Constant developments in combustion engines demand that engine oil too keeps pace with the technical status at any given time of the engines both in terms of its prope

The basic requirements placed on engine oils are listed verbally in the following list and fulfill th e for

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Area of friction and wear

1. Friction reduction
2. Fuel consumption reduction
3. Protection against wear
4. Oil film tensile strength
5. No surface damage (pitting)
6. Preservation of honing pattern
7. Matching additive reaction temperature
8. Neutralization capacity
9. Adhesive force

Range II: temperature and viscosity

10. T
    hermal stability
11. Oxidation resistance
12. Nitration resistance
13. High-temperature viscosity (shear rate, pressure)
14. Low-temperature viscosity (overflow, pumpability, continuous flow, no air inclusion)
15. Low temperature-dependent viscosity change
16. Viscosity stability (mechanical, thermal, oxidative)

Range III: purity

17. Dispersing power
18. Detergent effect
19. No ring riding/no ring sticking
20. Prevention of hot sludge
21. Prevention of cold sludge
22. Prevention of paint
23. Resistance to water
24. Resistance to anticorrosion/antifreeze agents

Range IV: no residues

25. No deposits on intake valves
26. No residue build up in combustion chamber
27. No glow ignition
28. No deposits in area of turbochargers

Range V: oil/engine components

29. Corrosion protection
30. Compatibility with metals and paints
31. Compatibility with elastomers (seals)
32. Compatibility with filter materials
33. No plugging of filters
34. T
    hermal conductivity/cooling effect
35. Sealing capability

Range VI: Base stock/additives

36. Solubility of additives
37. Homogeneity
38. No filtering out of additives
39. No heat development
40. Foaming prevention
41. Air output capacity
42. Low volatility/vaporization trend

Range VII: application

43. Fuel consideration
44. Miscibility/compatibility
45. Running-in characteristics
46. Large change intervals
47. Applicability in different types of engine (manual transmissions, hydraulic systems)
48. Constant quality
49. Inexpensive ease of manufacture
50. Availability
51. Storage life

Area VIII: Environment

52. No negative effects on health and environment
53. No negative effects on the exhaust gas aftertreatment systems
54. Does not contribute to particulates
55. Does not emit odors
56. No disadvantages when disposing off and recycling

Explanations on the individual items in the areas
Area I - Friction and wear

1. Friction reduction
As with every lubricating oil, engine oil is obviously intended to prevent friction as far as is possible. A low engine friction horsepower contributes to improving efficiency; the output generated by the engine should primarily be available to propel the vehicle.

2. Fuel consumption reduction
Because the saving of energy has become the main focus of interest, engine oils must thus also play their part in helping to further reduce fuel consumption levels. A fuel consumption saving is possible, in particular during the warm up period, i.e. in the time between the cold start and reaching operating temperature.
Th
rough the choice of suitable additives it is now possible to exert a positive influence on friction-related conditions.

In the development and application of such oils, which are to be welcomed in principle, attention must however be paid to the fact that no disadvantages of any kind whatsoever arise, in particular in relation to the engine's service life.
Wit
h regard to the individual car driver, the fleet owner and the national economy these oils must of course realize both financial and energy-related advantages. On no account should the fuel-consumption level rise.

3. Protection against wear
In order to ensure that an engine achieves as high a mileage as possible without sufferi

4. Oil film tensile strength
Even under the greatest of loads and at the highest of temperatures the oil film, e.g. between the piston ring and cylinder contact surface, must not break down, because direct metallic contact can lead to "seizure" and thus to a total loss.

5. No surface damage (pitting)
Th
e engine oils must protect all components from any surface damage and should not cause any such damage themselves.
Thi
s applies in particular to pittings on tappets, which can lead to damaging the cams.
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6. Preservation of honing pattern
A well preserved honing pattern on the cylinder contact surface is essential for ensuring a controlled oil consumption.
For this reason "bore polishing" or "deposits" must not occur.
Thi
s is absolutely essential if a long service life is to be achieved.

7. Matching additive reaction temperature
Th
e oil additives used for protection against wear do not achieve this solely on account of their presence, but rather through a chemical reaction on the surface of the components.

Th
erefore, one has to make sure that the reaction temperatures of the additives match those operating temperatures (and pressures), e. g. that are prevalent on the cams.

8. Neutralization capacity
Gasoline fuels and, in particular, diesel fuels contain sulfur. During combustion of this sulfur content the fuel may give off sulfurous acids or sulfuric acid together with combustion water.
Thi
s must on no account take place, and therefore such acids must always be immediately neutralized.

Engine oil must also be alkaline; this alkalinity is partially reduced during the neutralization process, however a certain residual alkalinity must be retained until the next oil change is due.

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9. Adhesive force
If the engine is switched off during full-load operation at a high temperature, a residual oil film must remain at the lubricating point, so that a subsequent start-off in a cold condition does not lead to damage as a result of "running dry".

Area II - Temperature and viscosity

10. Thermal stability
Engine oil must exhibit thermal stability at whatever temperature; it must not alter in an unfavorable way.

11. Oxidation stability
Because oxygen is always present as a result of the high temperatures in the engine compartment, the oil must be oxidation resistant; it must not lose its advantageous properties and not form any natural oil oxidation products or residue.
Thi
s would lead to a rise in the oil's acidity level and to the oil thickening.
Thi
ckening oil causes problems when cold-starting and increases the fuel-consumption level.

12. Nitration resistance
During combustion, nitrogen oxide is formed, which acts upon the oil together with the blow-by gases.
Thi
s in turn can lead to a nitration with subsequent sludge formation. Ever since the arrival of the "oil-sludge problems" one is aware of how important nitration resistance is.
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13. High-temperature viscosity

To preserve the minimum lubricating film that is absolutely essential at high loads, it is necessary to have sufficient viscosity during these high temperatures.

When specifying this minimum viscosity the factors of shear rate and pressure conditions that are prevalent at the lubricating points must also be taken into account alongside that of temperature

14. Low-temperature viscosity

Engine oil is called upon to play a vital contribution when starting and warming up the engine at low temperatures. In this context several, independent of each other, procedures must be heeded.

First of all, the oil's internal friction must not be too large, so that the crankshaft and the other engine components can break free and rotate or move. The oil must be pum

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15. Low temperature-dependent viscosity change

The viscosity specifications at high and low temperatures, which directly oppose the physical characteristics of the oil, result from the necessity to keep the temperature-dependent viscosity changes as few as possible. Engine oils should be able to be used regardless of the particular season of the year and the outside temperature.

16. Viscosity stability

Multigrade oils are capable of fulfilling the low temperature-dependent viscosity changes. If however, these are produced with viscosity index improvers, then care should be taken to ensure that these exhibit mechanical, thermal and oxidative shear resistance.

This means that the viscosity of fresh oil should be retained for as long as possible and should not be depleted before the scheduled oil change interval is reached.

Area III - Cleanliness

17. Dispersing power

The insoluble oil residue which is generated during the combustion process and the natural oil residue have to be dispersed and suspended; they must not coagulate and deposit themselves on the engine components, this applies to both particularly hot and cold positions.

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18. Detergent effect

Engine oil must be capable of "washing away" previously deposited sediments to a certain extent and thus achieve a cleansing effect.

19. No ring riding/no ring sticking

Combustion and oil residue, which cannot be borne by the oil, tends to deposit itself in the piston ring grooves, because this is where extremely high temperatures occur. Here however, the piston rings which play a significant role in the engine's operation, can be impaired in their tasks.

The piston rings must be free to move at all times.

Deposits on the base of the ring groove or on the back of the ring must not be so strong that the ring tends to "ride"; deposits on the ring or groove sides must not cause ring sticking to occur. Riding or sticking rings lead to a power loss, increased oil consumption, ring/cylinder scuffing and to engine failure as a result.

