG, ASTM D7220	IIIF	IIIG
EOT viscosity increase at 40°C (adjusted), %, max.	-	150
Viscosity increase at 40°C at 100 h. (unadjusted), % [B]	-	Report
Viscosity increase at 40°C at 80 h. (unadjusted), % [C]	-	Report
Viscosity increase at 40°C at 60 h. (unadjusted), % [D]	275	Report
EOT Ratio [(B-C)/(C-D)], max.	-	2.5
Roller Follower Wear Test (RWFT), ASTM D5966		
Run number		1 / 2 / 3
Pin wear, average, µm, max.	-	7.6 / 8.4 / 9.1

VOLVO trucks VDS-3 and VDS-4 Standards

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Oronite

Engine oil	VDS-3 STD 417-0002	VDS-4 STD 417-0001
Engine Oil Aeration Test (EOAT) , ASTM D6894, %vol, max.	-	8.0
Turbocharger deposits , CEC ⁽³⁾		
Boost pressure loss and/or, %, max.	-	TBD
Deposit weight, mg, max.	-	TBD
Volvo D12D460 , TC 415 ⁽⁸⁾		
Piston deposits, merit, min.	40	40
Ring riding, %, max.	50	50
Bore polish, cm ² , max.	150	150
Oil consumption (400 h.), g/h, max.	35	35
Oil consumption (final 100 h.), g/h, max.	35	35
Fuel economy D12D460⁽¹¹⁾ , ESC 13 mode, flat and hilly ⁽¹²⁾ , g/kWh, min.	-	xW-30: p/n 8715091

Notes:

- (1) If the base oil viscosity is lower than the indicated limits, Mack T10/T12, Cummins ISB and Cummins M11-EGR/ISM test results must be obtained on a formulation with the actual or lower base oil viscosity.
- (2) Additional requirements may be required for factory fill and Volvo Group branded products. Results according to ASTM D7216 or CEC L-039-96 are required.
- (3) Additional requirements may be required for factory fill and Volvo Group branded products. Results according to ASTM D7216 or CEC L-039-96 are required. However, results for VAMAC G material according to ASTM D7216 are always required.
- (4) Results from Cummins M11-EGR or Cummins ISM can be used
- (5) Mack T-11 (ASTM D7156) results obtained as part of API CI-4, CI-4 Plus or CJ-4 approval programs can be used
- (6) Slope is calculated using derivative of a 3rd order polynomial regression fit of soot vs relative viscosity using the last seven data points (150-300 h)
- (7) Mack T-10 or Mack T-12 results can be used
- (8) OM 441LA data can be used. Limits according to ACEA E7-04 Issue 2 apply.
- (9) Test code Volvo Powertrain Corp
- (10) Test to be developed by CEC. Requirement will be added when test is available.
- (11) Applies only for factory fill and Volvo Group branded products
- (12) According to Volvo Powertrain Corp. weighting factors

VOLKSWAGEN engine oil specifications

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Oronite

Specification	VW 504.00/507.00	VW 508.00/509.00	VW 502.00/505.01	VW 508.88/509.99	VW 502.00/505.00	VW 501.01/505.00
First fill	TL 521.95	TL 525.77	TL 521.67 (5W-40 only)	TL 525.53 (5W-40 only)	-	-
Last version date	Dec 2004 / Dec 2004	Mar 2014	Jul 2005 / Dec 2006	Apr 2013	Jul 2005 / May 2010	Mar 2005 / May 2010
Service fill	VW low ash, universal service fill oil, fully backward compatible & in EU used for extended drain, Mandatory for Diesels with DPF, only allowed in ultra low sulfur fuel regions.	VW 0W-20 low ash, long drain, high fuel economy oil, suitable only for HTHS 2.6 capable VW engines in EU and US, not backward compatible, not allowed outside EU and USA.	VW low ash service fill oil for Gasoline engines under severe duty & pump injector Diesels WITHOUT DPF	VW high ash oil for outside Europe with different quality fuel than in EU, normal drain, not allowed for Diesels with DPF, currently allowed only in Brazil.	VW normal ash service fill oil for Gasoline engines under severe duty and Diesels without pump injector, not allowed for pump injector Diesels.	VW normal ash standard service fill oil. Not allowed for pump injector Diesels, not allowed for modern day VW engines.
ACEA basis	A3/B4-12 (excl. TBN & S, ash limit) ≈ C3 due to VW DPF test	A1/B1-12 Unless otherwise stated per test	C3-12	A3/B4-12	A3/B4-12	A3/B3-12
SAE viscosity grade	0/5W-30	0W-20	0/5/10W-30/40	0/5/10W-30/40	0/5/10W-30/40	0...20W/30...60
HTHS , CEC L-36-A-90, mPa.s, min.	3.5	2.6	3.5	3.5	3.5	3.5
KV 100 , DIN 51562-1, mm ² /s	According SAE J300	≥ 7.8 & ≤ 9.3	According SAE J300	According SAE J300	According SAE J300	According SAE J300
Shear stability , CEC L-14-A-93, 30 cycles						
KV 100, DIN 51562-1, mm ² /s, % loss after shear, max.	15%	15%	15%	15%	15%	15%
KV 100, DIN 51562-1, mm ² /s, after shear, min.	Stay in grade	6.9	Stay in grade	Stay in grade	Stay in grade	Stay in grade
Noack volatility , CEC L-40-A-93, loss (B method), max.	11%	11%	13%	13%	13%	13%
TBN , DIN I51639-1, mg KOH/g, min.	Rate & Report	6.0	7.0	11.0	8.0	8.0
Sulfated ash , DIN 51575, % m/m	≤ 1.5 & pass VW DPF test	≤ 1.5 & pass VW DPF test	≤ 0.8	≥ 1.0 & ≤ 1.5	≤ 1.5	≤ 1.5
Phosphorus , DIN 51363-3, % m/m	Rate & Report	Rate & Report	≥ 0.07 ⁽¹⁾	≥ 0.08 & ≤ 0.15	≥ 0.08 ⁽¹⁾	≥ 0.08 ⁽¹⁾
Sulfur , DIN EN ISO 14596, % m/m, max.	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
Zirkonium content , PV1497, % m/m	-	0.0025	-	-	-	-
Color , no norm	-	Green	-	-	-	-

VOLKSWAGEN engine oil specifications

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Oronite

Specification	VW 504.00/507.00	VW 508.00/509.00	VW 502.00/505.01	VW 508.88/509.99	VW 502.00/505.00	VW 501.01/505.00
Color , no norm	-	Green	-	-	-	-
PAH value , VW 50550 and PV 1448, % m/m ⁽⁹⁾	Rate & Report	Rate & Report	Rate & Report ⁽⁹⁾	Rate & Report ⁽⁹⁾	-	-
Sum PAH 1 till 12, mg/kg, max.	10	10	< 10 ⁽⁹⁾	< 10 ⁽⁹⁾	-	-
Ben(a)pyren, mg/kg, max.	1	1	< 1 ⁽⁹⁾	< 1 ⁽⁹⁾	-	-
Impurities by particles , ISO 4406 ⁽⁸⁾	Class 23/22/18 for 4/6/14 µm, Class 23/18 for 5/15 µm	Class 23/22/18 for 4/6/14 µm, Class 23/18 for 5/15 µm	Class 23/22/18 for 4/6/14 µm, Class 23/18 for 5/15 µm	Class 23/22/18 for 4/6/14 µm, Class 23/18 for 5/15 µm		
Emulsion stability , ASTM D7563						
0°C and 24 h.	-	No phase separation	-	No phase separation	-	-
25°C and 24 h.	-	No phase separation	-	No phase separation	-	-
Corrosion test , PV 1401, corrosion grade, max. ⁽⁶⁾	1	1	1	1	-	-
Corrosion test , PV 1425						
Steel, grade, max.	1	1	1	1	-	-
Copper, grade, max.	2	2	2	2	-	-
Weight loss, % m/m, max.	0.5	0.5	0.5	0.5	-	-
Corrosion test , PV 1492, corrosion grade, max.	-	-	-	1	-	-
Biofuel oxidation stability , GFC-Lu-43A-1 ⁽⁵⁾	-	Limits according to ACEA C3	-	-	-	-
Low temperature pumpability , CEC L-105	-	Limits according to ACEA C3	-	-	-	-
VW oil / seal compat. , PV 3344 ⁽²⁾						
AEM1/AEM2	500 h.	500 h.	168 h.	168 h.	168 h.	168 h.
ACM1	500 h.	500 h.	168 h.	168 h.	168 h.	168 h.
AK6/1	168 h.	168 h.	3 x 94 h.	3 x 94 h.	3 x 94 h.	3 x 94 h.

VOLKSWAGEN engine oil specifications

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Oronite

Specification	VW 504.00/507.00	VW 508.00/509.00	VW 502.00/505.01	VW 508.88/509.99	VW 502.00/505.00	VW 501.01/505.00
M111 sludge , CEC L-053-T-95 [®]						
Average sludge, merit	> RL 140 + 5σ (or > 9.2)	-	> RL 140 + 4σ (or > 9.0)	-	> RL 140 + 4σ (or > 9.0)	> RL 140 + 4σ (or > 9.0)
Oil filter pressure, bar, max.	1.8	-	1.8	-	1.8	1.8
M271 sludge test , MB procedure						
Engine sludge average, merit, min.	9.1	9.1	-	9.1	-	-
OM 646 DE22LA wear , CEC L-099-08						
Cam wear inlet/outlet valve (average wear 8 cams), μm, max.	100 / 120	50 / 60	100 / 120	90 / 110	100 / 120	110 / 140
Cylinder wear (average 4 cylinders), μm, max.	5.0	5.0	5.0	5.0	5.0	5.0
Bore polishing (13 cm), max. value of 4 cylinders, %, max.	3.0	3.0	3.0	3.0	3.0	3.5
Bearing wear main/con rod bearing, μm, max. ⁽⁷⁾	-	2.1 / 2.1	-	-	-	-
Piston ring wear axial at ring 1/ring 2/ring 3, μm, max. ⁽⁷⁾	-	8.7 / 4.0 / 3.0	-	-	-	-
Piston ring wear radial at ring 1/ring 2/ring 3, μm, max. ⁽⁷⁾	-	10.0 / 12.0 / 8.0	-	-	-	-
Timing chain wear (elongation), %, max. ⁽⁷⁾	-	0.4	-	-	-	-
VW T4 , PV 1449						
Viscosity at 40°C at end of test, mm ² /s, max.	200 +/- test stand severity	200 +/- test stand severity	200 +/- test stand severity	200 +/- test stand severity	200 +/- test stand severity	-
Viscosity increase at 40°C, %, max.	130 +/- test stand severity	130 +/- test stand severity	130 +/- test stand severity	130 +/- test stand severity	130 +/- test stand severity	-
TBN end of test, DIN 51639-1, mg KOH/g, min.	Ref. oil of test stand (typical = 3)	Ref. oil of test stand (typical = 3)	Ref. oil of test stand + 1 (typical = 4)	Ref. oil of test stand + 3 (typical = 6)	Ref. oil of test stand + 1 (typical = 4)	-
TAN increase end of test, TAN points, max.	4	4	4	3	4	-
Piston merit, 5 parts, min.	1.0	1.0	1.0	1.0	1.0	-
Ring sticking, ASF, max.	None	None	None	None	None	-
VW fuel economy , PV 1451						
FE vs. RL 191 (15W-40), %, min.	0W-30: 2.5% / 5W-30: 2.0%	4.0% [®]	-	-	-	-
VW fuel economy, PV 1496 Audi EA888						

VOLKSWAGEN engine oil specifications

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Oronite

Specification	VW 504.00/507.00	VW 508.00/509.00	VW 502.00/505.01	VW 508.88/509.99	VW 502.00/505.00	VW 501.01/505.00
VW fuel economy , PV 1496 Audi EA888						
FE vs RL 5W-30, %, min.	only PV 1451 allowed	1.5% ⁽⁶⁾	-	-	-	-
VW TDI , PV 1452						
Piston deposits, merit, min.	> RL 206 + Std Dev	RL 206 + Std Dev	> RL 206 + Std Dev	RL 206 + Std Dev + 2	> RL 206 + Std Dev	> RL 206 + Std Dev - 4
Ring sticking. Average 1 st grade, ASF, max.	1.0	1.0	1.0	0.0	1.0	1.0
Ring sticking. Max. 1 st /2 nd grade, ASF, max.	1 / 0	1 / 0	1 / 0	0 / 0	1 / 0	1 / 0
End of test TBN, DIN 51639-1, mgKOH/g, min.	Rate & Report	Rate & Report	Rate & Report	6.0	6.0	4.0
End of test TAN, ASTM D 664, max.	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report	Rate & Report
VW 1.4 L FSI , PV 1481						
Inlet valve deposits, max.	Ref. oil FSI 5510 - 38.18%	Ref. oil FSI 5510 - 38.18%	-	Ref. oil FSI 5510 - 38.18%	-	-
VW DPF 1.9 L TDI , PV 1485						
Backpressure increase/oil consumption, mbar/kg, max.	6.0	6.0	-	-	-	-
VW RNT wear test	Full test (650 h.)	-	250 h. test	-	-	-
Baumuster prufung⁽⁴⁾	Complete program	VW508.00/509.00 program	Short program (4 engine tests)	-	-	-
OM 646 DE22LA Biodiesel test , CEC TDG-L104	-	Limits according to ACEA C3 when available	-	-	-	-
PSA TU 5JP , CEC L-088-02						
Pass	-	-	-	-	-	Limits according to ACEA A3/B3

Notes:

(1) If the phosphorus content is < 0.10 % m/m, functional and/or in-vehicle tests may be required for release. Type and scope of these tests shall be coordinated with VW prior to approval.

(2) Please refer to chapter « Elastomer compatibility » for limits

(3) M271 sludge can be used instead of M111 SL as approved by ACEA

(4) Consult VW for actual baumuster requirements

(5) Will be replaced by CEC L-109 when ready

(6) For VW508.00/509.00 fuel economy performance either PV 1451 or PV 1496, Audi EA888 can be used

(7) Control parameter. For information only.

(8) Factory fill only

ACC, API, ATC
and ATIEL CODES
of PRACTICE (CoP)



API and ATIEL base stock categories



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	Saturates ⁽¹⁾ wt%		Sulfur ⁽²⁾ wt%		Viscosity index ⁽³⁾
Group I	< 90	& / or	> 0.03	&	$80 \leq VI < 120$
Group II	≥ 90	&	≤ 0.03	&	$80 \leq VI < 120$
Group III	≥ 90	&	≤ 0.03	&	≥ 120
Group IV	Polyalphaolefins (PAO)				
Group V	All other base stocks not included in Group I, II, III, or IV.				

Notes:

(1) ASTM D2007 / IP129

(2) ASTM D2622 / ASTM D4294 / ASTM D4927, ASTM D1552 or ASTM D3120 may be used

(3) ASTM D2270

API Code of Practice definitions for base oil interchangeability guidelines



Oronite

Acc. to appendix	A	is / are
E.1.2.3	Base oil	The base stock or blend of base stocks used in an API-licensed oil
E.1.2.1	Base stock	A lubricant component that: - is produced by a single manufacturer to the same specifications (independent of feed source or manufacturer's location), - meets the same manufacturer's specification, - is identified by a unique formula, product identification number, or both, - may be manufactured using a variety of different processes including but not limited to distillation, solvent refining, hydrogen processing, oligomerization, esterification, and rerefining. Rerefined stock shall be substantially free from materials introduced through manufacturing, contamination, or previous use.
E.1.2.2	Base stock slate	A product line of base stocks that have different viscosities but are in the same base stock grouping and from the same manufacturer

ATIEL Code of Practice definitions for base stock interchange guidelines



Acc. to appendix	A	is / are
B.2.1	Base oil	The base stock or blend of base stocks which, when mixed with performance additives, is used in an engine lubricant marketed as conforming to ACEA Oil Sequences
B.2.2	Base stock	A base oil component that: - is produced and used in accordance with the ATIEL Base Oil Quality Assurance and Interchange Guidelines given in this Appendix B, - is produced by a single manufacturer or partner group to the same specification, independently of feed source or manufacturer's location, - meets the same manufacturer's or partner group's specification and is identified by a unique formula, product identification number or both, - may be manufactured using a variety of different processes including but not limited to distillation, solvent refining, hydrogen processing, oligomerization, esterification, and re-refining, - is substantially free from materials introduced through manufacturing, contamination, or previous use.
B.2.4	Base stock manufacturer	A company which produces, at one or more manufacturing sites, base stock(s) for use in lubricants for which compliance with ACEA Oil Sequences is claimed
B.2.5	Feedstock	The starting material (such as crude oil, refinery intermediate or used lubricating oil) from which base stocks are produced at a manufacturing site. A particular feedstock may originate from a single source or multiple sources.
B.2.6	Base stock slate	A product line of base stocks that: - is produced by the same manufacturer, - meets the ATIEL definition of base stock, - is in the same ATIEL Base Stock Group, - may have different specified viscosities and other properties, - has been demonstrated, in lubricants for which compliance with ACEA Oil Sequences is claimed, to be technically substitutable by other appropriate base stocks on the same slate.
B.2.7	Linked slates	Base stock slates that the lubricant manufacturer or base stock manufacturer or partner group concerned has demonstrated, according to the requirements of Appendix B, are interchangeable without the need for further engine testing.
B.2.8	Partner group	A voluntary grouping of two or more base stock manufacturers who have: - base stock slates complying with the ATIEL definition of base stock slate, - linked base stock slates on the basis of a written agreement
B.2.8	Base stock interchange	The process of substituting base stock(s) from alternative base stock slates in engine lubricants validated as complying with ACEA Oil Sequence(s).

ATIEL base stock interchange guidelines use of alternative base stocks in validated formulations



Oronite

Same slate or linked base stock slate App. B.4.1	Base stocks within the same base stock slate or within linked base stock slates may be interchanged without additional testing
Unlinked slate App. B.4.2	Base oil interchange tables (tables B.3 and B.4) identify the passing engine tests required to interchange base stocks in an originally tested engine oil formulation with those from a different base stock slate Passing results are required only for those engine tests that are a requirement of the ACEA classes and categories for which support is being established. Complete performance documentation is required for the original formulation. While applying these tables the performance additive package and treatment rate, the viscosity modifier and the viscosity grade of the formulations shall remain the same. Within the same viscosity grade, the VM concentration may be adjusted +/- 15% mass fraction without additional engine testing. Changes beyond this amount shall follow the technical principles established in the VGRA guidelines Where base stocks from more than one base stock group are interchanged simultaneously, the most severe testing requirements apply

ACC and ATC guidelines for minor formulation modifications

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		ACC ^(*) Appendix H of the ACC Code of Practice	Appendix #	ATC ^(**) Section h of the ATC Code of Practice	Section #
Performance additive package minor formulation modifications	Level 1	Level 2		Modifications within an ATC data set or programme	
Decrease in treatment level of either the entire performance additive package or its individual components		Not allowed except for ZnDTP or detergent rebalance		Not allowed except for permissible rebalance	h.1
Performance additive package treatment level increase	≤ 20%	> 20 to ≤ 30%	H 1	Allowed	h.2
Single component of performance additive package increase					
- present at > 1% in finished oil (major component)	≤ 20%	> 20 to ≤ 30%	H 2	Allowed	h.2
- present at ≤ 1% in finished oil					
• ≤ 0.3%	≤ 100%	> 100% to 200% (max. 0.6% in formulation to be tested)	H 3a		
• > 0.3% to ≤ 0.6%	≤ 50%	> 50% to 100%	H 3b		
• > 0.6% to ≤ 1%	≤ 30%	> 30% to 100% (max. 1.3% in formulation to be tested)	H 3c		
New component addition	Not possible	≤ 10% of total final performance additive package	H 4	≤ 10% of total final performance additive package	h.3
Rebalance of ZnDTP (only one permitted)	Not possible	Allowed while maintaining constant phosphorus level This may include introduction of a new ZnDTP ⁽¹⁾	H 5a H 5b	Allowed whilst maintaining constant formulation phosphorus level. This may include introduction of a new ZnDTP: only one new ZnDTP introduction is allowed	h.4
Rebalance of metallic detergents (only one permitted)	Not possible	Permitted if sulphated ash remains constant Overall soap must not be decreased Soap increase ≤ 30% per individual soap type	H 6	Acceptable provided overall soap level is not decreased, only one new metallic detergent introduction is allowed	h.5
Other limitations		Performance additive package minor modifications ≤ 3 or 4 ⁽²⁾ The sum of all modifications shall not result in an increase in treatment level of any major component > 30%	H 7	No	

Notes: The performance additive package commercialized must include all permitted minor modifications. ACC Appendix H 10, ATC Section h.6

(*) From ACC CoP Appendix H, Dec. 2010: Applies only to sequence IIIF, IIIG, IVA, VG, VIB, VID and VIII engine tests

(**) From ATC CoP Section H, Jan. 2010

Applies only to sequence IIIG, IIIGA, IIIF, IVA, VG, VIB, VID, and VIII engine tests

(1) An increase in treatment level of zinc dithiophosphate (ZnDTP), in a formulation where the phosphorus level from ZnDTP is greater than 0.04%, up to a max. of 0.12 % phosphorus from ZnDTP is acceptable with Level 2 support for the Sequence VIB and/or VID and Level 1 support for all other engine tests. For increases above 0.12% P from ZnDTP, Level 2 support is required for all engine tests. Alternatively, Guideline H2 or H3 could be used if applicable.

(2) Matrix approach allows 4 minor modifications; non-matrix approach only allows 3 minor modifications

ACC and ATC guidelines for minor formulation modifications

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Oronite

Base stocks and other constituents minor formulation modifications	ACC ⁽¹⁾ Appendix H of the ACC Code of Practice	Appendix #	ATC ^(**) Section h of the ATC Code of Practice						Section #
Base stock ratio change: Same slate	Acceptable with level 1 support: ≤ 15% absolute on a normalized to 100 % base stock ratio	H 8a	Unrestricted ⁽⁴⁾						H.8d
Different slate			Follow the principles given in h.7 (also covers new base stock addition)						
New base stock addition Same slate	Acceptable with level 1 support: ≤ 15% of base oil (base stock blend) ≤ 10 % in finished oil (limit to Group I, II, III or IV only)	H 8a	Within same base stock slate Group I to Group I, Group II to Group II, Group III to Group III, Group IV to Group IV is unrestricted.						H.7.1
Different slate			H 8b	Interchange Base Stock ^{(1) (4)}					
		Base stock in original formulation		Group I	Group II	Group III	Group IV	Group V	
		Group I		≤ 10%	≤ 10%	≤ 30% > 30% ⁽²⁾	≤ 30% > 30% ⁽²⁾	≤ 10 ⁽²⁾	
		Group II		≤ 10%	≤ 10%	≤ 30% > 30% ⁽²⁾	≤ 30% > 30% ⁽²⁾	≤ 10 ⁽²⁾	
		Group III		None	None	≤ 10%	≤ 30	≤ 10 ⁽²⁾	
		Group IV		None	None	None	(3)	≤ 10 ⁽²⁾	
Group V		None		None	None	None	None		
Matrix approach	Uses the API base oil interchangeability guidelines	Tests which are not deemed to be sensitive to base stock changes may be run in any applicable base stock (as per the ATIEL Code base oil interchange principles)						H.7.2	
Viscosity modifier treat level change Pour point depressant treat level or type Antifoam treat level or type	≤ 15% relative with level 1 Acceptable with level 1 Acceptable with level 1	H 8c H 9 H 9	≤ 15% relative allowed without further support >15 % relative is allowed if in alignment with ATIEL Viscosity Grade Read Across Guidelines Acceptable Acceptable						H.8a H.8b H.8c

Notes: The performance additive package commercialized must include all permitted minor modifications.

(ACC Appendix H 10, ATC Section h.9).

(*) From ACC CoP Appendix H, Dec. 2010: Applies only to sequence IIIF, IIIG, IVA, VG, VIB, VID and VII engine tests.

(**) From ATC CoP Section H, Jan. 2010: Cumulative substitutions must not exceed 10% or 30% by mass, as relevant and as defined above, from any initial/intermediate candidate for which test data are to be retained in support of the final candidate without specific engine test data (or other engine test data as in h.15.).

With specific engine test data (or other engine test data as in h.15.), replacement of Gp I or II with Gp III, IV or VI is unlimited.

Where changes such as above are introduced as the result of failing engine test data, and to pass an engine test, the reverse

substitution may not be made subsequently, even if apparently allowed under the rules above, without the relevant engine test having been re-run and passed on a system representative of the final base stock mix to be promoted.»

(1) All percentages are %m of the finished oil

(2) Allowed with specific engine test data (or other engine test data as in h.15.)

