

MTU_ValueService **Technical Documentation**

Fluids and Lubricants
Specification

A001061/33E

All commercial MTU series
(except Series 1800) and DDC S60 Marine



Printed in Germany

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Subject to alterations and amendments.

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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. The correct selection and treatment of these fluids and lubricants are therefore extremely important. This publication specifies which fluids and lubricants are to be used.

The Fluids and Lubricants Specifications will be amended or supplemented as necessary. Before using them, make sure you have the latest version. The latest version is also available at: [http://www.mtu-online.com/Service/Technische Dokumentation/Betriebsstoffvorschriften](http://www.mtu-online.com/Service/Technische_Dokumentation/Betriebsstoffvorschriften)

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 Organization
ASTM	American Society for Testing and Materials
IP	Institute of Petroleum

Note:

Use of the approved fluids and lubricants, either under the brand name or in accordance with the specifications given in this publication, constitutes part of the warranty conditions.

The supplier of the fluids and lubricants is responsible for the worldwide standard quality of the named products.



Fluids and lubricants for drive plants may be hazardous materials. Certain regulations must be obeyed when handling, storing and disposing of these substances.

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 not possible within this publication.

Users of the products named in these specifications 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 which it has approved.

2 Lubricants

Engine oils



Dispose of used fluids and lubricants in accordance with local regulations.
Used oil must never be disposed of via the fuel tank!

Requirements of the engine oils for MTU approval

The MTU requirements for approval of engine oils for diesel engines are contained in the MTU Factory Standards MTL 5044 and MTL 5051 for first-use oils and corrosion-inhibiting oils. For gas engines, oil approval requirements are contained in MTU Factory Standard MTL 5074. These standards can be ordered under these reference numbers. Manufacturers of engine oils are notified in writing if their product is approved.

Approved engine oils are divided into the following MTU Quality Categories:

- Oil category 1: Standard quality / Single and multigrade oils
- Oil category 2: Higher quality / Single and multigrade oils
- Oil category 2.1: Multigrade oils with a low ash-forming additive content (low SAPS oils)
- Oil category 3: Highest quality / Multigrade oils
- Oil category 3.1: Multigrade oils with a low ash-forming additive content (low SAPS oils)

Low SAPS oils are oils with a low sulfur and phosphor content and an ash-forming additive content of $\leq 1\%$.

They are only approved if the sulfur content in the fuel does not exceed 500 mg/kg. When using diesel particle filters, it is advisable to use these oils to avoid fast coating of the filter with ash particles.

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

Mixing of engine oils

Basically, engine oils of different SAE classes can also be mixed with one another and are compatible. This applies to all engine oils irrespective of whether they are based on mineral or synthetic base oils.

The performance and viscosity-temperature relation of oil mixtures, however, is poorer than with unmixed oils. For this reason, engines can only be run with oil mixtures in exceptional cases and following consultation with MTU.

Oil mixtures refer to residual oil quantities following an oil change. It does not refer to replenishment of used oil quantities through other approved oils.

Special features

MTU engine oils

One single-grade and one multigrade oil are available from MTU/MTU-DD. These engine oils are marketed under the name Power Guard DEO SAE 40 and SAE 15W-40. The engine oils are tuned to the MTU Off-Highway application groups and correspond to oil category 2. A single-grade and multigrade oil are available at MTU Asia. These engine oils are marketed under the name Fascination of Power SAE 40 or SAE 15W40.

Engine oils for the Series 2000, 4000-01, 4000-02

For Series 2000, 4000-01 and 4000-02 engines, engine oils other than those listed as approved in Section 6 may be used provided they satisfy all of the specifications and match all of the characteristics listed in Tables 1 and 2.

Performance specifications for engine oils for Series 2000 and 4000-01/02 (Table 1)

Oil category 1	Specification min. API CG-4/CH-4 and ACEA E2-96
Oil category 2	Specification ACEA E7-04
Oil category 3	Specification ACEA E4-04
Oil category 3.1	Specification ACEA E4-04, E6-04

Note for engine oils of category 1:

Engine oils which comply with only one of the standards API CF, CF-2, CF-4, CG-4, CH-4 or CI-4 or with a combination of these specifications, do not fully meet performance specifications.

If these oils are intended for use, the oil drain interval is to be shortened by up to 50% after consultation with MTU.

Chemical-physical characteristics for engine oils (Table 2)

	Test Method	Limit Value
Total base number	ASTM D 2896 ISO 3771	> 8mgKOH/g
Shear stability	ASTM D 3945 or CEC-L-14-A-88	Limit values of respective viscosity class
Deposit test ¹⁾	DIN 51535	Max. 120 mg

¹⁾ Required for multigrade oils used in closed crankcase ventilation.

Restrictions on Series 4000-03 Marine applications



The engines of the Series 4000-03 Marine must not use oils in oil category 1.

Restrictions on Series 595, 1163 and 8000 applications



For fast commercial ferries with Series 595 or 1163 engines, Category 2 or 3 oils are generally specified.

Oil Categories 2.1 and 3.1 may be used if the sulfur content in the fuel does not exceed 500 mg/kg.

For Series 8000, only the following engine oils may be used:

- Exxon Mobil Delvac1630 SAE 30
- Shell Sirius X SAE 30

Engine Oil Requirements for Gas Engines



Viscosity grade SAE 40 is stipulated 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 base numbers within a range of 4-6 mgKOH/g. This prevents increased ash deposits which can lead to reduced catalytic converter performance.

Selection of viscosity grades

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 multigrade oils, depending on the application. Standard values for the temperature limits in each viscosity grade are shown in Chart 1.

If the prevailing temperature is too low, the engine oil must be preheated.

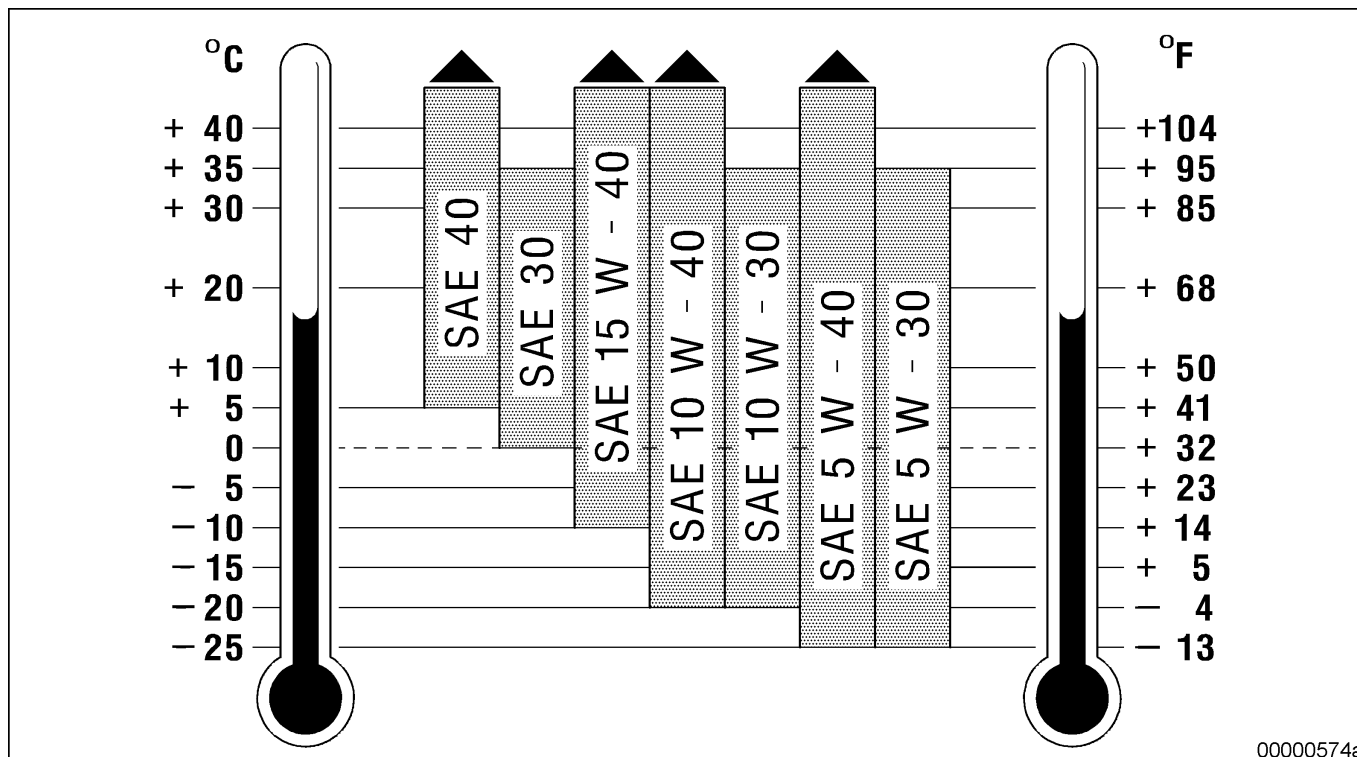


Diagram 1

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Oil Drain Intervals for Diesel Engines

Engine oil drain intervals depend on the engine-oil quality, its conditioning, the operating conditions and the fuel used. The intervals quoted (Table 3) are guidelines based on operational experience and are valid for applications with a standard load profile.

Oil Drain Intervals (Table 3)

Oil category	Without centrifugal oil filter	With centrifugal oil filter
1	250 operating hours	500 operating hours
2	500 operating hours	1000 operating hours
2.1 ¹⁾	500 operating hours	1000 operating hours
3	750 operating hours	1500 operating hours
3.1 ¹⁾	750 operating hours	1500 operating hours

1) = To be used in conjunction with fuels with max. 500 mg/kg sulfur content.

The oil drain intervals in the table are recommended guidelines when using diesel fuels with < 0.5% sulfur content. The limit values specified in Table 4 for used oil must be complied with. The numbers of operating hours quoted for oils must be confirmed by means of oil analysis.

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

- Extreme climatic conditions
- High engine start-up frequency
- Frequent and prolonged idling or low-load operation
- High sulfur content in the fuel of 0.5 to 1.5% by weight (→ Page 10)
New oils must be selected which have total base numbers appropriate to the sulfur content of the fuel in use. (→ Page 08)

For applications involving low runtimes, the engine oil must be changed every two years at the latest irrespective of its category.

Where engine oils with higher-grade corrosion-inhibiting characteristics are in use (→ Page 37), a change must be carried out every 3 years at the latest.

In individual cases the service life of the engine oil can be optimized by regular laboratory analysis and appropriate engine inspections in consultation with the MTU service point responsible:

The first oil sample should be taken from the engine as a “basic sample” after the engine has run for approximately 1 hour after being filled with fresh oil.

Further oil samples should be analyzed after engine runtimes which are to be specified. (→ Page 08)

The appropriate engine inspections are to be carried out before and after the oil analyses.

After completion of all analyses, and depending on the findings, special agreements can be reached for individual cases.

Oil samples must always be taken under the same conditions and at the point provided for that purpose (see Operating Instructions).

Oil drain intervals for gas engines in Series 4000 L61/L62

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

Regular oil analyses are necessary because of the varying gas qualities. At the beginning of the product's life cycle, oil samples must be taken and analyzed after every 500 hours of operation.

Given consistent gas quality, an oil drain interval of max. 1,500 hours of operation is recommended.

In individual cases, the oil change intervals can be optimized:

For this purpose, oil samples are analyzed after every 200 – 250 hours of operation (→ Page 08).

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

Special Additives

Engine oils approved have been specially developed for diesel engines and have all necessary properties. Further additives are therefore superfluous and may even be harmful.

Laboratory Analysis

General information

Orders for engine oil analyses can be placed with MTU.

The oil sample must be taken in accordance with the Operating Instructions.

The following data is 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 (for each oil change):

- Min. 0.25 liters used oil
- Min. 0.25 liters reference sample (after approx. 1 hour's operation)
- Min. 0.25 liters new oil

Spectrometric Oil Analysis

Analysis of the engine oil's additive-metal content is carried out by the MTU laboratory to determine the brand of oil.

MTU does not generally analyze 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 status
- Tolerance scatter
- Operating conditions
- Duty profile
- Fluids and lubricants
- Miscellaneous assembly materials

Unambiguous conclusions as to the wear status of the engine components involved are therefore not possible. This means that no limit values can be given for wear-metal contents.

Used-oil Analysis

In order to check the used oil, it is recommended that regular oil analyses be carried out. Oil samples should be taken and analyzed at least once per year and during each oil change and under certain conditions, depending on application and the engine's operating conditions, sampling / analysis should take place more frequently.

The test methods and limit values given in Table 4 and Table 5 (Analytical Limit Values for Diesel / Gas Engine Oils) indicate when the results of an individual oil sample analysis are to be regarded as abnormal.

An abnormal result requires immediate investigation and remedy of the abnormality.

The limit values relate to 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 particular components.

In addition to the analytical limit values, the engine condition, its operating condition and any operational faults are decisive factors with regard to oil changes.

Some of the 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 the previous analysis.
- Abnormal discoloration of components.

Analytical limit values for diesel engine oils (Table 4)

	Test Method	Limit Value
Viscosity at 100 °C max. mm ² /s	ASTM D445 DIN 51562	SAE 30 SAE 5W-30 SAE 10W-30
		SAE 40 SAE 10W-40 SAE 15W-40
min. mm ² /s		SAE 30 SAE 5W-30 SAE 10W-30
		SAE 40 SAE 10W-40 SAE 15W-40
Flash point °C (COC)	ASTM D 92 ISO 2592	Min. 190
Flash point °C (PM)	ASTM D 93 EN 22719	Min. 140
Soot (% weight)	DIN 51452 CEC-L-82-A-97	Max. 3.0 (Oil Category 1) Max. 3.5 (Oil category 2, 2.1, 3 and 3.1)
Total base number (mg KOH/g)	ASTM D 2896 ISO 3771	Min. 50% of new-oil value
Water (% by vol.)	DIN 51777 ASTM 1744	Max. 0.2
Ethylene glycol (mg/kg)	ASTM D 2982	Max. 100

Analytical limit values for gas engine oils SAE 40 (Table 5)

	Test Method	Limit Value
Viscosity at 100 °C (mm ² /s)	ASTM D 445 DIN 51562	max. 17.5 max. min. 11.5 min.

Total base number (mg KOH/g)	ASTM D 2896 ISO 3771	Min. 3
Acid number (mgKOH/g)	ASTM D664	New oil value + 2.5
pH value		Min. 4.5
Water (% by vol.)	DIN 51777	Max. 0.2
Oxidation (A/cm)	DIN 51453	Max. 20
Nitration (A/cm)		Max. 20
Wear elements (mg/kg)	RFA, ICP	
Iron (Fe)		Max. 30
Lead (Pb)		Max. 20
Aluminum (Al)		Max. 10
Copper (Cu)		Max. 20
Tin (Sn)		Max. 5
Silicon (Si)		Max. 15

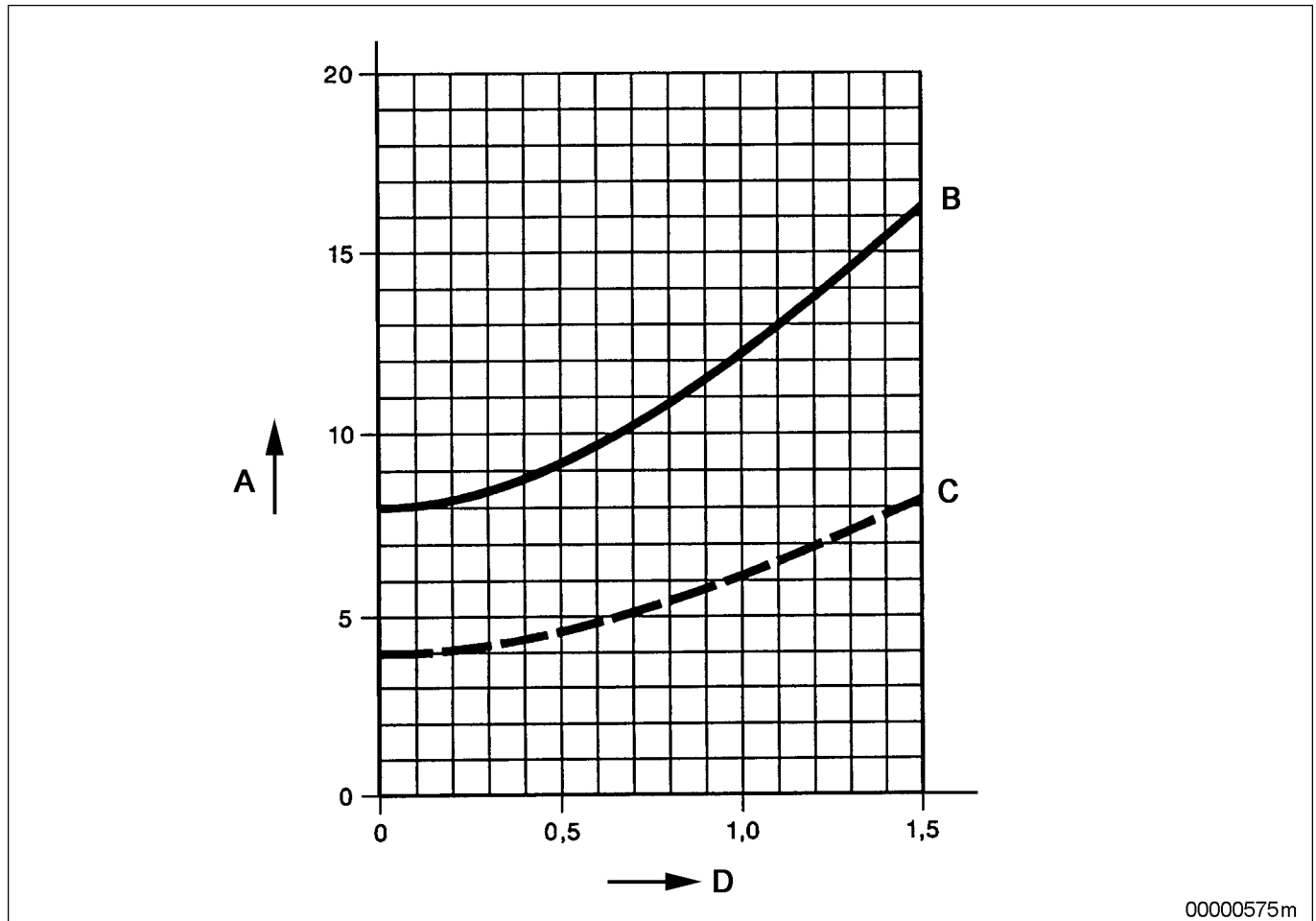
Use of High-Sulfur Diesel Fuel

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

- Use of an engine oil with a total base number (TBN) (ASTM D 2896) of more than 8 mgKOH/g
- Shortening of oil drain intervals (→ Page 07)

The total base numbers for the approved engine oils are listed in Chapter 6 (→ Page 37).

Chart 2 (Total Base Numbers) lists the recommended minimum total base numbers for new and used oils depending on the sulfur content of the diesel fuel.



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Diagram 2
A Total base number in mgKOH/g,
ISO 3771

B Recommended min. total base
number for fresh oil
C Min. total base number for used oil

D Sulfur content of fuel in % weight

Use of Low-Sulfur Diesel Fuel

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

Minimum Requirements for Operational Checks

Oil analyses can be carried out using the MTU Test Kit. The Test Kit contains all the equipment required as well as instructions for use.

The following checks can be performed:

- Determination of oil dispersing capacity (spot test)
- Determination of diesel fuel content in the oil.
- Determination of water content in oil

Lubricating Greases Requirements

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

Grease manufacturers are notified in writing if their product is approved by MTU.

Lubricating Greases for General Applications

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

- Emergency air shutoff flaps fitted between turbocharger and intercooler. (→ Page 11)
- Coupling internal centering

High Melting-point Greases

High-temperature grease (up to 250 °C) must be used for emergency shutoff flaps located between turbocharger and intercooler:

- Aero Shell Grease 15

- Optimol Inertox Medium

General purpose greases suffice for emergency air shutoff flaps located before the turbocharger or after the intercooler.