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20. Prevention of hot sludge

The formation of sludge should also be prevented at the highest occurring temperatures under all conditions. In particular this should be observed for diesel fuel engines. If the oil pump is forced to breathe in sludge the lubrication of the engine (oil supply/protection against wear) can no longer be guaranteed.

Beyond this, sludge is not only a blemish, it also hampers any maintenance work to be conducted on the engine, as well as draining oil and carrying out an oil-level check.

21. Prevention of cold sludge

Applies mainly to gasoline engines, but diesel engines that are frequently driven over short distances are also affected and therefore it is necessary that the formation of cold sludge is prevented. Its formation is greatly favored by the presence of condensed water and fuel residue as well as any failure to reach the regular operating temperature.

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22. Prevention of paint
Paint, which primarily occurs in gasoline engines after running at high temperatures is also to be prevented where possible.

Paint coats, that exceed specific limits, will impair the operation of engine components. Paint also hampers the heat transfer, heat dissipation is poorer and excessive temperatures are the result.

23. Resistance to water
Condensed water can form at any time and anywhere and succeed in entering the engine oil.
Thi
s must not be impaired in its quality and function in any way.

24. Resistance to antifreeze with corrosion inhibitor
Coolant (water and antifreeze with corrosion inhibitor) occurs only rarely in engine oil, however in the
ma
jo
rity of such cases this can ruin the engine oil and cause sludge to be formed in the engine.

A greater resistance of the engine oil to water and antifreeze with corrosion inhibitor is highly desirable.

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28. No deposits in area of turbochargers
Extremely high temperatures can occur close to turbochargers, particularly after switching off the engine. Here and in the entire charge-air cooling system there should be no formation of deposits.

Area V - Oils/engine components

29. Corrosion protection
All metallic engine components must be reliably protected against corrosion, this must also include long service life periods.
Thi
s requirement applies to all engine oils, in particular of course for running-in engine oils.

30. Compatibility with metals and paints
It goes without saying that engine oils must be compatible with all the various metals that are present in the engine construction and that they are in no way impaired.
Th
ere have however been no problems in this area for a long time.

Th
e engine oil must also be absolutely compatible with all paints used for the body paintwork, i. e., such paints must not be impaired in any way. Occasionally engine components are also painted on the inside, e. g. the crankcase.
Th
ese paints too must not be aggravated in any way by the engine oil.

Area IV - No residue

25. No deposits on intake valves
Deposits on intake valves cause engines, that in terms of emissions and fuel consumption are ideally set, to malfunction during operation, particularly during the warm-up phase. Although fuel does indeed exert an essential influence it is important to ensure that the engine oil formula does not enable the oil to contribute in any way to the formation of deposits

26. No residue formation in combustion chamber
A certain minimum amount of engine oil is also burnt in the combustion chamber, this must not however generate any residue or deposits.
In direct-
inj
ection diesel engines the distances between the underside of the valve disk and the top of the piston base is extremely small at specific crankshaft positions. On no account may contact take place as a consequence of any residue or deposits.

27. No glow ignition
Wh
en residue is formed in the combustion chamber of a gasoline engine, it can have an affect similar to a glow plug and cause advance ignition and piston scorching.
Thi
s must be prevented.
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31. Compatibility with elastomers (seals)
Similar requirements regarding compatibility with the elastomers (seals) are also essent

32. Compatibility with filter materials
Primary and bypass filters or their inserts are made of different materials, e. g. high-grade paper or stuffed cotton. Engine oil must be compatible with all these different materials and provide a trouble-free filtration.

33. No plugging of filters
Naturally, the engine oil itself, and in particular the additives in it, must not lead to the filter being plugged up (increase in differential pressure).

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34. Thermal conductivity/cooling effect
It is the task of engine oil to cool the engine components which are the most highly stressed from a temperature point of view, i.e. to dissipate the heat. Obviously the temperature level in the engine is highly dependent on the engine design and operating conditions. Only when the component and oil temperatures do not exceed a reasonable value, is it possible to guarantee a long service life for the engine.
To this end the engine oil must fulfill its role as a heat-transfer oil.

35. Sealing capability
Where possible a complete and faultless sealing between the combustion chamber and the engine compartment is a significant precondition for ensuring high degree of engine efficiency. Engine oil must support the piston rings in this task.

Area VI - Basic oils/additives

36. Solubility of additives
All additives used in the production of engine oil must be capable of being completely dissolved in the basic oil and remaining so.

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37. Homogeneity
The engine oil must be absolutely homogeneous, even if stored in large containers over a longer period of time and if it has been refilled frequently.

38. No filtering out of additives
Several of the previously mentioned points make it inevitable that the applied additive may not be filtered out.

39. No heat development
The additives do not work solely on account of their presence, but rather their chemical conversion. As little heat as possible should be generated by this process.

40. Foaming prevention
Oil is subjected to very turbulent motion in the crankcase; this gives rise to the possibility of air intake, particularly at very high engine speeds. However, this air intake must be as low as possible in order to prevent any substantial foaming. Oil foam can naturally not form the required lubricating film; as a result wear damage occurs. Similarly, the hydraulic valve-clearance compensation is also impaired, with the result that undesirable noise is heard when the gas content is too high.
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41. Air output capacity
However if foam has already formed, the entrained air must be released again immediately, i.e. the entrained air must not be retained.

42. Low volatility/vaporization trend
All combustion engines have a certain degree of oil consumption. As a result the necessity to top up with fresh oil also represents an advantage in terms of the qualitative

Area VII - Application

43. Fuel consideration
Fuel exerts a greater influence on the engine oil than was previously assumed.
This is not just a matter of the different levels of sulfur content in diesel and gasoline fuels. Unfavorable, poorly combustible diesel fuel qualities pollute the engine oil to a major extent with combustion residue.

Nonburned fuel residue reduces the viscosity of the oil. Fuel additives can impair the function of oil additives. Nonburned fuel additives make their way into the engine oil.

Other fuels, such as methanol or plant oil methyl ester can demand modified engine oils. Flexible engines that have been designed to cope with several types of fuel, should also be supplied with corresponding engine oils, that are suitable for all kinds of fuel and mixtures.
The suitability of engine oils must be checked completely for all alternative fuels.

44. Miscibility/compatibility
Engine oils, even if from various producers and different SAE areas, must be mixable and absolutely compatible.
This also applies to all products that are intended for the same purpose, regardless of whether they, e.g. are based on synthetic or mineral basic oils. Decisive is whether the mixture fulfills all the tasks placed on the engine oil in every mixture ratio. A reference to miscibility on its own is therefore not sufficient.

However its is also obvious that mixtures cannot always be as good as non-mixed oils with regard to all the criteria. Certain losses in terms of viscosity temperature behavior and performance cannot be ruled out.

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45. Running-in characteristics
Th
ose engine oils that are used for new or reconditioned engines must, alongside their other tasks, also accelerate the running-in characteristic or at least make it possible.

46. Large change intervals
Oil changes not only cost time and money, but also represent a
ma
jo
r organizational task where large fleets are concerned. During the necessary stand-down times the vehicle is not capable of fulfilling its transportation tasks. For this reason, there is now a call for engine oil to not only fully fulfill all of its tasks when new or after only a few thousand driven kilometers, but for it to also do so over as long a period of operation as possible. A "lifetime filling" however still remains an illusion.

47. Applicability in different types of engine (manual transmissions, hydraulic systems)
Th
e idea of developing an optimum oil for each different kind of engine, is only a positive notion at first glance, this applies even to running-in oils. It is much more appropriate, to cater for as many of the various types of engine on the market with as few engine oil versions as possible and to do so not only adequately, but also without any associated problems.

