Fluids and Lubricants Specifications

All commercial MTU Series
(except for 1600 and 1800 Series), DDC S60 Marine
and Two-Stroke Engines

A001061/35E

Power. Passion. Partnership.

Printed in Germany

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This handbook is provided for use by maintenance and operating personnel in order to avoid malfunctions or damage during operation.

Subject to alterations and amendments.

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1 Preface

1.1 General information

Used symbols and means of representation

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

	This symbol indicates instructions, tasks and operations that must be followed to avoid hazards to persons as well as damage to or destruction of material.

Note:

A note provides special instructions that must be observed when performing a task.

Fluids and lubricants

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.

Test standard	Designation
DIN	Federal German Standards Institute
EN	European Standards
ISO	International Standards Organization
ASTM	American Society for Testing and Materials
IP	Institute of Petroleum
DVGW	German Gas and Water Industry Association

Table 1: Test standards for fluids and lubricants

Applicability of this publication

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-Technische-Dokumentation

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

Warranty

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.

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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.

Preservation

All information on preservation, re-preservation and de-preservation including the approved preservatives is available in the MTU Preservation and Re-preservation Specifications (publication number A001070/...). The latest version is also available at:

http://www.mtu-online.com/mtu/mtu-valuecare/mtu-valueservice-Technische-Dokumentation

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2 Lubricants for Four-Cycle Engines

2.1 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 onsite climatic conditions. At present there is no international industrial standard which alone takes into account all these criteria.

	The use of engine oils not approved by MTU can mean that statutory emission limits can no longer be observed. This can be a punishable offense.

	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.

	When changing to an engine oil in Category 3, note that the improved cleaning effect of these engine oils can result in the loosening of engine contaminants (e.g. carbon deposits). It may be necessary therefore to reduce the oil change interval and oil filter service life (one time during change).

Special features

MTU/MTU-DD engine oils

The following single-grade and multigrade oils are available from MTU/MTU-DD.

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Manufacturer	Product name	SAE grade	Oil category
MTU/MTU-DD	Power Guard DEO SAE 40	40	2
	Power Guard DEO SAE 15W-40	15W-40	2
MTU-Asia	Fascination of Power	40	1
	Fascination of Power	40	2
	Fascination of Power	15W-40	2
	Fascination of Power Maxi Shield	15W-40	2
MTU-DD Australia	MTU Premium 30, 40	30, 40	2
	MTU Premium 15W-40	15W-40	2

Table 2:

Engine oil for the Series BR 2000 PLD, 4000-01, 4000-02

The engine in the Series 2000, 4000-01 and 4000-02 can use both the approved engine oils (→ Page 70) as well as other engine oil provided that all performance requirements and characteristics listed in (→ Table 3) and (→ Table 4) are met.

Performance requirements

Oil category	Specification
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

Table 3:

Chemical-physical properties

	Test method	Limit value
Total base number	ASTM D2896 ISO 3771	> 8mgKOH/g
Shear stability	ASTM D3945 or CEC-L-14-A-88	Limit values of respective viscosity grade
Deposit test [1)]	DIN 51535	Max. 120 mg

Table 4:

[1)] Required for multigrade oils used in closed crankcase breather.

Restrictions for applications of Series 2000 M84, 2000 M94, Cx6, Sx6 and 4000 M73, M93L N43 and N83

	Oils in oil category 1 must not be used!

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Restrictions for applications in Series 2000 M72

	The engine oil Mobil Delvac 1630/1640 must not be used!

Restrictions for application in Series 4000 T94, T94L, R64, R74, R84

	In engines in Series 4000 T94,T94L, only engine oils of oil category 3 or 3.1 of SAE grades 5W-40 or 10W-40 must be used! In engines in Series 4000 R64, R74 and R84, only engine oils of oil category 3.1 of SAE grades 5W-40 or 10W-40 must be used! The maximum oil service life is 1000 operating hours with observance of the analytical limit values for used oils!

Restrictions for applications in Series 595 and 1163

	Category 2 or Category 3 oils are normally stipulated for fast commercial ferries using Series 595 and Series 1163 engines.

Restrictions for applications in Series 956 TB31/TB32/TB33 and 1163 TB33

	Only the following engine oils may be used: • Shell Sirius X SAE 30 • Fascination of Power 15W-40 • Other engine oils upon request

Restrictions for Series 8000 applications

	Only the following engine oils may be used: • 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
	SAE grade 40 engine oils may only be used in combination with preheating and oil priming ($T_{oil\ >30\ °C}$).

Restrictions for Series S60 applications

	Only multigrade oils of SAE grade 15W-40 marked with index [2)] must be used. The maximum oil service life is 250 operating hours or 1 year.

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 oils for engines with exhaust aftertreatment

Engines with exhaust aftertreatment place special demands on the oils used to guarantee the operational reliability and service life of the exhaust system and the engine.

Depending on the technology used for exhaust aftertreatment, the following oils can be used.

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Exhaust gas technology	Approval for oil category				
	1	2	2.1	3	3.1
Oxidation catalyst without particulate filter	no[1)]	no[1)]	yes	no[1)]	yes
SCR system with vanadium catalysts (no particulate filter)	no[1)]	no[1)]	yes	no[1)]	yes
SCR system with zeolith catalysts (no particulate filter)	no[1)]	no[1)]	yes	no[1)]	yes
Diesel particulate filter	no[1)]	no[1)]	yes	no[1)]	yes
Combination system SCR+ particulate filter	no[1)]	no[1)]	yes	no[1)]	yes

Table 5:

[1)] = individual test possible for optional and retrofitted exhaust aftertreatment systems

	The use of engine oils of categories 1, 2 and 3 (with ash content >1%) on plants with exhaust aftertreatment results in a significantly reduced service life of the exhaust after treatment system and, with particulate filters, increased back pressure.

	For EPA Tier 4i or Tier 4 and EU IIIb-certified engines with exhaust aftertreatment, only low-ash engine oils of category 2.1 or 3.1 are permitted.

Any possible restrictions related to engine requirements must also be observed.

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 (→ Figure 1).

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

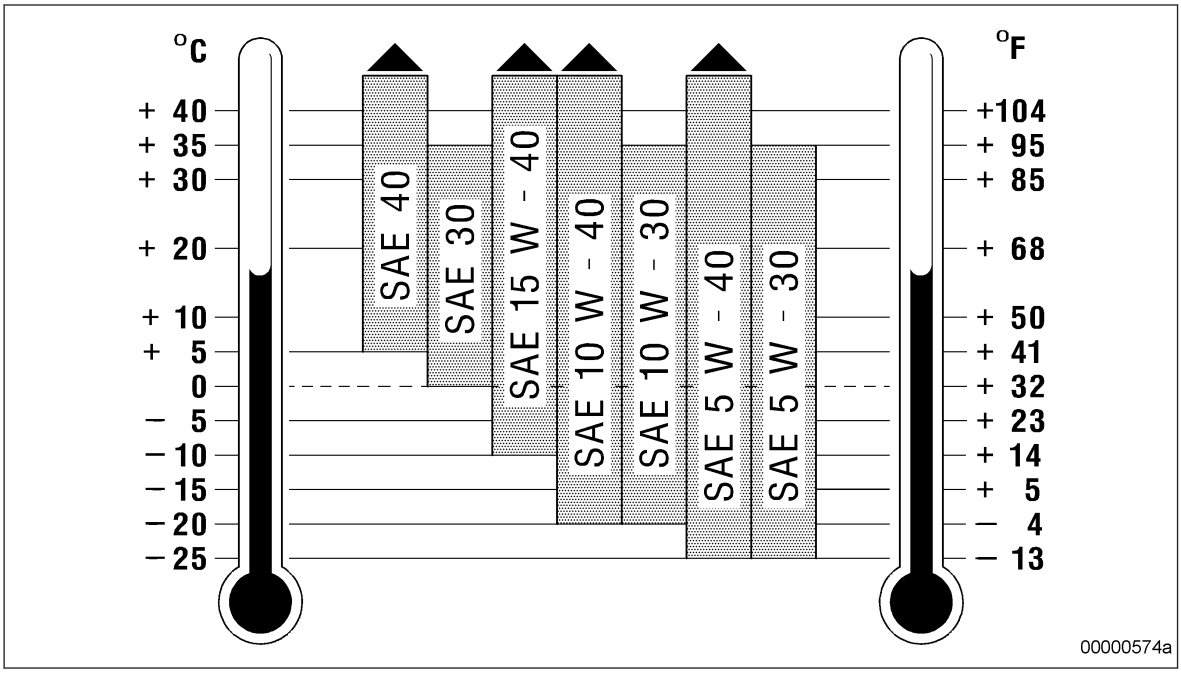

Figure 1: Viscosity grade chart

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) are guidelines based on operational experience and are valid for applications with a standard load profile.

Oil change intervals

Oil category	Without centrifugal oil filter	With centrifugal oil filter or by-pass 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

Table 6:

[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 defined limit values for the used oil (→ Table 7) must be observed. The numbers of operating hours quoted for oils must be confirmed by means of oil analysis.

The oil drain intervals must be determined by oil analysis if one or more of the following difficult operating conditions are encountered:
- Extreme climatic conditions
- High engine start-up frequency
- Frequent and prolonged idling or low-load operation
- High fuel sulfur content of 0.5 to 1.5% by weight (see "Use of High-Sulfur Fuel")

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 70), 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 samples are to be analyzed at specific intervals (see "Laboratory Analysis").

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).

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 analyses

General information

Orders for engine oil analyses can be placed with MTU.

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

The following data is required:
- Oil manufacturer
- Brand name with viscosity grade
- 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 specified test methods and limit values (Analytical Limit Values for Used Diesel Engine Oils) (→ Table 7) 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.

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Analytical limit values for used diesel engine oils

	Test method	Limit values	
Viscosity at 100 °C max. mm²/s	ASTM D445 DIN 51562	SAE 30 SAE 5W-30 SAE 10W-30	15.0
		SAE 40 SAE 5W-40 SAE 10W-40 SAE 15W-40 SAE 20W-40	19.0
min. mm²/s		SAE 30 SAE 5W-30 SAE 10W-30	9.0
		SAE 40 SAE 5W-40 SAE 10W-40 SAE 15W-40 SAE 20W-40	10.5
Flash point °C (COC)	ASTM D92 ISO 2592	Min. 190	
Flash point °C (PM)	ASTM D93 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 D2896 ISO 3771	Min. 50% of new-oil value	
Water (% by vol.)	ASTM D6304 EN 12937 ISO 6296	Max. 0.2	
Oxidation (A/cm)[1)]	DIN 51453[1)]	Max. 25	
Ethylene glycol (mg/kg)	ASTM D2982	Max. 100	

Table 7:

[1)] = only possible if there are no ester compounds

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
- Shorten the oil-change intervals (see Oil change intervals).

Chart (→ Figure 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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The total base numbers for the approved engine oils are listed in chapter Approved engine oils (→ Page 70).

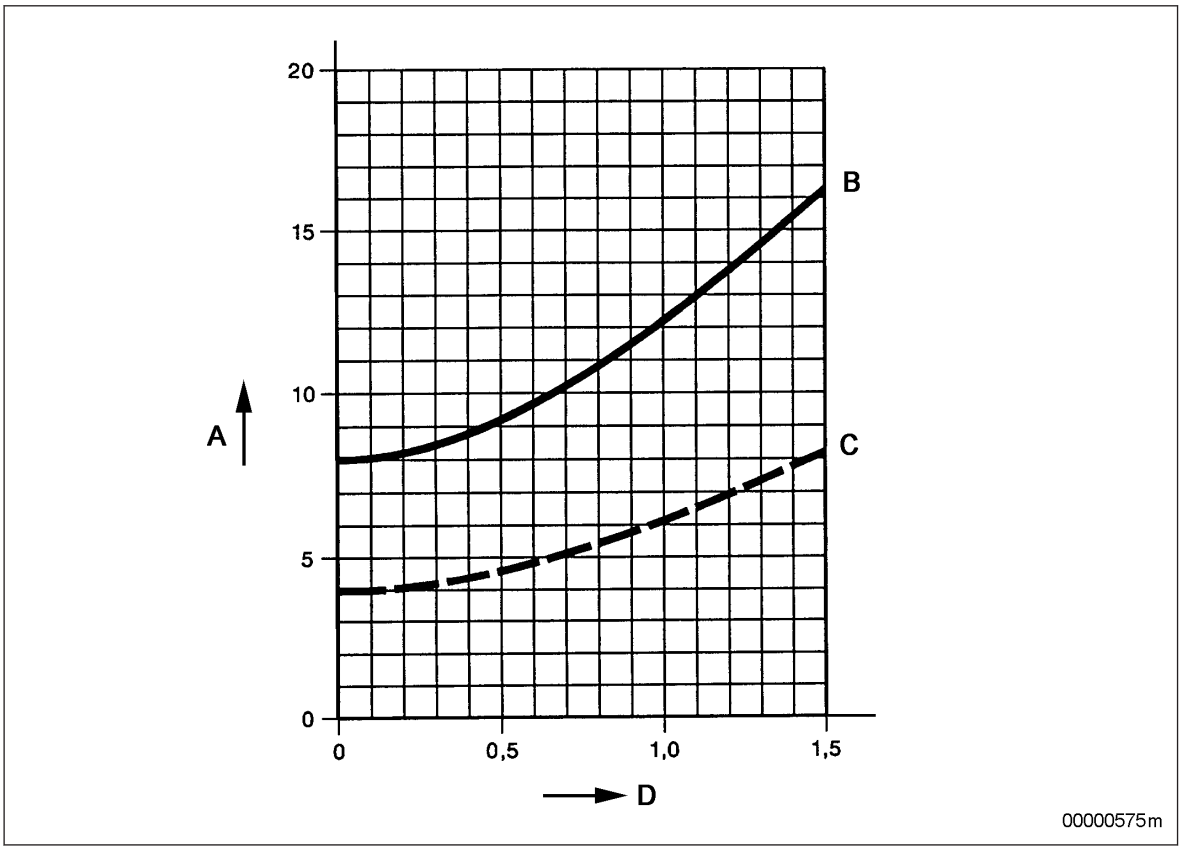

Figure 2: Total base number for engine oil depending on sulfur content of the diesel fuel

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

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2.2 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 (see Special-purpose lubricants)
- Coupling internal centering

Lubricating greases for applications at high temperatures

High-temperature grease (up to 250 °C) must be used for emergency-air 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

Oil for 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.

