

Fluids and Lubricants
Specification

A001061/23E

(For all engine series)

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1 Preface

The service life, operational reliability and function of the drive systems are largely dependent on the fluids and lubricants employed. Correct selection and handling of fluids and lubricants are therefore extremely important. Relevant instructions are contained in these Fluids and Lubricants Specifications.

The Fluids and Lubricants Specifications will be amended or supplemented as necessary. Before using, make sure you have the latest version.

If you have further queries, please contact your MTU representative.

Test standards for fluids and lubricants:

DIN	Federal German Standards Institute
EN	European Standards
ISO	International Standards Organisation
ASTM	American Society for Testing and Materials
IP	Institute of Petroleum

Use of the approved fluids and lubricants, whether under the brand name or specification given in this publication, constitutes part of the warranty conditions.

The supplier of the fluids and lubricants is responsible for the world-wide standard quality of the named products.



Drive system fluids and lubricants can be inherently dangerous. Certain regulations must be obeyed when handling, storing and disposing of them.

These regulations are contained in the manufacturers' instructions, legal requirements and technical guidelines valid in the individual countries. Great differences can apply from country to country and a generally valid guide to applicable regulations for fluids and lubricants is therefore impossible.

Users of the products named herein are therefore obliged to inform themselves of the locally valid regulations. MTU accepts no responsibility whatsoever for improper or illegal use of the fluids and lubricants approved by them.

2 Lubricants

2.1 Engine Oils

2.1.1 Requirements for MTU Approval (Diesel Engines)

The MTU requirements for approval of engine oils for diesel engines are contained in the MTU Factory Standard MTL 5044, and for gas engines in MTU Factory Standard MTL 5074. These standards can be ordered under these titles.

The engine-oil manufacturer will be notified in writing when his product is approved.

Approved engine oils are divided into the following MTU quality groups:

- Oil Category 1: Normal-quality oils
- Oil Category 2: Higher-quality oils
- Oil Category 3: Highest-quality oils

Selection of a suitable engine oil is based on fuel quality, intended oil drain interval and on-site climatic conditions. At present there is no international industrial standard which alone takes into account all these criteria.

2.1.2 Special Features

2.1.2.1 Engine Oils for Series 2000 and Series 4000 Engines

Engine oils other than those approved in Section 6 may be used in these engines provided they meet all the specifications given in Tables 1 and 2.

Performance Requirements for Series 2000 and Series 4000 Engine Oils

Table 1

Oil Category 1	API CG-4 and ACEA E2-96
Oil Category 2	ACEA E3-96

Note:

Engine oils meeting only one of the following standards, ACEA E1-96, API CF or API CF-4, or a combination of them, do not fulfil the entire performance requirements.

If these oils are intended for use, the oil drain interval is to be shortened after consultation with MTU.

Required Chemical and Physical Properties for Engine Oils

Table 2

	Test Method	Limit Value
Total base number (TBN)	ASTM D2896 ISO 3771	> 8mgKOH/g
Shear stability	ASTM D 3945 or CEC-L-14-A-88	Limit values of respective viscosity class
Deposit test ¹⁾	MTV 5040	Max. 110 mg
Evaporation loss (NOACK)	ASTM D 5800 or CEC-L-40-A-93	Max. 13%

¹⁾ Required for multi-grade oils used in closed crankcase ventilation.

2.1.2.2 Applications under Difficult Operating Conditions

Category 2 or Category 3 oils are generally prescribed for fast commercial ferries using Series 595 or Series 1163 engines.

2.1.3 Engine Oil Requirements for Gas Engines

The selection of a suitable engine oil for gas engines depends primarily on the type of gas used to power the engine. Another significant factor is the quality of the gas regarding its purity. This requires that the operator regularly carries out gas checks. The gas-engine oils to be used feature a low ash content (< 0.6%) and total base numbers within a range of 4-6 mgKOH/g. This prevents increased ash deposits which can lead to reduced catalytic converter performance.

2.1.4 Viscosity Grade Selection

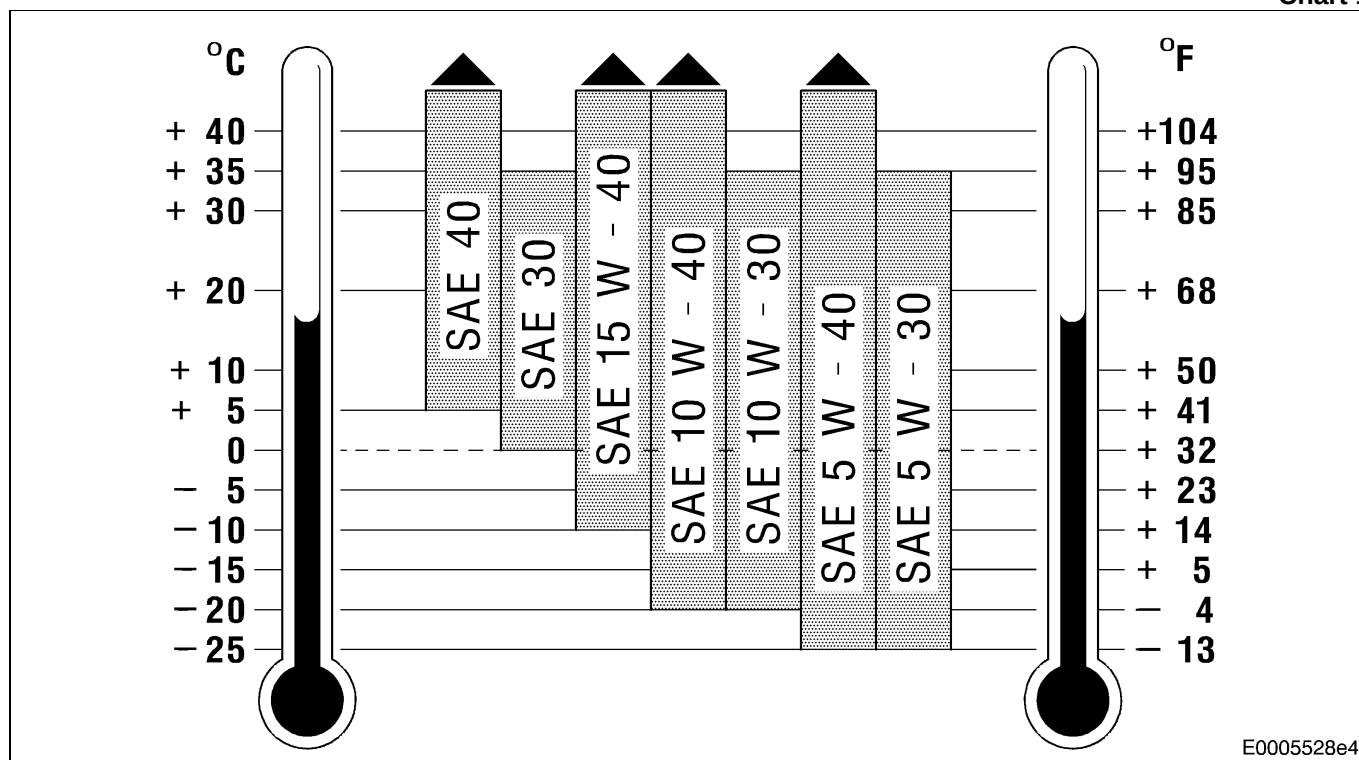
Selection of the viscosity grade is based primarily on the ambient temperature at which the engine is to be started and operated. If the relevant performance criteria are observed, the engines can be operated both with single-grade and multi-grade oils, depending on application.