(3) Substitution of Gp IV by another manufacturer's Gp IV is allowed as defined by the ATIEL Code of Practice (appendix B, base Stock Interchange Guidelines)

(4) Base stock groupings are as defined by the ATIEL Code of Practice, section B

ACC and ATC guidelines data required for candidate data packages

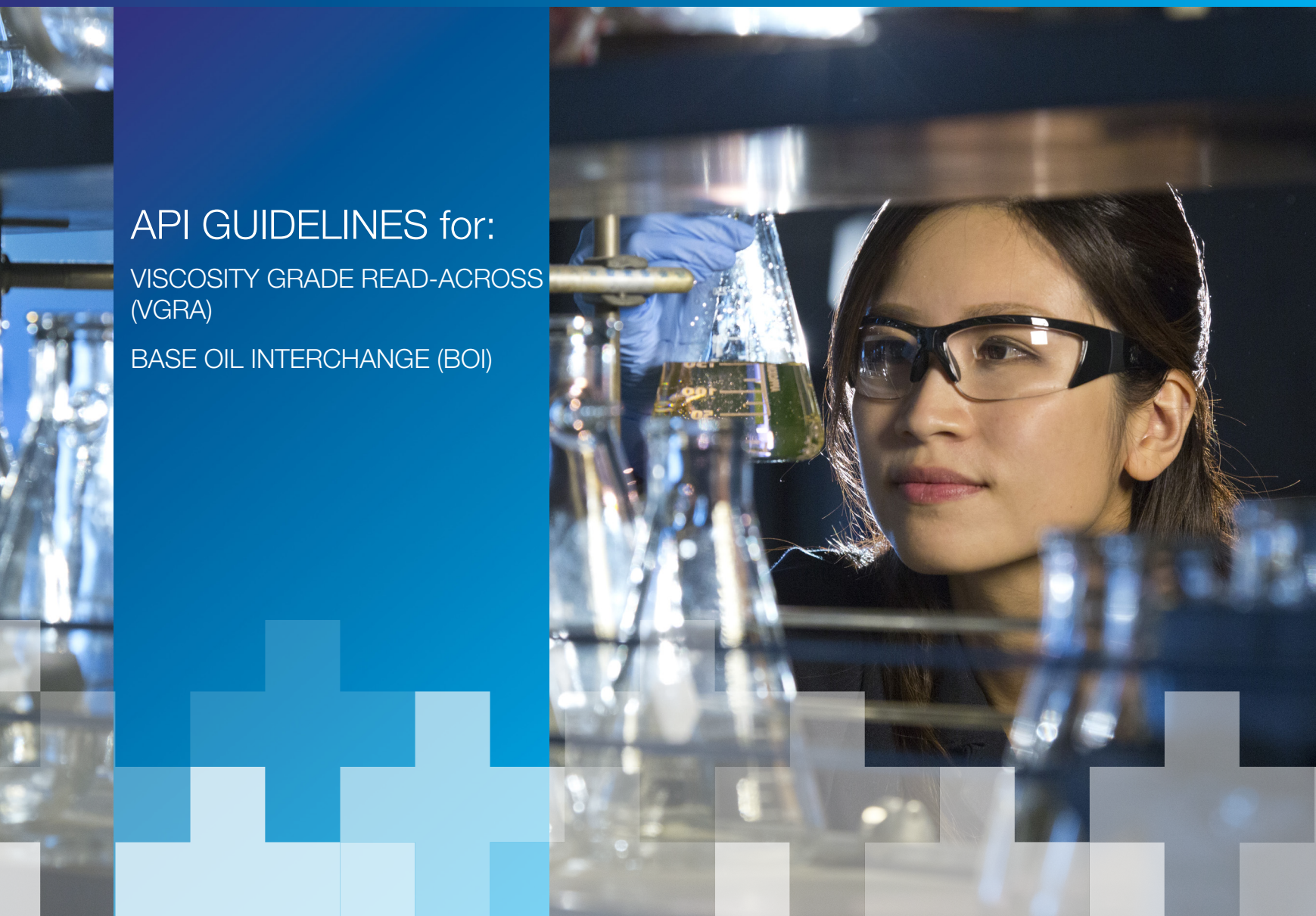


Oronite

ACC	Level 1 ACC CoP Appendix E.2.	INITIAL & MODIFIED FORMULATIONS • Analytical testing - All additive elements known to be present - TBN (ASTM D2896) FINAL FORMULATION • Analytical testing - All additive elements known to be present - TBN (ASTM D2896) - IR (infrared trace) • Base stock analysis - Saturates, sulfur & viscosity index	• Rheological testing - Viscosity at 100°C (ASTM D445) - CCS (if W grade) (ASTM D5293) - HTHS at 150°C (ASTM D4683, D4624, or D4741) • Rheological testing - Viscosity at 100°C (ASTM D445) - Viscosity at 40°C (ASTM D445) - CCS (if W grade) (ASTM D5293) - MRV (if W grade) (ASTM D4684) - HTHS at 150°C (ASTM D4683, D4624, or D4741)
	Level 2 (= Level 1+) ACC CoP appendix E.3. and definition of level 2 support in glossary of terms Tab 1	• Engine tests / Final formulation - Full length ASTM operationally valid engine tests on oils containing performance additive package(s) representative of the chemistry in the final formulation. - ASTM calibrated test stands to be used in all cases. - Tests limited to the following: - statistically designed engine test matrices, or - complete engine test programs, or - partial set of tests from same technology family	• Demonstrate no harm
ATC	ATC CoP Section G g.4	FOR ALL SUPPORTING AND FINAL FORMULATIONS • Analytical testing - Finished oil metals where present - Finished oil S, N, Si, P, Cl⁽¹⁾ - TBN (ASTM D2896) - Sulfated ash (ASTM D874)	• Rheological testing - Viscosity at 100°C (ASTM D445) - CCS (if W grade) (ASTM D5293) • Treatment level in finished oil of - Performance additive package - Base stocks - Viscosity modifier - Other constituents
	ATC CoP Section G g.2	• Base stock analysis - Saturates, sulfur & viscosity index	

Notes:

(1) Cl determination is only required on the final formulation and where an ACEA A/B or C claim is being made

A woman with dark hair, wearing safety glasses and a lab coat, is looking intently at a glass flask containing a yellow liquid. She is holding the flask with a blue-gloved hand. The background is a laboratory setting with various glassware and equipment. The image is overlaid with a blue gradient and a white crosshair pattern.

API GUIDELINES for:

VISCOSITY GRADE READ-ACROSS
(VGRA)

BASE OIL INTERCHANGE (BOI)

API 1509 - Engine oil licensing and certification system guidelines: technical principles for viscosity grades not covered in read across tables for formulations containing Group I, II, III and IV base stocks

F1.3

Tables F-2 through F-12 on following pages indicate when a viscosity grade read-across is allowed (X) and not allowed (-).

For viscosity grades not included in those tables, read across is allowed for certain tests if the viscosity grades meet all the applicable technical principles described in Table F-1.

Read-across for viscosity grades not covered by Table F-1 through F-13 is not allowed until API's BOI/VGRA task force reviews the justification and data supporting a change to the tables and recommends the change to the API Lubricants Committee and the Lubricants Committee approves the change.

Check marks in Table F-1 indicate which technical principles apply to a specific test.

Table F-1

Passenger car motor oils	Sequence								
	IID	L-38/ VIII	IIIE/IIIF/IIIG	IIIGA ⁽²⁾	IIIGB	IVA	VE	VG	VIA/VIB/VID
Detergent (dispersant)-inhibitor (DI) content of the read-across viscosity grade shall be equal to, or higher than, that of the original viscosity grade. The increase in DI is limited to the max. allowed by the ACC Code of Practice	√	√	√	√	√	√	√	√	⁽³⁾
Base stock blend kinematic viscosity at 100°C of the read-across viscosity grade must be equal to or higher than that of the original viscosity grade, considering the precision of the test method	NA	NA	√	√	NA	√	√	NA	⁽³⁾
The viscosity modifier (VM) content of the read-across viscosity grade must be equal to or lower than that of the original viscosity grade	NA	NA	⁽⁴⁾	⁽⁴⁾	NA	√	√ or ⁽⁵⁾	√ or ⁽⁵⁾	⁽³⁾

Diesel engine oils	1M-PC
Detergent (dispersant)-inhibitor (DI) content of the read-across viscosity grade shall be equal to or higher than that of the original viscosity grade. The increase in DI is limited to the max. allowed by the ACC Code of Practice	√
Base stock blend kinematic viscosity at 100°C of the read-across viscosity grade must be equal to or higher than that of the original viscosity grade, considering the precision of the test method	√
The viscosity modifier (VM) content of the read-across viscosity grade must be equal to or lower than that of the original viscosity grade	√
Finished oil volatility of the read-across viscosity grade must be equal to or lower than that of the original viscosity grade	√

Notes:

(1) √ = principle is applicable; NA = not applicable

(2) Technical principles for the sequence IIIGA are limited to 0W, 5W, and 10W multigrades

(3) New viscosity grades and associated read-across can only be added after review by the API BOI/VGRA task force and approval by the API Lubricants committee

(4) Viscosity modifier content must be no more than 1.5 times higher than the viscosity modifier content in the oil on which the test was run

(5) For dispersant-type VM, the VM content of the read-across viscosity grade must be equal to or higher than the original viscosity grade

(6) Read-across viscosity grades must contain an equal amount of the same Group V base stock (e.g., ester) in the finished oil blend if a Group V base stock is used in the original viscosity grade.

API 1509 - Engine oil licensing and certification system guidelines: viscosity grades read across requirements for formulations containing Group I, II, III and IV base stocks

L-38/Sequence VIII tests - Table F-2

Can be "Read-Across" to:													
Test run on	5W-20	5W-30	10W	10W-30	10W-40	15W-40	15W-50	20W	20W-40	20W-50	30	40	50
5W-20	NA	X	X	X	X	X	X	X	X	X	X	X	X
5W-30	X	NA	X	X	X	X	X	X	X	X	X	X	X
10W	-	-	NA	-	-	-	-	X	-	-	X	X	X
10W-30	-	-	X	NA	X	X	X	X	X	X	X	X	X
10W-40	-	-	X	X	NA	X	X	X	X	X	X	X	X
15W-40	-	-	-	X	X	NA	X	X	X	X	X	X	X
15W-50	-	-	-	-	X	X	NA	X	X	X	X	X	X
20W	-	-	-	-	-	-	-	NA	-	-	X	X	X
20W-40	-	-	-	-	-	X	X	X	NA	X	X	X	X
20W-50	-	-	-	-	-	-	X	X	X	NA	X	X	X
30	-	-	-	-	-	-	-	-	-	-	NA	X	X
40	-	-	-	-	-	-	-	-	-	-	-	NA	X
50	-	-	-	-	-	-	-	-	-	-	-	-	NA

Notes:
(1) X = read-across is permitted for the viscosity grades identified based on data and some applications of the technical principles approved by API BOI/VGRA task force and API lubricants committee
(2) A dash (-) means that read-across is not permitted; NA = not applicable

(3) New viscosity grades and associated read-across are allowed if the requirements described in F.1.3 are met

(4) Tested formulations containing Group V stocks must contain an equal amount of the same Group V base stock (e.g., ester) in the finished oil blend for application of viscosity grade read-across

(5) The read-across in this table applies only to bearing weight loss and piston varnish. All multigrade oils must stay-in-grade for 10 h. in the L-38/Seq. VIII tests (see ILSAC GF-1, GF-2, GF-3 and GF-4). Data to support stay-in-grade "read-across" shall be provided by the licensee for API service categories SM, SL, SJ, SH, and CG-4 and ILSAC GF-1, GF-2, and GF-3 oils (0W-XX, 5W-XX, 10W-XX).

(6) The guidelines in this table apply only to bearing weight loss. All multigrade oils must stay in grade for 10 h. Data to support stay-in-grade read across shall be provided by the licensee for active API service categories and ILSAC Standards. ASTM D6278 (30 passes) may be used to support stay-in-grade requirements, where the following limits must be met at 100 °C: SAE XW-20 5.6 cSt minimum, XW-30 8.5 cSt minimum, XW-40 11.5 cSt minimum, and XW-50 15.0 cSt minimum.

API 1509 - Engine oil licensing and certification system guidelines: viscosity grades read across requirements for formulations containing Group I, II, III and IV base stocks

Sequence IID - Table F-3

Can be "Read-Across" to:													
Test run on	5W-20	5W-30	10W	10W-30	10W-40	15W-40	15W-50	20W	20W-40	20W-50	30	40	50
5W-20	NA	X	X	X	X	X	X	X	X	X	X	X	—
5W-30	X	NA	X	X	X	X	X	X	X	X	X	X	—
10W	—	—	NA	—	—	—	—	X	—	—	X	X	—
10W-30	—	—	X	NA	X	X	X	X	X	X	X	X	—
10W-40	—	—	X	X	NA	X	X	X	X	X	X	X	—
15W-40	—	—	—	X	X	NA	X	X	X	X	X	X	X
15W-50	—	—	—	—	X	X	NA	X	X	X	X	X	X
20W	—	—	—	—	—	—	—	NA	—	—	X	X	X
20W-40	—	—	—	—	X	X	X	X	NA	X	X	X	X
20W-50	—	—	—	—	—	X	X	X	X	NA	X	X	X
30	—	—	—	—	—	—	—	X	—	—	NA	X	X
40	—	—	—	—	—	—	—	—	—	—	X	NA	X
50	—	—	—	—	—	—	—	—	—	—	—	—	NA

- Notes:**
- (1) X = read-across is permitted for the viscosity grades identified based on data and some applications of the technical principles approved by API BOI/VGRA task force and API lubricants committee
 - (2) A dash (-) means that read-across is not permitted; NA = not applicable
 - (3) New viscosity grades and associated read-across are allowed if the requirements described in F.1.3 are met
 - (4) Tested formulations containing Group V stocks must contain an equal amount of the same Group V base stock (e.g., ester) in the finished oil blend for application of viscosity grade read-across

API 1509 - Engine oil licensing and certification system guidelines: viscosity grades read across requirements for formulations containing Group I, II, III and IV base stocks

Sequence IIIE/IIIF/IIIG/IIIGB tests - Table F-4

Can be "Read-Across" to:													
Test run on	5W-20	5W-30	10W	10W-30	10W-40	15W-40	15W-50	20W	20W-40	20W-50	30	40	50
5W-20	NA	—	X	X	—	—	—	X	X	X	X	X	X
5W-30	X ^a	NA	X	X	X	X	X	X	X	X	X	X	X
10W	—	—	NA	—	—	—	—	X	—	—	X	X	X
10W-30	—	—	X	NA	X	X	X	X	X	X	X	X	X
10W-40	—	—	X	X	NA	X	X	X	X	X	X	X	X
15W-40	—	—	—	X	X	NA	X	X	X	X	X	X	X
15W-50	—	—	—	—	—	X	NA	—	X	X	X	X	X
20W	—	—	—	—	—	—	—	NA	—	—	X	X	X
20W-40	—	—	—	—	—	—	—	X	NA	X	X	X	X
20W-50	—	—	—	—	—	—	—	—	X	NA	X	X	X
30	—	—	—	—	—	—	—	—	—	—	NA	X	X
40	—	—	—	—	—	—	—	—	—	—	—	NA	X
50	—	—	—	—	—	—	—	—	—	—	—	—	NA

- Notes:**
- (1) X = read-across is permitted for the viscosity grades identified based on data and some applications of the technical principles approved by API BOI/VGRA task force and API Lubricants Committee. Viscosity modifier content must be no more than 1.5 times higher than the viscosity modifier content in the oil on which the test was run
 - (2) A dash (-) means that read-across is not permitted; NA = not applicable
 - (3) New viscosity grades and associated read-across are allowed if the requirements described in F.1.3 are met
 - (4) Tested formulations containing Group V stocks must contain an equal amount of the same Group V base stock (e.g., ester) in the finished oil blend for application of viscosity grade read-across
 - (a) The read from 5W-30 to 5W-20 applies to Sequence IIIF/IIIG only

API 1509 - Engine oil licensing and certification system guidelines: viscosity grades read across requirements for formulations containing Group I, II, III and IV base stocks

Sequence IIIGA and ROBO test - Table F-5

Can be "Read-Across" to:					
Test run on	5W-20	5W-30	10W	10W-30	10W-40
5W-20	NA	-	X	X	-
5W-30	X	NA	X	X	X
10W-30	-	-	X	NA	X
10W-40	-	-	X	X	NA

- Notes:**
- 1) X = read-across is permitted for the viscosity grades identified based on data and some applications of the technical principles approved by API BOI/VGRA task force and API lubricants committee.
Viscosity modifier content must be no more than 1.5 times higher than the viscosity modifier content in the oil on which the test was run
 - (2) A dash (-) means that read-across is not permitted; NA = not applicable
 - (3) Tested formulations containing Group V stocks must contain an equal amount of the same Group V base stock (e.g., ester) in the finished oil blend for application of viscosity grade read-across

API 1509 - Engine oil licensing and certification system guidelines: viscosity grades read across requirements for formulations containing Group I, II, III and IV base stocks

Sequence IVA test - Table F-6

Can be "Read-Across" to:													
Test run on	5W-20	5W-30	10W	10W-30	10W-40	15W-40	15W-50	20W	20W-40	20W-50	30	40	50
5W-20	NA	—	X	X	—	—	—	X	X ^a	X ^a	X	X	X
5W-30	X	NA	X	X	X	X	X	X	X	X	X	X	X
10W	—	—	NA	—	—	—	—	X	—	—	X	X	X
10W-30	—	—	—	NA	—	X	—	X	X	X	X	X	X
10W-40	—	—	—	X	NA	X	X	X	X	X	X	X	X
15W-40	—	—	—	X	—	NA	X	X	X	X	X	X	X
15W-50	—	—	—	—	—	—	NA	—	X	X	X	X	X
20W	—	—	—	—	—	—	—	NA	—	—	X	X	X
20W-40	—	—	—	—	—	X	—	—	NA	X	X	X	X
20W-50	—	—	—	—	—	—	—	—	—	NA	X	X	X
30	—	—	—	—	—	—	—	—	—	—	NA	X	X
40	—	—	—	—	—	—	—	—	—	—	—	NA	X
50	—	—	—	—	—	—	—	—	—	—	—	—	NA

- Notes:**
- (1) X = read-across is permitted for the viscosity grades identified based on data and some applications of the technical principles approved by API BOI/VGRA task force and API lubricants committee
 - (2) A dash (-) means that read-across is not permitted; NA = not applicable
 - (3) New viscosity grades and associated read-across are allowed if the requirements described in F.1.3 are met
 - (4) Tested formulations containing Group V stocks must contain an equal amount of the same Group V base stock (e.g., ester) in the finished oil blend for application of viscosity grade read-across
 - (a) Read-across permitted if requirements in F.1.3 are met

API 1509 - Engine oil licensing and certification system guidelines: viscosity grades read across requirements for formulations containing Group I, II, III and IV base stocks

Sequence VE/VG test nondispersant viscosity modifier - Table F-7

Can be "Read-Across" to:													
Test run on	5W-20	5W-30	10W	10W-30	10W-40	15W-40	15W-50	20W	20W-40	20W-50	30	40	50
5W-20	NA	—	X	X	—	—	—	X	—	—	X	X	—
5W-30	X	NA	X	X	X	X	X	X	X	X	X	X	—
10W	—	—	NA	—	—	—	—	X	—	—	X	X	—
10W-30	—	—	—	NA	—	X	—	X	X	X	X	X	—
10W-40	—	—	—	X	NA	X	X	X	X	X	X	X	—
15W-40	—	—	—	X	—	NA	X	X	X	X	X	X	X
15W-50	—	—	—	—	—	—	NA	—	X	X	X	X	X
20W	—	—	—	—	—	—	—	NA	—	—	X	X	X
20W-40	—	—	—	—	—	X	—	—	NA	X	X	X	X
20W-50	—	—	—	—	—	—	—	—	—	NA	X	X	X
30	—	—	—	—	—	—	—	—	—	—	NA	X	X
40	—	—	—	—	—	—	—	—	—	—	—	NA	X
50	—	—	—	—	—	—	—	—	—	—	—	—	NA

- Notes:**
- (1) X = read-across is permitted for the viscosity grades identified based on data and some applications of the technical principles approved by API BOI/VGRA task force and API lubricants committee
 - (2) A dash (-) means that read-across is not permitted; NA = not applicable
 - (3) New viscosity grades and associated read-across are allowed if the requirements described in F.1.3 are met
 - (4) Tested formulations containing Group V stocks must contain an equal amount of the same Group V base stock (e.g., ester) in the finished oil blend for application of viscosity grade read-across

API 1509 - Engine oil licensing and certification system guidelines: viscosity grades read across requirements for formulations containing Group I, II, III and IV base stocks

Sequence VE/VG test dispersant viscosity modifier^a - Table F-8

Can be "Read-Across" to:													
Test run on	5W-20	5W-30	10W	10W-30	10W-40	15W-40	15W-50	20W	20W-40	20W-50	30	40	50
5W-20	NA	X	—	X	X	X	X	—	X	X	—	—	—
5W-30	—	NA	—	Xb	X	X	X	—	X	X	—	—	—
10W	—	—	NA	—	—	—	—	X	—	—	X	X	—
10W-30	—	—	—	NA	X	X	X	—	X	X	—	—	—
10W-40	—	—	—	X	NA	X	X	—	X	X	—	—	—
15W-40	—	—	—	X	X	NA	X	—	X	X	—	—	—
15W-50	—	—	—	—	—	—	NA	—	X	X	—	—	—
20W	—	—	—	—	—	—	—	NA	—	—	X	X	X
20W-40	—	—	—	—	—	X	X	—	NA	X	—	—	—
20W-50	—	—	—	—	—	—	X	—	—	NA	—	—	—
30	—	—	—	—	—	X	X	—	X	X	NA	X	X
40	—	—	—	—	—	—	—	—	—	—	—	NA	X
50	—	—	—	—	—	—	—	—	—	—	—	—	NA

- Notes:**
- (1) X = read-across is permitted for the viscosity grades identified based on data and some applications of the technical principles approved by API BOI/VGRA task force and API lubricants committee
 - (2) A dash (-) means that read-across is not permitted; NA = not applicable
 - (3) New viscosity grades and associated read-across are allowed if the requirements described in F.1.3 are met
 - (4) Tested formulations containing Group V stocks must contain an equal amount of the same group V base stock (e.g., ester) in the finished oil blend for application of viscosity grade read-across
 - (a) Read-across is allowed to formulations with an equal or higher concentration of dispersant viscosity modifier
 - (b) 10W-30 read-across is permitted at a lower concentration of dispersant viscosity modifier than the 5W-30 provided that a passing SAE 30 is also obtained on the formulation where the DI treat remains unchanged

API 1509 - Engine oil licensing and certification system guidelines: viscosity grades read across requirements for formulations containing Group I, II, III and IV base stocks

Sequence VIA test - Table F-9

Can be "Read-Across" to:								
Test run on	0W-20	5W-20	0W-30	5W-30	0W-40	5W-40	10W-30	10W-40
0W-20	NA	-	-	-	-	-	-	-
5W-20	X1	NA	-	-	-	-	-	-
0W-30	X1	-	NA	-	-	-	-	-
5W-30	X1	X1	X2	NA	-	-	X4	-
0W-40	X1	-	X2	-	NA	-	-	-
5W-40	X1	X1	X2	X2	-	NA	-	-
10W-30	-	X1	X2	X2	-	-	NA	-
10W-40	-	-	-	X2	-	X2	X3	NA

Notes:

- (1) X1 = read-across allowed at 1.4% FEI or greater
- (2) X2 = read-across allowed at 1.1% FEI or greater
- (3) X3 = read-across allowed at 0.5% FEI or greater
- (4) X4 = read-across allowed if the 5W-30 meets 1.1% FEI and the HTHS of the 10W-30 is no more than 0.2cP higher than the 5W-30. This read-across is currently applicable to Group I base stocks only.
- (5) The data set used to establish the Sequence VIA viscosity grade read-across table had the following range of (Group I and Group II) base oil parameters:
 - Viscosity Index: Min. 93 – Max. 116
 - Saturates: Min. 71.5% – Max. 100%
 - Aromatics: Min. 0.0% – Max. 27%
 - Sulfur: Min. 0.0% – Max. 0.4% wt.

This information is for reference. It does not restrict application of the guidelines by the marketer who is responsible for ensuring that each licensed engine oil satisfies all engine and Laboratory test performance requirements.

(6) A dash (-) means that the read-across is not permitted; NA = not applicable

(7) New viscosity grades and associated read-across can only be added by requests to the API BOI/VGRA task force

(8) Tested formulations containing Group V stocks must contain an equal amount of the same Group V base stock (e.g., ester) in the finished oil blend for application of viscosity grade read-across.