Lubricating greases for curved tooth couplings

Depending on the application, the following lubricants have been approved for curved tooth 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.

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3 Lubricants for gas engines

3.1 Engine oils

	Dispose of used fluids and lubricants in accordance with local regulations.

	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.

Engine oil requirements for gas engines

	Viscosity grade SAE 40 is stipulated for gas engines! Multigrade oils are not permitted!

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 are characterized by the lowest possible ash content. This prevents increased ash deposits which can lead to reduced catalytic converter performance.

Oil drain intervals for Series 4000 L61/L62/L63/L62FB 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.

Gas engines for natural gas operation in Series 4000 L61/L62/L63:

Oil samples must be taken every 500 operating hours and examined.

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

Gas engines for biogas operation in Series 4000 L62FB:

Oil samples must be taken every 250 operating hours and examined.

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

When the limit values in accordance with (→ Table 8) are reached or exceeded, an immediate oil change is necessary.

The results of the oil analyses must be archived and the last respectively oil sample must be stored for any necessary follow-up examinations.

Analytical limit value for used gas engine oils SAE 40

	Test method	Limit values
Viscosity at 100 °C (mm²/s)	ASTM D445	Max. 17.5
	DIN 51562	Min. 11.5
Total base number (mg KOH/g)	ASTM D2896	Min. 3 and TBN > TAN
	ISO 3771	
Acid number, TAN (mgKOH/g)	ASTM D664	New oil value + 2.5

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	Test method	Limit values
iph value		Min. 4.5
Water (% by vol.)	ASTM D6304 EN 12937 ISO 6296	Max. 0.2
Glycol (mg/kg)	ASTM D2982	Max. 100
Oxidation (A/cm)	DIN 51453	Max. 20
Nitration (A/cm)	IR method	Max. 20
Wear elements (mg/kg)	RFA, ICP	
Iron (Fe)		Max. 30
Lead (Pb)		Max. 20
Aluminum (Al)		Max. 10
Copper (Cu)		Max. 20
Tin (Sn)		Max. 5
Silicon (Si)		Max. 15

Table 8:

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4 Lubricants for Two-Cycle Engines

4.1 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 of Series 53/71/92 and 149

SAE grade Specification		API CF-2	40 Limit values	50 Limit values
	Test method			
	ASTM	ISO		
Viscosity at 100 °C (mm^2/s)	D445	EN 3104	12.5 - 16.3	16.3 - 21.9
Viscosity at 40 °C (mm^2/s)	D445	EN 3104	130 - 150	200 - 300
Pour point (°C)	D97	3016	Max. -15	Max. -10
Flashpoint (°C)	D92	2592	Min. 225	Min. 230
Sulfated ash (by weight %)	D874	DIN 51575	Max. 1.0	Max. 0.8
Total base number (mgKOH/g)	D2896	3771	7.0 - 10.00	Min. 7.0
Calcium (mg/kg)		14596	No limit value	Max. 500
Phosphor mg/kg		DIN 51363-2/3	Min. 700	Max. 100
Zinc (mg/kg)		DIN 51391-3	Min. 700	Max. 100

Table 9:

Restrictions for Series 53/71/92 applications - all applications except marine

	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.

Restrictions for Series 53/71/92 marine applications

	No multigrade oils and single-grade oil of SAE grade 30 must be used!

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Restrictions for Series 53/71/92 applications

	For applications with coolant outlet temperatures > 94 °C, oils of SAE grade 50 must be used! If fuels with low-sulfur content of 0.5 to 1.0% are used, the oil service life is shortened.

Restrictions for Series 149 applications

	For applications with ambient temperatures > 35 °C, oils of SAE grade 50 must be used! Oil of SAE grade 50 can no longer be recommended at ambient temperatures <7 °C. If starting speed is no longer reached with the use of SAE grade 50 oils, oil from SAE grade 40 can also be used. No single-grade oils of SAE grade 30 or multigrade oils must be used! If fuel with a sulfur content of between 0.5 and 1% are used, oils with a base number of at least 10mg/KOH/g and with zinc and phosphor contents of max. 100 mg/kg must be used!

Analytical limit values for used diesel two-cycle engine oils

	ASTM	ISO	Limit value SAE 40	Limit value SAE 50
Viscosity at 100 °C (mm^2/s)	D445	EN 3104	Min. 12.5 Max. 16.3	Min. 16.0 Max. 22.0
Soot content (by weight %)		DIN 51452	Max. 0.8	Max. 0.8
Water (% by vol.)	D1744	EN 12937	Max. 0.3	Max. 0.3
Ethylene glycol	D2982	DIN 51375	Negative	Negative
Iron (mg/kg)	ASTM D5185		Max. 150	Max. 35
Aluminum, silicon, copper (mg/kg)	ASTM D5185		Max. 25	Max. 25
Lead (mg/kg)	ASTM D5185		Max. 10	Max. 10

Oil change intervals with use of fuels with sulfur content < 0.5%

Application	Series	Oil change interval
C&I, Marine	S 53/71/92	150 h or 1 year
	S 149	300 h or 1 year
Generator - emergency power	S 53/71/92/149	150 h or 6 months
Generator - continuous operation	S 53/71/92/149	150 h or 3 months

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5 Coolants

5.1 General information

Coolant definition

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

The corrosion-inhibiting effect of coolant is only ensured with the coolant circuit fully filled. The only exception is 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. This means that after draining the coolant the cooling circuit must be preserved if no more coolant is to be filled. The procedure is described in the MTU Preservation specifications A001070/.. of the engine.

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 antifreeze 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. Only exception: BASF G206 (special application)
- The coolant must be free of oil residue.
- 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.

	All coolants approved in these Fluids and Lubricants Specifications generally relate only to the coolant circuit of MTU engines. In the case of complete propulsion plants, the operating fluids approvals of the component manufacturer must be observed!

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5.2 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.

Item	Minimum	Maximum
Sum of alkaline earth metals *)	0 mmol/l	2.7 mmol/l
(Water hardness)	0°d	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!	

Table 10: Fresh water requirements for coolant treatment

1) Common designations for water hardness in various countries:

1 mmol/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

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5.3 Emulsifiable corrosion-inhibiting oils

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 and 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 "Flushing and cleaning specifications for engine cooling circuits" (→ Page 125).

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 chapter "Flushing and cleaning specifications for engine coolant circuits" (→ Page 125).

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 TE and SE (split-circuit cooling system)
- Series 396 TB (external intercooler with plate-core heat exchanger)
- Series 4000
- Series S60
- Two-cycle engines

The emulsifiable corrosion-inhibiting oil must never be used for coolant temperature >90 °C!

For approved coolant additives for the individual engine series, refer to chapter “Approved coolants" (→ Page 96).

Special approval presently in effect remains valid.

Flushing with water is required at every change to a different coolant product. This also applies to new engines if they are preserved with an emulsifiable corrosion inhibitor. The necessary work is described in the chapter "Flushing and cleaning specifications for engine coolant circuits" (→ Page 125).

TIM-ID: 0000018572 - 001

5.4 Corrosion inhibiting antifreeze

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

Provided that they are used in approved concentrations, corrosion-inhibiting antifreezes approved by MTU provide effective protection, see Operational monitoring (→ Page 25).

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 “Approved coolants" (→ Page 101).

Special approval presently in effect remains valid.

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

- Series 956-01, 956-02, 1163-02, 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 538, 595 and 8000:
  The use of corrosion-inhibiting antifreezes is not allowed for these engines.

The possibility of using corrosion inhibiting antifreezes for the above-mentioned series for other applications (e.g. genset, rail) is described in the overview in the chapter (→ Page 96).

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).

Flushing with water is required at every change to a different coolant product. This also applies to new engines if they are preserved with an emulsifiable corrosion inhibitor. The necessary work is described in the chapter "Flushing and cleaning specifications for engine coolant circuits" (→ Page 125).

TIM-ID: 0000018573 - 001

5.5 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 systems (with plate-core heat exchanger) and TE systems in Series 099, 183, 2000, 396 and 4000 engines.

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.

For approved coolant additives for the individual engine series, refer to chapter “Approved coolants" (→ Page 96).

Special arrangements presently in effect remain valid.

Flushing with water is required at every change to a different coolant product. This also applies to new engines if they are preserved with an emulsifiable corrosion inhibitor. The necessary work is described in the chapter "Flushing and cleaning specifications for engine coolant circuits" (→ Page 125).

TIM-ID: 0000018574 - 001

5.6 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
- Determination of corrosion-inhibiting oil content
- Determination of corrosion inhibitor/antifreeze 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.

As an additional exhaust gas cooler is installed in the Series 4000-04 and the cooling system is more sensitive, a regular check of the coolant is very important for trouble-free engine operation. This check must be carried out annually or after 3000 operating hours and every time the coolant is filled.

The concentration, pH value and silicon content (only with coolant that contain Si) must be within the values specified in the MTU Fluids and Lubricants Specifications.

Permissible concentrations

	Min. % by vol.	Max. % by vol.
Emulsifiable corrosion-inhibiting oils	1.0	2.0
Ethylene glycol corrosion inhibiting antifreeze	35 Antifreeze protection to approx. -25 °C The ready-mixed Power Cool Plus Marine (30/70) has a special approval and reduced antifreeze protection	50 Antifreeze protection to approx. -40 °C
Propylene glycol corrosion-inhibiting antifreeze	35 Antifreeze protection to approx. -18 °C	50 Antifreeze protection to approx. -32 °C
BASF G206	35 Antifreeze protection to approx. -18 °C	65 Antifreeze protection to approx. -65 °C

Table 11:

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	Min. % by vol.	Max. % by vol.
Water-soluble corrosion inhibitors: – Arteco Freecor NBI – BASF Glysacorr G93–94 – BP Castrol Extended Life Corrosion Inhibitor – CCI Corporation A216 – CCI Manufacturing IL Corp. A216 – Chevron Texcool A-200 – Detroit Diesel Corp. Power Cool Plus 6000 – Drew Marine Drewgard XTA – ExxonMobil Mobil Delvac Extended Life Corrosion Inhibitor – Ginouves York 719 – MTU Coolant CS100 – Tognum America Inc. Power Cool Plus 6000 – Old World Industries A216 – Valvoline ZEREX G-93	9	11
– Detroit Diesel Corp. Power Cool 2000 – Nalco Alfloc 2000 – Nalco Nalco 2000 – Nalco Nalcool 2000 – Penray 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 – Detroit Diesel Corp. Power Cool 3000 – Penray Pencool 3000	5	6

Table 12:

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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 XLI	BP Castrol Extended Life Corrosion Inhibitor	Nalco Alfloc (Maxitreat) 3477	
Drew Marine Drewgard XTA	Chevron Texaco Extended Life Corrosion Inhibitor Nitrite Free	CCI Manufacturing IL Corp.		
Ginouves York 719	Caltex XL Corrosion Inhibitor Concentrate	CCI Corporation A216		
MTU Coolant CS 100	Total WT Supra	Detroit Diesel Corp. Power Cool Plus 6000		
Tognum America Inc.Power Cool Plus 6000		ExxonMobil Mobil Delvac Extended Life Corrosion Inhibitor		
Valvoline ZEREX G-93		Old World Industries A216		
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

Table 13:

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

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Product Propylene glycol corrosion-inhibiting antifreeze | BASF G206 Reading on hand refractometer at 20 °C (= degrees Brix)		Corresponds to a concentration of
31.3	29.8	43% by volume
31.9	30.4	44% by volume
32.5	30.9	45% by volume
33.1	31.5	46% by volume
33.7	32.1	47% by volume
34.2	32.6	48% by volume
34.8	33.2	49% by volume
35.3	33.8	50% by volume
	34.4	51% by volume
	34.9	52% by volume
	35.5	53% by volume
	36.1	54% by volume
	36.7	55% by volume
	37.2	56% by volume
	37.8	57% by volume
	38.3	58% by volume
	38.9	59% by volume
	39.4	60% by volume
	39.9	61% by volume
	40.5	62% by volume
	41.0	63% by volume
	41.5	64% by volume
	42.0	65% by volume

Table 14:

TIM-ID: 0000018575 - 001

5.7 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	

Table 15:

The coolant must be changed in case of noncompliance with the above specifications.

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5.8 Storage stability of coolant concentrates

The storage stability specification is based on an original sealed and airtight container at a storage temperature of up to max. 30 °C.