With the great diversity of motor vehicles, resulting from the different requirements plac

In addition to their use in engines there are certain cases where there is also need to use engine oils in manual transmission and hydraulic systems.

48. Constant quality
It is not enough if the demands posed can only be fulfilled by samples manufactured un
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49. Inexpensive manufacturability
Th
e optimum engine oil formulation must also undergo inspection as to whether it can indeed be manufactured inexpensively.
Th
ere must be an appropriate relationship between price and quality.

50. Availability
Excellent engine oils must of course be available wherever there is a demand for them.

51. Storage life
On the condition that storage has taken place properly, i.e. good container, no ingress of contaminants and water, practically unlimited shelf life is to be claimed.

Area VIII - Environment

52. No negative effects on health and environment
The environment is naturally a factor of major importance. With regard to manufacture, application a

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53. No negative effects on the exhaust gas aftertreatment systems

(particulate trap, three way catalytic converter and Lambda probe)
A gasoline engine with a lambda probe and a three-way catalytic converter is ideally eq

54. No contribution to particulates
Further developments in diesel engines are geared towards
ma
jo
r efforts being undertaken to ensure that the level of particulates is significantly reduced. Because a significant portion of these particulates originates from oil, oil-consumption levels have been successfully cut back in recent years. However, the basic oil components and additives still require to be analyzed and optimized in terms of bringing about further particulate reductions.

55. Does not emit odors
Engine oils must not emit any unpleasant odors even at high temperatures. In this context, consideration should be given to drivers and passengers as well as the people who work in factories, workshops and warehouses.
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56. No disadvantages when disposing off and recycling

Until such time as lifetime oil is available oil will always need to be changed. Naturally, it is sensible to drain off this oil, collect it and to convey it to a reputable recycling plant. Right back at the initial conception of the engine oil, consideration must be given to ensuring that no problems will arise later on when it needs to be disposed off or recycled.

Summary:

Put simply, there should be no wear, no deposits, and the engine should remain as "new" for as long as possible.

Engine-oil tests

For the evaluation of engine oil quality there are both absolute dimensional units and comparative assessments and judgments. The fastest and most economical method of a series of test methods.

Th
e following test equipment is used in the appraisal of engine oils:

- testing machines with simple components
- test sets for inspecting oil on individual engine components
- single-cylinder engines on test rig
- multiple-cylinder engines on test rig
- engines in operation.

Because of the fact that these test methods differ significantly in outlay, the tests are conducted as each situation demands.

Wit
h regard to the overall assessment of an engine oil various countries and many different institutions have compiled specifications comprising

Th
e best known internationally are the classifications of the American Petroleum Institute (API, information on the Internet under www.api.org), as well as the test sequences of the European automotive manufacturers ACEA (ACEA = Association des Constructeurs Europeéns de L#Automobile; information on the internet under www.acea.be).
Th
e ACEA test sequences were presented for the first time in December 1995. As of January 1st 1996, these ACEA test sequences replaced the CCMC test sequences valid until then.

In the Mercedes-Benz engine oil specifications listed on the following pages the ACEA test sequences are taken into account as basic requirements. However, to some extent our requirements for modern engine oils in the Mercedes-Benz engine oil specifications go significantly beyond the requirements in the ACEA test sequences.

Due to the needs of current and future production engines, such as extension of oil cha

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Running-in engine oils

Running-in engine oils are suitable for running in and continued operation of engines beyond the prescribed maximum mileage or service life.
Th
ey are likewise used for function test and preservation of engines.

They are charged with the task of exerting a favorable influence on the engine's running-in process.

Sheet 225.0 (single-grade oils SAE 30) and
Sheet 225.1 (multigrade oils SAE 15W-30)

These break-in engine oils are suitable for passenger car and commercial vehicle engi
(For application refer also to Sheet 223.1).

Sheet 225.5 (multigrade oils SAE 15W-40)

These running-in engine oils have been approved for diesel engines model 300, model

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Sheet 225.6 (multigrade oils SAE 10W-40 and SAE 5W-30)
Th
ese break-in oils are released for diesel engines BR 300, BR 400, BR 500, BR 600, BR 900 for oil distances up to a maximum of 100.000 km (vehicle-dependent, corresponding to the maintenance booklet) and oil running times up to a maximum of 2000 h. (for use, see also Sheet 223.1)

Sheet 225.7 (multigrade oils SAE 15W-40)
These break-in engine oils have been approved for diesel engines model 100, model 600 for oil distan

Sheet 225.8 (multigrade oils SAE 10W-40)
These break-in oils are approved for certain engines of model100, model 200, model 600 (see Sheet 22

Th
ese oils are not approved for commercial vehicle engines (models 300, 400, 500 and 900) - these receive the oils on Sheet 225.6. (For application refer also to Sheet 223.1).
Additional information on Low SPAsh oils is available in Sheet 229.31.

In all cases, the oil change specifications, as specified in the maintenance booklet for the respective vehicle, apply.

Th
e most important requirements which we stipulate for a Mercedes-Benz approval of break-in oils can be seen in the summary table below " Mercedes-Benz specifications for engine oils (factory fill) V2003.1".
Th
e specification Sheet 225.11 is new (break-in oils with low sulfur content (low sulfur), low phosphorus content (low phosphorus) and low content of ash-forming components (low ash).

Sheet 225.10 (multigrade oils SAE 5W-30)
Th
ese low-friction break-in oils (for definition of low-friction oils, see Sheet 222.0) are only approved for the engines M 112, M 113, M 271, OM 611, OM 612, OM 613, OM 646, OM 647, OM 648, OM 664, OM 665 and OM 668.
Th
ey are not approved for engines M 111, M 137, M 160, M 166, M 275, OM 628, nor commercial vehicle engines OM 611 and OM 612 - these still contain oils from Sheet 225.8. Smart diesel OM 660 and AMG engines will continue to receive oils according to DBL 6674.31.

Th
ese oils are likewise not approved for commercial vehicle engines (models 300, 400, 500 and 900) - these receive the oils on Sheet 225.6. (For application refer also to Sheet 223.1).

Sheet 225.11 (multigrade oils SAE 5W-30) with low sulfur content, low phosphor content and low content of ash-forming components - "Low SPAsh oils"
Th
ese "Low SPAsh" break-in oils (for definition of low-friction oils, see Sheet 222.0) are initially only approved for model 600 EU4 passenger car diesel engines or cars which are equipped with diesel particulate filters. (For application refer also to Sheet 223.1).

Th
ese break-in oils are initially only planned for EU4 passenger car diesel engines or for vehicles which are equipped with a diesel particulate filter.

Mercedes-Benz specifications for engine oils (factory fill) V2002.2
oil requirements for initial fill oils

Mono/multigrade **MB working title** **SAE**	Name	=	**MB Sheet No.**							
			226.9 Multi 15 W -40 W	**225.0/.1** Mono/ Multi **Albatross** 30/ 15 W -30	**225.5** Mono/ Multi **Sirius** 15 W -40	**225.6** Multi **Topas** 10 W -40/ 5 -30	**225.7** Multi **Agate** 15 W -40	**225.8** Multi **Sapphire** 10 -40	**225.10 a.)** Multi **Diamond** 5 -30	**225.11 a.)** Multi **Opal** 5 -30
W W	W									
Application in engines **(see also Sheet 223.1)**	BR		CNG 300, 400 500, 900	(100, 600)	300, 400	300, 400, 500, 900, (600)	(100, 600)	100, 600	(100, 200, 600) see sheet 223.1 !	(600) see sheet 223.1 !

