Global Performance Specifications
for Light Duty Diesel Engine Oil
(Global DLD-1, DLD-2 and DLD-3)

SCOPE

These specifications have been jointly developed by Association des Constructucteurs Europeens D'Automobilies (ACEA), members of the Alliance of Automobile Manufacturers (Alliance), Engine Manufacturers Association (EMA) and Japan Automobile Manufacturers Association, Inc. (JAMA). They are performance specifications for engine oils to be used in high-speed, four stroke-cycle light-duty diesel engines designed for older vehicles and those designed to meet year 2000 and newer exhaust emission standards worldwide. Oils meeting these specifications are also compatible with certain older engines. Application of these oils is subject to the recommendation of individual engine manufacturers. Individual engine manufacturers have sole discretion as to oil recommendations for their engines. They may choose to recommend oils meeting these performance specifications, or oils meeting these specifications with additional performance requirements, or oils with other performance requirements.

Engine oils meeting the minimum performance requirements of Global DLD-1, DLD-2 and DLD-3 are intended to provide consistent oil performance worldwide and therefore may be recommended as appropriate by individual engine manufacturers to maintain engine durability wherever their engine is being used. These Specifications identify engine oils for use under adverse applications that necessitate wear control, high-temperature stability and soot handling properties. In addition, engine oils meeting the minimum performance requirements of Global DLD-1, DLD-2 and DLD-3 are expected to provide protection against oxidative and insolubles thickening, aeration, and excessive viscosity loss due to shear.

Global DLD-1 is intended to provide a basic level of performance, with particular properties, including corrosion resistance, that make such oils suitable for markets with high sulfur fuels approximating to World Wide Fuel Charter Category 1.

Engine oils meeting the minimum performance requirements of Global DLD-2 are expected to provide a higher level of performance plus a requirement for fuel efficiency, whilst Global DLD-3 provides the highest level of performance. Both of these are suitable for markets with fuels approximating to World Wide Fuel Charter Category 2.

Recommendations of these performance specifications in manufacturer's maintenance guides, owner's manuals, and related documents to describe the engine oils required for their products is voluntary. Oil marketers may voluntarily choose whether to market engine oils that meet these specifications. ACEA, Alliance, EMA and JAMA do not certify or license engine oils, are not responsible for individual oil marketer's claims of compliance with the Global DLD-1, DLD-2 and DLD-3 specifications, and make no representation or warranty concerning the appropriateness or performance of any oil alleged to meet these specifications.

TERMINOLOGY

LIGHT DUTY DIESEL

Engine oils formulated to these specifications are intended for use in cars and light commercial vehicle diesel engines, in accordance with the recommendations of the vehicle manufacturer.

PERFORMANCE LIMITS

The performance limits for these specifications are summarized in Tables 2a and 2b. While ACEA, Alliance members, EMA, and JAMA believe that in order to meet the performance limits of Global DLD-1, DLD-2 and DLD-3 engine oils should undergo a full test program, it is recognized that commercial practice often includes the use of base oil and viscosity modifier interchangeability and viscosity grade readacross guidelines. Therefore the use of interchangeability and readacross guidelines generally applied to the respective engine tests included is acceptable. ACEA, Alliance members, EMA and JAMA recommend that any producer or marketer claiming that an engine oil meets the Global DLD-1, DLD-2 and DLD-3 specifications have adequate performance data to support such claim and make such performance data reasonably available to interested parties upon request.

TEST AVERAGING ACCEPTANCE CRITERIA (TAAC)

Any data based approach for evaluation of the performance of an oil formulation where more than one test is run on an oil formulation, and the results are averaged. If three or more tests are conducted one test may be discarded from the average. All parameters must average to a passing result. TAAC only applies to those performance characteristics that are shown in Tables 2a and 2b with a single limit. Characteristics with more than one limit are based on the number of runs made and reflect the test's precision without further averaging.

CONDITIONS FOR USE OF PERFORMANCE CLAIMS

Any claims of oil performance meeting these sequences must be based on credible data and controlled tests in accredited test laboratories. The quality control and registration systems generally applied to the respective engine tests should also be used. Where limits are shown relative to a reference oil, these must be compared to the last valid Reference Result on that test stand prior to the candidate and using the same hardware.

SIGNIFICANCE AND USE OF THE RECOMMENDED PROPERTIES

For the benefit of end-users and other interested parties, the following section summarizes the critical properties of lubricating oils, and where appropriate, the reason for the selection of a particular quality level of that property.