Coolant concentrate	Limit value	Brand name / Comments
Emulsifiable corrosion-inhibiting oil	6 months	
Corrosion inhibiting antifreeze	Approx. 3 years	Observe manufacturer's specifications
Products containing propylene glycol	3 years	BASF G206
Water-soluble corrosion inhibitors	1 year	Detroit Diesel Corp. Power Cool 3000
		Penray Pencool 3000
	2 years	Arteco Freecor NBI
		Chevron Texcool A-200
		– Nalco Alfloc 2000
		Nalco Nalcool 2000
		Nalco Nalco 2000
		Detroit Diesel Corp. Power Cool 2000
		Penray Pencool 2000
	3 years	BASF Glysacorr G93–94
		Drew Marine Drewgard XTA
		Ginouves York 719
		Tognum America Inc.Power Cool Plus 6000
		Nalco Alfloc (Maxitreat) 3477
		Valvoline ZEREX G-93
	5 years	Arteco Havoline Extended Life Corrosion Inhibitor XLI [EU 032765]
		BP Castrol Extended Life Corrosion Inhibitor
		CCI Corporation A216
		CCI Manufacturing IL A216
		Chevron Texaco Extended Life Corrosion Inhibitor Nitrite Free [US 236514]
		Detroit Diesel Corp. Power Cool Plus 6000
		ExxonMobol Mobil Delvac Extended Life Corrosion Inhibitor
		Fleetguard DCA-4L
		Old World Industries A216
		Total WT Supra

Table 16:

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Note:

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

Containers must be hermetically sealed and stored in a cool, dry place. Frost protection must be provided in winter.

Further information can be obtained from the product and safety data sheets for the individual coolants.

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6 Fuels

6.1 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 specified characteristics and limit values (→ Table 17) guarantee an 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, total contamination and particle distribution 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:

		Test methods		Limit values
		ASTM		
Composition				The diesel fuel must be free of inorganic acids, visible water, solid foreign matter and chlorous compounds.
Total contamination (= fuel-insoluble ingredients)	max.	D6217	EN 12662	24 mg/kg
Spec. grav. at 15 °C	min.	D1298	EN ISO 3675	0.820 g/ml
	max.	D4052	EN ISO 12185	0.860 g/ml
API grade at 60 °F	min.	D287		41
	max.			33
Viscosity at 40 °C	min.	D445	EN ISO 3104	1.5 mm²/s
	max.			4.5 mm²/s
Flashpoint (closed crucible)	min.	D93	EN ISO 2719	55 °C (60 °C for SOLAS)[1)]
Boiling curve:		D86	EN ISO 3405	
– Initial boiling point				160 – 220 °C
– Volume share at 250 °C	max.			65% by volume
– Volume share at 350 °C	min.			85% by volume
– Residue and loss	max.			3% by volume

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		Test methods		Limit values
		ASTM		
Fatty acid methyl ester content (FAME)	max.		EN 14078 Internal MTU procedure	7.0% by volume
Water	max.	D6304	EN ISO 12937	200 mg/kg
Carbon residue from 10% distillation residue	max.	D189	EN ISO 10370	0.30% by weight
Oxide ash:		D482	EN ISO 6245	
– Engines without exhaust aftertreatment	max.			0.01 by weight %
– Engines with exhaust aftertreatment				(→ Page 52)
Sulfur:	max.	D5453, D2622	EN ISO 20846, EN ISO 20884	
– Engines without exhaust aftertreatment				- 0.5% by weight
– Engines with exhaust aftertreatment				- 0.0015% by weight
– Series 2000 Cx6/Sx6, Series 4000 T94/T94L/R64/R74/R84				- 0.0015% by weight
Cetane number	min.	D613	EN ISO 5165, EN ISO 15195	45
Cetane index	min.	D976	EN ISO 4264	42
Corrosion effect on copper. 3 hrs. at 50 °C	Max. degree of corrosion	D130	EN ISO 2160	1a
Oxidation stability	min.		EN 15751	20 hours
Oxidation stability	max.	D2274	EN ISO 12205	25 g/m³
Lubricity at 60 °C	max.	D6079	EN ISO 12156-1	520 µm
Filter plugging point		D4359	DIN EN 116	See Note [2)]
Neutralization number	max.	D974		0.2 mgKOH/g
Particle distribution for fuel in tank	max.		ISO 4406	ISO class 18/17/14

Table 17:

[1)] For marine application, a min. flashpoint of 60 °C (Solas = Safety of life at sea) applies.

[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.

Note: 1 by weight % = 10000 mg/kg = 10000 ppm

Laboratory analyses

An order for fuel analysis can be placed with MTU.

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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

Approved diesel fuels for MTU engines

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

Distillate fuels

DIN EN 590 and ASTM D975

Fuel specifications Restrictions Series	DIN EN 590:2010-05 Summer and winter quality - SOLAS: Flashpoint min. 60 °C - Particle distribution for fuel in tank: max. ISO classes 18/17/14	ASTM D975-11 Grade 1-D S 15, S 500, S 5000 - SOLAS: Flashpoint min. 60 °C - Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - Particle distribution for fuel in tank: max. ISO classes 18/17/14 - With exhaust aftertreatment: Sulfur content max. 15 mg/kg	ASTM D975-11 Grade 2-D S 15, S 500, S 5000
S 60	Approval issued	Approval issued	Approval issued
099	Approval issued	Approval issued	Approval issued
183	Approval issued	Approval issued	Approval issued
396 C&I, Genset, Marine, Rail, Submarine	Approval issued	Approval issued if: - cetane number min. 45 or - cetane index min. 42 - viscosity min. 1.5 mm^2/s	Approval issued if: - cetane number min. 45 or - cetane index min. 42
538 Marine 595 Marine	Approval issued Anti-wear additive required	Approval issued if: - cetane number min. 45 or - cetane index min. 42 - viscosity min. 1.5 mm^2/s Anti-wear additive necessary if sulfur content max. 50 mg/kg	Approval issued if: - cetane number min. 45 or - cetane index min. 42 Anti-wear additive necessary if sulfur content max. 50 mg/kg
956-01 Genset 956-02 Genset 956-03 Genset	Approval issued Anti-wear additive required	Approval issued Anti-wear additive necessary if sulfur content max. 50 mg/kg	Approval issued Anti-wear additive necessary if sulfur content max. 50 mg/kg

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Fuel specifications Restrictions Series	DIN EN 590:2010-05 Summer and winter quality - SOLAS: Flashpoint min. 60 °C - Particle distribution for fuel in tank: max. ISO classes 18/17/14	ASTM D975-11 Grade 1-D S 15, S 500, S 5000 - SOLAS: Flashpoint min. 60 °C - Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - Particle distribution for fuel in tank: max. ISO classes 18/17/14 - With exhaust aftertreatment: Sulfur content max. 15 mg/kg	ASTM D975-11 Grade 2-D S 15, S 500, S 5000
956-01 Marine 956-02 Marine	Approval issued Anti-wear additive required	Approval issued if: - cetane number min. 45 or - cetane index min. 42 - viscosity min. 1.5 mm^2/s Anti-wear additive necessary if sulfur content max. 50 mg/kg	Approval issued if: - cetane number min. 45 or - cetane index min. 42 Anti-wear additive necessary if sulfur content max. 50 mg/kg
956-01 Rail	Approval issued Anti-wear additive required	Approval issued if: - cetane number min. 45 or - cetane index min. 42 - viscosity min. 1.5 mm^2/s Anti-wear additive necessary if sulfur content max. 50 mg/kg	Approval issued if: - cetane number min. 45 or - cetane index min. 42 Anti-wear additive necessary if sulfur content max. 50 mg/kg
1163-03 Genset	Approval issued Anti-wear additive required	Approval issued Anti-wear additive necessary if sulfur content max. 50 mg/kg	Approval issued Anti-wear additive necessary if sulfur content max. 50 mg/kg
1163-02 Marine 1163-03 Marine	Approval issued Anti-wear additive required	Approval issued if: - cetane number min. 45 or - cetane index min. 42 - viscosity min. 1.5 mm^2/s Anti-wear additive necessary if sulfur content max. 50 mg/kg	Approval issued if: - cetane number min. 45 or - cetane index min. 42 - viscosity min. 1.5 mm^2/s Anti-wear additive necessary if sulfur content max. 50 mg/kg

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Fuel specifications Restrictions Series	DIN EN 590:2010-05 Summer and winter quality - SOLAS: Flashpoint min. 60 °C - Particle distribution for fuel in tank: max. ISO classes 18/17/14	ASTM D975-11 Grade 1-D S 15, S 500, S 5000 - SOLAS: Flashpoint min. 60 °C - Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - Particle distribution for fuel in tank: max. ISO classes 18/17/14 - With exhaust aftertreatment: Sulfur content max. 15 mg/kg	ASTM D975-11 Grade 2-D S 15, S 500, S 5000
2000 CR	Approval issued	Approval issued if: - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 15 mg/kg (CR) - sulfur content max. 500 mg/kg (PLD) - viscosity min. 1.5 mm^2/s	Approval issued if: - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 15 mg/kg (CR) - sulfur content max. 500 mg/kg (PLD)
2000 Cx6, Sx6	Approval issued		
2000 PLD	Approval issued		
4000-01	Approval issued	Approval issued if: - cetane number min. 45 or - cetane index min. 42 - viscosity min. 1.5 mm^2/s	Approval issued if: - cetane number min. 45 or - cetane index min. 42
4000-02	Approval issued		
4000-03 C, G, P, R, S	Approval issued		
4000 M23F, M23S	Approval issued		
4000 M33F, M33S	Approval issued		
4000 M53, M53R	Approval issued		
4000 M63, M63L	Approval issued		
4000 M73 - M93L, N43S, N83	Approval issued		
4000 T94, T94L	Approval issued	Approval issued if: - cetane number min. 45 or - cetane index min. 42 - viscosity min. 1.5 mm^2/s - sulfur content max. 15 mg/kg	Approval issued if: - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 15 mg/kg
4000 R64, R74, R84	Approval issued		

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Fuel specifications Restrictions Series	DIN EN 590:2010-05 Summer and winter quality - SOLAS: Flashpoint min. 60 °C - Particle distribution for fuel in tank: max. ISO classes 18/17/14	ASTM D975-11 Grade 1-D S 15, S 500, S 5000 - SOLAS: Flashpoint min. 60 °C - Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - Particle distribution for fuel in tank: max. ISO classes 18/17/14 - With exhaust aftertreatment: Sulfur content max. 15 mg/kg	ASTM D975-11 Grade 2-D S 15, S 500, S 5000
8000	Approval issued	Approval issued if: - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 50 mg/kg - viscosity min. 1.5 mm^2/s	Approval issued if: - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 50 mg/kg
Two-cycle engines			
S53, S71, S92, S149	Approval issued	Approval issued if: - lubricity max. 460 µm	Approval issued if: - lubricity max. 460 µm

Table 18:

British Standard 2869

Fuel specifications Restrictions Series	BS 2869:2010 Part 1 Class A2 - SOLAS: Flashpoint min. 60 °C - Density: max. 860 kg/m^3 - Viscosity: max. 4.5 mm^2/s. If viscosity min. 4.5 mm^2/s: Preheating required - Particle distribution for fuel in tank: max. ISO classes 18/17/14 - With exhaust aftertreatment: Sulfur content: max. 15 mg/kg	BS 2869:2010 Part 2 Class D
S 60	Approval issued	Approval issued
099	Approval issued	Approval issued
183	Approval issued	Approval issued
396 C&I, Genset, Marine, Rail, Submarine	Approval issued	Approval issued
538 Marine	Approval issued	Approval issued if: - sulfur content min. 500 mg/kg
595 Marine	Anti-wear additive necessary	
956-01 Genset	No approval	No approval
956-02 Genset	No approval	No approval

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Fuel specifications	BS 2869:2010 Part 1 Class A2	BS 2869:2010 Part 2 Class D
Restrictions	- SOLAS: Flashpoint min. 60 °C - Density: max. 860 kg/m^3 - Viscosity: max. 4.5 mm^2/s. If viscosity min. 4.5 mm^2/s: Preheating required - Particle distribution for fuel in tank: max. ISO classes 18/17/14 - With exhaust aftertreatment: Sulfur content: max. 15 mg/kg	
Series		
956-03 Genset	No approval	No approval
956-01 Marine 956-02 Marine	Approval issued Anti-wear additive necessary	Approval issued if: - sulfur content min. 500 mg/kg
956-01 Rail	Approval issued Anti-wear additive necessary	Approval issued if: - sulfur content min. 500 mg/kg
1163-03 Genset	No approval	No approval
1163-02 Marine 1163-03 Marine	Approval issued Anti-wear additive necessary	Approval issued if: - sulfur content min. 500 mg/kg
2000 CR 2000 Cx6, Sx6 2000 PLD	No approval	No approval
4000-01 4000-02 4000 C, G, P, R, S 4000 M23F, M23S 4000 M33F, M33S 4000 M53, M53R 4000M63,M63L 4000 M73 - 93L, N43S, N83	Approval issued	Approval issued
4000 T94, T94L 4000 R64, R74, R84	Approval issued if: - sulfur content max. 15 mg/kg	Approval issued if: - sulfur content max. 15 mg/kg
8000	Approval issued	Approval issued if: - sulfur content max. 50 mg/kg
Two-cycle engines		
S53, S71, S92, S149	Approval issued if: - lubricity max. 460 µm	Approval issued if: - lubricity max. 460 µm