Multi-grade oils are used only in open crankcase ventilation systems, such as in off-highway vehicles (e.g. tractors, earth-moving equipment, dump haulers). If the prevailing temperature is too low, the engine oil must be pre-heated.



Viscosity grade SAE 40 is prescribed for gas engines!

Chart 1



2.1.5 Oil Drain Intervals for Diesel Engines

Engine-oil drain interval depends on the engine-oil quality, its conditioning, the operating conditions and the fuel used.

Specific limits based on previous experience are given in the appropriate Maintenance Schedules and Operating Instructions.

The oil drain intervals must be determined by oil analysis if one or more of the following difficult operating conditions is encountered:

- Extreme climatic conditions
 - High engine-startup frequency
 - Frequent and prolonged idling or low-load operation
 - High fuel sulfur content of 0.5% to 1.5% by weight (see 2.1.9 "Use of High-sulfur Fuel")
- New oils are to be chosen that have total base numbers corresponding to the sulfur content of the fuel used (see 2.1.8 "Laboratory Analysis").

The engine oils are to be changed after two years at the latest in applications with short operating periods.

Engine oils with higher corrosion-inhibiting properties (see 6.1.1) must be changed every 3 years at the latest.

In individual cases the engine-oil drain intervals can be optimised by regular laboratory analysis and engine inspections:

The first or "reference" sample of the new oil must be taken from the engine after approx. 1 hour's operation. Further samples are to be analyzed at specific intervals, determined by engine hours run (see 2.1.8 "Laboratory Analysis").

The appropriate engine inspections are to be carried before and after oil analysis.

After completion of all analyses, special agreements may be made for individual cases, depending on the findings.

2.1.6 Oil Drain Intervals for Gas Engines

Determine the oil drain intervals based on the oil analyses as described in the individual Maintenance Schedule. Regular oil analysis is necessary because of the varying gas qualities. It is recommended that oil samples be examined every 500 operating hours.

In individual cases, the oil change intervals can also be optimised:

This requires oil samples to be analyzed every 200 - 250 operating hours (see 2.1.8 "Laboratory Analysis")

The oil samples must always be taken from the provided extraction point and under the same conditions.

2.1.7 Special Additives

Engine oils approved by MTU have been specially developed for diesel engine service and have all necessary properties, further additives are therefore superfluous and may even be harmful.

2.1.8 Laboratory Analysis

2.1.8.1 General

Engine oil analysis can be ordered from the MTU laboratory, oil-analysis laboratories or the oil manufacturer.

The oil sample must be extracted in accordance with the operating instructions.

The following data are required:

- Oil manufacturer
- Brand name with viscosity class
- Oil service life to date
- Serial number of engine from which oil sample was taken

The following must be submitted:

- Min. 0.25 litre used oil
- Min. 0.25 litre reference sample (after approx. 1 hour operation) or new oil

2.1.8.2 Used-oil Analysis

In order to check the used oil, it is recommended that regular oil analysis be carried out. Oil samples should be taken at least during each oil change, and even more often under certain circumstances, depending on engine application.

The test methods and limit values stated in Table 3 and Table 4 ("Analytical Limit Values for Diesel / Gas Engines") indicate when the result of an individual oil sample analysis should be regarded as abnormal when any historical information on the engine or the oil is not available.

An abnormal result requires immediate investigation and remedy of the abnormal operating condition.

Analytical Limit Values for Diesel Engines**Table 3**

	Test Method	Limit Value
Viscosity at 100 °C Max. mm ² /s	ASTM D 445 DIN 51562	SAE 30 SAE 5W-30 14.0 SAE 10W-30
		SAE 40 SAE 10W-40 18.0 SAE 15W-40
Min. mm ² /s		SAE 30 SAE 5W-30 9.0 SAE 10W-30
		SAE 40 SAE 10W-40 11.5 SAE 15W-40
Flash point °C	ASTM D 92 ISO 2592	Min. 190
Soot	DIN 51452	Max. 2.0% by weight
Total contamination	DIN 51365	Max. 2.5% by weight
Total base number (TBN) (mg KOH/g)	ASTM D 2896 ISO 3771	Min. 50% of new-oil value
Water	ASTM D 1744	Max. 0.2% by volume
Glycol	ASTM D 2982 DIN 51375	Max. 0.1 %

Analytical Limit Values for Gas Engines**Table 4**

	Test Method	Limit Value
Viscosity at 100 °C	ASTM D 445	
Max. mm ² /s	DIN 51562	SAE 40 17.5
Min. mm ² /s		SAE 40 11.5
Total contamination	DIN 51365	Max. 0.5% by weight
Total base number (mg KOH/g)	ASTM D 2896 ISO 3771	Min. 3
Acid number (mgKOH/g)	ASTM D 664	Max. 80% of actual base number
pH value		Min. 4.5
Water	ASTM D 1744	Max. 0.2% by volume
Oxidation at 5.8 µm	IR	Max. 20 A/cm
Nitration at 6.1 µm	IR	Max. 20 A/cm
Wear elements (mg/kg)	RFA, ICP	
Iron (Fe)		Max. 30 mg/kg
Lead (Pb)		Max. 20 mg/kg
Aluminium (Al)		Max. 10 mg/kg
Copper (Cu)		Max. 20 mg/kg
Tin (Sn)		Max. 5 mg/kg
Silicon (Si)		Max. 15 mg/kg

The limit values are based on individual oil samples. When these limit values are reached or exceeded, an immediate oil change is necessary. The results of the oil analysis do not necessarily give an indication of the wear status of certain components.

In addition to the analytical limit values, engine condition, operational requirements and possible malfunctions are also decisive factors governing the oil drain interval.

Other signs of oil deterioration are:

- Abnormally heavy deposits or precipitates in the engine or engine-mounted parts such as oil filters, centrifugal oil filters, or separators, especially in comparison with previous analysis.
- Abnormal discoloration of subassemblies.

2.1.8.3 Spectrometric Oil Analysis

An analysis of the engine oil's additive-metal content will be carried out by the MTU laboratory to determine the oil brand.

MTU does not generally analyse the oil's wear-metal contents in order to determine the degree of engine wear. These content levels are very much dependent on the following factors, among others:

- Individual engine equipment
- Tolerance scatter
- Operating conditions
- Duty profile
- Fluids and lubricants
- Miscellaneous assembly materials

It is therefore impossible to draw definite conclusions on the wear status of the respective engine parts, which means that no limit values can be given for wear-metal contents.