API 1509 - Engine oil licensing and certification system guidelines: viscosity grades read across requirements for formulations containing Group I, II, III and IV base stocks

Sequence VIB test - Table F-10

Can be "Read-Across" to:								
Test run on	0W-20	5W-20	0W-30	5W-30	0W-40	5W-40	10W-30	10W-40
0W-20	NA	—	—	—	—	—	—	—
5W-20	X1	NA	—	—	—	—	—	—
0W-30	X1	—	NA	—	—	—	—	—
5W-30	X1	X1	X1	NA	—	—	X3	—
0W-40	X1	—	X1	—	NA	—	—	—
5W-40	X1	X1	X1	X1	—	NA	—	—
10W-30	X1	X1	X1	X1	—	—	NA	—
10W-40	X1	X1	X1	X1	X2	X2	X2	NA

Notes:

(1) X1 = VGRA allowed if result on the tested oil meets requirements for the read-across grade

(2) X2 = read-across allowed

(3) X3 = read-across allowed provided the Noack volatility of the 10W-30 is less than or equal to the Noack of the 5W-30 and the HTHS of the 10W-30 is no more than 0.1 cP higher than the HTHS of the 5W-30, within the precision of the tests, and the delta between the CCS of the 10W-30 oil and the max. CCS limit is greater than or equal to the delta between the CCS of the 5W-30 oil and the max. CCS limit at the appropriate temperatures.

(4) A dash (-) means that the read-across is not permitted; NA = not applicable

(5) New viscosity grades and associated read-across can only be added by requests to the API BOI/VGRA task force

(6) Tested formulations containing Group V stocks must contain an equal amount of the same Group V base stock (e.g., ester) in the finished oil blend for application of viscosity grade read-across

API 1509 - Engine oil licensing and certification system guidelines: viscosity grades read across requirements for formulations containing Group I, II, III and IV base stocks

Sequence VID test - Table F-11

Can be "Read-Across" to:								
Test run on	0W-20	5W-20	0W-30	5W-30	10W-30	0W-40	5W-40	10W-40
0W-20	NA	X1	—	—	—	—	—	—
5W-20	X1	NA	—	—	—	—	—	—
0W-30	X2	X2	NA	X1	X1	—	—	—
5W-30	X2	X2	X1	NA	X1	—	—	—
10W-30	X2	X2	X2	X2	NA	X1	X1	X1
0W-40	—	—	—	—	X1	NA	X1	X1
5W-40	—	—	—	—	X1	X1	NA	X1
10W-40	—	—	—	—	X1	X1	X1	NA

Notes:

X1 = VGRA is allowed if HTHS@100°C (D6616) of the candidate oil is less than or equal to the original tested oil OR if HTHS@100°C (D6616) of the candidate oil meets the conditions of Equations F.1.0

X2 = VGRA is allowed if the original tested oil meets the FEI Sum and FEI2 limit requirements for the read-across viscosity grade and the HTHS@100°C (D6616) of the candidate oil is less than or equal to the original tested oil

Equations F.1.0

Testing is not required if both equations are true:

$$H_{\text{candidate}} \leq H_{\text{original}} + ((FEI_{\text{sumLimit}} - FEI_{\text{sumOriginal}}) / -0.485) + (H_{\text{original}} * R)$$

$$H_{\text{candidate}} \leq H_{\text{original}} + ((FEI2_{\text{Limit}} - FEI2_{\text{Original}}) / -0.227) + (H_{\text{original}} * R)$$

Where:

$H_{\text{candidate}}$ is the HTHS@100°C of the candidate oil as measured by ASTM D6616

H_{original} is the HTHS@100°C of the original tested oil as measured by ASTM D6616

FEI_{sumLimit} is the FEI sum passing limit for the original tested viscosity grade

$FEI_{\text{sumOriginal}}$ is the FEI sum ($FEI1_{\text{original}} + FEI2_{\text{original}}$) result of the original tested oil

-0.485 is the FEIsum coefficient from the Seq. VID industry matrix model

$FEI2_{\text{Limit}}$ is the FEI2 passing limit for the original tested viscosity grade

$FEI2_{\text{Original}}$ is the FEI2 result of the original tested oil

-0.227 is the FEI2 coefficient from the Seq. VID industry matrix model

R is the reproducibility as reported in the most recent version of ASTM D6616. The current **R** = 0.035 (3.5%) for ASTM D6616-07

The range of the HTHS@100°C used to develop the Seq. VID industry matrix model was 5.44 to 7.68 cP (5.25 to 7.95 cP when allowance is made for D6616 reproducibility)

This information is for reference. It does not restrict application of the guidelines by the marketer who is responsible for ensuring that each licensed engine oil satisfies all engine and Laboratory test performance requirements

API 1509 - Engine oil licensing and certification system guidelines: viscosity grades read across requirements for formulations containing Group I, II, III and IV base stocks

F.4.1 HOMOGENEITY & MISCIBILITY (H & M) and EOFT (GM 9099P FILTERABILITY - Standard method)

These tests are required in the core data set (see ACC code of practice for definition of core data set), and then read-across is allowed to all other viscosity grades within the same base stock slate.

F.4.2 EOWTT (GM 9099P FILTERABILITY - Modified method for ILSAC GF-2/GF-3)

This test must be run on the formulation with the highest additive (DI/VI) combination

Results are then read-across results to all other base oil/viscosity grade formulations using same or lower concentration of the identical additive (DI/VI) combination

Each different (DI/VI) combination must be tested

F.4.3 Ball Rust Tests (BRT)

If there is one passing Ball Rust Test (BRT) (ASTM D6557) in the core data set as defined by the ACC code of practice, read-across is allowed to all other viscosity grades and base oil slates.

F.4.4 EMULSION RETENTION D7563 - VGRA

For oils formulated with Group II and/or Group III base stocks, the emulsion retention ASTM D7563 is required only for the highest additive (DI/VI) concentration.

Read across is allowed to all other Group II, Group III and combinations of Group II and Group III base oil / viscosity grade formulations using the same or lower concentration of the identical additive (DI/VI) combination.

If the PPD type is changed for the DI/VI combination, testing is required

F.5.4 HTCBT (ASTM D6594)

If there is one passing HTCBT (ASTM D6594) in the core data set as defined by the ACC Code of Practice, read-across is allowed to all other viscosity grades and base oil slates.

TEOST test (Method 33) - Table F-12

Can be "Read-Across" to:

Test run on	5W-20	5W-30	10W-30	10W-40	15W-40	20W-40	20W-50	Mono- Grade
5W-20	NA	X	—	—	—	—	—	—
5W-30	X	NA	X	X	X	X	X	X
10W-30	—	—	NA	X	X	X	X	X
10W-40	—	—	X	NA	X	X	X	X
15W-40	—	—	—	—	NA	X	X	X
20W-40	—	—	—	—	—	NA	X	X
20W-50	—	—	—	—	—	X	NA	X

Notes:

(1) X = read-across is permitted for viscosity grades identified based on data and some application of technical principles approved by API BOI/VGRA task force and API lubricants committee

(2) Monogrades are defined as SAE 10W, SAE 20W, SAE 30, SAE 40, and SAE 50

(3) A dash (-) means that read-across is not permitted; NA = not applicable

(4) Tested formulations containing Group V stocks must contain an equal amount of the same Group V base stock (e.g., ester) in the finished oil blend for application of viscosity grade read-across

(5) New viscosity grades and associated read-across are allowed if requirements described in F.1.3 are met

API 1509 - Engine oil licensing and certification system guidelines: viscosity grades read across requirements for formulations containing Group I, II, III and IV base stocks

TEOST MHT-4 - Table F-13

Can be "Read-Across" to:													
Test run on	5W-20	5W-30	10W	10W-30	10W-40	15W-40	15W-50	20W	20W-40	20W-50	30	40	50
5W-20	NA	X	—	X	X	—	—	—	—	—	—	—	—
5W-30	X	NA	—	X	X	—	—	—	—	—	—	—	—
10W	—	—	NA	—	—	—	—	—	—	—	—	—	—
10W-30	X	X	—	NA	X	X	X	—	—	—	—	—	—
10W-40	X	X	—	X	NA	X	X	—	—	—	—	—	—
15W-40	—	—	—	X	X	NA	X	—	—	—	—	—	—
15W-50	—	—	—	X	X	X	NA	—	—	—	—	—	—
20W	—	—	X	—	—	—	—	NA	—	—	—	—	—
20W-40	—	—	—	X	X	X	X	—	NA	X	—	—	—
20W-50	—	—	—	X	X	X	X	—	X	NA	—	—	—
30	—	—	X	—	—	—	—	X	—	—	NA	—	—
40	—	—	X	—	—	—	—	X	—	—	X	NA	—
50	—	—	X	—	—	—	—	X	—	—	X	X	NA

- Notes:**
- (1) X = read-across is permitted for the viscosity grades identified based on data and some applications of the technical principles approved by API BOI/VGRA task force and API lubricants committee
 - (2) A dash (-) means that read-across is not permitted; NA = not applicable
 - (3) Tested formulations containing Group V stocks must contain an equal amount of the same Group V base stock (e.g., ester) in the finished oil blend for application of viscosity grade read-across
 - (4) If the viscosity grade of interest is not in the table, then the TEOST MHT-4 must be run
 - (5) The principles behind this table are that higher base oil viscosity tends to give poorer performance and that VM level is not necessarily detrimental

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GF-5 Elastomer compatibility test (ASTM D7216 annex 2A) - Table F-14

For viscosity grades not listed in the table below, bracketing two passing formulations for a given technology may be used to waive additional testing.

VGRA is allowed if the candidate's base oil viscosity at 100°C falls within the range of the base oil viscosity at 100°C of the 2 passing formulations.

Can be "Read-Across" to:						
Test run on	0W-20	0W-30	5W-20	5W-30	10W-30	10W-40
0W-20	NA	X	X	X	X	X
0W-30	X	NA	X	X	X	X
5W-20	X	X	NA	X	X	X
5W-30	X	X	X	NA	X	X
10W-30	X	X	X	X	NA	X
10W-40	X	X	X	X	X	NA

- Notes:**
- (1) X = read-across is permitted for the viscosity grades identified based on data and some applications of the technical principles approved by API BOI/VGRA task force and API lubricants committee
 - (2) A dash (-) means that read-across is not permitted; NA = not applicable
 - (3) Tested formulations containing Group V stocks must contain an equal amount of the same Group V base stock (e.g., ester) in the finished oil blend for application of viscosity grade read-across

API 1509 - Engine oil licensing and certification system guidelines: viscosity grades read across requirements for formulations containing Group I, II, III and IV base stocks

Table F-15

Read-across for viscosity grades not covered explicitly by this table are not allowed unless permitted by table F-1

Performance test	From SAE	To SAE
Caterpillar 1K	10W-40	10W-30, 15W-40, 15W-50
	15W-40	10W-30, 20W-40, 20W-50
	30	10W, 20W, 40, 10W-30, 15W-40, 20W-50
	40	10W, 20W, 30, 10W-30, 15W-40, 20W-50
Caterpillar 1M-PC^(a)	5W-30	All single grades & 5W-20, 10W-30, 10W-40, 15W-40, 15W-50, 20W-40, 20W-50
	10W-30	All single grades & 15W-40, 15W-50, 20W-40, 20W-50
	10W-40	All single grades & 10W-30, 15W-40, 15W-50, 20W-40, 20W-50
	20W-20 ^(b)	All single grades except 10W
	30	All single grades except 10W
	40	All single grades except 10W
	50	All single grades except 10W
	10W	All single grades
	15W-40	All single grades & 20W-40, 20W-50
	15W-50	All single grades & 15W-40, 20W-40, 20W-50
	20W-40	All single grades except 10W & 20W-50
	20W-50	All single grades except 10W & 20W-40
Caterpillar 1N	15W-40	10W-30, 20W-40, 20W-50
	20W-20 ^(b)	10W
	30	10W, 20W-20 ^(b)
	40	10W, 20W-20 ^(b) , 30
	50	10W, 20W-20 ^(b) , 30, 40
Caterpillar 1P	10W-30	15W-40, 20W-40, 20W-50
	10W-40	10W-30, 15W-40, 15W-50, 20W-40, 20W-50
	15W-40	20W-40, 20W-50
	15W-50	15W-40, 20W-40, 20W-50
Caterpillar 1R	10W-30	15W-40
	10W-40	10W-30, 15W-40, 15W-50
Caterpillar C13	10W-30	15W-40
	10W-40	10W-30, 15W-40
	15W-50	15W-40

Notes:

(1) This table originally became effective January 1, 1992. Engine manufacturers may not recommend all of the viscosity grades shown in the table for a particular engine type

(2) Tested formulations containing Group V stocks must contain an equal amount of the same Group V base stock (e.g., ester) in the finished

oil blend for application of viscosity grade read-across

(a) No 0W and 5W single grades were considered for this table. 1M-PC read-across guidelines effective December 1, 2002

(b) These read across also apply to SAE 20 and SAE 20W monograde oil

API 1509 - Engine oil licensing and certification system guidelines: viscosity grades read across requirements for formulations containing Group I, II, III and IV base stocks

Table F-15

Read-across for viscosity grades not covered explicitly by this table are not allowed unless permitted by table F-1.

Performance test	From SAE	To SAE
Corrosion laboratory test (CBT)	10W-30	15W-40
Elastomer compatibility	10W-30 15W-40	15W-40 10W-30
High temperature corrosion laboratory test (HT-CBT)	See F.5.4	
Mack M11HST	10W-30 15W-40	10W-40, 15W-40, 15W-50 10W-40, 15W-50
Mack M11EGR	10W-30 15W-40	10W-40, 15W-40, 15W-50 10W-40, 15W-50
Cummins ISB	10W-30 15W-40	10W-40, 15W-40, 15W-50 10W-40, 15W-50
Cummins ISM	10W-30 15W-40	10W-40, 15W-40, 15W-50 10W-40, 15W-50
Cummins NTC-400	15W-40 20W-50 30 40	10W-30, 20W-50 ^(c) 10W-30, 15W-40 10W, 20W, 10W-30, 15W-40, 20W-50 10W, 20W, 30, 10W-30, 15W-40, 20W-50
Detroit Diesel 6V 92TA	10W-XX ^(d) 10W-30 15W-XX ^(d) 15W-40 20W-XX ^(d) 30 40	15W-XX ^(d) , 20W-XX ^(d) , 30, 40, 50 15W-40, 20W-50, 30, 40, 50 20W-XX ^(d) , 30, 40, 50 20W-50, 30, 40, 50 30, 40, 50 40, 50 50
Navistar Engine Oil Aeration Test (EOAT)	10W 10W-30 15W-40 15W-50 40	10W-30, 15W-40, 15W-50 10W, 15W-40, 15W-50 10W, 10W-30, 15W-50 10W, 10W-30, 15W-40 10W, 30, 10W-30, 15W-40, 15W-50
Roller Follower Wear Test (RFWT)	10W-30 15W-40	10W-40, 15W-40, 15W-50, 20W-40, 20W-50, 30, 40, 50 15W-50, 20W-40, 20W-50, 40, 50

Notes:

(1) This table originally became effective January 1, 1992. Engine manufacturers may not recommend all of the viscosity grades shown in the table for a particular engine type

(2) Tested formulations containing Group V stocks must contain an equal amount of the same Group V base stock (e.g., ester) in the finished

oil blend for application of viscosity grade read-across.

(c) 20W-50 must contain no more bright stock than the 15W-40

(d) Provided the XX for "Grade tested" is less than or equal to XX of the multigrade oil for "Read across to."

API 1509 - Engine oil licensing and certification system guidelines: viscosity grades read across requirements for formulations containing Group I, II, III and IV base stocks

Table F-15

Read-across for viscosity grades not covered explicitly by this table are not allowed unless permitted by table F-1

Performance test	From SAE	To SAE
Mack T-6^(e)	10W-30	15W-40, 20W-50
	15W-40	10W-30, 20W-50
	20W-50	10W-30, 15W-40
	30	10W, 20W, 40, 10W-30, 15W-40, 20W-50
Mack T-7^(f)	10W-30	15W-40, 20W-50
	15W-40	10W-30, 20W-50
	20W-50	10W-30, 15W-40
	30	10W, 20W, 40, 10W-30, 15W-40, 20W-50
Mack T-8, Mack T-8A and Mack T-8E^(f)	15W-40	10W-30, 10W-40, 15W-50
Mack T-9^(e)	10W-30	10W-40, 15W-40, 15W-50, 20W-40 ^(h) , 20W-50 ^(h)
	15W-40	15W-50, 20W-40 ^(h) , 20W-50 ^(h)
Mack T-10	10W-30	10W-40, 15W-40, 15W-50, 20W-40 ^(h) , 20W-50 ^(h)
	15W-40	15W-50, 20W-40 ^(h) , 20W-50 ^(h)
Mack T-10A	15W-40	0W-XX, 5W-XX, and 10W-XX
Mack T-11^(g)	10W-30	10W-40
	10W-40	10W-30
	15W-40	10W30, 10W-40, 15W-50
	15W-50	10W-30, 10W-40, 15W-40
	20W-40	10W-30, 10W-40, 15W-40, 15W-50, 20W-50
	20W-50	10W-30, 10W-40, 15W-40, 15W-50, 20W-40
Mack T-11A	15W-40	0W-XX, 5W-XX, & 10W-XX
Mack T-12	10W-30	10W-40, 15W40, 15W50, 20W-40 ^(h) , 20W-50 ^(h)
	15W-40	15W-50, 20W-40 ^(h) , 20W-50 ^(h)

Notes:

(1) This table originally became effective January 1, 1992. Engine manufacturers may not recommend all of the viscosity grades shown in the table for a particular engine type

(2) Tested formulations containing Group V stocks must contain an equal amount of the same Group V base stock (e.g., ester) in the finished oil blend for application of viscosity grade read-across

(e) A CF-4 test program with T-9 data to validate engine wear performance must use the T-6 viscosity grade read across guidelines

(f) A CF-4 test program with T-8A or T-8E data to validate soot handling performance must use the T-7 viscosity grade read across guidelines

(g) Base oil saturates in the test and final formulations must comply with the guidelines in E.3.1.9, and in cases where a dispersant viscosity modifier (DVM) is used, the DVM level in the final formulation must be equal to or greater than the level in the test oil.

(h) Provided the saturates level in the new candidate oil is equal to or greater than the original candidate oil and the sulfur level is equal to or less than that of the original candidate oil within the precision of the tests.

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Interchange for passenger car motor oils - Appendix E.2

E.2.1 GUIDELINES

E.2.1.1 Based on existing engine test data submitted to API, the passing engine tests specified in section E.2 are required for interchanging the base stock in an original API-Licensed PCMO.

E.2.1.2 In any case where base stocks of more than one Group are interchanged simultaneously, the most severe testing requirement applies.

E.2.1.3 Engine testing is not required when a single interchange base stock that meets the definition of Group I, Group II, Group III, or Group IV is used at less than or equal to 10 mass percent of the blended PCMO formulation. In some cases, higher percentages of Group III or Group IV may be substituted without further engine testing as specified in appendix E, or in the ACC code (appendix I, guideline 5). The ACC code should be followed for Group V.

E.2.1.4 The PCMO blended with the interchange base stock shall meet all physical and chemical specifications and laboratory test requirements for the appropriate API service category and/or ILSAC specification.

E.2.1.5 Base stocks approved under the provisions of these guidelines may be commingled without further testing, consistent with provisions of appendix F.

E.2.1.6 Acceptable test methods for base stock and base oil blend properties are listed in table E-1.

It is understood that when comparing properties, the precision of the methods is taken into consideration.

In the following tables, BOBV refers to the base oil blend viscosity measured by ASTM D445.

E.2.1.7 For engine oils licensed by API against the ILSAC GF-5 standard, the licensee shall ensure that the ROBO or IIIGA data supporting the final formulation was produced in a formulation containing the pour point depressant and base stock(s) used in the licensed formulation.

E.2.2.1 API recognizes the importance of the multiple test evaluation procedures.

Engine testing to support base oil interchangeability shall be in accordance with appendix N.

These guidelines shall be used in conjunction with the ACC Code.

E.2.2.2 Complete performance documentation is required for the original passenger car motor oils (PCMO).

The detergent inhibitor (DI) and / or viscosity modifier (VM) remain unchanged when interchange base oils are tested, except as provided by the ACC code.

A base oil interchange obtained under these guidelines applies to a single PCMO formulation.

In the event of a change in the DI and/or VM outside the ACC code, these guidelines shall be reapplied.

Table E-1 - Analytical methods for base shock

Property	Test method
Saturates	ASTM D2007
Viscosity index	ASTM D2270
Sulfur (use one listed method)	ASTM D1552
	ASTM D2622
	ASTM D3120
	ASTM D4294
	ASTM D4927

Note:

The most recent version of each of the listed standards shall be used

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E.2.2.3 - For the passenger car tests listed in table E-2, these guidelines may allow some testing relief.
Check the guidelines for each specific test before establishing the test program requirements for a specific oil formulation.

Table E-2 - Tests for API S category base oil interchange

Test name	ASTM	Appendix E Reference	SH	SJ	SL	SM	SN	Energy Conserving	Resource Conserving	ILSAC GF-5
Sequence IID	D5244	E.4.6	X	X						
Sequence IIIE	D5533	E.2.2.4.1	X	X						
Sequence IIIF	D6984	E.2.2.4.1	X	X	X					
Sequence IIIG/IIIGA/IIIGB	D7320	E.2.2.4.1			X	X	X		X	X
Sequence IVA	D6891	E.2.2.4.2	X	X	X	X	X			X
Sequence VE	D5302	E.2.2.4.3	X	X	X					
Sequence VG	D6593	E.2.2.4.3	X	X	X	X	X			X
Sequence VIA	D6202	E.2.2.4.4						X		
Sequence VIB	D6837	E.2.2.4.4						X		
Sequence VID	D7589	E.2.2.4.5							X	X
CRC L-38	D5119	E.2.2.4.6	X	X						
Sequence VIII	D6709	E.2.2.4.6	X	X	X	X	X			X
Ball Rust Test	D6557	E.4.6	X	X	X	X	X			X
EOFT	D6795	E.4.4	X	X	X	X	X			X
Filterability - EOWTT	D6794	E.4.5		X	X	X	X			X
Homogeneity & Miscibility	D6922	E.4.4	X	X	X	X	X			X
TEOST 33/33C	D6335	E.4.2		X						X
TEOST MHT	D7097	E.4.3			X	X	X			X
Aged oil low temp. vis. ROBO	D7528	E.2.1.7					X			X
Elastomer compatibility std. ref. elastomers	D7216	E.4.13							X	X

Note:

X = test methods where BOI is defined. Testing requirements can be found in API 1509 appendices G and Q and/or ASTM D4485

E.2.2.4 - Passenger car engine test required for interchanging the base stock given in E.2.2.4.1 through E.2.2.4.5.

The BOI guidelines vary according to the API base oil group and amount of the base stocks used in the original test oil and the candidate oil formulations. All percentages are mass percent of the total formulation unless otherwise noted. The data set used to establish the BOI guidelines involving Group III base oils is based on a base oil VI range up to 126 VI, within the precision of the test.

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E.2.2.4.1 - Sequence IIIE / IIIF / IIIFHD / IIIG and IIIGA tests required for interchanging the base stock⁽²⁾ - Table E-3

Base stock in original test oil	Interchange base stock				
	Group I	Group II	Group III	Group IV	Group V
Group I	Required	Required	≤ 30% not required > 30% required	≤ 30% not required > 30% required	Required
Group II	Required	Required	≤ 30% not required > 30% required	≤ 30% not required > 30% required	Required
Group III	Required	Required	Required	≤ 30% not required > 30% required	Required
Group IV	Required	Required	≤ 30% not required > 30% required	Not required ⁽¹⁾	Required
Group V	Required	Required	Required	Required	Required

Notes:

(1) Not required provided the interchange Group IV meets the original manufacturer's specifications in all physical and chemical properties

(2) Single Technology Matrix (STM) is an alternate approach to BOI for Sequence IIIF, IIIFHD, IIIG and IIIGA (see appendix R). Additionally, once five passing IIIGB tests have been demonstrated on a unique technology (A Unique Technology is a single package (DI) at a constant treat rate), then no additional Sequence IIIGB testing is required for that unique technology.