Table 19:

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Heating oil

Fuel specifications	DIN 51603-1:2011-09		DIN 52603-1:2011-09
	Heating oil EL standard	Heating oil EL low-sulfur	Heating oil EL alternative
Restrictions	- Solas: Flashpoint min. 60 °C - cetane number min. 45 or - cetane index min. 42 - lubricity max. 520 µm - Particle distribution for fuel in tank: max. ISO classes 18/17/14 - With exhaust aftertreatment: Sulfur content max. 15 mg/kg		
Series			
S60	Approval issued	Approval issued	No approval
099	Approval issued	Approval issued	No approval
183	Approval issued	Approval issued	No approval
396 C&I, Genset, Marine, Rail, Submarine	Approval issued	Approval issued	No approval
538 Marine 595 Marine	Approval issued if: - sulfur content max. 500 mg/kg	Approval issued Anti-wear additive necessary	No approval
956-01 Genset 956-02 Genset 956-03 Genset	No approval	No approval	No approval
956-01 Marine 956-02 Marine	Approval issued if: - sulfur content max. 500 mg/kg	Approval issued Anti-wear additive necessary	No approval
956-01 Rail	Approval issued if: - sulfur content max. 500 mg/kg	Approval issued Anti-wear additive necessary	No approval
1163-03 Genset	No approval	No approval	No approval
1163-02 Marine 1163-03 Marine	Approval issued if: - sulfur content max. 500 mg/kg	Approval issued Anti-wear additive necessary	No approval

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Fuel specifications	DIN 51603-1:2011-09		DIN 52603-1:2011-09
	Heating oil EL standard	Heating oil EL low-sulfur	Heating oil EL alternative
Restrictions	- Solas: Flashpoint min. 60 °C - cetane number min. 45 or - cetane index min. 42 - lubricity max. 520 µm - Particle distribution for fuel in tank: max. ISO classes 18/17/14 - With exhaust aftertreatment: Sulfur content max. 15 mg/kg		
Series			
2000 CR	No approval	Approval issued if: - sulfur content max. 15 mg/kg	No approval
2000 Cx6, Sx6			
2000 PLD			
4000-01	Approval issued	Approval issued	No approval
4000-02	Approval issued	Approval issued	No approval
4000-03 C, G, P, R, S	Approval issued	Approval issued	No approval
4000 M23F, M23S	Approval issued if: - cetane number min. 40	Approval issued if: - cetane number min. 40	No approval
4000 M33F, M33S			
4000 M53, M53R			
4000 M63, M63L			
4000 M73 - 93L, N43S, N83	Approval issued	Approval issued	No approval
4000 T94, T94L	No approval	Approval issued if: - sulfur content max. 15 mg/kg	No approval
4000 R64, R74, R84			
8000	Approval issued	Approval issued	No approval
Two-cycle engines			
S53, S71, S92, S149	No approval	No approval	No approval

Table 20:

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Marine distillate fuels in accordance with ISO 8217:2011-09

Fuel specifications	Marine distillate fuel in accordance with DIN ISO 8217:2011-09			
	DMX	DMA	DMZ	DMB
Restrictions	To comply with SOLAS the flash-point must be min. 60 °C			
	- Proportion of water: 200 mg/kg - Total contamination: Max. 24 mg/kg - Particle distribution for fuel in tank: max. ISO classes 18/17/14 With exhaust aftertreatment: Sulfur content max. 15 mg/kg			
Series				
S60	Approval issued	No approval	No approval	No approval
099	Approval issued	upon request	upon request	No approval
183	Approval issued	upon request	upon request	No approval
396 C&I, Genset, Marine, Rail, Sub-marine	Approval issued if: - sulfur content max. 0.5%	upon request	upon request	No approval
538 Marine	Approval issued if: - sulfur content max. 0.5%	upon request	upon request	No approval
595 Marine	Approval issued if: - sulfur content max. 0.5%	Approval issued if: - density 0.820 to 0.870 g/ml - viscosity 1.5 to 4.5 mm^2/s - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5%		No approval
956-01 Genset	No approval	No approval	No approval	No approval
956-02 Genset	No approval	No approval	No approval	No approval
956-03 Genset	No approval	No approval	No approval	No approval
956-01 Marine	Approval issued if: - sulfur content max. 0.5%	Approval issued if: - density 0.820 to 0.870 g/ml - viscosity 1.5 to 4.5 mm^2/s - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5%		No approval
956-02 Marine				

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Fuel specifications	Marine distillate fuel in accordance with DIN ISO 8217:2011-09			
	DMX	DMA	DMZ	DMB
Restrictions	To comply with SOLAS the flash-point must be min. 60 °C			
	- Proportion of water: 200 mg/kg - Total contamination: Max. 24 mg/kg - Particle distribution for fuel in tank: max. ISO classes 18/17/14 With exhaust aftertreatment: Sulfur content max. 15 mg/kg			
Series				
956-01 Rail	Approval issued if: - sulfur content max. 0.5%	Approval issued if: - density 0.820 to 0.870 g/ml - viscosity 1.5 to 4.5 mm^2/s - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5%		No approval
1163-03 Genset	No approval	No approval	No approval	No approval
1163-02 Marine 1163-03 Marine	Approval issued if: - sulfur content max. 0.5%	Approval issued if: - density 0.820 to 0.870 g/ml - viscosity 1.5 to 4.5 mm^2/s - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5%		No approval
2000 CR 2000 Cx6, Sx6 2000 PLD	No approval	No approval	No approval	No approval
4000-01 4000-02 4000-03 C, G, P, R, S	Approval issued if viscosity min. 4.5 mm^2/s: - preheating required	Approval issued if: - density 0.820 to 0.870 g/ml - cetane number min. 45 or - cetane index min. 42 if viscosity min. 4.5 mm^2/s: - preheating required		No approval
4000 M23F, M23S 4000 M33F, M33S 4000 M53, M53R 4000 M63, M63L	Approval issued if viscosity min. 4.5 mm^2/s: - preheating required	Approval issued if: - NFV filter and water separator are used Except for area of application of EPA Tier 2		No approval

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Fuel specifications	Marine distillate fuel in accordance with DIN ISO 8217:2011-09			
	DMX	DMA	DMZ	DMB
Restrictions	To comply with SOLAS the flash-point must be min. 60 °C			
	- Proportion of water: 200 mg/kg - Total contamination: Max. 24 mg/kg - Particle distribution for fuel in tank: max. ISO classes 18/17/14 With exhaust aftertreatment: Sulfur content max. 15 mg/kg			
Series				
4000 M73 - M93L, N43S, N83	Approval issued if viscosity min. 4.5 mm^2/s: - preheating required	Approval issued if: - density 0.820 to 0.870 g/ml - cetane number min. 45 or - cetane index min. 42 - NFV filter and water separator are used if viscosity min. 4.5 mm^2/s: - preheating required Except for area of application of EPA Tier 2		No approval
4000 T94, T94L	No approval	No approval	No approval	No approval
4000 R64, R74, R84				
8000	Approval issued if viscosity min. 4.5 mm^2/s: - preheating required	Approval issued if: - density 0.820 to 0.870 g/ml - viscosity 1.5 to 4.5 mm^2/s - cetane number min. 45 or - cetane index min. 42 if viscosity min. 4.5 mm^2/s: - preheating required		No approval
Two-cycle engines				
S53, S71, S92, S149	No approval	No approval	No approval	No approval

Table 21:

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Aviation turbine fuel

Fuel specifications Restrictions Series	F-34 / F-35 JP-8	F-44 JP-5	F-63 in accordance with DCSEA 108/A
S60	Generally not approved, approval upon request		
099	Generally not approved, approval upon request		
183	Generally not approved, approval upon request		
396 C&I, Genset, Marine, Rail, Submarine	Generally not approved, approval upon request		
538 Marine	Generally not approved, approval upon request		
595 Marine			
956-01 Genset	Generally not approved		
956-02 Genset			
956-03 Genset			
956-01 Marine	Generally not approved, approval upon request		
956-02 Marine			
956-01 Rail	Generally not approved, approval upon request		
1163-03 Genset	Generally not approved		
1163-02 Marine	Generally not approved, approval upon request		Approval issued
1163-03 Marine			
2000 CR	Generally not approved, approval upon request		
2000 Cx6, Sx6			
2000 PLD			
4000-01	Generally not approved, approval upon request		
4000-02			
4000-03 C, G, P, R, S			
4000 M23F, M23S	Generally not approved, approval upon request		
4000 M33F, M33S			
4000 M53, M53R			
4000 M63, M63L			
4000 M73 - M93L	Generally not approved, approval upon request		
4000 T94, T94L	Generally not approved, approval upon request		
4000 R64, R74, R84			
8000	Generally not approved		
Two-cycle engines			
S53, S71, S92, S149	Generally not approved		

Table 22:

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NATO diesel fuels

Fuel specifications Restrictions Series	NATO Code F-54 in accordance with TL 9140-001 Issue 8 Approval if fuel corresponds to diesel fuel DIN EN 590:2010-05 - Total contamination: Max. 24 mg/kg - Lubricity: max. 520 µm Furthermore: - SOLAS: Flashpoint min. 60 °C - Particle distribution for fuel in tank: max. ISO classes 18/17/14 - With exhaust aftertreatment: Sulfur content max. 15 mg/kg	NATO Code F-54 in accordance with STANAG 7090 Issue 4 Approval if fuel corresponds to diesel fuel DIN EN 590:2010-05 - Density: min. 0.820 g/ml - Total contamination: Max. 24 mg/kg - Lubricity: max. 520 µm Furthermore: - SOLAS: Flashpoint min. 60 °C - Particle distribution for fuel in tank: max. ISO classes 18/17/14 - With exhaust aftertreatment: Sulfur content max. 15 mg/kg
S60	Approval issued	Approval issued
099	Approval issued	Approval issued
183	Approval issued	Approval issued
396 C&I, Genset, Marine, Rail, Submarine	Approval issued	Approval issued
538 Marine	Approval issued	Approval issued
595 Marine	Anti-wear additive necessary if sulfur content max. 50 mg/kg	Anti-wear additive necessary
956-01 Genset	Approval issued	Approval issued
956-02 Genset	Anti-wear additive necessary if sulfur content max. 50 mg/kg	Anti-wear additive necessary
956-03 Genset		
956-01 Marine	Approval issued	Approval issued
956-02 Marine	Anti-wear additive necessary if sulfur content max. 50 mg/kg	Anti-wear additive necessary
956-01 Rail	Approval issued Anti-wear additive necessary if sulfur content max. 50 mg/kg	Approval issued Anti-wear additive necessary
1163-03 Genset	Approval issued Anti-wear additive necessary if sulfur content max. 50 mg/kg	Approval issued Anti-wear additive necessary
1163-02 Marine	Approval issued	Approval issued
1163-03 Marine	Anti-wear additive necessary if sulfur content max. 50 mg/kg	Anti-wear additive necessary
2000 CR	Approval issued if:	Approval issued if:
2000 Cx6, Sx6	- sulfur content max. 15 mg/kg	- sulfur content max. 15 mg/kg
2000 PLD	Approval issued	Approval issued

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Fuel specifications Restrictions Series	NATO Code F-54 in accordance with TL 9140-001 Issue 8 Approval if fuel corresponds to diesel fuel DIN EN 590:2010-05 - Total contamination: Max. 24 mg/kg - Lubricity: max. 520 µm Furthermore: - SOLAS: Flashpoint min. 60 °C - Particle distribution for fuel in tank: max. ISO classes 18/17/14 - With exhaust aftertreatment: Sulfur content max. 15 mg/kg	NATO Code F-54 in accordance with STANAG 7090 Issue 4 Approval if fuel corresponds to diesel fuel DIN EN 590:2010-05 - Density: min. 0.820 g/ml - Total contamination: Max. 24 mg/kg - Lubricity: max. 520 µm Furthermore: - SOLAS: Flashpoint min. 60 °C - Particle distribution for fuel in tank: max. ISO classes 18/17/14 - With exhaust aftertreatment: Sulfur content max. 15 mg/kg
4000-01	Approval issued	Approval issued
4000-02		
4000-03 C, G, P, R, S		
4000 M23F, M23S	Approval issued	Approval issued
4000 M33F, M33S		
4000 M53, M53R		
4000 M63, M63L		
4000 M73 - 93L, N43S, N83	Approval issued	Approval issued
4000 T94, T94L	Approval issued if: - sulfur content max. 15 mg/kg	Approval issued if: - sulfur content max. 15 mg/kg
4000 R64, R74, R84		
8000	Approval issued if: - sulfur content max. 50 mg/kg	Approval issued
Two-cycle engines		
S53, S71, S92, S149	Approval issued if lubricity max. 460 µm	

Table 23:

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Fuel specifications	NATO Code F 75 TL 9140-0003	NATO Code F 75 STANAG 1385
Comments	- Reduced power possible due to min. density of 0.815 g/ml	- Possible power reduction and increase due to density range of 0.815 to 0.880 g/ml - max. sulfur content 1.0 % → Adapt oil and oil change interval
Restrictions	- Particle distribution for fuel in tank: max. ISO classes 18/17/14 - With exhaust aftertreatment: Sulfur content max. 15 mg/kg	- Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - Particle distribution for fuel in tank: max. ISO classes 18/17/14 With exhaust aftertreatment: Sulfur content max. 15 mg/kg
Series		
S60	No approval	No approval
099	Approval issued	upon request
183	Approval issued	upon request
396 C&I, Genset, Marine, Rail, Submarine	Approval issued	upon request
538 Marine	Approval issued	upon request
595 Marine	Approval issued	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5 % and min. 0.05 %
956-01 Genset	No approval	No approval
956-02 Genset		
956-03 Genset		
956-01 Marine	Approval issued	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5 % and min. 0.05 %
956-02 Marine		
956-01 Rail	Approval issued	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5 % and min. 0.05 %

