MTU_Value*Service*
Technical Documentation

Fluids and Lubricants
Specifications

A001061/34E
All commercial MTU Series
(except for 1600 and 1800 series),
DDC S60 Marine and Two-Stroke Engines

Printed in Germany

1 Preface

General information

The following instructions are highlighted in the text and must be observed:

Instructions, procedures and operations that must be followed to avoid hazards to persons as well as damage to or destruction of material.

Notice:

Provides special instructions that must be observed when performing an operation.

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/mtu/mtu-valuecare/mtu-valueservice-technical-documentation/

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.

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2 Lubricants for four-stroke engines

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 ≤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.

	Compliance with the EPA emission limits can no longer be ensured when engine oils are used that are not approved by MTU. The use of such unapproved engine oils leads to the annulment of the EPA certificate.

	Mixing different engine oils is strictly prohibited! Changing to another oil grade can be done together with an oil change. The remaining oil quantity in the engine oil system is not critical in this regard.

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 and SAE 15W-40.

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 8 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 E7–08
Oil category 2.1	Specification ACEA E9 or API CJ4
Oil category 3	Specification ACEA E4–08
Oil category 3.1	Specification ACEA E6–08

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 2000 M84, 2000 M94, and 4000-03 marine applications

The engines of the Series 2000 M84, 2000 M94 and 4000-03 marine must not use Category 1 oils.

Restrictions on Series 595, 956 TB31/TB32/TB33 and 1163 applications

For fast commercial ferries with Series 595, Series 956 TB31/TB32/TB33 or 1163 engines, Category 2 or 3 oils are generally specified.

Restrictions on Series 8000 applications

Only the following engine oils may be used:
- BP Energol HPDX SAE 30 / SAE 40
- Castrol HLX SAE 30 / SAE 40
- Chevron Delo 400 SAE 30 / SAE 40
- Exxon Mobil Delvac 1630 SAE 30
- Exxon Mobil Delvac 1640 SAE 40
- Shell Sirius X SAE 30 / SAE 40
- MTU Power Guard DEO SAE 40

SAE-40 engine oils may only be used in combination with preheating and oil priming (T_{oil} >30 °C).

Restrictions when using low SAPS oils

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

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.

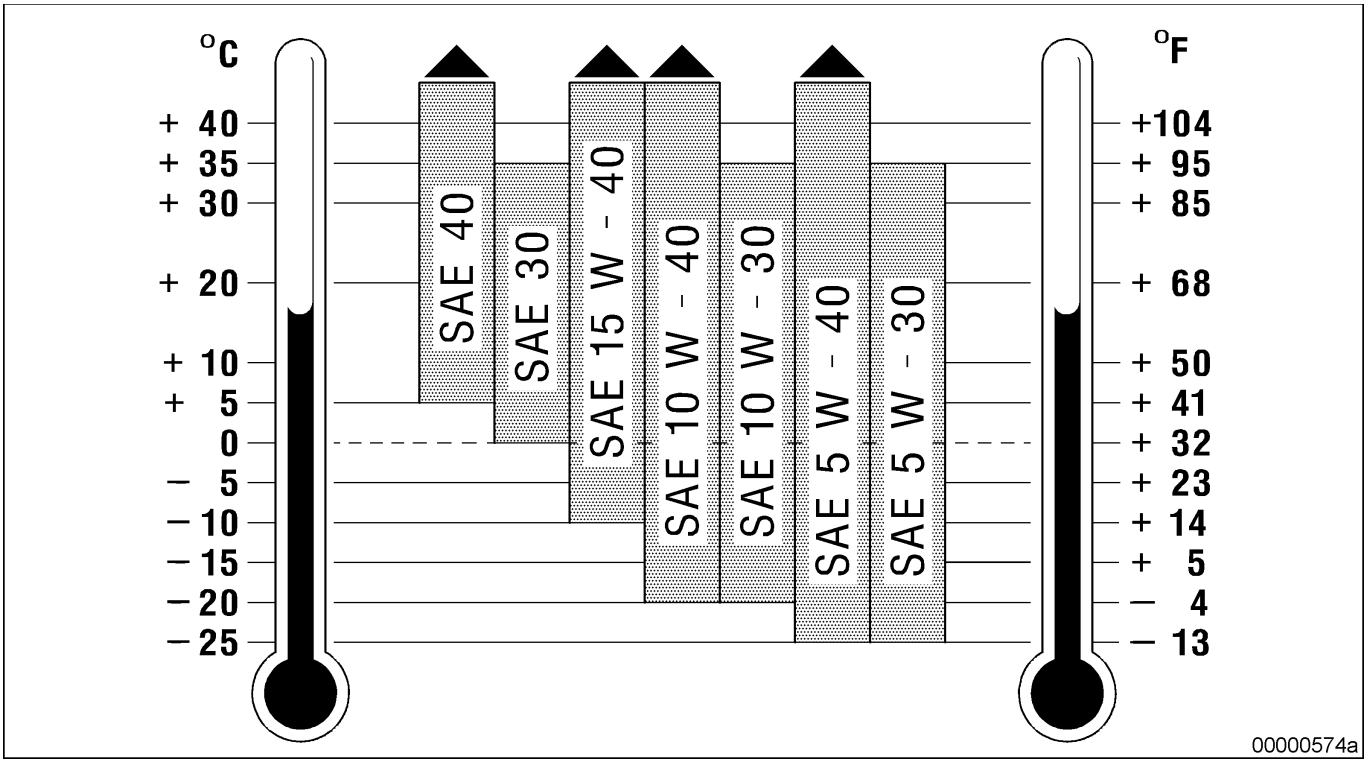

Chart 1

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.

TIM-ID: 0000010135 – 007

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 45), 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 Series 4000 L61/L62 gas engines

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 used 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 used diesel engine oils (Table 4)

	Test Method	Limit Value	
Viscosity at 100 °C max. mm²/s	ASTM D445 DIN 51562	SAE 30 SAE 5W-30 SAE 10W-30	. 15.0
		SAE 40 SAE 10W-40 SAE 15W-40	19.0
min. mm²/s		SAE 30 SAE 5W-30 SAE 10W-30	9.0
		SAE 40 SAE 10W-40 SAE 15W-40	10.5
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.)	ASTM D 6304 EN 12937 ISO 6296	Max. 0.2	

TIM-ID: 0000010135 – 007

Oxidation (A/cm)	DIN 51453	Max. 25
Nitration (A/cm)	DIN 51453	Max. 5.5 Corresponding to limit value 25 when determined with IR method
Ethylene glycol (mg/kg)	ASTM D 2982	Max. 100

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

	Test Method	Limit Value
Viscosity at 100 °C (mm²/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.)	ASTM D 6304 EN 12937 ISO 6296	Max. 0.2
Oxidation (A/cm)	DIN 51453	Max. 20
Nitration (A/cm)	IR method	Max. 20
Wear elements (mg/kg) Iron (Fe) Lead (Pb) Aluminum (Al) Copper (Cu) Tin (Sn) Silicon (Si)	RFA, ICP	 Max. 30 Max. 20 Max. 10 Max. 20 Max. 5 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) 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 8 (→ Page 45).

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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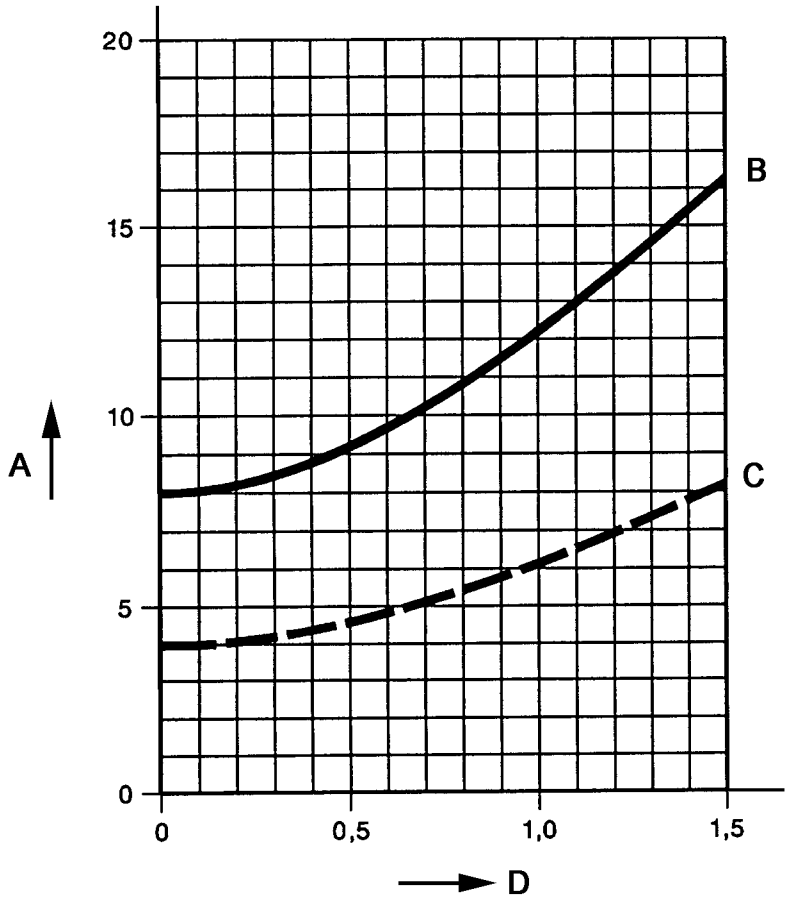

Chart 2
A Total base number in mgKOH/g, ISO 3771
B Recommended min. total base number for fresh oil
C Min. total base number for used oil
D Sulfur content of fuel in % weight

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 12)
- 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.

Greases for internal centerings of couplings

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 Lubricants for two-cycle engines

Engine oils

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

Engine oil requirements for two-cycle engines

SAE grade		**40**	
Specification		**API CF-2**	
	Test Method		**Limit Value**
	ASTM	**ISO**	
Viscosity at 100 °C (mm^2/s)	D 445	EN 3104	12.5 - 16.3
Viscosity at 40 °C (mm^2/s)	D 445	EN 3104	130 - 150
Pour point (°C)	D 97	3016	Max. -15
Flashpoint (°C)	D 92	2592	Max. 225
Sulfated ash (by weight %)	D 874	DIN 51575	Max. 1.0
Total base number (mgKOH/g)	D 2896	3771	7.0 - 10.0
Sulfur (mg/kg)		14596	4000 - 8000
Phosphor mg/kg		DIN 51363-2/3	800 - 1000
Zinc (mg/kg)		DIN 51391-3	800 - 1000

Start failures may occur at ambient temperatures < 0 °C when the engine is operated with SAE grade 40 oils.
If no start aids are available, oils of SAE grade 30 may be used as a short-term solution. At lower temperatures (-18 to -32 °C) oils of SAE grade 15W-40 may also be used. These oils must, however, comply with the specification API CF-2 and have a high-temperature viscosity of min. 3.7 cP at 150 °C.
The oil grade must be changed back to SAE 40 as soon as the temperatures allow to do so.

Analytical limit values for used two-cycle engine oils SAE 40

	ASTM	**ISO**	**Limit Value**
Viscosity at 100 °C (mm^2/s)	D 445	EN 3104	Min. 12.5 Max. 16.3
Soot content (by weight %)		DIN 51452	Max. 0.8
Water (% by vol.)	D 1744	EN 12937	Max. 0.3
Ethylene glycol	D 2982	DIN 51375	Negative
Iron (mg/kg)	ASTM D 5185		Max. 150

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	ASTM	**ISO**	**Limit Value**
Aluminum, silicon, copper (mg/kg)	ASTM D 5185		Max. 25
Lead (mg/kg)	ASTM D 5185		Max. 10

4 Coolants

General information

Coolant definition

Coolant = coolant additive (concentrate) + freshwater in the specified mixing ratio ready for use in the engine.

The corrosion-inhibiting effect of coolant is only ensured with the coolant circuit fully filled. The only exception is Shell Oil 9156, which maintains its corrosion-inhibiting character even when the coolant was drained due to oil-film formation in the circuit.