Coupling Internal Centerings

Greases for internal centerings:

- Esso Unirex N3 (stable up to approx. 160 °C)

Special-Purpose Lubricants

Turbochargers

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

For ABB turbochargers which are not connected to the engine lube oil system, mineral-based turbine oils with viscosity grade ISO-VG 68 must be used.

Gear Couplings

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

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

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

3 Coolants

Requirements

Coolants must be prepared from suitable fresh water and an MTU-approved coolant additive. Conditioning of the coolant takes place outside the engine.



Mixing of different coolant additives and supplementary additives is prohibited!

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

- Emulsifiable corrosion-inhibiting oils, MTL 5047
- Corrosion-inhibiting antifreeze: MTL 5048
- Water-soluble corrosion inhibitors, MTL 5049

Coolant manufacturers are informed in writing if their product is approved by MTU.

To prevent cooling system damage:

- When topping up (following loss of coolant) it must be ensured that the concentration of corrosion-inhibiting additive in the cooling system is 50% by volume (frost-protection to -37 °C).
- Do not use concentrations of corrosion-inhibiting additives exceeding 55% by volume (max. antifreeze protection). Concentrations in excess of this reduce antifreeze protection and heat dissipation.

Coolant mixtures:

Antifreeze protection to °C	-37	approx. -45
Water % by vol.	50	45
Corrosion-inhibiting additive % by vol.	50	Max. 55

Fresh water

Only clean, clear water with values in accordance with those in the following table must be used for preparing the coolant. If the limit values for the water are not achieved, its hardness or mineral content can be decreased by adding demineralized water.

	Min.	Max.
Total earth alkalines ¹⁾ (Water hardness)	0 mmol/l 0°d	2.7 mmol/l 15°d
pH-value at 20 °C	6.5	8.0
Chloride ions		100 mg/l
Anion total		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°d = 1.79° French hardness
- 1°d = 1.25° English hardness

Coolant Additives

Emulsifiable Corrosion Inhibiting Oils

A 2% by volume concentration must be used for initial filling.

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

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

The required quantity of corrosion-inhibiting oil is best mixed in advance in a container with 4 to 5 times the amount of fresh water and then added to the coolant when the engine is 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 unfavorable conditions, individual cases of bacterial attack may occur in the emulsifiable corrosion-inhibiting oils. In such cases, and after consultation with the MTU chemical laboratory, the emulsion is to be treated with biocides.

Note:

Slight precipitation may occur where coolant emulsions are used. This is shown by a layer on the surface of the coolant in the expansion tank. This is of no significance provided that the emulsion concentration remains within the specified limit values. Change the coolant in the event of a sudden drop in coolant additive concentration or if the additive is no longer absorbed. If necessary, the engine coolant chambers are to be cleaned (see the Flushing and Cleaning Specification for Engine Coolant Systems at the end of this specification).

Emulsifiable corrosion-inhibiting oil must never be used for coolant temperatures >90 °C except during test stand runs and test runs.

Emulsifiable corrosion-inhibiting oil is to be used for the Series 595, 956 and 1163 engines in marine applications exclusively.

Emulsifiable corrosion-inhibiting oils must not be used with the following Series:

- Series 183
- Series 396 TB (external charge air cooling with plate core heat exchanger)
- Series 396 TE (split-circuit cooling system)
- Series 4000
- Series 8000

Corrosion-inhibiting antifreezes

General information

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, the MTU-approved corrosion inhibiting antifreezes ensure adequate corrosion protection.

The corrosion inhibiting 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 corrosion-inhibiting antifreeze is used, a higher engine temperature will result.

Limitations on the Use of Corrosion-Inhibiting Antifreezes

Marine engines are subject to the following limitations when using corrosion-inhibiting antifreezes:

- Series 538, 595 and 956/1163:
These engines are fitted with heating units. Because of their cooler capacity, corrosion-inhibiting antifreezes must not be used.
- Series 099, 183, 396:
The use of corrosion-inhibiting antifreeze in these engines is permitted only at seawater temperatures of up to 20 °C maximum.
- Series 2000 and 4000:
Corrosion-inhibiting antifreeze may be used with these engines at seawater temperatures up to 25 °C
- Series 8000:
The use of corrosion-inhibiting antifreezes is not allowed for these engines.

Corrosion-inhibiting antifreezes can be used without reservation in vehicle, locomotive and stationary applications.

Corrosion-Inhibiting Antifreezes for Special Applications

Propylene glycol-based corrosion-inhibiting antifreezes are stipulated for use in some types of applications. These products have a lower thermal conductivity than the usual ethylene glycol products. This brings about a higher temperature level in the engine. Specifications for concentrations are in accordance with (→ Table Calc. table for corrosion-inhibiting antifreezes for special applications (Table 8) on page 17).

The product BASF G206 (see Chapter 6) is available for use at extremely low temperatures (< -40 °C) (→ Page 37). Specifications for concentrations are in accordance with (→ Table Calc. table for corrosion-inhibiting antifreezes for special applications (Table 8) on page 17).

Water-soluble corrosion inhibitors

General information

Water-soluble corrosion inhibitors are required for higher coolant temperatures and large temperature drops in heat exchangers, e.g. in TB- (with plate core heat exchanger) and TE-systems in Series 396, 4000 and 183 engines.

For Series 8000 engines, only water-soluble corrosion-inhibitors in accordance with Chapter 6 may be used. (→ Page 37)

The watersoluble corrosion inhibitors recommended by MTU ensure adequate protection provided the correct concentrations are used. The relevant concentration range for use is listed in the section on Operational Monitoring (→ Table Permissible concentrations (Table 6) on page 16) under "Water-soluble corrosion inhibitors".

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

Note:

Flushing with water is required during every product change. This also applies to new engines. The work involved and cleaning agents required are described in the MTU Flushing and Cleaning Specifications (see appendix to these Fluids and Lubricants Specifications).

Coolant additives for aluminum-free engine series (Series 2000 C&I, Series 4000 C&I/Genset)

For Series 2000 C&I, Series 4000 C&I and Series 4000 genset engines, all of the coolant additives listed in Chapter 6 as being suitable for light-alloy-free engines may be used. (→ Page 37) The restrictions listed under "Remarks" with.



The coolant additives listed in Chapter 6 must not be used for any other engine series! (→ Page 37)

Operational Monitoring

Inspection of the fresh water and continuous monitoring of the coolant are essential for trouble-free engine operation. Fresh water and coolant should be inspected at least once per year and with each fill-up. Inspections can be carried out using the MTU test kit which contains the necessary equipment, chemicals and instructions for use.

The following tests can be conducted with the MTU Test Kit:

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

Orders for fresh water and coolant analysis may be placed with MTU. Samples of min. 0.25 l must be supplied.

Permissible concentrations (Table 6)

	Min. % by vol.	Max. % by vol.
Emulsifiable corrosion-inhibiting oils	1.0	2.0
Corrosion-inhibiting antifreezes	35 Antifreeze protection to approx. –25 °C	50 Antifreeze protection to approx. –40 °C
Propylene glycol corrosion-inhibiting antifreeze	35 Antifreeze protection to approx. –25 °C	50 Antifreeze protection to approx. –40 °C
BASF G206	35 Antifreeze protection to approx. –18 °C	65 Antifreeze protection to approx. –65 °C
Water-soluble corrosion inhibitors		
– BASF Glyscorr G93–94 – Ginouves York 719 – Valvoline ZEREX G-93 CCI Manufacturing IL Corp.	9	11
– Nalco Alfloc 2000 – Nalco Nalcool 2000 – Nalco Nalco 2000 – Detroit Diesel Power Cool 2000 – Peentryay Pencil 2000	3	4
– Nalco Alfloc 3477 – Artec Havoline Extended Life Corrosion Inhibitor – Chevron Texaco Extended Life Corrosion Inhibitor Nitrite Free – Caltex XL Corrosion Inhibitor Concentrate	7	11
– Fleetguard DCA-4L	5	6

Table 7 can be used to determine the concentration of water-soluble corrosion inhibitors using the hand refractometer. Calibrate the hand refractometer with clean water at coolant temperature. Coolant temperature should be 20 – 30 °C.

Test kits are available from the manufacturer for determining the concentration of the other water-soluble corrosion inhibitors.

Calculation table for water-soluble corrosion inhibitors (Table 7)

Product	Product	Product	Product	
BASF Glyscorr G93-94	Arteco Havoline Extended Life Corrosion Inhibitor	CCI Manufacturing IL Corp.	- Nalco Alfloc 3477	
Ginouves York 719	Chevron Texaco Extended Life Corrosion Inhibitor Nitrite Free			
Valvoline ZEREX G-93	Caltex XL Corrosion Inhibitor Concentrate			
Reading on hand refractometer at 20 °C (= degrees Brix)				Corresponds to a concentration of
3.5	2.6	4.9	1.75	7% by volume
4.0	3.0	5.6	2.0	8% by volume
4.5	3.4	6.3	2.25	9% by volume
5.0	3.7	7.0	2.5	10% by volume
5.5	4.1	7.7	2.75	11% by volume
6.0	4.4	8.4	3.0	12% by volume

Calc. table for corrosion-inhibiting antifreezes for special applications (Table 8)

Product	Product	
Propylene glycol corrosion-inhibiting antifreeze	BASF G206	
Reading on hand refractometer at 20 °C (= degrees Brix)		Corresponds to a concentration of
26.3	24.8	35% by volume
26.9	25.5	36% by volume
27.5	26.1	37% by volume
28.2	26.7	38% by volume
28.8	27.4	39% by volume
29.5	28.0	40% by volume
30.1	28.6	41% by volume
30.8	29.2	42% by volume
31.3	29.8	43% by volume
31.9	30.4	44% by volume
32.5	30.9	45% by volume

33.1	31.5	46% by volume
33.7	32.1	47% by volume
34.2	32.6	48% by volume
34.8	33.2	49% by volume
35.3	33.8	50% by volume
	34.4	51% by volume
	34.9	52% by volume
	35.5	53% by volume
	36.1	54% by volume
	36.7	55% by volume
	37.2	56% by volume
	37.8	57% by volume
	38.3	58% by volume
	38.9	59% by volume
	39.4	60% by volume
	39.9	61% by volume
	40.5	62% by volume
	41.0	63% by volume
	41.5	64% by volume
	42.0	65% by volume

Limit values for prepared coolant (Table 9)

pH value when using:		
– Emulsifiable corrosion inhibiting oil	Min. 7.5	Max. 9.5
– Corrosion inhibitor / antifreeze	Min. 7.0	Max. 9.0
– Water-soluble corrosion inhibitor for engines with aluminum / light-alloy parts	Min. 7.0	Max. 9.0
– Water-soluble corrosion inhibitor for engines without aluminum / light-alloy parts	Min. 7.0	Max. 11.0
Silicon (valid for coolants containing Si)	Min. 25 mg/l	

TIM ID: 000010136 - 005

Storage capability of coolant concentrates up to max. 35 °C (Table 10)

Emulsifiable corrosion-inhibiting oil	6 months	
Corrosion-inhibiting antifreezes	5 years	
Products containing propylene glycol	3 years	BASF G206
Water-soluble corrosion inhibitors	2 years	– Nalco Alfloc 2000 Nalco Nalcool 2000 Nalco Nalco 2000 Detroit Diesel Power Cool 2000 Pentray Pencool 2000
	3 years	Alfloc 3477 BASF Glyscorr G93–94 Ginouves York 719 Valvoline ZEREX G-93
	5 years	Arteco Havoline Extended Life Corrosion Inhibitor Caltex XL Corrosion Inhibitor Concentrate Chevron Texaco Extended Life Corrosion Inhibitor Nitrite Free Fleetguard DCA-4L CCI Manufacturing IL A216

4 Fuels

Diesel Fuels

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 worldwide. The properties and limit values specified in Table 11 (fuels of comparable quality) ensure optimum engine performance.

In order to achieve optimum engine performance and satisfactory service life for the entire fuel and injection system, the limit values for water and total contamination must be complied with in the engine tank for all approved fuel qualities. Furthermore, it is advisable to integrate an additional filtering system in the fuel system.

Emission certification

The certification measurements for verifying observance of the statutory emission limits are carried out with the respectively prescribed certification fuels.



Dispose of used fluids and lubricants in accordance with local regulations.
Used oil must never be disposed of via the fuel tank!

Fuels of comparable quality with following test results: (Table 11)

		Test Method		Limit Value
		ASTM	ISO	
Composition				The diesel fuel must be free of inorganic acids, visible water, solid foreign matter and chlorous compounds.
Total contamination	Max.	D 6217	EN 12662	24 mg/kg
Spec. grav. at 15 °C	Min.	D 1298	EN 3675	0.820 g/ml
	Max.	D 4052	EN 12185	0.860 g/ml
API grade at 60 °F	Min.	D 287		41
	Max.			33
Viscosity at 40 °C	Min.	D 445	EN 3104	1.5 mm ² /s
	Max.			4.5 mm ² /s
Flashpoint (closed crucible)	Min.	D 93	EN 22719	60 °C
Boiling curve:		D 86	3405	
	– Initial boiling point			160 – 220 °C
	– Recovery at 250 °C	Max.		65% by volume
	– Recovery at 350 °C	Min.		85% by volume
– Residue and loss	Max.			3% by volume
Water	Max.		EN 12937	200 mg/kg
Carbon residue from 10% distillation residue	Max.	D 189	EN 10370	0.30% by weight

TUM ID: 0000010137 - 007

		Test Method		Limit Value
		ASTM	ISO	
Oxide ash	Max.	D 482	EN 6245	0.01 by weight %
Sulfur ¹⁾	Max.	D 5453 D 2622	EN 20846 EN 20884	0.5 by weight %
Cetane number	Min.	D 613	EN 5165	45
Cetane index	Min.	D 976	EN 4264	42
Corrosion effect on copper. 3 hrs. at 50 °C	Max. degree of corrosion	D 130	EN 2160	1a
Oxidation resistance	Max.	D 2274	EN 12205	25 g/m ³
Lubricity at 60 °C	Max.	D6079	12156-1	460 µm
Filter plugging point		D 4359	EN 116	See Note 2)
Neutralization number	Max.	D 974		0.2 mgKOH/g

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

2) 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.

Laboratory Analysis

An order for fuel analysis can be placed with MTU.

The following data is required:

- Fuel specifications
- Sampling point
- Serial number of engine from which fuel sample was taken

Submit the following:

- 0.5 liters of fuel

Requirements

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

Distillate Fuels

- Diesel fuel in accordance with EN 590
- Grade No. 1–D (S15, S500, S5000) in accordance with ASTM D 975–06
- Grade No. 2–D (S15, S500, S5000) in accordance with ASTM D 975–06



Distillate fuels with a sulfur content <math>< 50 \text{ mg/kg}</math> must not be used if lubricity (HFRR) is <math>< 460 \mu\text{m}</math>. Distillate fuels according to ASTM D 975–06 must only be used for Series 4000-03 if the cetane number ≥ 45 or the cetane index ≥ 42 .



Distillate fuels according to ASTM D 975-06 are generally approved. A lubricity of $\leq 460 \mu\text{m}$ is required because with lubricities $> 460 \mu\text{m}$ increased wear must be expected!

Marine Distillate Fuels

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

- DMX acc. to ISO 8217
- DMA according to ISO 8217 with the restrictions specified in Table 12
 - Not for Series 2000, S60

Fuel specifications for marine applications (Table 12)

Applies to Series 595/4000-01/4000-02/4000-03/956/1163/8000

Characteristics		Test Method		Limit Value	Typical Test Data*	Limit Values**
Spec. grav. at 15 °C	g/ml	D 1298 D 4052	EN 3675 EN 12185	Min. Max.	0.820 0.870	0.820 0.890
Kinematic viscosity at 40 °C	mm ² /s	D 445	EN 3104	Min. Max.	1.5 4.5	1.5 6.0
Cetane number		D 613	EN 5165	Min.	45	40
Cetane index		D 976	EN 4264	Min.	42	40
Carbon residue from 10% distillation residue	by weight %	D 189	EN 10370	Max.	0.3	0.3
Flashpoint (closed crucible)	°C	D 93	EN 22719	Min.	60	60
Proportion of water	mg/kg		EN 12937	Max.	200	200
Total contamination	mg/kg		EN 12662	Max.	24	24
Oxide ash	by weight %	D 482	EN 6245	Max.	0.01	0.01
Sulfur	by weight %	D 2622	EN 20884	Max.	0.5	1.5
Lubricity at 60 °C	µm	D 6079	ISO 12156-1	Max.	460	460

* = limit values with which fuel must comply at inlet to engine

** = limit values that can be approved in special project cases through special measures, such as the use of filter system, water separator, additives or additional maintenance tasks. The special measures serve to optimize the DMA fuel with regard to requirements before entry to the engine and must be coordinated with MTU.



Aviation turbine fuels are generally not approved.

– Other qualities on request

Biodiesel

The standardized general term “FAME” (Fatty Acid Methyl Ester) is used here to designate biodiesel fuels.

The following engines are approved / not approved (as indicated) for operation with 100% FAME in compliance with EN 14214.

Series	Approved / Not approved	Conversion necessary
SUN		Not approved
700		Not approved
750		Not approved
OM 457 LA	From series introduction	No
460	From series introduction	No
900	From series introduction	No
500	From series introduction	No
S 40		Not approved
S 50		Not approved
S 60		Not approved
1800	From series introduction	No
2000		Not approved
396		Not approved
4000		Not approved
595		Not approved
956		Not approved
1163		Not approved
8000		Not approved



Diesel fuel with a FAME content of max. 5% in compliance with DIN EN 590 may be used. Such fuel may also be used in engines which have not been approved for operation with FAME, without affecting oil drain intervals.

It is intended that future engine series will be approved for operation with 100% FAME. Further details will be published at the appropriate time.

Fuel

- The fuel must comply with DIN EN 14214. Operation with fuels of lower quality can lead to damage and malfunctions.
- Either FAME or diesel fuel may be used. The various mixtures of FAME and normal diesel fuel which may occur in the fuel tank as a result, present no problems.

Engine Oil and Servicing

- For operation using 100% FAME, engine oils are to be preferred which comply with MB Fluids and Lubricants Specifications, Sheet 228.5 or Oil Category 3 in accordance with MTU Fluids and Lubricants Specifications. Engine oils in accordance with Sheet 228.3 or Oil Category 2 as per MTU Fluids and Lubricants Specifications may also be used provided that oil drain intervals are reduced.
- A certain amount of fuel always finds its way into the engine oil via the pistons and cylinders. Its high boiling point means that FAME does not evaporate but remains in the engine oil in its entirety. Under certain conditions chemical reactions may take place between FAME and the engine oil. This can lead to engine damage.
- For this reason, engine oil and filter change intervals must be shortened for operation both with pure FAME and with FAME-diesel mixtures.

- For Series 457, 460/1800, 900 and 500 engines, special equipment is available which facilitates an increase in the engine oil change intervals for operation with 100% FAME. This involves fitting the engines with special equipment Code MK21 (special unit pump) and Code MK04 (fuel prefilter with heated water separator).

Engine version	Engine oil change interval
Engines not fitted with special equipment for operation with FAME	Reduction of engine oil change interval to 30% of the interval required for operation with fossil diesel fuels.
Engines fitted with special equipment Code MK21 and Code MK04	Reduction of engine oil change interval to 50% of the interval required for operation with fossil diesel fuels.



The relevant engine oil change intervals must be complied with without fail!
Exceeding the engine oil change intervals can cause engine damage!

- Operation with 100% FAME requires shortened fuel filter change intervals. A new fuel filter must be fitted each time the engine oil is changed.
- Fuel and engine oil must be changed approximately 25 operating hours after conversion to FAME due to the danger of blockage caused by loosened deposits (FAME has a pronounced cleaning effect).
- Over longer periods, fuel filter service life may be reduced as a result of old residues being carried into the filter from the fuel system. A special, approved fuel prefilter can be installed as an improvement. This fuel prefilter with heated water separator is already installed on engines fitted with special equipment Code MK04.

Engine Power and Engine Standstill

- Due to its calorific value, operation with 100% FAME involves a reduction of approx. 8%-10% in engine power. This leads to a corresponding increase in fuel consumption as compared to operation with diesel fuel. Engine power corrections are not permissible.
- Prior to any extended period out of operation, the fuel system must be flushed out in order to prevent congestion. For flushing, the engine must be operated for at least 30 minutes on diesel fuel.