Corrosiveness

Some oils may inadequately inhibit chemical attack of the metals from which the various engine components are constructed, and is a particular risk for those markets using fuel with high sulfur content, approximating to World Wide Fuel Charter Category 1. The Ball Rust Test BRT evaluates protection of steel and iron components against rust. The

Cummins High Temperature CBT evaluates corrosion of lead, copper and tin at the higher temperatures found in some engines. The ability of an oil to tolerate acidic combustion products can also be predicted by its total base number (TBN). For high fuel sulfur markets, the TBN should exceed 10.

Foaming / Aeration

Excessive oil aeration can cause low oil pressure, resulting in problems such as malfunction of hydraulic valve lifters, and oil with an excessive amount of air does not lubricate engine parts properly, potentially leading to abnormal engine wear. The standard test methods for foaming characteristics of lubricating oils are ASTM D892 and D6082.

Fuel Economy

The friction resulting from the motion of lubricated engine components can be affected by the properties of the engine oil. Engine oil can be designed to reduce fuel consumption, and this is measured using the Mercedes M111E fuel economy engine test.

Oxidation Control

The moving parts of an engine are designed to operate on a lubricating film. The thickness of this film determines the load carrying ability of the engine components. Therefore, to properly perform, the oil must maintain a consistent viscosity not only when new but also during service. Several factors impact an oil's ability to maintain a consistent viscosity. Soot and oxidation typically cause viscosity to increase while fuel contamination and shear typically cause viscosity to decrease. Oxidation may be inhibited with the proper oil formulation. Oxidation control is measured with the Peugeot TU5JP-L4 engine test.

Ring sticking and Piston Cleanliness

Experience has shown buildup of deposits to cause improper piston and ring operation that can lead to high oil consumption and cylinder scuffing. This condition generally determines the life to overhaul for most diesel engines and may have an effect on emission levels. Two engine tests have been identified to measure this performance requirement. The VW IDI Intercooler test is used for evaluating piston deposit control in IDI engines, while the VW TDI test is used for higher performance DI engines

Shear Stability

Engine oils that contain polymers typically undergo viscosity loss when subjected to high shear conditions. High shear regimes in an engine exist in piston ring and cylinder wall interface, valve train, and other areas of high relative parts velocity, high loading, and/or high temperature. Shear stability is measured by ASTM D6278, which accommodates the European CEC L-14-A-93 technique. Shearing which results in a permanent viscosity loss is evaluated in this test by passing fresh oil through a high shear fixture, followed by measuring kinematic viscosity (ASTM D445). Engine oil producing a test result below the prescribed limit may not maintain sufficient oil film thickness in heavily loaded areas of the engine.

Soot Control and Dispersion

High levels of soot in the engine oil can cause sludge formation, wear, deposits and filter plugging. Soot accumulates in the engine oil of a diesel engine as a result of engine timing and combustion. Although the engine oil does not typically impact the formation of soot, a properly formulated engine oil can reduce the effects of soot on engine durability. The Peugeot XUD11BTE engine test is used to measure this performance requirement.

Volatility

This characteristic evaluates the volatility of engine oils at 250 °C using a NOACK evaporative tester (ASTM D5800). Oils that exhibit high evaporative rate (high volatility) tend to have high oil consumption rates in engines.

Wear

Component wear is directly related to engine service life and may also affect performance and emissions. Valve train wear protection is measured in two tests. The Mitsubishi 4D34T4 measures engine oil performance effects on cam lobe wear, whilst the Mercedes OM602A test also evaluates oil performance impact on cam lobe wear, in addition to bore polishing and piston wear.

DESCRIPTION OF ENGINE TESTS

The following table (Table 1) provides a summary of the engine tests used for this Specification. The tests that describe the performance of engine oils which meet these recommendations have been identified by the particular engine manufacturer of each named test as being representative, either through actual field testing or engineering judgment, of the measured characteristic.

A brief description of each test follows. The complete engine test procedures described in this section are available from the CEC and JASO.