Apart from that, only the corrosion inhibitors approved for internal preservation of the coolant circuit provide proper corrosion protection when the medium was drained.

The entire cooling system must be free of zinc components. This also applies to coolant supply and return/drain lines as well as to storage bins.

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 conditions for the approval of coolant additives are specified in the following MTU works standards (MTL):

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

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 not only water but also concentrate is added. The specified antrifreeze and/or corrosion inhibitor concentration must be maintained.
- 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.
- The coolant must be free of oil residues.
- All corrosion inhibitors currently approved for internal coolant circuit preservation are water-soluble and do not provide antifreeze protection. Make sure that the engine is stored safe from frost, because a certain amount of coolant remains in the engine after draining.

Fresh water requirements

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 exceeded, 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
Sulfate ions		100 mg/l
Anions total		200 mg/l
Bacteria, fungi, yeasts	are not permitted!	

[1)] Common designations for water hardness in various countries:

1mmol/l = 5.6°d = 100 mg/kg $CaCO_3$
- 1°d = 17.9 mg/kg $CaCO_3$, USA hardness
- 1°d = 1.79° French hardness
- 1°d = 1.25° English hardness

Emulsifiable corrosion-inhibiting oils

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

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

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. Treat the coolant emulsion with biocide in this case! refer to Chapter 10 (Flushing and cleaning specifications for engine coolant circuits).

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 specifications for engine coolant circuits).

Only emulsifiable corrosion-inhibiting oils must be used in engines of the following series:

- Series 538
- Series 595
- Series 956 TB33 up to year of manufacture end of 2008 (see nameplate)
- 1163 -03

Emulsifiable corrosion-inhibiting oils must not be used in engines of the following series:

- Series 099
- Series 183
- Series 2000
- Series 396 TB (external charge air cooling with plate core heat exchanger)
- Series 396 TE (split-circuit cooling system)
- Series 4000
- Series 8000

Special approval presently in effect remain valid.

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

Corrosion-inhibiting antifreezes

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 (see operational monitoring, permissible concentration (→ Table Permissible concentrations on page 17)).

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

For approved coolant additives for the individual engine series, refer to Chapter 8 “Approved fluids and Lubricants".

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

- Series 956-01, 956-02, 1163-03:
  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 max.
- 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, except Series 8000 engines.

Note:

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.

The product BASF G206 is available for use at extremely low temperatures (< -40 °C).

Special approval presently in effect remain valid.

Water-soluble corrosion inhibitors

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 8 may be used.

Special arrangements presently in effect remain valid.

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.

Flushing with water is required at every change to a different coolant product. This also applies to new engines. The required procedures are described in Chapter 10 (Flushing and cleaning specifications for engine coolant circuits).

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

	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		
– Arteco Freecor NBI – BASF Glysacorr G93–94 – CCI Manufacturing IL Corp. A216 – Chevron Texcool A-200 – Detroit Diesel Power Cool Plus 6000 – Ginouves York 719 – Valvoline ZEREX G-93.	9	11
– Detroit Diesel Power Cool 2000 – Nalco Alfloc 2000 – Nalco Nalco 2000 – Nalco Nalcool 2000 – Peentray Pencool 2000	3	4
– Arteco Havoline Extended Life Corrosion Inhibitor XLI [EU 032765] – Chevron Texaco Extended Life Corrosion Inhibitor Nitrite Free [US 236514] – Nalco Alfloc (Maxitreat)3477 – Total WT Supra	7	11
– Fleetguard DCA-4L	5	6

Determination of concentration with hand refractometer

Calibrate the hand refractometer with clean water at coolant temperature. Coolant temperature should be 20 – 30 °C.

Test kits to determine the concentration of other water-soluble corrosion inhibitors, which are approved but not listed in the tables, are available from the respective coolant manufacturer.

Calibration table for water-soluble corrosion inhibitors

Product	**Product**	**Product**	**Product**	
BASF Glysacorr G93–94	Arteco Havoline Extended Life Corrosion Inhibitor	CCI Manufacturing IL Corp.	Nalco Alfloc (Maxitreat) 3477	
Ginouves York 719	Chevron Texaco Extended Life Corrosion Inhibitor Nitrite Free			
Valvoline ZEREX G-93	Caltex XL Corrosion Inhibitor Concentrate			

Product	Product	Product	Product	
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

Calibration table for corrosion-Inhibiting antifreezes for special applications

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

Product		
Propylene glycol corrosion-inhibiting antifreeze BASF G206		
Reading on hand refractometer at 20 °C (= degrees Brix)		**Corresponds to a concentration of**
	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 coolants

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	

The coolant must be changed in case of non-compliance with the above specifications.

Storage capability of coolant concentrates up to max. 35 °C (in original, hermetically sealed packing)

Emulsifiable corrosion-inhibiting oil	6 months	
Corrosion-inhibiting antifreezes	3 years	
Products containing propylene glycol	3 years	BASF G206
Water-soluble corrosion inhibitors	2 years	Arteco Freecor NBI Chevron Texcool A-200 – Nalco Alfloc 2000 Nalco Nalcool 2000

		Nalco Nalco 2000 Detroit Diesel Power Cool 2000 Pentray Pencool 2000
	3 years	BASF Glysacorr G93–94 Detroit Diesel Power Cool Plus 6000 Ginouves York 719 Nalco Alfloc (Maxitreat) 3477 Valvoline ZEREX G-93
	5 years	Arteco Havoline Extended Life Corrosion Inhibitor XLI [EU 032765] CCI Manufacturing IL A216 Chevron Texaco Extended Life Corrosion Inhibitor Nitrite Free [US 236514] Fleetguard DCA-4L Total WT Supra

Note:
For reasons of corrosion protection, do not store in galvanized bins. Take this requirement into account when coolant must be transferred.

5 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 1 (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 1)

		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 mm²/s
	Max.			4.5 mm²/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
Fatty acid methyl ester content (FAME, DIN 14214)	Max.		DIN 51627-1	7.0% by volume
Water	Max.	D 6304	EN 12937	200 mg/kg

		Test Method		Limit Value
		ASTM	**ISO**	
Carbon residue from 10% distillation residue	Max.	D 189	EN 10370	0.30% by weight
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 stability	Min.		DN 15751	20 hours
Oxidation stability	Max.	D 2274	EN 12205	25 g/m³
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

Diesel fuel approvals applicable to the following engine series

- S60
- Series 099
- Series 183
- Series 396
- Series 538
- Series 595
- Series 956
- Series 1163
- Series 2000
- Series 4000-01
- Series 4000-02
- Series 4000-03 work boat applications (see Table 2)

Engine model designations for Series 4000-03 work boat applications (Table 2)

Work boat	Propulsion engine				Marine genset engine			
8V4000	M53R	M53	M63	-	M33F	M33S	M23F	M23S
12V4000	M53R	M53	M63	-	M33F	M33S	M23F	M23S
16V4000	M53R	M53	M63	M63L	M33F	M33S	M23F	M23S

- Series 4000-03 except work boat applications
- Series 8000

Approved diesel fuels for MTU engines

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

Distillate fuels (Table 3)

Fuel specification	EN 590 sulfur-free (<50 mg/kg sulfur)	ASTM D 975-09 Grade 1-D			ASTM D 975-09 Grade 2-D		
		S5000	S500	S15	S5000	S500	S15
Additional requirements	None	Lubricity (HFFR) must be ≤460µm					
Series							
S60	√	√	√	√	√	√	√
Series 099	√	√	√	√	√	√	√
Series 183	√	√	√	√	√	√	√
Series 396	√	√	√	√	√	√	√
Series 538	√ Requires anti-wear additive see Table 11	√	√	√ Requires anti-wear additive, see Table 11	√	√	√ Requires anti-wear additive, see Table 11
Series 595		√	√		√	√	
Series 956		√	√		√	√	
Series 1163		√	√		√	√	
Series 2000	√	√	√	√	√	√	√
Series 4000-01	√	√	√	√	√	√	√
Series 4000-02	√	√	√	√	√	√	√
Series 4000-03 work boat applications (Table 2)	√	√	√	√	√	√	√

Fuel specification	EN 590 sulfur-free (<50 mg/kg sulfur)	ASTM D 975-09 Grade 1-D			ASTM D 975-09 Grade 2-D		
		S5000	S500	S15	S5000	S500	S15
Additional requirements	None	Lubricity (HFFR) must be ≤460µm					
Series							
Series 4000-03 except work boat applications	√	√	√	√ If cetane number ≥ 45 resp. cetane index ≥ 42	√	√	√ If cetane number ≥ 45 resp. cetane index ≥ 42
Series 8000	√	√	√	√	√	√	√

Marine distillate fuels (Table 4)

Fuel specifications	DMX acc. to ISO 8217	DMA acc. to ISO 8217
Additional requirement	Restrictions with regard to oil quality and oil change intervals	
Series		
S60	√	Not approved
Series 099	√	Consult MTU
Series 183	√	Consult MTU
Series 396	√	Consult MTU
Series 538	√	Consult MTU
Series 595	√	√ with restrictions acc. to Table 15
Series 956	√	√ with restrictions acc. to Table 15
Series 1163	√	√ with restrictions acc. to Table 15
Series 2000	√	Not approved
Series 4000-01	√	√ with restrictions acc. to Table 15
Series 4000-02	√	√ with restrictions acc. to Table 15
Series 4000-03 work boat applications (Table 2)	√	√ Worldwide except the area of applicability of EPA-Tier 2* if NFV filter and water separator are used
Series 4000-03 except work boat applications	√	√ with restrictions acc. to Table 15
Series 8000	√	√ with restrictions acc. to Table 15

√= Approved

* = The use of DMA fuel acc. to ISO 8217 involves the risk of not meeting the requirements of the US emission standard EPA-Tier 2 per 40 CFR 94. Therefore, DMA acc. to ISO 8217 is not approved for this emission standard.

According to Table 4, DMA acc. to ISO 8217 may be used for Series 595, 956, 1163, 4000-01, 4000-02, 4000-03 (except work boat) and Series 8000 with the following restrictions only:

Fuel specifications for marine applications (Table 5)

Characteristics		**Test Method**		**Limit Value**	**Typical Failure 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	mm2/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

Aviation turbine fuels (Table 6)

Fuel specifications	F 34	F 35	F 40	F 44
	JP-8	JP A-1	JP-4	JP-5
Additional requirement				
Series				
S60	Generally not approved Consultation with MTU necessary.			
Series 099				
Series 183				
Series 396				
Series 538				
Series 595				
Series 956				
Series 1163				
Series 2000				
Series 4000-01				
Series 4000-02				
Series 4000-03 work boat applications (Table 2)				
Series 4000-03 except work boat applications				
Series 8000				

NATO diesel fuels (Table 7)

Fuel specifications	F-54 TL 9140-0001	F-75 TL 9140-0003	F-75 STANAG 1385 Edition 3
Revision	**March 1997**	**September 2006**	**April 2006**
Additional requirement	**Lubricity (HFFR) must be ≤460µm**		
		Reduced power possible due to min. density 0.815 g/ml	– Reduced power possible due to min. density 0.815 g/ml – Increased power possible due to max. 1%, i.e. select oil grade and adapt oil change interval accordingly – Water separator and filter required because water content and total contamination are not specified
Series			
S60	√	√	√

TIM-ID: 0000010137 – 008

Fuel specifications	F-54 TL 9140-0001	F-75 TL 9140-0003	F-75 STANAG 1385 Edition 3
Revision	**March 1997**	**September 2006**	**April 2006**
Additional requirement	**Lubricity (HFFR) must be ≤460µm**		
		Reduced power possible due to min. density 0.815 g/ml	– Reduced power possible due to min. density 0.815 g/ml – Increased power possible due to max. 1%, i.e. select oil grade and adapt oil change interval accordingly – Water separator and filter required because water content and total contamination are not specified
Series			
Series 099	√	√	√
Series 183	√	√	√
Series 396	√	√	√
Series 538	√	√	√
Series 595	√	√	√
Series 956	√	√	√
Series 1163	√	√	√
Series 2000	√	√	√
Series 4000-01	√	√	√
Series 4000-02	√	√	√
Series 4000-03 work boat applications (Table 2)	√	√	√
Series 4000-03 except work boat applications	√	√	√ if cetane number ≥ 45 resp. cetane index ≥ 42
Series 8000	√	√	√

NATO diesel fuels (Table 8)

Fuel specifications	F-76 STANAG 1385 Edition 3	F-76 DEF-STAN 91-4	F-76 MIL-PRF-16884L
Revision	**April 2006**	**July 2004**	**October 2006**
Additional requirement	– Lubricity (HFFR) must be ≤460µm – Reduced power possible due to min. density 0.860 g/ml – Water separator and filter required because water content and total contamination are not specified		
	Sulfur content max. 1%, i.e. select oil grade and adapt oil change interval accordingly		
Series			
S60	√	√	√
Series 099	√	√	√
Series 183	√	√	√
Series 396	√	√	√
Series 538	√	√	√
Series 595	√	√	√
Series 956	√	√	√
Series 1163	√	√	√
Series 2000	√	√	√
Series 4000-01	√	√	√
Series 4000-02	√	√	√
Series 4000-03 work boat applications (Table 2)	√	√	√
Series 4000-03 except work boat applications	√ if cetane number ≥ 45 resp. cetane index ≥ 42	√	√ if cetane number ≥ 45 resp. cetane index ≥ 42
Series 8000	√	√	√

– 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 (Table 9).