MB Read Across (based on ATC, ATIEL)	RA		no	no	no	no	yes o.)	yes o.)	yes o.)	yes o.)
Prescribed Additive Package	yes/no		no	yes	yes	no	yes	no	no	no
Additive packed to be used			5	3.9% Oloa 4659	14% LZ 3997	5	14.2% LZ 8885	14.2% LZ 8885	5	5
Possible base stock acc. ATIEL	MODEL		5	I	I	I, III, IV, V	I	I, III, IV, V	I, III, IV, V	II, III, IV, V
ACEA - only MB tests m.)		?	(A2-96)			B2-98 E4-99	A2-96	A2-96 A3-02	A3-02	A3-02
see ACEA 2002 European Oil Sequence		?	(E2-96) i.)			(E5-02) m.)	B2-98	B2-98 B3-98	B3-98 B4-02	B3-98 B4-02
Laboratory Tests										
Sulfated Ash	% b.w.	>	1.00	1.80	2.00	2.00	1.50	1.50	1.50	**0.80**
T BN (ISO 3771, fresh oil)	mgKOH/g	?	5	5	5	5	5	5	5	6.0
Pour point	°C	>	*/-27	*/-27	*/-27	-27	-27	-27	-36	-36
Evaporative Loss (CEC L-40-A-93, Noack)	%	>	13.0	13.0	13.0	13.0	13.0	13.0	10.0	12.0
Viscosity @high temp./high shear rate CEC L-36-A-97	mPa*s	>	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Sulfur	% b.w.	>	5	5	5	5	5	5	0.5	**0.20**
Phosphorus	% b.w.	>	5	5	5	5	5	5	0.11	**0,08**
Chlorine	% b.w.	>	5	5	5	5	5	5	0.005	0.0050
DBL	DBL		6610	6774	6674.00	6674.2 ff.	6674.10	6674	6674	6674
Elastomer Compatibility b.)	DBL		Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Engine Tests (x = number of tests for Package Pass)						acc. 228.5		acc. 229.1	acc. 229.5	acc. 229.31
M 111 (CEC L-53-T-95) c.)			x i.)					x	x	x l.)
Engine sludge avg.	merit	?	RHD 140+ 2 l	5	5	5	5	RHD 140+ 2 l	8.00 (a. 439h)	RHD 140+ 3 l
Cam wear avg.	Cm	>	5.0	5	5	5	5	5.0	5.0 (a. 439h)	3
M 111 (CEC L-54-T-96)										X
Fuel economy improvement vs. RHD 191	%	>	5	5	5	5	5	5	1.7	1.00
OM 611 DE22LA (MB DL, 300 h) c.) q.)						x q.)		x q.)	x q.)	x q.)
Piston cleanliness (avg. 4 pistons)	merit	?	5	5	5	27.0	5	23.0	27.0	25.00
Ring sticking	yes/no	>	5	5	5	no (ASF > 2.5)	5	no (ASF > 2.5)	no (ASF > 2.5)	no (ASF > 2.5)
Engine sludge avg.	merit	?	5	5	5	9.00	5	8.00	9.00	8.50
Viscosity increase at 100 °C p.) - target value	%	>	5	5	5	90	5	100.0	90	100.00
Oil consumption p.) q.) - target value	g/test	>	5	5	5	6000	5	6000.0	6000	6000.00
Bore polishing (13 mm) - max. value of 4 cyl.	%	>	5	5	5	3.0	5	4.0	3.0	3.50
T iming chain wear (elongation) p.) - target value	%	>	5	5	5	0.4	5	0.4	0.4	0.40
Cylinder wear (avg. 4 cylinder)	Cm	>	5	5	5	5.2	5	7.0	5.2	7.0
Cam wear, inlet/outlet valve (avg. max. wear 8 cams)	Cm	>	5	5	5	121.8/ 139.2	5	139.2/ 156.6	121.8/ 139.2	139.2/ 156.6
Bearing wear, main/con rod bearing e.)	Cm	>	5	5	5	2.1/2.1	5	2.1/2.1	2.1/2.1	2.1/2.1
Piston ring wear axial @ ring 1/ ring 2/ ring 3 e.)	Cm	>	5	5	5	8.7/2.8/ 2.4	5	10.4/4.2/ 2.4	8.7/2.8/ 2.4	10.4/4.2/ 2.4
Piston ring wear radial @ ring 1/ ring 2/ ring 3 e.	Cm	>	5	5	5	5.6/8.4/ 8.0	5	5.6/8.4/ 8.0	5.6/8.4/ 8.0	5.6/8.4/ 8.0

OM 602 A (CEC L-51-A-98) c.) k.)						x		x	x	x
Piston cleanliness (no ring sticking)	merit	?	5	5	5	26.0	5	20.0	26.0	24.0
Bore polishing (13 mm)	%	>	5	5	5	3.0	5	7.0	3.0	4.5
Cylinder wear avg. new/old	Cm	>	5	5	5	15.0/10.0	5	20.0/12.0	15.0/10.0	15.0/10.0
Cam wear avg. new/old	Cm	>	5	5	5	45.0/28.0	5	50.0/30.0	45.0/28.0	45.0/28.0
Oil consumption	kg/test	>	5	5	5	10.0	5	10.0	10.0	10.0
Viscosity increase at 40 °C	%	>	5	5	5	60.0	5	90.0	60.0	70.0
Engine sludge avg.	merit	?	5	5	5	9.00	5	8.80	9.00	8.90
VW TDI (CEC L-78-T-97) or (CEC L-78-T-99)									x	x
ACEA B4-02	Pass		5	5	5	5	5	5	yes	yes
VW PV 1449									x	x
V W 502.00 or PV 1449	Pass		5	5	5	5	5	5	yes	yes
DC tests for 225.10 or maintenance 2000 a.) **Bench Tests at DC**							x	x	x	x
M 111 E23	Pass		5	5	5	5	no	no	yes	no
(T est rig Snail program PSP)										
OM 611 DE 22LA (12 point DL)	Pass		5	5	5	5	no	no	no q.)	no
M 112 E32 (12 point DL)	Pass		5	5	5	5	no	no	yes	no
M 113 E43 (12 point DL)	Pass		5	5	5	5	no	no	yes	no
M 111 00E23 ML (40 point DL)	Pass		5	5	5	5	no	no	yes	no
Field Test (S: Snail, B: Barracuda)										
S: 1x A 140; 1x E 430	Pass		5	5	5	5	no	no	yes	no
B: 1x E 220 CDI 99; 1x A 170 CDI; 1x ML 320	Pass		5	5	5	5	no	no	yes	no
OM 364 LA (CEC L-42-T-99) c.) f.)						x				
Piston cleanliness	merit	?	5	5	5	50.0	5	5	5	5
Bore polishing	%	>	5	5	5	0.5	5	5	5	5
Cylinder wear avg.	Cm	>	5	5	5	2.5	5	5	5	5
Engine sludge avg.	merit	?	5	5	5	9.60	5	5	5	5
Oil consumption	kg/test	>	5	5	5	10.0	5	5	5	5
OM 364 A (CEC L-42-A-92) c.) f.)			x i.)							
Piston cleanliness	merit	?	31,0	5	5	5	5	5	5	5
Bore polishing e.)	%	>	8.0	5	5	5	5	5	5	5
Cylinder wear avg. e.)	Cm	>	7.0	5	5	5	5	5	5	5
Engine sludge avg.	merit	?	9.00	5	5	5	5	5	5	5
Oil consumption	kg/test	>	18.0	5	5	5	5	5	5	5
OM 441 LA Euro II (CEC L-52-T-97) c.) f.)						x d.)				
Engine sludge avg.	merit	?	5	5	5	9.00	5	5	5	5
Piston cleanliness	merit	?	5	5	5	40.0	5	5	5	5
General engine deposits	demerit	>	5	5	5	3.0	5	5	5	5
W ear rating avg.	demerit	>	5	5	5	2.5	5	5	5	5
Bore polishing	%	>	5	5	5	2.0	5	5	5	5
Cylinder wear avg.	mm	>	5	5	5	0.008	5	5	5	5
Ring sticking 2. piston rings	ASF	>	5	5	5	1.0	5	5	5	5
Specific oil consumption	g/h	>	5	5	5	100.0	5	5	5	5
Boost pressure loss at 400 hours	%	>	5	5	5	4.0 n.)	5	5	5	5
OM 501 LA Euro III actual production c.)										
All parameters	rating	?	5	5	5	ref. oil	5	5	5	5
OM 906 LA Euro III actual production c.)										
All parameters	rating	?	5	5	5	ref. oil	5	5	5	5