E.2.2.4.2 - Sequence IVA tests required for interchanging the base stock - Table E-4

Base stock in original test oil	Interchange base stock				
	Group I	Group II	Group III	Group IV	Group V
Group I	Not required if BOBV @ 100°C ≥ original	Not required if BOBV @ 100°C ≥ original	≤ 30% not required > 30% not required if BOBV @ 100°C ≥ original	≤ 30% not required > 30% and ≤ 50% not required if BOBV @ 100°C ≥ original > 50% required	Required
Group II	Not required if BOBV @ 100°C ≥ original	Not required if BOBV @ 100°C ≥ original	≤ 30% not required > 30% not required if BOBV @ 100°C ≥ original	≤ 30% not required, > 30% and ≤ 50% not required if BOBV @ 100°C ≥ original > 50% required	Required
Group III	Not required if BOBV @ 100°C ≥ original	Not required if BOBV @ 100°C ≥ original	Not required if BOBV @ 100°C ≥ original	≤ 30% not required if BOBV @ 100°C ≥ original > 30% required	Required
Group IV	Required	Required	≤ 30% not required > 30% required	Not required ⁽¹⁾	Required
Group V	Required	Required	Required	Required	Required

Note:

BOBV refers to the base oil blend viscosity measured by ASTM D445

(1) Not required provided the interchange Group IV meets the original manufacturer's specifications in all physical and chemical properties

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E.2.2.4.3 - Sequence VE / VG tests required for interchanging the base stock - Table E-5

Base stock in original test oil	Interchange base stock				
	Group I	Group II	Group III	Group IV	Group V
Group I	Not required if sulfur $\leq$ & saturates $\geq$ original	Not required	Not required	$\leq$ 50% not required > 50% required	Required
Group II	Required	Not required if saturates $\geq$ original	Not required	$\leq$ 50% not required > 50% required	Required
Group III	Required	Required	Not required	Required	Required
Group IV	Required	Required	Required	Not required ⁽¹⁾	Required
Group V	Required	Required	Required	Required	Required

Note:

(1) Not required provided the interchange Group IV meets the original manufacturer's specifications in all physical and chemical properties

E.2.2.4.4 - Sequence VIA / VIB tests required for interchanging the base stock - Table E-6

Base stock in original test oil	Interchange base stock				
	Group I	Group II	Group III	Group IV	Group V
Group I	Not required if CCS & HTHS $\leq$ original	Not required if CCS & HTHS $\leq$ original	Required	Required	Required
Group II	Not required if CCS & HTHS $\leq$ original	Not required if CCS & HTHS $\leq$ original	Required	Required	Required
Group III	Not required if CCS & HTHS $\leq$ original	Not required if CCS & HTHS $\leq$ original	Not required if CCS & HTHS & base oil VI $\leq$ original	Required	Required
Group IV	Required	Required	Required	Not required ⁽¹⁾	Required
Group V	Required	Required	Required	Required	Required

Note:

(1) Not required provided the interchange Group IV meets the original manufacturer's specifications in all physical and chemical properties

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E.2.2.4.5 - Sequence VID tests required for interchanging the base stock - Table E-7

Base stock in original test oil	Interchange base stock				
	Group I	Group II	Group III	Group IV	Group V
Group I	Required	Required	Required	Required	Required
Group II	Required	Not required if $\text{HTHS@100}^\circ\text{C(D6616)} \leq \text{original}$ If $\text{HTHS@100}^\circ\text{C} > \text{the original}$, see Equations E.1.0		Required	Required
Group III	Required			Required	Required
Group IV	Required	Required	Required	Not required ⁽¹⁾	Required
Group V	Required	Required	Required	Required	Required

Equation E.1.0

If $\text{HTHS@100}^\circ\text{C}$ of the candidate oil is $>$ the $\text{HTHS@100}^\circ\text{C}$ the original passing oil, testing is not required if both equations are true:

$$H_{\text{Candidate}} \leq H_{\text{Original}} + ((\text{FElsum}_{\text{Limit}} - \text{FElsum}_{\text{Original}}) / -0.485) + (H_{\text{Original}} * R)$$

$$H_{\text{Candidate}} \leq H_{\text{Original}} + ((\text{FEI2}_{\text{Limit}} - \text{FEI2}_{\text{Original}}) / -0.227) + (H_{\text{Original}} * R)$$

Where:

$H_{\text{Candidate}}$ is the $\text{HTHS@100}^\circ\text{C}$ of the candidate oil as measured by ASTM D6616

H_{Original} is the $\text{HTHS@100}^\circ\text{C}$ of the original tested oil as measured by ASTM D6616

$\text{FElsum}_{\text{Limit}}$ is the FEI sum passing limit for the original tested viscosity grade

$\text{FElsum}_{\text{Original}}$ is the FEIsum ($\text{FEI1}_{\text{Original}} + \text{FEI2}_{\text{Original}}$) result of the original tested oil

-0.485 is the FEIsum coefficient from the Seq. VID industry matrix model

$\text{FEI2}_{\text{Limit}}$ is the FEI2 passing limit for the original tested viscosity grade

$\text{FEI2}_{\text{Original}}$ is the FEI2 result of the original tested oil

-0.227 is the FEI2 coefficient from the Seq. VID industry matrix model

R is the reproducibility as reported in the most recent version of ASTM D6616.

$R = 0.035$ (3.5%) for ASTM D6616-07

The range of $\text{HTHS@100}^\circ\text{C}$ used to develop the Seq. VID industry matrix model was 5.44 to 7.68 cP.

(1) Not required provided the interchange Group IV meets the original manufacturer's specifications in all physical and chemical properties.

E.2.2.4.6 - Sequence VIII / CRC L-38 tests required for interchanging the base stock⁽²⁾ - Table E-8

Base stock in original test oil	Interchange base stock				
	Group I	Group II	Group III	Group IV	Group V
Group I	Not required	Not required	Not required	Not required	Required
Group II	Not required	Not required	Not required	Not required	Required
Group III	Not required	Not required	Not required	$\leq 30\%$ not required $> 30\%$ required	Required
Group IV	Required	Required	$\leq 30\%$ not required $> 30\%$ required	Not required ⁽¹⁾	Required
Group V	Required	Required	Required	Required	Required

Notes:

(1) Not required provided the interchange Group IV meets the original manufacturer's specifications in all physical and chemical properties

(2) These BOI guidelines apply only to bearing weight loss

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Interchange for Diesel engine oils - Appendix E.3

E.3.1 GUIDELINES

E.3.1.1 - Based on existing engine test data submitted to API, passing engine tests specified in section E.3 are required for interchanging the base stock in an original API-Licensed heavy duty engine oil (HDEO).

E.3.1.2 - In any case where base stocks of more than one group are interchanged simultaneously, the most severe testing requirement applies.

E.3.1.3 - Engine testing is not required when a single interchange base stock that meets the definition of Group I, Group II, Group III, or Group IV is used at less than or equal to 10 mass percent of the blended HDEO formulation. In some cases, higher percentages of Group III or Group IV may be substituted without further engine testing as specified in appendix E or in the ACC Code (appendix I, Guideline 5). The ACC Code should be followed for Group V.

E.3.1.4 - The HDEO blended with the interchange base oil shall meet all physical and chemical specifications required for the appropriate API service category.

E.3.1.5 - Base stocks approved under the provisions of these guidelines may be commingled without further testing, consistent with appendix F.

E.3.1.6 - Acceptable test methods for base stock and base oil blend properties are listed in table E-1.

It is understood that when comparing properties, the precision of the methods is taken into consideration.

In the following tables, BOBV refers to the base oil blend viscosity measured by ASTM D445.

E.3.2.1 - API recognizes the importance of the multiple test evaluation procedures.

Engine testing to support base oil interchangeability shall be in accordance with appendix N.

These guidelines shall be used in conjunction with the ACC Code.

E.3.2.2 - Complete performance documentation is required for the original HDEO's.

The detergent inhibitor (DI) and / or viscosity modifier (VM) remain unchanged when interchange base oils are tested, except as provided by the ACC Code.

A base oil interchange obtained under these guidelines applies to a single HDEO formulation.

In the event of a change in the DI and / or VM outside the ACC code, these guidelines shall be reapplied.

E.3.2.3 - When a base stock or slate of base stocks is to be changed in a number of different viscosity grades containing a single HDEO formulation, these guidelines shall be used in conjunction with appendix F, except when the recommended grade for testing contains less than or equal to 10 mass percent of the interchange base stock in the formulation. In this case, the next higher viscosity grade shall be tested.

E.3.2.5 - Heavy duty engine tests required for interchanging the base stock given in E.3.2.5.1 through E.3.2.5.16.

The BOI guidelines vary according to the API base oil group and amount of the base stocks used in the original test oil and the candidate oil formulations.

All percentages are mass percent of the total formulation unless otherwise noted.

The data set used to establish the BOI guidelines involving Group III base oils is based on a base oil VI range up to 126 VI, within the precision of the test.

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E.3.2.4 - For the HDEO tests listed in Table E-8, the BOI guidelines may allow some testing relief.
Check the guidelines for each specific test before establishing the test program requirements for a specific oil formulation.

Table E-9 - Tests for API C category base oil interchange

Test name	ASTM	Appendix E Reference	CF	CF-2	CG-4	CH-4	CI-4	CI-4 w/ CI-4 PLUS	CJ-4
Sequence IIIF / IIIFHD	D6984	E.2.2.4.1			X	X	X	X	X
Sequence IIIG	D7320	E.2.2.4.1			X	X	X	X	X
CRC L-38	D5119	E.2.2.4.5	X	X	X				
Sequence VIII	D6709	E.2.2.4.5	X	X	X				
Caterpillar 1M-PC	D6618	E.3.2.5.1	X	X					
Caterpillar C13	D7484	E.3.2.5.16							X
Caterpillar 1K	D6750 (1K)	E.3.2.5.3				X	X	X	
Caterpillar 1N	D6750 (1N)	E.3.2.5.4			X		X	X	X
Caterpillar 1P	D6681	E.3.2.5.6				X	X	X	
Caterpillar 1R	D6923	E.3.2.5.5					X	X	
Engine oil aeration test	D6894	E.3.2.5.11			X	X	X	X	X
Cummins ISM	D7468	E.3.2.5.13					X	X	X
Cummins ISB	D7484	E.3.2.5.13							X
Cummins M11	D6838	E.3.2.5.12				X			
Cummins M11 EGR	D6975	E.3.2.5.12					X	X	
Detroit Diesel 6V92TA	D5862	E.3.2.5.2		X					
Mack T-8	D5967	E.3.2.5.8			X				
Mack T-8E	D5967	E.3.2.5.8				X	X	X	
Mack T-9	D6483	E.3.2.5.7				X			
Mack T-10	D6987/M	E.3.2.5.9				X	X	X	
Mack T-10A	75h used oil in D4684	E.4.7					X	X	
Mack T-11	D7156	E.3.2.5.15						X	X
Mack T-11A	D6896	E.4.10						X	X
Mack T-12	D7422	E.3.2.5.14					X	X	X
Roller follower wear test	D5966	E.3.2.5.10			X	X	X	X	X
Cummins HTCBT	D6594	E.4.11				X	X	X	X
Elastomer compatibility CI-4	D7216	E.4.8					X	X	
Elastomer compatibility CJ-4	D7216	E.4.9							X

Note:

X = Test methods where BOI is defined. Testing requirements can be found in API 1509 appendices G and Q and/or ASTM D4485

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E.3.2.5.1 - Caterpillar 1M-PC tests required for interchanging the base stock - Table E-10

Base stock in original test oil	Interchange base stock				
	Group I	Group II	Group III	Group IV	Group V
Group I	Required	Required	Required	Required ≤ 30% not required for API CF if candidate oil also meets API SJ	Required
Group II	Not required	Not required	Required	Required ≤ 30% not required for API CF if candidate oil also meets API SJ	Required
Group III	Required	Required	Not required	Required	Required
Group IV	Required	Required	Required	Not required ⁽¹⁾	Required
Group V	Required	Required	Required	Required	Required

Note:

(1) Not required provided the interchange Group IV meets the original manufacturer's specifications in all physical and chemical properties

E.3.2.5.2 - Detroit Diesel 6V92TA tests required for interchanging the base stock - Table E-11

Base stock in original test oil	Interchange base stock				
	Group I	Group II	Group III	Group IV	Group V
Group I	Not required if BOBV at 100°C ≥ original	Not required if BOBV at 100°C ≥ original	Required	Required	Required
Group II	Not required if BOBV at 100°C ≥ original	Not required if BOBV at 100°C ≥ original	Required	Required	Required
Group III	Required	Required	Required	Required	Required
Group IV	Required	Required	Required	Not required ⁽¹⁾	Required
Group V	Required	Required	Required	Required	Required

Note:

(1) Not required provided the interchange Group IV meets the original manufacturer's specifications in all physical and chemical properties AND the BOBV @ 100°C is ≥ the BOBV in the originally approved formulation

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E.3.2.5.3 - Caterpillar 1K tests required for interchanging the base stock - Table E-12

Base stock in original test oil	Interchange base stock				
	Group I	Group II	Group III	Group IV	Group V
Group I	Not required	Not required	≤ 30% not required > 30% required	≤ 30% not required > 30% required	Required
Group II	Not required	Not required	≤ 30% not required > 30% required	≤ 30% not required > 30% required	Required
Group III	Required	Required	Required	Required	Required
Group IV	Required	Required	Required	Not required ⁽¹⁾	Required
Group V	Required	Required	Required	Required	Required

Note:

(1) Not required provided the interchange Group IV meets the original manufacturer's specifications in all physical and chemical properties

E.3.2.5.4 - Caterpillar 1N tests required for interchanging the base stock - Table E-13

Base stock in original test oil	Interchange base stock				
	Group I	Group II	Group III	Group IV	Group V
Group I	Not required	Not required	Required	Required	Required
Group II	Not required	Not required	Required	Required	Required
Group III	Required	Required	Required	Required	Required
Group IV	Required	Required	Required	Not required ⁽¹⁾	Required
Group V	Required	Required	Required	Required	Required

Note:

(1) Not required provided the interchange Group IV meets the original manufacturer's specifications in all physical and chemical properties

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E.3.2.5.5 - Caterpillar 1R tests required for interchanging the base stock - Table E-14

Base stock in original test oil	Interchange base stock				
	Group I	Group II	Group III	Group IV	Group V
Group I	Not required	Not required	Required	Required	Required
Group II	Required	Not required	Required	Required	Required
Group III	Required	Required	Required	Required	Required
Group IV	Required	Required	Required	Not required ⁽¹⁾	Required
Group V	Required	Required	Required	Required	Required

Note:

(1) Not required provided the interchange Group IV meets the original manufacturer's specifications in all physical and chemical properties

E.3.2.5.6 - Caterpillar 1P tests required for interchanging the base stock - Table E-15

Base stock in original test oil	Interchange base stock				
	Group I	Group II	Group III	Group IV	Group V
Group I	Not required	Required in only one Group II base stock for CH-4, Not required for CI-4	Required	Required	Required
Group II	Not required	Not required	Required	Required	Required
Group III	Required	Required	Required	Required	Required
Group IV	Required	Required	Required	Not required ⁽¹⁾	Required
Group V	Required	Required	Required	Required	Required

Note:

(1) Not required provided the interchange Group IV meets the original manufacturer's specifications in all physical and chemical properties

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E.3.2.5.7 - Caterpillar Mack T-9 tests required for interchanging the base stock - Table E-16

Base stock in original test oil	Interchange base stock				
	Group I	Group II	Group III	Group IV	Group V
Group I	Not required if sulfur $\leq$ and saturates $\geq$ original	Not required	$\leq$ 30% not required > 30% required	$\leq$ 30% not required > 30% required	Required
Group II	Required	Not required if saturates $\geq$ original	$\leq$ 30% not required > 30% required	$\leq$ 30% not required > 30% required	Required
Group III	Required	Required	Required	Required	Required
Group IV	Required	Required	Required	Not required ⁽¹⁾	Required
Group V	Required	Required	Required	Required	Required

Note:

(1) Not required provided the interchange Group IV meets the original manufacturer's specifications in all physical and chemical properties

E.3.2.5.8 - Caterpillar Mack T-8 / T-8E tests required for interchanging the base stock - Table E-17

Base stock in original test oil	Interchange base stock				
	Group I	Group II	Group III	Group IV	Group V
Group I	Not Required if either of the following is met: 1. Saturates of original is $\geq$ 80% and interchange base oil saturates is $\geq$ original 2. Saturates of original is < 80% and interchange base oil saturates is $\geq$ original at 95% confidence level	Not required	Not required	Not required	Required
Group II	Required	Not required if saturates $\geq$ original	Not required	Not required	Required
Group III	Required	Required	Required	Required	Required
Group IV	Required	Required	Required	Not required ⁽¹⁾	Required
Group V	Required	Required	Required	Required	Required

Note:

(1) Not required provided the interchange Group IV meets the original manufacturer's specifications in all physical and chemical properties

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E.3.2.5.9 - Caterpillar Mack T-10 tests required for interchanging the base stock - Table E-18

Base stock in original test oil	Interchange base stock				
	Group I	Group II	Group III	Group IV	Group V
Group I	Not required if sulfur $\leq$ AND saturates $\geq$ AND BOBV at 100°C $\geq$ original	Not required if saturates $\geq$ AND BOBV at 100°C $\geq$ original	$\leq$ 30% not required if saturates $\geq$ AND BOBV at 100°C $\geq$ original > 30% required	$\leq$ 30% not required if saturates $\geq$ AND BOBV at 100°C $\geq$ original > 30% required	Required
Group II	Required	Not required if saturates $\geq$ AND BOBV at 100°C $\geq$ original	$\leq$ 30% not required if saturates $\geq$ AND BOBV at 100°C $\geq$ original > 30% required	$\leq$ 30% not required if saturates $\geq$ AND BOBV at 100°C $\geq$ original > 30% required	Required
Group III	Required	Required	Required	Required	Required
Group IV	Required	Required	Required	Not required ⁽¹⁾	Required
Group V	Required	Required	Required	Required	Required

Note:

(1) Not required provided the interchange Group IV meets the original manufacturer's specifications in all physical and chemical properties

E.3.2.5.10 - Caterpillar RFWTs required for interchanging the base stock - Table E-19

Base stock in original test oil	Interchange base stock				
	Group I	Group II	Group III	Group IV	Group V
Group I	Not required	Not required	$\leq$ 30% not required > 30% required	$\leq$ 30% not required > 30% required	Required
Group II	Required in only one Group I base stock	Not required	$\leq$ 30% not required > 30% required	$\leq$ 30% not required > 30% required	Required
Group III	Required	Required	Required	Required	Required
Group IV	Required	Required	Required	Not required ⁽¹⁾	Required
Group V	Required	Required	Required	Required	Required

Note:

(1) Not required provided the interchange Group IV meets the original manufacturer's specifications in all physical and chemical properties

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E.3.2.5.11 - EOATs required for interchanging the base stock - Table E-20

Base stock in original test oil	Interchange base stock				
	Group I	Group II	Group III	Group IV	Group V
Group I	Not required	Not required	≤ 30% not required > 30% required	≤ 30% not required > 30% required	Required
Group II	Not required	Not required	≤ 30% not required > 30% required	≤ 30% not required > 30% required	Required
Group III	Required	Required	Required	Required	Required
Group IV	Required	Required	Required	Not required ⁽¹⁾	Required
Group V	Required	Required	Required	Required	Required

Note:

(1) Not required provided the interchange Group IV meets the original manufacturer's specifications in all physical and chemical properties

E.3.2.5.12 - Caterpillar Cummins M11 / M11 EGR tests required for interchanging the base stock - Table E-21

Base stock in original test oil	Interchange base stock				
	Group I	Group II	Group III	Group IV	Group V
Group I	Not required if sulfur ≤ and saturates ≥ original	Not required	≤ 30% not required > 30% required	≤ 30% not required > 30% required	Required
Group II	Required	Not required if saturates ≥ original	≤ 30% not required > 30% required	≤ 30% not required > 30% required	Required
Group III	Required	Required	Required	Required	Required
Group IV	Required	Required	Required	Not required ⁽¹⁾	Required
Group V	Required	Required	Required	Required	Required

Note:

(1) Not required provided the interchange Group IV meets the original manufacturer's specifications in all physical and chemical properties

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E.3.2.5.13 - Cummins ISM and ISB tests required for interchanging the base stock - Table E-22

If only one passing Cummins ISM or ISB test is available on a given technology, table E-22 applies.

If more than one passing Cummins ISM or ISB test is available on a given technology, BOI is allowed if the candidate's base oil blend saturates level, sulfur content and BOBV @ 100°C fall within the range of saturates, sulfur and BOBV @ 100°C of the base oil blends in the original passing oils with a minimum of two tested / two passed and the Group III content of the candidate falls within the range of the Group III content covered by the original passing oils.

Base stock in original test oil	Interchange base stock				
	Group I	Group II	Group III	Group IV	Group V
Group I	Not required if sulfur $\leq$ and saturates $\geq$ original	Not required	$\leq 30\%$ not required $> 30\%$ required	$\leq 30\%$ not required $> 30\%$ required	Required
Group II	Required	Not required if saturates $\geq$ original	$\leq 30\%$ not required $> 30\%$ required	$\leq 30\%$ not required $> 30\%$ required	Required
Group III	Required	Required	Required	Required	Required
Group IV	Required	Required	Required	Not required ⁽¹⁾	Required
Group V	Required	Required	Required	Required	Required

Note:

(1) Not required provided the interchange Group IV meets the original manufacturer's specifications in all physical and chemical properties

E.3.2.14 - Mack T-12 tests required for interchanging the base stock - Table E-23

If only one passing Mack T-12 test is available on a given technology, table E-23 applies.

If more than one passing Mack T-12 test is available on a given technology, BOI is allowed if the candidate's base oil blend saturates level, sulfur content and BOBV @ 100°C fall within the range of saturates, sulfur and BOBV @ 100°C of the base oil blends in the original passing oils with a minimum of two tested/two passed and the Group III content of the candidate falls within the range of the Group III content covered by the original passing oils.

Base stock in original test oil	Interchange base stock				
	Group I	Group II	Group III	Group IV	Group V
Group I	Not required if sulfur $\leq$ and saturates $\geq$ and BOBV at 100°C $\geq$ original	Not required if saturates $\geq$ and BOBV at 100°C $\geq$ original	$\leq 30\%$ not required if saturates $\geq$ and BOBV at 100°C $\geq$ original $> 30\%$ required	$\leq 30\%$ not required if saturates $\geq$ and BOBV at 100°C $\geq$ original $> 30\%$ required	Required
Group II	Required	Not required if saturates $\geq$ and BOBV at 100°C $\geq$ original	$\leq 30\%$ not required if saturates $\geq$ and BOBV at 100°C $\geq$ original $> 30\%$ required	$\leq 30\%$ not required if saturates $\geq$ and BOBV at 100°C $\geq$ original $> 30\%$ required	Required
Group III	Required	Required	Required	Required	Required
Group IV	Required	Required	Required	Not required ⁽¹⁾	Required
Group V	Required	Required	Required	Required	Required

Note:

(1) Not required provided the interchange Group IV meets the original manufacturer's specifications in all physical and chemical properties

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E.3.2.5.15 - Mack T-11 tests required for interchanging the base stock - Table E-24

Base oil interchange for all Mack T-11 engine tests associated with API CJ-4 and for Mack T-11 engine tests associated with API CI-4 and CI-4 PLUS started after April 28, 2006, may be determined using the method provided in table E-24. Table E-24 defines the minimum saturates content of the candidate oil that can be interchanged from the original test oil.

Table E-24 Mack T-11 BOI saturates requirements (within a range)

Tested oil	Candidate oil
$X \leq 70.0$	80.0 min.
$70.0 < X < 95.0$	$(0.6 \cdot X + 38)$ min.
$X \geq 95.0$	95.0 min.

E.3.2.5.16 - Caterpillar C13 tests required for interchanging the base stock

If only one passing Caterpillar C13 test is available on a given technology and only Group II and/or Group III base stocks are present in the passing C13 oil and the candidate, then C13 BOI is allowed if the candidate's base oil blend viscosity index (VI) is equal to or less than the VI of the base oil blend of the passing C13 oil. If Group I base stock is present in either the passing C13 oil or the candidate, then C13 BOI is allowed if the base oil blend of the candidate has the same saturates level, the same or less sulfur and the same or lower VI than the base oil blend of the passing C13 oil. Additional guidelines apply when Group III base stock is present in the C13 passing oil:

- The candidate oil must have Group III content equal to or less than the passing oil.
- The typical VI of the Group III in the candidate must be no more than 6 units higher than the typical VI of the Group III in the passing C13 oil with no allowance for test precision.

Group IV base stocks can be interchanged provided the interchange Group IV meets the original manufacturer's specifications in all physical and chemical properties.

When Group V base stocks are present, the C13 test must be run.

If more than one passing Caterpillar C13 test is available on a given technology, BOI is allowed if the candidate's base oil blend saturates level, sulfur content and viscosity index fall within the range of saturates level, sulfur, and VI of the base oil blends in the original passing oils (minimum two tested/two passed oils) and the Group III content of the candidate oil falls within the range of the Group III content covered by the original passing oils. Additionally, the typical VI of the Group III in the candidate oil must be no more than 6 units higher than the typical VI of the Group III in the passing C13 oil with no allowance for test precision.