2.1.9 Use of High-sulfur Fuel

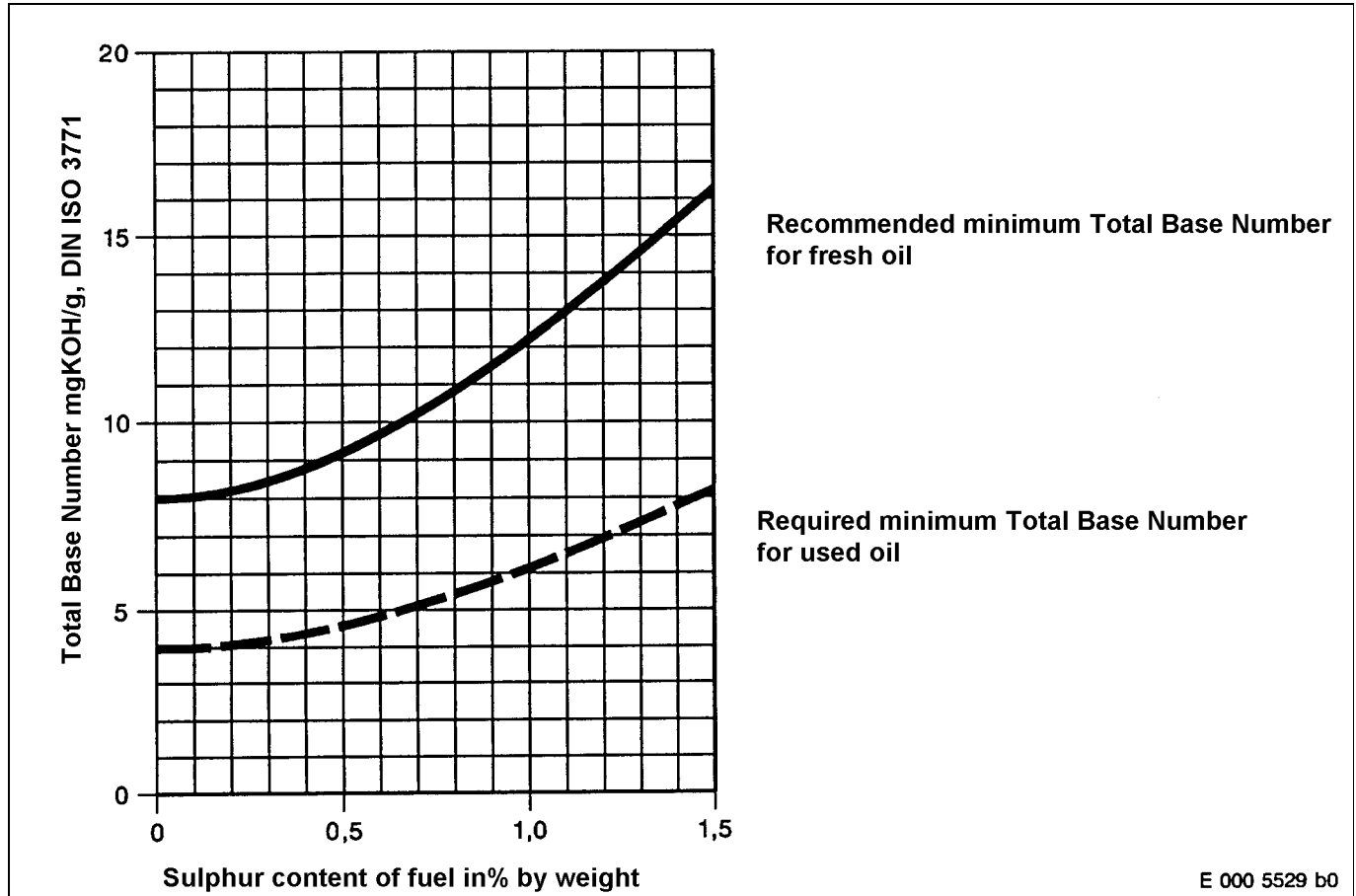
The following measures must be taken in the case of fuels with a sulfur content over 0.5%:

- Use of an engine oil with a total base number (TBN) (ASTM D 2896) of more than 8 mgKOH/g.
- The oil drain interval is to be shortened (see 2.1.5 "Oil Drain Intervals for Diesel Engines").

Chart 2 (total base number) shows the recommended initial TBN for new oil and the recommended minimum TBN for used oil depending on the fuel's sulfur content.

Engine Oil Total Base Numbers Depending on Fuel's Sulfur Content

Chart 2



2.1.10 Use of Low-sulfur Fuel

The use of fuels with low sulfur content (< 0.5%) does not influence the oil drain intervals.

2.1.11 Minimum Requirements for Operational Checks

The oil analysis required by the Maintenance Schedule can be made using the MTU Test Kit. This test kit contains all the necessary equipment and instructions.

The following checks can be performed:

- Determination of oil dispersancy (spot test)
- Determination of fuel content
- Determination of water content

2.2 Lubricating Greases

2.2.1 Requirements

The MTU conditions for lubricating-grease approval are specified in the MTU Factory Standard MTL 5050 which can be ordered under this title.

The grease manufacturer will be notified in writing after his product has been approved by MTU.

2.2.2 General Purposes

Lithium-saponified greases are to be used for all lubrication points with the exception of:

- Emergency air shut-off flaps located between the turbocharger and intercooler (see 2.2.3 "High Melting-point Greases")
- Coupling internal centerings

2.2.3 High Melting-point Greases

This type of grease must be used for emergency air shut-off flaps located between the turbocharger and intercooler:

- Aero Shell Grease 15

General-purpose greases suffice for emergency air shut-off flaps which are located before the turbocharger or after the intercooler.

2.2.4 Coupling Internal Centerings

Lubricating grease for internal centerings:

- Esso Unirex N3

2.3 Special Purpose Lubricants

2.3.1 Turbochargers

Exhaust turbochargers with integrated oil supply are generally connected to the engine oil system.

For ABB exhaust turbochargers with self-contained oil systems, ISO-VG68 viscosity-grade turbine oils with a mineral-oil base must be used.

2.3.2 Gear Couplings

Depending on the application, the following lubricants have been approved for gear couplings:

- Klüber: Structovis BHD MF (highly viscous lubricating oil)
- Klüber: Klüberplex GE11-680 (adhesive transmission agent)

Guidelines on use and service life are contained in the relevant Operating Instructions and Maintenance Schedules.

3 Coolants

3.1 Requirements

Coolant must be prepared from suitable fresh water and an MTU-approved coolant additive.

Mixing of different coolant additives is prohibited.

The MTU conditions for coolant additive approval are specified in MTU Factory Standards (MTL). The following standards are available:

- Emulsifiable corrosion preventive oils, MTL 5047
- Antifreeze (corrosion inhibiting), MTL 5048
- Water-soluble corrosion inhibitors, MTL 5049

The coolant manufacturer will be informed in writing after his product has been approved by MTU.