Quality assurance & certif. tests in DC factory & DC in-house tests in actual engines c.)										
All parameters	rating	?	5	5	ref. oil	ref. oil	ref. oil	ref. oil	ref. oil	ref. oil
Bearing Wear c.) d.)						x d.)				
for SAE X W -40 and X W -50, w. o. 0 W -40			5	5	5	no	5	5	5	5
for SAE X W -30 and 0 W -40			5	5	5	yes	5	5	5	5
Oil drain interval for OM 441 LA	h		5	5	5	400	5	5	5	5
Field Trail with Trucks d.)			x i.)			x d.)				
for SAE X W -40 and X W -50, w.o. 0 W -40			(yes) i.)	5	5	no	5	5	5	5
for SAE X W -30 and 0 W -40			(yes) i.)	5	5	requested	5	5	5	5
Field trail with Actros trucks - oil strategy 2000	Matrix		5	5	5	possible	5	5	5	5

Notes:

a.) For Sheet 225.10 and 225.11 please contact Mr. Schenk, EP/MGB, phone +49-711-17-53244 before you start. Further requirements are listed in the performance standard.

b.) Elastomer compatibility tests according VDA 675301 and DBL 6674 with materials NBR34, AK6, ACM E7503 and EAM D8948/200.1

c.) Rerating by MB, department EP/MGB for all related engine parts.

d.) Evaluation of bearing wear in a OM 441 LA engine with new crankshaft and premeasured bearings. Rerating by MB, department PBE/DHM
Conditions: Sheet 228.3/.5 no oil drain, Sheet 228.1 oil drain after 200 h.

e.)
T
he worst result can be replaced by the second worst to calculate the average.

f.) For sheet 227.0/.1 and 228.0/.1/.2/.3 approval to OM 364 LA test or OM 364 A test or OM 441 LA test is mandatory. For Sheet 228.0/.1 oil drain in OM 441 LA after 200 h.

g.) Shear stability (CEC L-14-A-93): stay in grade.

i.) Approval conditions for engine oils or natural gas (CNG) engines: positive field test with MB CNG buses or a pass result in a 500 h CNG engine test by MB do Brazil or a read across from MAN M 3271 approval.

k.) New/Old Limits.
T
he new limits are only valid for test runs after 11.6.97 with tappets from Euroval.

l.) RL 140 + 2 I with reference fuel batch 1.

m.)
W
hen ACEA E5-02 is claimed, our MB OM 441 LA test and all other tests within ACEA E5-02 are mandatory.

n.) For OM 441 LA tests started after 1.9.1999.

o.) MB Read Across for engine tests
is based on
A
T
C and
A
T
IEL Code of Practice. Regarding
A
T
IEL Base Oil Interchange (BOI) for sheet 225.8, 225.10 and 225.11 MB tests (M 111 Sludge,
M 111 Fuel Economy, OM 602 A or OM 611 DE 22 LA) have to be run in every case, other tests will not be accepted.

p.)
T
arget value - no
limit
!
If result does not meet the target value, additional support data is needed.

q.) For Sheet 225.11 both tests OM 611 DE 22 LA and OM 602 A have to be run. For all other sheets also both tests
OM 611 DE 22 LA and OM 602 A have to be run after 01/01/2003. After 01/01/2004 OM 602A will be not mandatory anymore.
T
he new 300 hrs. OM 611 DE 22 LA test replaces the 600 hrs. OM 611 DE 22 LA test in the test matrix for sheet 225.10.

Engine oils (Service)

These engine oils are for service purposes, in other words for the continued operation of engines at t

An overview of our requirements on service engine oils for a Mercedes-Benz approval is printed in the table "Mercedes-Benz specifications for engine oils (service fill) V2003.1" on the following pages.

Engine oils (service) for commercial vehicles with natural-gas engines and industrial engines (natural gas) in the commercial vehicles' sector

Sheet 226.9 (multigrade oils)

Engine oils as under Specification 226.9 have been approved for all stationary and non-stationary commercial vehicle natural-gas engines based on BR 300 and BR 400

Engine oils (service) for commercial-vehicle and passenger-car diesel fuel engines, and industrial engines (diesel) from the commercial-vehicle and passenger-car sectors (BR 300, BR 400, BR 500, BR 600, BR 900)

Th
ese engine oils can be used as a continued operation oil in certain Mercedes-Benz diesel engines.
Th
ese oils are not approved for gasoline-fuel engines
!

Sheet 227.0 (single-grade oils) and
Sheet 227.1 (multigrade oils)

Engine oils in accordance with Sheet 227.0/.1 are only approved for certain non-supercharged diesel engines (see Sheet 223.2).
Th
ey are only approved for use in supercharged diesel engines in exceptional cases, where for instance no engine oils as under sheets 228.0/.1/.2/.3/.5 are available. **New approvals for these operating fluid sheets** have not been granted since 01.01.2003
!
The two sheets are listed in Supplement 12 in the Mercedes-Benz Specifications for Operating Fluids. As of January 1st, 2004 these sheets will be deleted! As an alternative or substitute for these oils, the single-grade and multigrade oils listed in 228.0/.1/.2/.3/.5 can be used.
(for use, see Sheet 223.2).

Sheet 228.0 (single-grade oils) and
Sheet 228.1 (multigrade oils)
Engine oils in accordance with Sheet 228.0/.1 are approved for certain diesel engines.
Th
e requirements for an approval of these engine oils are listed on the following pages in the table "Mercedes-Benz specifications for engine oils (service fill) V2003.1".
Th
ese engine oils are required to fulfill at least ACEA E2. Beyond this are the more comprehensive specifications of DaimlerChrysler AG.
(for use, see Sheet 223.2).

Sheet 228.2 (single-grade oils) and
Sheet 228.3 (multigrade oils)
Engine oils in accordance with Sheet 228.2/.3 are approved for certain diesel engines (see Sheet 223.2).
Th
e requirements for an approval of these engine oils are listed on the previous pages in the table "Mercedes-Benz specifications for engine oils (service fill) V2003.1".
Th
ese engine oils are required to fulfill at least ACEA E3. Beyond this are the more comprehensive specifications of DaimlerChrysler AG.
(for use, see Sheet 223.2).

Engine oils (service) for
Passenger vehicle engines (BR 100, BR 200, BR 600),
Commercial vehicle engines from the passenger vehicle sector (BR 100, BR 200, BR 600) and
Industrial engines from the car sector (series 100, series 600)

Th
e engine oils on Sheets 229.1, 229.3, 229.31 and 229.5 can be used as continued running oils (service engine oils for the oil service) depending on quality and application in certain Mercedes-Benz passenger car engines.
Th
ese oils are **not** approved for commercial vehicle diesel engines BR 300, BR 400, BR 500, BR 900.