Table 1
Global DLD-1, DLD-2, DLD-3 Engine Test Summary

Test Identification	Engine Speed r/min	Test Duration (hr)	Operation	Power (kW)
VW IDI Intercooler	4500	10 + 50	Steady	55 min
XUD11 BTE	1000 and 4300	75	Cyclic	0 and 80 min
OM602A	0 to 4600	200	Cyclic	0 to 88 min
Mitsubishi 4D34T4	3200	160	Steady	120
VW TDI	Idle and 4150	2 + 54	Cyclic	0 to max
M111E	Idle to 3071	24	Cyclic	20 to 95
TU5JP-L4	5500	72	Steady	62

VW IDI INTERCOOLER (CEC L-46-T-93)
A 4 cylinder, 1.6 liter turbocharged intercooled IDI Diesel engine (59 kW, 155 Nm) is used to assess automotive lubricants with regards to piston cleanliness, piston ring sticking and changes in engine oil properties. This test comprises a total of 50 hours, running continuously at full speed and load (4,500 r/min and 130^{0}C oil temperature)
Primary test parameters: Ring sticking
Piston cleanliness

PEUGEOT XUD11BTE (CEC-L-56-T-98)
The PSA XUD11 BTE is a 2.1 liter, 4 cylinder, pre-combustion chamber Diesel engine. The main objective of the test is to evaluate the viscosity increase of the oil in presence of soot. The engine is running at full load in 30 minutes cycles including 2 minutes idle for 75 hours. The engine setting is adjusted to a level of 2.0 smoke index and 800°C exhaust gas temperature. Coolant and oil temperature are controlled at 100 °C and 110°C respectively. The test used a 0.3 % sulfur fuel. The level of soot at End Of Test is around 4%.
Primary test Parameters: Absolute Viscosity Increase at 100°C at 3% soot
Piston Cleanliness

MERCEDES BENZ OM 602 A (CEC-L-51-A-98)
The OM 602 A is a 2.5 liter, in line, 5 cylinder diesel engine. The test duration is 200 hours. The engine operation is cyclic, with a 1 hour cycle. Engine speeds range from 0 to 4,600 rpm, and engine power from 0 to 88 kw minimum. Fluid temperatures range from 22 to 92 (coolant) and 45 to 142 (oil) degrees C respectively.
Primary test parameters: Cam wear
Viscosity Increase
Bore polishing
Cylinder wear
Oil consumption

MITSUBISHI 4D34T4 (JASO M354-1999)
Protection performance of soot related valve train wear can be evaluated by this test. Decrease in cam-lobe height is used to determine the level of valve train wear. The test engine is the Mitsubishi 4D34T4 engine, a 3.9-liter, in-line, 4-cylinder, with charge-air inter-cooling. In order to obtain better discrimination among oils, a nodular cast iron camshaft, which is different from that of the production engine, is used. The engine conditions are set up to produce around 4.5% soot increase at the end of the test. This is achieved by operating at a steady state of 3200 rpm with 10% over fueled during the total test duration of 160 hours.
Primary test parameters: Cam lobe wear

VW TDI (CEC-L-78-T-99)
A 4 cylinder, 1.9 liter turbocharged intercooled DI Diesel engine (81 kW, 235 Nm) is used to investigate piston ring sticking and piston cleanliness. Test duration is 54 hours. A cyclic engine operation is used consisting of alternating cold idling phases and phases with maximum load (at 4,150 r/min and 145^{0}C oil temperature)
Primary test parameters: Piston cleanliness
Ring sticking

MERCEDES BENZ M111E (CEC-L-54-T-96)
The M111 is a 4 cylinder, 2.0 liter gasoline engine and is used to assess the fuel economy improvement of an engine oil compared to a 15W-40 reference oil. Test duration is 24 hours. Both steady and cyclic engine operation is used. Engine speeds range from idle to 3,071 rpm, and engine power from 0 to 49 kw. Fluid temperatures range from 20 to 95^{0}C (coolant) and 20 to 100^{0}C (oil).

Primary test parameters: Fuel economy improvement

PEUGEOT TU5 JP (CEC-L-88-T-02)
The Peugeot TU5 JP test is primarily designed to evaluate an oils ability to resist thickening when subject to high-temperature service. The test has a duration of 72 hours, and oil addition is not permitted. During the test, the oil temperature is typically at approx 150^{0}C. The thickening measured in this test is not soot related.

Primary test parameters: Ring sticking
Piston varnish
Viscosity increase

DESCRIPTION OF BENCH TESTS[1]

While full scale fired engine tests are preferred for the evaluation of lubricant performance properties, it is not practical from a cost or availability perspective to measure certain properties. Therefore laboratory tests that simulate these performance areas are utilized. Such laboratory, or bench, tests offer evaluation of performance properties at a reduced cost and cycle time compared to engine tests. The following section provides a description of the bench tests utilized in these Specifications.