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. 7% 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).

Table 10

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 catalyst 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 Series 538, 595, 956, 1163 engines 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 11 and must be added to the fuel at the specified concentration. The additive must be filled before every refueling.

Approved anti-wear additives (Table 11)

Manufacturer	Brand name	Concentration for use
The Lubrizol Corporation 29400 Lakeland Boulevard Wickliffe, Ohio 44092 USA Tel. +01 440–943–4200	ADX 766 M	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 51603 -1, the maximum sulfur content for EL Standard heating oil is specified as 1000 mg/kg to 50 mg/kg.The max. sulfur content for EL Standard low-sulfur heating oil is 50 mg/kg.

Lubricity

As a basic principle, lubricity additives are not added to the heating oil. Lubrication problems can therefore be expected when using these qualities of heating oil because of the missing additives.

Compliance with the lubricity specification as per DIN EN ISO 12156-1 (HFRR-Test) of max. 460 µm must be ensured in coordination with the respective heating oil supplier.

Valve wear

On Series 538, 595, 956, 1163 engines with cylinder heads not fitted with valve seat inserts, the use of low-sulfur heating oil (< 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 11 and must be added to the heating oil at the specified concentration. The additive must be filled before every refueling.

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 11) on page 33) 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 12)

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

Manufacturer	Brand name	Concentration for use
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	Dieselcure 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 13. Examples of typical natural gas compositions are shown in Tables 14 and 15. 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 16.

Main elements of natural gases (Table 13)

Name	Components	Unit	Value range
Natural gas	CO	% by vol.	<2
	CO_2	% by vol.	<10
	CH_4	% by vol.	80-100
	C_2H_6	% by vol.	<12
	C_3H_8	% by vol.	<9
	C_4H_{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 14)

		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

		Russia	North Sea I	North Sea II	Network gas
C_2H_4	% by vol.	0.0000	0.0000	0.0000	0.0000
C_2H_6	% by vol.	0.5000	8.4000	11.6000	5.3000
C_3H_6	% by vol.	0.0000	0.0000	0.0000	0.0000
C_3H_8	% by vol.	0.2000	1.7000	3.1000	1.4000
C_4H_6	% by vol.	0.0000	0.0000	0.0000	0.0000
C_4H_8	% by vol.	0.0000	0.0000	0.0000	0.0000
C_4H_{10}	% by vol.	0.1000	0.7000	0.5000	0.6000
C_5H_{12}	% by vol.	0.0000	0.0000	0.0000	0.0000
C_XH_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_2O	% by vol.	0.0000	0.0000	0.0000	0.0000
H_2S	% 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
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 15))

		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_2H_4	% by vol.	0.0000	0.0000	0.0000
C_2H_6	% by vol.	2.8000	3.7000	1.1000
C_3H_6	% by vol.	0.0000	0.0000	0.0000

		Holland I	Holland II	Osthannover (East Hanover)
C_3H_8	% by vol.	0.4000	0.7000	0.1000
C_4H_6	% by vol.	0.0000	0.0000	0.0000
C_4H_8	% by vol.	0.0000	0.0000	0.0000
C_4H_{10}	% by vol.	0.3000	0.3000	0.0000
C_5H_{12}	% by vol.	0.0000	0.0000	0.0000
C_XH_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_2O	% by vol.	0.0000	0.0000	0.0000
H_2S	% 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
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 gaseous fuel

Requirements and marginal conditions fuels and fuel supply (Table 16)

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	– –	See Operating Instructions (Techn. Data)	Depending on model type
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

Designation	Unit	Limit Value	Remarks
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 control valve	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
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, silicons)	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 gaseous fuel 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_2S	mg/m^3_N	5	DVGW worksheet G260
Chlorine	mg/m^3_N	10*	With higher values, consultation with manufacturer and analysis are necessary

Designation	Unit	Limit Value	Remarks
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/m^3_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/m^3_N (Table 14) is used. The permissible value for total sulfur in the gas thus corresponds exactly to the limit value specified in Table 16.

When using gas from Osthannover, for example, with Hu = 8.15 kWh/m_N (Table 15) the permissible max. value of total sulfur is calculated thus:

permissible total sulfur content = 30 mg/m^3_N ∗ (8.15 kWh/m^3_N : 10.0 kWh/m^3_N) = 24.5 mg/m^3_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.

6 NO_x reducing agent AUS 32 for SCR after-treatment systems

General information

SCR (Selective Catalytic Reduction) catalysts can be used for NO_x- emission reduction. The reducing agent (urea solution with an urea concentration of 32.5%) in such catalysts reduces the nitrogen oxide emissions.

To ensure efficient operation of the exhaust gas after-treatment system, compliance of the reducing agent with the quality requirements stipulated in DIN 70070 / ISO 222 41-1 is mandatory.

In Europe, this reducing agent is often offered under the brand name “AdBlue”.

The test methods to determine the quality and characteristics of the reducing agent are specified in the standards DIN 70071 / ISO 222 41-2. The following table shows the quality characteristics of the reducing agent together with the associated test methods (extract from ISO 222 41-1).

	Unit	Test Method ISO	Limit Value
Urea content	by weight %	22241–2 Annex B	31.8 - 33.2
Spec. grav. at 20 °C	kg/m^3	3675 12185	1087.0 - 1092.0
Refractive index at 20 °C		22241–2 Annex C	1.3817 - 1.3840
Alkalinity as NH_3	by weight %	22241–2 Annex D	Max. 0.2
Biuret content	by weight %	22241–2 Annex E	Max. 0.3
Aldehyde content	mg/kg	22241–2 Annex F	Max. 5
Non-soluble constituents	mg/kg	22241–2 Annex G	Max. 20
Phosphate content as $P0_4$	mg/kg	22241–2 Annex B	Max. 0.5
Metal contents		22241–2 Annex I	
Calcium	mg/kg		Max. 0.5
Iron	mg/kg		Max. 0.5
Copper	mg/kg		Max. 0.2
Zinc	mg/kg		Max. 0.2
Chrome	mg/kg		Max. 0.2
Nickel	mg/kg		Max. 0.2
Aluminum	mg/kg		Max. 0.5
Magnesium	mg/kg		Max. 0.5
Sodium	mg/kg		Max. 0.5

	Unit	Test Method ISO	Limit Value
Potassium	mg/kg		Max. 0.5
Identity			Identical with the reference sample

Storage of reducing agent

For instructions on storage, packing and transport, refer to the ISO 222 41-3 standard . The instructions of the manufacturer must be observed.

The reducing agent crystallizes at -11 °C.

Avoid direct sunlight because it promotes the occurrence of microorganisms and the decomposition of the reducing agent.

7 Preservatives

Requirements

The MTU conditions for preservative approval are specified in MTU Factory Standards for Deliveries (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 specifications", Chapter 9 (→ Page 83)

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 "Approved fluids and lubricants", Chapter 8 (→ Page 45).

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.

Corrosion inhibitors for internal preservation of the cooling circuit

See "Approved fluids and lubricants", Chapter 8 (→ Page 45)

See "Preservation specifications", Chapter 9 (→ Page 83)

8 Approved fluids and lubricants

Engine oils for four-cycle engines

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 Addinol Turbo Diesel MD305 Addinol Turbo Diesel MD405	40 30 40	X	 X X		
Avia	Avia Special HDC	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			
Cyclon Hellas	Cyclon D Prime	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			
	Titan Universal HD 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 Akron Extra Fleet	40 40	X 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 Marbrax CCD-410	30 40		X X		
Petrol Ofisi	Süpersarj MF 30	30	X			
PTT Public Comp.	PTT Navita MTU Type 1	40	X			
Repsol YPF	Repsol Serie 3 Repsol Marino 3	30, 40 30, 40		X X		
SRS Schmierstoff Vertrieb GmbH	SRS Antikorrol M	30	X			Increased corrosion protection
	SRS Rekord	30, 40		X		
Shell	Shell Gadinia Shell Rimula X Monograde Shell Rimula R3 Shell Rimula 3+ Shell Sirius Monograde	30, 40 30, 40 30, 40 30, 40 30, 40	 X X X X	X		
Sakson	Parnas Hercules 1	40	X			
Total	Elf Performance Super D Fina Delta Super Total Rubia S	30, 40 30, 40 30, 40		X X X		
United Oil	XD 7000 Extra Duty-3U XD 7000 Extra Duty-4U	30 40	X 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 Mobil Pegasus 805	40 40	X X			
Fuchs	Fuchs Titan Ganymet LA	40	X			

Manufacturer	Brand name	SAE Vis-cosity class	TBN			Remarks
			5 – 6 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Shell	Shell Mysella LA 40	40	X			
SRS Schmierstoff Vertrieb GmbH	SRS 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)
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
	Mobilgard	15W-40	X			1) and oil change interval 500 operating hours
	Mobil Delvac Super 1400A	15W-40	X			1) and oil change interval 500 operating hours

TIM-ID: 0000020848 – 004

Manufacturer	Brand name	SAE Vis-cosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
	Essolube XT 5	15W-40	X			1) and oil change interval 500 operating hours
Feoso Oil	Super VG Motor Oils	15W-40	X			
Fuchs	Titan Hydromat SL SAE 10W40 Titan Universal HD	10W-40 15W-40	 X	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			
OMV AG	OMV Truck M plus	15W-40	X			
OOO “LLK-International”	Teboil Power Plus Avantgarde Extra	15W-40 15W-40	X X			
OPET Petrolcülük	Omega Turbo Power SHPD	15W-40		X		1) and oil change interval 500 operating hours
Petróleos de Portugal	Galp Galaxia Super 15W-40 Galp MDM 1 15W-40	15W-40 15W-40	X X			
Shell Tongyi (Beijing) Petroleum Chemical Co., Ltd.	You Ya Wong	15W-40	X			
SRS Schmierstoff Vertrieb GmbH	SRS Primalub	15W-40	X			
Singapore Petroleum Comp.	SPC SDM 801	15W-40	X			
Sinopec	Great wall century supremacy	15W-40		X		2)
Total	Elf Performance Super D Fina Kappa Turbo DI Total Caprano TD Total Rubia 4400 Total Rubia XT	15W-40 15W-40 15W-40 15W-40 15W-40	X X X X X			
TNK Lubricants LLC	TNK Revolux D1 TNK Revolux D2	15W-40 15W-40		X X		

Manufacturer	Brand name	SAE Vis-cosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Unicorn Oil Comp.	Dexus 9000	15W-40	X			
Unil Opal	Intercooler 400	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) Approved for Series 8000 * (→ Table Note on page 49)
	Fascination of Power	40		X		18l barrel (order no. 93636/P) 200l container (order no. 94545/D) available through MTU Asia

Note

For Series 8000 engines, the approved SAE-40 engine oils may only be used in combination with preheating and oil priming (T_{oil}> 30 °C).