General information
In 1997 we introduced a new approval system for passenger car engine oils which has been considerably expanded compared to the earlier approval procedure and demands precise documentation of the oil quality.
Th
e approval control for passenger car engine oils which was valid up until then and based on the CCMC test sequences became invalid with the appearance of Sheet 229.1
!

Th
e current approval system for passenger car engine oils with Sheets 229.1, 229.3, 229.31 and 229.5 is in harmony with ACEA test sequences introduced for the first time on 01.01.96, however in respect of the requirements goes significantly beyond them.

Every engine oil approved by us are therefore required to also pass a gasoline and a passenger-car diesel test sequence.
We
regard it as important that all the engine tests relevant to our approval procedure are reappraised by us in the Abteilung Betriebstoffe (Operating Fluids department), EP/MGB, HPC C405, D-70546 Stuttgart and we get an insight into the relevant test bench report.

Sheet 228.5 (multigrade oils)
Engine oils in accordance with Sheet 228.5 are approved for certain diesel engines (see
(for use, see Sheet 223.2).

Thi
s approval system for passenger car engine oils has been made consistently more advanced and expanded since its introduction.

To
day our customers have an adequate choice of options with engine oils on Sheets 229.1, 229.3, 229.31 and 229.5 of the Mercedes-Benz Specifications for Operating Fluids so that they can decide for themselves on a particular quality level and an optimum engine oil for their operating conditions.

Th
e use of Sheets 229.1, 229.3, 229.31 and Sheet 229.5 in certain passenger car gasoline and passenger car diesel engines (BR 100, BR 200, BR 600) is described in more detail on Sheet 223.2.

Whi
ch engine or which vehicle can use which oil quality over which oil change interval is also listed in the Service Information for passenger cars: "Engine oil change" SI18.00-P-0011A dated 18.04.2002. In each case the maintenance procedures which are stipulated individually for each vehicle model apply.

Whi
ch requirements apply to an approval of these passenger car engine oils are listed on the following pages in the table "Mercedes-Benz specifications for engine oils (service fill) V2003.1".

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and B3 and B4. Beyond this are the more comprehensive specifications of DaimlerChrysler AG has further requirements.

Sheet 229.1 (multigrade oils)

Th
ese engine oils are approved for certain passenger car engines (BR 100, BR 200, BR 600), commercial vehicle engines from the passenger car range (BR 100, BR 200, BR 600) and industrial engines from the passenger car range (BR 100, BR 200, BR 600). (for use, see Sheet 223.2).

Th
e requirements for an approval of these engine oils are listed on the following pages in the table "Mercedes-Benz specifications for engine oils (service fill) V2003.1".
Th
ese engine oils must at least fulfill ACEA A2 or A3 and B2 or B3. Beyond this are the more comprehensive specifications of DaimlerChrysler AG.

The requirements for an approval of these engine oils are listed on the following pages

Compared with Sheet 229.1 these engine oils exhibit the following features:
- higher quality (with regard to wear and cleanliness)
- fuel saving potential
- better cold-starting properties
- better environmental compatibility (reduced chlorine and sulfur content).

Sheet 229.3 (multigrade oils)

Th
ese low-friction engine oils are approved for certain passenger car engines (BR 100, BR 200, BR 600), commercial vehicle engines from the passenger car range (BR 100, BR 200, BR 600) and industrial engines from the passenger car range (BR 100, BR 200, BR 600) and we highly recommend them. (for use, see Sheet 223.2).

Sheet 229.31 (multigrade oils with low sulfur content, low phosphor content and low content of ash-forming components - "Low SPAsh oils")

Th
ese Low SPAsh low viscosity engine oils are approved for certain passenger car engines (model 100, model 200, model 600), commercial vehicle engines from the passenger car range (model 100, model 200, model 600) and industrial engines from the passenger car range (model 100, model 200, model 600).
(for use, see Sheet 223.2).
For EU4 passenger car diesel engines or passenger car diesel-powered vehicles, which are equipped with diesel particulate filters, these "Low SPAsh" engine oils from Sheet 229.31 must be used !

Th
e requirements for an approval of these engine oils are listed on the following pages in the table "Mercedes-Benz specifications for engine oils (service fill) V2003.1". Approvals are only possible for low-viscosity engine oils, which comply with the low limits with regard to sulfur, phosphor content and the content of ash-forming components.
Th
e engine oils to be approved for Sheet 229.5 must at least meet ACEA A3 andB3 and B4. Beyond this are the more comprehensive specifications of DaimlerChrysler AG.

Compared with oils from Sheets 229.1/ 229.3 / 229.5 these oils also excel on account of:
- low sulfur content, low phosphor content and a low content of ash-forming components.
  T
  his means improved compatibility with exhaust gas aftertreatment systems such as, e.g. diesel particulate filter

Compared with oils from Sheet 229.1 these oils also excel on account of:
- improved environmental compatibility (reduced chlorine, sulfur and phosphor content)
- higher quality (with regard to wear and cleanliness)
- fuel saving potential
- better cold-starting properties

Th
e additive and mineral oil companies were notified by us on 9.8.2002 about the introduction of these new oil categories. Below follows an excerpt from this correspondence with a list of additional background information.

"T
o meet the coming emissions standards EU 4 and EU 5, in the future, additional exhaust gas aftertreatment systems, such as diesel particulate filters and NOx storage three way catalytic converters, will be necessary in passenger cars.

Th
ese exhaust gas aftertreatment systems must fulfill their function reliably over a very long application period specified by the legislator and must not be impaired or even destroyed by components of the engine oil.

Th
e aim is therefore to use such engine oils which if possible have no influence or a slight negative influence on these exhaust gas aftertreatment systems and permit a long life of these systems.
Th
erefore on the one hand this engine oil must maintain the effectiveness of EU 4 / EU 5 emission cleaning systems over long runtimes and on the other hand exhibit the previous good performance.

It is necessary to significantly reduce the content of ash-forming components of the engine oil (measured quantity is the sulfated ash) and simultaneously to reduce the sulfur and phosphorous content to a lower level.
Th
ese requirements have a very significant influence on the selection of base stocks and additives and consequently on the oil formulations.

The performance of these engine oils, which means low wear and good cleanliness for

---

Th
e aim is thus the development of an engine oil with low sulfur content, low phosphorous content and low content of ash-forming components of the engine oil (low ash) or in brief a so-called "Low SPAsh" engine oil.

Th
e new service oil specification will be designated as Sheet 229.31, the new First-Fill oil specification will be designated as Sheet 225.11 of the Mercedes-Benz Specifications for Operating Fluids.

It is planned that the new service engine oils on Sheet 229.31 may be used in all new as well as old passenger car gasoline and passenger car diesel engines. Downwards compatibility should be maintained.

Wit
h this letter on the one hand we want to inform you about the technical requirements and on the other hand about the planned introduction date in the Mercedes-Benz Specifications for Operating Fluids.

As in the past the technical requirements are based on laboratory and engine tests.

Th
e detailed requirements for an approval of these engine oils are listed on the following pages in the
Ta
ble "Mercedes-Benz specifications for engine oils (service fill) ".

"T
he sulfur content is limited to a maximum of 0.20% by weight, the phosphorous content to a maximum of 0.08% by weight and the sulfated ash must be less than 0.80% by weight.

To
gether with the Sheets 229.31 and 225.11 a new engine test is introduced based on the passenger car diesel engine OM 611 DE 22 LA (MB in-house program, 300 hours runtime, sulfur-free diesel fuel !).

In the case of Sheets 229.31 and 225.11 this test is to be run in addition to the OM 602 A test which is already known.
Th
e OM 602 A test is as always necessary right from the start in order to safeguard the downwards compatibility and operation with high-sulfur diesel fuel.