SHEAR STABILITY
The Standard Test Method for Shear Stability of Polymer-Containing Fluids Using a Diesel Injector Nozzle, ASTM 6278 or CEC L-14-A-93, measures the percent viscosity loss at 100 degrees C of polymer containing fluids when evaluated with a Bosch PE 2 A 90C300/3S2266 double plunger injection pump connected to an atomization chamber equipped with a Bosch DN 8 S2 pintle nozzle injector.

The engine oil is passed through the diesel injector nozzle at a shear rate that causes the less shear stable polymer molecules to degrade. The resultant degradation reduces the kinematic viscosity of the test oil. The specification requires that the oil remain within the designated SAE viscosity grade after 30 test cycles.

HIGH TEMPERATURE / HIGH SHEAR RATE VISCOSITY

Three test methods are listed for measurement of this property, consistent with the SAE J300 viscosity classification. Each method evaluates engine oil viscosity by subjecting it to conditions of high shear rate ($1 \times 10^6\ s^{-1}$) and high temperature (150 degrees C).

ASTM D4683 and CEC L-36-A-97 utilizes a motor driven tapered rotor that is closely fitted in a matched stator. The rotor exhibits a reactive torque response when it encounters a viscous resistance from an oil filling the gap between the rotor and stator. The unit is calibrated with reference oils.

ASTM D4624 utilizes a capillary viscometer which responds to the apparent shear rate at the walls of the capillary as determined by the pressure drop and flow rate through the capillary under desired conditions. This unit is also calibrated using reference oil.

VOLATILITY

The Standard Test Method for Evaporation Loss of Lubricating Oils by the Noack Method, ASTM D5800 or CEC L-40-A-93 or JPI-5S-41-93, measures the mass of volatile vapors lost when an oil is heated in a test crucible to 250^oC with a constant flow of air drawn through it for 60 minutes. The loss in the mass of oil is determined and reported.

SULFATED ASH

The Standard Test Method for Sulfated Ash from Lubricating Oils and Additives, D874, covers the determination of the sulfated ash from unused lubricating oils containing certain metals. In this test method an oil sample is ignited and burned until only ash and carbon remain. After cooling, the residue is treated with sulfuric acid and heated to 775 degrees C until oxidation of carbon is complete. The ash is then cooled, retreated with sulfuric acid, and heated at 775 degrees C to a constant weight. The resulting mass as a percentage of the initial oil sample mass provide the reported value for this specification.

TBN

The Standard Test Methods for Base Number of Petroleum Products by Potentiometric Titration are ASTM D2896 and D4739. These test methods cover the determination of basic constituents in petroleum products by titration, and can be used to indicate and predict the relative changes that may occur in an oil during use under oxidizing or other service conditions.

CORROSION

The Standard Test Method for Evaluation of Corrosiveness of Diesel Engine Oil, ASTM D6594, is used to test diesel engine lubricants to determine their tendency to corrode alloys of lead and copper commonly used in cam followers and bearings.

Four metal coupons of copper, lead, tin and phosphor bronze are immersed in a measured amount of engine oil at 135 degrees C. Air is passed through the oil for the 168 hour test duration. The oil is then analyzed for copper, lead and tin content using spectrometric analysis, ASTM D5185. Concentration of these metals must be below specified levels to meet the requirements of the DLD-1 or DLD-3 Specifications.

The Standard Test Method for Evaluation of Rust Preventive Characteristics of Automotive Engine Oils, ASTM D6557, covers a Ball Rust Test (BRT) procedure for evaluating the antirust ability of fluid lubricants. The procedure is particularly suitable for the evaluation of automotive engine oils under low-temperature, acidic service conditions.

ELASTOMER COMPATIBILITY

The Evaluation of Oil-Elastomer Compatibility, either by CEC-L-39-T-97 plus DaimlerChrysler requirement for AEM or by complete DaimlerChrysler requirements plus CEC elastomer RE3, is aimed at determining the degree of compatibility of lubricating oils and cured elastomers used in the automotive industry. Elastomer test pieces are immersed in the test oil for a given period of time and at a given temperature. The size, the volume, the hardness, and the stress-strain properties are determined before and after immersion. The compatibility of the oil and the elastomer is estimated by the change in these characteristics.

The materials and test temperatures are provided in the following table. Immersion duration is 168 hours (7 days), in fresh oil with no elastomer preaging.