TIM-ID: 0000020848 – 004

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 Lubex Marine M-40	30 40		X X		
BP p.l.c.	BP Energol HPDX	30, 40		X		Approved for fast commercial vessels up to 1500h Approved for Series 8000 * (→ Table Note: on page 52)
Castrol Ltd.	Castrol HLX	30, 40		X		Approved for fast commercial vessels up to 1500h Approved for Series 8000 * (→ Table Note: on page 52)
Cepsa Lubricants	Ertoil Koral HDL	30, 40			X	
Chevron	Texaco Ursa Super TD Texaco Ursa Premium TDX Caltex Delo Gold [ISOSYN]	30, 40 40 30, 40	 X	X X 	 	.
	Chevron Delo 400	30, 40	X			Approved for Series 8000 * (→ Table Note: on page 52)
Chevron – Lyteca –	Texaco Ursa Premium TDX	40		X		
Cyclon Hellas	Cyclon D Super	40		X		
Delek	Delkol Super Diesel Delkol Super Diesel MT Mono	40 40	 X	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		Approved for Series 8000 * (→ Table Note: on page 52)
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			

Manufacturer	Brand name	SAE Vis-cosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Klora	Klora SAE 40	40	X			
Koçak Petrol Ürünleri San	Speedol Ultra HDX 30 Speedol Ultra HDX 40	30 40			X 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 Marbrax CCD-410-AP	30 40			X X	
Petrol Ofisi	Turbosarj Ekstra SAE 40-E PO Turbosarj Extra PO Turbosarj Extra 30 A PO Turbosarj Extra 40	40 30, 40 30 40	X	X	X 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	Approved for Series 8000 * (→ Table Note: on page 52)
Singapore Petroleum Comp.	SPC 900 SDM 900	40 30, 40	X X			
Sonol, Israel	Sonol 2340	40		X		
Sonol	Seamaster 40	40	X			
SRS Schmierstoff Vertriebs GmbH	SRS Rekord plus	30, 40		X		
Statoil	Statoil Diesel Way	30, 40				
Total	Total Disola MT 30 Total Disola MT 40 Total Rubia TIR XLD	30 40 40	X X		X	

TIM-ID: 0000020848 – 004

Note:

For Series 8000 engines, the approved SAE-40 engine oils may only be used in combination with preheating and oil priming (T_{oil}> 30 °C).

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 Vis-cosity 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 Vis-cosity 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		
	Addinol Diesel Longlife MD1546	15W-40		X		2), not for Series 4000
	Addinol Diesel Longlife MD1547	15W-40		X		2)

TIM-ID: 0000020848 – 004

Manufacturer	Brand name	SAE Vis-cosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Anomina Petroli Italiana	IP Tarus	15W-40	X			
	IP Tarus Turbo	15W-40	X			
	IP Tarus 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 Ultra Diesel CH-4	15W-40		X		2)
Aral AG	Aral Extra Turboral	10W-40		X		
Avia Mineralöl AG	Avia Multi CFE Plus	10W-40		X		
	Avia Turbosynth CFE	10W-40		X		
BayWa AG	Tectrol Super Truck 1540	15W-40		X		2)
	Tectrol Super Truck Plus 1540	15W-40	X			2)
	Tectrol Turbo 4000	10W-40		X		
Belgin Madeni Yaglar	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)
	BP Vanellus Longdrain	15W-40		X		2)
Castrol Ltd.	Castrol Diesel X	15W-40	X			2)
	Castrol Tection T	15W-40		X		2)
	Castrol Tection Plus	15W-40		X		2)
	Castrol Rivermax RX Plus	15W-40	X			2)
Cepsa	Cepsa Euromax	15W-40		X		2)

Manufacturer	Brand name	SAE Vis-cosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
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)
	Chevron Ursa Super Plus	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	
Cyclon Hellas	Cyclon D Super	15W-40	X			2)
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			
Engen Petroleum Ltd.	Dieselube 700 Super	15W-40		X		2)
ENI S.p.A.	Agip Sigma Truck	15W-40	X			
	Agip Sigma Turbo	15W-40	X			
	Agip Blitum T	15W-40	X			
Exol Lubricants Ltd.	Taurus Extreme M	15W-40	X			2)
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			2)
	Mobil Delvac XHP	15W-40	X			
Feoso Oil	Ultra VG Motor Oils	15W-40	X			
Petronas Lubricants International	Urania LD7	15W-40		X		

Manufacturer	Brand name	SAE Vis-cosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
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)
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 Tirot 15W-40	15W-40		X		
Liqui Moly	Liqui Moly Touring High Tech SHPD	15W-40		X		
Lotos Oil	Turdus Powertec CI-4 15W-40	15W-40		X		2)
Mauran SAS	Turboland	15W-40	X			2)
Meguin GmbH	megol Motorenoel SHPD	15W-40	X			
	megol Motorenoel HD-C3	15W-40	X			
MOL-LUB Ltd.	MOLDynamic MK9	15W-40				
	MOL Mk-9	15W-40		X		
	Mol Dynamic Super Diesel	15W-40	X			
Motor Oil, Hellas	EMO SHPD Plus	15W-40		X		

Manufacturer	Brand name	SAE Vis-cosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Ölwerke Julius Schindler	OJS Econo Veritas HDE Plus	10W-40		X		
Orlen	Platinum Ultor	15W-40	X			2)
	Platinum Ultor Plus	15W-40			X	2)
OMV AG	OMV eco truck extra	10W-40		X		
	OMV truck LD	15W-40	X			2)
OOO “LLK-International”	Teboil Super HPD	15W-40		X		2)
	Avantgarde Ultra	15W-40		X		2)
Panolin AG	Panolin Universal SFE	10W-40		X		
	Panolin Diesel Synth	10W-40		X		
PDVSA Deltaven S.A.	Ultradiesel MT	15W-40	X			
Pennzoil Products	Supreme Duty Fleet Motor Oil	15W-40	X			
	Longlife EF Heavy Duty Multigrade Engine Oil	15W-40	X			
Pertamina	Meditran SMX	15W-40		X		2)
Petro-Canada Lubricants	Duron	15W-40		X		2)
	Duron XL Synthetic Blend	15W-40		X		2)
Petrol Ofisi	PO Maximus Turbo Dizel Extra	15W-40	X			
	PO Turbo Dizel Extra	15W-40	X			2)
Petroleus de Portugal	Galp Galaxia LD star	15W-40		X		
Petrolimex Petrochmical 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	15W-40	X			2)
	Prista Turbo Diesel	15W-40	X			
Ravensberger Schmierstoff-vertrieb GmbH	RAVENOL Expert SHPD	10W-40		X		
	RAVENOL Mineralöl Turbo Plus SHPD	15W-40	X			2)
Repsol YPF	Repsol Extra Vida MT	15W-40	X			
S.A.E.L.	Gulf Gulfleet Long Road	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 MV	15W-40	X			
	Shell Rimula R3 X	15W-40		X		
	Shell Rimula X	15W-40		X		
	Shell Rotella T2	15W-40		X		
	Shell Rotella T Multigrade	15W-40		X		2)
	Shell Sirius	15W-40		X		2)
	Rimula X CH-4	15W-40		X		
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	SRS Motorenöl O-236	15W-40	X	X		2)
	SRS Multi-Rekord top	15W-40				2)
	SRS Multi Rekord plus	15W-40	X			
	SRS Turbo Rekord	15W-40	X	X		2)
	SRS Turbo Diesel Plus	15W-40		X		2)
	SRS Cargolub TFX	10W-40				2)
Statoil	Turbosynt	15W-40			X	2)
Statoil Lubricants	MaxWay	10W-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)
	Fina Kappa Extra Plus	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)
TNK Lubricants	TNK Revolux D3	15W-40		X		2)

TIM ID: 0000020848 – 004

Manufacturer	Brand name	SAE Vis-cosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Unil Opal	Medos 700	15W-40	X			2)
Valvoline	All Fleet Extra	15W-50	X			2)
	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	
Bucher AG	Motorex Focus CF	15W-40	X			
Pennzoil Products	Pennzoil Long-Life Gold	15W-40		X		
Petro-Canada	Duron -E	15W-40	X			
Shell	Shell Rimula Super	15W-40		X		2)
	Shell Rimula R4L	15W-40		X		2)
	Shell Rimula RT4L	15W-40		X		2)
	Shell Rotella T	15W-40		X		2)
	Shell Rotella T3	15W-40		X		2)
	Shell Rotella T Triple Protection	15W-40		X		2)
SK Energy	ZIC XQ 5000	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 1049	10W-40			X	

Manufacturer	Brand name	SAE Vis-cosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
Aral AG	Aral Super Turboral	5W-30			X	
Avia Mineralöl AG	Avia Turbosynth HT-U	5W-30			X	
BayWa AG	Tectrol Super Truck 530 Tectrol Super Truck 1040	5W-30 10W-40		 X	X	
BP p.l.c	BP Energol IC-MT BP Vanellus E8 Ultra	10W-40 5W-30			X X	
Bucher	Motorex MC Power 3	10W-40			X	
Castrol Ltd.	Castrol Enduron MT Castrol Enduron Plus Castrol Elixion 5W-30 Castrol Elixion HD	10W-40 5W-30 5W-30 5W-30		 X	X X X	
Cepsa	Cepsa Eurotrans SHPD Cepsa Eurotrans SHPD	5W-30 10W-40		 X	X	
Chevron	Caltex Delo XLD Multigrade Texaco Ursa Super Texaco Ursa Premium FE Texaco Ursa TDX Texaco Ursa Super TDX	10W-40 10W-40 5W-30 10W-40 10W-40		 X	X X X X	
Elinoil	Elin Diesel Tec Synthetic	10W-40		X		
ENI S.p.A.	Agip Sigma Trucksint TFE Agip Sigma Super TFE Agip Sigma Ultra TFE	5W-40 10W-40 10W-40		 X	X X	
Enoc	Enoc Vulcan 770 SLD	10W-40		X		
Exxon Mobil	Mobil Delvac XHP Extra Mobil Delvac 1 SHC	10W-40 5W-40			X X	
Exol Lubricants Ltd.	Taurus Extreme M3	10W-40			X	
Petronas Lubricants International	Urania 100 K Urania FE	10W-40 5W-30			X X	
Fuchs	Titan Cargo SL Titan Cargo MC	5W-30 10W-40			X X	
Ginouves	York 847 10W40	10W-40			X	
Gulf Oil International	Gulf Fleet Force synth. Superfleet ELD	5W-30 10W-40		 X	X	

TIM ID: 0000020848 – 004

Manufacturer	Brand name	SAE Vis-cosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
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 MOL Dynamic Synt Diesel	10W-40 10W-40		X 	 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 Schmierstoff-vertrieb GmbH	RAVENOL Super Performance Truck RAVENOL Performance Truck	5W-30 10W-40			X X	
Redoil Italia	Challoils Syntextruck	10W-40		X		
Repsol YPF	Repsol Diesel UHPD Repsol Diesel Turbo VHPD	10W-40 5W-30			X X	
Shell	Shell Rimula R6 ME Shell Rimula R6 M	5W-30 10W-40			X X	
SMV GmbH JB German Oil	JB German Oil Hightech Truck	10W-40			X	

Manufacturer	Brand name	SAE Vis-cosity class	TBN			Remarks
			8 – 10 mgKOH/g	10 – 12 mgKOH/g	>12 mgKOH/g	
SRS Schmierstoff Vertrieb GmbH	SRS Cargolub TFF SRS Cargolub TFL SRS Cargolub TFG	10W-40 5W-30 10W-40			X X X	
Total	Antar Maxolia Elf Performance Experty FE Elf Performance Experty Fina Kappa Syn FE Total Rubia TIR 8600 Total Rubia TIR 9200 FE	10W-40 5W-30 10W-40 5W-30 10W-40 5W-30		X X 	 X X X X	
Unil Opal	LCM 800	10W-40			X	
Valvoline International	Profleet Valvoline Pro Fleet Extra	10W-40 5W-30			X X	
Wolf Oil Corporation	Champion Turbofleet UHPD	10W-40				
Yacco	Yacco Transpro 45	10W-40			X	