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Complete laboratory testing is required for interchanging a base stock in an API-licensed oil except where noted in the guidelines below

E.4.2 - TEOST 33 tests required for interchanging the base stock - Table E-26

Base stock in original test oil	Interchange base stock				
	Group I	Group II	Group III	Group IV	Group V
Group I	Not required	Not required	Required	Required	Required
Group II	Not required	Not required	Not required	Required	Required
Group III	Required	Not required	Not required	Required	Required
Group IV	Required	Required	Required	Required	Required
Group V	Required	Required	Required	Required	Required

E.4.3 - TEOST MHT tests required for interchanging the base stock - Table E-27

Base stock in original test oil	Interchange base stock				
	Group I	Group II	Group III	Group IV	Group V
Group I	Not required if sulfur $\geq$ & saturates $\leq$ original	Required	Required	Required	Required
Group II	Not required	Not required	Not required	Required	Required
Group III	Required	Not required	Required	Required	Required
Group IV	Required	Required	Required	Required	Required
Group V	Required	Required	Required	Required	Required

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E.4.4 - Homogeneity and miscibility (H&M) ASTM D6922 and engine oil filterability (EOFT) ASTM D6795 [formerly known as GM 9099P filterability (standard method)] tests are required in one viscosity grade represented in the core data set. Each base oil interchange requires only one H&M and one EOFT test. (See ACC code for definition of core data set.) Core data sets are typically developed in SAE 5W-30, 10W-30, 10W-40 or 15W-40 viscosity grades.

E.4.5 - The engine oil water tolerance test (EOWTT) ASTM D6794 [formerly GM 9099P filterability (modified method for ILSAC GF-2/GF-3)] for each base oil interchange is required only in the viscosity grade with the highest additive (DI/VI) combination.

E.4.6 - If there is one passing Ball Rust Test (BRT) ASTM D6557 in the core data set as defined by the ACC code, read-across is allowed to all other viscosity grades and base oil slates.

E.4.7 - A Mack T-10A test is not required for base oil interchange if the saturates and sulfur content (within the precision of the two analytical tests) of the interchange base oil fall within the range of the saturates and sulfur content of the base oils in the original candidate oils (minimum two candidate oils), and fresh oil MRV-TP1 (ASTM D4684) at -20°C of the interchange candidate is equal to or less than the BOI matrix limit.

The BOI matrix limit is defined as :

$$\text{BOI matrix limit} = 25000 - \text{margin of safety}$$

Margin of safety is defined as :

$$\text{Margin of safety} = \text{largest of } Y1-X1, Y2-X2, \text{ or } 0$$

where

X1 = fresh oil MRV-TP1 at -20°C for original candidate oil 1

X2 = fresh oil MRV-TP1 at -20°C for original candidate oil 2

Y1 = MRV-TP1 at -20°C of 75-hour T-10A sample for original candidate oil 1

Y2 = MRV-TP1 at -20°C of 75-hour T-10A sample for original candidate oil 2

E.4.8 - The CI-4 elastomer compatibility test is not required if the saturates and sulfur content (within the precision of the tests) of the interchange base oil fall within the range of the saturates and sulfur content of the base oils in the original candidate oils (minimum two candidate oils) and the DI package is unchanged.

E.4.9 - The CJ-4 elastomer compatibility test is not required if the saturates and sulfur content (within the precision of the tests) of the interchange base oil fall within the range of the saturates and sulfur content of the base oils in the original candidate oils (minimum two candidate oils) and the DI package is unchanged.

E.4.10 In addition to the Mack T-11 BOI guidelines being met, for base oil interchange in the Mack T-11A the fresh oil MRV-TP1 (ASTM D4684) at -20°C of the interchange candidate must be less than or equal to 20000 cPs with no yield stress.

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E.4.10 - In addition to the Mack T-11 BOI guidelines being met, for base oil interchange in the Mack T-11A the fresh oil MRV-TP1 (ASTM D4684) at -20°C of the interchange candidate must be less than or equal to 20000 cPs with no yield stress.

E.4.11 - If there is one passing high-temperature corrosion laboratory test (HTCBT) (ASTM D6594) in the core data set as defined by the ACC code, read-across is allowed to all other viscosity grades and base oil slates.

E.4.12 - For oils formulated with Group II and / or Group III base stocks, the emulsion retention ASTM D7563 is required only for the highest additive (DI/VI) concentration. Read across is allowed to all other Group II, Group III and combinations of Group II and Group III base oil/viscosity grade formulations using the same or lower concentration of the identical additive (DI/VI) combination. If the PPD type is changed for the DI/VI combination, testing is required.

E.4.13 - A passing GF-5 elastomer compatibility test (ASTM D7216 annex A2) in the core data set (as defined in the ACC code) run in Group II or Group III or a mix of Group II and Group III, can be read across to formulations using other Group II or Group III or a mix of Group II and Group III base stocks.

Additionally, there is no viscosity grade restriction if the read across is limited to 0W-20, 0W-30, 5W-20, 5W-30, 10W-30 and 10W-40 viscosity grades.

When reading to a candidate using Group I base stocks, the GF-5 elastomer compatibility test (ASTM D7216 Annex A2) is not redrequired if the base oil saturates and base oil sulfur content (within the precision of the tests) of the interchange base oil fall within the range of the base oil saturates and base oil sulfur content of the base oils in the original candidate oils (minimum two candidate oils) and the DI package is unchanged.

ATIEL GUIDELINES for:
VISCOSITY GRADE READ-ACROSS
(VGRA)
BASE OIL INTERCHANGE (BOI)
VISCOSITY MODIFIER
INTERCHANGE (VMI)



ATIEL viscosity grade read across guidelines



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Tu3MS test Test run on:	Can be read across (RA) to:														
↓	0W-20	0W-30	0W-40	5W-20	5W-30	5W-40	5W-50	10W-30	10W-40	10W-50	10W-60	15W-40	15W-50	20W-40	20W-50
0W-20	-	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA
0W-30		-	RA		RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA
0W-40			-			RA	RA		RA	RA	RA	RA	RA	RA	RA
5W-20		RA	RA	-	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA
5W-30			RA		-	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA
5W-40						-	RA		RA	RA	RA	RA	RA	RA	RA
5W-50							-		RA	RA	RA		RA		RA
10W-30			RA			RA	RA	-	RA	RA	RA	RA	RA	RA	RA
10W-40							RA		-	RA	RA	RA	RA	RA	RA
10W-50										-	RA		RA		RA
10W-60											-				
15W-40							RA			RA	RA	-	RA	RA	RA
15W-50											RA		-		RA
20W-40							RA			RA	RA		RA	-	RA
20W-50											RA				-

Stipulated requirement: the KV at 100°C of the finished oil of the read across grade must be greater than or equal to that of the tested grade

Tu572 test Test run on:	Can be read across (RA) to:														
↓	0W-20	0W-30	0W-40	5W-20	5W-30	5W-40	5W-50	10W-30	10W-40	10W-50	10W-60	15W-40	15W-50	20W-40	20W-50
0W-20	-			RA	RA			RA	RA			RA	RA	RA	RA
0W-30	RA	-		RA	RA	RA		RA	RA	RA		RA	RA	RA	RA
0W-40	RA	RA	-	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA
5W-20				-				RA				RA		RA	RA
5W-30	RA			RA	-			RA	RA			RA	RA	RA	RA
5W-40	RA	RA		RA	RA	-		RA	RA	RA		RA	RA	RA	RA
5W-50	RA	RA	RA	RA	RA	RA	-	RA	RA	RA	RA	RA	RA	RA	RA
10W-30				RA				-				RA		RA	RA
10W-40	RA			RA	RA			RA	-			RA	RA	RA	RA
10W-50	RA	RA		RA	RA	RA		RA	RA	-		RA	RA	RA	RA
10W-60	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	-	RA	RA	RA	RA
15W-40				RA				RA				-		RA	RA
15W-50	RA			RA	RA			RA	RA			RA	-	RA	RA
20W-40														-	
20W-50				RA				RA				RA		RA	-

Stipulated requirement: if the viscosity modifier treat rate increase is larger than 15% wt relative, Level 2 technical support data must be available to justify the read across

ATIEL viscosity grade read across guidelines



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M111 sludge test (non dispersant viscosity modifier)															
Test run on:	Can be read across (RA) to:														
↓	0W-20	0W-30	0W-40	5W-20	5W-30	5W-40	5W-50	10W-30	10W-40	10W-50	10W-60	15W-40	15W-50	20W-40	20W-50
0W-20	-			RA	RA			RA	RA			RA	RA	RA	RA
0W-30	RA	-		RA	RA	RA		RA	RA	RA		RA	RA	RA	RA
0W-40	RA	RA	-	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA
5W-20				-				RA				RA		RA	RA
5W-30	RA			RA	-			RA	RA			RA	RA	RA	RA
5W-40	RA	RA		RA	RA	-		RA	RA	RA		RA	RA	RA	RA
5W-50	RA	RA	RA	RA	RA	RA	-	RA	RA	RA	RA	RA	RA	RA	RA
10W-30				RA				-				RA		RA	RA
10W-40				RA	RA			RA	-			RA	RA	RA	RA
10W-50	RA			RA	RA	RA		RA	RA	-		RA	RA	RA	RA
10W-60	RA	RA		RA	RA	RA	RA	RA	RA	RA	-	RA	RA	RA	RA
15W-40				RA				RA				-		RA	RA
15W-50				RA				RA	RA			RA	-	RA	RA
20W-40														-	
20W-50												RA		RA	-

Stipulated requirement: if the viscosity modifier treat rate increase is larger than 15% wt relative, Level 2 technical support data must be available to justify the read across

M111 sludge test (dispersant viscosity modifier)															
Test run on:	Can be read across (RA) to:														
↓	0W-20	0W-30	0W-40	5W-20	5W-30	5W-40	5W-50	10W-30	10W-40	10W-50	10W-60	15W-40	15W-50	20W-40	20W-50
0W-20	-	RA			RA	RA			RA				RA		
0W-30		-	RA			RA	RA			RA	RA				
0W-40			-				RA				RA				
5W-20	RA			-	RA			RA	RA			RA	RA		RA
5W-30	RA	RA			-	RA			RA	RA			RA		
5W-40		RA	RA			-	RA			RA	RA				
5W-50			RA				-				RA				
10W-30	RA			RA	RA			-	RA			RA	RA		RA
10W-40	RA	RA			RA	RA			-	RA	RA		RA		
10W-50		RA	RA			RA	RA			-	RA				
10W-60			RA				RA				-				
15W-40	RA			RA	RA			RA	RA			-	RA		RA
15W-50	RA	RA			RA	RA			RA	RA			-		
20W-40								RA				RA		-	RA
20W-50	RA				RA			RA	RA			RA	RA		-

Stipulated requirement: if the viscosity modifier treat rate increase is larger than 20% wt relative, or the decrease is larger than 10% wt relative, Level 2 technical support data must be available to justify the read across.

ATIEL viscosity grade read across guidelines



Oronite

DV4 test (non dispersant viscosity modifier)															
Test run on:	Can be read across (RA) to:														
↓	0W-20	0W-30	0W-40	5W-20	5W-30	5W-40	5W-50	10W-30	10W-40	10W-50	10W-60	15W-40	15W-50	20W-40	20W-50
0W-20	-			RA	RA			RA	RA			RA	RA	RA	RA
0W-30	RA	-		RA	RA	RA		RA	RA	RA		RA	RA	RA	RA
0W-40	RA	RA	-	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA
5W-20				-				RA				RA		RA	RA
5W-30	RA			RA	-			RA	RA			RA	RA	RA	RA
5W-40	RA	RA		RA	RA	-		RA	RA	RA		RA	RA	RA	RA
5W-50	RA	RA	RA	RA	RA	RA	-	RA	RA	RA	RA	RA	RA	RA	RA
10W-30				RA				-				RA		RA	RA
10W-40				RA	RA			RA	-			RA	RA	RA	RA
10W-50	RA			RA	RA	RA		RA	RA	-		RA	RA	RA	RA
10W-60	RA	RA		RA	RA	RA	RA	RA	RA	RA	-	RA	RA	RA	RA
15W-40				RA				RA				-		RA	RA
15W-50				RA				RA	RA			RA	-	RA	RA
20W-40														-	
20W-50												RA		RA	-

Stipulated requirement: if the viscosity modifier treat rate increase is larger than 15% wt relative, Level 2 technical support data must be available to justify the read across

DV4 test (dispersant viscosity modifier)															
Test run on:	Can be read across (RA) to:														
↓	0W-20	0W-30	0W-40	5W-20	5W-30	5W-40	5W-50	10W-30	10W-40	10W-50	10W-60	15W-40	15W-50	20W-40	20W-50
0W-20	-	RA			RA				RA				RA		
0W-30		-	RA			RA	RA			RA	RA				
0W-40			-				RA				RA				
5W-20	RA			-	RA			RA	RA			RA	RA		RA
5W-30	RA	RA			-	RA			RA	RA			RA		
5W-40		RA	RA			-	RA			RA	RA				
5W-50			RA				-				RA				
10W-30	RA			RA	RA			-	RA			RA	RA		RA
10W-40	RA	RA			RA	RA			-	RA	RA		RA		
10W-50		RA	RA			RA	RA			-	RA				
10W-60			RA				RA				-				
15W-40	RA			RA	RA			RA	RA			-	RA		RA
15W-50	RA	RA			RA	RA			RA	RA			-		
20W-40								RA				RA		-	RA
20W-50	RA				RA			RA	RA			RA	RA		-

Stipulated requirement: if the viscosity modifier treat rate increase is larger than 20% wt relative, or the decrease is larger than 10% wt relative, Level 2 technical support data must be available to justify the read across

ATIEL viscosity grade read across guidelines



Oronite

OM602A & OM646LA wear test																	
Test run on:	Can be read across (RA) to:																
↓	0W-20	0W-30	0W-40	5W-20	5W-30	5W-40	5W-50	10W-30	10W-40	10W-50	10W-60	15W-40	15W-50	20W-40	20W-50	30	40
0W-20	-	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA
0W-30		-	RA		RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA
0W-40			-			RA	RA		RA	RA	RA	RA	RA	RA	RA	RA	RA
5W-20		RA	RA	-	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA
5W-30			RA		-	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA
5W-40						-	RA		RA	RA	RA	RA	RA	RA	RA	RA	RA
5W-50							-			RA	RA		RA		RA		RA
10W-30			RA			RA	RA	-	RA	RA	RA	RA	RA	RA	RA	RA	RA
10W-40							RA		-	RA	RA	RA	RA	RA	RA	RA	RA
10W-50										-	RA		RA		RA		RA
10W-60											-						
15W-40							RA			RA	RA	-	RA	RA	RA	RA	RA
15W-50											RA		-		RA		RA
20W-40							RA			RA	RA		RA	-	RA	RA	RA
20W-50											RA				-		RA
30																-	RA
40																	-

Stipulated requirement: the KV at 100°C of the finished oil of the read across grade must be greater than or equal to that of the tested grade (applies to multi-grade oils only)

ATIEL viscosity grade read across guidelines



Oronite

M111E fuel economy test															
Test run on:	Can be read across (RA) to:														
↓	0W-20	0W-30	0W-40	5W-20	5W-30	5W-40	5W-50	10W-30	10W-40	10W-50	10W-60	15W-40	15W-50	20W-40	20W-50
0W-20	-														
0W-30	RA	-													
0W-40	RA	RA	-	RA											
5W-20	RA			-											
5W-30	RA	RA		RA	-										
5W-40	RA	RA	RA	RA	RA	-									
5W-50	RA	RA	RA	RA	RA	RA	-	RA							
10W-30	RA	RA		RA	RA			-							
10W-40	RA	RA	RA	RA	RA	RA		RA	-						
10W-50	RA	RA	RA	RA	RA	RA	RA	RA	RA	-					
10W-60	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	-	RA		RA	
15W-40	RA	RA	RA	RA	RA	RA		RA	RA			-			
15W-50	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA		RA	-		
20W-40	RA	RA	RA	RA	RA	RA		RA	RA			RA		-	
20W-50	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA		RA	RA	RA	-

Stipulated requirement: the KV at 40°C of the finished oil of the read across grade must be lower than or equal to that of the tested grade.

The KV at 100°C of the finished oil of the read across grade must be lower than or equal to that of the tested grade.

The HTHSV of the finished oil blend of the read across grade must be lower than or equal to that of the tested grade.

ATIEL viscosity grade read across guidelines



Oronite

VW DI test (non-dispersant viscosity modifier)															
Test run on:	Can be read across (RA) to:														
↓	0W-20	0W-30	0W-40	5W-20	5W-30	5W-40	5W-50	10W-30	10W-40	10W-50	10W-60	15W-40	15W-50	20W-40	20W-50
0W-20	-			RA	RA			RA	RA			RA	RA	RA	RA
0W-30	RA	-		RA	RA	RA		RA	RA	RA		RA	RA	RA	RA
0W-40	RA	RA	-	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA
5W-20				-				RA				RA		RA	RA
5W-30	RA			RA	-			RA	RA			RA	RA	RA	RA
5W-40	RA	RA		RA	RA	-		RA	RA	RA		RA	RA	RA	RA
5W-50	RA	RA	RA	RA	RA	RA	-	RA	RA	RA	RA	RA	RA	RA	RA
10W-30				RA				-				RA		RA	RA
10W-40	RA			RA	RA			RA	-			RA	RA	RA	RA
10W-50	RA			RA	RA	RA		RA	RA	-		RA	RA	RA	RA
10W-60	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	-	RA	RA	RA	RA
15W-40				RA				RA				-		RA	RA
15W-50				RA	RA			RA	RA			RA	-	RA	RA
20W-40														-	
20W-50				RA				RA				RA		RA	-

Stipulated requirement: if the viscosity modifier treat rate increase is larger than 15% wt relative, Level 2 technical support data must be available to justify the read across

OM441LA & OM501LA test (non-dispersant viscosity modifier)												
Test run on:	Can be read across (RA) to:											
↓	0W-30	5W-30	5W-40	5W-50	10W-30	10W-40	15W-40	15W-50	20W-40	20W-50	30	40
0W-30	-											
5W-30		-			RA	RA	RA	RA				
5W-40			-			RA	RA	RA				
5W-50				-				RA				
10W-30					-		RA					
10W-40						-	RA	RA				
15W-40							-					
15W-50								-				
20W-40									-			
20W-50										-		
30											-	
40												-

Stipulated requirement: if the viscosity modifier treat rate increase is larger than 15% wt relative, Level 2 technical support data must be available to justify the read across

ATIEL viscosity grade read across guidelines



Oronite

MACK T-8E test (for ACEA oil sequences only)												
Test run on:	Can be read across (RA) to:											
↓	0W-30	5W-30	5W-40	5W-50	10W-30	10W-40	15W-40	15W-50	20W-40	20W-50	30	40
0W-30	-											
5W-30	RA	-	RA	RA								
5W-40	RA		-	RA								
5W-50	RA			-								
10W-30	RA	RA	RA	RA	-	RA						
10W-40	RA	RA	RA	RA		-						
15W-40	RA	RA	RA	RA	RA	RA	-	RA				
15W-50	RA	RA	RA	RA	RA	RA		-				
20W-40	RA	RA	RA	RA	RA	RA	RA	RA	-	RA		
20W-50	RA	RA	RA	RA	RA	RA	RA	RA		-		
30	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	-	RA
40	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA	-

Note: These read across guidelines have been produced only for test data to be used to support ACEA claims and must not be used to support API claims where the relevant read across guidelines from API 1509 must be used

MACK T-11 test												
Test run on:	Can be read across (RA) to:											
↓	0W-30	5W-30	5W-40	5W-50	10W-30	10W-40	15W-40	15W-50	20W-40	20W-50	30	40
0W-30	-											
5W-30		-										
5W-40			-									
5W-50				-								
10W-30					-	RA						
10W-40					RA	-						
15W-40					RA	RA	-	RA				
15W-50					RA	RA	RA	-				
20W-40					RA	RA	RA	RA	-	RA		
20W-50					RA	RA	RA	RA	RA	-		
30											-	
40												-

Base oil saturates in the test and final formulations must comply with the guidelines in the table here below.

Tested oil saturate content	Candidate oil saturate requirement
If $X \leq 70.0$	80.0 minimum
If saturate content X in the range $70.0 < X < 95.0$	$(0.6 \times X + 38)$ minimum
If ≥ 95.0	95.0 minimum

In cases where a dispersant viscosity modifier (DVM) is used, the DVM level in the final formulation must be equal to or greater than the level in the test oil

ATIEL viscosity grade read across guidelines



Oronite

MACK T-12 test												
Test run on:	Can be read across (RA) to:											
↓	0W-30	5W-30	5W-40	5W-50	10W-30	10W-40	15W-40	15W-50	20W-40	20W-50	30	40
0W-30	-											
5W-30		-										
5W-40			-									
5W-50				-								
10W-30					-	RA	RA	RA	RA	RA		
10W-40						-						
15W-40							-	RA	RA	RA		
15W-50								-				
20W-40									-			
20W-50										-		
30											-	
40												-

Stipulated requirement: If the viscosity modifier treat rate increase is larger than 15% wt relative, Level 2 technical support data must be available to justify the read across.
Read across is only allowed when the Sulfur level of the R/A grade is equal or less than in the tested grade

CUMMINS ISM test												
Test run on:	Can be read across (RA) to:											
↓	0W-30	5W-30	5W-40	5W-50	10W-30	10W-40	15W-40	15W-50	20W-40	20W-50	30	40
0W-30	-											
5W-30		-										
5W-40			-									
5W-50				-								
10W-30					-	RA	RA	RA				
10W-40						-						
15W-40						RA	-	RA				
15W-50								-				
20W-40									-			
20W-50										-		
30											-	
40												-

Stipulated requirement: if the viscosity modifier treat rate increase is larger than 15% wt relative, Level 2 technical support data must be available to justify the read across

Table 4.1.A/B base oil interchange for ACEA Gasoline and light duty Diesel engine oil sequences



Base stock in original formula	Interchange base stock ^{(1) (3) (4) (5) (6)}								
	GROUP I		GROUP II		GROUP III		GROUP IV		GROUP V
GROUP I	≤ 10%	NONE	≤ 10%	NONE	≤ 30%	NONE	≤ 30%	NONE	
	> 10%	TU572 VG M111 sludge M111 FE VW DI	> 10%	TU572 TU3MS OM602A or OM646LA DV4 M111 FE VW DI	> 30%	TU572 VG M111sludge TU3MS DV4 M111 FE VW DI	> 30%	TU572 VG M111sludge TU3MS DV4 M111FE VW DI	ALL
GROUP II	≤ 10%	NONE	≤ 10%	NONE	≤ 30%	NONE	≤ 30%	NONE	ALL
	> 10%	ALL	> 10%	ALL	> 30%	ALL	> 30%	ALL	
GROUP III	≤ 10%	NONE	≤ 10%	NONE	≤ 10%	NONE	≤ 10%	NONE	ALL
	> 10%	ALL	> 10%	ALL	> 10%	ALL	> 10% ≤ 30%	VG and M111 sludge	
							> 30%	ALL	
GROUP IV	≤ 10%	NONE	≤ 10%	NONE	≤ 10%	NONE	NONE ⁽²⁾		ALL
	> 10%	ALL	> 10%	ALL	> 10% ≤ 30%	VG and M111 sludge			
					> 30%	ALL			
GROUP V	ALL		ALL		ALL		ALL		ALL

Notes:

(1) ALL = all tests specified within the ACEA Oil Sequence category.

NONE = no engine tests are required. Laboratory tests must be run and requirements be met

(2) Group IV base oils are polyalphaolefins (PAO). PAOs can be interchanged without additional qualification testing, as long as the interchange PAO meets the original PAO manufacturer's specifications in physical and chemical properties. The following key properties need to be met in the substituted stock:

- Kinematic viscosity at 100°C, 40°C and -40°C
- Viscosity index
- Noack volatility
- Pour point
- Unsaturates

(3) All percentages are % mass of the formulated oil

(4) No M111 FE testing is required if the HTHS and KV 40°C of the interchange formulation are lower or equal to that of the original formulation

(5) An interchange of up to 30% from Group I, II, III, IV or V to Group I, II, III, IV or V is permitted without requirement for M111 FE testing provided the requirements in Note 4 are also met.