3.2 Fresh Water

For coolant preparation, use only clean, clear water with the following values (Table 5):

Table 5

	Min.	Max.
Total alkaline earth metals ¹⁾ (water hardness)	0 mmol/l 0°d	2.7 mmol/l 15°d
pH-Wert at 20°C	6.5	8.0
Chloride ions		100 mg/l
Total anions		200 mg/l

¹⁾ Common designations for water hardness in various countries:

1mmol/l = 5.6°d = 100 mg/kg CaCO₃

- 1°d = 17.9 mg/kg CaCO₃, USA hardness
- = 1.79° French hardness
- = 1.25° British hardness

3.3 Emulsifiable Corrosion Preventive Oils

An emulsion with 2.0% (by volume) corrosion preventive oil must be used for initial filling or refilling after cleaning the system.

Emulsions of MTU-approved corrosion preventive oils (1.0 - 2.0% by volume) and suitable fresh water provide adequate corrosion protection.

Some corrosion preventive oils tend to foam if used with completely desalinated water. This can be avoided by adding an appropriate quantity of harder water.

It is advisable to first mix the required quantity of corrosion preventive oil with 4 to 5 times the same amount of fresh water in a container, and to introduce this mixture into the system with the engine running at operating temperature.

In maintenance stations or multi-engine installations the complete amount of coolant required should be prepared in a separate container, it can then be used for initial filling or replenishment as required.



Under unfavourable conditions, individual cases of bacterial attack in the coolant emulsions may occur. In such a case, and after consultation with the MTU chemical laboratory, the emulsion is to be treated with biocides.

Coolant emulsions must not be used for engines with TB (with plate-core heat exchanger) and TE cooling systems in the 396 and 183 series.

3.4 Antifreezes with Corrosion Inhibiting Properties

3.4.1 General

These antifreezes are necessary for engines without heating facilities and operating in areas where below-freezing temperatures may occur.

Provided that the specified concentrations are maintained, these MTU-approved antifreezes ensure adequate corrosion protection.

The antifreeze concentration must therefore be determined not only in accordance with the minimum anticipated temperatures but with the corrosion protection requirements also.



If a higher level of antifreeze/corrosion inhibitor is used, higher engine temperatures result.

3.4.2 Engine Antifreeze/Corrosion Inhibitor Limitations

Marine engine antifreezes/corrosion inhibitors are subject to the following limitations:

- Series 538, 595 and 956/1163 engines:
These engines are equipped with heating facilities.
Because of their heat exchanger capacity, antifreeze/corrosion inhibitors are not to be used.
- Series 099, 183, and 396 engines:
The use of antifreeze/corrosion inhibitors in these engines is permitted only with seawater temperatures of up to 20°C maximum.
- Series 2000 and 4000 engines:
The use of antifreeze/corrosion inhibitors in these engines is permitted with seawater temperatures of up to 25°C.

Antifreeze/corrosion inhibitors can be used without reservation in vehicle, locomotive and stationary applications.

3.5 Water-soluble Corrosion Inhibitors

Water-soluble corrosion inhibitors are necessary for higher coolant temperatures or higher temperature differentials in heat exchangers, e.g. in TB (with plate-core heat exchanger) and TE systems in Series 396 and 183 engines.

The water-soluble corrosion inhibitors recommended by MTU ensure adequate protection provided the correct concentrations are used. The individual concentration tolerances are given in Section 3.6 "Water-soluble Corrosion Inhibitors", Table 6.

Special arrangements are possible after consultation with MTU. Special arrangements presently in effect remain valid.

Note:

Before the initial use of water-soluble corrosion inhibitors, the system must first be flushed out with water. This also applies to new engines.

3.6 Operational Monitoring

Fresh water examinations and frequent coolant-mixture checks are of prime importance in ensuring trouble-free engine operation and can be performed using the MTU Test Kit which contains the necessary equipment, chemicals and instructions for use.

The following checks can be performed:

- Determination of total hardness (°d)
- pH value
- Chloride content of fresh water
- Corrosion preventive oil content
- Antifreeze (corrosion inhibiting) concentration
- Water-soluble corrosion inhibitor content

Permissible Concentrations

Table 6

	Min. vol. %	Max. vol. %
Emulsifiable corrosion preventive oil	1.0	2.0
Antifreeze (corrosion inhibiting)	35 Antifreeze to approx. -25°C	50 Antifreeze to approx. -40°C
Water-soluble corrosion inhibitor	9	11

Use of coolant emulsions can lead to light precipitation during operation. This is shown by a layer on the surface of the coolant in the expansion tank. This is of no importance as long as the coolant concentration remains within the specified tolerances.

In the event of a sudden drop in coolant additive concentration, or if the additive is no longer absorbed, change the coolant. If necessary, clean the engine coolant system, see "Diesel Engine Cooling System Cleaning Instructions", Publication No. M060262.

3.7 Tolerances for Prepared Coolant

Table 7

pH value when using:		
– Emulsifiable corrosion preventive oil	Min. 7.5	Max. 9.5
– Antifreezes (corrosion inhibiting)	Min. 7.0	Max. 9.0
– Water-soluble corrosion inhibitor	Min. 7.0	Max. 9.0
Silicon (Si)	Min. 25 mg/l	

3.8 Coolant Service Life

Table 8

Coolant service life when using:	Max.	Remarks
Emulsifiable corrosion preventive oil	6000 1 operating hours or year	See table 6.3.1
Antifreeze (corrosion inhibiting)	9000 3 5 operating hours or years years	See tables 6.3.2 and 6.3.3
Water-soluble corrosion inhibitor	6000 2 operating hours or years	See table 6.3.4

4 Fuels

4.1 Diesel Fuels

4.1.1 Selection of a Suitable Diesel Fuel

The quality of the fuel is very important for satisfactory engine performance, long engine service life and acceptable exhaust emission levels. The engines can be operated with most diesel fuels sold world-wide. The properties and limit values specified in Table 9 (fuels of comparable quality) ensure optimum engine performance.

Fuels of comparable quality with following test results:

Table 9

		Test Method		Limit Value
		ASTM	ISO	
Composition				The fuel must be free of acids, visible water and solid contaminants
Total contamination	Max.		EN 12662	24 mg/kg
Density at 15 °C	Min. Max.	D 1298	EN 3675	0.820 g/ml 0.860 g/ml
API at 60 °F	Min. Max.	D 287		41 33
Viscosity at 40 °C	Min. Max.	D 445	EN 3104	1.5 mm ² /s 4.5 mm ² /s
Flash point		D 93	EN 22719	See note ²⁾
Boiling curve: - Initial boiling point - Recovered at 250 °C - Recovered at 350 °C - Residue and loss	Max. Min. Max.	D 86	3405	160 - 220 °C 65% by volume 85% by volume 3% by volume
Water	Max.	D 1744		0.03% by volume
Conradson carbon residue of 10% distillation residue	Max.	D 189	EN 10370	0.3 by weight %
Ash	Max.	D 482	EN 6245	0.01 by weight %
Sulfur ¹⁾	Max.	D 2622	EN 14596	0.5 by weight %
Cetane number	Min.	D 613	EN 5165	45
Cetane index	Min.	D 4737	EN 4264	42
Copper corrosion 3 hrs at 50 °C	Degree of corrosion Max.	D 130	EN 2160	1a
Oxidation resistance	Max.	D 2274	EN 12205	25 g/m ³
Lubricity at 60°C	Max.		12156-1	0.46 mm
Filter plugging point		D 4359	EN 116	See note ³⁾

¹⁾ Sulfur content of more than 0.5% requires an engine oil with a higher TBN and shorter oil drain intervals.