Multigrade oils – Category 3.1 (low SAPS oils)

	[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 Extra Truck MD 1049 LE	10W-40	X			
Aral AG	Aral Mega Turboral LA	10W-40			X	
BayWa AG	Tectrol Super Truck Plus 1040	10W-40			X	
BP p.l.c.	BP Vanellus Max Drain Eco	10W-40			X	
Cepsa	Cepsa Eurotech LS	10W-40			X	
Chevron	Texaco Ursa Ultra	10W-40	X			
Exxon Mobil	Mobil Delvac 1 LE Mobil Delvac XHP LE	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	
Fuchs	Titan Cargo Maxx	10W-40	X			
Gulf Oil	Gulf Superfleet XLE	10W-40	X			
Huiles Berliet S.A.	RTO Extensia FP	10W-40	X			
Igol	Protruck 200 X	10W-40	X			
INA Rfinerija nafte Rjeka	INA Super 9000	10W-40			X	
Kuwait Petroleum R&T	Q T 900	10W-40	X			
Meguin	megol Motorenöl UHPD Low Saps	5W-30			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 Shell Rimula R6 LM	10W-40 10W-40	X X			
SK energy	ZIC XQ 5000	10W-40	X			
SRS Schmierstoff Vertrieb GmbH	SRS Cargolub TLA SRS Turbo Diesel LA	10W-40 10W-40	X X			2) 2)
Svenska Statoil	Statoil TruckWay E6	10W-40	X			
Total	Total Rubia TIR 8900 Elf Performance Experty LSX	10W-40 10W-40	X X			
Valvoline	Valvoline ProFleet LS	10W-40			X	

Engine oils for two-cycle engines

If the engine oils listed here are not available, two-cylce engine oils may be used, provided they comply with the requirements listed in the table (Engine oil requirements for two-cycle engines (→ Page 13)).

Manufacturer	Product name
Chevron	Ursa Extra Duty SAE 40
ExxonMobil	Exxon XD-3 Monogrades SAE 40 Mobile Delvac 1240
Panolin	Extra Diesel DD SAE 40
Shell	Shell Rotella DD+40

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	
SRS Schmierstoff Vertrieb GmbH	SRS Wiolub LFK2	
Shell	Shell Retinax EP2	
Total	Total Multis 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 15)

Corrosion-inhibiting antifreeze concentrate

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Arteco	Freecor SPC [EU Code 502247]	9000 / 3	
Avia	Antifreeze APN	9000 / 5	
BASF	Glysantin G05 Glysantin Protect G05 Glysantin G48 Glysantin Protect Plus / G48 Glysantin G30 Glysantin Alu Protect / G30	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	
Clariant	Genatin Super	9000 / 3	
CCI Corporation	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 Castrol Antifreeze NF	9000 / 5 9000 / 5	
Fuchs	Maintain Fricofin Maintain Fricofin G12 Plus	9000 / 5 9000 / 3	

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Ginouves	York 716	9000 / 5	
Krafft	Refrigerante ACU 2300	9000 / 3	
Maziva	INA Antifriz Al Super	9000 / 5	
MOL-LUB	EVOX Extra G48 Antifreeze concentrate	9000 / 5	
MTU Detroit Diesel Australia	Power Cool - HB500	9000 / 3	
Nalco	Nalcool 5990	9000 / 3	
Nalco Australia	Nalcool NF 48	9000 / 5	
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	
Ravensberger Schmierstoffvertrieb GmbH	RAVENOL Kühlerfrostschutz silikatfrei	9000 / 3	
Recochem	R542	9000 / 3	
Shell	Glyco Shell Glyco Shell longlife Shell HD Premium	9000 / 5 9000 / 3 9000 / 3	
Sotragal – Mont Blanc	Antigel Power Cooling Concentrate	9000 / 5	
Total	Glacelf MDX	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 Corporation	L 415 (50%)	9000 / 3	
CCI Manufacturing IL Corporation	C 521 (50%)	9000 /3	

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Detroit Diesel	Power Cool Plus Marine (30/70) Power Cool Off-Highway 50/50 (50%)	9000 / 5 9000 / 5	
MTU Detroit Diesel Australia	Power Cool - HB500 Premix 50/50	9000 / 3	
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	
Valvoline	Zerex G05 50/50 Mix	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 Corporation	A 216	6000 / 2	
CCI Manufacturing IL 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	

TIM-ID: 0000020848 – 004

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 15)

Water-soluble corrosion inhibitors concentrates

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Arteco	Freecor NBI	6000 / 2	
BASF	Glysacorr G93-94	6000 / 2	
CCI Corporation	A 216	6000 / 2	
CCI Manufacturing IL 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 15)

Corrosion-inhibiting antifreeze concentrate

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Arteco	Freecor SPC [EU Code 502247]	9000 / 3	
Avia	Antifreeze APN	9000 / 5	
BASF	Glysantin G05 Glysantin Protect G05 Glysantin G48 Glysantin Protect Plus / G48 Glysantin G30 Glysantin Alu Protect / G30	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	
Clariant	Genatin Super	9000 / 3	
CCI Corporation	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 Castrol Antifreeze NF	9000 / 5 9000 / 5	

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Fuchs	Maintain Fricofin Maintain Fricofin G12 Plus	9000 / 5 9000 / 3	
Ginouves	York 716	9000 / 5	
Krafft	Refrigerante ACU 2300	9000 / 3	
Maziva	INA Antifriz Al Super	9000 / 5	
MOL-LUB	EVOX Extra G48 Antifreeze concentrate	9000 / 5	
MTU Detroit Diesel Australia	Power Cool - HB500	9000 / 3	
Nalco	Nalcool 5990	9000 / 3	
Nalco Australia	Nalcool NF 48	9000 / 5	
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	
Ravensberger Schmierstoffvertrieb GmbH	RAVENOL Kühlerfrostschutz silikatfrei	9000 / 3	
Recochem	R 542	9000 / 3	
Shell	Glyco Shell Glyco Shell longlife Shell HD Premium	9000 / 5 9000 / 3 9000 / 3	
Sotragal – Mont Blanc	Antigel Power Cooling Concentrate	9000 / 5	
Total	Glacelf MDX	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 Corporation	L 415 (50%)	9000 / 3	

Manufacturer	Brand name	Runtime Hour / Year	Remarks
CCI Manufacturing IL 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	
MTU Detroit Diesel Australia	Power Cool - HB500 Premix 50/50	9000 / 3	
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	
Valvoline	Zerex G-05 50/50 Mix	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 Corporation	A 216	6000 / 2	
CCI Manufacturing IL 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	

Coolant additives for Series 538, 595, 1163-03 and Series 956 TB33 (up to year of manufacture end of 2008 as per nameplate)

For details and special information, see chapter on “Coolants” (→ Page 15)

Special arrangements presently in effect remain valid.

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 956-01/02 and Series 1163-02, Marine application

For details and special information, see chapter on “Coolants” (→ Page 15)

Special arrangements presently in effect remain valid.

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)

Water-soluble corrosion inhibitors concentrates

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Arteco	Freecor NBI	6000 / 2	
BASF	Glysacorr G93-94	6000 / 2	
CCI Corporation	A 216	6000 / 2	
CCI Manufacturing IL 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	

Coolant additives for Series 956 -01/02, 1163-02 and Series 956 TB33 (year of manufacture 2009 and later as per nameplate)

For details and special information, see chapter on “Coolants” (→ Page 15)

Special arrangements presently in effect remain valid.

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
Arteco	Freecor SPC [EU Code 502247]	9000 / 3	
Avia	Antifreeze APN	9000 / 5	
BASF	Glysantin G05 Glysantin Protect G05 Glysantin G48 Glysantin Protect Plus / G48 Glysantin G30 Glysantin Alu Protect / G30	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	
Clariant	Genatin Super	9000 / 3	
CCI Corporation	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 Castrol Antifreeze NF	9000 / 5 9000 / 5	
Fuchs	Maintain Fricofin Maintain Fricofin G12 Plus	9000 / 5 9000 / 3	
Ginouves	York 716	9000 / 5	
Krafft	Refrigerante ACU 2300	9000 / 3	
Maziva	INA Antifriz Al Super	9000 / 5	
MOL-LUB	EVOX Extra G48 Antifreeze concentrate	9000 / 5	
MTU Detroit Diesel Australia	Power Cool - HB500	9000 / 3	
Nalco	Nalcool 5990	9000 / 3	
Nalco Australia	Nalcool NF 48	9000 / 5	

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	
Ravensberger Schmierstoffvertrieb GmbH	RAVENOL Kühlerfrostschutz silikatfrei	9000 / 3	
Recochem	R 542	9000 / 3	
Shell	Glyco Shell Glyco Shell longlife Shell HD Premium	9000 / 5 9000 / 3 9000 / 3	
Sotragal – Mont Blanc	Antigel Power Cooling Concentrate	9000 / 5	
Total	Glacelf MDX	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 Corporation	L 415 (50%)	9000 / 3	
CCI Manufacturing IL 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	
MTU Detroit Diesel Australia	Power Cool - HB500 Premix 50/50	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	
Valvoline	Zerex G-05 50/50 Mix	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 Corporation	A 216	6000 / 2	
CCI Manufacturing IL 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 and 4000 Marine (raw water temperature <25°C) , Series 2000 Genset, Series 4000 Gas and Rail with cooling systems containing light-alloy components

For details and special information, see chapter on “Coolants” (→ Page 15)

Corrosion-inhibiting antifreeze concentrate

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Arteco	Freecor SPC [EU Code 502247]	9000 / 3	
Avia	Antifreeze APN	9000 / 5	
BASF	Glysantin G05 Glysantin Protect G05 Glysantin G48 Glysantin Protect Plus / G48 Glysantin G30 Glysantin Alu Protect / G30	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	
CCI Corpration	L415	9000 / 3	

Manufacturer	Brand name	Runtime Hour / Year	Remarks
CCI Manufacturing IL Corporation	C521	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 Castrol Antifreeze NF	9000 / 5 9000 / 5	
Fuchs	Maintain Fricofin Maintain Fricofin G12 Plus	9000 / 5 9000 / 3	
Ginouves	York 716	9000 / 5	
Krafft	Refrigerante ACU 2300	9000 / 3	
Maziva	INA Antifriz Al Super	9000 / 5	
MOL-LUB	EVOX Extra G48 Antifreeze concentrate	9000 / 5	
MTU Detroit Diesel Australia	Power Cool - HB500	9000 / 3	
Nalco	Nalcool 5990	9000 / 3	
Nalco Australia	Nalcool NF 48	9000 / 5	
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
Ravensberger Schmierstoffvertrieb GmbH	RAVENOL Kühlerfrostschutz silikatfrei	9000 / 3	
Recochem	R542	9000 / 3	
Shell	Glyco Shell Glyco Shell longlife Shell HD Premium	9000 / 5 9000 / 3 9000 / 3	
Sotragal – Mont Blanc	Antigel Power Cooling Concentrate	9000 / 5	
Total	Glacelf MDX	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 Corporation	L 415 (50%)	9000 / 3	
CCI Manufacturing IL Corporation	C 521 (50%)	9000 /3	
Detroit Diesel	Power Cool Plus Marine (30/70) Power Cool Off-Highway (50%)	9000 / 5 9000 / 5	
MTU Detroit Diesel Australia	Power Cool - HB500 Premix 50/50	9000 / 3	
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	
Valvoline	Zerex G-05 50/50 Mix	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 Corporation	A 216	6000 / 2	
CCI Manufacturing IL 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	

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Valvoline	ZEREX G-93	6000 / 2	

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

For details and special information, see chapter on “Coolants” (→ Page 15)