Material Designation	**General Elastomer Type**	**Test Temperature**
CEC RE 1 or DC FPM	Fluoro-elastomer	150^{o}C
CEC RE 2 or DC ACM	Acrylic	150^{o}C
CEC RE 3	Silicone	150^{o}C
CEC RE 4 or DC NBR	Nitrile	100^{o}C
DC AEM	Vamac	150^{o}C

FOAMING TENDENCY

The Standard Test Method for Foaming Characteristics of Lubricating Oils, ASTM D892 covers the determination of the foaming characteristics of lubricating oils at 24 degrees C and 93.5 degrees C. It provides a means of empirically rating the foaming tendency and stability of the foam.

The sample, maintained at a temperature of 24 degrees C is blown with air at a constant rate for 5 minutes, then allowed to settle for 10 minutes. The volume of foam is measured at the end of both periods (Sequence I). The foaming tendency is provided by the first measurement, the foam stability by the second. The test is repeated using a new portion of sample at 93.5 degrees C (Sequence II) however the settling time is reduced to 1 minute. For Sequence III the same sample is used from Sequence II, after the foam is collapsed and cooled to 24 degrees C, the oil is blown with dry air for 5 minutes, then settled for 10 minutes. The tendency and stability are again measured.

The Standard Test Method for High Temperature Foaming Characteristics of Lubricating Oils, ASTM D 6082, test method describes the procedure for determining the foaming characteristics of lubricating oils at 150 degrees C.

A measured quantity of sample is heated to 49 degrees C for 30 minutes and allowed to cool to room temperature. The sample is transferred to a 1000 mL graduated cylinder heated to 150 degrees C, and aerated at 200 mL/min with dry air for 5 minutes with a metal diffuser. The amount of foam generated before disconnecting the air is a measure of the foaming tendency, the amount of static foam after one minute of settling provides a measure of the foam stability.

PRODUCT LABELLING

ACEA, Alliance members, EMA and JAMA recommend that any producer or marketer claiming that an engine oil meets a Global DLD-1, DLD-2 and / or DLD-3 specification have adequate performance data to support such claim and should make such performance data available to members of ACEA, Alliance, EMA or JAMA upon request.

All products claiming to meet the requirements of DLD-1, DLD-2 and / or DLD-3 must display the following label immediately adjacent to that part of the product container detailing any performance claims.

ACEA, AAM, EMA and JAMA do not certify or license engine oils, are not responsible for individual marketers' claims of compliance with the Global DLD-1, DLD-2, and DLD-3 specifications, and make no representation or warranty concerning the appropriateness or performance of any oil alleged to meet these specifications. The marketer of an oil claiming to meet DLD-1, DLD-2 and / or DLD-3 is responsible for all aspects of product liability.

For DLD-1 products:	For DLD-2 products:	For DLD-3 products:
DLD-1	**DLD-2**	**DLD-3**

The above comprises a rectangle at least 11mm high x 25mm wide. It will have a white background and a border of black, double lines in at least 1.5 pt width. The text itself will be black and in Arial Bold font of at least 22 pt height.

The additional display of this logo elsewhere on the packaging is encouraged.

FIRST ALLOWABLE USE OF CLAIMS

Claims to meet the requirements of DLD-1, DLD-2 and / or DLD-3 are not permitted before 1st January 2003.

REFERENCED DOCUMENTS

Interested parties should consult the most recent versions of the documents referenced below.

ASTM Standards:

- E 29 Practice for Using Significant Digits in Test Data to Determine Conformance to Specifications:
- E 178 Practice for Dealing with Outlying Observations
- D 874 Test Method for Sulfated Ash from Lubricating Oils and Additives
- D 892 Test Method for Foaming Characteristics of Lubricating Oils
- D 2896 Test Method for Base Number of Petroleum Products by Potentiometric Perchloric Acid Titration
- D 4624 Test Method for Measuring Viscosity by Capillary Viscometer at High Temperature and High Shear Rates
- D 4683 Test Method for Measuring Apparent Viscosity at High Shear Rate and High Temperature by Tapered Bearing Simulator
- D 4739 Test Method for Base Number Determination by Potentiometric Titration
- D 5800 Test Method for Evaporation Loss of Lubricating Oils by the Noack Method
- D 6082 Test Method for High Temperature Foaming Characteristics of Lubricating Oils
- D 6278 Test Method for Shear Stability of Polymer Containing Fluids using a European Diesel Injector Apparatus
- D 6594 Test Method for Evaluation of Corrosiveness of Diesel Engine Oil at 135^{o}C
- D 6557 Test Method for Evaluation of Rust Preventive Characteristics of Automotive Engine Oils

CEC Testing Standards:

- CEC L-46-T-93 Test for Ring sticking and Piston cleanliness.
- CEC L-56-T-98 Test for Medium temperature dispersivity
- CEC L-51-A-98 Test for Wear, Viscosity stability and Oil consumption
- CEC L-78-T-99 Test for DI Piston cleanliness and Ring sticking
- CEC L-54-T-96 Test for Fuel Economy Effects
- CEC L-88-T-02 Test for High temperature deposits, Ring sticking and Oil thickening
- CEC L-39-T-96 Elastomer Compatibility Test
- CEC L-36-A-90 HT/HS Viscosity by Ravenfield Viscometer
- CEC L-14-A-93 Test Method for Shear Stability of Polymer Containing Fluids using a Diesel Injector Nozzle Shear
- CEC L-40-A-93 Test Method for Evaporation Loss of Lubricating Oils by the Noack Method

JASO Testing Standard:

- JASO M 354-1999 Test Method for Evaluation of Valvetrain Wear Performance
- JASO DH1 Application Manual

Society of Automotive Engineers:

- J300 Engine Oil Viscosity Classification System

Other Publications:

- ACEA/Alliance/EMA/JAMA World Wide Fuels Charter

Table 2a
Global Engine Oil Service Specification DLD-1, DLD-2, DLD-3

Characteristic	Test Method	Test Name	Requirements	Limits		
				DLD-1	DLD-2	DLD-3
Engine Tests						
Ring sticking & Piston cleanliness (1)	CEC L-46-T-93	VW 1.6 TC D	Ring sticking, merit Piston cleanliness, merit.	≥ RL 148 ≥ RL 148	≥ RL 148 ≥ RL 148	
Medium temperature dispersivity	CEC L-56-T-98	Peugeot XUD11BTE	Absolute viscosity increase at 100°C and 3% soot (measurement with CEC L-83-A-97 method) Piston merit (5 elements) (average for 4 pistons)	≤ 0.90 x RL197 result. ≥ (RL197 minus 6 pts)	≤ 0.50 x RL197 result. ≥ (RL197 minus 6 pts.)	≤ 0.50 x RL197 result. ≥ RL197
Wear, Viscosity stability & Oil consumption	CEC L-51-A-98	Mercedes Benz OM602A	Cam wear. Average, µm Viscosity increase at 40°C, % Bore polishing, % Cylinder wear. Average, µm Oil consumption, kg/test	≤ 50.0 ≤ 90 ≤7.0 ≤20.0 ≤10.0	≤ 50.0 ≤ 90 ≤7.0 ≤20.0 ≤10.0	≤ 50.0 ≤ 90 ≤7.0 ≤20.0 ≤10.0
Wear, Valvetrain	JASO M354-1999	Mitsubishi 4D34T4 160 Hrs	Cam Lobe Wear, µm Average	≤ 95.0	≤ 95.0	≤ 95.0
DI diesel Piston cleanliness & Ring sticking	CEC L-78-T-99	VW DI	Piston cleanliness, merit Ring sticking (Rings 1 & 2), ASF Average of all 8 rings Max. for any 1st ring Max. for any 2nd ring	----- ----- ----- -----	----- ----- ----- -----	≥ RL206 minus 3 pts ≤ 1.2 ≤ 2.5 ≤ 0.0
Fuel economy	CEC L-54-T-96	Mercedes Benz M111E	Fuel economy improvement vs. Reference oil RL191 (15W-40), %	--	≥ 2.5	--
Oxidation	CEC L-88-T-02	Peugeot TU5JP	Ring sticking (each part), merit Piston varnish (5 elements) (average of 4 pistons) Absolute viscosity increase at 40°C between min and max values during test Oil consumption	≥ 9.0 ≥ RL216 ≤ 1.5 x RL216 Report	≥ 9.0 ≥ RL216 ≤ RL216 Report	≥ 9.0 ≥ RL216 ≤ 0.8 x RL216 Report

(1). A passing result in the CEC L-78-T-99 test (VW DI) to the DLD-3 requirements may be used in place of the CEC L-46-T-93 test.