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Fuel specifications	NATO Code F 75 TL 9140-0003	NATO Code F 75 STANAG 1385
Comments	- Reduced power possible due to min. density of 0.815 g/ml	- Possible power reduction and increase due to density range of 0.815 to 0.880 g/ml - max. sulfur content 1.0 % → Adapt oil and oil change interval
Restrictions	- Particle distribution for fuel in tank: max. ISO classes 18/17/14 - With exhaust aftertreatment: Sulfur content max. 15 mg/kg	- Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - Particle distribution for fuel in tank: max. ISO classes 18/17/14 With exhaust aftertreatment: Sulfur content max. 15 mg/kg
Series		
1163-03 Genset	No approval	No approval
1163-02 Marine	Approval issued	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5 % and min. 0.05 %
1163-03 Marine		
2000 CR	No approval	No approval
2000 Cx6, Sx6		
2000 PLD		
4000-01	Approval issued	Approval issued if: - cetane number min. 45 or - cetane index min. 42
4000-02		
4000-03 C, G, P, R, S		
4000 M23F, M23S	Approval issued	Approval issued
4000 M33F, M33S		
4000 M53, M53R		
4000 M63, M63L		
4000 M73 - 93L, N43S, N83	Approval issued	Approval issued if: - cetane number min. 45 or - cetane index min. 42
4000 T94, T94L	No approval	No approval
4000 R64, R74, R84		

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Fuel specifications	NATO Code F 75 TL 9140-0003	NATO Code F 75 STANAG 1385
Comments	- Reduced power possible due to min. density of 0.815 g/ml	- Possible power reduction and increase due to density range of 0.815 to 0.880 g/ml - max. sulfur content 1.0 % → Adapt oil and oil change interval
Restrictions	- Particle distribution for fuel in tank: max. ISO classes 18/17/14 - With exhaust aftertreatment: Sulfur content max. 15 mg/kg	- Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - Particle distribution for fuel in tank: max. ISO classes 18/17/14 With exhaust aftertreatment: Sulfur content max. 15 mg/kg
Series		
8000	Approval issued if: - sulfur content max. 50 mg/kg	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 50 mg/kg
Two-cycle engines		
S53, S71, S92, S149	No approval	No approval

Fuel specifications	NATO Code F 76 STANAG 1385 Edition 5	NATO Code F 76 DEF-STAN 91-4 Issue 8	NATO Code F 76 MIL-DTL-16884L
Restrictions	- Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - Particle distribution for fuel in tank: max. ISO classes 18/17/14 - With exhaust aftertreatment: Sulfur content max. 15 mg/kg		
Series			
S60	Approval issued	Approval issued if: - density 0.820 to 0.860 g/ml	Approval issued
099	Approval issued	Approval issued if: - density 0.820 to 0.860 g/ml	Approval issued
183	Approval issued	Approval issued if: - density 0.820 to 0.860 g/ml	Approval issued

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Fuel specifications	NATO Code F 76 STANAG 1385 Edition 5	NATO Code F 76 DEF-STAN 91-4 Issue 8	NATO Code F 76 MIL-DTL-16884L
Restrictions	- Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - Particle distribution for fuel in tank: max. ISO classes 18/17/14 - With exhaust aftertreatment: Sulfur content max. 15 mg/kg		
Series			
396 C&I, Genset, Marine, Rail, Submarine	upon request	Approval issued if: - density 0.820 to 0.860 g/ml	upon request
538 Marine	upon request	Approval issued	upon request
595 Marine	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5 %	Approval issued if: - density 0.820 to 0.860 g/ml	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42
956-01 Genset	No approval	No approval	No approval
956-02 Genset			
956-03 Genset			
956-01 Marine	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5 %	Approval issued if: - density 0.820 to 0.860 g/ml	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42
956-02 Marine			
956-01 Rail	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5 %	Approval issued if: - density 0.820 to 0.860 g/ml	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42
1163-03 Genset	No approval	No approval	No approval

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Fuel specifications	NATO Code F 76 STANAG 1385 Edition 5	NATO Code F 76 DEF-STAN 91-4 Issue 8	NATO Code F 76 MIL-DTL-16884L
Restrictions	- Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - Particle distribution for fuel in tank: max. ISO classes 18/17/14 - With exhaust aftertreatment: Sulfur content max. 15 mg/kg		
Series			
1163-02 Marine 1163-03 Marine	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42 - sulfur content max. 0.5 %	Approval issued if: - density 0.820 to 0.860 g/ml	Approval issued if: - density 0.820 to 0.860 g/ml - cetane number min. 45 or - cetane index min. 42
2000 CR 2000 Cx6, Sx6 2000 PLD	No approval	No approval	No approval
4000-01 4000-02 4000-03 C, G, P, R, S	Approval issued if: - cetane number min. 45 or - cetane index min. 42	Approval issued	Approval issued if: - cetane number min. 45 or - cetane index min. 42
4000 M23F, M23S 4000 M33F, M33S 4000 M53, M53R 4000 M63, M63L	Approval issued	Approval issued	Approval issued
4000 M73 - M93L, N43S, N83	Approval issued if: - cetane number min. 45 or - cetane index min. 42	Approval issued	Approval issued if: - cetane number min. 45 or - cetane index min. 42
4000 T94, T94L 4000 R64, R74, R84	No approval	No approval	No approval

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Fuel specifications	NATO Code F 76 STANAG 1385 Edition 5	NATO Code F 76 DEF-STAN 91-4 Issue 8	NATO Code F 76 MIL-DTL-16884L
Restrictions	- Proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - Particle distribution for fuel in tank: max. ISO classes 18/17/14 - With exhaust aftertreatment: Sulfur content max. 15 mg/kg		
Series			
8000	Approval issued if: - cetane number min. 45 or - cetane index min. 42 - density 0.820 to 0.870 g/ml - sulfur content max. 50 mg/kg	Approval issued if: - cetane number min. 45 or - cetane index min. 42 - density 0.820 to 0.870 g/ml - sulfur content max. 50 mg/kg	Approval issued if: - cetane number min. 45 or - cetane index min. 42 - density 0.820 to 0.870 g/ml - sulfur content max. 50 mg/kg
Two-cycle engines			
S53, S71, S92, S149	No approval	No approval	No approval

Table 24:

– Other qualities on request

Diesel fuels for engines with exhaust aftertreatment

Engines with exhaust aftertreatment place special demands on the fuels used to guarantee the operational reliability and service life of the exhaust system and the engine.

Depending on the technology used for exhaust aftertreatment, the following fuels can be used.

	Technical approval for					
Exhaust gas technology	DIN EN 590:2010-05	ASTM D975-11 Grade 1-D	ASTM D975-11 Grade 2-D	DMX in accordance with DIN ISO 8217:2011-09	DMA in accordance with DIN ISO 8217:2011-09	Heating oil in accordance with DIN 51603-1:2011-09 EL low-sulfur
Restrictions:						
Oxidation catalyst DOC (without particulate filter)		S15	S15	No approval	No approval	No approval
Particle oxidation catalyst (POC)	Ash <10 mg/kg	S15 Ash <10 mg/kg	S15 Ash <10 mg/kg	No approval	No approval	No approval

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	Technical approval for					
SCR system with vanadium catalysts (no particulate filter)		S15 S<500 mg/kg with individual case approval	S15 S<500 mg/kg with individual case approval	Individual case approval		
SCR system with zeolith catalysts (no particulate filter)		S15	S15	No approval	No approval	No approval
Diesel particulate filter (DPF)	Ash <10 mg/kg	S15 Ash <10 mg/kg	S15 Ash <10 mg/kg	Individual case approval		No approval
Combination system SCR + particulate filter	Ash <10 mg/kg	S15 Ash <10 mg/kg	S15 Ash <10 mg/kg	Individual case approval		No approval

Table 25:

Any possible restrictions related to engine requirements must also be observed.

	Diesel fuel with a proportion of biodiesel (FAME, fatty acid methyl ester) of max. 7% in accordance with DIN EN 590:2010-05 may be used. The use of fuels with an increased proportion of biodiesel is not permitted for plants with exhaust aftertreatment because trace elements they may contain can act as catalyst poisons and lead to filter obstructions.

	For engines with exhaust aftertreatment certified for EPA Tier 4i or Tier 4 and EU IIIb, fuel in accordance with DIN EN 590:2010-05 and ASTM D 975-11 Grade1-D S15 and Grade 2-D S15 are permitted.

	Commercially available diesel fuel according to DIN EN 590:2010-05 normally contains significantly less ash-creating components than permitted by the relevant standards (typical ash content max. 0.001 %). The particulate filters are designed for these low loads accordingly because the exhaust system would otherwise be completely overdimensioned. The maximum ash content in fuel specified by MTU has been defined to ensure that the particulate filter reaches the assured service life without the back pressure of the filter becoming too high for the engine.

	The use of fuel additives for minimizing wear is not permitted on plants with exhaust aftertreatment!

Use of fuel additives for lowering soot regeneration temperature on plants with soot filter

Fuel additives for lowering the soot regeneration temperature (FBC, fuel borne catalyst) are generally not approved. The exhaust aftertreatment system from MTU are designed such that soot regeneration takes place without additives.

Biodiesel

The standardized general term “FAME” (fatty acid methyl ester) is used here to designate biodiesel fuels.

The following engines are approved/not approved for operation with 100% FAME in compliance with DIN EN 14214:2010-04.

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Approved/non-approved engines for operation with 100% FAME

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

Table 26:

Diesel fuel with a FAME content of max. 7% in compliance with DIN EN 590 2010-05 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 14214:2010-04. 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, 900 and 500 engines, special equipment is available which facilitates an increase in the engine oil change intervals for operation with 100% FAME (→ Table 27). This involves fitting the engines with special equipment Code MK21 (special unit pump) and Code MK04 (fuel prefilter with heated water separator).

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Effects on the engine oil change interval with operation with 100% FAME

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 standard 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 standard interval required for operation with fossil diesel fuels.

Table 27:

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 FAME-free 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.

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A sulfur content of max. 50 mg/kg or 10 mg/kg (depending on category) has been a European Union requirement since 01 Jan 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 362, 538, 652, 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. The approved supplementary additives (→ Table 28) must be mixed with the fuel in the predefined concentration. The additive must be filled before every refueling.

Approved anti-wear additives

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 -350 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 -350 mg per 1 kg

Table 28:

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.

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6.2 Heating oil EL

Heating oil differs from diesel fuel mainly because of the following non-specified characteristics:

– Cetane number

– Sulfur content

– Oxidation stability

– Corrosion effect on copper

– Lubricity

– Low temperature behavior

If the heating requirements comply with the specifications of the diesel fuel DIN EN 590:2010-05 (summer and winter quality), there are no technical reasons why it can not be used in the diesel engine

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6.3 Fuel additives / microorganisms in fuel

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 (→ Page 32) 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

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 / 100 l
Schülke und Mayr 22840 Norderstedt Tel. +49 (0) 40/52100-00 Fax. +49 (0) 40/52100-244	grotamar 71 grotamar 82 StabiCor 71	0.5 l / ton 1.0 l / 1000 l 0.5 l / ton
Rohm und Haas In der Kron 4 60489 Frankfurt Tel. +49 (0) 69/78996–0 Fax. +49 (0) 69/7895356	Kathon FP 1.5	100-200 mg/kg
Maintenance Technologies Simon's Town 7995 Cape Town – South Africa Tel. +27 21 9877377 Fax. +27 21 9794611 E-mail: maintech@telkomsa.net	Dieselcure Fuel Decontainment	1 : 4000 (250mg/kg)

Table 29:

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6.4 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 ingredients are specified in (→ Table 30) and (→ Table 31). Examples of typical natural gas compositions are shown in (→ Table 32) and (→ Table 33). The typical properties of fuel gases with a biogenic origin are shown in (→ Table 34). 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 common 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 (→ Table 35).