²⁾ The flash point temperature is a safety-related factor which must be established according to local conditions.

³⁾ It is the fuel supplier's responsibility to provide a fuel that will assure correct engine operation at the expected minimum temperatures and under the given geographical and other local conditions.

4.1.2 Requirements

Commercially available diesel fuels which meet the following specifications are approved for use:

Diesel Fuels

- Diesel fuel as per EN 590
- Grade No. 1-D as per ASTM D 975
- Grade No. 2-D as per ASTM D 975
- Class A2 as per BS 2869 - 1998

Marine Distillate Fuels

The following can be used if the oil quality and service-life limitations are taken into consideration:

- DMX as per ISO 8217
- DMA as per ISO 8217
- Other qualities available upon request

4.1.3 Low-sulfur Diesel Fuels

Sulfur is contained in chemically bound form in crude oil and therefore in fuel in varying levels.

In the European Union, since 1 October 1996, a sulfur content of max. 0.05% by weight has been authorized. Sulfur contents at and below this level are designated "low in sulfur". Low sulfur diesel fuels are recommended for environmental reasons. In order to avoid wear problems, lubricity additives too are added.

4.1.4 Diesel Fuels in Winter Operation

At low outdoor temperatures, the diesel fuel's flow property can be unacceptable on account of paraffin precipitation.

In order to prevent operational problems (e.g. clogged filters), during the winter months, diesel fuel with suitable cold-flow characteristics is available on the market. Deviations are possible before and after winter and in individual countries. If no frost-resistant diesel fuels are available, it is necessary to add petroleum before the frost period begins: as a guideline, adding 5% by volume achieves an improvement of frost resistance of approx. 1° C.

Add the additive to the diesel fuel in good time before the flow property of the diesel fuel is impaired by paraffin precipitation. Malfunctions resulting from paraffin precipitation can only be eliminated by heating the entire fuel system.



Petrol (gasoline) is not to be added!

4.1.4.1 Flow Improvers

Although these improvers cannot prevent paraffin precipitation, they influence the size of the crystals and allow the fuel to pass through the filter.

The effectiveness of flow improvers is not guaranteed for every fuel.

Certainty is only assured after laboratory examination of the filtering capability.

Required quantities and mixing procedures must be carried out according to the manufacturer's instructions.

4.2 Vegetable-oil Methylester (PME)

4.2.1 Requirements

MTU engines can also be run on vegetable-oil methylester (MTU must be consulted). The fuel must fulfil the requirements of draft standard DIN E 51606.

If mixtures of diesel fuel and PME are used, then the PME quantity is not to exceed 20% because of decreasing tensile strength of the elastomers.

In the case of operation with pure PME or an admixture $\leq 20\%$, the following measures are required or the following deviations to be expected compared with diesel fuel.

- In the fuel system, gaskets made of fluorine rubber elastomers must be used.
- In contrast to pure diesel fuel, vegetable-oil methylester has the following density differences (Table 10).

Table 10

Density in g/ml at 15 °C	Vegetable oil methylester (PME)	Diesel Fuel
Min.	0.875	0.820
Max.	0.900	0.860

The calorific value of approx. 37.2 MJ/kg is considerably lower than for diesel fuel, which is approx. 43 MJ/kg. In event of use of 100% PME, reduced performances of approx. 5 to 12% are calculated from the heating and density values. Fuel consumption increases correspondingly.

- The engine oil's drain intervals are to be halved.
- At outdoor temperatures of below -15 °C, fuel preheating is necessary to guarantee the required flow characteristics.
- At present nothing is known about the PME storage properties. In particular, it is not known whether polymerisation takes place as a result of time and temperature. Operation with extended out-of-service periods is therefore not advisable.

4.3 Domestic Fuel

Domestic fuel (heating oil) differs from diesel fuel mainly because of the following characteristics:

- Cetane number
- Sulfur content
- Oxidation stability
- Copper corrosion
- Low-temperature behaviour

Domestic fuel can be used in the diesel engine if its characteristics agree technically with the diesel fuel specifications.

4.3.1 Cetane Number

The cetane number is not specified in DIN 51 603 T1. If domestic fuel is used, the cetane number must therefore be quoted by the supplier or measured and be at least 45 as required in the MTU Fluids and Lubricants Specification. The purely calculated cetane index must not be less than 42.

4.3.2 Sulfur Content

The maximum sulfur content for domestic fuel according to DIN 51 603 T1 is 0.2%. Depending on the production capacity at the refineries, the market can offer domestic fuels containing diesel-fuel ingredients with a sulfur content of $<0.05\%$. Lubrication additives are not added on principle as the oil is primarily intended for heating purposes. Lubrication problems can therefore be expected when using these qualities of domestic fuel because of the missing additives.

Consultation with the fuel supplier is necessary.

4.4 Fuel Additives

The engines are so designed that satisfactory operation with normal, commercially available fuels is ensured. Many of these fuels contain performance-enhancing additives.

The additives are added by the supplier as he is responsible for product quality.

Additional additives are therefore not required.



Attention is drawn to the fact that the use of other diesel fuels or additives than those stipulated in the MTU Fluids and Lubricants Specification is always the responsibility of the operator.

4.5 Fuel for Gas Engines

The gas engines must be operated with natural gas. The quality must be checked half-yearly by gas analysis to detect alterations of harmful components in the gas and take appropriate measures. This will prevent corrosion damage to the engine.

If specific limit values are exceeded, engine operation must be interrupted in order to prevent damage to engine components.



Attention is drawn to the fact that if the specified limit values are exceeded the manufacturer's warranty is cancelled. Further operation is possible after consulting MTU or SKL plus written confirmation relating to necessary measures.

Requirements for Gas Fuel

Table 11

Methane content	% by volume	≥ 80
Methane number		Min. 70
Lower calorific value	MJ/m ³	≥ 34
Sulfur content	mg/m ³	< 1170
Hydrogen sulfide	% by volume	Max. 0.08
Total halogens	mg/m ³	0
Silicon	mg/m ³	0
Dust	mg/m ³	< 50
Relative humidity	%	Max. 60 at min. operating temperature
C _m H _n vapours	%	< 60

The limit values are based on methane at 100% by volume, or 10 kWh/m³ for each of any further combustible gases present in normal condition.

4.6 Microorganisms in Fuel

Bacterial attack in the fuel may occur under unfavourable conditions. In such a case, the fuel must be treated with biocides in accordance with the manufacturer's specifications.