General Information

- We can make no comment with regard to the level of FAME resistance of the fuel system, which is not part of our scope of supply.
- FAME is an extremely effective solvent. Any contact with paint, for example, must therefore be avoided.
- The characteristic smell of FAME exhaust, especially during long periods of idling, may be perceived as unpleasant. The nuisance caused by smell can be reduced by an oxidation catalyzer which may be installed by the vehicle / equipment manufacturers at their own risk.



Our company accepts no responsibility for and provides no warranty in respect of any fault or damage connected in any way with the use of FAME of a lower quality or resulting from noncompliance with our specifications on operation using FAME. All resultant irregularities and consequential damage lie outside our responsibility.

Vegetable Oils as an Alternative to Diesel Fuel



The use of pure vegetable oils as an alternative to diesel fuel or FAME is strictly prohibited due to the absence of standardization and to negative experience (engine damage caused by coking, deposits in the combustion chambers and oil sludge)!

Low-Sulfur Diesel Fuels

Sulfur is contained in chemically bound form in crude oil and is therefore present in fuel at varying levels. A sulfur content of max. 50 mg/kg or 10 mg/kg (depending on category) has been a European Union requirement since 01.01.2005. The term “sulfur-free” is used here to designate diesel fuels with a sulfur content of max. 10 mg/kg. Low-sulfur diesel fuels (max. 50 mg/kg) are to be recommended for environmental reasons. In order to avoid problems with wear, lubricity additives, among other things, are added by the manufacturer.

On older series engines (Series 538, 595, 956, 1163) with cylinder heads not fitted with valve seat inserts, the use of low-sulfur fuel (< 50 mg/kg) can lead to increased valve seat wear. This wear can be reduced by the addition of anti-wear additives. Approved additives are listed in Table 13 and must be added to the fuel. The additive must be filled before every refueling.

Approved anti-wear additives (Table 13)

Manufacturer	Brand name	Concentration for use
Liqui Moly Jerg-Wielandstr.4 89081 Ulm Tel. +49 (0)731/1420-13 Fax. +49 (0)731/1420-82	Blei-Ersatz	250 mg per 1 kg
The Lubrizol Corporation 29400 Lakeland Boulevard Wickliffe, Ohio 44092 USA Tel. +01 440-943-4200	ADX 76611	250 mg per 1 kg
Tunap Industrie GmbH Bürgermeister-Seidl-Str. 2 82515 Wolfratshausen Tel. +49 (0)8171/1600-0 Fax. +49 (0)8171/1600-91	Tunadd PS	250 mg per 1 kg

Diesel Fuels in Winter Operation

At low outdoor temperatures, the diesel fuel's fluidity can be inadequate 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 during transitional periods and in individual countries. If no frost-resistant diesel fuels are available, paraffin oil or aviation turbine fuel must be added before frost sets in. As a basic guide, 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 fluidity 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) must not be added.

Flow improvers

Flow improvers cannot prevent paraffin precipitation but they do influence the size of the crystals and allow the diesel fuel to pass through the filter.

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

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

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

Heating Oil EL

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

- Cetane number
- Sulfur content
- Oxidation stability
- Corrosion effect on copper

- Lubricity
- Low temperature behavior

Technically, if the characteristics of domestic heating oil satisfy the specifications for the required diesel fuel, then it can be used in a diesel engine.

Cetane number

DIN 51 603 -1 does not specify the cetane number. If heating oil 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 calculated cetane index must not be less than 42.

Sulfur content

In accordance with DIN 51 603 -1, the maximum sulfur content for EL-1 standard heating oil is 0.2%. The maximum sulfur content for EL-1 heating oil is 50 mg/kg. Lubricity additives must never be added as its primary purpose is for heating. Lubrication problems can therefore be expected when using these qualities of heating oil because of the missing additives.

Consultation with the individual fuel supplier is necessary.

Supplementary fuel additives

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

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

The anti-wear additives in (→ Table Approved anti-wear additives (Table 13) on page 27) represent an exception.



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

Microorganisms in fuel

Bacterial attack and sludge formation may occur in the fuel under unfavorable conditions. In such cases, the fuel must be treated with biocides in accordance with the manufacturer's specifications. Overconcentration must always be avoided.

For prophylactic use, the appropriate concentration must be identified in consultation with the relevant manufacturer.

Approved biocides (Table 14)

Manufacturer	Brand name	Concentration for use
ISP Global Technologies Deutschland GmbH Emil-Hoffmann-Str. 1a 50996 Köln Tel. +49 (0)2236 9649 304/301 Fax. +49 (0)2236 9649 295	Bakzid	100 ml per 100 l
Schülke und Mayr 22840 Norderstedt Tel. +49 (0) 40/52100-00 Fax. +49 (0) 40/52100-244	Grota MAR 71 StabiCor 71	0.5 l / ton 0.5 l / ton
Rohm und Haas In der Kron 4 60489 Frankfurt Tel. +49 (0) 69/78996-0 Fax. +49 (0) 69/7895356	Kathon FP 1.5	100-200 mg/kg
Maintenance Technologies Simon's Town 7995 Cape Town – South Africa Tel. +27 21 9877377 Fax. +27 21 9794611 E-mail: maintech@telkomsa.net	Diesalcure Fuel Decontainment	1 : 4000 (250mg/kg)

Fuel for gas engines

Gas engines must be operated exclusively with gases which have been specifically approved for the type of gas engine in use. The suitability for use of approved gas types must be checked every six months by means of a gas analysis in order to detect changes in the gas composition and changes to harmful components in the gas and to take appropriate action. In the entire application and operating range of the engine, the use of fuels is restricted to purely gaseous fuels. Liquid fuels are not permissible and not specified.

Components that may be used for gas engines are listed in the following tables. Generally valid limits for the main elements are specified in Table 15. Examples of typical natural gas compositions are shown in Tables 16 and 17. The listed components are relevant to gas engines. Components other than those listed below are not permitted for gas engines. They provide a reference value for the most gas

compositions used today. Limit values for the individual components, unless they are explicitly restricted, are based on the general requirements of freedom from fluid elements, the exclusion of condensate and hydrocarbons and the global parameters of gas mixing in accordance with Table 18.

Main elements of natural gases (Table 15)

Name	Components	Unit	Value range
Natural gas	CO	% by vol.	<2
	CO ₂	% by vol.	<10
	CH ₄	% by vol.	80-100
	C ₂ H ₆	% by vol.	<12
	C ₃ H ₈	% by vol.	<9
	C ₄ H ₁₀	% by vol.	<1
	N ₂	% by vol.	< 20
	O ₂	% by vol.	< 3

Examples for natural gases

Typical natural gas compositions, natural gas H (according to DVGW worksheet G260) (Table 16)

		Russia	North Sea I	North Sea II	Network gas
CO	% by vol.	0.0000	0.0000	0.0000	0.0000
CO ₂	% by vol.	0.1000	0.0000	0.3000	1.4000
CH ₄	% by vol.	98.3000	88.6000	83.0000	88.6000
C ₂ H ₄	% by vol.	0.0000	0.0000	0.0000	0.0000
C ₂ H ₆	% by vol.	0.5000	8.4000	11.6000	5.3000
C ₃ H ₆	% by vol.	0.0000	0.0000	0.0000	0.0000
C ₃ H ₈	% by vol.	0.2000	1.7000	3.1000	1.4000
C ₄ H ₆	% by vol.	0.0000	0.0000	0.0000	0.0000
C ₄ H ₈	% by vol.	0.0000	0.0000	0.0000	0.0000
C ₄ H ₁₀	% by vol.	0.1000	0.7000	0.5000	0.6000
C ₅ H ₁₂	% by vol.	0.0000	0.0000	0.0000	0.0000
C _X H _Y	% by vol.	0.0000	0.0000	0.0000	0.0000
N ₂	% by vol.	0.8000	0.6000	1.5000	2.7000
O ₂	% by vol.	0.0000	0.0000	0.0000	0.0000
H ₂	% by vol.	0.0000	0.0000	0.0000	0.0000
H ₂ O	% by vol.	0.0000	0.0000	0.0000	0.0000
H ₂ S	% by vol.	0.0000	0.0000	0.0000	0.0000
SO ₂	% by vol.	0.0000	0.0000	0.0000	0.0000
AR	% by vol.	0.0000	0.0000	0.0000	0.0000
Σ	% by vol.	100.000	100.000	100.000	100.000

		Russia	North Sea I	North Sea II	Network gas
Ho	kWh/m ³ _N	11.1	12.2	12.5	11.5
Hu	kWh/m ³ _N	10.0	11.0	11.3	10.3
Density	kg/m ³ _N	0.731	0.810	0.853	0.814
rel. density	--	0.56	0.62	0.66	0.63
Ws,n	kWh/m ³ _N	14.7	15.4	15.4	14.5
Methane number	Methane no. (±2)	89	72	68	78

Typical natural gas composition, natural gas L (according to DVGW worksheet G260 (Table 17))

		Holland I	Holland II	Osthannover (East Hanover)
CO	% by vol.	0.0000	0.0000	0.0000
CO ₂	% by vol.	1.0000	1.3000	0.7000
CH ₄	% by vol.	81.3000	82.9000	79.5000
C ₂ H ₄	% by vol.	0.0000	0.0000	0.0000
C ₂ H ₆	% by vol.	2.8000	3.7000	1.1000
C ₃ H ₆	% by vol.	0.0000	0.0000	0.0000
C ₃ H ₈	% by vol.	0.4000	0.7000	0.1000
C ₄ H ₆	% by vol.	0.0000	0.0000	0.0000
C ₄ H ₈	% by vol.	0.0000	0.0000	0.0000
C ₄ H ₁₀	% by vol.	0.3000	0.3000	0.0000
C ₅ H ₁₂	% by vol.	0.0000	0.0000	0.0000
C _X H _Y	% by vol.	0.0000	0.0000	0.0000
N ₂	% by vol.	14.2000	11.1000	18.6000
O ₂	% by vol.	0.0000	0.0000	0.0000
H ₂	% by vol.	0.0000	0.0000	0.0000
H ₂ O	% by vol.	0.0000	0.0000	0.0000
H ₂ S	% by vol.	0.0000	0.0000	0.0000
SO ₂	% by vol.	0.0000	0.0000	0.0000
AR	% by vol.	0.0000	0.0000	0.0000
Σ	% by vol.	100.000	100.000	100.000
Ho	kWh/m ³ _N	9.76	10.20	9.04
Hu	kWh/m ³ _N	8.81	9.21	8.15
Density	kg/m ³ _N	0.836	0.832	0.835

		Holland I	Holland II	Osthannover (East Hanover)
Rel. density	--	0.64	0.64	0.64
Ws,n	kWh/m ³ _N	12.2	12.7	11.3
Methane number	Methane no. (±2)	90	86	101

Requirements for fuel gas

Requirements and marginal conditions fuels and fuel supply (Table 18)

Designation	Unit	Limit Value	Remarks
Type of gas		Natural gas	Applies to natural gas H and L, other gases are currently not approved
Methane number	--	≥ 70	Combustion knock, gas analysis and consultation with manufacturer
Calorific power Hu	kWh/m ³ _N	8.0 < Hu < 11.5	Consultation with manufacturer required in case of lower values.
Calorific value deviation from the setting value	%	± 5	Consultation with manufacturer required for higher values
Permissible change speed of calorific value	kWh/m ³ _N /h	0.5	Linear constant change required
Density of gas	kg/m ³ _N	0.73-0.84	The density of the gas can fluctuate in accordance with the composition; it is constant for a certain type of gas. When using gas from different gas supply areas, the density may vary. When changing the gas supplier, a gas analysis is necessary; an adaptation of the mixture control may be necessary.
Setting value for gas pressure, gas train entry	mbar	80-200	Observe the specifications for the gas train corresponding to the project
Gas pressure deviation from the setting value	%	± 5	
Permissible change speed of gas pressure	mbar/min.	0.08	Constant change required
Gas temperature	°C	10 < T < 40	Condensation of water vapor at <10 °C, thermal aging of NBR materials (seals, diaphragms) and influence on elasticity characteristics at higher temperatures
Gas temperature deviation from the setting value	°C	± 9	
Permissible change speed of gas temperature	K/min.	0.3	
Rel. gas humidity in gas at 20 °C	%	<30	No steam condensation in the pressure and temperature range; for higher values, a gas drying system must be provided

Designation	Unit	Limit Value	Remarks
Oil vapors (HC with carbon number >5)	mg/m ³ _N	< 0.4	No condensation in lines carrying fuel gas and fuel gas-air mixture, nor formation of condensable oil mists
HC solvent vapors	mg/m ³ _N	0	Consultation with manufacturer and analysis necessary
Organically fixed silicon (e.g. hydrosilicons, siloxanes, silicones)	mg/m ³ _N	< 1.0	Consultation with manufacturer and analysis necessary
Inorganically fixed silicon	mg/m ³ _N CH ₄	< 5	With Si >5 mg/m ³ _N based on 100% CH ₄ fuel gas content, wear products must be taken into consideration during the oil analysis
Dust 3-10 µm	mg/m ³ _N	5	DVGW worksheet G260
Dust <3µm	mg/m ³ _N	Analysis	
Total sulfur	mg/m ³ _N	30	DVGW worksheet G260
Mercaptan sulfur	mg/m ³ _N	6	DVGW worksheet G260
Hydrogen sulphide H ₂ S	mg/m ³ _N	5	DVGW worksheet G260
Chlorine	mg/m ³ _N	10*	With higher values, consultation with manufacturer and analysis are necessary
Fluorine	mg/m ³ _N	5*	With higher values, consultation with manufacturer and analysis are necessary
Chlorine + fluorine	mg/m ³ _N	10*	With higher values, consultation with manufacturer and analysis are necessary
NH ₃	ppm	70*	With higher values, consultation with manufacturer and analysis are necessary

* = a non-binding guideline value, where oxidation-type catalytic converters are in use. Analysis and consultation with MTU necessary.

The limit values are based on a calorific value of 10 kWh/m³_N. This corresponds to a reference to fuels with 100% by vol. methane or, if there are other combustible elements in the fuel, an equal energy equivalent and thus an equal input of pollutants.

Example:

Russian natural gas with a calorific value of 10 kWh/m³_N (Table 16) is used. The permissible value for total sulfur in the gas thus corresponds exactly to the limit value specified in Table 18.

When using gas from Osthannover, for example, with $H_u = 8.15 \text{ kWh/m}^3_{\text{N}}$ (Table 17) the permissible max. value of total sulfur is calculated thus:

$$\text{permissible total sulfur content} = 30 \text{ mg/m}^3_{\text{N}} * (8.15 \text{ kWh/m}^3_{\text{N}} : 10.0 \text{ kWh/m}^3_{\text{N}}) = 24.5 \text{ mg/m}^3_{\text{N}}$$



No warranty is given in respect of impairment and / or damage (corrosion, contamination etc.) resulting from gases or materials the presence of which was unknown and agreed upon on conclusion of contract.

5 Preservatives

Requirements

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

- Initial-operation oil and corrosion-inhibitor oil, MTL 5051
- Corrosion inhibitors for external preservation, MTL 5052

The preservation product manufacturer is informed in writing if his product is approved by MTU.

Types of Preservation

See Preservation Specification, Chapter 8 (→ Page 77)

Initial Operation Oils and Corrosion Inhibiting Oils for Internal Preservation

SAE 30 viscosity grade corrosion inhibiting 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. Some are also suitable for continuous operation, see Chapter 6 (→ Page 37).

Corrosion Inhibitors for External Preservation

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

Corrosion Inhibiting Oils for Internal Preservation of the Fuel System

Fuel injection-pump test oil conforming to DIN ISO 4113 is to be used for internal preservation of the fuel system. The engine should be run with these oils for the last 10 minutes before shutdown.

Preservation can also be effected using diesel fuel to which approximately 10-12% corrosion-inhibitor oil for internal preservation has been added.

6 Approved fluids and lubricants

Engine oils

For details and special information, see chapter on "Lubricants" (→ Page 05)

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

Manufacturer	Brand name	SAE Vis- cosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Addinol Lube Oil	Addinol Marine MS4011	40	X			
	Addinol Turbo Diesel MD305	30		X		
	Addinol Turbo Diesel MD405	40		X		
Avia	Avia Special HDC	30, 40	X			
BP p.l.c.	Energol DS3-153/154	30, 40			X	
Castrol Ltd.	Castrol MLC	30, 40		X		
Cepsa Lubricantes	Cepsa Rodaje Y Proteccion	30	X			Increased corrosion protection
Chevron	Texaco Ursa Super LA	30, 40	X			
ENI S.p.A	Agip Cladium 120	30, 40				Not for Series 2000, 4000
Exxon Mobil	Essolube X 4	40	X			
Fuchs	Titan Universal HD	30, 40	X			
	FuchsTitan EM 30 MTU	30	X			Increased corrosion protection
Gulf Oil Ltd.	Gulf Superfleet	40	X			
Hindustan Petr. Comp. India	Hylube MTU	40	X			
Huiles Berliet S.A.	RTO Prexima	30, 40		X		
Idemitsu, Singapore	Daphne Marine Oil MT	40		X		
Igol, France	Trans Turbo Mono	40		X		
Kuwait Petroleum	Q8 T 520	30, 40	X			
Mexicana De Lubri- cantes, Mexico	Mexlub CF/CF-2	40	X			
	Akron Extra Fleet	40	X			
Misr Petroleum Company	Misr Super DEO CG-4	40	X			
Motor Oil (Hellas)	EMO Turbo Champion Plus	30, 40	X			
OMV AG	OMV truck	30, 40	X			

Manufacturer	Brand name	SAE Vis- cosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Pertamina Indonesia	Meditran SMX	40	X			
Petrobras	Marbrax CCD-310	30		X		
	Marbrax CCD-410	40		X		
Petrol Ofisi	Süpersarj MF 30	30	X			
PTT Public Comp.	PTT Navita MTU Type 1	40	X			
Ravensberger Schmierstoffvertrieb GmbH	RAVENOL Standard Truck	30, 40	X			
SRS Schmierstoff Vertrieb GmbH	Wintershall Antikorrol M	30	X			Increased corrosion protection
	Wintershall Rekord	30, 40		X		
Shell	Shell Gadinia	30, 40		X		
	Shell Rimula X Monograde	30, 40	X			
	Shell Rimula R3	30, 40	X			
	Shell Sirius Monograde	30, 40	X			
Sakson	Parnas Hercules 1	40	X			
Total	Elf Performance Super D	30, 40		X		
	Fina Delta Super	30, 40		X		
	Total Rubia S	30, 40		X		
United Oil	XD 7000 Extra Duty-3U	30	X			
	XD 7000 Extra Duty-4U	40	X			

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

Manufacturer	Brand name	SAE Vis- cosity class	TBN			Remarks
			5 – 6 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Chevron	Texaco Geotex LA 40	40	X			
Exxon Mobil	Mobil Pegasus 705	40	X			
	Mobil Pegasus 805	40	X			
Fuchs	Fuchs Titan Ganymet LA	40	X			
Shell	Shell Mysella LA 40	40	X			
SRS Schmierstoff Vertrieb GmbH	Wintershall Mihagrun LA 40	40	X			
Total	Nateria MH 40	40	X			

Multigrade oils – Category 1, SAE-grades 10W-40 and 15W-40 for Diesel Engines

1) These multigrade oils can only be used if crankcase ventilation is routed to atmosphere.