(6) Only the tests included in the ACEA sequence for which read across is required have to be run

Table 4.1.C base oil interchange for ACEA Gasoline and Diesel
with after treatment devices engine oil sequences



Base stock in original formula	Interchange base stock ^{(1) (3) (4) (5) (6)}								
	GROUP I		GROUP II		GROUP III		GROUP IV		GROUP V
GROUP I	≤ 10%	NONE	≤ 10%	NONE	≤ 30%	NONE	≤ 30%	NONE	ALL
	> 10%	TU572 VG M111 sludge M111 FE VW DI	> 10%	TU572 TU3MS OM602A or OM646LA DV4 M111 FE VW DI	> 30%	TU572 VG M111sludge TU3MS DV4 M111 FE VW DI	> 30%	TU572 VG M111sludge TU3MS DV4 M111FE VW DI	
GROUP II	≤ 10%	NONE	≤ 10%	NONE	≤ 30%	NONE	≤ 30%	NONE	ALL
	> 10%	ALL	> 10%	ALL	> 30%	ALL	> 30%	ALL	
GROUP III	≤ 10%	NONE	≤ 10%	NONE	≤ 10%	NONE	≤ 10%	NONE	ALL
	> 10%	ALL	> 10%	ALL	> 10%	ALL	> 10% ≤ 30%	VG and M111 sludge	
							> 30%	ALL	
GROUP IV	≤ 10%	NONE	≤ 10%	NONE	≤ 10%	NONE	NONE ⁽²⁾		ALL
	> 10%	ALL	> 10%	ALL	> 10% ≤ 30%	VG and M111 sludge			
					> 30%	ALL			
GROUP V	ALL		ALL		ALL		ALL		ALL

Notes:

(1) ALL = all tests specified within the ACEA Oil Sequence category.

NONE = no engine tests are required. Laboratory tests must be run and requirements be met

(2) Group IV base oils are polyalphaolefins (PAO). PAOs can be interchanged without additional qualification testing, as long as the interchange PAO meets the original PAO manufacturer's specifications in physical and chemical properties. The following key properties need to be met in the substituted stock:

- Kinematic viscosity at 100°C, 40°C and -40°C
- Viscosity index
- Noack volatility
- Pour point
- Unsaturates

(3) All percentages are % mass of the formulated oil

(4) No M111 FE testing is required if the HTHS and KV 40°C of the interchange formulation are lower or equal to that of the original formulation

(5) An interchange of up to 30% from Group I, II, III, IV or V to Group I, II, III, IV or V is permitted without requirement for M111 FE testing provided the requirements in Note 4 are also met.

(6) Only the tests included in the ACEA sequence for which read across is required have to be run

Table 4.1.E base oil interchange for ACEA heavy duty diesel engine oil sequences



Base stock in original formula	Interchange base stock ^{(1) (3) (4) (5) (6)}								
	GROUP I		GROUP II		GROUP III		GROUP IV		GROUP V
GROUP I	≤ 10%	NONE	≤ 10%	NONE	≤ 30%	NONE	≤ 30%	NONE	ALL
	> 10%	OM441LA or OM501LA Mack T-8E Mack T-12 ISM	> 10%	OM602A or OM646LA OM441LA or OM501LA Mack T-12	> 30%	OM441LA or OM501LA Mack T-12 ISM	> 30%	OM441LA or OM501LA Mack T-12 ISM	
GROUP II	≤ 10%	NONE	≤ 10%	NONE	≤ 30%	NONE	≤ 30%	NONE	ALL
	> 10%	ALL	> 10%	ALL	> 30%	OM602A or OM646LA OM441LA or OM501LA Mack T-12 ISM	> 30%	OM602A or OM646LA OM441LA or OM501LA Mack T-12 ISM	
GROUP III	≤ 10%	NONE	≤ 10%	NONE	≤ 10%	NONE	≤ 30%	NONE	ALL
	> 10%	ALL	> 10%	ALL	> 10%	OM602A or OM646LA OM441LA or OM501LA Mack T-8E & T-11 Mack T-12 ISM	> 30%	OM602A or OM646LA OM441LA or OM501LA Mack T-12 ISM	
GROUP IV	≤ 10%	NONE	≤ 10%	NONE	≤ 30%	NONE	NONE ⁽²⁾		ALL
	> 10%	ALL	> 10%	ALL	> 30%	OM602A or OM646LA OM441LA or OM501LA Mack T-8E & T-11 Mack T-12 ISM			
GROUP V	ALL		ALL		ALL		ALL		ALL

Notes:

(1) ALL = all tests specified within the ACEA Oil Sequence category.

NONE = no engine tests are required. Laboratory tests must be run and requirements be met

(2) Group IV base oils are polyalphaolefins (PAO). PAOs can be interchanged without additional qualification testing, as long as the interchange PAO meets the original PAO manufacturer's specifications in physical and chemical properties. The following key properties need to be met in the substituted stock:

- Kinematic viscosity at 100°C, 40°C and -40°C
- Viscosity index
- Noack volatility
- Pour point
- Unsaturates

(3) All percentages are % mass of the formulated oil

(4) No M111 FE testing is required if the HTHS and KV 40°C of the interchange formulation are lower or equal to that of the original formulation

(5) An interchange of up to 30% from Group I, II, III, IV or V to Group I, II, III, IV or V is permitted without requirement for M111 FE testing provided the requirements in Note 4 are also met.

(6) Only the tests included in the ACEA sequence for which read across is required have to be run

ATIEL viscosity modifier interchange guidelines



Oronite

Performance category	NDVM to NDVM ⁽¹⁾ (2) (3)	DVM to DVM or NDVM to DVM ⁽¹⁾ (2) (3)
Gasoline / Light duty Diesel	TU572 M111 and VG VW DI M111 FE	TU572 M111 and VG OM602A or OM646LA DV4 VW DI M111 FE
Gasoline / Light duty Diesel with after treatment devices	TU572 M111 and VG VW DI M111 FE	TU572 M111 and VG OM602A or OM646LA DV4 VW DI M111 FE
Heavy duty Diesel	Mack T-8E ⁽⁵⁾ OM441LA or OM501LA ISM ⁽⁴⁾ (6)	OM602A or OM646LA Mack T-8E OM441LA or OM501LA ISM ⁽⁴⁾ (6)

Notes:

(1) Full testing is required for VMI not listed above

(2) Physical mixes of NDVM and DVM are treated as DVM

(3) Only the tests included in the ACEA sequence for which read across is required have to be run

(4) ISM not required if the new oil formulation has the same or a greater HTHS value compared with the original tested formulation

(5) Mack T-8E requirement is waived, if the replacement NDVM is within the same chemical type as the tested NDVM ("chemical type" means chemical family such as, but not limited to, styrene ester, polymethacrylate, styrene butadiene, styrene isoprene, polyisoprene, olefin copolymer and polyisobutylene).

(6) The M111 or M111-EGR test may be used in place of the ISM test

TEST and ENGINES



Engine test conditions



Oronite

Tests	Engine characteristics						Test conditions								Performance ratings								
	Procedure reference	Inject. type	Engine type	Aspiration	Engine displ., l.	Max. output, kW/rpm	Fuel type: RON/Pb,g/l	Fuel type: % S (FAME %)	Oil fill volume, l.	Total test duration, h.	Duration of each phase, h.	Engine speed, rpm	Load, kW.	Oil temp., °C	Deposit/piston cleanliness	Sludge	Varnish	Vis. incr. /Oxid.	Rust/ corros.	Ring	Wear	Others	
ACEA tests																							
Audi FE	PV 1451	MP	L4 (20v)		1.8	110-5700	95-0		3.5	Appr.110	2X4 FE cyc. (4)	-	-	7°C to > 80°C								Fuel Cons. vs. RL191	
Mercedes M111FE	CEC L-054-96	MP	L4 (16v)		2.0	100-5500	95-0		4	3 times appr. 2 h ⁽²⁾	13 step cycle	750-3070	0-49	20-75								Fuel economy	
Mercedes M111SL	CEC L-53-T-95	MP	L4 (16v)		2.0	100-5500	95-0		4.35	286 ⁽¹⁾	48-76-100 ⁽¹⁾	750-6000	0-100	15-130	X	X				RS	Cam		
Mercedes OM 364LA	CEC L-42-X3-97	DI	L4	TC/IC	4.0	103-2400		0.3	5.8	300	50	1000-2400	30-98	114-126	X	X			X	Liner	BP/OC		
Mercedes OM 441LA	CEC L-52-T-97	DI	V6	TC/IC	11.0	243-2100		0.05	18	400	50	1140-2100	0-/ 240	120	X	X				X	General	BP/OC	
Mercedes OM 501LA	CEC L-101-08	DI	V6	TC/IC	11.9	360-1800		<0.0003 (4-5)	19.1 kg	300	50	1080-1800	18-360	106-126.5	X	X					BP	OC	
Mercedes OM 602A	CEC L-51-A-98	IDI	L5	TC	2.5	90-4600		0.3	7.6	200	1	1000-5000	0-90	50-142	X	X		X		Cam Liner	BP/OC		
Mercedes OM 611 DE 22 LA	MB DL,300h	DI	L4 (16v)	TC	2.2	105-4200		0.005		300					X	X		X	X	X	BP/OC		
Mercedes OM 646LA	CEC L-099-08	DI	L4 (16v)	TC/IC	2.2	110-4200		<0.0003 (4-5)	5 kg	300	50	750-4200	0-110	45-135							Cam		
PSA DV4 TD	CEC L-93-04	DI	L4	TC	1.4	51-4000		0.03	4.7	120	0.5	1100-4000	0-40	120	X			X				Oil soot	
PSA DV6	CEC TDG-L-106	DI	L4	TC	1.6	82-3600		0.00 (4,5)	3.7	120	0.77 0.14 0.08	3600 1750-1000	0-82	120	X			X				Oil soot	
PSA TU-3MS	CEC L-038-94	SP	L4 (16v)		1.4	53-5500	95-0		3	100	40-60	1500-3000	1.6-11	40-100							Cam	Follower scuffing	

Engine test conditions



Oronite

Tests	Engine characteristics						Test conditions									Performance ratings								
	Procedure reference	Inject. type	Engine type	Aspiration	Engine displ., l.	Max. output, kW/rpm	Fuel type: RON/Pb,g/l	Fuel type: % S (FAME %)	Oil fill volume, l.	Total test duration, h.	Duration of each phase, h.	Engine speed, rpm	Load, kW.	Oil temp., °C	Deposit/piston cleanliness	Sludge	Varnish	Vis. incr. /Oxid.	Rust/ corros.	Ring	Wear	Others		
ACEA tests																								
PSA TU-5JP-L4	CEC L-088-02	MP	L4 (16v)		1.6	80-5800	95-0		3.2	72	6*2 phases (6*12h.)	5600	62	150			X	X		RS		OC		
Volvo D12D	PK320	DI	L6	TC	12.1	338		0.0003	17.8	400	0.1 0.2	600-1800	0-338	110-125	X					Ring riding	BP/OC			
Volvo D12DFE		DI	L6	TC	12.1	338		0.0003		24	3* 8h.	600-1700	0-338	110-125								Fuel economy		
VW 1.6 TC D	CEC L-46-T-93	IDI	L4	TC/IC	1.6	59-4500		0.3	4.5	50		4500	59	130	X				X					
VW FSI	PV 1481	MP	L4		1.4	-/-	95-0		-	100	-	-	-	-								Weight incr. of inlet valves, Inlet manifold, EGR-valve		
VW T4	PV 1449	MP	L4		2.0	62-4300	95-0		5.0	248	192-56	880-4300	0-62	40-133	X			X		RS		BN		
VW TDI	CEC L-078-99	DI	L4	TC/IC	1.9	81-4150		0.3	4.5	54	2.5 0.5	4150-Idle	81-Idle	145-40	X			X		X				

Engine test conditions



Oronite

Tests	Engine characteristics						Test conditions								Performance ratings									
	Procedure reference	Inject. type	Engine type	Aspiration	Engine displ., l.	Max. output, kW/rpm	Fuel type: RON/ Pb,g/l	Fuel type: % S (FAME %)	Oil fill volume, l.	Total test duration, h.	Duration of each phase, h.	Engine speed, rpm	Load, kW.	Oil temp., °C	Deposit/ piston cleanliness	Sludge	Varnish	Vis. incr. /Oxid.	Rust/ corros.	Ring	Wear	Others		
JASO tests																								
Mitsubishi 4D34T4	JASO M 354:05	DI	L4	TC/IC	3.9	121.4-3200		0.05 max. (0.001 max.)	7.0	160	-	3200	121.4	105							Cam			
HINO N04C	JASO M 354:15	DI	L4	TC/IC	4.0	120-2800		0.05 max. (0.001 max.)	8.0	200	-	2800	120	113							Tappet			
Nissan TD25	JASO M 336:98	IDI	L4	-	2.5	55.0-4300		0.05 max. (0.001 max.)	4.8	200	-	4300	55.0	120	X					RS				
HINO N04C	JASO M 336:14	DI	L4	TC/IC	4.0	120-2800		0.05 max. (0.001 max.)	8.0	200	-	2800	120	113	X	WTD				RS				
Nissan VG20E	JASO M 331:91	PFI	V6		2.0	91.9-6000	89-93 0		2	200 or 300	1h (24+24+12)	800 1800 3500	1.6 18.5 34.1	50 96 117		X								
Nissan KA24E	JASO M 328:95	PFI	L4		2.4	103-5600	89 min. 0		3	100	1h (50+10)	800 1500	1.2 2.3	50 60.5						Cam				
Toyota 1GFE	JASO M 333:93	PFI	L6		2.0	99-5600	89 min. 0		2.5	48 or 96		4800	29,6	149				X						
API / ILSAC tests																								
BRT	ASTM D6557	Bench test to replace Seq IID engine test							0.1	18									rust					
CAT 1M-PC (for CF)	ASTM D6618	IDI	1Y73 Singl.Cyl	TC	2.2	31.3-1800		0.40 min.	6.8	120		1800	31	Bearing 96	WTD TGF		WTD		RSC RS	Liner scuffing				
Caterpillar 1K	ASTM D6750	DI	1Y540 Singl.Cyl	TC	2.4	52-2100		0.40	6.0	252		2100	52	Bearing 107	WDK TGF TLHC		WDK			RS				
Caterpillar 1N	ASTM D6750	DI	1Y540 Singl.Cyl	TC	2.4	52-2100		0.05	6.0	252		2100	52	Bearing 107	WDN TGF TLHC		WDN			RS	Liner scuffing	OC		
Caterpillar 1P	ASTM D6681	DI	1Y3700 Singl.Cyl	TC	2.43	44-1800		0.05	6.8	360		1800	44	130+/-3	WDP TLC TGC		WDP					OC		

Engine test conditions



Oronite

Tests	Engine characteristics						Test conditions								Performance ratings							
	Procedure reference	Inject. type	Engine type	Aspiration	Engine displ., l.	Max. output, kW/rpm	Fuel type: RON/Pb,g/l	Fuel type: % S (FAME %)	Oil fill volume, l.	Total test duration, h.	Duration of each phase, h.	Engine speed, rpm	Load, kW.	Oil temp., °C	Deposit/ piston cleanliness	Sludge	Varnish	Vis. incr. /Oxid.	Rust/ corros.	Ring	Wear	Others
API / ILSAC tests																						
Caterpillar 1R	ASTM D6923	DI	1Y3700 Singl.Cyl	TC	2.43	44-1800		0.05	6.8	504		1800	68	120	WD TLC TGC		WDR			RS	Liner scuffing	OC
Caterpillar C13	ASTM D7484	DI	C13	TC	12.5	391-1800		0.0015	38	500		1800	1760	Gallery 98	WTD TGC TLHC					RSC RS, weight loss	Bearing	OC
Cummins ISB	ASTM D7549	DI	L6	TC	5.9	224-2600		0.0015	14.5	350	100-250	1600-Cyclic	70	110						Valve train		
Cummins ISM	ASTM D7468	DI	L6	TC	10.82	332-1900		0.05	24.8	200	50	1600+/-2 1800+/-5	300	115		Rocker cover				Weight loss	Valve train	Filter plug
Cummins M11	ASTM D6838	DI	370E	TC	11.0	275-1800		0.05	29	200	50	1600+/-2 1800+/-5	275	130 maxi.		Filter plugg.				Valve train		
Cummins M11-EGR	ASTM D6975	DI	L6	TC	11.0	275-1800		0.05		300	50	1600+/-2 1800+/-5				Filter plugg.				Valve train		
Cummins NTC-400		DI		TC/IC	14	298-2100		0,4		200		2100	298	250	X					Cam follower pin	OC	
DD6V92TA	ASTM D5862	DI	V6 2 Cycle	TC IC	9.0	370-2300		0.1-0.4	22	100		1200-2300	130-364 379	102-111					Face distress	Liner scuffing	Port plugg	
EOFT Navistar	ASTM D6894	DI	V8	TC	7.3	160-3000		0.05	16	20		0	153									Deaeration
Mack T-6		DI	6	TC	11			0.1-0.3		600	12	1400-1800 2100		113	X			X		Wear		
Mack T-9	ASTM D6483	DI	E7-350	TC	12.0	261-1800		0.05	45.4	500	75/425	1800-1250	0-261	99-107					X	Weight loss	Liner + BC	TR

Engine test conditions



Oronite

Tests	Engine characteristics						Test conditions								Performance ratings							
	Procedure reference	Inject. type	Engine type	Aspiration	Engine displ., l.	Max. output, kW/rpm	Fuel type: RON/Pb,g/l	Fuel type: % S (FAME %)	Oil fill volume, l.	Total test duration, h.	Duration of each phase, h.	Engine speed, rpm	Load, kW.	Oil temp., °C	Deposit/piston cleanliness	Sludge	Varnish	Vis. incr. /Oxid.	Rust/corros.	Ring	Wear	Others
API / ILSAC tests																						
Mack T-10	ASTM D6987	DI	L6	TC	12.0	343-1800		0.05	35.9	300	75-225	1800-1200	245-325	88-112					Weight loss	Liner	BC & OC	
Mack T-12	ASTM D7422	DI	L6	TC	12.0	343-1800		0.0015	35.9	300	100-200	1800-1200	245-325	88-116					Weight loss	Liner	BC & OC	
Mack T-7	ASTM RR:D02-1220	DI	EM6-285 L6	TC/IC	11.0	210		0.4	56.8	150		1200	181	113				X				
Mack T-8A	ASTM D5967	DI	E.7	TC	12.0	258-1800		0.05	45.4	150		1800	258	100-107		Filter plugg.		X				
Mack T-8	ASTM D5967	DI	E.7	TC	12.0	258-1800		0.05	45.4	250		1800	258	100-107		Filter plugg.		X			OC	
Mack T-8E	ASTM D5967	DI	E.7	TC	12.0	258-1800		0.05	45.4	300		1800	258	100-107				X			OC	
Mack T-11	ASTM D7156	DI	L6	TC	12.0	343-1800		0.05	30.9	252		1800	240	88				X				
RPWT	ASTM D5966	IDI	V6	-	6.5	155-3500		0.05	6.0	50		1000	30-34	120						Roller fol-lower		
SEQ IIIE	ASTM D5533		V6		3.8		Leaded Gasoline		5.3	64		3000	50.6	149				X		RS	Cam + lobe	OC
SEQ IIIF	ASTM D6984		V6		3.8		Unl. Gasoline		15	80		3600	73.6	155	X		X	X		RS	Cam + lifter	
SEQ IIIG	ASTM D7320		V6		3.8	125 bhp/3600	Unl. Gasoline			100	Steady state	3600		150	X			X		Hot stuck	X	OC

Engine test conditions



Oronite

Tests	Engine characteristics						Test conditions								Performance ratings							
	Procedure reference	Inject. type	Engine type	Aspiration	Engine displ., l.	Max. output, kW/rpm	Fuel type: RON/ Pb,g/l	Fuel type: % S (FAME %)	Oil fill volume, l.	Total test duration, h.	Duration of each phase, h.	Engine speed, rpm	Load, kW.	Oil temp., °C	Deposit/ piston cleanliness	Sludge	Varnish	Vis. incr. /Oxid.	Rust/ corros.	Ring	Wear	Others
API / ILSAC tests																						
SEQ IV-A	ASTM D6891	PFI	L4		2.4	103-5600	89 min. 0		3	100	1h. (50+10)	800 1500	1.2 2.3	50 60.5							Cam	
SEQ VE	ASTM D5302	PFI	Ford OCH-4		2.3		Unl. Philips « J »		3.67	288	120 ⁽¹⁾ x 72 75 ⁽¹⁾ x 72 45 ⁽¹⁾ x 72	2500 2500 750	25 25 0.75	68 99 46		X	X			RS	Cam	
SEQ VG	ASTM D6593	PFI	Ford V8		4.6		Unl. Gasoline		3	216	108 67.5 40.5	1200 2900 700		68 100 45		X	X			RS		
SEQ VI-B	ASTM D6837	MP	Ford V-8 ('93)		4.6		Unl. Gasoline		6	133	I aging = 16 II aging = 80 FEI I 7.5 FE II 7.5	800 1500	2.18 15.39	45 105								Fuel economy
SEQ VI-D	ASTM D7589	MP	GM V6 LY7		3.6		Unl. Gasoline		5.4	155		695-2000	1.5-22	35-115								Fuel econ./ FE retention
SEQ VIII	ASTM D6709		CLR mono		0.7	3.7-3150	Unl. Gasoline		1.8	40		3150	~ 3.7	143					BWL			Shear stability

(1) Depending on fuel batch severity
(2) Ref.-cand.-ref.

OC = Oil consumption
BP = Bore polishing
DI = Direct Injection
TCIC = Turboc. intercooler
TGC = Top groove carbon
TGF = Top groove filling

TLC = Top land carbon
TLHC = Top land heavy carbon
BWL = Bearing Weight Loss
IC = Intercooler
IDI = Indirect Diesel Injection
MP = Multi point
SC = Supercharged
RS = Ring Sticking
WDK = Total weighted demerit for Cat 1K

WDN = Total weighted demerit for Cat 1N
WDP = Total weighted demerit for Cat 1P
WTD = Total weighted demerit
PFI = Port fuel injection
ED = Engine Deposit
RSC = Ring side clearance
RS = Ring Sticking
OC = Oil consumption
TC = Turbocharged

BC = Bearing corrosion
L4 = In Line 4 cylinders
V6 = 6 cylinders in V
L6 = In Line 6 cylinders
V8 = 8 cylinders in V
BP = Bore Polishing
SP = Single point



ELASTOMER COMPATIBILITY TESTING

Elastomer compatibility operating conditions and limits

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Oronite

Specifications	ACEA 2008 / 2010 / 2012						
Elastomer material	RE1 (FPM, Fluoro)		RE2-99 (ACM, Acrylic)	RE3-04 (VMQ, Silicon)		RE4 ⁽¹⁾ (NBR, Nitrate)	DBL-AEM (Vamac, Ethylene acrylic)
Related specifications	Seq. A/B, C	Seq. E	Seq. A/B, C, E	Seq. A/B, C	Seq. E	Seq. A/B, C, E	
Operating conditions	CEC L-039-96					CEC L-039-96	CEC L-039-96
Test piece	S 2					S 2	S 2
Duration, h.	168					168	168
Pre-aging of the oil	No					No	No
Oil weight, g.	270					270	270
Temperature, °C	150					100	150
Variations after test in:							
Hardness change, points.	-1/+5	-1/+5	-5/+8	-22/+1	-25/+1	-5/+5	-5/+10
Tensile strength change, %	-40/+10	-50/+10	-15/+18	-30/+10	-45/+10	-20/+10	-35/-
Elongation at break change, %	-50/+10	-60/+10	-35/+10	-20/+10	-20/+10	-50/+10	-50/-
Volume change, %, max.	-1/+5	-1/+5	-7/+5	-1/+22	-1/+30	-5/+5	-5/+15

Note:

(1) As per 14 April 2014, RE4 seal material has been removed from the test method

Specifications	JASO DH-1 / DH-2 / DL-1					
Elastomer material	RE1 (FPM, Fluoro)		RE2-99 (ACM, Acrylic)	RE3-04 (VMQ, Silicon)	RE4 (NBR, Nitrate)	DBL-AEM (Vamac, Ethylene acrylic)
Related specifications	DH-1, DL-1	DH-2	DH-1, DH-2, DL-1	DH-1, DH-2, DL-1	DH-1, DH-2, DL-1	
Operating conditions	CEC L-039-96				CEC L-039-96	CEC L-039-96
Test piece	S 2				S 2	S 2
Duration, h.	168				168	168
Pre-aging of the oil	No				No	No
Oil weight, g.	270				270	270
Temperature, °C	150				100	150
Variations after test in:						
Hardness change, points.	-1/+5	-1/+5	-5/+8	-25/+1	-5/+5	-35/-
Tensile strength change, %	-40/+10	-50/+10	-15/+18	-45/+10	-20/+10	-50/-
Elongation at break change, %	-50/+10	-60/+10	-35/+10	-20/+10	-50/+10	-5/+15
Volume change, %, max.	-1/+5	-1/+5	-7/+5	-1/+30	-5/+10	-

Elastomer compatibility operating conditions and limits

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Oronite

Specifications	GLOBAL DHD-1			
Elastomer material	RE1 (FPM, Fluoro)	RE2 (ACM, Acrylic)	RE3 (VMQ, Silicon)	RE4 (NBR, Nitrile)
Operating conditions	CEC L-039-96			CEC L-039-96
Test piece	S 2			S 2
Duration, h.	168			168
Pre-aging of the oil	No			No
Oil weight, g.	270			270
Temperature, °C	150			100
Variations after test in:				
Hardness change, points.	-1/+5	-5/+5	-25/+1	-5/+5
Tensile strength change, %	-40/+10	-15/+10	-45/+10	-20/+10
Elongation at break change, %	-50/+10	-35/+10	-20/+10	-50/+10
Volume change, %, max.	-1/+5	-5/+5	-1/+30	-5/+5

Elastomer compatibility operating conditions and limits

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Oronite

Specifications	API CI-4, CI-4 PLUS, CUMMINS 20078, API CJ-4, CUMMINS 20081, Detroit Diesel Power Guard oil (93k214 / 215 / 218), Mack EO-N / O Premium Plus, Volvo VDS-3, VDS-4				
	Elastomer material	Nitrile	Silicone	Polyacrylate	FKM
Operating conditions	ASTM D7216				
Duration, h.	336				
Pre-aging of the oil	No				
Temperature, °C	100	150	150	150	150
Variations after test in: ^{(1) (2)}					
Volume change, %	+5/-3	+Ref. oil/-3	+5/-3	+5/-2	+Ref. Oil/-3
Hardness change, points.	+7/-5	+5/-Ref. oil	+8/-5	+7/-5	+5/-Ref. oil
Tensile strength change, %	+10/-Ref. oil	+10/-45	+18/-15	+10/-Ref. oil	+10/-Ref. oil
Elongation at break change, %	+10/-Ref. oil	+20/-30	+10/-35	+10/-Ref. oil	+10/-Ref. oil
Compression set ⁽³⁾	Report	Report	Report	Report	Report

Notes:

(1) These are unadjusted specification limits for elastomer compatibility. Candidate oils shall, however, conform the adjusted specification limits, the calculation of which is described in ASTM D4485 annex A4.