4.6.1 Approved Biocides

Table 12

Manufacturer	Brand name
Bode Chemie	Bakzid
Schülke und Mayr	MAR 71

5 Preservatives

5.1 Requirements

The MTU conditions for preservative approval are specified in MTU Factory Standards (MTL). The standards are available for:

- Corrosion preventive oils for internal preservation, MTL 5051
- Corrosion inhibitors for external preservation, MTL 5052

The preservative manufacturer will be informed in writing after his product has been approved by MTU.

5.2 Types of Preservation

Preservation must be carried out on:

- New or major-overhauled diesel engines, gearboxes and couplings after the test bench run (always carried out at MTU)
- Diesel engines, transmissions and couplings which are to be taken out of service for a period in excess of 3 months, if possible immediately after the last service run.

Preservation has a service life of:

- Up to 12 months under favourable storage conditions.
- Up to 6 months under unfavourable storage conditions, i.e. high humidity, salt-laden air, extreme changes in temperature, etc.

Re-preservation must be carried out at defined intervals after the preservation period has lapsed.

Re-preservation has a service life of:

- Up to 6 months under favourable storage conditions.
- Up to 3 months under unfavourable storage conditions, i.e. high humidity, salt-laden air, extreme changes in temperature, etc.

For preservation tasks and services, see the Operating Instructions.

Diesel engines, transmissions and couplings provided with special packing need not be re-preserved, unless the relative humidity inside the packing is above 50%

- see Inspection Instructions for MTU Special Packing, Publication No. A060374.

5.3 Corrosion Preventive Oils for Internal Preservation

SAE 30 viscosity grade corrosion preventive oils are to be used for internal preservation (oil-moistened components) of MTU engines and gearboxes.

These oils may also be used for running-in and acceptance testing procedures, they are not, however, suitable for continuous operation.

5.4 Corrosion Inhibitors for External Preservation

For external preservation, all non-painted parts are to be treated with a corrosion inhibitor which provides a wax-like protective coating after the inhibitor solvent has evaporated.

5.5 Corrosion Preventive Oils for Internal Preservation of the Fuel System

Fuel injection-pump test oil which conforms to DIN ISO 4113 is to be used for internal preservation of the fuel system. The engine should be run for the last 10 minutes before shutdown using this oil.

Fuel system internal preservation may also be performed using diesel fuel to which approximately 10% corrosion preventive oil for internal preservation has been added.

6 Approved Fluids and Lubricants

6.1 Engine Oils

See Sections 2.1 and 2.3 for details and special features

6.1.1 Single-grade Oils - Category 1, SAE-grades 30 and 40 for Diesel Engines

Manufacturer	Brand name	Remarks
Abu Dhabi National Oil, UAE	Adnoc HPSP SAE 40	
Addinol Mineralöl GmbH	Addinol Marine MS 4011 SAE 40 Addinol Turbo Diesel MD 305 Addinol Turbo Diesel MD 405	
Agip Petroli S.p.A.	Agip Cladium 120	Not Series 2000, 4000
Aral Lubricants	Aral Basic Turboral	
BP Oil International	Vanellus C Extra SAE 30	Only for Series 183, 396
	Vanellus C3 Energol DS3-123/124 Energol DS3-153/154	
Caltex Services, UK	Delo 500 Delo 600	
Castrol	Castrol Series IV SAE 30	Only for Series 183, 396
	Castrol CRD-DB Castrol Marine MPX Castrol Marine MLC	
Cato Oil	Mystik JT-8 Super Heavy Duty SAE 40 Mystik JT-8 Extra SAE 40	Only for Series 183, 396
Cepsa Lubricantes	Cepsa Retto Super Serie 3 SAE 30	
	Cepsa Rodaje Y Proteccion SAE 30	Increased corrosion protection
Chevron International Oil Comp.	Delo 500	
Compania Espanola De Petroleos S.A.	Cepsa Super Serie 3	Not Series 2000, 4000
EKO, Greece	EKO Marsa	
Elf Lubrifiants	Elf Performance 3D	
Emirates Lubeoil Co.	Crown Super Duty Plus 40	
Engen, South Africa	Dieselube 530 Dieselube 540	
Equilon Enterprises LLC	Shell Rimula Oil SAE 30, 40	Only Series 183, 396
Esso AG	Essolube D-3+	
	MZK engine oil LD30	Increased corrosion protection

Manufacturer	Brand name	Remarks
Esso Lubricants Americas	Essolube X 311	
Esso Lubricants Europe	Essolube X 301	
Esso Marine Lubricants Europe	Exxmar CM	
Esso, Singapore	Essolube XD-3 Essolube XD-3 Extra	
Esso Standard, Thailand	Essolube XD-3	
Fuchs Mineralölwerke GmbH	Titan Universal HD	
Hindustan Petr. Comp. India	Hylube MTU SAE 40	
Idemitsu, Singapore	Daphne Marine Oil MT SAE 40	
Indian Oil Corp. Lt.	Servo Ultra 40 RR	Not Series 2000, 4000
LPC Hellas	Voyager Prime	
Lyteca, Ecuador	Ursa Super LA-3 SAE40	
Mexicana De Lubricantes, Mexico	Mexlub CF/CF-2 SAE 40	
Mobil Oil	Delvac 1300	Only Series 183, 396
	Mobil Motrex 1330	
Motor Oil (Hellas)	EMO Diesellube 4D EMO Turbo Champion Plus	
ÖMV AG	ÖMV truck 30	
	ÖMV truck 40	
Pennzoil Products	Supreme Duty Diesel Engine Oil SAE 30	Only Series 183, 396
Pertamina, Indonesia	Meditran SMX 40	
Petmal, Malaysia	Stalia XD SAE 40	
Petrobras Distribuidora S.A.	Lubrax MD 400	Not Series 2000, 4000
Petrogal, Portugal	Galp Diesel SAE 30	
Petronas Dagangan, Malaysia	Motulub CS 3/M SAE 40	
Petrol Ofisi	Turbosarj SAE30 Süpersarj C Süpersarj M-F 30	
Petromin Lubricating Oil	Super Diesel Engine Oil HD3	
Quaker State	QS FCI HDX Plus Engine Oil SAE 40	Only Series 183, 396
Raloy	Raloy Monogrado Diesel SAE 40	

Manufacturer	Brand name	Remarks
Repsol	Repsol Serie 3	
Schmierstoffraffinerie, Salzbergen	Wintershall Antikorrol M SAE 30	Increased corrosion protection
	Wintershall Rekord	
Shell	Shell Rimula X Monograde Shell Sirius Oil Shell Gadinia Oil	
Shell, Netherlands	Shell Nautica	
Singapore Petroleum Comp.	SPC SDM 801 SPC SDM 706 SAE 40	
Statoil	Motorolja 20W/30 (Ref No SSL 92314)	
Texaco	Ursa Super LA Ursa LA SAE 40	
Veba Oil	Movara Extra Motoröl	
Yukong, Korea	SD 5000 SAE 40	