2) Engine oils with the index 2) are also approved for “Series 60”

Manufacturer	Brand name	SAE Vis- cosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Addinol Lube Oil	Addinol Super Star MX 1547	15W-40		X		
Avia	Avia HDC Extra UTM	15W-40		X		
BP p.l.c.	BP Vanellus C5 Global	15W-40	X			
Chevron	Texaco Ursa Super LA	15W-40	X			
Claas	Claas Agrimot SDM	15W-40	X			
ENI S.p.A	Agip Superdiesel Multigrade	15W-40	X			2)

Manufacturer	Brand name	SAE Vis- cosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Exxon Mobil	Mobil Delvac MX	15W-40		X		1) and oil change interval 500 operating hours
	Mobil Delvac MX Extra	10W-40		X		1) and oil change interval 500 operating hours
	Essolube XT 5	15W-40		X		1) and oil change interval 500 operating hours
	Essolube XT 3	15W-40	X			1)
	Mobil Delvac Super 1300	15W-40	X			1)
Feoso Oil	Super VG Motor Oils	15W-40	X			
Fuchs	Titan Hydromat SL SAE 10W40	10W-40		X		
	Titan Universal HD	15W-40	X			
Gulf Oil International	Gulf Superfleet	15W-40	X			
Igol, France	Trans Turbo 4X	15W-40	X			
Kuwait Petroleum	Q8 T 520	15W-40	X			
Lukoil Oil Company LLK-International	Lukoil-Super	15W40	X			
OPET Petrolcülük	Omega Turbo Power SHPD	15W-40		X		1) and oil change interval 500 operating hours
OMV AG	OMV Truck M plus	15W-40	X			
Petróleos de Portugal	Galp Galaxia Super 15W-40	15W-40	X			
	Galp MDM 1 15W-40	15W-40	X			
Shell Tongyi (Beijing) Petroleum Chemical Co., Ltd.	You Ya Wong	15W-40	X			
SRS Schmierstoff Vertrieb GmbH	Wintershall Primalub	15W-40	X			
Singapore Petroleum Comp.	SPC SDM 801	15W-40	X			
Sinopec	Great wall century supremacy	15W-40		X		2)

Manufacturer	Brand name	SAE Vis- cosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Total	Elf Performance Super D	15W-40	X			
	Fina Kappa Turbo DI	15W-40	X			
	Total Caprano TD	15W-40	X			
	Total Rubia 4400	15W-40	X			
	Total Rubia XT	15W-40	X			
Unicorn Oil Comp.	Dexus 9000	15W-40	X			
United Oil	XD 9000 Ultra Diesel-U	15W-40	X			

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

MTU/MTU-DD single-grade engine oil

	Brand name	SAE Vis- cosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
	Power Guard DEO SAE 40	40		X		20l Container (Order No. X00037908) 208l Container (Order No. X00037903)
	Fascination of Power	40		X		18l barrel (order no. 93636/P) 200l container (order no. 94545/D) available through MTU Asia

Other Single-grade Engine Oils

Manufacturer	Brand name	SAE Vis- cosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Addinol	Addinol Turbo Diesel MD 407	40	X			
Belgin Madeni Yaglar	Lubex Marine M-30	30		X		
	Lubex Marine M-40	40		X		
BP p.l.c.	BP Energol HPDX	30, 40		X		Approved for fast commercial vessels up to 1500h
Castrol Ltd.	Castrol HLX	30, 40		X		Approved for fast commercial vessels up to 1500h
Cepsa Lubricants	Ertoil Koral HDL	30, 40			X	
Chevron	Texaco Ursa Super TD	30, 40		X		
	Texaco Ursa Premium TDX	40		X		
	Caltex Delo Gold [ISOSYN]	30, 40	X			
	Chevron Delo 400	30, 40	X			
Chevron – Lyteca –	Texaco Ursa Premium TDX	40		X		

Manufacturer	Brand name	SAE Vis- cosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Cyclon Hellas	Cyclon D Super	40		X		
Delek	Delkol Super Diesel	40		X		
	Delkol Super Diesel MT Mono	40	X			
ENI S.p.A.	Agip Sigma GDF	40		X		
Exxon Mobil	Mobil Delvac 1630	30		X		Approved for Series 8000
	Mobil Delvac 1640	40		X		
Gulf Oil Ltd.	Gulf Superfleet Plus	40	X			
Hyrax Oil	Hyrax top deo	40	X			
Klora Gres Ve Yağ Sanay A. Ş	Klora Motor Yagi SAE 40 K	40	X			
Koçak Petrol Ürünleri	Speedol Ultra HDX	30, 40	X			
Kuwait Petroleum	Q8 T 750	30, 40	X			
Motor Oil, Hellas	EMO SHPD Plus	30, 40	X			
Panolin AG	Panolin Extra Diesel	40	X			
Paz Lubricants & Chemicals	Pazl Marine S 40	40	X			
Petrobras	Marbrax CCD-310-AP	30			X	
	Marbrax CCD-410-AP	40			X	
Petrol Ofisi	Turbosarj Ekstra SAE 40-E	40		X		
	PO Turbosarj Extra	30, 40	X			
Petróleos de Potugal	Galp Galaxia 40	40		X		
PTT Public Comp.	PTT Navita MTU Type 2	40		X		
Shell	Shell Sirius X	30			X	Approved for Series 8000
	Shell Sirius X	40			X	
Singapore Petroleum Comp.	SPC 900	40	X			
	SDM 900	30, 40	X			
Sonol, Israel	Sonol 2340	40		X		
SRS Schmierstoff Vertriebs GmbH	Wintershall Rekord plus	30, 40		X		

Manufacturer	Brand name	SAE Vis- cosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Statoil	Statoil Diesel Way	30, 40				
Total	Total Disola MT 30	30	X			
	Total Disola MT 40	40	X			
	Total Rubia TIR XLD	40			X	

Multigrade oils – Category 2, SAE-grades 10W-40, 15W40 and 20W-40 for Diesel Engines

²⁾ Engine oils with the index ²⁾ are also approved for “Series 60“

MTU/MTU-DD multigrade engine oil

Manufacturer	Brand name	SAE Viscosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
	Power Guard DEO SAE 15W-40	15W-40		X		20l container (order no. X00037902) ²⁾ 208l container order no. X00037897) ²⁾
	Fascination of Power	15W-40		X		18l container (order no. 91818/P) ²⁾ 200l container (order no. 92727/D) ²⁾ available through MTU Asia

Other multigrade oils

Manufacturer	Brand name	SAE Viscosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Addinol Lube Oil	Addinol Diesel Longlife MD1047	10W-40		X		²⁾
	Addinol Diesel Longlife MD1548	15W-40		X		²⁾
	Addinol Diesel Power MD1547	15W-40		X		²⁾ , not for Series 4000
	Addinol Diesel Longlife MD1546	15W-40		X		²⁾
	Addinol Diesel Longlife MD1547	15W-40		X		²⁾
Anomina Petroli Italiana	IP Taurus	15W-40	X			
	IP Taurus Turbo	15W-40	X			
	IP Taurus Turbo Plus	15W-40	X			²⁾
API	D Multi Diesel Turbo	15W-40		X		²⁾
AP Oil International Ltd.	AP X-Super Dieselube Turbo CF-4	15W-40	X			
Arabi Enertech KSC	Burgan Diesel CH-4	15W-40		X		²⁾

Manufacturer	Brand name	SAE Vis- cosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Belgin Madeni Yağlar	Lubex Marine M	15W-40		X		
Bharat Petroleum	MAK MB SHPD 15W-40	15W-40		X		
Bölünmez Petrocülük A-S	MOIL Dizel 15W-40	15W-40		X		
BP p.l.c.	BP Vanellus C6 Global	15W-40	X			2)
	BP Vanellus C6 Global Plus	10W-40		X		
	BP Vanellus E6	15W-40		X		2)
	BP Vanellus C7 Global	15W-40	X			2)
	BP Vanellus Multi-Fleet	15W-40	X			2)
	BP Mine Multi	15W-50	X			2)
Castrol Ltd.	Castrol Diesel X	15W-40	X			2)
	Castrol Tecton T	15W-40		X		2)
	Castrol Tecton Plus	15W-40		X		2)
Cepsa	Cepsa Euromax	15W-40		X		2)
Chevron	Caltex Delo SHP Multigrade	15W-40		X		
	Caltex Delo Gold [ISOSYN] Multigrade	15W-40		X		2)
	Caltex Delo 400 Multigrade	15W-40		X		
	Chevron RPM Heavy Duty Motor Oil	15W-40		X		2)
	Chevron Delo 400 Multigrade	15W-40		X		2)
	Texaco Ursa Super Plus	15W-40		X		2)
	Texaco Ursa Super TD	10W-40		X		2)
	Texaco Ursa Super TDS	15W-40		X		2)
	Texaco Ursa Premium TDX					
	Chinese Petroleum Company	CPC Superfleet CG-4 Motor Oil	15W-40	X		
Conoco Phillips Com.	Conoco Hydroclear Power D	15W-40			X	
Cubalub	Cubalub ExtraDiesel	15W-40			X	
Delek	Delkol Super Diesel	15W-40	X			
Denizati Petrokimya Urunleri San	Seahorse Motor Oil 15W-40	15W-40		X		
EKO	Eko Forza Extra	15W-40	X			
ENI S.p.A.	Agip Sigma Truck	15W-40	X			
	Agip Sigma Turbo	15W-40	X			
	Agip Blitum T	15W-40	X			

Manufacturer	Brand name	SAE Vis- cosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Exxon Mobil	Mobilgard 1 SHC	20W-40			X	Approved for fast commercial vessels up to 1500h
	Essolube XT 4	15W-40	X			2)
	Mobil Delvac Super 1400	15W-40	X			
	Mobil Delvac XHP	10W-40		X		
	Mobil Delvac XHP	15W-40	X			
Feoso Oil	Ultra VG Motor Oils	15W-40	X			
FL Selenia	Urania LD7	15W-40		X		
Fuchs	Fuchs Titan Truck Plus	15W-40		X		2)
	Fuchs Titan HPE	15W-40	X			2)
	Fuchs Titan Cargo LD	10W-40		X		2)
	Titan Unic Plus MC	10W-40		X		
	Titan Unic Ultra MC	10W-40		X		
	Titan Formel Plus	15W-40		X		
	Titan Truck	15W-40		X		
	Titan Unimax	15W-40		X		
	Gulf Oil International	Gulf Superfleet LE	10W-40		X	
Gulf Superfleet LE		15W-40		X		2)
Gulf Superfleet Supreme		10W-40		X		
Gulf Superfleet Supreme		15W-40		X		2)
Gulf Superfleet Plus		15W-40	X			
Huiles Berliet S.A.	RTO Maxima RD	15W-40	X			2)
	RTO Maxima RLD	15W-40	X			2)
Hyrax Oil	Hyrax Admiral	15W40	X			
Igol, France	Trans Turbo 5X	15W-40	X			
	Trans Turbo 7X	15W-40	X			2)
	Trans Turbo 9X	15W-40	X			2)
	Protruck 100 X	10W-40		X		
	Protruck 100 X	15W-40		X		2)
Imperial Oil	Esso XD-3 Extra	15W-40		X		2)
Indy Oil SA	Indy Super Turbo Diesel	15W-40		X		2)
Indian Oil Corp.	Servo Premium (N)	15W-40		X		2)
Kuwait Petroleum	Q8 T 720	10W-40	X			2)
	Q8 T 750	15W-40	X			2)
Kocak Petrol Ürünleri San	Speedol SHPD Tiro 15W-40	15W-40		X		

Manufacturer	Brand name	SAE Vis- cosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Lotos Oil	Turdus Powertec CI-4 15W-40	15W-40		X		2)
Lukoil Oil Company LLK-International	Lukoil Avangard	15W-40	X			
Mauran SAS	Turboland	15W-40	X			2)
MOL-LUB Ltd.	MOLDynamic MK9 MOL Mk-9 Mol Dynamic Super Diesel	15W-40 15W-40 15W-40		X X		
Motor Oil, Hellas	EMO SHPD Plus	15W-40		X		
OMV AG	OMV eco truck extra OMV truck LD	10W-40 15W-40	X X	X		2)
Panolin AG	Panolin Universal SFE Panolin Diesel Synth	10W-40 10W-40		X X		
PDVSA Deltaven S.A.	Ultradiesel MT	15W-40	X			
Pennzoil Products	Supreme Duty Fleet Motor Oil Longlife EF Heavy Duty Multigrade Engine Oil Pennzoil Long-Life Gold	15W-40 15W-40 15W-40	X X		X	2)
Pertamina	Meditran SMX	15W-40		X		2)
Petro-Canada Lubricants	Duron Duron XL Synthetic Blend	15W-40 15W-40		X X		2) 2)
Petrol Ofisi	PO Maximus Turbo Dizel Extra PO Turbo Dizel Extra	15W-40 15W-40	X X			2)
Petrolimex Petrochemical Joint-Stock Company	PLC Diesel SHPD 15W-40	15W-40		X		2)
Petron Corporation	Petron REV-X Trekker	15W-40	X			
Prista Oil AD	Prista SHPD Prista Turbo Diesel	15W-40 15W-40	X X			2)
Ravensberger Schmierst- offvertrieb GmbH	RAVENOL Expert SHPD RAVENOL Formel Diesel Super RAVENOL Mineralöl Turbo Plus SHPD	10W-40 15W-40 15W-40		X X X		2)
Repsol YPF	Repsol Extra Vida MT	15W-40	X			
Shanghai HIRI Lubricants	HIRI 245	15W-40	X			2)

Manufacturer	Brand name	SAE Vis- cosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Shell	Shell DEO Super	15W-40		X		2)
	Shell Rimula MV	15W-40	X			2)
	Shell Rimula R3 X	15W-40		X		
	Shell Rimula R4 L	15W-40		X		2)
	Shell Rimula RT4 L	15W-40		X		2)
	Shell Rimula Super	15W-40		X		2)
	Shell Rimula X	15W-40		X		
	Shell Rotella T	15W-40		X		2)
	Shell Rotella T Multigrade	15W-40		X		2)
	Rimula X CH-4	15W-40		X		2)
Sinclair Oil Corp.	Sinclair Dura Tec Premium 1000	15W-40		X		
Singapore Petroleum Company	SDM 900, SAE 15W40	15W-40		X		2)
Sinopec Corp.	Great Wall Jinpai Zunlong	15W-40	X			2)
SRS Schmierstoff Vertrieb GmbH	Wintershall Multi-Rekord top	15W-40		X		2)
	Wintershall Multi Rekord plus	15W-40	X			
	Wintershall Turbo Rekord	15W-40		X		
	Wintershall Turbo Diesel Plus	15W-40		X		2)
	Wintershall TFX	10W-40		X		2)
Statoil	Turbosynt	15W-40			X	2)
Svenska Statoil	MaxWay	15W-40		X		2)
Total	Antar Milantar PH	15W-40	X			2)
	Antar Milantar PX	15W-40	X			2)
	Elf Performance Trophy DX	15W-40	X			2)
	Elf Performance Victory	15W-40		X		2)
	Fina Kappa Optima	15W-40	X			2)
	Total Caprano TDH	15W-40	X			2)
	Total Caprano TDI	15W-40	X			2)
	Total Disola W	15W-40		X		
	Total Rubia TIR 6400	15W-40	X			
	Total Rubia TIR 7400	15W-40		X		2)
Unil Opal	Medos 700	15W-40	X			2)
Valvoline	Valvoline Premium Blue	15W-40		X		
Yacco	Inboard 100 4 T Diesel	15W-40	X			2)
	Transpro 40 S	10W-40		X		

Multigrade oils – Category 2.1 (low SAPS oils)

Manufacturer	Brand name	SAE Vis- cosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Imperial Oil	Esso XD-3 Extra CJ-4	15W-40	X			

Multigrade oils – Category 3, SAE-grades 5W-30, 5W-40, and 10W-40 for Diesel Engines,

Manufacturer	Brand name	SAE Vis- cosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Addinol Lube Oil	Addinol Ultra MD 0538	5W-30			X	
	Addinol Super Truck MD 1048	10W-40			X	
Aral AG	Aral Super Turboral	5W-30			X	
BP p.l.c	BP Energol IC-MT	10W-40			X	
	BP Vanellus E8 Ultra	5W-30			X	
Bucher	Motorex MC Power 3	10W-40			X	
Castrol Ltd.	Castrol Enduron MT	10W-40			X	
	Castrol Enduron Plus	5W-30			X	
	Castrol Elixion 5W-30	5W-30		X		
Cepsa	Cepsa Eurotrans SHPD	5W-30			X	
	Cepsa Eurotrans SHPD	10W-40		X		
Chevron	Caltex Delo XLD Multigrade	10W-40			X	
	Texaco Ursa Super	10W-40		X		
	Texaco Ursa Premium FE	5W-30			X	
	Texaco Ursa Super TDX	10W-40			X	
Elinoil	Elin Diesel Tec Synthetic	10W-40		X		
ENI S.p.A.	Agip Sigma Trucksint TFE	5W-40			X	
	Agip Sigma Super TFE	10W-40		X		
	Agip Sigma Ultra TFE	10W-40			X	
Enoc	Enoc Vulcan 770 SLD	10W-40		X		
Exxon Mobil	Mobil Delvac XHP Extra	10W-40			X	
	Mobil Delvac 1 SHC	5W-40			X	

Manufacturer	Brand name	SAE Vis- cosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
FL Selenia	Urania 100 K Urania FE	10W-40 5W-30		X	X	
Fuchs	Titan Cargo SL Titan Cargo MC Titan Cargo LDF	5W-30 10W-40 10W-40			X X X	
Ginouves	York 847 10W40	10W-40			X	
Gulf Oil International	Gulf Fleet Force synth. Superfleet ELD	5W-30 10W-40		X	X	
Huiles Berliet S.A.	RTO Extensia ECO RTO Extensia RXD	5W-30 10W-40		X	X	
Igol, France	Trans Turbo 8X	5W-30			X	
INA	INA Super 2000	10W-40			X	
Iranol Oil Co.	Iranol D – 40000	10W-40		X		
Kuwait Petroleum	Q8 T 860 Q8 T 905	10W-40 10W-40	X	X		
Lotos Oil	Turdus Semisynthetic XHPDO Turdus Powertec Synthetic	10W-40 5W-30		X	X	
Meguin	Megol Motorenöl Super LL Dimo Premium Megol Engine Oil Diesel Truck Performance	10W-40 10W-40		X	X	
MOL-LUB	MOL Synt Diesel	10W-40		X		
Ölwerke Julius Schindler	Econo Veritas Truck FE	5W-30			X	
OMV	OMV truck FE plus OMV super truck	10W-40 5W-30			X X	
Panolin	Panolin Diesel HTE	10W-40			X	
Petróleos de Portugal	Galp Galaxia Ultra EC Galp Galaxia Extreme	10W-40 5W-30		X X		
Petrol Ofisi	PO Maxima Diesel	10W-40		X		
Prista Oil AD	Prista UHPD	10W-40	X			
Ravensberger Schmierstoffvertrieb GmbH	RAVENOL Super Performance Truck RAVENOL Performance Truck	5W-30 10W-40			X X	

Manufacturer	Brand name	SAE Vis- cosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Redoil Italia	Challoils Syntextruck	10W-40		X		
Repsol YPF	Repsol Diesel Turbo VHPD	5W-40			X	
Shell	Shell Rimula Ultra	5W-30			X	
	Shell Rimula R6 M	5W-30			X	
	Shell Rimula Ultra E7	10W-40			X	
SMV GmbH JB German Oil	JB German Oil High Tech Truck	10W-40			X	
SRS Schmierstoff Vertrieb GmbH	Wintershall TFF	10W-40			X	
	Wintershall TFL	5W-30			X	
	Wintershall TFG	10W-40			X	
Total	Antar Maxolia	10W-40		X		
	Elf Performance Experty FE	5W-30			X	
	Elf Performance Experty	10W-40		X		
	Fina Kappa First	5W-30			X	
	RTO Extensia ECO	5W-30			X	
	RTO Extensia RXD	10W-40		X		
	Total Rubia TIR 8600	10W-40			X	
	Total Rubia TIR 9200 FE	5W-30			X	
Unil Opal	LCM 800	10W-40			X	
Valvoline International	Profleet	10W-40	X			
	Valvoline Pro Fleet Extra	5W-30			X	
Wolf Oil Corporation	Champion Turbofleet UHPD	10W-40				
Yacco	Yacco Transpro 45	10W-40			X	

Multigrade oils – Category 3.1 (Low SAPS Oils)