Main ingredients of natural gases

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

Table 30:

Main ingredients of fuel gases of biogenic origin, mainly from fermentation processes

Name	Components	Unit	Value range
Fuel gases of biogenic origin	CO	% by vol.	unnamed
	CO_2	% by vol.	15 - 50
	CH_4	% by vol.	40 - 85
	C_2H_6	% by vol.	unnamed
	C_3H_8	% by vol.	unnamed
	C_4H_{10}	% by vol.	unnamed
	N_2	% by vol.	remainder
	O_2	% by vol.	remainder

Table 31:

TIM-ID: 0000018625 - 001

Examples for natural gases

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

		Russia	North Sea I	North Sea II	Network gas
CO	% by vol.	0.0000	0.0000	0.0000	0.0000
CO_2	% by vol.	0.1000	0.0000	0.3000	1.4000
CH_4	% by vol.	98.3000	88.6000	83.0000	88.6000
C_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

Table 32:

Typical natural gas compositions, natural gas L (according to DVGW worksheet G260)

		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

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		Holland I	Holland II	Osthannover (East Hanover)
C_2H_6	% by vol.	2.8000	3.7000	1.1000
C_3H_6	% by vol.	0.0000	0.0000	0.0000
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

Table 33:

Typical characteristics of fuel gases of biogenic origin from fermentation processes (according to DVGW worksheet G262)

		Biogas plants	Reference bio-gas plant in Northern Ger-many	Sewage gas plant	Landfill gas plant
CO	% by vol.	0	0	0	0
CO_2	% by vol.	15 - 50 (50*)	45*	20 - 35 (35*)	20 - 40 (40*)
CH_4	% by vol.	50 - 85 (50*)	52*	65 - 70 (65*)	65 - 70 (40*)
C_2H_4	% by vol.	0	0	0	0
C_2H_6	% by vol.	0	0	0	0
C_3H_6	% by vol.	0	0	0	0
C_3H_8	% by vol.	0	0	0	0
C_4H_6	% by vol.	0	0	0	0
C_4H_8	% by vol.	0	0	0	0

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		Biogas plants	Reference biogas plant in Northern Germany	Sewage gas plant	Landfill gas plant
C_4H_{10}	% by vol.	0	0	0	0
C_5H_{12}	% by vol.	0	0	0	0
C_XH_Y	% by vol.	0	0	0	0
N_2	% by vol.	5 - 10 (0*)	2.4*	5 - 10 (0*)	10 - 20 (20*)
O_2	% by vol.	0 - 2.5 (0*)	0.6*	0 - 0.6 (0*)	0 - 2.7 (0*)
H_2	% by vol.	0	0	0	0
H_2O	% by vol.	**	*	*	*
H_2S	% by vol.	≤0.66 (0*)	≤0.005*	≤0.66 (0*)	≤0.66 (0*)
SO_2	% by vol.	0	0	0	0
AR	% by vol.	0	0	0	0
Σ	% by vol.	100.000	100.000	100.000	100.000
The values marked with an asterisk * are used for calculating the following gas properties.					
Ho	kWh/m^3_N	5.53	5.75	7.19	4.42
Hu	kWh/m^3_N	4.98	5.18	6.48	3.99
Density	kg/m^3_N	1.347	1.301	1.158	1.323
rel. density	– –	1.042	1.006	0.896	1.027
Ws,n	kWh/m^3_N	5.42	5.73	7.6	4.37
Methane number	Methane no. (±2)	>140	146	133.8	>150

Table 34:

** = steam saturation corresponding to gas temperature

Requirements for fuel gas

Requirements and site conditions for natural gas fuel and the corresponding fuel supply

Designation	Unit	Limit value	Note
Type of gas		Natural gas	Applies to natural gas H and L, other gases are currently not approved
Methane number	--	≥70	Depending on the model type, power and fuel consumption adaptations may be necessary. Operating Instructions (Techn. data) must be observed Consultation with manufacturer and gas analysis required in case of lower values.
Calorific power Hu	kWh/m^3_N	8.0< Hu <11.0	Consultation with manufacturer required in case of lower and higher values.

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Designation	Unit	Limit value	Note
Calorific value deviation from the setting value	%	± 5	Consultation with manufacturer required for higher values
Permissible change speed of calorific value	kWh/m^3_N/h	0.5	Linear constant change required
Density of gas	kg/m^3_N	0.73-0.84	The density of the gas can fluctuate in accordance with the composition; it is constant for a certain type of gas. When using gas from different gas supply areas, the density may vary. When changing the gas supplier, a gas analysis is necessary; an adaptation of the mixture control may be necessary.
Setting value for gas pressure, gas 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

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Designation	Unit	Limit value	Note
Inorganically fixed silicon	mg/m³$_N$$CH_4$	< 5	With Si >5 mg/m³$_N$ based on 100% CH_4 gaseous fuel content, wear products must be taken into consideration during the oil analysis.
Dust 3- 10 µm	mg/m³$_N$	5	DVGW worksheet G260
Dust<3µm	mg/m³$_N$	Analysis	
Total sulfur	mg/m³$_N$	30	DVGW worksheet G260
Mercaptan sulfur	mg/m³$_N$	6	DVGW worksheet G260
Hydrogen sulfide H_2S	mg/m³$_N$	5	DVGW worksheet G260
Chlorine	mg/m³$_N$	10*	With higher values, consultation with manufacturer and analysis are necessary
Fluorine	mg/m³$_N$	5*	With higher values, consultation with manufacturer and analysis are necessary
Chlorine + fluorine	mg/m³$_N$	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

Table 35:

* = 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 32) is used. The permissible value for total sulfur in the gas thus corresponds exactly to the limit value specified in (→ Table 35).

When using gas from Osthannover, for example, with Hu = 8.15 kWh/m$^3{}_N$(→ Table 33), the permissible max. value of total sulfur is calculated thus:

permissible total sulfur content = 30 mg/m³$_N$ * (8.15 kWh/m$^3{}_N$: 10.0 kWh/m$^3{}_N$) = 24.5 mg/m³$_N$

	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.

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Requirements and site conditions for fuel from biogenic gases from fermentation processes and the corresponding fuel supply

Designation	Unit	Limit value	Note
Type of gas		Biogenic gases from fermentation processes	
Methane number	--	≥115	Below this limit there is a danger of combustion knock; gas analysis and consultation with manufacturer are required
Calorific power Hu	kWh/m^3_N	4.0< Hu < 8.0	Consultation with manufacturer required in case of lower and higher values.
Calorific value deviation from the setting value	%	±20	Consultation with manufacturer required for higher values
Permissible change speed of calorific value	$kWh/m^3_N/h$	1.0	Linear constant change with operating variables that are otherwise constant, e.g. gas pressure, gas temperature, engine load
Maximum change speed of calorific value in relation to setting value	%/min.	10.0	Fast change of calorific value, e.g. during starts and start-up procedures with a frequency of/h
Density of gas	kg/m^3_N	0.93 - 1.40	The gas density can fluctuate according to the composition. If there are changes to the main substrate and/or significant changes in the mixing ratio of the substrates, a gas analysis or, if necessary, an adaptation of the mixture control is necessary.
Setting value for gas pressure according to gas train	mbar	30 - 250	Project-specific features must be noted when designing the gas train. This applies to the gas inlet at the gas control valve on the engine side
Gas pressure fluctuation in relation to setting value	%	±10	This applies to the gas inlet at the gas control valve on the engine side
Permissible change speed of calorific value	mbar/min.	1	This applies to the gas inlet at the gas control valve on the engine side
Gas temperature	°C	0<t<50	Phase transitions in the fuel gas-air-mixture during engine operation are not permitted; thermal aging of NBR materials (gaskets, diaphragms) and influencing of the elasticity at higher temperatures. This applies to the gas inlet at the gas control valve on the engine side
Gas temperature fluctuation in relation to setting value	°C	±15	This applies to the gas inlet at the gas control valve on the engine side

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Designation	Unit	Limit value	Note
Permissible change speed of gas temperature	K/min.	0.3	This applies to the gas inlet at the gas control valve on the engine side
Rel. humidity in gas at 35 °C and 1.013 bar	%	< 80	No phase transitions permitted in the fuel gas-air-mixture during engine operation in the pressure and temperature range; at 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	
Organically fixed silicon (e.g. hydrosilicons, siloxanes, silicons)	mg/m^3_N	< 4*	
Inorganically fixed silicon	mg/m^3_N	< 2*	With Si >5 mg/m^3_Nbased 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	2*	
Dust<3µm	mg/m^3_N	Analysis	
Total sulfur	mg/m^3_N	800*	
Mercaptan sulfur	mg/m^3_N	4*	
Hydrogen sulfide H_2S	mg/m^3_N	850*	
Total of all chlorine and fluorine compounds	mg/m^3_N	≤ 40*	
Chlorine	mg/m^3_N	≤ 40*	With higher values, consultation with manufacturer and analysis are necessary
Fluorine		≤ 20*	With higher values, consultation with manufacturer and analysis are necessary
NH_3	ppm	70*	With higher values, consultation with manufacturer and analysis are necessary

Table 36:

* = these values are non-binding guidelines for Series 4000 L62FB engines. When using Series 4000 L62FB in gensets with and without exhaust gas heat cogeneration and/or exhaust aftertreatment systems, the respective specifications of the genset manufacturer must be observed.

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7 NOx Reducing Agent AUS 32 for SCR Exhaust After-Treatment Systems

7.1 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 (→ Table 37) shows the quality characteristics of the reducing agent together with the associated test methods (extract from ISO 222 41-1).

	SCR systems from MTU are usually designed for a concentration of 32.5% urea. The use of NOx reducing agent with other urea concentrations (AUS 40, AUS 48) requires a different design of the dosing systems. Systems with the corresponding design must be run with the appropriately adapted concentration. The purity requirements of the reducing agent then comply with the standards for AUS 32

	The use of antifreeze additives for AUS 32, or winter urea, is generally not approved.

Quality features and test procedures for the reducing agent

	Unit	Test method ISO	Limit values
Urea content	by weight %	22241–2 Annex B	31.8 - 33.2
Spec. grav. at 20 °C	kg/m³	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

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

Table 37:

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.

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8 Approved engine oils and lubricating greases

8.1 Engine oils for four-cycle engines

8.1.1 Series-based usability of engine oils in MTU oil category 1

Series	Oil category 1	Oil category 1	Comments
	Single-grade oils SAE30/40	Multigrade oils	
S60	no	no	
099	yes	yes	
183	yes	yes	
396	yes	yes	
538	yes	yes	
595	yes[1)]	yes[1)]	[1)] = not for fast commercial vessels
956	no	no	
956 TB31/32/33	no	no	
1163	yes[2)]	yes[2)]	[2)] = not for fast commercial vessels
1163-03	no	no	
2000 CR	yes	yes	
2000 M84/M94	no	no	
2000 M72	yes	yes	
2000 Cx6/Sx6	no	no	
2000 PLD	yes	yes	
4000-01	yes	yes	
4000-02	yes	yes	
4000-03 G/S/P/C/R	yes	yes	
4000 M23F - M63L	yes	yes	
4000-03 M73-M93L / N43/N83	no	no	
4000 T94/T94L	no	no	
4000 R64/R74/R84	no	no	
8000	no	no	

yes = approval issued

no = no approval

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8.1.2 Single-grade oils – Category 1, SAE-grades 30 and 40 for diesel engines

For details and special features, see chapter “Lubricants for four-cycle engines”(→ Page 7)

MTU/MTU-DD single-grade engine oils

Manufacturer	Brand name	SAE Viscosity grade	TBN			Comments
			8–10mgKOH/g	10–12 mgKOH/g	>12 mgKOH/g	
MTU Asia	Fascination of Power Maxi Light	40	X			

Table 38:

Other single-grade engine oils

Manufacturer	Brand name	SAE Viscosity grade	TBN			Comments
			8–10mgKOH/g	10–12 mgKOH/g	>12 mgKOH/g	
Addinol Lube Oil	Addinol Marine MS4011	40	X			
	Addinol Turbo Diesel MD305	30		X		
	Addinol Turbo Diesel MD405	40		X		
Aegean Oil SA	Vigor Super D	40	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
Cyclon Hellas	Cyclon D Prime	30, 40	X			
ENI S.p.A	Agip Cladium 120	30, 40				Not for Series 2000, 4000
Gulf Oil International	Gulf Superfleet	40	X			
Hindustan Petr. Comp. India	Hylube MTU	40	X			
Igol, France	Trans Turbo Mono	40		X		
Kuwait Petroleum	Q8 T 520	30, 40	X			
Misr Petroleum Company	Misr Super DEO CG-4	40	X			
Motor Oil (Hellas)	EMO Turbo Champion Plus	30, 40	X			
OMV AG	OMV truck	30, 40	X			
Pertamina, Indonesia	Meditran SMX	40	X			
Petrobras Distribuidora S.A.	Marbrax CCD-310	30		X		
	Marbrax CCD-410	40		X		
PTT Public Comp.	PTT Navita MTU Type 1	40	X			

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Manufacturer	Brand name	SAE Viscosity grade	TBN			Comments
			8–10mgKOH/g	10–12 mgKOH/g	>12 mgKOH/g	
Repsol YPF	Repsol Serie 3	30, 40		X		
	Repsol Marino 3	30		X		
	Repsol Marino 3 SAE 40	40			X	
Sakson	Parnas Hercules 1	40	X			
SRS Schmierstoff Vertrieb GmbH	SRS Rekord	30, 40		X		
Shell	Shell Gadinia	30, 40		X		
	Shell Rimula R3	30, 40	X			
	Shell Rimula 3+	30, 40	X			
	Shell Sirius Monograde	30, 40	X			
SK Lubricants	SD 5000	40	X			
Total	Elf Performance Super D	30, 40		X		
	Fina Delta Super	30, 40		X		
	Total Rubia S	30, 40		X		
United Oil	XD 7000 Extra Duty-3U	30	X			
	XD 7000 Extra Duty-4U	40	X			

Table 39:

TIM-ID: 0000018628 - 001

8.1.3 Multigrade oils – Category 1, SAE-grades 10W-40 and 15W-40 for diesel engines

For details and special features, see chapter “Lubricants for four-cycle engines”(→ Page 7)

	[1] = These multigrade oils can only be used if crankcase ventilation is routed to atmosphere.
	[2] = Engine oils marked [2] are also permitted for the "Series 60"