6.1.2 Single-grade Oils - Category 1, SAE-grade 40 for Gas Engines

Manufacturer	Brand name	Remarks
Mobil Oil	Pegasus 705 SAE 40	
Shell	Shell Mysella LA 40	

6.1.3 Multi-grade Oils - Category 1, SAE-grades 10W-30 and 15W-40 for Diesel Engines
¹⁾ See Note on page 23

Manufacturer	Brand name	Remarks
76 Products	76 Royal Triton QLT Motor Oil SAE 15W-40 76 Guardol QLT Motor Oil SAE 15W-40	Only Series 183, 396 and ¹⁾
Addinol Mineralöl GmbH	Addinol Super Star MX1547 SAE 15W-40	
Amalie Oil	Amalie XLO SAE 15W-40 Amalie XLO SAE 10W-30	
American Refining Group	Gulf Super Duty Plus SAE 15W-40	Only Series 183, 396 and ¹⁾
Castrol Lubricants	Castrol Series IV SAE 15W-40	Only Series 183, 396 and ¹⁾
Castrol, South Africa	Castrol Myndio Plus SAE 15W-40	
Cato Oil	Mystik Syngard SX8 SAE 15W-40	Only Series 183, 396 and ¹⁾
Chevron	Chevron Euro 3 SAE 15W-40	Only Series 183, 396 and ¹⁾
Conoco	HD Fleet Hi TBN SAE 15W-40	
D-A Lubricant Comp	D-A Extra Treated Diesel Oil III SAE 15W-40	Only Series 183, 396 and ¹⁾
EKO, Greece	Forza SAE15W-40	
Esso Lubricants Americas	Essolube XT 331 SAE 15W-40	
Esso Lubricants Europe	Essolube XT 301 SAE 15W-40	
Esso Marine Lubricants Europe	Exxmar CM 15W-40	
Esso, Singapore	Essolube XT 331 SAE 15W-40	
Equilon Enterprises LLC	Shell Rotella T Multigrade SAE 15W-40 Ursa Premium TDX SAE 15W-40	Only Series 183, 396 and ¹⁾
Exxon	1820 Engine Oil SAE 15W-40	Only Series 183, 396 and ¹⁾
Idemitsu, Singapore	Daphne Marine Oil MT SAE 15W-40	¹⁾
Kompressol	Kompressol-Ultralub C SAE 15W-40	
Koramo, Czech Republic	Mogul Diesel DT SAE 15W-40	
Mobil Oil	Delvac 1300 Super SAE 15W-40	Only Series 183, 396 and ¹⁾

Manufacturer	Brand name	Remarks
ÖMV AG	ÖMV Truck M plus SAE 15W-40 ÖMV Extra BB SAE 15W-40	
Petmal, Malaysia	Stalia XD SAE 15W-40	
Petro, Canada	Duron SAE 15W-40	
Petrogal, Portugal	Galp MDM1 SAE 15W-40	
Raloy	Raloy Multigrado Diesel SAE 15W-40	
Schmierstoffraffinerie, Salzbergen	Wintershall Rekord 15/40 SAE 15W-40 Wintershall Multi Rekord SAE 15W-40	
Singapore Petroleum Comp.	SPC SDM 801 SAE 15W-40	
Sun Comp.	Sun Super C SAE 15W-40	Only Series 183, 396 and ¹⁾
Yukong, Korea	SD 5000 SAE 15W-40	



¹⁾ These multi-grade oils can only be used if the crankcase ventilation is led to atmosphere.

6.1.4 Single-grade Oils - Category 2, SAE-grades 30 and 40 for Diesel Engines

Manufacturer	Brand name	Remarks
Abu Dhabi National Oil Co., UAE	Adnoc Extra Super Engine Oil SAE 40 Adnoc Extra Super Plus Engine Oil SAE 40	
BP Marine	Energol HPDX SAE 40	
BP Oil International	Energol SHPD SAE 40	
BP South Africa	Vanellus C3 Extra SAE 40	
Castrol	Castrol Marine HLX	
Chevron International Oil Comp.	Chevron Delo SHP	
DEA Mineraloel AG	DEA Cronos Super	
Elf Lubrifiants	Antar Grapholia MS SAE 30 Elf Performance Super D Elf Disola MT Antar Traxolia Z	
Engen, South Africa	Dieselube 630 SAE 30	
Esso AG	Exxmar CM Super 40	
Esso Petroleum Comp. Ltd.	Essolube TD Exxmar CM Super	
Kuwait Petroleum	Q8T700 SAE 20W-30	
Mobil Oil	Mobil Delvac 1400 (RN 2770) Mobil Delvac HP Monograde	
Motor Oil, Hellas	EMO SHPD Plus	
Panolin AG	Panolin Extra Diesel 40	
Pennzoil Products	Supreme Duty Supreme Duty Fleet Motor Oil SAE 30	
Shell	Shell Sirius X Oil	
Singapore Petroleum Comp.	SDM 900	
Statoil	Diesel Way	
Texaco	Ursa Super TD Mono, SAE 30 Ursa Premium TDX SAE 40	
Total	Rubia TIR XLD SAE 40	
TotalFina	Caprano TD	
YPF, Argentina	Diesel Movil AT Diesel YPF AT	

6.1.5 Multi-grade Oils - Category 2 , SAE-grades 5W-40W, 10W-40, 15W-40 and 20W-40 for Diesel Engines
¹⁾ See Note at end of table, page 26

Manufacturer	Brand name	Remarks
Addinol Lube Oil	Addinol Diesel Longlife MD 1546 SAE 15W-40	
Agip Petroli	Agip Blitum T SAE 15W-40 Agip Sigma Turbo SAE 15W-40	
Amalie Oil	Amalie Super XLO SAE 15W-40	
Aral Lubricants	High Turboral SAE 10W-40 Mega Turboral SAE 10W-40	
Caltex, UK	Caltex Delo SHP Caltex Delo SHP Multigrade SAE15W-40	
Castrol International	Castrol RX Super Plus SAE 15W-40	
Castrol, South Africa	Castrol Syndio Plus SAE 15W-40	
Cepsa Lubricants	Cepsa Special SHPD SAE 15W-40	
Chinese Petroleum Corp.	CPC Superfleet D5 Synthetikoil SAE 15W-40	
Conoco	Power D Engine Oil SAE 15W-40	¹⁾
DEA Mineraloel AG	DEA Cronos Synth SAE5W-40	
Elf Lubrifiants	Elf Performance 3D SAE 15W-40 Elf Performance Super SAE 15W-40	
Esso Imperial Canada	Essolube VM SAE 15W-40	
Fuchs	Titan Unic Plus MC SAE 10W-40	
Fuchs DEA	DEA Cronos Premium FX SAE 10W-40	
ITALIANA Petroli	IP Tarus Turbo SAE 15W-40	
Koramo, Czech Republic	Mogul Diesel DTT SAE 15W-40	
Mobil Oil	Mobilgard 1 SHC SAE 20W-40	
	Delvac HP SAE 15W-40	¹⁾
Motor Oil, Hellas	EMO SHPD Plus SAE 15W-40	
Panolin AG	Panolin Universal SFE SAE 10W-40	
Pennzoil Quaker State	Supreme Duty Fleet Motor Oil SAE15W-40	
Petro Canada	Duron XL SAE 15W-40	
Schmierstoffraffinerie, Salzbergen	Wintershall Turbo Diesel SAE 15W-40	

Manufacturer	Brand name	Remarks
Statoil	Turbosynt SAE 15W-40	
Veba Oel	Veba Virada ECO Truck SAE 10W-40	



¹⁾ These multi-grade oils can only be used if the crankcase ventilation is led to atmosphere.