Manufacturer	Brand name	SAE Vis- cosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Addinol Lube Oil	Addinol Extra Truck MD 1049 LE	10W-40	X			
Cepsa	Cepsa Eurotech LS	10W-40			X	
Chevron	Texaco Ursa Ultra	10W-40	X			
Exxon Mobil	Mobil Delvac XHP LE	10W-40			X	
FL Selenia	Urania Ecosynth	10W-40	X			
Fuchs	Titan Cargo Maxx	10W-40	X			
Gulf Oil	Gulf Superfleet XLE	10W-40	X			
Igol	Protruck 200 X	10W-40	X			
Kuwait Petroleum R&T	Q T 900	10W-40	X			
Panolin	Panolin Diesel Synth EU-4	10W-40	X			
Petróleos de Portugal	Galp Galaxia Ultra LS	10W-40	X			
Repsol YPF	Repsol Diesel Turbo UHPD MID SAPS	10W-40	X			
Shell	Shell Rimula Signia	10W-40	X			
	Shell Rimula R6 LM	10W-40	X			
SRS Schmierstoff Vertrieb GmbH	Wintershall TLA	10W-40	X			
Svenska Statoil	Statoil TruckWay E6	10W-40	X			
Valvoline	Valvoline Perofleet LS	10W-40			X	

Lubricating Greases for General Applications

For details and special information, see chapter on "Lubricants" (→ Page 05)

Manufacturer	Brand name	Remarks
Aral AG	Mehrzweckfett Arallub HL2	
BP p.l.c.	Energrease LS2	
Castrol Ltd.	Spheerol AP2	
Chevron	Multifak EP2	
Exxon Mobil	Beacon 2X	
SRS Schmierstoff Vertrieb GmbH	Wintershall Wiolub LFK2	
Shell	Shell Retinax EP2	
Veedol International	Multipurpose	

Coolant additives for Series 099 Marine, Series 183/183 Marine, Series 396 Marine, Series 396TE (raw water temperature <20 °C)

For details and special information, see chapter on "Coolants" (→ Page 13)

Corrosion-inhibiting antifreeze concentrate

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Addinol	Antifreeze Super	9000 / 5	
Arteco	Freecor SPC [EU Code 502247]	9000 / 3	
Ashland	Drewgard ZX	9000 / 3	
Avia	Antifreeze APN	9000 / 5	
BASF	Glysantin G05	9000 / 5	
	Glysantin Antikorrosion	9000 / 5	
	Glysantin G48	9000 / 5	
	Glysantin Protect Plus	9000 / 5	
	Glysantin G30	9000 / 3	
	Glysantin Alu Protect	9000 / 3	
Bucher	Motorex Antifreeze G05	9000 / 5	
	Motorex Antifreeze Protect G48	9000 / 5	
	Motorex Antifreeze Protect Plus G30	9000 / 3	
Chevron	URSA AFC +	9000 / 3	
	Chevron Delo Custom Made +	9000 / 3	
Clariant	Genatin Super	9000 / 3	
CCI	L 415	9000 / 3	
CCI Manufacturing IL Corporation	C 521	9000 / 3	

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Detroit Diesel	Power Cool Antifreeze Power Cool Off.Highway	9000 / 3 9000 / 5	
Deutsche BP	Aral Antifreeze Extra ARAL Antifreeze SF Castrol Antifreeze NF Castrol Antifreeze SF Veedol Antifreeze NF Veedol Antifreeze SF	9000 / 5 9000 / 3 9000 / 5 9000 / 3 9000 / 5 9000 / 3	
Fuchs	Fricofin Maintain Fricofin Maintain Fricofin G12 Plus	9000 / 5 9000 / 5 9000 / 3	
Ginouves	York 716	9000 / 5	
Ineos	C2272	9000 / 3	
Krafft	Refrigerante ACU 2300	9000 / 3	
Maziva	INA Antifriz AI Super	9000 / 5	
MOL-LUB	EVOX Plus G05 Antifreeze concentrate EVOX Plus concentrate EVOX Extra G48 Antifreeze concentrate	9000 / 5 9000 / 5 9000 / 5	
Nalco	Nalcool 5990	9000 / 3	
Old World	Fleetcharge SCA Precharged Heavy Duty Coolant Antifreeze FinalCharge GLOBAL Extended Life Coolant Antifreeze	9000 / 3 9000 / 3	
OMV	OMV Coolant Plus OMV Coolant SF	9000 / 5 9000 / 3	
Panolin	Panolin Antifrost MT-325	9000 / 5	
Ravensberger Schmierstoffvertrieb GmbH	RAVENOL Kühlerfrostschutz silikatifrei	9000 / 3	
Recochem	R542	9000 / 3	
Samyang	Auto Cool S100	9000 / 5	
Shell	Glyco Shell Glyco Shell SF longlife Shell HD Premium	9000 / 5 9000 / 3 9000 / 3	
Sotragal – Mont Blanc	Antigel Power Cooling Concentrate	9000 / 5	
Total	Glacelf MDX	9000 / 5	

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Univar	BR Standard Blue Antifreeze	9000 / 5	
Valvoline	Zerex G-05 Zerex G-48 Zerex G-30	9000 / 5 9000 / 5 9000 / 3	

Corrosion-inhibiting antifreeze ready mixtures

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Bantleon	Avilub Antifreeze Mix (50%)	9000 / 5	
BASF	Kühlstoff G05-23/50 (50%)	9000 / 5	
Castrol Ltd.	Castrol Antifreeze NF Premix (45%)	9000 / 5	
CCI	L 415 (50%)	9000 / 3	
CCI Manufacturing Corporation	C 521 (50%)	9000 / 3	
Detroit Diesel	Power Cool Plus Marine (30/70) Power Cool Off-Highway 50/50 (50%)	9000 / 5 9000 / 5	
Samyang	Auto Cool S105 (50%)	9000 / 5	
Sotragal – Mont Blanc	L.R.-30 Power Cooling (44%) L.R.-38 Power Cooling (52%)	9000 / 5 9000 / 5	
Old World	Final Charge Global 50/50 Prediluted Extended Life Coolant / Antifreeze	9000 / 3	
Total	Coolelf MDX (40%)	9000 / 5	

Corrosion-inhibiting antifreeze concentrates for special applications

Manufacturer	Brand name	Runtime Hour / Year	Remarks
BASF	G206	9000 / 3	For use in arctic regions (< -40 °C)

Water-soluble corrosion inhibitors concentrates

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Arteco	Freecor NBI	6000 / 2	
BASF	Glysacorr G93-94	6000 / 2	
CCI	A 216	6000 / 2	
CCI Manufacturing Corporation	A216	6000 / 2	
Chevron	Texcool A – 200	6000 / 2	
Detroit Diesel	Power Cool Plus 6000	6000 / 2	
Ginouves	York 719	6000 / 2	
Old World	A 216	6000 / 2	
Valvoline	ZEREX G-93	6000 / 2	

Coolant additives for Series 099 Marine, Series 183/183 Marine, Series 396 Marine, Series 396TE (raw water temperature >20 °C)

For details and special information, see chapter on “Coolants” (→ Page 13)

Water-soluble corrosion inhibitors concentrates

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Arteco	Freecor NBI	6000 / 2	
BASF	Glysacorr G93-94	6000 / 2	
CCI	A 216	6000 / 2	
CCI Manufacturing Corporation	A216	6000 / 2	
Chevron	Texcool A – 200	6000 / 2	
Detroit Diesel	Power Cool Plus 6000	6000 / 2	
Ginouves	York 719	6000 / 2	
Old World	A 216	6000 / 2	
Valvoline	ZEREX G-93	6000 / 2	

Coolant additives for Series 396 TB

For details and special information, see chapter on “Coolants” (→ Page 13)

Emulsifiable corrosion inhibiting oils

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Shell	Shell Oil 9156	6000 / 1	For applicability, see chapter 3 (emulsifiable corrosion inhibitor oils)

Corrosion-inhibiting antifreeze concentrate

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Addinol	Antifreeze Super	9000 / 5	
Arteco	Freecor SPC [EU Code 502247]	9000 / 3	
Ashland	Drewgard ZX	9000 / 3	
Avia	Antifreeze APN	9000 / 5	
BASF	Glysantin G05 Glysantin Antikorrosion Glysantin G48 Glysantin Protect Plus Glysantin G30 Glysantin Alu Protect	9000 / 5 9000 / 5 9000 / 5 9000 / 5 9000 / 3 9000 / 3	
Bucher	Motorex Antifreeze G05 Motorex Antifreeze Protect G48 Motorex Antifreeze Protect Plus G30	9000 / 5 9000 / 5 9000 / 3	
Chevron	URSA AFC + Chevron Delo Custom Made +	9000 / 3 9000 / 3	
Clariant	Genatin Super	9000 / 3	
CCI	L 415	9000 / 3	
CCI Manufacturing IL Corporation	C 521	9000 / 3	
Detroit Diesel	Power Cool Antifreeze Power Cool Off.Highway	9000 / 3 9000 / 5	
Deutsche BP	Aral Antifreeze Extra ARAL Antifreeze SF Castrol Antifreeze NF Castrol Antifreeze SF Veedol Antifreeze NF Veedol Antifreeze SF	9000 / 5 9000 / 3 9000 / 5 9000 / 3 9000 / 5 9000 / 3	
Fuchs	Fricofin Maintain Fricofin Maintain Fricofin G12 Plus	9000 / 5 9000 / 5 9000 / 3	
Ginouves	York 716	9000 / 5	

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Ineos	C2272	9000 / 3	
Krafft	Refrigerante ACU 2300	9000 / 3	
Maziva	INA Antifriz AI Super	9000 / 5	
MOL-LUB	EVOX Plus G05 Antifreeze concentrate EVOX Plus concentrate EVOX Extra G48 Antifreeze concentrate	9000 / 5 9000 / 5 9000 / 5	
Nalco	Nalcool 5990	9000 / 3	
Old World	Fleetcharge SCA Precharged Heavy Duty Coolant Antifreeze FinalCharge GLOBAL Extended Life Coolant Antifreeze	9000 / 3 9000 / 3	
OMV	OMV Coolant Plus OMV Coolant SF	9000 / 5 9000 / 3	
Panolin	Panolin Antifrost MT-325	9000 / 5	
Ravensberger Schmierstoffvertrieb GmbH	RAVENOL Kühlerfrostschutz silikatfrei	9000 / 3	
Recochem	R 542	9000 / 3	
Samyang	Auto Cool S100	9000 / 5	
Shell	Glyco Shell Glyco Shell SF longlife Shell HD Premium	9000 / 5 9000 / 3 9000 / 3	
Sotragal – Mont Blanc	Antigel Power Cooling Concentrate	9000 / 5	
Total	Glacelf MDX	9000 / 5	
Univar	BR Standard Blue Antifreeze	9000 / 5	
Valvoline	Zerex G-05 Zerex G-48 Zerex G-30	9000 / 5 9000 / 5 9000 / 3	

Corrosion-inhibiting antifreeze ready mixtures

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Bantleon	Avilub Antifreeze Mix (50%)	9000 / 5	
BASF	Kühlstoff G05-23/50 (50%)	9000 / 5	
Castrol Ltd.	Castrol Antifreeze NF Prmix (45%)	9000 / 5	
CCI	L 415 (50%)	9000 / 3	
CCI Manufacturing Corporation	C 521 (50%)	9000 / 3	
Detroit Diesel	Power Cool Plus Marine (30/70) Power Cool Off-Highway 50/50 (50%)	9000 / 5 9000 / 5	
Samyang	Auto Cool S105 (50%)	9000 / 5	
Sotragal – Mont Blanc	L.R.-30 Power Cooling (44%) L.R.-38 Power Cooling (52%)	9000 / 5 9000 / 5	
Old World	Final Charge Global 50/50 Prediluted Extended Life Coolant / Antifreeze	9000 / 3	
Total	Coolelf MDX (40%)	9000 / 5	

Corrosion-Inhibiting Antifreezes for Special Applications

Manufacturer	Brand name	Runtime Hour / Year	Remarks
BASF	G206	9000 / 3	For use in arctic regions (< -40 °C)

Water-soluble corrosion inhibitors concentrates

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Arteco	Freecor NBI	6000 / 2	
BASF	Glysacorr G93-94	6000 / 2	
CCI	A 216	6000 / 2	
CCI Manufacturing Corporation	A216	6000 / 2	
Chevron	Texcool A – 200	6000 / 2	
Detroit Diesel	Power Cool Plus 6000	6000 / 2	
Ginouves	York 719	6000 / 2	
Old World	A 216	6000 / 2	
Valvoline	ZEREX G-93	6000 / 2	

Coolant additives for Series BR 538, 595, 956, 1163 Marine application

For details and special information, see chapter on “Coolants” (→ Page 13)

Emulsifiable corrosion inhibiting oils

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Shell	Shell Oil 9156	6000 / 1	For applicability, see chapter 3 (emulsifiable corrosion inhibitor oils)

Coolant additives for Series BR 956, 1163, genset application

For details and special information, see chapter on “Coolants” (→ Page 13)

Emulsifiable corrosion inhibiting oils

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Shell	Shell Oil 9156	6000 / 1	For applicability, see chapter 3 (emulsifiable corrosion inhibitor oils)

Corrosion-inhibiting antifreeze concentrate

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Addinol	Antifreeze Super	9000 / 5	
Arteco	Freecor SPC [EU Code 502247]	9000 / 3	
Ashland	Drewgard ZX	9000 / 3	

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Avia	Antifreeze APN	9000 / 5	
BASF	Glysantin G05 Glysantin Antikorrosion Glysantin G48 Glysantin Protect Plus Glysantin G30 Glysantin Alu Protect	9000 / 5 9000 / 5 9000 / 5 9000 / 5 9000 / 3 9000 / 3	
Bucher	Motorex Antifreeze G05 Motorex Antifreeze Protect G48 Motorex Antifreeze Protect Plus G30	9000 / 5 9000 / 5 9000 / 3	
Chevron	URSA AFC + Chevron Delo Custom Made +	9000 / 3 9000 / 3	
Clariant	Genatin Super	9000 / 3	
CCI	L 415	9000 / 3	
CCI Manufacturing IL Corporation	C 521	9000 / 3	
Detroit Diesel	Power Cool Antifreeze Power Cool Off.Highway	9000 / 3 9000 / 5	
Deutsche BP	Aral Antifreeze Extra ARAL Antifreeze SF Castrol Antifreeze NF Castrol Antifreeze SF Veedol Antifreeze NF Veedol Antifreeze SF	9000 / 5 9000 / 3 9000 / 5 9000 / 3 9000 / 5 9000 / 3	
Fuchs	Fricofin Maintain Fricofin Maintain Fricofin G12 Plus	9000 / 5 9000 / 5 9000 / 3	
Ginouves	York 716	9000 / 5	
Ineos	C2272	9000 / 3	
Krafft	Refrigerante ACU 2300	9000 / 3	
Maziva	INA Antifriz AI Super	9000 / 5	
MOL-LUB	EVOX Plus G05 Antifreeze concentrate EVOX Plus concentrate EVOX Extra G48 Antifreeze concentrate	9000 / 5 9000 / 5 9000 / 5	
Nalco	Nalcool 5990	9000 / 3	

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Old World	Fleetcharge SCA Precharged Heavy Duty Coolant Antifreeze FinalCharge GLOBAL Extended Life Coolant Antifreeze	9000 / 3 9000 / 3	
OMV	OMV Coolant Plus OMV Coolant SF	9000 / 5 9000 / 3	Check specification
Panolin	Panolin Antifrost MT-325	9000 / 5	
Ravensberger Schmierstoffvertrieb GmbH	RAVENOL Kühlerfrostschutz silikatfrei	9000 / 3	
Recochem	R 542	9000 / 3	
Samyang	Auto Cool S100	9000 / 5	
Shell	Glyco Shell Glyco Shell SF longlife Shell HD Premium	9000 / 5 9000 / 3 9000 / 3	
Sotragal – Mont Blanc	Antigel Power Cooling Concentrate	9000 / 5	
Total	Glacelf MDX	9000 / 5	
Univar	BR Standard Blue Antifreeze	9000 / 5	
Valvoline	Zerex G-05 Zerex G-48 Zerex G-30	9000 / 5 9000 / 5 9000 / 3	

Corrosion-inhibiting antifreeze ready mixtures

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Bantleon	Avilub Antifreeze Mix (50%)	9000 / 5	
BASF	Kühlstoff G05-23/50 (50%)	9000 / 5	
Castrol Ltd.	Castrol Antifreeze NF Prmix (45%)	9000 / 5	
CCI	L 415 (50%)	9000 / 3	
CCI Manufacturing Corporation	C 521 (50%)	9000 / 3	
Detroit Diesel	Power Cool Plus Marine (30/70) Power Cool Off-Highway 50/50 (50%)	9000 / 5 9000 / 5	
Samyang	Auto Cool S105 (50%)	9000 / 5	
Sotragal – Mont Blanc	L.R.-30 Power Cooling (44%) L.R.-38 Power Cooling (52%)	9000 / 5 9000 / 5	
Old World	Final Charge Global 50/50 Prediluted Extended Life Coolant / Antifreeze	9000 / 3	
Total	Coolelf MDX (40%)	9000 / 5	

Corrosion-Inhibiting Antifreezes for Special Applications

Manufacturer	Brand name	Runtime Hour / Year	Remarks
BASF	G206	9000 / 3	For use in arctic regions (> -40 °C)

Water-soluble corrosion inhibitors concentrates

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Arteco	Freecor NBI	6000 / 2	
BASF	Glysacorr G93-94	6000 / 2	
CCI	A 216	6000 / 2	
CCI Manufacturing Corporation	A216	6000 / 2	
Chevron	Texcool A – 200	6000 / 2	
Detroit Diesel	Power Cool Plus 6000	6000 / 2	
Ginouves	York 719	6000 / 2	
Old World	A 216	6000 / 2	
Valvoline	ZEREX G-93	6000 / 2	

Coolant additives for Series 2000, 4000 Marine application (raw water temperature <25 °C)

For details and special information, see chapter on “Coolants” (→ Page 13)

Corrosion-inhibiting antifreeze concentrate

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Addinol	Antifreeze Super	9000 / 5	
Arteco	Freecor SPC [EU Code 502247]	9000 / 3	
Ashland	Drewgard ZX	9000 / 3	
Avia	Antifreeze APN	9000 / 5	
BASF	Glysantin G05	9000 / 5	
	Glysantin Antikorrosion	9000 / 5	
	Glysantin G48	9000 / 5	
	Glysantin Protect Plus	9000 / 5	
	Glysantin G30	9000 / 3	
	Glysantin Alu Protect	9000 / 3	
Bucher	Motorex Antifreeze G05	9000 / 5	
	Motorex Antifreeze Protect G48	9000 / 5	
	Motorex Antifreeze Protect Plus G30	9000 / 3	
CCI	L415	9000 / 3	
CCI Manufacturing IL	C521	9000 / 3	
Chevron	URSA AFC +	9000 / 3	
	Chevron Delo Custom Made +	9000 / 3	

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Clariant	Genatin Super	9000 / 3	
Detroit Diesel	Power Cool Antifreeze Power Cool Off-Highway	9000 / 3 9000 / 5	
Deutsche BP	Aral Antifreeze Extra ARAL Antifreeze SF Castrol Antifreeze NF Castrol Antifreeze SF Veedol Antifreeze NF Veedol Antifreeze SF	9000 / 5 9000 / 3 9000 / 5 9000 / 3 9000 / 5 9000 / 3	
Fuchs	Fricofin Maintain Fricofin Maintain Fricofin G12 Plus	9000 / 5 9000 / 5 9000 / 3	
Ginouves	York 716	9000 / 5	
Ineos	C2272	9000 / 3	
Krafft	Refrigerante ACU 2300	9000 / 3	
Maziva	INA Antifriz AI Super	9000 / 5	
MOL-LUB	EVOX Plus G05 Antifreeze concentrate EVOX Plus concentrate EVOX Extra G48 Antifreeze concentrate	9000 / 5 9000 / 5 9000 / 5	
Nalco	Nalcool 5990	9000 / 3	
Old World	Fleetcharge SCA Precharged Heavy Duty Coolant / Antifreeze Final Charge Global Extended Life Coolant Antifreeze	9000 / 3 9000 / 3	
OMV	OMV Coolant Plus OMV Coolant SF	9000 / 5 9000 / 3	Check specification
Panolin	Panolin Anti-Frost MT-325	9000 / 5	
Ravensberger Schmierstoffver- trieb GmbH	RAVENOL Kühlerfrostschutz silikatfrei	9000 / 3	
Recochem	R542	9000 / 3	
Samyang	Auto Cool S100	9000 / 5	
Shell	Glyco Shell Glyco Shell SF longlife Shell HD Premium	9000 / 5 9000 / 3 9000 / 3	
Sotragal – Mont Blanc	Antigel Power Cooling Concentrate	9000 / 5	
Total	Glacelf MDX	9000 / 5	