(2) Ref. oil is TMC 1006 (original blend or subsequent approved re-blends of TMC 1006)

(3) Only required for Detroit Diesel power guard oils 93K214, per ASTM D395

Specifications	API SN, SN resource conserving, ILSAC GF-5				
Elastomer material	Hydrogenated nitrile (HNBR-1)	Silicone (VMQ-1)	Polyacrylate (ACM-1)	Fluorocarbon (FKM-1)	Ethylene acrylic (AEM-1)
Operating conditions	ASTM D7216 annex A2				
Duration, h.	336				
Pre-aging of the oil	No				
Temperature, °C	100	150	150	150	150
Variations after test in: ⁽¹⁾					
Volume change, %	-5/10	-5/40	-5/9	-2/3	-5/30
Hardness change, points.	-10/5	-30/10	-10/10	-6/6	-20/10
Tensile strength change, %	-20/15	-50/5	-40/40	-65/10	-30/30

Note:

(1) Candidate oil testing for elastomer compatibility shall be performed using the five Standard Reference Elastomers (SREs) referenced herein and defined in SAE J2643.

Candidate oil testing shall be performed according to ASTM D7216 annex A2.

The post-candidate-oil-immersion elastomers shall conform to the specification limits detailed herein.

Elastomer compatibility operating conditions and limits

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Oronite

Specifications	MB 226.5	MB 226.51	MB 226.9/228.31	MB 228.0/1/2/3	MB 228.5	MB 228.51	MB 229.1/3/5	MB 229.31/51/52
Requirements	ACEA A3/B3	ACEA C4	ACEA E9	ACEA E7	ACEA E4	ACEA E6	ACEA A3/B4	ACEA C3

Specifications	MAN M 3275-1 / 2, M 3277, M 3377, M 3477, M 3575, M 3677		MTU MTL 5044 Type 1, 2, 2.1, 3, 3.1	
Elastomer material	NBR (SRE-NBR 28)	FPM (AK 6)	SRE-NBR 28	FKM-AK6
Operating conditions	VDA 675 301	VDA 675 301 and M 3273 ⁽¹⁾	DIN 53521	DIN 53521
Test piece	S 2	S 2	S 2	S 2
Duration, h.	168	168	168	168
Pre-aging of the oil	No	No	No	No
Oil weight, specimen/oil ratio	1: 80	1: 80	1: 80	1: 80
Temperature, °C	100	150	100	150
Variations after test in:				
Hardness change, points.	-10	-5/+5	-10/0	-5/+5
Tensile strength change, % min.	-20	-30	-20	-50
Elongation at break change, %, min.	-30	-40	-35	-55
Volume change, %	0/+10	-2/+5	0/+10	0/+5

Note:

(1) Procedure with addition of 0.6 % vol. of hydrochloric acid to the candidate oil to test.

Elastomer compatibility operating conditions and limits

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Oronite

Specifications	GM dexos 1 & 2					
Elastomer material	RE1 (FPM)	RE4 (NBR)	DBL AEM (VAMAC)	Nitrile (NBR-1)	Silicone (VMQ-1)	Polyacrylate (ACM-1)
Operating conditions	CEC L-039-96		VDA 675301	ASTM D7216 Annex A2		
Test piece	S 2		S 2			
Duration, h.	168		168			
Pre-aging of the oil	No		No			
Oil weight, g. or specimen: oil ratio	270		1 : 80			
Temperature, °C	150		150			
Variations after test in:						
Hardness change, points.	-1/+5	-5/+5	-5/+10	-5/+5	-20/+10	-10/+10
Tensile strength change, %.	-40/+10	-20/+10	-35/-	-20/+10	-45/0	-30/+30
Elongation at break change, %.	-50/+10	-50/+10	-50/-	-35/0	-40/0	-45/+5
Volume change, %.	-1/+5	-5/+5	-5/+15	-5/+5	-5/+40	-5/+5
Tensile stress at 50% elongation change, %	-	-	-	-10/+35	-50/+10	-20/+65

Elastomer compatibility operating conditions and limits

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Oronite

Specifications	VOLKSWAGEN service fill specifications							
VW 504 00/507 00	X		X		X		X	
VW 508 00/509 00	X		X		X		X	
VW 502 00/505 01		X		X		X		X
VW 508 88/509 99		X		X		X		X
VW 502 00/505 00		X		X		X		X
VW 501 01/505 00		X		X		X		x
Elastomer material	RE-AK6/1 ⁽¹⁾		RE-ACM1 ⁽²⁾		RE-AEM2 ⁽³⁾		RE-AEM1 ⁽⁴⁾	
Operating conditions	PV 3344, PV 3323, DIN 53504 S3A Yes 1 : 80 150							
Procedure								
Test piece								
Pre aging								
Ratio specimen: oil								
Temperature, °C								
Duration, h.	168	282 (3 x 94)	500	168	500	168	500	168
Variations after test in:								
Tensile strength, N/mm², min.	7	8	-	-	-	-	-	-
Tensile strength change at break, % max.	60	50	40	30	40	35	40	30
Elongation at break, %, min.	160	160	-	-	-	-	-	-
Elongation at break change, %, max.	50	50	40	30	40	40	40	30
Hardness change, points.	-	-	-4/+10	-5/+6	-4/+10	-10/+10	-4/+10	-8/+8
Weight change, %	-	-	-2/+6	-2/+4	-3/+10	-3/+15	-3/+10	-3/+15
Cracks	None	None	-	-	-	-	-	-

Notes:

(1) Old name: FPM AK6

(2) Old name: ACM

(3) Old name: Vamac

(4) RE-AEM1 scheduled to disappear, AEM2 is replacement

Elastomer compatibility operating conditions and limits

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Oronite

Specifications	VOLKSWAGEN service fill specifications							
VW TL 521 67		X		X		X		X
VW TL 525 53		X		X		X		X
VW TL 521 95	X		X		X		X	
VW TL 525 77	X		X		X		X	
Elastomer material	RE-AK6/1 ⁽¹⁾		RE-ACM1 ⁽²⁾		RE-AEM2 ⁽³⁾		RE-AEM1 ⁽⁴⁾	
Operating conditions	PV 3344, PV 3323, DIN 53504 S3A Yes 1 : 80 150							
Procedure								
Test piece								
Pre aging								
Ratio specimen: oil ratio								
Temperature, °C								
Duration, h.	168	282 (3 x 94)	500	168	500	168	500	168
Variations after test in:								
Tensile strength, N/mm², min.	7	8	-	-	-	-	-	-
Tensile strength change at break, % max.	60	50	40	30	40	35	40	30
Elongation at break, %, min.	160	160	-	-	-	-	-	-
Elongation at break change, %, max.	50	50	40	30	40	40	40	30
Hardness change, points.	-	-	-4/+10	-5/+6	-4/+10	-10/+10	-4/+10	-8/+8
Weight change, %	-	-	-2/+6	-2/+4	-3/+10	-3/+15	-3/+10	-3/+15
Cracks	None	None	-	-	-	-	-	-

Notes:

(1) Old name: FPM AK6

(2) Old name: ACM

(3) Old name: Vamac

(4) RE-AEM1 scheduled to disappear, AEM2 is replacement

Elastomer compatibility operating conditions and limits

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Oronite

Specifications	FORD WSS-M2C948-B	
Elastomer material	RE1, RE2-99, RE3-04, RE4, DBL-AEM	Ford HNBR (Hydrogenated nitrile)
Operating conditions		CEC L-039-96
Test piece	According ACEA Sequences	S 2
Duration, h.		168
Pre-aging of the oil		No
Oil weight, g		270
Temperature, °C		150
Variations after test in:		
Hardness change, points.	According ACEA Sequences	-5/+6
Tensile strength change, %		-30/+20
Elongation at break change, %		-35
Volume change, %		-5/+5

REQUIREMENTS for APPROVALS and PERFORMANCE RECOGNITION



APPROVALS and PERFORMANCE RECOGNITION

- 1 -



Oronite

Specifications		OIL COMPANY actions				OEM actions			FEES						
		Official letter	Forms	Sample	IR	Official letter	Validity period	Qualified prod. list	Original	Reblend	Rebrand	Formulation change	Annual field sample	Annual renewal fee	Small changes, documentation fees
API licensing		No	Yes	No	No	Yes	1 year	Yes ⁽²⁾	⁽³⁾	⁽³⁾	⁽³⁾	No			
ACEA		No	Yes	No	No	No	⁽¹⁾	No	No	0	0	0	0	0	0
BMW		Yes	Yes	Yes	No	Yes	2 years	Yes	108 000 €	2 000 €	1 000 €	3 000 €	No	No	No
Cummins CES 20072, 20074, 20075, 20076, 20077, 20078, 20081		No	Yes ⁽⁴⁾	Yes	No	Yes	⁽¹⁾	Cummins internal	1,050 US \$	1,050 US \$	1,050 US \$	1,050 US \$	No	No	100-200 US \$
Detroit Diesel 93K214, 93K215, 93K216, 93K218		No	Yes ⁽⁴⁾	Yes	No	Yes	1 year	DDC website	1,050 US \$	1,050 US \$	1,050 US \$	1,050 US \$	No	Yes ⁽⁵⁾	100-200 US \$
JASO DH-1, DH-2, DL-1		Yes	Yes	No	Yes	Yes	1 year ⁽⁷⁾	Yes	40 000 ¥	40 000 ¥	40 000 ¥	No, without change of product name	No	Yes ⁽⁷⁾	No
Mack EO-M Plus		No	Yes ⁽⁴⁾	Yes	No	Yes	⁽¹⁾	Mack website	1,080 US \$	1,080 US \$	1,080 US \$	1,080 US \$	No	No	100-200 US \$
Mack EO-N Premium Plus 2003		No	Yes ⁽⁴⁾	Yes	No	Yes	⁽¹⁴⁾	Mack website	1,080 US \$	1,080 US \$	1,080 US \$	1,080 US \$	Yes ⁽⁶⁾	No	100-200 US \$
Volvo VDS-4 / Mack EO-O Premium Plus		No	Yes ⁽⁴⁾	Yes	No	Yes	2 years	Mack website	1,080 US \$	1,080 US \$	1,080 US \$	1,080 US \$	Yes ⁽⁶⁾	No	100-200 US \$
MAN 270, MAN 271		Yes	Yes	2l	No	Yes	2 years	Yes	2 500 €	2 500 €	900 €	2 450 €			
MAN M3275-1, M3275-2, MAN M3277, MAN M3477, M3575		Yes	Yes	2l	No	Yes	2 years	Yes	6 650 €	2 500 €	900 €	6 650 €			
MB 227.0/1		No	No	No	No	No	-	-	-	-	-	-			
Mercedes-Benz		Yes	Yes ⁽⁶⁾	Yes	No	Yes	5 years max. ⁽⁹⁾	Yes	2 000 €	2 000 €	2 000 €	1 000 €			
MTU	Single grade	Yes	Yes ⁽¹³⁾	Yes ⁽¹³⁾	Yes ⁽¹³⁾	Yes	2 years max.	Yes	1 250 €	1 000 €	1 000 €	625			
	Multi-grade								1 750 €	1 250 €	1 250 €				
Dexos		No	Yes	Yes	No	No	*	Yes	1,000 US \$	3,150 US \$	3,150 US \$	1,000 US \$	Yes	Yes**	

Notes:

* First generation dexos1TM licenses will expire on August 31, 2016. Second generation dexos1TM formulations will be accepted for review at the March 2015 dexos Approval Committee Meeting. dexos2TM to be determined.

** A blender is charged 3,150 US \$ for the initial qualification fee, and each formulation that a blender has registered is also charged a License Release Fee of 1,000 US \$ per calendar year.

APPROVALS and PERFORMANCE RECOGNITION

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Oronite

Specifications	OIL COMPANY actions				OEM actions			FEES						
	Official letter	Forms	Sample	IR	Official letter	Validity period	Qualified prod. list	Original	Reblend	Rebrand	Formulation change	Annual field sample	Annual renewal fee	Small changes, documentation fees
Opel B 040 2095, B 040 2098	Yes	Yes	Yes	Yes	Yes	2 years	Yes	2 500 €	2 500 €	2 500 €	2 500 €			
Porsche	Yes	Yes	No	Yes	Yes	3 years	Yes	89 900 €	2 900 €	2 900 €	2 900 €	No	No	No
PSA	No	Yes	Yes	Yes	Yes	1 year	Yes	20 000€	20 000€	20 000€	20 000€	No	Yes	No
Renault	No	Yes	Yes	No	Yes	5 years	Yes	5 800€	5 800€	5 800€	5 800€	No	No	Yes
Renault trucks	Yes	Yes	No	No	Yes	⁽¹⁾	No	No	No	No	No			
Volvo VDS, VDS-2	Yes	No	No	No	Yes ⁽¹⁰⁾	⁽¹⁾	No	No	No	No	No			
Volvo VDS-3, VDS-4	Yes	Yes	No	No	Yes ⁽¹⁰⁾	⁽¹⁾	No	No	No	No	No			
VW 500 00⁽¹¹⁾, VW 501 01⁽¹¹⁾, VW 502 00, VW 503 00, VW 503 01, VW 505 00, VW 506 00, VW 506 01	Yes	Yes	No	Yes	Yes	3 years	No ⁽¹²⁾	0 €	3 000€	1 340€	3 000€	No	No	No

Notes:

(1) Valid until specification change or modification in lubricant formulation

(2) API publication 1520

(3) Fees are calculated according to a yearly volume of production of lubricants to be licensed: minimum is US \$ 1250 for API members and US \$ 1500 for non-members. In addition, an annual fee of US \$ 0.0020 per gallon of licensed motor oil after the 1st million gallons of product is assessed.

(4) Forms submitted to test engineering Inc. of San Antonio, Texas

(5) Annual renewal fee is US \$ 500/product

(6) Mack field sample US \$ 1000 each

(7) To maintain on-file registration, it is required to pay an on-file maintenance fee: minimum charge is 30 000 ¥ per year up to 1 000 kl of sales of each registered oil. For sales quantity of 1 000 kl or more, fees are calculated in increments of 30 ¥ per kl.

(8) Electronic application via DC BEAM system

(9) Validity as long as original approval. Yearly renewal required.

(10) VOLVO sends a recognition letter

(11) VW 500 00 and VW 501 01: rebrand, reblend and renewal are possible but no new approval

(12) VAG France publishes a list

(13) Application must include appendix F and IR run in a approved laboratory which will send a 100 ml sample to MTU upon applicant request

(14) Valid as long as the company participates in the annual field sample program and the chemical analysis comparisons are within acceptable limits

OEM REQUIREMENTS for NATURAL GAS ENGINE OILS



Requirements for gas engine oils for busses and trucks



Oronite

Specifications	Cummins CES 2007 ⁽¹⁾	Daimler MB 226.9	Detroit Diesel 93K216	Iveco	MAN M3271-1/-3	Renault trucks RGD	Volvo spark ignited
Viscosity grades (SAE J300)	15W-40	Acc. ACEA	15W-40	Acc. ACEA	30, 40, 5W-x, 10W-x, 15W-x / 5W-x, 10W-x	Acc. ACEA	xW-30, xW-40
ACEA / API performance level	-	-	-	ACEA E6 (+2 TBN) or ACEA B5 (light-duty only)	- / ACEA E6	ACEA E6 + VDS-3 level (excluding engine tests)	ACEA E6 + VDS-3
Laboratory tests							
HTHS viscosity , CEC L-36-90, ASTM D4683, mPa.s, min.	-	3.5	4.2	Acc. ACEA	3.5	3.5	Report
Shear stability , CEC L-14-93, ASTM D6278, D7109	-	Stay in grade ⁽²⁾	12.5	Stay in grade	xW-30: 9; xW-40: 12	Stay in grade	xW-30: 9.3; xW-40: 12.5
Viscosity at 100°C after 90 cycles shear (ASTM D445), mm ² /s, min.	-	-	3.9	-	-	xW-30: 3.4; xW-40: 3.7	xW-30: 3.4; xW-40: 3.7
HT/HS viscosity after 90 cycles shear (ASTM D4683), mPa.s, min.	-	-	-	-	-	-	-
Evaporative loss , Noack, ASTM D5800, % loss, max.	-	13	15	13	13	13	13
Sulfated ash , ASTM D874, % m/m, max.	0.5	1.0	0.8	Acc. ACEA	1.0	1.0	1.0
Zinc , ASTM D5185, % m/m, min.	0.06-0.085	Report	-	-	≥ 0.08/Report	-	-
Phosphorus , ASTM D5185, % m/m	0.06-0.08	Report	-	Acc. ACEA	≤ 0.08	Report	0.12
Calcium , ASTM D5185, %, max.	0.12	-	-	-	Report	-	-
TBN , ASTM D2896, D4739, mg KOH/g, min.	5	-	-	HD: 9, LD: 8	6	6	Acc. VDS-3, VDS-4
TAN , ASTM D664, mg KOH/g	0.5-1.5	-	-	-	-	-	-
Pour point , ASTM D97, °C, max.	-	-27	-25	-	5W-x: -40, 40: -15	-	Report
Foaming tendency , ASTM D892 (no option A) Sequence I, II, III, ml, max.	-	10/0, 50/0, 10/0	10/0, 20/0, 10/0	10/0, 50/0, 10/0	10/0, 50/0, 10/0	10/0, 50/0, 10/0	10/0, 20/0, 10/0
High temperature foaming tendency , ASTM D6082, ml, max.	-	Rate & Report	100/0	Acc. ACEA	-	200/50	Acc. VDS-3, VDS-4
Corrosion tendency , CBT, HTCBT, ASTM D5968, D6594							
Copper increase, ppm, max.	20	-	20	-	-	-	20
Lead increase, ppm, max.	120	-	120	-	-	-	120
Tin increase, ppm, max.	50	-	50	-	-	-	-
Copper strip rating (ASTM D130), max.	3	-	3	-	-	-	3
Thin Film Oxygen Uptake Test (TFOUT) , ASTM D4742, min., min.	-	-	X-(0.22(X+5)) ⁽³⁾	-	-	-	-
Engine tests							
Dynamometer tests	CES 14274	500 h CNG engine test or read-across from MAN M3271 ⁽⁴⁾	1000 h standard lab. test in a DDC Series 50G Model MK engine	Acc. ACEA	-/Acc. ACEA	-	Acc. ACEA E6 + VDS-3
Field tests	3 engine types for 1 year	MB CNG busses ⁽⁴⁾	6 engines for 1 year or 60,000 mls	-	Field test by EMRA department	-	-

Notes:
 (1) CJ-4 oils is recommended for CNG, LNG/diesel dual fuel engines
 (2) After 30 cycles
 (3) Where X = Engine Tested Oil TFOUT
 (4) Passing result required in engine test or field test

UNIT CONVERSION



Unit conversion tables

Temperature conversion



Oronite

To °F	From °T	To °C	To °F	From °T	To °C	To °F	From °T	To °C	To °F	From °T	To °C	To °F	From °T	To °C
-144.4	-98	-72.22	96.8	36	2.22	249.8	121	49.44	402.8	206	96.67	683.6	362	183.33
-140.8	-96	-71.11	98.6	37	2.78	251.6	122	50.00	404.6	207	97.22	687.2	364	184.44
-137.2	-94	-70.00	100.4	38	3.33	253.4	123	50.56	406.4	208	97.78	690.8	366	185.56
-133.6	-92	-68.89	102.2	39	3.89	255.2	124	51.11	408.2	209	98.33	694.4	368	186.67
-130.0	-90	-67.78	104.0	40	4.44	257.0	125	51.57	410.0	210	98.89	698.0	370	187.78
-126.4	-88	-66.67	105.8	41	5.00	258.8	126	52.22	411.8	211	99.44	701.6	372	188.89
-122.8	-86	-65.56	107.6	42	5.56	260.6	127	52.78	413.6	212	100.00	705.2	374	190.00
-119.2	-84	-64.44	109.4	43	6.11	262.4	128	53.33	415.4	213	100.56	708.8	376	191.11
-115.6	-82	-63.33	111.2	44	6.67	264.2	129	53.89	417.2	214	101.11	712.4	378	192.22
-112.0	-80	-62.22	113.0	45	7.22	266.0	130	54.44	419.0	215	101.67	716.0	380	193.33
-108.4	-78	-61.11	114.8	46	7.78	267.8	131	55.00	420.8	216	102.22	719.6	382	194.44
-104.8	-76	-60.00	116.6	47	8.33	269.6	132	55.56	422.6	217	102.78	723.2	384	195.56
-101.2	-74	-58.89	118.4	48	8.89	271.4	133	56.11	424.4	218	103.33	726.8	386	196.67
-97.6	-72	-57.78	120.2	49	9.44	273.2	134	56.67	426.2	219	103.89	730.4	388	197.78
-94.0	-70	-56.67	122.0	50	10.00	275.0	135	57.22	428.0	220	104.44	734.0	390	198.89
-90.4	-68	-55.56	123.8	51	10.56	276.8	136	57.78	431.6	222	105.56	737.6	392	200.00
-86.8	-66	-54.44	125.6	52	11.11	278.6	137	58.33	435.2	224	106.67	741.2	394	201.11
-83.2	-64	-53.33	127.4	53	11.67	280.4	138	58.89	438.8	226	107.78	744.8	396	202.22
-79.6	-62	-52.22	129.2	54	12.22	282.2	139	59.44	442.4	228	108.89	748.4	398	203.33
-76.0	-60	-51.11	131.0	55	12.78	284.0	140	60.00	446.0	230	110.00	752.0	400	204.44
-72.4	-58	-50.00	132.8	56	13.33	285.8	141	60.56	449.6	232	111.11	755.6	402	205.56
-68.8	-56	-48.89	134.6	57	13.89	287.6	142	61.11	453.2	234	112.22	759.2	404	206.67
-65.2	-54	-47.78	136.4	58	14.44	289.4	143	61.67	456.8	236	113.33	762.8	406	207.78
-61.6	-52	-46.67	138.2	59	15.00	291.2	144	62.22	460.4	238	114.44	766.4	408	208.89
-58.0	-50	-45.56	140.0	60	15.56	293.0	145	62.78	464.0	240	115.56	770.0	410	210.00
-54.4	-48	-44.44	141.8	61	16.11	294.8	146	63.33	467.6	242	116.67	773.6	412	211.11
-50.8	-46	-43.33	143.6	62	16.67	296.6	147	63.89	471.2	244	117.78	777.2	414	212.22
-47.2	-44	-42.22	145.4	63	17.22	298.4	148	64.44	474.8	246	118.89	780.8	416	213.33
-43.6	-42	-41.11	147.2	64	17.78	300.2	149	65.00	478.4	248	120.00	784.4	418	214.44
-40.0	-40	-40.00	149.0	65	18.33	302.0	150	65.56	482.0	250	121.11	788.0	420	215.56
-36.4	-38	-38.89	150.8	66	18.89	303.8	151	66.11	485.6	252	122.22	791.6	422	216.67
-32.8	-36	-37.78	152.6	67	19.44	305.6	152	66.67	489.2	254	123.33	795.2	424	217.78
-29.2	-34	-36.67	154.4	68	20.00	307.4	153	67.22	492.8	256	124.44	798.8	426	218.89
-25.6	-32	-35.56	156.2	69	20.56	309.2	154	67.78	496.4	258	125.56	802.4	428	220.00
-22.0	-30	-34.44	158.0	70	21.11	311.0	155	68.33	500.0	260	126.67	806.0	430	221.11
-18.4	-28	-33.33	159.8	71	21.67	312.8	156	68.89	503.6	262	127.78	809.6	432	222.22
-14.8	-26	-32.22	161.6	72	22.22	314.6	157	69.44	507.2	264	128.89	813.2	434	223.33
-11.2	-24	-31.11	163.4	73	22.78	316.4	158	70.00	510.8	266	130.00	816.8	436	224.44
-7.6	-22	-30.00	165.2	74	23.33	318.2	159	70.56	514.4	268	131.11	820.4	438	225.56
-4.0	-20	-28.89	167.0	75	23.89	320.0	160	71.11	518.0	270	132.22	824.0	440	226.67