Table 2b
Global Engine Oil Service Specification DLD-1, DLD-2, DLD-3

Characteristic	Test Method	Test Name	Requirements	Limits		
				DLD-1	DLD-2	DLD-3
Bench Tests						
Viscosity grades		Kinematic Viscosity	SAE J300 Latest Active Issue	xW-50 xW-40 xW-30	xW-30 xW-20	xW-50 xW-40 xW-30
Shear stability	ASTM D 3945 CEC L-14-A-93	Bosch Injector Test	Viscosity after 30 Cycles, measured at 100 °C, mm^2/s xW-50 xW-40 xW-30 xW-20	≥ 15.0 ≥ 12.0 ≥ 9.0 --	-- -- ≥ 8.6 Stay in grade	Stay in grade Stay in grade Stay in grade --
Viscosity at high temp. & high shear rate (HTHS)	ASTM D 4624 / D 4683 / CEC-L-36-A-90	HP Capillary Viscometer / Tapered Bearing Simulator / Ravenfield	High Temperature / High Shear Rate Viscosity, mPa.s	3.5 Min.	xW-30 2.9 min xW-20 2.6 min	3.5 Min.
Evaporative loss	ASTM D 5800 CEC L-40-A-93	NOACK	% Mass Loss, Max	15 for 10W-x or lower 13 for others	15	13
Sulfated ash	ASTM D 874	Sulfated Ash	Mass %, Max.	1.8	1.3	1.6
TBN	ASTM D 4739 / D 2896	TBN	mg KOH/g, min	10	-	-
Corrosion	ASTM D 6594	Corrosion Bench Test	Used Oil Element Content above Baseline, ppm, Max.	Copper 20, Lead 120, Tin 50	- - -	Copper 20, Lead 120, Tin 50
Corrosion	ASTM D 6557	Ball Rust Test	Average gray value, min	100	-	100

Table 2c
Global Engine Oil Service Specification DLD-1, DLD-2, DLD-3

Characteristic	Test Method	Test Name	Requirements	Limits			
Bench Tests							
Oil / elastomer Compatibility (2)	CEC-L-39-T-96	Variation after 7 days fresh oil, No presaging		RE 1	RE 2	RE 3	RE 4
		Hardness DIDC	points, max.	-1/+5	-5/+8	-25/+1	-5/+5
		Tensile Strength	%. max	-40/+10	-15/+18	-45/ +10	-20/+10
		Elongation rupture	%, max	-50/10	-35/+10	-20/+10	-50/+10
		Volume variation	%, max.	-1/+5	-7/+5	-1 /+30	-5/+5
Foaming tendency	ASTM D892 without option A	Sequence I (24^{o}C)	Tendency / Stability, ml. max. After 1 Min. settling	10 / nil			
		Sequence II (94^{o}C)		50 / nil			
		Sequence III (24^{o}C)		10 / nil			
Foaming - High Temperature	ASTM D 6082	Sequence IV (150^{o}C)	Tendency / Stability, ml. max. After 1 Min. settling	100 / nil			

(2). Use either complete Daimler-Chrysler requirements (VDA 675301, 7 days, 4 materials (NBR: NBR34 DIN 53538 T3 (100 ºC); FPM: AK6 (150 ºC); ACM: E7503 (150 ºC); AEM: D 8948/200.1 (150 ºC)) + CEC RE3 according to requirements above, or complete CEC requirements according to above + DC requirements for AEM. The Elastomer Compatibility Limits are those stated in ACEA 2002 European Oil Sequences and apply to the elastomer batches available at that time. Consult the most recent ACEA Oil Sequence publication for the information on the limits with current more recent elastomer batches. New CEC RE3 material and limits are to be developed and added to CEC requirements as soon as possible.

APPENDIX
Global DLD Data Tables

The following data tables are provided for recording the chemical, physical, and performance information for engine oil products marketed as meeting the Global DLD-1, DLD-2 or DLD-3 specifications. As stated in the Specifications, ACEA, Alliance members, EMA and JAMA recommend that any producer or marketer claiming that an engine oil meets a Global DLD-1, DLD-2 or DLD-3 specification have adequate performance data to support such claim and should make such performance data available to members of ACEA, Alliance, EMA or JAMA upon request. Indicate any read across processes used and provide the relation between the tested and the marketed formulations.

It is recognized that such data are sensitive and will be maintained in strictest confidence by members of ACEA, Alliance, EMA, and JAMA. However, the disposition of whether or not a product in general, meets this specification may be publicly stated.