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Univar	BR Standard Blue Antifreeze	9000 / 5	
Valvoline	Zerex G-05 Zerex G-48 Zerex G-30	9000 / 5 9000 / 5 9000 / 3	

Corrosion-inhibiting antifreeze ready mixtures

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Bantleon	Avilub Antifreeze Mix (50%)	9000 / 5	
BASF	Kühlstoff G05-23/50 (50%)	9000 / 5	
Castrol Ltd.	Castrol Antifreeze Premix (45%)	9000 / 5	
CCI	L 415 (50%)	9000 / 3	
CCI Manufacturing Corporation	C 521 (50%)	9000 / 3	
Detroit Diesel	Power Cool Plus Marine (30/70) Power Cool Off-Highway (50%)	9000 / 5 9000 / 5	
Samyang	Auto Cool S105 (50%)	9000 / 5	
Sotragal – Mont Blanc	L.R.-30 Power Cooling (44%) L.R.-38 Power Cooling (52%)	9000 / 5 9000 / 5	
Old World	Final Charge Global 50/50 Prediluted Extended Life Coolant / Antifreeze	9000 / 3	
Total	Coolelf MDX (40%)	9000 / 5	

Corrosion-inhibiting antifreeze concentrates for special applications

Manufacturer	Brand name	Runtime Hour / Year	Remarks
BASF	G206	9000 / 3	For use in arctic regions (> -40 °C)

Water-soluble corrosion inhibitors concentrates

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Arteco	Freeco NBI	6000 / 2	
BASF	Glysacorr G93-94	6000 / 2	
CCI	A 216	6000 / 2	
CCI Manufacturing Corporation	A216	6000 / 2	
Chevron	Texcool A – 200	6000 / 2	
Detroit Diesel	Power Cool Plus 6000	6000 / 2	
Ginouves	York 719	6000 / 2	
Old World	A216	6000 / 2	
Valvoline	ZEREX G-93	6000 / 2	

Coolant additives for Series 2000, 4000 Marine application (raw water temperature >25 °C)

For details and special information, see chapter on “Coolants” (→ Page 13)

Water-soluble corrosion inhibitors concentrates

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Arteco	Freecor NBI	6000 / 2	
BASF	Glysacorr G93-94	6000 / 2	
CCI	A 216	6000 / 2	
CCI Manufacturing Corporation	A216	6000 / 2	
Chevron	Texcool A – 200	6000 / 2	
Detroit Diesel	Power Cool Plus 6000	6000 / 2	
Ginouves	York 719	6000 / 2	
Old World	A216	6000 / 2	
Valvoline	ZEREX G-93	6000 / 2	

Coolant additives for light-alloy-free engines (Series 2000 C&I, Series 4000 C&I, 4000 Genset)

For details and special information, see chapter on “Coolants” (→ Page 13)

Corrosion-inhibiting antifreeze concentrate

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Addinol	Antifreeze Super	9000 / 5	
Arteco	Freecor SPC [EU Code 502247] Havoline Extended Life Coolant [EU Code 30379] (XLC)	9000 / 3 9000 / 3	
Ashland	Drewgard ZX	9000 / 3	
Avia	Antifreeze APN	9000 / 5	
BASF	Glysantin G05 Glysantin Antikorrosion Glysantin G48 Glysantin Protect Plus Glysantin G30 Glysantin Alu Protect	9000 / 5 9000 / 5 9000 / 5 9000 / 5 9000 / 3 9000 / 3	
Bucher	Motorex Antifreeze G05 Motorex Antifreeze Protect G48 Motorex Antifreeze Protect Plus G30	9000 / 5 9000 / 5 9000 / 3	
Caltex	Caltex Extended Life Coolant [Code510614] (XLC)	9000 / 3	
CCI	L415	9000 / 3	
CCI Manufacturing IL	C521	9000 / 3	
Chevron	URSA AFC + Chevron Delo Custom Made + Havoline Dexcool Extended Life Antifreeze [US Code 227994]	9000 / 3 9000 / 3 9000 / 3	
Clariant	Genatin Super	9000 / 3	
Detroit Diesel	Power Cool Antifreeze Power Cool Off.Highway	9000 / 3 9000 / 5	
Deutsche BP	Aral Antifreeze Extra ARAL Antifreeze SF Castrol Antifreeze NF Castrol Antifreeze SF Veedol Antifreeze NF Veedol Antifreeze SF	9000 / 5 9000 / 3 9000 / 5 9000 / 3 9000 / 5 9000 / 3	
Fuchs	Fricofin Maintain Fricofin Maintain Fricofin G12 Plus	9000 / 5 9000 / 5 9000 / 3	
Fuchs Australia	Titan HDD Coolant Concentrate	9000 / 3	

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Ginouves	York 716	9000 / 5	
Ineos	C2272	9000 / 3	
Krafft	Refrigerante ACU 2300 Energy Plus K-140	9000 / 3 9000 / 3	
Maziva	INA Antifriz AI Super	9000 / 5	
MOL-LUB	EVOX Plus G05 Antifreeze concentrate EVOX Plus concentrate EVOX Extra G48 Antifreeze concentrate	9000 / 5 9000 / 5 9000 / 5	
Nalco	Nalcool 4070 Nalcool 5990	9000 / 3 9000 / 3	
OAO	Cool Stream Premium C	9000 / 3	
Old World	Fleetcharge SCA Precharged Heavy Duty Coolant / Antifreeze Final Charge Global Extended Life Coolant Antifreeze	9000 / 3 9000 / 3	
OMV	OMV Coolant Plus OMV Coolant SF	9000 / 5 9000 / 3	
Panolin	Panolin Anti-Frost MT-325	9000 / 5	
Ravensberger Schmierstoffver- trieb GmbH	RAVENOL Kühlerfrostschutz silikatfrei	9000 / 3	
Recochem	R542 Turbo Power R824M	9000 / 3 9000 / 3	
Samyang	Auto Cool S100	9000 / 5	
Shell	Glyco Shell Glyco Shell SF longlife Shell HD Premium Shell HD Premium N	9000 / 5 9000 / 3 9000 / 3 9000 / 3	
Sotragal – Mont Blanc	Antigel Power Cooling Concentrate	9000 / 5	
Total	Elf Glacelf Auto Supra Glacelf MDX Glacelf Supra	9000 / 3 9000 / 5 9000 / 3	
Univar	BR Standard Blue Antifreeze	9000 / 5	
Valvoline	Zerex G-05 Zerex G-48 Zerex G-30	9000 / 5 9000 / 5 9000 / 3	

Corrosion-inhibiting antifreeze ready mixtures

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Arteco	Havoline Extended Life Coolant + B2 50/50 OF01 [EU Code 33073] (50%)	9000 / 3	
	Havoline Extended Life Coolant + B2 40/60 OF01 [EU Code 33069] (40%)	9000 / 3	
	Havoline Extended Life Coolant + B2 35/65 OF01 [EU Code 33074] (35%)	9000 / 3	
Bantleon	Avilub Antifreeze Mix (50%)	9000 / 5	
BASF	Kühlstoff G05-23/50 (50%)	9000 / 5	
Caltex	Caltex Extended Life Coolant Pre-Mixed 50/50 [Code 510609] (50%)	9000 / 3	
Castrol Ltd.	Castrol Antifreeze Premix (45%)	9000 / 5	
CCI	L 415 (50%)	9000 / 3	
CCI Manufacturing Corporation	C 521 (50%)	9000 / 3	
Chevron	Havoline Dexcool Extended Life Prediluted 50/50 Antifreeze Coolant [US Code 227995] ((50%))	9000 / 3	
Detroit Diesel	Power Cool Plus Marine (30/70)	9000 / 3	
	Power Cool Off-Highway (50%)	9000 / 5	
Fleetguard	PG XL (40%)	9000 / 3	
Fuchs Australia	Titan HDD Premix Coolant (50%)	9000 / 3	
Nalco	Nalcool 4100 (50%)	9000 / 3	
Samyang	Auto Cool S105 (50%)	9000 / 5	
Sotragal – Mont Blanc	L.R.-30 Power Cooling (44%)	9000 / 5	
	L.R.-38 Power Cooling (52%)	9000 / 5	
Old World	Final Charge Global 50/50 Prediluted Extended Life Coolant / Antifreeze	9000 / 3	
Total	Coolelf MDX (40%)	9000 / 5	

Corrosion-inhibiting antifreeze ready mixtures

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Arteco	Havoline Extended Life Coolant + B2 50/50 OF01 [EU Code 33073] (50%)	9000 / 3	
	Havoline Extended Life Coolant + B2 40/60 OF01 [EU Code 33069] (40%)	9000 / 3	
	Havoline Extended Life Coolant + B2 35/65 OF01 [EU Code 33074] (35%)	9000 / 3	
Caltex	Caltex Extended Life Coolant Pre-Mixed 50/50 [Code 510609] (50%)	9000 / 3	
Chevron	Havoline Dexcool Extended Life Prediluted 50/50 Antifreeze Coolant [US Code 227995] (50%)	9000 / 3	
Fleetguard	PG XL (40%)	9000 / 3	Propylene glycol
Fuchs Australia	Titan HDD Premix Coolant (50%)	9000 / 3	
Nalco	Nalcool 4100 (50%)	9000 / 3	
Old World	Final Charge Global 50/50 Prediluted Extended Life Coolant / Antifreeze	9000 / 3	
Total	Coolelf Supra (40%)	9000 / 3	

Corrosion-inhibiting antifreeze concentrates for special applications

Manufacturer	Brand name	Runtime Hour / Year	Remarks
BASF	G206	9000 / 3	For use in arctic regions (> -40 °C)

Water-soluble corrosion inhibitors concentrates

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Arteco	Freecor NBI Havoline Extended Life Corrosion Inhibitor [EU Code 32765] (XLI)	6000 / 2 6000 / 2	
BASF	Glysacorr G93-94	6000 / 2	
Caltex	XL Corrosion Inhibitor Concentrate [Code510533]	6000 / 2	
CCI	A 216	6000 / 2	
CCI Manufacturing Corporation	A 216	6000 / 2	
Chevron	Texcool A – 200	6000 / 2	
Detroit Diesel	Power Cool Plus 2000 Power Cool Plus 6000	6000 / 2 6000 / 2	
Fleetguard	DCA-4L	2000 / 1	
Ginouves	York 719	6000 / 2	
Nalco	Alfloc (Maxitreat) 3477 Alfloc 2000 Nalco 2000 Nalcool 2000	6000 / 2 6000 / 2 6000 / 2 6000 / 2	
Old World	A 216	6000 / 2	
Penray	Pencool 2000	6000 / 2	
Total	Total WT Supra	6000 / 2	
Valvoline	ZEREX G-93	6000 / 2	

Water-soluble corrosion inhibiting antifreezes ready mixtures

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Caltex	Caltex XL Corrosion Inhibitor [Code 510534] (10%)	6000 / 2	
Nalco	Alfloc (Maxitreat) 3443 (7%)	6000 / 2	

Coolant additives for Series 8000

For details and special information, see chapter on “Coolants” (→ Page 13)

Water-soluble corrosion inhibitors concentrates

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Arteco	Freecor NBI	6000 / 2	
BASF	Glyscorr G93-94	6000 / 2	
CCI	A 216	6000 / 2	
CCI Manufacturing Corporation	A 216	6000 / 2	
Chevron	Texcool A – 200	6000 / 2	
Detroit Diesel	Power Cool Plus 6000	6000 / 2	
Ginouves	York 719	6000 / 2	
Old World	A 216	6000 / 2	
Valvoline	ZEREX G-93	6000 / 2	

Preservatives

For details and special information, see chapter on “Preservation” (→ Page 35)

Initial operation corrosion-inhibiting oils for internal preservation

Manufacturer	Brand name	Remarks
BP p.l.c.	Motorenschutzöl MEK SAE 30	
Cespa Lubricants	Cespa Rodaje Y Proteccion SAE 30	Full-load engine oil in compliance with Oil Category 1
Exxon Mobil	Mobilarma 524	Only suitable for preservation run! (→ Page 77)
Fuchs	Titan EM 30 MTU	Full-load engine oil in compliance with Oil Category 1
SRS Schmierstoff Vertrieb GmbH	Wintershall Antikorrol M SAE 30	Full-load engine oil in compliance with Oil Category 1
Shell	Shell Running-In Oil 7294 SAE 30 Shell Ensis Engine Oil SAE 30	

Corrosion inhibitors for external preservation

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

Corrosion inhibiting oils for internal preservation of the fuel system

Manufacturer	Brand name	Remarks
Esso	Prüföl 4113	
Ravensberger Schmierstoffvertrieb GmbH	RAVENOL Calibration Fluid	
SRS Schmierstoff Vertrieb GmbH	Wintershall Calibration Fluid	
Shell	V – Oil 1404	
	Shell Oil S 9356	

Corrosion inhibitors for internal preservation of cooling system

Manufacturer	Brand name	Remarks
BASF	Glyscorr P113	10%
Exxon Mobil	Kutwell 40	2%
Shell	Shell Oil 9156	2%

7 Preservation Specifications

Preliminary note

Please note the following warnings in bold type:

Caution!

Work which has to be carried out exactly in order to avoid danger to persons.

Attention!

Work which has to be carried out exactly in order to avoid damage or destruction of material.

Note:

If a particular aspect requires special attention while work is being carried out.

Introduction

The preservation and re-preservation specifications apply to all diesel and gas engines from MTU. They apply to new engines direct from the test stand, to field engines in uninterrupted operation and to engines that have been decommissioned for a scheduled major overhaul, provided that the period between the end of engine operation and return to operation is more than 3 months and that storage conditions are normal. If storage conditions are difficult or unsuitable, preservation must be carried out in any case.

Cooling circuits must always be preserved after the coolant has been drained irrespective of the storage conditions.

Preservation is carried out during the acceptance test on the test stand, or immediately after it. Engines in the field must be preserved immediately after their last service period. The re-preservation interval depends on the storage conditions.

A distinction is made between the following storage conditions:

normal	(free of frost, closed heated rooms, max. temperature fluctuations of between 10 and 40 °C, clean, monthly average relative air humidity ≤ 65%)
difficult	(dust / contamination, with drops below dew point > 20% of the month, monthly average relative air humidity > 65%)
unsuitable	(salt-laden air, outdoor storage)

The following packaging and re-preservation intervals based on the above:

normal storage conditions:	Standard packaging, re-preservation every 12 months
difficult storage conditions:	Standard packaging, re-preservation every 6 months
unsuitable storage conditions:	Special packaging, re-preservation every 12 months, additionally every 3 – 4 months a check of the humidity indicator in the special packaging

The preservation or re-preservation agent is the same for all engine types. The type of engine packaging depends on the storage and transport conditions. The gearbox manufacturer's preservation specifications must also be complied with when complete powerpacks / drive systems are to be preserved.

Note:

Warranty claims are invalid if the storage is not according to specifications.

Do not use natural rubber sealing material, as it is not resistant to aging.

Only MTU-approved fluids and lubricants as specified in Chapter 6 (Approved Fluids and Lubricants) are to be used for preservation and re-preservation (→ Page 37).

In event of extended out-of-service periods, machined, non-protected surfaces, for example cylinder liner running faces, are susceptible to corrosion and must therefore be preserved.

The applicable engine documentation must also be considered together with this Preservation Specification. Refer to the engine documentation for tasks and checks to be carried out when shutting down an engine and before re-operating an engine.

Preserving diesel engines

Out-of-service period of < 1 month with engines installed

Engines do not need to be preserved separately. It is sufficient to close the emergency-air shutoff flaps, if fitted.

Out-of-service period of 1 – 3 months with engines installed or removed

Run engine up to operating temperature, then run up to rated speed for about 30 seconds and then shut down at rated speed. The engine must not be started again. This engine run must also be carried out before the engine is removed for a period out-of-service.

Engine in installed condition

The following openings must be sealed tightly:

- Cooling-air inlet
- Combustion-air inlet (close the emergency air shutoff flaps if they are provided).
- Exhaust outlet
- Crankcase breather, if possible (when venting to atmosphere)

With engine removed

The following openings must be sealed tightly:

- Cooling-air inlet
- Combustion-air inlet (Close the emergency air shutoff flaps if they are provided).
- Exhaust outlet
- Crankcase breather, if possible (when venting to atmosphere).
- Coolant circuit
- Fuel system
- Lubricating oil system
- Hydraulic oil circuit
- Electrical connections

Commissioning these engines

Remove all sealing covers. The engine can then be put into operation according to the engine documentation.

Out-of-service period of > 3 months, new engines, overhauled engines

General information

The preservation work must be recorded in the check sheet (→ Page 93). For engines put into storage under manufacturer's warranty, the monitoring card (→ Page 94) must be filled out and returned to MTU in good time before the engine is put into service.

Note

If the engine cannot be properly accessed to carry out preservation work (e.g. charge-air pipe inaccessible) then the engine must be removed and mounted on a ground run base or a test stand while preservation is completed.

Preservation of cooling system, lubrication system and fuel system of new engines

- Clean engine if necessary.
- Completely fill cooling system with inhibitor concentrate Glysacorr P 113 (9-11% by vol.) and water (91 – 89% by vol.).
- Fill with initial operation corrosion inhibitor oil in accordance with current MTU specs A 001061 at least up to the min. mark.
- Fill the fuel system completely with diesel fuel.
- Carry out the engine preservation run for approx. 10 mins at increased idling speed; the inhibitor concentrate must reach at least operating temperature.
- Shut down engine.
- Allow engine to cool down, where possible, to max. 40 °C.
- Drain the inhibitor concentrate.
- Drain initial operation corrosion inhibitor oil.
- Leave the fuel in the system.



If there is danger of frost, fill up with antifreeze (40%)! (Only for installed engines)

Preservation of combustion chamber on new engines

- Clean engine if necessary.
- Fill with initial operation corrosion-inhibiting oil up to the “Min” mark at least.
- Clear access to the charge-air pipe. This may require removal of the flame-start canisters, sensors, covers or pipes. Access to the charge-air pipe must be available after the intercooler, after the pressure fine filter / air filter and after the turbocharger.
- Bar warm engine with starting equipment. The engine must not respond. This requires actuation of the stop lever in the case of mechanical governors. With electronic governors, switch off the power supply and turn the engine over either with the emergency start or another suitable method.
- While the engine is turning, fill with initial operation corrosion inhibitor oil in accordance with the current MTU Fluids and Lubricants Specifications A001061/.. for approx. 15 seconds with a fine atomizer spray gun into the charge air manifold openings.
- Drain initial operation corrosion inhibitor oil.
- Re-seal the openings to the charge-air manifolds.

Preservation of cooling system, lubrication system and fuel system of engines from the field

- Clean engine if necessary.
- Drain engine oil.
- Fill with initial operation corrosion inhibitor oil in accordance with the current MTU Fluids and Lubricants Specifications A001061/.. up to the Min. mark at least
- Fill the fuel system completely with diesel fuel
- When using a corrosion inhibiting antifreeze, leave it in the system; otherwise, drain coolant and fill the system in accordance with MTU Fluids and Lubricants Specifications A001061/.. with corrosion inhibiting antifreeze if there is a risk of frost. If there is no risk of frost, the customer’s coolant can be left in the system.
- Carry out the engine preservation run for approx. 10 mins at increased idling speed; the coolant must reach at least operating temperature.
- Shut down engine.
- Leave corrosion inhibiting antifreeze in the system
- Drain initial operation corrosion inhibitor oil.
- Leave the fuel in the system.