Manufacturer	Brand name	SAE Viscosity grade	TBN 8–10mgKOH/g	TBN 10–12 mgKOH/g	TBN >12 mgKOH/g	Comments
Addinol Lube Oil	Addinol Super Star MX 1547	15W-40		X		
Avia	Avia HDC Extra UTM	15W-40		X		
Claas	Claas Agrimot SDM	15W-40	X			
ENI S.p.A	Agip Superdiesel Multigrade	15W-40	X			[2]
Exxon Mobil Corporation	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
	Mobil Delvac Super 1400A	15W-40	X			[1] and oil change interval 500 operating hours
	Essolube XT 5	15W-40	X			[1] and oil change interval 500 operating hours
Gulf Oil International	Gulf Superfleet	15W-40	X			
Igol, France	Trans Turbo 4X	15W-40	X			
Kuwait Petroleum	Q8 T 520	15W-40	X			
OMV AG	OMV Truck M plus	15W-40	X			
OOO “LLK-International”	Avantgarde Extra	15W-40	X			
	Lukoil-Avantgarde	15W-40	X			
	Teboil Power Plus	15W-40	X			
OPET Petrolcülük	Omega Turbo Power SHPD	15W-40		X		[1] and oil change interval 500 operating hours
Petróleos de Portugal, Petrogal S.A.	Galp Galaxia Super 15W-40	15W-40	X			
Singapore Petroleum Comp.	SPC SDM 801	15W-40	X			
SRS Schmierstoff Vertrieb GmbH	SRS Primalub	15W-40	X			
Sinopec	Great wall century supremacy	15W-40		X		[2]
SK Lubricants	SD 5000 Gold	15W-40	X			[2]

TIM-ID: 0000018950 - 001

Manufacturer	Brand name	SAE Viscosity grade	TBN			Comments
			8–10mgKOH/g	10–12 mgKOH/g	>12 mgKOH/g	
Total	Elf Performance Super D	15W-40	X			
	Fina Kappa Turbo DI	15W-40	X			
	Total Caprano TD	15W-40	X			
	Total Rubia 4400	15W-40	X			
	Total Rubia XT	15W-40	X			
TNK Lubricants LLC	TNK Revolux D1	15W-40		X		
	TNK Revolux D2	15W-40		X		
Unil Opal	Intercooler 400	15W-40	X			
United Oil	XD 9000 Ultra Diesel-U	15W-40	X			

Table 40:

TIM-ID: 0000018950 - 001

8.1.4 Series-based usability of engine oils in MTU oil category 2 and 2.1 (low SAPS)

Series	Oil category 2	Oil category 2	Oil category 2.1 (low SAPS)	Comments
	Single-grade oils	Multigrade oils	Multigrade oils	
S60	no	restricted[1)]	restricted[2)]	[1)] = only 15W-40 and min. API CH-4 [2)] = only 15W-40 and API CJ-4
099	yes	yes	yes	
183	yes	yes	yes	
396	yes	yes	yes	
538	yes	yes	yes	
595	yes	yes	yes	
956	yes	yes	yes	
956 TB31/32/33	Sirius X 30	Fascination of Power 15W-40 Shell Rimula R3X 15W-40	no	
1163	yes	yes	yes	
1163-03	Sirius X 30	Fascination of Power 15W-40	no	
2000 CR	yes	yes	yes	
2000 M84/M94	yes	yes	yes	
2000 M72	yes[3)]	yes	yes	[3)] = except Mobil Delvac 1630/1640
2000 Cx6/Sx6	yes	yes	yes	
2000 PLD	yes	yes	yes	
4000-01	yes	yes	yes	
4000-02	yes	yes	yes	
4000-03 G/S/P/C/R	yes	yes	yes	
4000 M23F - M63L	yes	yes	yes	
4000 M73-M93L / N43/N83	yes	yes	yes	
4000 T94/T94L	no	no	no	
4000 R64/74/84	no	no	no	
8000	restricted [4)]	no	no	[4)]= only named engine oils Reapproval only after engine test in Series 8000

yes = approval issued

no = no approval

TIM-ID: 0000034394 - 001

8.1.5 Single-grade oils – Category 2, SAE-grades 30 and 40 for diesel engines

For details and special features, see chapter “Lubricants for four-cycle engines”(→ Page 7)

Tognum/MTU - single-grade engine oils

	Brand name	SAE Viscosity grade	TBN 8–10mgKOH/g	TBN 10–12 mgKOH/g	TBN >12 mgKOH/g	Comments
Tognum America Inc.	Power Guard DEO SAE 40	40		X		20 l container (Order No. X00062816) 210 l container (Order No. X00062817)
Tognum Asia Pte Ltd.	Fascination of Power	40		X		18 l barrel (order no. 93636/P) 200 l container (order no. 94545/D) available through MTU Asia
MTU Detroit Diesel Australia	MTU Premium SAE 30	30	X			
	MTU Premium SAE 40	40	X			

Table 41:

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).

Table 42:

Other single-grade engine oils

Manufacturer	Brand name	SAE Viscosity grade	TBN 8–10mgKOH/g	TBN 10–12 mgKOH/g	TBN >12 mgKOH/g	Comments
Addinol	Addinol Turbo Diesel MD 407	40	X			
Belgin Madeni Yaglar	Lubex Marine M	30			X	
	Lubex Marine M	40			X	
Castrol Ltd.	Castrol HLX	30, 40		X		Approved for fast commercial vessels up to 1500h Approved for Series 8000 (→ Table 42)

TIM-ID: 0000018996 - 001

Manufacturer	Brand name	SAE Viscosity grade	TBN			Comments
			8–10mgKOH/g	10–12 mgKOH/g	>12 mgKOH/g	
Cepsa Lubricants	Ertoil Koral HDL	30, 40			X	
Chevron	Texaco Ursa Super TD	30, 40		X		
	Texaco Ursa Premium TDX	40		X		
	Caltex Delo Gold [ISOSYN]	30, 40	X			
	Chevron Delo 400	30, 40	X			Approved for Series 8000 (→ Table 42)
Chevron – Lyteca –	Texaco Ursa Premium TDX	40		X		
Cyclon Hellas	Cyclon D Super	40		X		
Delek	Delkol Super Diesel	40		X		
	Delkol Super Diesel MT Mono	40	X			
ENI S.p.A.	Agip Sigma GDF	40		X		
Exxon Mobil Corporation	Mobil Delvac 1630	30		X		Approved for Series 8000 (→ Table 42)
	Mobil Delvac 1640	40		X		Approved for Series 8000 (→ Table 42)
Fuchs Europe Schmierstoffe GmbH	Titan Universal HD	30, 40	X			
	Titan Universal HD 30 MTU	30	X			Increased corrosion protection
Gulf Oil International	Gulf Superfleet Plus	40	X			
Hyrax Oil	Hyrax top deo	40	X			
Klora Gres Ve Yağ Madeni A. Ş	Klora SAE 40	40	X			
Koçak Petrol Ürünleri San	Speedol Ultra HDX 30 TBN 12	30			X	
	Speedol Ultra HDX 40 TBN 12	40			X	
Koçak Petrol Ürünleri	Speedol Ultra HDX		X			
Kuwait Petroleum	Q8 T 750	30, 40	X			
Motor Oil, Hellas	EMO SHPD Plus					
OMV Petrol Ofisi A.S.	PO Turbosarj Extra	30, 40	X			
	PO Turbosarj Extra 30 A	30			X	
	PO Turbosarj Extra 40 A	40			X	
	PO Turbosarj Extra 30 L	30			X	
	PO Turbosarj Extra 40 L	40			X	
OOO Lukoil International	Lukoil Avantgarde M 40	40	X			
Panolin AG	Panolin Extra Diesel					
Paz Lubricants & Chemicals	Pazl Marine S 40					
Petrobras Distribuidora S.A.	Marbrax CCD-310-AP					
	Marbrax CCD-410-AP					

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Manufacturer	Brand name	SAE Viscosity grade	TBN			Comments
			8–10mgKOH/g	10–12 mgKOH/g	>12 mgKOH/g	
Petroleos de Potugal, Petrogal S.A.	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 (→ Table 42)
	Shell Sirius X	40			X	Approved for Series 8000 (→ Table 42)
Singapore Petroleum Comp.	SPC SDM 40	40	X			
	SDM 900	30, 40	X			
Sonol, Israel	Sonol 2340	40		X		
Sonol	Seamaster 40	40	X			
SRS Schmierstoff Vertriebs GmbH	SRS Rekord plus 30	30		X		
	SRS Rekord plus 40	40		X		
	SRS Antikorrol M plus	30		X		Increased corrosion protection
Starpet Madeni Yaglar	Triton STX 3016	30			X	
	Triton STX 4016	40			X	
Statoil Lubricants	PowerWay 30	30				
	PowerWay 40	40				
Total	Total Disola MT 30	30	X			
	Total Disola MT 40	40	X			
ZAO Zavod imeni Shaumyana	M-14D2CE	40			X	

Table 43:

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8.1.6 Multigrade oils - Category 2 of SAE grades 10W-40, 15W-40 and 20W-40 for diesel engines

For details and special features, see chapter “Lubricants for four-cycle engines”(→ Page 7)

	[2] Engine oils marked [2] are also approved for “Series 60“

Tognum/MTU - multigrade engine oils

Manufacturer	Brand name	SAE Viscosity grade	TBN 8–10mgKOH/g	TBN 10–12 mgKOH/g	TBN >12 mgKOH/g	Comments
Tognum America Inc.	Power Guard DEO SAE 15W-40	15W-40		X		20 l container (Order No. X00062818)[2] 210 l container (Order No. X00062819)[2]
Tognum Asia Pte Ltd.	Fascination of Power	15W-40	X			18 l container (Order No. 91818/P)[2] 200 l container (Order No. 92727/D)[2] available through MTU Asia
	Fascination of Power Maxi Shield	15W-40	X			[2]
MTU Detroit Diesel Australia	MTU Premium 15W-40	15W-40		X		[2]

Table 44:

Other multigrade oils

Manufacturer	Brand name	SAE Viscosity grade	TBN 8–10mgKOH/g	TBN 10–12 mgKOH/g	TBN >12 mgKOH/g	Comments
Aegean Oil S.A.	Vigor Turbo SD 15W-40	15W-40	X			[2]
Addinol Lube Oil	Addinol Super Longlife MD1047	10W-40		X		[2]
	Addinol Diesel Longlife MD1548	15W-40		X		[2]
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]
Arabi Enertech KSC	Burgan Ultra Diesel CH-4	15W-40		X		[2]

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Manufacturer	Brand name	SAE Viscosity grade	TBN			Comments
			8–10mgKOH/g	10–12 mgKOH/g	>12 mgKOH/g	
Aral AG	Aral Extra Turboral	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 Plus	10W-40		X		
	BP Vanellus Multi-Fleet	15W-40	X			2)
	BP Multi Mine	15W-40	X			2)
	BP Vanellus Longdrain	15W-40		X		2)
Cepsa	Cepsa Euromax SHPD	15W-40		X		2)
Chevron	Caltex Delo SHP Multigrade	15W-40		X		
	Caltex Delo Gold Multigrade	15W-40	X			
	Caltex Delo Gold [ISOSYN] Multigrade	15W-40		X		2)
	Caltex Delo 400 Multigrade	15W-40		X		
	Chevron Delo 400 Multigrade	15W-40		X		2)
	Chevron Delo Gold Multigrade	15W-40	X			
	Chevron Ursa Super Plus	15W-40		X		2)
	Texaco Ursa Super Plus	15W-40		X		2)
	Texaco Ursa Super TD	15W-40		X		2)
	Texaco Ursa Super TDS	10W-40		X		2)
	Texaco Ursa Premium TDX	15W-40		X		2)
Chinese Petroleum Company	CPC Superfleet CG-4 Motor Oil	15W-40	X			
Conoco Phillips Com.	Conoco Hydroclear Power D	15W-40			X	
Cubalub	Cubalub Extra Diesel MX	15W-40			X	2)
	Cubalub Extra Diesel	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			

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Manufacturer	Brand name	SAE Viscosity grade	TBN			Comments
			8–10mgKOH/g	10–12 mgKOH/g	>12 mgKOH/g	
Exol Lubricants Ltd.	Taurus Extreme M	15W-40	X			2)
Exxon Mobil Corporation	Mobilgard 1 SHC	20W-40			X	Approved for fast commercial vessels up to 1500h
	Mobil Delvac Super 1400 E	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			
Fuchs Europe Schmierstoffe GmbH	Fuchs Titan Truck Plus	15W-40		X		2)
	Titan Unimax Ultra MC	10W-40		X		
	Titan Formel Plus	15W-40		X		
	Fuchs Titan Truck	15W-40		X		2)
	Titan Unimax Plus MC	10W-40		X		
	Fuchs Titan Universal HD	15W-40	X			
Gazpromneft Lubricants Ltd.	G-Profi MSI 10W-40	10W-40		X		
	G-Profi MSI 15W-40	15W-40		X		
	G-Profi MSH 15W-40	15W-40		X		
	G-Profi MSI plus 15W-40	15W-40		X		2)
	SibiMotor Diesel Premium	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			
Hessol Lubrication GmbH	Hessol Turbo Diesel	15W-40		X		2)
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)