Unit conversion tables

Temperature conversion



Oronite

To °F	From °T	To °C	To °F	From °T	To °C	To °F	From °T	To °C	To °F	From °T	To °C	To °F	From °T	To °C
-0.4	-18	-27.78	168.8	76	24.44	321.8	161	71.67	521.6	272	133.33	827.6	442	227.78
3.2	-16	-26.67	170.6	77	25.00	323.6	162	72.22	525.2	274	134.44	831.2	444	228.89
6.8	-14	-25.56	172.4	78	25.56	325.4	163	72.78	528.8	276	135.56	834.8	446	230.00
10.4	-12	-24.44	174.2	79	26.11	327.2	164	73.33	532.4	278	136.67	838.4	448	231.11
14.0	-10	-23.33	176.0	80	26.67	329.0	165	73.89	536.0	280	137.78	842.0	450	232.22
17.6	-8	-22.22	177.8	81	27.22	330.8	166	74.44	539.6	282	138.89	845.6	452	233.33
21.2	-6	-21.11	179.6	82	27.78	332.6	167	75.00	543.2	284	140.00	849.2	454	234.44
24.8	-4	-20.00	181.4	83	28.33	334.4	168	75.56	546.8	286	141.11	852.8	456	235.56
28.4	-2	-18.89	183.2	84	28.89	336.2	169	76.11	550.4	288	142.22	856.4	458	236.67
32.0	0	-17.78	185	85	29.44	338.0	170	76.67	554.0	290	143.33	860.0	460	237.78
33.8	1	-17.22	186.8	86	30.00	339.8	171	77.22	557.6	292	144.44	863.6	462	238.89
35.6	2	-16.67	188.6	87	30.56	341.6	172	77.78	561.2	294	145.56	867.2	464	240.00
37.4	3	-16.11	190.4	88	31.11	343.4	173	78.33	564.8	296	146.67	870.8	466	241.11
39.2	4	-15.56	192.2	89	31.67	345.2	174	78.89	568.4	298	147.78	874.4	468	242.22
41.0	5	-15.00	194.0	90	32.22	347.0	175	79.44	572.0	300	148.89	878.0	470	243.33
42.8	6	-14.44	195.8	91	32.78	348.8	176	80.00	575.6	302	150.00	881.6	472	244.44
44.6	7	-13.89	197.6	92	33.33	350.6	177	80.56	579.2	304	151.11	885.2	474	245.56
46.4	8	-13.33	199.4	93	33.89	352.4	178	81.11	582.8	306	152.22	888.8	476	246.67
48.2	9	-12.78	201.2	94	34.44	354.2	179	81.67	586.4	308	153.33	892.4	478	247.78
50.0	10	-12.22	203.0	95	35.00	356.0	180	82.22	590.0	310	154.44	896.0	480	248.89
51.8	11	-11.67	204.8	96	35.56	357.8	181	82.78	593.6	312	155.56	899.6	482	250.00
53.6	12	-11.11	206.6	97	36.11	359.6	182	83.33	597.2	314	156.67	903.2	484	251.11
56.4	13	-10.58	208.4	98	36.67	361.4	183	83.89	600.8	316	157.78	906.8	486	252.22
57.2	14	-10.00	210.2	99	37.22	363.2	184	84.44	604.4	318	158.89	910.4	488	253.33
59.0	15	-9.44	212.0	100	37.78	365.0	185	85.00	608.0	320	160.00	914.0	490	254.44
60.8	16	-8.89	213.8	101	38.33	366.8	186	85.56	611.6	322	161.11	917.6	492	255.56
62.6	17	-8.33	215.6	102	38.89	368.6	187	86.11	615.2	324	162.22	921.2	494	256.67
64.4	18	-7.78	217.4	103	39.44	370.4	188	86.67	618.8	326	163.33	924.8	496	257.78
66.2	19	-7.22	219.2	104	40.00	372.2	189	87.22	622.4	328	164.44	928.4	498	258.89
68.0	20	-6.67	221.0	105	40.56	374.0	190	87.78	626.0	330	165.56	932.0	500	260.00

Unit conversion tables

Temperature conversion



Oronite

To °F	From °T	To °C	To °F	From °T	To °C	To °F	From °T	To °C	To °F	From °T	To °C	To °F	From °T	To °C
69.8	21	-6.11	222.8	106	41.11	375.8	191	88.33	629.6	332	166.67	Interpolation 1.8 1 0.56 °T Figures are readings in either °F or °C Equivalent to 273.15 K (kelvin)		
71.6	22	-5.56	224.6	107	41.67	377.6	192	88.89	633.2	334	167.78			
73.4	23	-5.00	226.4	108	42.22	379.4	193	89.44	636.8	336	168.89			
75.2	24	-4.44	228.2	109	42.78	381.2	194	90.00	640.4	338	170.00			
77.0	25	-3.89	230.0	110	43.33	383.0	195	90.56	644.0	340	171.11			
78.8	26	-3.33	231.8	111	43.89	384.8	196	91.11	647.6	342	172.22			
80.6	27	-2.78	233.6	112	44.44	386.3	197	91.67	651.2	344	173.33			
82.4	28	-2.22	235.4	113	45.00	388.4	198	92.22	654.8	346	174.44			
84.2	29	-1.67	237.2	114	45.56	390.2	199	92.78	658.4	348	175.56			
86.0	30	-1.11	239.0	115	46.11	392.0	200	93.33	662.0	350	176.67			
87.8	31	-0.50	240.8	116	46.67	393.8	201	93.89	665.6	352	177.78			
89.6	32	0.00*	242.6	117	47.22	395.6	202	94.44	669.2	354	178.89			
91.4	33	0.56	244.4	118	47.78	397.4	203	95.00	672.8	356	180.00			
93.2	34	1.11	246.2	119	48.33	399.2	204	95.56	676.4	358	181.11			
95.0	35	1.67	248.0	120	48.89	401.0	205	96.11	680.0	360	182.22			

Unit conversion tables

Measurement conversion from US to SI units - 1 -



Oronite

Customary Unit	x Factor =	SI Unit	Customary Unit	x Factor =	SI Unit
Area		square meter, m²	Flow		meter³ or kilogram
square foot, ft ²	9.2903	square decimeter, dm ²			second, m ³ or kg/s
square inch, in ²	6.4516	square centimeter, cm ²	foot ³ /minute, ft ³ /min	0.47195	decimeter ³ /second, dm ³ /s
square US statute mile, mi ²	2.59	square kilometer, km ²	Imp gallon/hour, gal/h	1.2628	centimeter ³ /second, cm ³ /s
			US gallon/hour, gal/h	1.0515	centimeter ³ /second, cm ³ /s
square yard, yd ²	0.83613	square meter, m ²	pound-mass/minute, lbm/min	7.5599	gram/second, g/s
Density		kilogram/meter³, kg/m³	short ton/hour, st/h	0.252	kilogram/second, kg/s
gram/centimeter ³ , g/cm ³	1000	kilogram/meter ³ , kg/m ³			
ounce-mass/inch ³ ozm/in ³	1.73	megagram/meter ³ , Mg/m ³	Force		newton, N (kg•m/s²)
pound-mass/foot ³ , lbm/ft ³	16.018	kilogram/meter ³ , kg/m ³	dyne	10	micronewton, μN
pound-mass/Imp gallon, lbm/gal	99.776	kilogram/meter ³ , kg/m ³	kilogram-force, kgf	9.80665	newton, N
pound-mass/US gallon, lbm/gal	119.83	kilogram/meter ³ , kg/m ³	avdp pound-force, lbf	4.44822	newton, N
long ton/yard ³ , lHyd ³	1.3289	megagram/meter ³ , Mg/mv	poundal, pdl	0.13826	newton, N
Energy or Work		joule, J (N•m, kg•m /s²)	Length		meter, m
British thermal unit, Btu (Int. Table)	1.05506	kilojoule, kJ	angstrom, Å	100	picometer, pm
calorie, cal (Int. Table)	4.1868	joule, J	foot, ft	0.3048	meter, m
foot-pound-force, ft•lbf	1.35582	joule, J	inch, in	25.4	millimeter, mm
horsepower-hour, hp•h	2.6856	megajoule, MJ	micron, μ	1	micrometer, μm
meter kilogram-force, m•kgf	9.80665	joule, J	Int, nautical mile, naut mi (6076.1 ft)	1.852	kilometer, km
watt-hour, W•h	3.6	kilojoule, kJ	US statute mile, mi (5280 ft)	1.6093	kilometer, km
			yard, yd	0.9144	meter, m

Unit conversion tables

Measurement conversion from US to SI units - 2 -



Oronite

Customary Unit	x Factor =	SI Unit	Customary Unit	x Factor =	SI Unit
Mass		kilogram, kg	Viscosity dynamic		pascal-second, Pa.s
avdp ounce-mass, ozm	28.3495	gram, g	kinematic		meter²/second, m²/s
avdp pound-mass, lbm	0.45359	kilogram, kg	centipoises, cP	1.0	millipascal-second, mPa•s
long ton, lt (2240 lbm)	1.01605	megagram, Mg	centistokes, cSt	1.0	millimeter ² /second, mm ² /s
metric ton (tonne), mt (2204.6 lbm)	1000.0	kilogram, kg			
short ton, st (2000 lbm)	907.18	kilogram, kg	Volume		cubic meter, m³
			barrel (oil), bbl (42 US gal, 35 Imp gal)	0.15899	cubic meter, m ³
Power		watt, W (J/s, kg.m²/s)	cubic foot, ft ³ (1728 in ³)	28.317	cubic decimeter, dm ³
Btu (Int. Table)/hour, Btu/h	0.29307	watt, W	Imp gallon, gal (160 Imp oz, 0.16054 ft ³)	4.5461	liter, l
kilo calorie(Int. Table)/hour, kcal/h	1.1639	watt, W	US gallon, gal (128 US oz, 0.13368 ft ³)	3.7854	liter, l
foot-pound-force/second, ft•lbf/s	1.35582	watt, W	cubic inch, in ³	16.387	cubic centimeter, cm ³
horsepower, hp (550ft•lbf/s)	745.70	watt, W	liter, L	1.0	cubic decimeter, dm ³
metric horsepower, mhp, PS or CV	735.50	watt, W	US fluid ounce, fl oz	29.574	cubic centimeter, cm ³
			US liquid pint, liq pt (16 fl oz)	0.47318	liter, l
Pressure or Stress		pascal, Pa (N/m², kg/m.s²)	US liquid quart, liq qt (32 fl oz)	0.94635	liter, l
normal atmosphere, atm (760 torr)	101.325	kilopascal, kPa	cubic yard, yd ³	0.76455	cubic meter, m ³
bar, b	100.0	kilopascal, kPa			
dyne/centimeter ² , dyne/cm ²	0.1	pascal, Pa			
inch of water @ 39.2°F (4°C)	249.08	pascal, Pa			
kilogram-force/centimeter ² , kgf/cm ²	98.0665	kilopascal, kPa			
millimeter of Hg @ 0°C (32°F), torr	133.322	pascal, Pa			
pound-force/inch ² , psi	6.89476	kilopascal, kPa			
long ton/inch ² , lt/in ²	15.4443	megapascal, MPa			

Unit conversion tables



Oronite

Decimal inches to millimeters

in	mm	in	mm	in	mm
.01	.254	.36	9.144	.71	18.034
.02	.508	.37	9.398	.72	18.288
.03	.762	.38	9.652	.73	18.542
.04	1.016	.39	9.906	.74	18.796
.05	1.270	.40	10.160	.75	19.050
.06	1.524	.41	10.414	.76	19.304
.07	1.778	.42	10.668	.77	19.558
.08	2.032	.43	10.922	.78	19.812
.09	2.286	.44	11.176	.79	20.066
.10	2.540	.45	11.430	.80	20.320
.11	2.794	.46	11.684	.81	20.574
.12	3.048	.47	11.938	.82	20.828
.13	3.302	.48	12.192	.83	21.082
.14	3.556	.49	12.446	.84	21.336
.15	3.810	.50	12.700	.85	21.590
.16	4.064	.51	12.954	.86	21.844
.17	4.318	.52	13.208	.87	22.098
.18	4.572	.53	13.462	.88	22.352
.19	4.826	.54	13.716	.89	22.606
.20	5.080	.55	13.970	.90	22.860
.21	5.334	.56	14.224	.91	23.114
.22	5.588	.57	14.478	.92	23.368
.23	5.842	.58	14.732	.93	23.622
.24	6.096	.59	14.986	.94	23.876
.25	6.350	.60	15.240	.95	24.130
.26	6.604	.61	15.494	.96	24.384
.27	6.858	.62	15.748	.97	24.638
.28	7.112	.63	16.002	.98	24.892
.29	7.366	.64	16.256	.99	25.146
.30	7.620	.65	16.510	1.00	25.400
.31	7.874	.66	16.764		
.32	8.128	.67	17.018		
.33	8.382	.68	17.272		
.34	8.638	.69	17.526		
.35	8.890	.70	17.780		

Millimeters to inches

in	mm	in	mm	in	mm
1	0.0394	36	1.4173	71	2.7953
2	0.0787	37	1.4567	72	2.8346
3	0.1181	38	1.4961	73	2.8740
4	0.1575	39	1.5354	74	2.9134
5	0.1968	40	1.5748	75	2.9528
6	0.2362	41	1.6142	76	2.9921
7	0.2756	42	1.6535	77	3.0315
8	0.3150	43	1.6929	78	3.0709
9	0.3543	44	1.7323	79	3.1102
10	0.3937	45	1.7716	80	3.1496
11	0.4331	46	1.8110	81	3.1890
12	0.4724	47	1.8504	82	3.2283
13	0.5118	48	1.8898	83	3.2677
14	0.5512	49	1.9291	84	3.3071
15	0.5906	50	1.9685	85	3.3465
16	0.6299	51	2.0079	86	3.3858
17	0.6693	52	2.0472	87	3.4252
18	0.7087	53	2.0866	88	3.4646
19	0.7480	54	2.1260	89	3.5039
20	0.7874	55	2.1654	90	3.5433
21	0.8268	56	2.2047	91	3.5827
22	0.8661	57	2.2441	92	3.6220
23	0.9055	58	2.2835	93	3.6614
24	0.9449	59	2.3228	94	3.7008
25	0.9842	60	2.3622	95	3.7402
26	1.0236	61	2.4016	96	3.7795
27	1.0630	62	2.4409	97	3.8189
28	1.1024	63	2.4803	98	3.8583
29	1.1417	64	2.5197	99	3.8976
30	1.1811	65	2.5591	100	3.9370
31	1.2205	66	2.5984		
32	1.2596	67	2.6378		
33	1.2992	68	2.6772		
34	1.3386	69	2.7165		
35	1.3780	70	2.7559		

Unit conversion tables



Oronite

Decimal inches to millimeters

in	mm	in	mm	in	mm
.01	.254	.36	9.144	.71	18.034
.02	.508	.37	9.398	.72	18.288
.03	.762	.38	9.652	.73	18.542
.04	1.016	.39	9.906	.74	18.796
.05	1.270	.40	10.160	.75	19.050
.06	1.524	.41	10.414	.76	19.304
.07	1.778	.42	10.668	.77	19.558
.08	2.032	.43	10.922	.78	19.812
.09	2.286	.44	11.176	.79	20.066
.10	2.540	.45	11.430	.80	20.320
.11	2.794	.46	11.684	.81	20.574
.12	3.048	.47	11.938	.82	20.828
.13	3.302	.48	12.192	.83	21.082
.14	3.556	.49	12.446	.84	21.336
.15	3.810	.50	12.700	.85	21.590
.16	4.064	.51	12.954	.86	21.844
.17	4.318	.52	13.208	.87	22.098
.18	4.572	.53	13.462	.88	22.352
.19	4.826	.54	13.716	.89	22.606
.20	5.080	.55	13.970	.90	22.860
.21	5.334	.56	14.224	.91	23.114
.22	5.588	.57	14.478	.92	23.368
.23	5.842	.58	14.732	.93	23.622
.24	6.096	.59	14.986	.94	23.876
.25	6.350	.60	15.240	.95	24.130
.26	6.604	.61	15.494	.96	24.384
.27	6.858	.62	15.748	.97	24.638
.28	7.112	.63	16.002	.98	24.892
.29	7.366	.64	16.256	.99	25.146
.30	7.620	.65	16.510	1.00	25.400
.31	7.874	.66	16.764		
.32	8.128	.67	17.018		
.33	8.382	.68	17.272		
.34	8.638	.69	17.526		
.35	8.890	.70	17.780		

Millimeters to inches

mm	in	mm	in	mm	in
1	0.0394	36	1.4173	71	2.7953
2	0.0787	37	1.4567	72	2.8346
3	0.1181	38	1.4961	73	2.8740
4	0.1575	39	1.5354	74	2.9134
5	0.1968	40	1.5748	75	2.9528
6	0.2362	41	1.6142	76	2.9921
7	0.2756	42	1.6535	77	3.0315
8	0.3150	43	1.6929	78	3.0709
9	0.3543	44	1.7323	79	3.1102
10	0.3937	45	1.7716	80	3.1496
11	0.4331	46	1.8110	81	3.1890
12	0.4724	47	1.8504	82	3.2283
13	0.5118	48	1.8898	83	3.2677
14	0.5512	49	1.9291	84	3.3071
15	0.5906	50	1.9685	85	3.3465
16	0.6299	51	2.0079	86	3.3858
17	0.6693	52	2.0472	87	3.4252
18	0.7087	53	2.0866	88	3.4646
19	0.7480	54	2.1260	89	3.5039
20	0.7874	55	2.1654	90	3.5433
21	0.8268	56	2.2047	91	3.5827
22	0.8661	57	2.2441	92	3.6220
23	0.9055	58	2.2835	93	3.6614
24	0.9449	59	2.3228	94	3.7008
25	0.9842	60	2.3622	95	3.7402
26	1.0236	61	2.4016	96	3.7795
27	1.0630	62	2.4409	97	3.8189
28	1.1024	63	2.4803	98	3.8583
29	1.1417	64	2.5197	99	3.8976
30	1.1811	65	2.5591	100	3.9370
31	1.2205	66	2.5984		
32	1.2596	67	2.6378		
33	1.2992	68	2.6772		
34	1.3386	69	2.7165		
35	1.3780	70	2.7559		

AAM	Alliance of Automobile Manufacturers	FAP	Filtre à Particules, Particulate Filter (= DPF)
ACC	American Chemistry Council	FSI	Fuel Stratified Injection
ACEA	Association des Constructeurs Européens d'Automobiles	GDI	Gasoline Direct Injection
ACM	Acrylic Copolymer Material (Seal - Monomer is Ethylene Acrylate)	GFC	CEC French National Organisation
AFNOR	Association Française de Normalisation		(Groupement Français de Coordination)
API	American Petroleum Institute	GRPE	Group of Reporters on Pollution and Energy
ASTM	American Society for Testing Materials, USA	HC	HydroCarbon
	Technical Committee of Petroleum Additive Manufacturers in Europe	HDI	High pressure Direct Injection (Diesel)
ATC	(Additives Technical Committee)	HEUI	Hydraulically actuated and Electronically controlled Unit Injector
ATIEL	Association Technique de l'Industrie Européenne des Lubrifiants	HPI	High Pressure Injection (Diesel)
BN	Base Number (TBN: Total Base Number)	HTCBT	High Temperature Corrosion Bench Test (Cummins)
BOI	Base Oil Interchangeability	HTHS	High Temperature High Shear (Viscosity)
BTC	CEC British National Organisation (British Technical Committee)	IDI	Indirect Diesel Injection
CCFA	Comité des Constructeurs Français d'Automobiles (France)	ILMA	Independent Lubricant Manufacturer Association (USA)
CEC	Conseil Européen de Coordination	ILSAC	International Lubricant Standardization & Approval Committee
CEN	Comité Européen de Normalisation	IP	Institute of Petroleum, UK
CCMC	Comité des Constructeurs d'Automobiles du Marché Commun	ISO	International Organisation for Standardization
CEFC	Conseil Européen des Fédérations de l'Industrie Chimique	JAMA	Japan Automobile Manufacturers Association, Inc.
CIMAC	Congrès International des Machines à Combustion	JASO	Japan Automobile Standards Organisation
CMA	Chemical Manufacturers Association, USA	JIS	Japan Industry Standard
CONCAWE	Conservation of Clean Air and Water in Europe	JPI	Japan Petroleum Institute
CoP	Code of Practice	JSAE	Society of Automotive Engineers, Japan
CRC	Coordination Research Council, USA	LDF	Long Drain Field test (Scania)
CRT	Continuously Regenerating Trap	LEDL	Low Emission Diesel Lubricant
CUNA	CEC Italian National Organisation	LRI	Lubricant Review Institute, USA
	(Commissione tecnica di Unificazione neel' Autoveicolo)	MTAC	Multiple Test Acceptance Criteria
DHD	Diesel Heavy Duty (Global DHD-1 specification)	MVEG	Motor Vehicle Emission Group
DI	Direct Injection	NBR	Nitrile Butadiene Rubber (seal)
DIN	Deutsches Institut für Normung	OEM	Original Equipment Manufacturers
DKA	CEC German National Organisation	OHC	OverHead Camshaft
	(Deutscher Koordinierung Ausschuss)	OICA	Organisation Internationale des Constructeurs Automobiles (EU)
DPF	Diesel Particulate Filter	OMEM	Other Major Engine Manufacturers
EAM	Ethylene Acrylic copolymer Material (Seal)	PAJ	Petroleum Association of Japan
EAME	Europe Africa Middle-East	PDSC	Pressure Differential Scanning Calorimeter
ECTC	Engine Coolant Technical Committee of CEC	RNT	Radio Nucleide (wear) Test
ECU	Electronic Control Unit (Gasoline + Diesel)	RWFT	Roller Follower Wear Test
EDC	Electronic Diesel Control	SAAC	Statistical Application Advisory Committee of CEC
EELQMS	European Engine Lubricant Quality Management System	SAE	Society of Automobile Engineers, USA
EFTC	Engine Fuel Technical Committee of CEC	SAPS	Sulfated Ash, Phosphorus and Sulfur
EGR	Exhaust Gas Recirculation	TDI	Turbocharged Direct Injection
ELTC	Engine Lubricant Technical Committee of CEC	TLTC	Transmission Lubricant Technical Committee of CEC
EMA	Engine Manufacturers Association, USA	TRWL	Top Ring Weight Loss
EOAT	Engine Oil Aeration Test	VDA	Verband der Automobilindustrie, Germany
EOLCS	Engine Oil Licensing and Certification System	VDS	Volvo Drain Specification
EPA	Environmental Protection Agency	VTW	Valve Train Wear
EUDC	Extra Urban Driving Cycle		
EUROPIA	European Petroleum Industry Association		

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We have an unwavering focus on operational excellence with a commitment to supply quality products safely and reliably, on time, every time.

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-  Regional headquarters
-  Manufacturing and Supply

-  Technology center OEM center testing group
-  OEM center testing group
-  Shareholder interest Manufacturing & Supply



Oronite

WORLDWIDE HEADQUARTERS

Chevron Oronite Company LLC
6001 Bollinger Canyon Road
San Ramon, CA 94583-2324 - USA
Phone: (1) 713 432 2500
Fax: (1) 713 432 3330

REGIONAL HEADQUARTERS

Americas Region
Chevron Oronite Company LLC
4800 Fournace Place
Bellaire, TX 77401-2325 - USA
Phone: (1) 713 432 2500
Fax: (1) 713 432-3330

Asia-Pacific Region
Chevron Oronite Pte. Ltd.
21 Sakra Road
Singapore, 627890 - SINGAPORE
Phone: (65) 6867 6557
Fax: (65) 6263 2505

Europe, Africa, Middle East Region
Chevron Oronite S.A.S. - Registered Office
1, rue Eugène et Armand Peugeot
CS 10022 - 92508 Rueil-Malmaison Cedex - FRANCE
Phone: (33) 1 46 39 36 00
Fax: (33) 1 46 39 37 80
Share capital € 18,407,665
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