6.1.6 Multi-grade Oils - Category 3, SAE-grades 5W-30, 5W-40 and 10W-40 for Diesel Engines

Manufacturer	Brand name	Remarks
Addinol Lube Oil	Addinol Super Truck MD 1048 SAE 10W-40	
Aral Lubricants	Aral Mega Turboral SAE 10W-40 Super Turboral SAE 5W-30	
Avia	Turbosynth HT-E SAE 10W-40	
BP Oil International	Vanellus HT Extra SAE 10W-40 BP Vanellus E 4 Plus SAE 10W-40	
Castrol Ltd.	Castrol Dynamax SAE 10W-40 Rivermax SRX 10W-40 Syntruck SAE 5W-40	
Cepsa	Cepsa Eurotrans SHPD 10W-40	
Elf	Elf Performance Expert FE SAE 5W-30	
Elf Lubricants	Elf Performance Expert SAE 10W-40 Antar Maxolia SAE 10W-40	
Esso Lubricants Europe	Essolube XTS 501 SAE 10W-40	
Esso Marine Lubricants	Exxmar SCM SAE 10W-40	
Kompressol	Kompressol-FX SAE 10W-40	
Meguin	Megol Motorenöl Super Leichtlauf DIMO SAE10W-40	
Mobil Oil	Mobil Delvac XHP Extra SAE 10W-40 Mobil Delvac 1 SHC SAE 5W-40	
OMV	OMV truck FE plus SAE 10W-40	
Petro Oil	Petro Oil Diesel XHPDO CF SAE 10W-40	
Raiffeisen	Raiffeisen Power Truck SAE10W-40	
S.A. Espanola Lubrificantes	Gulfleet Highway SAE 10W-40	
Schmierstoffraffinerie, Salzbergen	Wintershall TFG SAE 10W-40	
Shell	Shell Rimula Ultra SAE 5W-30 Shell Rimula Ultra SAE 10W-40	
TotalFina	Kappa Ultra SAE 10W-40 FINA Milkano SYN SAE 10W-40	
Veedol International	Veedol Dynastar SAE 10W-40 Veedol Dynastar FS SAE 5W-40	

6.2 General Purpose Greases

See Section 2.2 for details and special features

Manufacturer	Brand name	Remarks
Aral Lubricants	Mehrzweckfett Arallub HL2	
Avia	Avialith 2	
BP Oil International	Energrease LS2 Mehrzweckfett L2	
Caltex Services, UK	Marfak All Purpose 2	
Castrol	Spheerol AP2	
DEA Mineraloel AG	Glissando 20	
Exxon	Beacon 2	
FINA Europe S.A.	Marson L2	
Mobil Oil	Mobilux 2 Mobilgrease HP 222	
Shell	Shell Retinax EP2	
Texaco	Multifak 20	
Veedol International	Multipurpose	

6.3 Coolant Additives

See Section 3 for details and special features

6.3.1 Emulsifiable Corrosion Preventive Oils

Manufacturer	Brand name	Remarks
Deutsche Shell	Shell Oil 9156	Not Series 183, 396 TB (with plate-core heat exchanger) and TE cooling systems

6.3.2 Antifreezes with Corrosion Inhibiting Properties - Concentrates

Manufacturer	Brand name	Remarks
ARTECO	Havoline AF 542	
Avia Mineralöl AG	Avia Frostschutz	Not Series 4000
	Avia Antifreeze APN	1)
BASF	Glysantin G03 = BASF Kühlerschutz G03	Not Series 4000
	Glysantin G05 = Glysantin Anticorrosion	1)
	Glysantin G48 = Glysantin Protect Plus	1)
	Glysantin G30 = Glysantin Alu Protect	
BP	BP Antifrost X 2270 A	
Bremin Mineralöl	Glyco Star nitritfrei	
Castrol International	Castrol Anti-Freeze NF	1)
Clariant	Genatin super	
DEA	DEA radiator antifreeze	1)
Elf Lubrifiants	Glacelf SX	Not Series 4000
	Glacelf MDX	1)
Ginouves	York 716	1)
Ineos	Napgel C 2270/1	
Krafft	Refrigerante ACU 2300	
Mobil Lubricant	Antifrost 600	
Panolin - Switzerland	Anti-Frost MT 30	
Veedol International	Veedol Antifreeze NF	1)

1) Service life: 5 years or 9000 operating hours

6.3.3 Antifreezes with Corrosion Inhibiting Properties - Ready Mixed

Manufacturer	Brand name	Remarks
BASF	Kühlstoff G05-24/50 (50%)	¹⁾
Elf Lubrifiants	Coolelf SX (40%)	Not Series 4000
	Coolelf MDX (40%)	¹⁾
Sotragal - Mont Blanc	L.R.-30 Power Cooling (44%)	¹⁾

¹⁾ Service life: 5 years or 9000 operating hours

6.3.4 Water-soluble Corrosion Inhibitors

Manufacturer	Brand name	Remarks
BASF	Glysacorr G93-94	
Ginouves	York 719	

6.4 Preservatives

See Section 5 for details and special features

6.4.1 Corrosion Preventive Oils for Internal Preservation

Manufacturer	Brand name	Remarks
Aral Lubricants	Degol LS 30	
BP Oil	Motorenschutzöl MEK	
Cepsa Lubricants	Cepsa Rodaje Y Proteccion SAE 30	Also full-load engine-operation capable, com-parable with Category 1
Esso AG	MZK engine oil LD 30	Also full-load engine-operation capable, com-parable with Category 1
Schmierstoffraffinerie, Salzbergen	Wintershall Antikorrol M SAE 30	Also full-load engine-operation capable, com-parable with Category 1
Shell	Shell Oil S 7294 SAE 30	

6.4.2 Corrosion Inhibitors for External Preservation

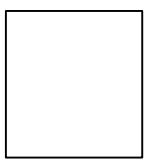
Manufacturer	Brand name	Remarks
Castrol	Rustilo 181	
Esso Lubricants	Rust BAN 397	
Valvoline Oel	Tectyl 846	

6.4.3 Corrosion Preventive Oils for Internal Preservation of the Fuel System

Manufacturer	Brand name	Remarks
Esso	Test oil 4113	
Schmierstoffraffinerie, Salzbergen	Wintershall Calibration Fluid	
Deutsche Shell	V - Oel 1404	

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