Water-soluble corrosion inhibitors concentrates

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Arteco	Freecor NBI	6000 / 2	
BASF	Glysacorr G93-94	6000 / 2	
CCI Corporation	A 216	6000 / 2	
CCI Manufacturing IL 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 of Series 2000 C&I, Series 4000 C&I, Genset (without light-alloy components in the cooling system)

For details and special information, see chapter on “Coolants” (→ Page 15)

Corrosion-inhibiting antifreeze concentrate

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Arteco	Freecor SPC [EU Code 502247] Havoline Extended Life Coolant [EU Code 30379] (XLC)	9000 / 3 9000 / 3	
Avia	Antifreeze APN	9000 / 5	
BASF	Glysantin G05 Glysantin Protect G05 Glysantin G48 Glysantin Protect Plus / G48 Glysantin G30 Glysantin Alu Protect / G30	9000 / 5 9000 / 5 9000 / 5 9000 / 5 9000 / 3 9000 / 3	

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Bucher	Motorex Antifreeze G05 Motorex Antifreeze Protect G48 Motorex Antifreeze Protect Plus G30	9000 / 5 9000 / 5 9000 / 3	
Caltex	Caltex Extended Life Coolant [AP Code 510614] (XLC)	9000 / 3	
CCI Corporation	L415	9000 / 3	
CCI Manufacturing IL Corporation	C521	9000 / 3	
Chevron	Havoline Dexcool Extended Life Antifreeze [US Code 227994]	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 Castrol Antifreeze NF	9000 / 5 9000 / 5	
Fuchs	Maintain Fricofin Maintain Fricofin G12 Plus	9000 / 5 9000 / 3	
Fuchs Australia	Titan HDD Coolant Concentrate	9000 / 3	
Ginouves	York 716	9000 / 5	
Krafft	Refrigerante ACU 2300 Energy Plus K-140	9000 / 3 9000 / 3	
Maziva	INA Antifriz Al Super	9000 / 5	
MOL-LUB	EVOX Extra G48 Antifreeze concentrate	9000 / 5	
MTU Detroit Diesel Australia	Power Cool - HB500 Power Cool - HB800	9000 / 3 9000 / 3	
Nalco	Nalcool 4070 Nalcool 5990	9000 / 3 9000 / 3	
Nalco Australia	Nalcool NF 48	9000 / 5	
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	
Ravensberger Schmierstoffvertrieb GmbH	RAVENOL Kühlerfrostschutz silikatfrei	9000 / 3	

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Recochem	R542 R824M	9000 / 3 9000 / 3	
Shell	Glyco Shell Glyco Shell 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	Glacelf Auto Supra Glacelf MDX Glacelf Supra	9000 / 3 9000 / 5 9000 / 3	
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%) Havoline Extended Life Coolant + B2 40/60 OF01 [EU Code 33069] (40%) Havoline Extended Life Coolant + B2 35/65 OF01 [EU Code 33074] (35%)	9000 / 3 9000 / 3 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 [AP Code 510609] (50%)	9000 / 3	
Castrol Ltd.	Castrol Antifreeze NF Premix (45%)	9000 / 5	
CCI Corporation	L 415 (50%)	9000 / 3	
CCI Manufacturing IL Corporation	C 521 (50%)	9000 /3	
Chevron	Havoline Dexcool Extended Life Predeluted 50/50 Antifreeze Coolant [US Code 227995] ((50%)	9000 / 3	
Detroit Diesel	Power Cool Plus Marine (30/70) Power Cool Off-Highway (50%)	9000 / 3 9000 / 5	
Fleetguard	PG XL (40%)	9000 / 3	Propyl glycol
Fuchs Australia	Titan HDD Premix Coolant (50%)	9000 / 3	

Manufacturer	Brand name	Runtime Hour / Year	Remarks
MTU Detroit Diesel Australia	Power Cool - HB500 Premix 50/50 Power Cool - HB800 Premix 50/50	9000 / 3 9000 / 3	
Nalco	Nalcool 4100 (50%)	9000 / 3	
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%) Coolelf Supra (40%)	9000 / 5 9000 / 3	
Valvoline	Zerex G-05 50/50 Mix	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 inhibitor 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	
CCI Corporation	A 216	6000 / 2	
CCI Manufacturing IL 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	

Manufacturer	Brand name	Runtime Hour / Year	Remarks
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
Nalco	Alfloc (Maxitreat) 3443 (7%)	6000 / 2	

Coolant additives for Series 8000

For details and special information, see chapter on “Coolants” (→ Page 15)

Water-soluble corrosion inhibitors concentrates

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Arteco	Freecor NBI	6000 / 2	
BASF	Glysacorr G93-94	6000 / 2	
CCI Corporation	A 216	6000 / 2	
CCI Manufacturing IL 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	

Coolant additives for Series 60

For details and special information, see chapter on “Coolants” (→ Page 15)

Corrosion-inhibiting antifreeze concentrate

Manufacturer	Brand name	Runtime Hour / Year	Remarks
BASF	Glysantin G05 Glysantin Protect / G05 Glysantin G30 Glysantin Alu Protect / G30	9000 / 5 9000 / 5 9000 / 3 9000 / 3	

Manufacturer	Brand name	Runtime Hour / Year	Remarks
Bucher	Motorex Antifreeze G05 Motorex Antifreeze Protect Plus G30	9000 / 5 9000 / 3	
Detroit Diesel	Power Cool Antifreeze Power Cool Off Highway	9000 / 3 9000 / 5	
Fuchs	Maintain Fricofin G 12 Plus	9000 / 3	
MTU Detroit Diesel Australia	Power Cool - HB500	9000 / 3	
Nalco	Nalcool 5990	9000 / 3	
OMV	OMV Coolant SF	9000 / 3	
Ravensberger Schmierstoffvertrieb GmbH	RAVENOL Kühlerfrostschutz silikatfrei	9000 / 3	
Recochem	R 542	9000 / 3	
Shell Global Solutions	Shell HD Premium Glyco Shell longlife	9000 / 3 9000 / 3	
Valvoline	Zerex G05 Zerex G30	9000 / 5 9000 / 3	

Corrosion-inhibiting antifreeze ready mixtures

Manufacturer	Brand name	Runtime Hour / Year	Remarks
BASF	Kühlstoff G0523/50 (50%)	9000 / 5	
Detroit Diesel	Power Cool Plus Marine (30/70) Power Cool Off Highway 50/50 (50%)	9000 / 5 9000 / 5	
MTU Detroit Diesel Australia	Power Cool - HB500 Premix 50/50	9000 / 3	
Valvoline	Zerex G-05 50/50 Mix	9000 / 5	

Water-soluble corrosion inhibitor concentrates

Manufacturer	Brand name	Runtime Hour / Year	Remarks
BASF	Glysacorr G 93–94	6000 / 2	
Detroit Diesel	Power Cool Plus 6000	6000 / 2	
Ginouves	York 719	6000 / 2	
Valvoline	Zerex G-93	6000 / 2	

Coolant additives for two-cycle engines

Corrosion-inhibiting antifreeze concentrate

Manufacturer	Brand name	Remarks
MTU Friedrichshafen	Powercool	
Old World Industries.	Powercool Antifreeze & Coolant Powercool Extended Life Antifreeze & Coolant	

Corrosion-inhibiting antifreeze ready mixtures

Manufacturer	Brand name	Remarks
MTU Friedrichshafen	Powercool Plus Extended Life Antifreeze & Coolant Premix 50/50	
Old World Industries.	Powercool 50/50 Antifreeze & Coolant	

Water-soluble corrosion inhibitor concentrates

Manufacturer	Brand name	Remarks
MTU Friedrichshafen	Powercool 2000 Powercool 3000	
Penray	Pencool 2000 Pencool 3000	

Preservatives

For details and special information, see chapter on “Preservation” (→ Page 43)

Initial operation corrosion-inhibiting oils for internal preservation

Manufacturer	Brand name	Remarks
BP p.l.c.	Motorenschutzöl MEK SAE 30	
Cepsa Lubricants	Cepsa Rodaje Y Proteccion SAE 30	Full-load engine oil in compliance with Oil Category 1
Exxon Mobil	Mobilarma 524	Only suitable for preservation run!
Fuchs	Titan Universal HD 30 MTU	Full-load engine oil in compliance with Oil Category 1
SRS Schmierstoff Vertrieb GmbH	SRS Antikorrol M SAE 30 SRS Motorenöl O-236 SAE 15W-40	Full-load engine oil in compliance with Oil Category 1 Full-load engine oil in compliance with Oil Category 2

Manufacturer	Brand name	Remarks
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	
Valvoline Oel	Tectyl 846	

Corrosion inhibiting oils for internal preservation of the fuel system

Manufacturer	Brand name	Remarks
SRS Schmierstoff Vertrieb GmbH	SRS Calibration Fluid	
Shell	V – Oil 1404	
	Shell Oil S 9356	

Corrosion inhibitors for internal preservation of cooling system

Manufacturer	Brand name	Remarks
BASF	Glysacorr P113	9 - 11%
Exxon Mobil	Kutwell 40	1 - 2%
Shell	Shell Oil 9156	1 - 2%

9 Preservation specifications

General information

The preservation and represervation specifications apply to all MTU diesel and gas engines as delivered from the factory, i.e:

- reserve stock engines
- installed engines that have not yet been put into service
- field engines with extended downtime, e.g. normal out-of-service periods, out-of-service-periods for scheduled maintenance or unscheduled repair work.

Field engines and engines that were put out of service for a scheduled major overhaul must be preserved immediately after their last service period.

All MTU engines are delivered with initial preservation as per factory standard MTV 5073.

	Cooling circuits must always be preserved after the coolant has been drained. Preservation is not required if the coolant is left in the system.

Represervation intervals depending on the storage conditions

Definition of 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)

Storage conditions	Packaging	Represervation	Remarks
Normal	Standard packaging	Every 12 months	
Difficult	Standard packaging	Every 6 months	
Unsuitable	Special packaging	Every 12 months	Additionally every 3 - 4 months a check of the humidity indicator in the special packaging

The preservation or represervation 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 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 8 (Approved fluids and lubricants) (→ Page 45) are to be used for preservation and represervation .

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 < 3 months

Engines do not need to be preserved separately. It is sufficient to close the emergency-air shutoff flaps, if fitted. All fluids and lubricants remain in the engine.

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

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. All fluids and lubricants remain in the engine.

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)

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

Prior to removal, 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.

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
- Leave the coolant in the cooling circuit

If it is not possible to leave the coolant in the cooling circuit, drain the coolant and proceed as follows:
- Clean engine if necessary.
- Fill cooling circuit completely with approved corrosion inhibitor for internal preservation of the coolant circuit (further on referred to as "preservation liquid") in accordance with the instructions in Chapter 8.
- 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.
- Stop the engine
- Allow engine to cool down, where possible, to max. 40 °C.
- Drain the inhibitor concentrate.
- Drain engine oil
- Leave the fuel in the system

If it is not possible to leave the fuel in the system, preserve the fuel circuit in accordance with the instructions in Chapter 7, "Preservatives", under "Corrosion inhibiting oils for internal preservation of the fuel system " (→ Page 43)

Note regarding the cooling circuit:

To avoid time-consuming flushing cycles when filling the coolant system after engine preservation with emulsion-type preservatives, we recommend to use Glysacorr P 113 as preservation liquid.