Preservation of combustion chamber on engines from the field

- Clean engine if necessary.
- Fill with initial operation corrosion-inhibiting oil up to the “Min” mark at least.
- Clear access to the charge-air pipe. This may require removal of the flame-start canisters, sensors, covers or pipes. Access to the charge-air pipe must be available after the intercooler, after the pressure fine filter / air filter and after the turbocharger.
- Bar warm engine with starting equipment. The engine must not respond. This requires actuation of the stop lever in the case of mechanical governors. With electronic governors, switch off the power supply and turn the engine over either with the emergency start or another suitable method.
- While the engine is turning, fill with initial operation corrosion inhibitor oil in accordance with the current MTU Fluids and Lubricants Specifications A001061/.. for approx. 15 seconds with a fine atomizer spray gun into the charge air manifold openings.
- Drain initial operation corrosion inhibitor oil.
- Re-seal the openings to the charge-air manifolds.

**In addition to the preservation steps, the following measures must still be carried out:
in installed condition:**

- Seal following openings tight against moisture:
 - Cooling-air inlet
 - Combustion-air inlet (close the emergency air shutoff flaps if they are provided)
 - Exhaust outlet

with engine removed:

- Seal following openings tight against moisture:
 - Cooling-air inlet
 - Combustion-air inlet (close the emergency air shutoff flaps if they are provided)
 - Exhaust outlet
 - Electrical plug connectors
 - Crankcase vent (with venting to atmosphere)
 - Coat or spray non-painted parts with corrosion inhibitor for external preservation in accordance with MTU Fluids and Lubricants Specifications A001061/..

- Seal check sheet in a clear plastic envelope and attach to engine at a clearly visible location.
- Complete the check sheet after completion of preservation work.
- Seal supply and drain lines of:
 - Coolants
 - Fuel
 - Engine oil

Preserving diesel engines

- Remove sealed covers from combustion-air inlet and exhaust outlet.
- Preserve combustion chamber (see item Preservation of combustion chamber).
- Seal off the combustion air intake and exhaust outlet openings against moisture / humidity once again.
- Fill the cooling circuit with an external pump with corrosion inhibiting antifreeze, or fill 100% with customer's coolant (without antifreeze if there is no risk of frost).
- Leave corrosion inhibiting antifreeze in the system

Represervation of the cooling system is not necessary with further represervation replenishments.

Before return to service, the engine must be depreserved. The following steps must be carried out:

- Clean engine if necessary.
- Remove all sealing covers
- Drain off remaining corrosion-inhibiting oil.
- Fit new oil filters (inserts) (not applicable for new deliveries; after 1 year at latest).
- Fit new oil filters (inserts) (not applicable for new deliveries; after 1 year at latest).
- Fill up with engine oil.
- Bar engine manually.
- Prepare engine for operation.
- Renew coolant

Note

Put engine into operation according to the engine documentation.

Preserving gas engines

The same specifications as for preservation or represervation of diesel engines apply.

The following section lists deviations from the above-named specifications.

Preservation of cooling system and lubrication system of new engines

- Clean engine if necessary.
- Completely fill cooling system with inhibitor concentrate Glysacorr P 113 (9-11% by vol.) and water (91 – 89% by vol.).
- Fill with initial operation corrosion inhibitor oil in accordance with the current MTU Fluids and Lubricants Specifications A001061/.. up to the Min. mark at least.
- Run the engine for 15 minutes at half load.
- Shut down engine.
- Allow engine to cool to max. 40 °C.
- Drain the inhibitor concentrate.
- Drain initial operation corrosion inhibitor oil.



If there is danger of frost, fill up with antifreeze (40%)! (Only for installed engines)

Preservation of combustion chamber on new engines

- Clean engine if necessary.
- Fill with initial operation corrosion-inhibiting oil up to the "Min" mark at least.
- Clear access to the charge-air pipe. This may require removal of the flame-start canisters, sensors, covers or pipes. Access to the charge-air pipe must be available after the intercooler, after the pressure fine filter / air filter and after the turbocharger.
- Use the starting system to bar the engine. The engine must not respond. To ensure this, the gas supply must be reliably interrupted by closing the gas line.

- While the engine is turning, fill with initial operation corrosion inhibitor oil in accordance with the current MTU Fluids and Lubricants Specifications A001061/.. for approx. 15 seconds with a fine atomizer spray gun into the charge air manifold openings.
- The starter unit must only be used to bar the engine if the engine is filled at least up to the “Min” mark and the oil filters are filled with initial operation corrosion-inhibiting oil.
- Drain initial operation corrosion inhibitor oil.
- Re-seal the openings to the charge-air manifolds.

Preservation of cooling system and lubrication system of engines from the field

- Clean engine if necessary.
- Drain engine oil.
- Fill with initial operation corrosion inhibitor oil in accordance with the current MTU Fluids and Lubricants Specifications A001061/.. up to the Min. mark at least
- When using a corrosion inhibiting antifreeze, leave it in the system; otherwise, drain coolant and fill the system in accordance with MTU Fluids and Lubricants Specifications A001061/.. with corrosion inhibiting antifreeze if there is a risk of frost. If there is no risk of frost, the customer’s coolant can be left in the system.
- Run the engine for 15 minutes at half load.
- Shut down engine.
- Leave corrosion inhibiting antifreeze or the customer’s coolant in the system.
- Drain initial operation corrosion inhibitor oil.

Preservation of combustion chamber on engines from the field

- Clean engine if necessary.
- Drain the customer’s engine oil.
- Fill with initial operation corrosion-inhibiting oil up to the “Min” mark at least.
- Clear access to the charge-air pipe. This may require removal of the flame-start canisters, sensors, covers or pipes. Access to the charge-air pipe must be available after the intercooler, after the pressure fine filter / air filter and after the turbocharger.
- Use the starting system to bar the engine. The engine must not respond. To ensure this, the gas supply must be reliably interrupted by closing the gas line.
- While the engine is turning, fill with initial operation corrosion inhibitor oil in accordance with the current MTU Fluids and Lubricants Specifications A001061/.. for approx. 15 seconds with a fine atomizer spray gun into the charge air manifold openings.
- The starter unit must only be used to bar the engine if the engine is filled at least up to the “Min” mark and the oil filters are filled with initial operation corrosion-inhibiting oil.
- Drain initial operation corrosion inhibitor oil.
- Re-seal the openings to the charge-air manifolds.

Represerving gas engines

- Remove sealed covers from combustion-air inlet and exhaust outlet.
- Preserve combustion chamber (see item Preservation of combustion chamber).
- Seal off the combustion air intake and exhaust outlet openings against moisture / humidity once again.
- Fill the cooling circuit with an external pump with corrosion inhibiting antifreeze, or fill 100% with customer’s coolant (without antifreeze if there is no risk of frost).
- Leave corrosion inhibiting antifreeze in the system

Represervation of the cooling system is not necessary with further represervation replenishments.

Before return to service, the engine must be depreserved. The following steps must be carried out:

- Clean engine if necessary.
- Remove all sealing covers
- Drain off remaining corrosion-inhibiting oil.
- Fit new oil filters (inserts) (not applicable for new deliveries; after 1 year at latest).
- Fit new oil filters (inserts) (not applicable for new deliveries; after 1 year at latest).
- Fill up with engine oil.
- Bar engine manually.
- Prepare engine for operation.
- Renew coolant

Note

Put engine into operation according to the engine documentation.

Special packing

Special packing must be carried out for storage outdoors, immediately following preservation if possible, for engines which are to be taken out of service for more than 36 months or which are to be transported by sea or in polar or tropical regions, see Section (→ Page 78) and (→ Page 80). Likewise, special packing is also usually advisable for protecting the engine against corrosion during shorter periods of storage.

General information on special packing

Engines / drive plants must be specially packed for transportation by sea or in polar / tropical regions and before long-term storage. This means that the engine must be preserved according to Section (→ Page 78) or (→ Page 80) (completely drain off coolant and preservation oil) and enclosed in special packing in addition.

The following types of special packing are available:

- Envelopes of bonded-layer material (e.g. aluminum bonded-layers).
- Hygroscopic (water-absorbing) materials (e.g. silica gel).

The engine is welded into a foil with limited water-vapor permeability, the enclosed air is then extracted by means of a vacuum-cleaner, and is dried to the desired relative humidity with desiccant. Desiccant is used to achieve a specific relative humidity inside the foil envelope. The climatic packing of bonded-layer material hinders the formation of condensed water on the metal surface and resulting corrosion.

Maintenance Intervals

Every 3 to 4 months

- Check humidity indicators (→ Page 84)

Note:

When storing the engine in special packing (with laminated-aluminum layers), note that the elastomers have a limited life. The calculation of the total service life of the elastomers begins with either the year of manufacture or last engine overhaul (see nameplate). Based on current knowledge, elastomer components made of fluorocarbon rubber (e.g. O-rings) have a total service life of about 20 years and those made of other rubber materials (hoses) have a total service life of about 10 years.

In cases of storage for more than 10 years (from date of manufacture on identification plate) but before putting into service

- Replace all rubber parts on engine (hoses, sleeves, etc.)

Storage beyond 20 years (as of year of manufacture on nameplate) but before commissioning:

- Replace all elastomers during a major overhaul of the engine.

Note:

A long storage period shortens the time limit for an engine's major overhaul (TBO) because of the limited total service life of the elastomers. MTU recommends that engines should not be stored for more than 10 years.

Envelopes of laminated material

The envelopes consist of tightly-bonded layers of aluminum composite foil which has limited permeability to water vapour and gas.

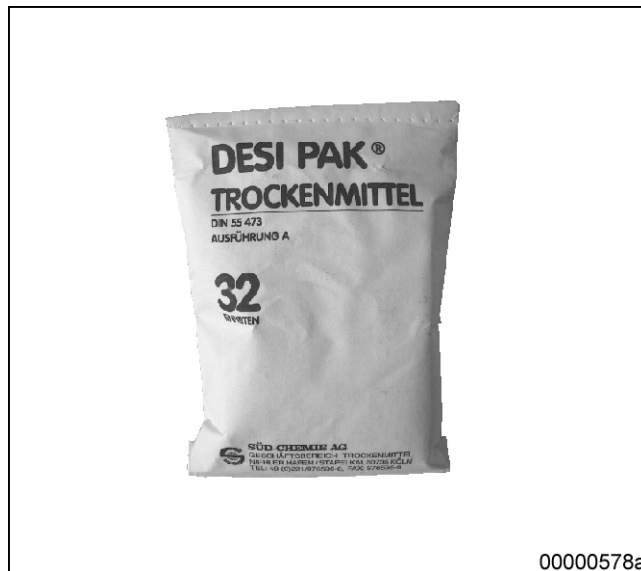
The material used by MTU is composed of polyethylene – aluminum and polyester, with the following properties:

- Temperature range for applications from +70 °C to –50 °C.
- Water vapor permeability (WVP): 0.1 g/m² per day at 38 °C and 80% relative humidity (compared with PVC soft foil: WVP 6 g/m² per day)

Desiccant

Desiccant, mostly silica gel, is the name usually given to water-absorbing materials as used in the special packing. The desiccant is in packs of highly-permeable (for water vapour) and strong material (e.g. natron crepe paper) which are placed in the transport package.

Desiccant pack



The following drying-agent packs are used for transport packing:

- MTU-No. 49542 desiccant 125 g = 4 units
- MTU No. 49543 desiccant 259 g = 8 units
- MTU-No. 49544 desiccant 500 g = 16 units
- MTU No. 49545 desiccant 1000 g = 32 units

Calculation of required desiccant

The amount of units placed in the special packing depends on the climatic conditions and type of storage at the place of destination. The minimum amount of units to be used is calculated as follows:

Climatic zone	Per m ² laminated aluminum foil surface (A)	Per kg auxiliary packing materials (APM)	Desiccant units (DU)
A Europe (excluding Russia)	6 x A	17 x APM	= DU per shipment package
B USA Canada Mediterranean Near East	8 x A	20 x APM	= DU per shipment package
C Russia South and Middle America Middle and Far East	17 x A	20 x APM	= DU per shipment package

Procedure

1. Measure surface A of the laminated aluminum foil for the packing.
2. Weigh the packing material (e.g. wood, corrugated cardboard, etc.) necessary to support and protect the engine within the special packing envelope.
3. Determine which climatic zone(s) the protected engine will be transported through and finally stored in.
4. Calculate the required desiccant (DU).

TUM ID: 0000010139 - 006

Note:

If the laminated aluminum foil is replaced or repaired following damage, the calculation for the desiccant required (DU) must be carried out again as follows (example) (→ Page 83).

Calculation example for desiccant units

Determination of DU for the seaworthy transport of an engine to Singapore:

- Laminated aluminum foil surface 10 m²
- Packing material: 3 kg
- Packing for climatic zone C:

	17 DU/m ² laminated aluminum foil	x 10 m ²	=	170
+	20 DU/kg	x 3 kg	=	60
		Total		230 DU

Result: Sufficient protection of the engine requires 230 desiccant units (DU).

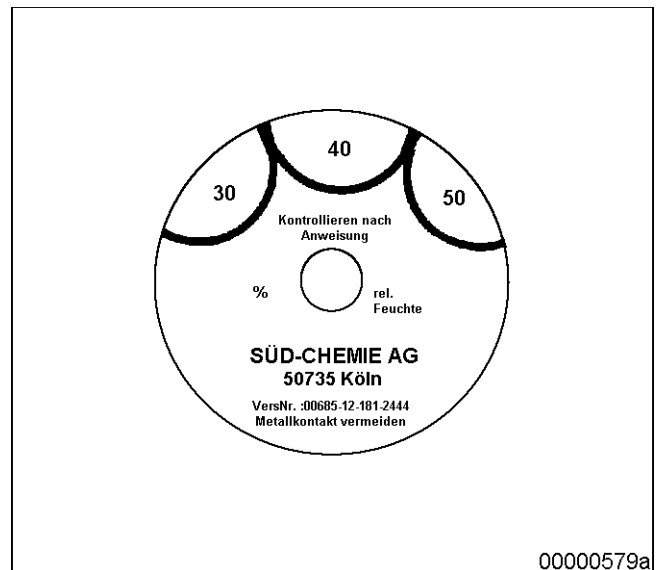
Humidity Indicator

Humidity indicators can be inserted into the foil envelope to show the saturation level of the desiccant. The indicators signalize by changing color that the specified level of relative humidity has been exceeded. An increase in relative humidity e.g. due to leaks or damage, presents a risk of corrosion for the engine.

A viewing window with a humidity indicator is screwed into the laminated aluminum foil at a point as far away as possible from the desiccant. It is thus possible to check the relative humidity inside the foil envelope and / or to verify any changes.

The humidity must be checked regularly every 3 to 4 months.

- 30 Colored pink:
Relative humidity above 30%.
- 40 Colored pink:
Relative humidity above 40%
- 50 Colored pink:
Relative humidity above 50%



Relative humidity above 30%

Reduce time between checks, i.e. check every 4 weeks.

Relative humidity above 40%

The desiccant must be replaced (→ Page 91); evenly distribute the new desiccant primarily in the upper section of the packaging. Required units of desiccant for special packaging (→ Page 83).

Relative humidity above 50%

Check condition of packed engine, represerve engine, (→ Page 80)and (→ Page 81) and repack engine (→ Page 85).

Note:

The humidity indicator regenerates itself; replacement is not necessary.

Order numbers for packing materials

Details required when ordering from MTU:

- MTU No. 20447 Humidity indicator
- MTU No. 20448 Viewing window
- MTU-No. 49542 desiccant 125 g = 4 units
- MTU-No. 49543 desiccant 250 g = 8 units
- MTU-No. 49544 desiccant 500 g = 16 units
- MTU No. 49545 desiccant 1000 g = 32 units
- MTU No. 49576 Laminated aluminum foil 1.00 m wide
- MTU No. 49577 Laminated aluminum foil 1.25 m wide
- MTU No. 49579 Laminated aluminum foil 1.50 m wide
- MTU No. 49578 PE (polyethylene) foam foil 1.25 m wide, 4 mm thick

Special packing procedure for finished products

Preparation for special packing

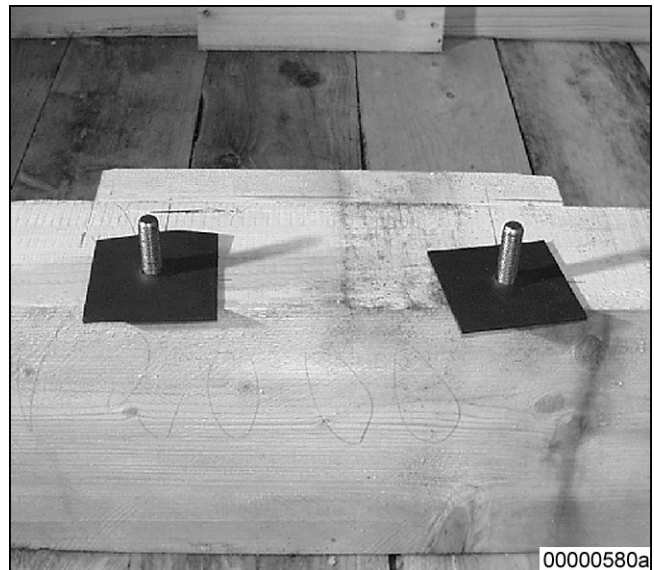
Provided that the engine is not new or has not undergone a major overhaul carried out by MTU (and has already been preserved), preservation (→ Page 78)and (→ Page 80) must be carried out before special packing takes place. Coolant and preservation oil must be completely drained.

Transportation locking device

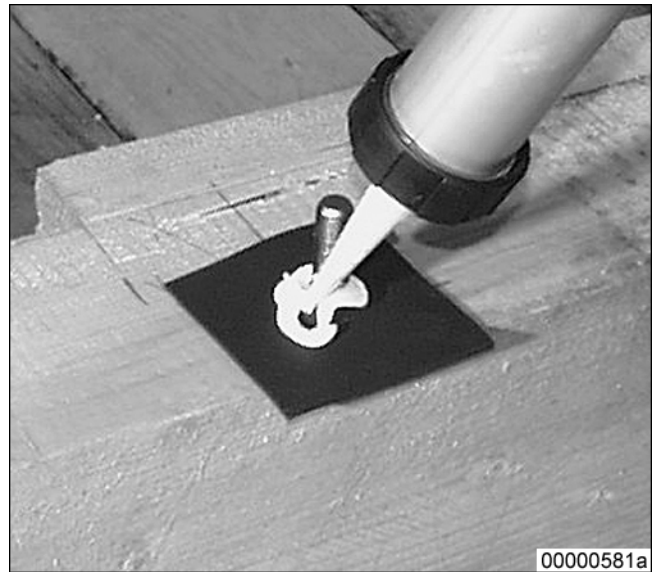
Check whether a transportation locking device is required (see engine documentation or consult MTU). Block crankshaft and engine mounts as specified in the engine documentation.

Special packing of an engine

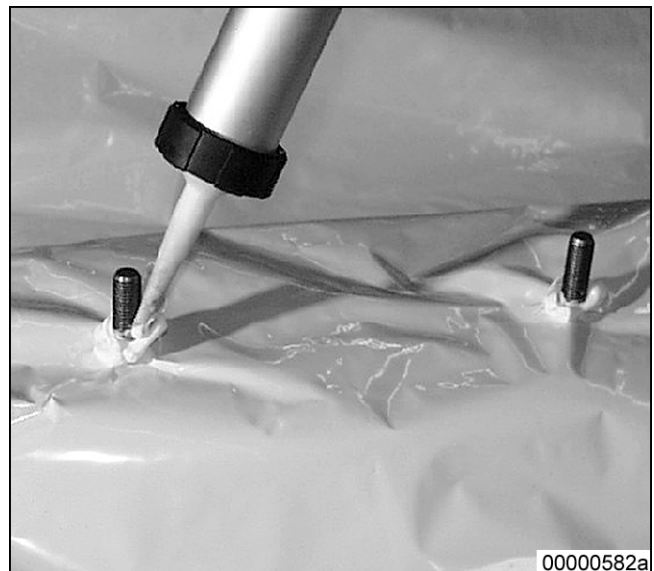
The laminated aluminum foil is to be clamped between two hard-rubber pads around the anchor studs. Use a hole punch to cut out holes for the studs.



Coat the intermediate pads liberally with non-hardening sealant (Loctite 5970, MTU Part No. 50773) around the studs.



After positioning the aluminum foil over the studs, coat liberally around the stud holes with non-hardening sealant (Loctite 5970, MTU Part No. 50773).



Position the second hard-rubber pads.