Should you still have questions on the approval procedure, on the approval requirements or approval conditions, we will be pleased to discuss this in detail with you.
Contact: Mr. Schenk, Abteilung Betriebsstoffe [Operating Fluids Department] EP/MGB,
Tel
.:+49 (0) 711 17 53244,
e-mail: Michael.Schenk@DaimlerChrysler.com.

Sheet 229.5 (multigrade oils)
Th
ese low-viscosity engine oils are approved for specific passenger car engines (model 100, model 200, model 600), commercial vehicle engine from the passenger car sector (model 100, model 200, model 600) and industrial engines from the passenger car sector (model 100, model 200, model 600) except the gasoline engine M 166 from the A-Class and are specifically recommended by us. For use, see Sheet 223.2.

Compared with Sheet 229.1 and 229.3 the engine oils are characterized by:
- highest quality (with regard to wear and cleanliness) for approved passenger car engine oils
- even further improved fuel saving potential
- potential for even longer oil change intervals (in combination with new oil filter elements)
- further improved environmental compatibility

Although these oils will possibly be more expensive due to these advantageous properties.

Th
e most important requirements which we stipulate for an approval of engine oils for the oil service can be seen in the following overview table "Mercedes-Benz specifications for engine oils (service fill) V2002.2".

Requirements for approval of these engine oils are listed on the following pages in the table "Mercedes-Benz specifications for engine oils (service fill) V2003.1". The eng

Mercedes-Benz specifications for engine oils (service fill) V2002.2
Service oil requirements

			MB Sheet No.								
Mono/multigrade			**226.9** Multi	**227.0/.1 a.)** Mono/ Multi	**228.0/.1** Mono/ Multi	**228.2/.3** Mono/ Multi	**228.5** Multi	**229.1** Multi	**229.3** Multi	**229.31 a.)** Multi	**229.5 a.)** Multi

Viscosity Grades	SAE		acc. ACEA	acc. ACEA	acc. ACEA	acc. ACEA X W	acc. ACEA W W	acc. ACEA W W	0 - , 5 - X	0 - , 5 -, 10 - X	0 -, 5 -, 10 - X
SAE XW-30 and 0W-40		?	no	no	yes d.) g.)	yes d.) g.)	yes d.) g.)	A3-02+ B3-98	A3-02+ B3-98	A3-02+ B3-98	A3-02+ B3-98
MB Read Across (based on ATC, ATIEL)	RA		no	no	no	no	no	yes o.)	yes o.)	yes o.)	yes o.)
Package Pass 15W-40/20W-40/20W-50 (SN)	possible		(yes)	yes	yes	yes	no	no	no	no	no
ACEA - only MB tests m.)		?	(A2-96)	B2-98	B2-98	B2-98 E3-96	B2-98 E4-99	A2-96 A3-02	A3-02	A3-02	A3-02
see ACEA 2002 European Oil Sequence		?	(E2-96) i.)	(E2-96)	E2-96	(E5-02) m.)	(E5-02) m.)	B2-98 B3-98	B3-98 B4-02	B3-98 B4-02	B3-98 B4-02
Laboratory Tests											
Sulfated Ash	% b.w.	>	1.00	1.80	2.00	2.00	2.00	1.50	1.50	**0.80**	1.50
T BN (ISO 3771, fresh oil)	mgKOH /g	?	5	5	5	5	5	5	5	6.0	5
Pour point	°C	>	*/-27	*/-27	*/-27	*/-27	-27	-27	-36	-36	-36
Evaporative Loss (CEC L-40-A-93, Noack)	%	>	13.0	13.0	13.0	13.0	13.0	13.0	13.0	12.0	10.0
Viscosity @high temp./high shear rate CEC L-36-A-97	mPa*s	?	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Sulfur	% b.w.	>	5	5	5	5	5	5	0.5	**0.20**	0.50
Phosphorus	% b.w.	>	5	5	5	5	5	5	5	**0,08**	0.11
Chlorine	% b.w.	>	5	5	5	5	5	5	0.0100	0.0050	0.0050
DBL	DBL		6610	6612	6610	6610	6610	6615	6615	6615	6615
Elastomer Compatibility b.)	DBL		Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Engine Tests (x = number of tests for Package Pass)											
M 111 (CEC L-53-T-95) c.)			x i.)					x	x l.)	x l.)	x
Engine sludge avg.	merit	?	+ 2 l	5	5	5	5	+ 2 l	+ 3 l	+ 3 l	8.00 (a. 439h)
Cam wear avg.	Cm	>	5.0	5	5	5	5	5.0	3.0	3.0	5.0 (a.439h)
M 111 (CEC L-54-T-96)									x	x	x
Fuel economy improvement vs. RHD 191	%	>	5	5	5	5	5	5	1.00	1.00	1.70

OM 611 DE22LA					x q.)	x q.)	x q.)	x q.)	x q.)	x q.)	x q.)
(MB DL, 300h) c.) q.)											
Piston cleanliness	merit	?	5	5	23.0	25.0	27.0	23.0	25.0	25.0	27.0
(avg. 4 pistons)											
Ring sticking	yes/no	>	5	5	no (ASF > 2.5)	no (ASF > 2.5)	no (ASF > 2.5)	no (ASF > 2.5)	no (ASF > 2.5)	no (ASF > 2.5)	no (ASF > 2.5)
Engine sludge avg.	merit	?	5	5	8.00	8.50	9.00	8.00	8.50	8.50	9.00
Viscosity increase at 100 °C p.)	%	>	5	5	100	100	90	100	100	100	90
- target value											
Oil consumption p.) q.)	g/test	>	5	5	6000	6000	6000	6000	6000	6000	6000
- target value											
Bore polishing (13 mm)	%	>	5	5	4.0	3.5	3.0	4.0	3.5	3.5	3.0
- max. value of 4 cyl.											
T	%	>	5	5	0.4	0.4	0.4	0.4	0.4	0.4	0.4
iming chain wear (elongation) p.)											
- target value											
Cylinder wear (avg. 4 cylinder)	Cm	>	5	5	7.0	7.0	5.2	7.0	7.0	7.0	5.2
Cam wear, inlet/outlet valve	Cm	>	5	5	139.2/	139.2/	121.8/	139.2/	139.2/	139.2/	121.8/
(avg. max. wear 8 cams)					156.6	156.6	139.2	156.6	156.6	156.6	139.2
Bearing wear,	Cm	>	5	5	2.1/2.1	2.1/2.1	2.1/2.1	2.1/2.1	2.1/2.1	2.1/2.1	2.1/2.1
main/con rod bearing e.)											
Piston ring wear axial	Cm	>	5	5	10.4/4.2/	10.4/4.2	8.7/2.8	10.4/4.2	10.4/4.2	10.4/4.2	8.7/2.8
@ ring 1/ ring 2/ ring 3 e.)					2.4	/2.4	/2.4	/2.4	/2.4	/2.4	/2.4
Piston ring wear radial	Cm	>	5	5	5.6/8.4/	5.6/8.4/	5.6/8.4/	5.6/8.4/	5.6/8.4/	5.6/8.4/	5.6/8.4/
@ ring 1/ ring 2/ ring 3 e.)					8.0	8.0	8.0	8.0	8.0	8.0	8.0
OM 602 A (CEC L-51-A-98) c.) k.)				(x) a.)	x	x	x	x	x	x	x
Piston cleanliness	merit	?	5	20.0	22.0	24.0	26.0	20.0	24.0	24.0	26.0
(no ring sticking)											
Bore polishing (23 mm)	%	>	5	7.0	6.0	4.5	3.0	7.0	4.5	4.5	3.0
Cylinder wear avg. new/old	Cm	>	5	20.0/	18.0/	15.0/	15.0/	20.0/	15.0/	15.0/	15.0/
				12.0	11.0	10.0	10.0	12.0	10.0	10.0	10.0
Cam wear avg. new/old	Cm	>	5	50.0/	50.0/	45.0/	45.0/	50.0/	45.0/	45.0/	45.0/
				30.0	29.0	28.0	28.0	30.0	28.0	28.0	28.0
Oil consumption	kg/test	>	5	10.0	10.0	10.0	10.0	10.0	10	10	10.0
Viscosity increase at 40 °C	%	>	5	90.0	80.0	70.0	60.0	90.0	70.0	70.0	60.0
Engine sludge avg.	merit	?	5	8.80	8.90	8.90	9.00	8.80	8.90	8.90	9.00
VW TDI (CEC L-78-T-97) or									x	x	x
(CEC L-78-T-99)											
ACEA B4-02	Pass		5	5	5	5	5	5	yes	yes	yes
VW PV 1449									x	x	x
V	Pass		5	5	5	5	5	5	yes	yes	yes
W											
502.00 or PV 1449											
DC tests package for 229.5 a.)											x
Bench Tests at DC											
M 111 E23	Pass		5	5	5	5	5	no	no	no	yes
(											
T											
est bench Snail program PSP)											
OM 611 DE 22LA	Pass		5	5	5	5	5	no	no	no	no q.)
(12 point DL, 600 hrs.) q.)											
M 112 E32 (12 point DL)	Pass		5	5	5	5	5	no	no	no	yes
Field Test (S: Snail,											
B: Barracuda)											
S: 1x C 320	Pass		5	5	5	5	5	no	no	no	yes
B: 1x E220 CDI 99;	Pass		5	5	5	5	5	no	no	no	yes
1x A 170 CDI;											
1x ML 320											