Out-of-service period of > 3 months with field engines installed or removed

Preservation of cooling system, lubrication system and fuel system, if the coolant can be left in the system

- Clean engine if necessary.
- Drain engine oil.
- Fill with initial operation corrosion-inhibiting oil in accordance with Chapter 8 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 Chapter 8 with approved corrosion-inhibiting antifreeze, if freezing temperatures are expected. 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.
- Stop the engine
- Leave the engine coolant in the system

- Drain initial operation corrosion inhibitor oil.
- Leave the fuel in the system

If it is not possible to leave the fuel in the system, preserve the fuel circuit in accordance with the instructions in Chapter 7, "Preservatives", under "Corrosion inhibiting oils for internal preservation of the fuel system " (→ Page 43)

Preservation of cooling system, lubrication system and fuel system, if the coolant cannot be left in the system

- Clean engine if necessary.
- Fill cooling circuit completely with approved corrosion inhibitor for internal preservation of the coolant circuit (further on referred to as "preservation liquid") in accordance with the instructions in Chapter 8.
- Drain engine oil
- Fill with initial operation corrosion-inhibiting oil in accordance with Chapter 8 up to the “Min” mark at least
- 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.
- Stop the 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 it is not possible to leave the fuel in the system, preserve the fuel circuit in accordance with the instructions in Chapter 7, "Preservatives", under "Corrosion inhibiting oils for internal preservation of the fuel system " (→ Page 43)

Note regarding the cooling circuit:

To avoid time-consuming flushing cycles when filling the coolant system after engine preservation with emulsion-type preservatives, we recommend to use Glysacorr P 113 as preservation liquid.

Represervation is not required if the engine is completely filled with coolant after the preservation run.

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

Preservation of combustion chamber

- Clean engine if necessary.
- Fill with initial operation corrosion-inhibiting oil up to the “Min” mark at least.
- Remove sealed covers from combustion-air inlet and exhaust outlet.
- 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 Chapter 8 for approx. 15 seconds with a fine atomizer spray gun into the charge air manifold openings.
- Drain initial operation corrosion inhibitor oil.
- Seal off the combustion air intake and exhaust outlet openings against moisture / humidity once again.
- 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 Chapter 8.
- 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

The preservation work must be recorded in the check sheet (→ Page 98). For engines put into storage under manufacturer's warranty, the monitoring card (→ Page 99) must be filled out and returned to MTU Friedrichshafen GmbH in good time before the engine is put into service.

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.

Note on commissioning:

Before putting into to service, the engine must be depreserved, see Section "Depreserving diesel and gas engines before putting into service"

Preserving gas engines

Out-of-service period of < 3 months

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 field engines with out-of-service period > 3 months

- Clean engine if necessary.
- Drain engine oil.
- Fill with initial operation corrosion-inhibiting oil in accordance with Chapter 8 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 Chapter 8 with approved corrosion-inhibiting antifreeze, if freezing temperatures are expected. 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.
- Stop the engine
- Leave corrosion inhibiting antifreeze or the customer's coolant in the system.
- Drain initial operation corrosion inhibitor oil.

If it is not possible to leave the coolant in the cooling circuit, drain the coolant and proceed as follows:

- Clean engine if necessary.
- Drain engine oil
- Fill cooling circuit completely with approved corrosion inhibitor for internal preservation of the coolant circuit (further on referred to as "preservation liquid") in accordance with the instructions in Chapter 8.
- Fill with initial operation corrosion-inhibiting oil in accordance with Chapter 8 up to the "Min" mark at least
- Run the engine for 15 minutes at half load.
- Stop the engine
- Allow engine to cool down, where possible, to max. 40 °C.
- Drain the inhibitor concentrate.
- Drain initial operation corrosion inhibitor oil.

Note regarding the cooling circuit:

To avoid time-consuming flushing cycles when filling the coolant system after engine preservation with emulsion-type preservatives, we recommend to use Glysacorr P 113 as preservation liquid.

Represervation is not required if the engine is completely filled with coolant after the preservation run.

Preservation of combustion chambers of field engines with out-of-service period > 3 months

- Clean engine if necessary.
- Drain engine oil.
- Fill with initial operation corrosion-inhibiting oil up to the "Min" mark at least.
- Remove sealed covers from combustion-air inlet and exhaust outlet.
- 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 Chapter 8 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.
- Seal off the combustion air intake and exhaust outlet openings against moisture / humidity once again.
- 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 Chapter 8.
    - 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:
    - Coolant
    - Fuel
    - Engine oil

Represerving diesel and gas engines

The represervation procedure is identical with the preservation procedure for diesel and gas engines in the field with out-of-service periods of > 3 months. (→ Page 86)

Represervation of preserved engines must be carried out depending on the storage conditions at the represervation intervals specified in Chapter 9.

The following rules apply to engines with filled cooling, lube oil and fuel systems:

- Lube oil and fuel systems filled:
  - Represerve after 6-12 months, depending on the storage conditions
- Cooling systems filled with corrosion-inhibiting antifreeze:
  - Change coolant after 3 years, referenced to the data of manufacture of the product
- Cooling systems filled with water-soluble corrosion inhibitor:
  - Renew coolant after 2 years, referenced to the date of manufacture of the product
- Cooling systems filled with emulsifiable corrosion inhibitor oil:
  - Renew coolant after 6 years, referenced to the date of manufacture of the product

:

Depreserving diesel and gas engines before putting into service

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).
- Only for diesel engines:
  - 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.

- Fill with or renew coolant

	Depreservation is not required on installed field engines with out-of-service periods up to 3 months. Only the covers must be removed (→ Page 84).

Note on commissioning:

Put engine into operation according to the engine documentation.

Special packing

Special packing must be carried out for engines which are to be taken out of service for more than 36 months. For engines to be stored outdoors or to be transported by sea or in polar or tropical regions, special packing should be carried out immediately after preservation, see Sections (→ Page 84)and (→ Page 86). Likewise, special packing is also usually advisable for protecting the engine against corrosion during shorter periods of storage .

Coolant and preservative oil must be drained completely for special packing.

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

- Check the humidity indicator every 3 to 4 months (→ Page 90).
- In cases of storage for more than 10 years (from date of manufacture on identification plate) but before putting into service, all rubber components (sleeves, hose lines, etc.) on the engine must be replaced.
- Storage beyond 20 years (as of year of manufacture on nameplate) but before commissioning, all elastomer components must be replaced as part of a major engine overhaul.

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.

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 Friedrichshafen GmbH recommends that engines should not be stored for more than 10 years.

General information on special packing

Envelopes of laminated material

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

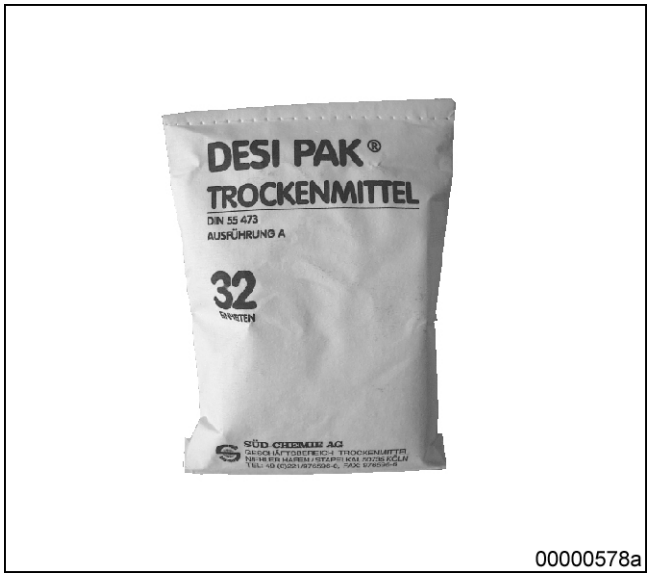
The material used by MTU Friedrichshafen GmbH is composed laminated aluminium foil made of polyethylene – aluminum and polyester, with the following properties:

- 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 vapor) 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 m² 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).

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) .

Calculation example for desiccant units
Determination of DU for the seaworthy transport of an engine to Singapore:

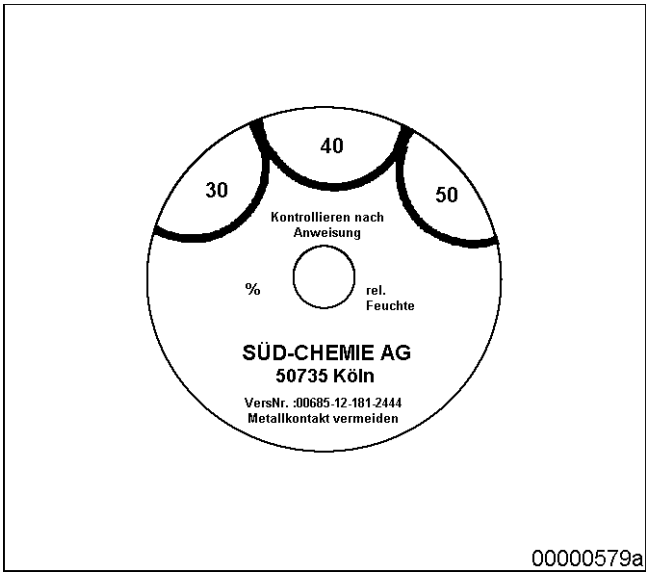
- Laminated aluminum foil surface 10 m²
- Packing material: 3 kg
- Packing for climatic zone C:

	17 DU/m² laminated aluminum foil	x 10 m²	=	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.

		Action
30	Colored pink: Relative humidity above 30%.	Reduce time between checks, i.e. check every 4 weeks.
40	Colored pink: Relative humidity above 40%	The desiccant must be replaced (→ Page 97); evenly distribute the new desiccant primarily in the upper section of the packaging. For required units of desiccant for special packing , see calculation example for desiccant units.
50	Colored pink: Relative humidity above 50%	Check condition of packed engine, represerve engine, (→ Page 87)and repack engine (→ Page 91)



Note:
The humidity indicator regenerates itself; replacement is not necessary.

Order numbers for packing materials
Details required when ordering from MTU Friedrichshafen GmbH:
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

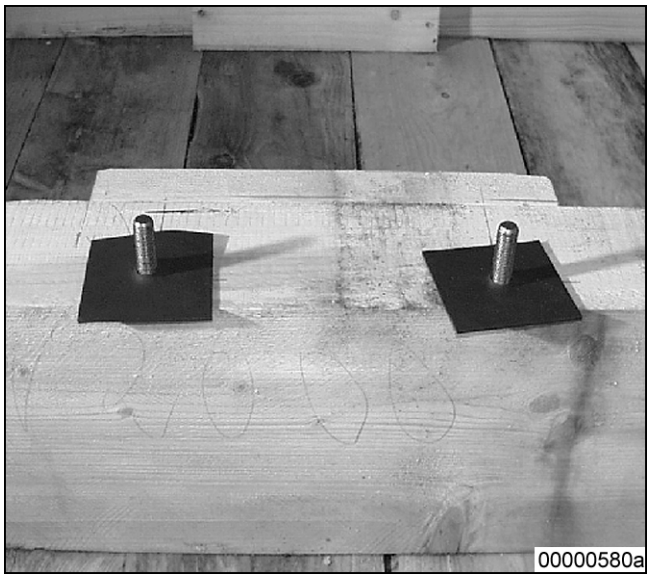
Provided that the engine is not new or has not undergone a major overhaul carried out by MTU (and has already been preserved), preservation (→ Page 84) and (→ Page 86) must be carried out before special packing takes place. Coolant and preservation oil must be completely drained.

Transportation locking device

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

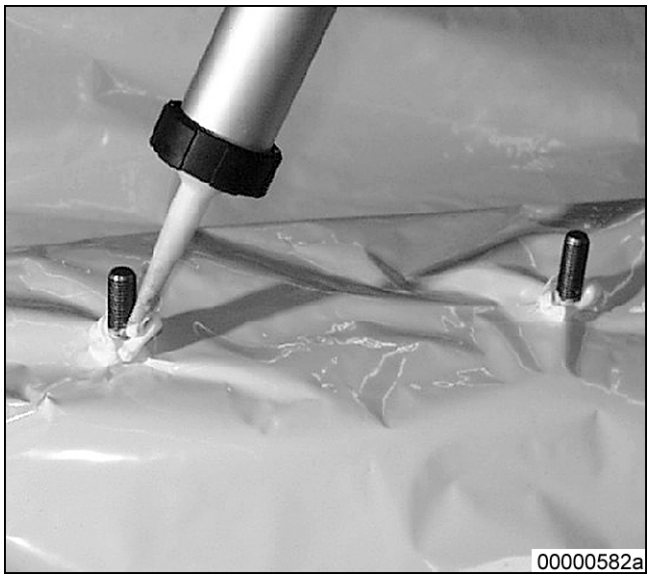
Special packing of an engine

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).