Global Engine Oil Service Specification DLD-1, DLD-2 or DLD-3 Formulation Information and Performance Test Results

Oil Product Name			
Current Date			
Marketing Oil Company			
Address			
Contact			
Telephone Number			
Email address			
DLD performance level claimed			
Viscosity grade			
Formulation Number / Code			
Market Region for this Formulation			
	Test Method	**Specified Limit**	**Test Result**
Chemical and Physical Properties			
Viscosity, mm^2/s @ 100 ^oC	ASTM D445	per J300	
Viscosity, mm^2/s @ 40 ^oC	ASTM D445	Report	
Viscosity Index		Report	
Low Temp Crank Vis, mPa.s @ XX ^oC	ASTM D5293 per J300	per J300	
Low Temp Pump Vis, mPa.s @ XX ^oC	ASTM D4684 per J300	per J300	
Pour Point, °C	ASTM D97		
HT/HS, mPa.s	ASTM D4624 / D4683 / CEC L-36-A-90	per DLD performance level	

TBN, mg KOH/g (limit for DLD-1 only)	ASTM D2896 / D4739	10 min.	
TAN, mg HCl/g	ASTM D664		
Oil Product Name			
Formulation Number			
	Test Method	**Specified Limit**	**Test Result**
Sulfated Ash, % mass	ASTM D874	per DLD performance level	
Elemental	ASTM D5185	Report	
Barium, ppm			
Boron, ppm			
Calcium, ppm			
Magnesium, ppm			
Molybdenum, ppm			
Phosphorus, ppm			
Silicon, ppm			
Sodium, ppm			
Zinc, ppm			
Chlorine, ppm			
Sulfur, % wt	ASTM D1552 or equiv	Report	
Nitrogen, % wt	ASTM D3228 or equiv	Report	
Viscosity after Shear, cSt	CEC L-14-A-93 / ASTM D6278	Per DLD performance claim	
Volatility, % wt	ASTM D5800 / CEC L-40-A-93	Per DLD performance claim	
Foaming Tendency	ASTM D 892	Tendency / Stability	
Sequence I		10 / nil	
Sequence II		50 / nil	
Sequence III		10 / nil	
High Temperature Foaming	ASTM D6082	100 / nil	
Corrosion - CBT (not DLD-2)	ASTM D6594 (HTCBT)	20 / 120 / 50 (max) Cu / Pb / Sn	
Corrosion – BRT (not DLD-2)	ASTM D6557	100 min.	

Oil Elastomer Compatibility	CEC L-39-T-95 / Daimler-Chrysler requirements (state which)			
	Pass or Fail -			
Material	Hardness	Tensile	Elongation	Volume Change
CEC RE 1 or DC FPM				
CEC RE 2 or DC ACM				
CEC RE 3				
CEC RE 4 or DC NBR				
DC AEM				

	Test Method	**Specified Limit**	**Test Result**
VW IDI Intercooler	CEC L-46-T-93	per DLD performance level	
Formulation Number Tested			
Ring sticking, merit		RL148 result	
		Candidate result	

Piston cleanliness, merit		RL148 result	
		Candidate result	

Oil Product Name			
Formulation Number			
	Test Method	**Specified Limit**	**Test Result**
Peugeot XUD11BTE	CEC L-56-T-98	per DLD performance level	
Formulation Number Tested			
Absolute viscosity incr. at 100°C & 3% soot (measurement with CEC L-83-A-97 method), mm^2/s		RL197 result	
		Candidate result	
Piston merit (5 elements) (Average for 4 pistons), merit		RL197 result	
		Candidate result	
MB OM 602 A	CEC L-51-A-98		
Formulation Number Tested			
Cam wear. Average, µm		≤50.0	
Viscosity increase at 40°C, %		≤90	
Bore polishing, %		≤7.0	
Cylinder wear. Average, µm		≤20.0	
Oil consumption, kg/test		≤10.0	
Mitsubishi 4D34T4, 160 hrs	JASO M354-1999		
Formulation Number Tested			
Average Cam Lobe Wear, µm		≤95.0	
VW TDI	CEC L-78-T-99	per DLD performance level	
Formulation Number Tested			
Piston cleanliness, merit		RL206 result	
		Candidate result	
Ring sticking (Rings 1 & 2) Average of all 8 rings, ASF Max. for any 1st ring, ASF Max. for any 2nd ring, ASF		 ≤1.2 ≤2.5 ≤0.0	
MB M111E	CEC L-54-T-96	DLD-2 only	
Formulation Number Tested			
Fuel economy improvement vs. Reference oil RL191 (15W-40), %		≥ 2.5	
Peugeot TU5JP-L4	CEC L-88-T-02	per DLD performance level	
Formulation Number Tested			
Ring sticking (each part), merit		≥ 9.0	
Piston varnish (average of 4 pistons), merit		RL216 result	
		Candidate result	

Absolute viscosity incr. at 40ºC between min and max values during test, mm^2/s		RL216 result	
		Candidate result	
Oil consumption, kg/test			

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