OM 364 LA (CEC L-42-T-99) c.) f.)				(2x) a.)	3 X	3 X	x				
Piston cleanliness	merit	?	5	35.0	40.0	45.0	50.0	5	5	5	5
Bore polishing	%	>	5	6.0	3.5	1.0	0.5	5	5	5	5
Cylinder wear avg.	Cm	>	5	4.0	3.5	3.0	2.5	5	5	5	5
Engine sludge avg.	merit	?	5	9.30	9.40	9.50	9.60	5	5	5	5
Oil consumption	kg/test	>	5	20.0	16.0	12.0	10.0	5	5	5	5
OM 441 LA Euro II (CEC L-52-T-97) c.) f.)					3x d.)	3x d.)	x d.)				
Engine sludge avg.	merit	?	5	5	9.00	9.00	9.00	5	5	5	5
Piston cleanliness	merit	?	5	5	20.0	25.0	40.0	5	5	5	5
General engine deposits	demerit	>	5	5	3.0	3.0	3.0	5	5	5	5
W ear rating avg.	demerit	>	5	5	2.5	2.5	2.5	5	5	5	5
Bore polishing	%	>	5	5	3.0	2.0	2.0	5	5	5	5
Cylinder wear avg.	mm	>	5	5	0.008	0.008	0.008	5	5	5	5
Ring sticking 2. piston rings	ASF	>	5	5	1.0	1.0	1.0	5	5	5	5
Specific oil consumption	g/h	>	5	5	100.0	100.0	100.0	5	5	5	5
Boost pressure loss at 400 hours	%	>	5	5	R&R n.)	9.0 n.)	4.0 n.)	5	5	5	5
Bearing Wear c.) d.)					x d.)	x d.)	x d.)				
for SAE X W -40 and X W -50, w. o. 0 W -40			5	5	no	no	no	5	5	5	5
for SAE X W -30 and 0 W -40			5	5	yes	yes	yes	5	5	5	5
Oil drain interval for OM 441 LA	h		5	5	5/200	5/400	400	5	5	5	5
Field Trail with Trucks d.)			x i.)		x d.)	x d.)	x d.)				
for SAE X W -40 and X W -50, w.o. 0 W -40			(yes) i.)	5	no	no	no	5	5	5	5
for SAE X W -30 and 0 W -40			(yes) i.)	5	no	no	requested	5	5	5	5
Field trail with Actros trucks - oil strategy 2000	Matrix		5	5	5	possible	possible	5	5	5	5

Notes:

a.) For Sheets 229.5 and 229.31 please contact Mr. Schenk, EP/MGB, phone +49-711-17-53244 before you start. Further requirements are listed in the performance standard.
No new approvals will be given for Sheet 227.0/.1 after 01/01/2003.

b.) Elastomer Compatibility tests according VDA 675301 and DBL 6674 with materials NBR 34, AK6, ACM E7503 and EAM D8948/200.1

c.) Rerating by MB, department EP/MGB for all related engine parts.

d.) Evaluation of bearing wear in a OM 441 LA engine with new crankshaft and premeasured bearings. Rerating by MB, department PBE/DHM
Conditions: Sheet 228.3/.5 no oil drain, Sheet 228.1 oil drain after 200h.

e.)
T
he worst result can be replaced by the second worst to calculate the average.

f.) For sheet 227.0/.1 and 228.0/.1/.2/.3 approval a OM 364 LA test or a OM 441 LA test is mandatory. Only for Sheet 228.0/.1 oil drain in OM 441 LA after 200h.

g.) Shear stability (CEC L-14-A-93): stay in grade.

i.) Approval conditions for engine oils for natural gas (CNG) engines: positive field test with MB CNG busses or a pass result in a 500h CNG engine test by MB do Brazil or a read across from MAN M 3271 approval.

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k.) New/Old Limits.
T
he new limits are only valid for test runs after 11.6.97 with tappets from Euroval.

l.) RL 140 + 2 l with reference fuel batch 1.

m.)
W
hen ACEA E5-02 is claimed, our MB OM 441 LA test and all other tests within ACEA E5-02 are mandatory.

n.) For OM 441 LA tests started after 1.9.1999.

o.) MB Read Across for engine tests is based on
A
T
C and
A
T
IEL Code of Practice. Regarding
A
T
IEL Base Stock Interchange (BOI) for Sheet 229.1/.3/.31 and 229.5 MB tests (M 111 sludge, M 111 Fuel Economy or OM 602 A or OM 611 DE 22 LA) have to be run in every case, other tests will not be accepted.

p.)
T
arget value - no
limit
!
If test result does not meet the target value, additional support data in MB engines tests is needed.

q.) For sheet 229.31 both tests OM 611 DE 22 LA and OM 602 A have to be run as long as OM 602 A test available.
For all other sheets also both tests OM 611 DE 22 LA and OM 602 A have to be run after 01/01/2004
OM 602 A will be not mandatory anymore.
T
he new 300 hrs. OM 611 DE 22 LA test replaces the 600 hrs. OM 611 DE 22 LA test in
the test matrix for sheet 229.5.

Comments on and supplements to the requirements for engine oils

In the overview tables shown previously on the requirements for engine oils (Factory and Service Fill), i.e. in the "Mercedes-Benz specifications for engine oils" only the most important requirements are listed in the interest of clarity. Further requirements and details can be obtained from the appropriate DBL delivery instructions.
Th
e Abteilung Betriebstoffe [operating fluids department] EP/MGB, HPC C405, D-70546 Stuttgart, will also be pleased to provide you with information on this.

Apart from quality the viscosity (SAE grades) must also be observed when selecting engine oils. Information on this can be found on Sheets 223.1 or 223.2 and on Sheets 224.1 or 224.2.
Not every grade of approved engine oil is available with its respective viscosity grade. Single-grade engine oils are only approved for certain types of engine in summer.
To
day, they should only be used in pronouncedly warmer climes (in the corresponding SAE class).