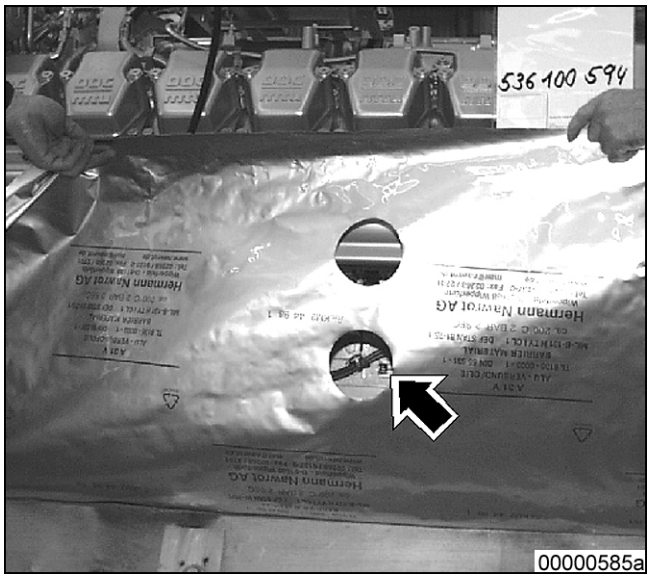


Position the second hard-rubber pads.

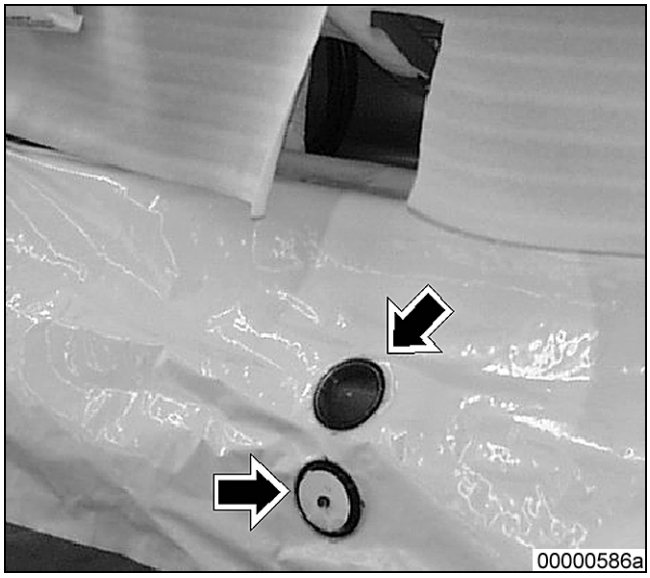
For additional protection of the laminated aluminum foil, position foam foil over the upper hard-rubber pad. The complete system is compressed and sealed after the engine mounts are installed and secured.

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

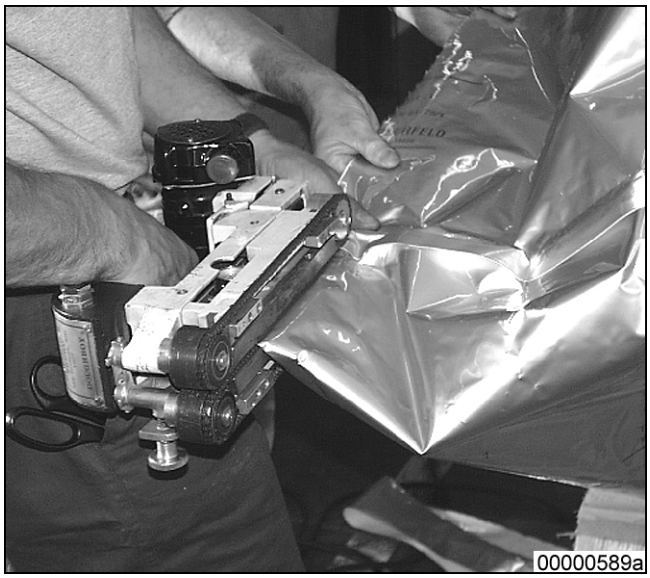
Place the calculated amount of desiccant units (see calculation example for desiccant units) inside the envelope. The desiccant units must be arranged in the upper third of the envelope and attached to the engine, hanging free wherever possible. Ensure that the desiccant units are attached (with string, 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.

TIM-ID: 0000010139 – 007

Laminated aluminum foil sealing

Use a manual foil-welding unit suitable for aluminum laminate foils to seal the aluminum laminate envelope (→ Page 98).



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 90). The results of the check must be entered on the monitoring sheet (→ Page 99). If the engine is still under warranty, return the monitoring sheet (→ Page 99) to MTU Friedrichshafen GmbH 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 laminated aluminum composite foil is damaged.

Desiccant replacement

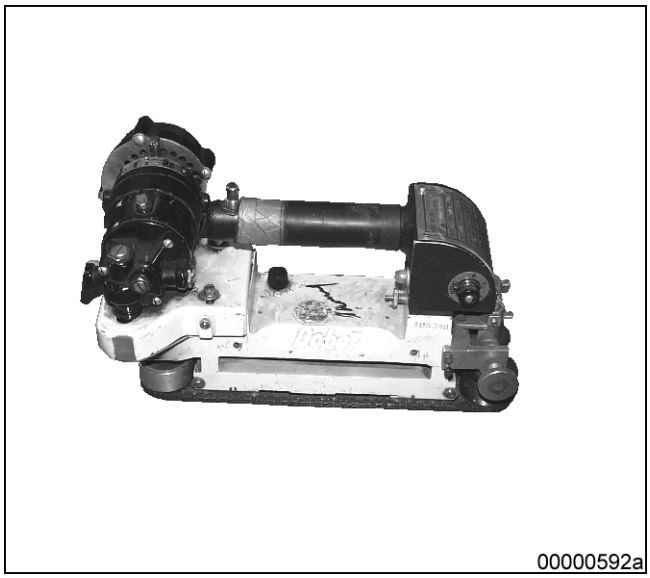
Open the upper section of the envelope and remove the old desiccant. Place the same amount of fresh desiccant in the upper section of the envelope (→ Page 95). Re-weld the envelope and extract the air (→ Page 96).

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 95) and the air must be extracted again (→ Page 96). 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 90) and the manual welding unit (→ Page 98) 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/represervation check sheet

Engine model: ..... Engine No. ..... Acceptance date: ..... Correct completion of the preservation tasks as specified in the preservation specifications 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. Brand of coolant used: ..... Coolant is not drained		
Is preserved with an approved corrosion inhibitor for internal preservation of the cooling circuit Corrosion inhibitor used: ..... Coolant is drained		

TIM-ID: 0000010139 – 007

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 depreservation and return to MTU Friedrichshafen GmbH in good time before the engine is put into service.		

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		

TIM-ID: 0000010139 – 007

	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 depreservation of engines in special packing

Check sheet for engine depreservation		
Attention!		
Before opening the envelope, read this check sheet carefully and follow the instructions exactly, especially those requiring contact with MTU Friedrichshafen GmbH.		
	Task	Remarks
1.	Read off the humidity status at the indicators and enter 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.
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.	
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.	
6.	Record the date of depreservation on the Monitoring Sheet.	
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.	
8	Compliance with the initial-operation instructions in the engine documentation is mandatory.	

10 Flushing and cleaning specifications for engine coolant circuits

General information

These cleaning specifications are for the engine coolant circuits in MTU diesel engines and gas engines.

In the course of time, sludge deposits from aging coolant additives can accumulate in the coolant circuits. 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 circuit 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 coolant circuit 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 coolant circuits with treated engine coolant as stipulated in the current MTU Fluids and Lubricants Specifications A001061 (→ Page 45).

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	7)
Henkel	P3-Saxin	2% by weight	Powder	7)
Novamax	Grision 5716	2% by weight	Powder	7)
Nalco	Maxi Clean 2[1)]	2% by volume	Liquid	40495

Manufacturer	Product name	Concentration for use		Order No.
For coolant systems:				
For subassemblies:				
Henkel	P3-FD[2)]	3 to 5% by weight	Powder	[7)]
Henkel	Porodox[3)]	5 to 10% by weight	Powder	[7)]
Kluthe	Hakutex 60	100% by volume	Liquid	50602
Novamax	Euron 13084[1)]	5 to 10% by weight	Powder	[7)]
For coolant systems contaminated with bacteria, fungi or yeast (so-called system cleaners):				
Schülke & Mayr GmbH	Grotan forte[5)]	0.15% by volume	Liquid	40400
Schülke & Mayr GmbH	Grotanol SR1[6)]	1% by volume	Liquid	40339
Troy Chemical Company	Troyshield SC1[6)]	1% by volume	Liquid	[7)]

[1)] Not suitable for galvanized surfaces

[2)] For greasy lime deposits

[3)] Preferred for heavy lime deposits

[4)] For heavy lime deposits

[5)] Bacteria contamination up to 10^4

[6)] Bacteria contamination up to $>10^4$, contamination with fungi and yeast

[7)] Not stocked by MTU

Flushing engine coolant circuits

Drain engine coolant.

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

Fill coolant circuit 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 circuits

Prepare concentrated solution of detergent (for coolant circuits) 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 circuit.

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 coolant circuit 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):
Cleaning 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.

Coolant circuits contaminated with bacteria, fungi or yeast

System cleaning

The system cleaner must flow a sufficiently long time through the complete cooling system to ensure effective cleaning and disinfection.

Therefore, the predefined amount of the approved system cleaner must be added to the contaminated coolant in the system. Use a circulating pump to provide continuous mixture flow through the coolant system for at least 24 hours.

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Flushing

After draining the coolant/system cleaner mixture, the coolant circuit must be flushed with fresh water as long as visible contamination can be detected and until the flush water has the ph-value of the fresh water (maximum deviation of the ph-values: <1).

Refill

Before refilling with coolant, ensure the cooling system is free of contaminants.

11 Revision overview from version A001061/33 to A001061/34

Ser. no.	Page	Subject	Action	Item
1	Title page		added	Series 1600 + two-cycle engines
2	03	Preface	revised	Internet address
3	05	Mixing of engine oils	revised	whole paragraph
4	06	Restrictions on Series 2000 M84, 2000 M94, and 4000-03 marine applications	added	Series 2000 M84, 2000 M94
5	06	Restrictions on Series 595, 956 TB31/TB32/TB33 and 1163 applications	revised	Series 8000 engines deleted
6	06	Restrictions on Series 8000 applications	added	whole paragraph
7	07	Restrictions when using low SAPS oils	added	whole paragraph
8	10	Analytical limit values for used diesel engine oils (Table 10)	added in line water (test method): new line added: new line added:	 EN 12937 Oxidation Nitration
9	15	Engine oils for two-cycle engines	added	complete chapter
10	17	Coolants	revised	complete chapter
11	25	Fuels of comparable quality with following test results (Table 1)	new line added: new line added:	Fatty acid methyl ester (FAME) content Oxidation stability min.
12	26	Diesel fuel approvals applicable to the following engine series	revised	whole paragraph
13	32	Biodiesel	revised	Notice
14	34	Approved anti-wear additives	omitted	Manufacturer: Liqui Moli

Ser. no.	Page	Subject	Action	Item
15	35	Heating Oil EL	Sulfur content revised added added	whole paragraph Lubricity Valve wear
16	39	Requirements and marginal conditions fuels and fuel supply (Table)	Line 3 revised Line 8 revised	
17	41	NO_x reducing agent AUS 32 for SCR after-treatment systems	added	complete chapter
18	43	Corrosion inhibitors for internal preservation of the coolant circuit	added	whole paragraph
19	45	Approved fluids and lubricants (engine oils)	revised	complete chapter
2063	63	Approved fluids and lubricants (coolant additives)	revised	complete chapter
21	83	Preservation specifications	revised	complete chapter
22	103	Flushing and cleaning specifications for engine coolant circuits	Table (approved cleaning products) revised added	complete chapter Coolant systems contaminated with bacteria, fungi or yeast