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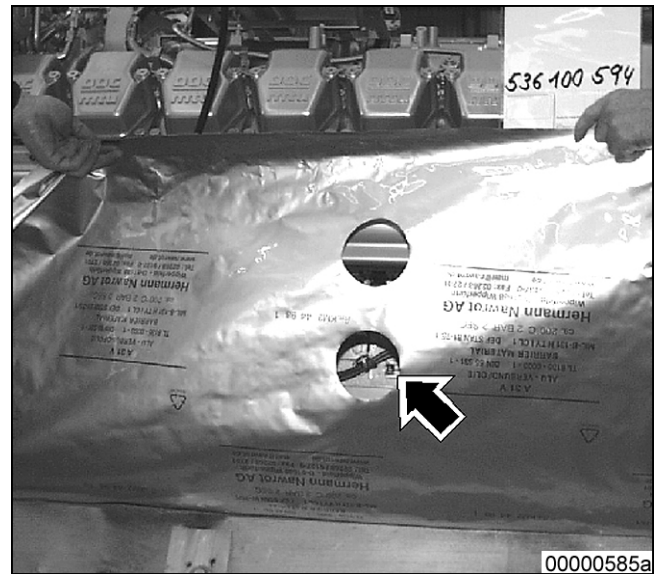
For additional protection of the laminated aluminum foil, position foam foil over the upper hard-rubber pad. The complete system is compressed and sealed after the engine mounts are installed and secured.



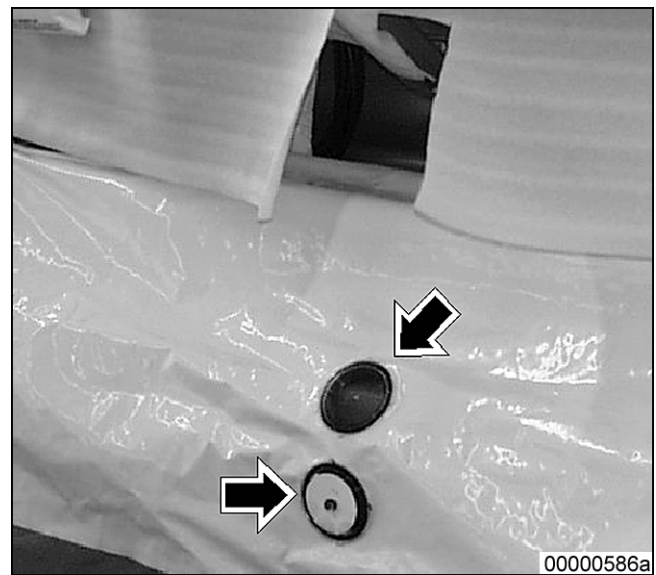
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Installation of Humidity Indicator

The holes for the indicator and the viewing window are to be cut into the laminated aluminum foil in a clearly visible position and as far as possible from the desiccant units. The viewing window must be so positioned that the engine No. can be checked.



Screw in the humidity indicator and the viewing window.



Cushioning of engine edges and corners

Engine edges and corners, which could damage the laminated aluminum foil, must be cushioned using foam foil or foam rubber.



Location of desiccant units

Use the formula (→ Page 83) to calculate the required number of desiccant units and put them in place. The desiccant units must be arranged in the upper third of the envelope and attached to the engine, hanging free wherever possible. Ensure that the desiccant units are attached (with string, adhesive tape or other suitable material) so that no damage can be caused to the desiccant units, the engine or the laminated aluminum foil.

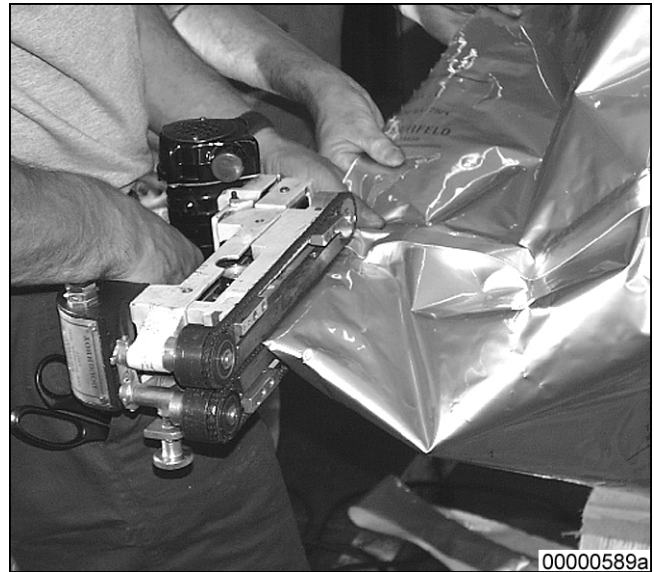


Note:

The desiccant units must not be in direct contact with corrosion-sensitive engine components.

Laminated aluminum foil sealing

Use a manual foil-welding unit suitable for aluminum laminate foils to seal the aluminum laminate envelope (→ Page 92).



Prior to final sealing of the aluminum laminate envelope, use a vacuum pump (e.g. vacuum cleaner) to extract the entrapped air.



As a consequence of the resulting pressure drop, the envelope must shrink into light contact with the engine. Excessively heavy contact must be avoided as friction damage could result during transportation.



Note:

When the air is extracted, the air humidity is eliminated, thus ensuring a favorably low initial level of moisture in the packaging. Extraction of the air also verifies that the envelope is free of leaks. If the envelope is not adequately sealed, it will re-expand within 30 minutes.

A leak can be found by pressurizing the envelope and repaired by welding.

Special packing checks

Humidity check

Humidity within the envelope must be checked regularly every 3 – 4 months (→ Page 84). The results of the check must be entered on the monitoring sheet (→ Page 94). If the engine is still under warranty, return the monitoring sheet (→ Page 94) to MTU Friedrichshafen after putting the engine into service.

Attention!

When checking the special packing, ensure that the laminated aluminum foil is not damaged, exercise great care when opening the transportation box (if provided).

The condition of the laminated aluminum foil is to be checked minutely at every customs, stock or storage check. Protection against corrosion is not guaranteed if the aluminum composite foil is damaged.

Desiccant replacement

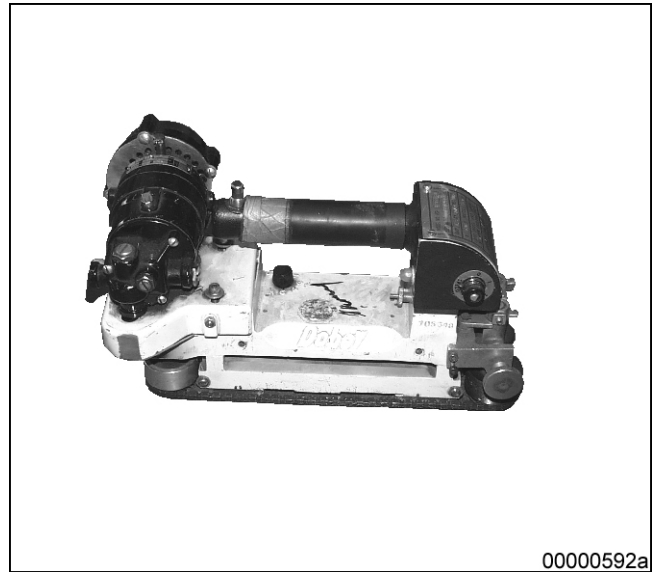
Open the upper section of the envelope and remove the old desiccant. Place the same amount of fresh desiccant in the upper section of the envelope (→ Page 89). Re-weld the envelope and extract the air (→ Page 90).

Repair of special packing

If the laminated aluminum foil is damaged, the damaged area can be cut out and a new section welded into position. If repairs have to be carried out, the envelope must be stocked with fresh desiccant (→ Page 89) and the air must be extracted again (→ Page 90). Incorrect repair, e.g. using adhesive tape, is not permissible, as the partial vacuum in the envelope cannot be maintained. In order to ensure correct repair, the specified packing materials (→ Page 84) and the manual welding unit (→ Page 92) must be used.

Manual welding unit

A supplier of foil-welding units is, for example:
W. Kopp Verpackungsmaschinen
Stettener Straße 111-117
D-73732 Esslingen- Waeldenbronn
Designation: HSD 95 Cello manual sealing unit



Form Sheets

Preservation Check Sheet

Engine model: Engine No. Acceptance date: Correct completion of the preservation tasks as specified in the preservation instructions must be certified on this check sheet by the person completing the various tasks.		
Tasks completed	Date	Name
Lubrication system		
Preserved with preservation oil. Brand of oil used:		
Fuel system		
Preserved with preservation fuel. Preservation fuel used: Fuel main and prefilters, fuel pipework not drained.		
Cooling system		
Is preserved with specified coolant. Coolant is not drained (except with special packing, engines which have been de-installed and engines for dispatch).		
Non-painted parts		
These are brush-coated with corrosion inhibitor. All engine openings are sealed as specified. All parts to be kept free of paint such as flywheel, starter ring gear and starter pinion as well as non-painted sections of the control linkage and the uncovered coupling flange (as appropriate) for the 3-phase generator are brush-coated with corrosion-inhibiting oil. Corrosion inhibitor used:		
Engine is preserved as specified.		
Represervation completed as specified		
On completion of preservation, place the completed check sheet in a plastic envelope. Seal the envelope and tie it to the engine at a clearly visible location. Keep this check sheet with the engine until completion of de preservation.		

T/M/ID: 000001/0139 - 005

Monitoring Sheet for Engines in Special Packing

Engine model: Engine No. Date of delivery:

The following checks are to be made before, during and at the end of the engine storage period and correct execution must be confirmed by date and signature.

Note:

With new products, entry of the delivery date is mandatory.

No.	Task	Date	Name
1	Visual check of special packing for damage Relative humidity: %		
2	Relative humidity: %		
3	Relative humidity: %		
4	Relative humidity: %		
5	Relative humidity: %		
6	Relative humidity: %		
7	Relative humidity: %		
8	Relative humidity: %		
9	Relative humidity: %		
10	Relative humidity: %		
11	Relative humidity: %		
12	Relative humidity: %		
13	Humidity indicator check before opening the envelope Relative humidity: %		
14	Depreservation completed		
15	Date of scheduled initial operation of engine		
Repairs		Tasks completed	
	To the laminated aluminum foil or packing box		

Important NOTE: Inform MTU during the warranty period:

Inform MTU

- If two or all three humidity indicators are pink.
- If external corrosion on the engine or damage to rubber hose connections is found when the engine is depreserved.

Inform MTU in good time before initial operation of the engine.

Check sheet for de preservation of engines in special packing

Check sheet for engine de preservation			
Attention!			
Before opening the envelope, read this check sheet carefully and follow the instructions exactly, especially those requiring contact with MTU.			
1.	Read off the humidity status at the indicators and enter on the Monitoring Sheet.	6.	Record the date of de preservation on the Monitoring Sheet.
Attention: a. If all 3 fields are blue, everything is OK b. If the 30% and 40% sections are partly or totally pink, check the envelope for damage. Report damaged envelopes to MTU. c. If all three fields are pink, do not open the envelope and report to MTU.		7.	Do not remove the sealing covers from the engine openings (turbocharger inlet, exhaust manifold outlet, coolant inlet and outlet, connecting flanges for vent lines on coolant distribution pipes) until these are to be used.
2.	If the humidity readings are in order and there are no visible signs of faults / damage, remove the laminated aluminum foil from the engine.	8.	Compliance with the initial-operation instructions in the engine documentation is mandatory.
3.	Check the exposed engine externally for corrosion or damage. Enter date and findings on the Monitoring Sheet.		
4.	Inspect visually all rubber-hose connections, they must not be brittle or swollen.		
5.	Report any faults to MTU immediately and await their reply. Do not prepare the engine for installation or make changes. Store the engine in a dry and covered location.		

8 Flushing and Cleaning Specifications for Engine Coolant Systems

General information

These cleaning specifications are for the engine cooling systems in MTU diesel engines

In the course of time, sludge deposits from aging coolant additives can accumulate in the cooling system. Reduced cooling capacity, clogged vent lines and drain points and dirty coolant level sight-glasses can result.

Below-standard water quality or incorrect coolant preparation can also heavily contaminate the system.

If such conditions occur, the coolant system is to be flushed out with fresh water, repeatedly if necessary.

If these flushing sequences are insufficient or if the system is too heavily contaminated, the system and all affected parts must be cleaned.

Only clean, fresh water (no river or sea water) must be used for flushing.

Only MTU-approved or corresponding products at the specified concentrations may be used for cleaning. The specified cleaning procedure is to be complied with.

Immediately after flushing or cleaning, fill the cooling systems with treated engine coolant as stipulated in the current MTU Fluids and Lubricants Specifications A001061 (→ Page 37).



Fluids and lubricants (e.g. treated engine coolant), used flushing water, cleaning agents and cleaning solutions can be hazardous materials. Certain regulations must be obeyed when handling, storing and disposing of these substances.

These regulations are contained in the manufacturer's instructions, legal requirements and technical guidelines valid in the individual countries. Considerable differences can apply from country to country so that no generally valid statement on the applicable regulations for fluids and lubricants etc. can be made in this publication.

Users of the products named in these specifications 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 / cleaning agents which it has approved.



Scrap oil heat exchangers from engines with bearing or piston seizures or friction damage!

Test equipment, auxiliary materials and fluids and lubricants

MTU test kit or electric pH-value measuring instrument

- Fresh water
- Prepared engine coolant
- Superheated steam
- Compressed air

Approved Cleaning Products

Manufacturer	Product name	Concentration for use		Order No.
For coolant systems:				
Henkel	P3-Neutrasel 5262	2% by volume	Liquid	4)
Henkel	P3-Saxin	2% by weight	Powder	4)
Novamax	Grision 5716	2% by weight	Powder	4)
Nalco	Maxi Clean 2	2% by volume	Liquid	40495
For subassemblies:				
Henkel	P3-FD ¹⁾	3 to 5% by weight	Powder	4)
Henkel	Porodox ²⁾	5 to 10% by weight	Powder	4)
Kluthe	Hakutex 60	100% by volume	Liquid	50602
Novamax	Euron 13083)	5 to 10% by weight	Powder	4)

¹⁾For greasy lime deposits

³⁾For heavy lime deposits

²⁾Preferred for heavy lime deposits

⁴⁾Not stocked by MTU

Flushing engine coolant systems

Drain engine coolant.

Measure pH-value of the fresh water (MTU test kit or electric pH-value measuring device).

Fill coolant system with fresh water.

- Never pour cold water into a hot engine!

Preheat, start and run engine until warm.

Run engine for approx. 30 minutes at increased speed.

Take flush-water sample (engine-coolant-sample extraction cock).

Shut down engine and drain flush water.

Measure pH-value of the flush-water sample (MTU test kit or electric pH-value measuring device).

If pH-value after flushing is only slightly above pH-value of fresh water, (pH-value difference < 1):

Fill system with treated coolant and start engine.

If pH-value after flushing is still significantly above pH-value of fresh water, (pH-value difference > 1):

Fill system with fresh flush water and repeat flushing process.

If the pH-value after 4 or 5 flushing sequences is still significantly above pH-value of fresh water, (pH-value difference > 1):

Clean coolant system and, if necessary, the components also.

For further information, see Operating Instructions for engine in question.

Cleaning engine coolant systems

Prepare concentrated solution of detergent (for coolant systems) in warm fresh water.

In the case of powdered products, stir until the detergent is completely dissolved and without sediment.

Pour solution together with fresh water into coolant system.

Start engine and run until warm.

Run engine for approx. 2 hours at increased speed.

Shut down engine.

Drain off cleaning agents and flush the engine cooling system with fresh water.

Take flush-water sample (engine-coolant-sample extraction cock).

Measure pH-value of the flush-water sample (MTU test kit or electric pH-value measuring device).

If pH-value after flushing is only slightly above pH-value of fresh water, (pH-value difference < 1):

Fill system with treated coolant and start engine.

If pH-value after flushing is still significantly above pH-value of fresh water, (pH-value difference > 1):

Clean components

For further information, see Operating Instructions for engine in question.

Cleaning components

Remove, disassemble and clean components that are exposed to heavy sludge deposits e.g. expansion tanks, preheating units, heat exchangers (coolant cooler, oil heat-exchanger, intercooler, charge-air preheater, fuel preheater etc.) and lower sections of pipework.

Before cleaning, examine degree of contamination on water sides.

If greasy lime deposits are found, first degrease the water side.

Stubborn deposits caused by oil mist in intercoolers can be removed with Kluthe Hakutex 60.

Remove hard lime deposits with a decalcifying product.

In the event of stubborn lime deposits, a 10% inhibited hydrochloric solution may have to be used.

Dissolve deposits on and in heat-exchanger elements in a heated cleaning bath.

Use only approved detergents in the permissible concentration.

Always follow the manufacturer's instructions when preparing cleaning baths!

- Deposits on the oil side can also be dissolved in a kerosene bath.
- The period spent in the cleaning bath depends on the type and degree of contamination, as well as the temperature and activity of the bath.

Clean individual components such as housings, covers, pipes, sight glasses, heat-exchanger elements and similar with superheated steam, a nylon brush (soft) and a powerful water jet.

In order to avoid damage:

- Do not use hard or sharp-edged tools (steel brushes, scrapers etc.) (oxide protective layer)
- Do not set the water-jet pressure too high (damage, e.g. to cooling fins)

After cleaning, blow through the heat exchanger elements with low-pressure steam in the direction opposite to operational flow, rinse with clear water (until pH-value difference is < 1) and blow dry with compressed or hot air.

Check that all components are in perfect condition, repair or replace as necessary.

Flush oil and engine coolant sides of heat-exchanger elements with corrosion-inhibiting oil.

- This step may be omitted if the heat exchanger is installed and taken into service immediately after cleaning.

After reinstalling all components, flush engine-coolant system once.

Check coolant system for leaks during initial operation of engine.

For further information, see the Maintenance Manual for the engine in question.

9 Revision overview from version A001061/33 to A001061/32

General section

All information on the Series 1800 has been taken from MTU Fluids and Lubricants Specifications A001061/32. The Series 1800 has its own MTU Fluids and Lubricants Specifications, which are available under publication number A001062/..

Ser. no.	Page	Subject	Action	Measure
1		Requirements of the engine oils for MTU approval	added	Oil category 2.1
2		Mixing of engine oils	added	whole paragraph
3		Special Features	added	Single-grade and multigrade oils are available through MTU Asia
4		Performance specifications for engine oils for Series 2000 and 4000	added	Oil category 2.1
5		Oil change intervals	added	Oil category 2.1
6		Analytical limit values for diesel engine oils	added in Soot (limit value) line:	Oil category 2.1
7		Analytical limit values for gas engine oils	omitted in Wear elements (silicon) line:	Index ¹⁾
8		Requirements	added	Conditioning of the coolant takes place outside the engine.
9		Information (after Table 8)	Position changed	moved forward to paragraph on Emulsifiable corrosion inhibiting oils
10		Selection of a Suitable Diesel Fuel	Change	2nd paragraph new
11		Emission certification	added	whole paragraph
12		Warning	added	Dispose of used fluids and lubricants ...
13		Fuels of comparable quality with following test results (Table 11)	added in line Total contamination	D 6217 in column Test methods

Ser. no.	Page	Subject	Action	Measure
14		Distillate Fuels	added to warning	Distillate fuels according to ASTM D 975–06 must only be used, ...
15		Marine Distillate Fuels	omitted (with DMA according to ISO 8217)	Series 8000 M71: generally usable Series 8000 M90: Approved for specific projects only.
16		Marine Distillate Fuels	added	Fuel specifications for marine applications (Table 12)
17		Warning	added	Aviation turbine fuels are generally not approved.
18		Approved anti-wear additives	added	Manufacturer: The Lubrizol Corporation
19		Fuel for Gas Engines	complete chapter revised	
20		Approved fluids and lubricants (engine oils)	revised	complete chapter
21		Approved fluids and lubricants (coolant additives)	revised	complete chapter structure based on series
22		Approved fluids and lubricants Series 1800 (engine oils + coolant additives)	omitted	complete chapter
23		Preservation Specifications	complete chapter revised	
24		Approved Cleaning Products	change of material number	P3-Neutrasel