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Manufacturer	Brand name	SAE Viscosity grade	TBN			Comments
			8–10mgKOH/g	10–12 mgKOH/g	>12 mgKOH/g	
Kuwait National Lube Oil MfgCo (KNLOC)	Burgan Ultra Diesel CH-4	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		
LLK Finland Oy	Teboil Super HPD	10W-40		X		
Lotos Oil	Turdus Powertec CI-4 15W-40	15W-40		X		2)
Mauran SAS	Turboland	15W-40	X			2)
Mega Lube Marketers cc.	Megalube Diesel Engine Oil	15W-40		X		
Meguin GmbH	megol Motorenoel SHPD	15W-40	X			
	megol Motorenoel HD-C3	15W-40	X			
MOL-LUB Ltd.	MOLDynamic MK9	15W-40		X		
	MOL Mk-9	15W-40		X		
	Mol Dynamic Super Diesel	15W-40	X			
Morris Lubricants	Ring Free V.S. plus	15W-40	X			2)
Motor Oil, Hellas	EMO SHPD Plus	15W-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)
OMV Petrol Ofisi	PO Maximus Turbo Diesel Extra	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)
	Meditran SX Plus	15W-40		X		2)
Petrobras Distribuidora S.A.	Lubrax Nautica Diesel	15W-40		X		2)
Petro-Canada Lubricants	Duron	15W-40		X		2)
	Duron XL Synthetic Blend	15W-40		X		2)

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Manufacturer	Brand name	SAE Viscosity grade	TBN			Comments
			8–10mgKOH/g	10–12 mgKOH/g	>12 mgKOH/g	
Petroleos de Portugal, Petrogal S.A.	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			
Petronas Lubricants International	Urania LD7	15W-40		X		
	Petronas Urania Supremo CI-4	15W-40	X			2)
Prista Oil AD	Prista SHPD	15W-40	X			2)
	Prista Turbo Diesel	15W-40	X			
Qatar Lubricants Company Ltd.	QALCO Topaz HMF	15W-40	X			
Ravensberger Schmierstoffvertrieb 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			
	Repsol Neptuno S-Turbomar	15W-40	X			
S.A.E.L.	Gulf Gulfleet Long Road	15W-40	X			
Shanghai HIRI Lubricants	HIRI 245	15W-40	X			2)
Shell	Shell Rimula MV	15W-40	X			
	Shell Rimula R3 MV	15W-40	X			2)
	Shell Rimula R3 X	15W-40		X		
	Shell Rimula R4	15W-40		X		2)
	Shell Rimula RT4	15W-40		X		2)
	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)
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			2) enhanced corrosion protection
	SRS Multi-Rekord top	15W-40		X		2)
	SRS Multi Rekord plus	15W-40	X			
	SRS Turbo Rekord	15W-40	X			2)
	SRS Turbo Diesel Plus	15W-40		X		2)
	SRS Cargolub TFX	10W-40		X		

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Manufacturer	Brand name	SAE Viscosity grade	TBN			Comments
			8–10mgKOH/g	10–12 mgKOH/g	>12 mgKOH/g	
Statoil Lubricants	MaxWay	10W-40		X		2)
	MaxWay 15-40	15W-40	X			2)
Svenska Statoil	MaxWay	15W-40		X		2)
Total	Antar Milantar PH	15W-40	X			2)
	Antar Milantar PX	15W-40	X			2)
	Elf Performance Trophy DX	15W-40	X			2)
	Elf Performance Victory	15W-40		X		2)
	Fina Kappa Optima	15W-40		X		2)
	Fina Kappa Extra Plus	15W-40	X			2)
	Total Caprano Energy FE	15W-30		X		
	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 7200 FE	15W-30		X		
	Total Rubia TIR 7400	15W-40		X		2)
	Total Rubia Works 1000	15W-40		X		
TNK Lubricants	TNK Revolux D3	15W-40		X		2)
Unil Opal	Medos 700	15W-40	X			2)
Valvoline	All Fleet Extra	15W-40	X			
Yacco SAS	Inboard 100 4 T Diesel	15W-40	X			2)
	Transpro 40 S	10W-40		X		

Table 45:

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8.1.7 Multigrade oils – Category 2.1 (low SAPS oils)

For details and special features, see chapter “Lubricants for four-cycle engines”(→ Page 7)

	[2)] Engine oils marked [2)] are also approved for “Series 60“

Manufacturer	Brand name	SAE Viscosity grade	TBN 8–10mgKOH/g	TBN 10–12 mgKOH/g	TBN >12 mgKOH/g	Comments
Bucher AG Langenthal	Motorex Focus CF	15W-40	X			2)
Chevron	Caltex Delo 400 LE	15W-40	X			2)
	Chevron Delo 400 LE	15W-40	X			2)
ConocoPhillips Lubricants	Guardol ECT	15W-40	X			2)
	Kenndall Super-D XA	15W-40	X			2)
ENI SpA.	Agip Sigma Truck E9	15W-40	X			2)
ExxonMobil Corporation	Mobil Delvac 1 ESP	5W-40		X		
Fuchs Europe	Fuchs Titan Cargo	15W-40	X			2)
Gulf Oil International	Gulf Supreme Duty XLE	15W-40	X			
Fuchs Europe	Fuchs Titan Cargo	15W-40	X			2)
Panolin AG	Panolin Universal LA-X	15W-40	X			2)
Pennzoil Products	Pennzoil Long-Life Gold	15W-40		X		2)
Petro-Canada	Duron -E	15W-40	X			2)
Repsol YPF	Repsol Diesel Turbo THPD Mid Saps	15W-40	X			2)
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 T2	15W-40		X		2)
	Shell Rotella T3	15W-40		X		2)
	Shell Rotella T5	10W-30	X			
	Shell Rimula R5LE	10W-30	X			
	Shell Rotella T Triple Protection	15W-40		X		2)
SK energy	ZIC XQ 5000	15W-40	X			2)
SRS Schmierstoff Vertrieb GmbH	SRS Turbo Rekord plus	15W-40	X			2)
Statoil Lubricants	MaxWay E9 15W-40	15W-40	X			2)

Table 46:

TIM-ID: 0000019003 - 001

8.1.8 Series-based usability of engine oils in MTU oil category 3 and 3.1 (low SAPS)

Series	Oil category 3	Oil category 3.1 (low SAPS)	Comments
	Multigrade oils	Multigrade oils	
S60	restricted[1)]	restricted[2)]	[1)] = only 15W-40 and min. API CH-4 [2)] = only 15W-40 and API CJ-4
099	yes	yes	
183	yes	yes	
396	yes	yes	
538	yes	yes	
595	yes	yes	
956	yes	yes	
956 TB31/32/33	no	no	
1163	yes	yes	
1163-03	no	no	
2000 CR	yes	yes	
2000 M84/M94	yes	yes	
2000 M72	yes	yes	
2000 Cx6/Sx6	yes	yes	
2000 PLD	yes	yes	
4000-01	yes		
4000-02	yes	yes	
4000-03 G/S/P/C/R	yes	yes	
4000 M23F - M63L	yes	yes	
4000-03 M73-M93L / N43S/N83	yes	yes	
4000 T94/T94L	yes[3)]	yes[3)]	[3)] = only 5W-40, 10W-40
4000 R64/R74/R84 (DPF)	no	yes[4)]	[4)] = only 5W-40, 10W-40
8000	restricted [5)]	restricted [5)]	[5)]= only named engine oils

yes = approval issued

no = no approval

TIM-ID: 0000034414 - 001

8.1.9 Multigrade oils – Category 3, SAE-grades 5W-30, 5W-40, and 10W-40 for diesel engines

For details and special features, see chapter “Lubricants for four-cycle engines”(→ Page 7)

Manufacturer	Brand name	SAE Viscosity grade	TBN			Comments
			8–10mgKOH/g	10–12 mgKOH/g	>12 mgKOH/g	
Addinol Lube Oil	Addinol Ultra Truck MD 0538	5W-30			X	
	Addinol Super Truck MD 1049	10W-40			X	
Aral AG	Aral Super Turboral	5W-30			X	
Avia Mineralöl AG	Avia Turbosynth HT-U	5W-30			X	
BayWa AG	Tectrol Super Truck 530	5W-30			X	
	Tectrol Super Truck 1040	10W-40		X		
BP p.l.c.	BP Energol IC-MT	10W-40			X	
Castrol Ltd.	Castrol Enduron MT	10W-40			X	
	Castrol Enduron Plus	5W-30			X	
	Castrol Elixion HD	5W-30			X	
Cepsa	Cepsa Eurotrans SHPD	5W-30			X	
	Cepsa Eurotrans SHPD	10W-40		X		
Chevron	Caltex Delo XLD Multigrade	10W-40			X	
	Chevron Delo XLD Multigrade	10W-40			X	
	Texaco Ursa Super	10W-40		X		
	Texaco Ursa Premium FE	5W-30			X	
	Ursa TDX	10W-40			X	
	Texaco Ursa Super TDX	10W-40				
Elinoil	Elin Diesel Tec Synthetic	10W-40		X		
ENI S.p.A.	Agip Sigma Trucksint TFE	5W-40			X	
	Agip Sigma Super TFE	10W-40			X	
	Agip Sigma Ultra TFE	10W-40			X	
Enoc	Enoc Vulcan 770 SLD	10W-40		X		
Exxon Mobil Corporation	Mobil Delvac XHP Extra	10W-40			X	
	Mobil Delvac XHP Ultra 5W-30	5W-30			X	
	Mobil Delvac 1 SHC	5W-40			X	
Exol Lubricants Ltd.	Taurus Extreme M3	10W-40			X	
Fuchs Europe Schmierstoffe GmbH	Titan Cargo SL	5W-30			X	
	Titan Cargo MC	10W-40			X	
Ginouves	York 847 10W40	10W-40			X	

TIM-ID: 0000019006 - 001

Manufacturer	Brand name	SAE Viscosity grade	TBN			Comments
			8–10mgKOH/g	10–12 mgKOH/g	>12 mgKOH/g	
Gulf Oil International	Gulf Fleet Force synth.	5W-30			X	
	Superfleet ELD	10W-40		X		
	Gulf Superfleet XLD	10W-40			X	
Huiles Berliet S.A.	RTO Extensia RXD ECO	5W-30			X	
	RTO Extensia RXD	10W-40		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	10W-40		X		
	Q8 T 905	10W-40	X			
LLK Finland Oy	Teboil Super XLD-2	5W-30			X	
Lotos Oil	Turdus Semisynthetic XHPDO	10W-40		X		
	Turdus Powertec Synthetic	5W-30			X	
Meguin	Megol Motorenöl Super LL Dimo Premium	10W-40			X	
	Megol Engine Oil Diesel Truck Performance	10W-40			X	
MOL-LUB	MOL Synt Diesel	10W-40		X		
	MOL Dynamic Synt Diesel	10W-40			X	
OMV	OMV super truck	5W-30			X	
Orlen Oil Sp.o.o.	Platinum Ultor Max	5W-30			X	
OOO LLK International	Lukoil Avantgarde Professional	10W-40			X	
Panolin	Panolin Diesel HTE	10W-40			X	
Petroleos de Portugal, Petrogal S.A.	Galp Galaxia Extreme	5W-30		X		
	Galp Galaxia Ultra XHP	10W-40			X	
Petronas Lubricants International	Urania Maximo	10W-40			X	
	Urania Optimo	10W-40			X	
	Urania 100 K	10W-40			X	
	Urania FE	5W-30			X	
Ravensberger Schmierstoff Vertrieb GmbH	RAVENOL Super Performance Truck	5W-30			X	
	RAVENOL Performance Truck	10W-40			X	
Repsol YPF	Repsol Turbo UHPD	10W-40			X	
	Repsol Diesel Turbo VHPD	5W-30			X	

TIM-ID: 0000019006 - 001

Manufacturer	Brand name	SAE Viscosi-ty grade	TBN			Comments
			8–10mgKOH/g	10–12 mgKOH/g	>12 mgKOH/g	
Shell	Shell Normina Extra	10W-40			X	
	Shell Rimula R5 M	10W-40			X	
	Shell Rimula R6 M	10W-40			X	
	Shell Rimula R6 ME	5W-30			X	
SMV GmbH JB German Oil	JB German Oil Hightech Truck	10W-40			X	
SRS Schmierstoff Vertrieb GmbH	SRS Cargolub TFF	10W-40			X	
	SRS Cargolub TFL	5W-30			X	
	SRS Cargolub TFG	10W-40			X	
	SRS Cargolub TFG plus	10W-40			X	
Statoil Lubricants	MaxWay Ultra 5W-30	5W-30			X	
	MaxWay Ultra E4 10W-40	10W-40			X	
Total	Antar Maxolia	10W-40		X		
	Elf Performance Experty FE	5W-30			X	
	Elf Performance Experty	10W-40		X		
	Fina Kappa Syn FE	5W-30			X	
	Total Rubia TIR 8600	10W-40			X	
	Total Rubia TIR 9200 FE	5W-30			X	
Unil Opal	LCM 800	10W-40			X	
Valvoline	Profleet	10W-40			X	
Wolf Oil Corporation	Champion Turbofleet UHPD	10W-40				
Yacco SAS	Yacco Transpro 45	10W-40			X	

Table 47:

TIM-ID: 0000019006 - 001

8.1.10 Multigrade oils – Category 3.1 (low SAPS oils)

For details and special features, see chapter “Lubricants for four-cycle engines”(→ Page 7)

[2] Engine oils marked [2] are also approved for “Series 60“

Manufacturer	Brand name	SAE Viscosity grade	TBN 8–10mgKOH/g	TBN 10–12 mgKOH/g	TBN >12 mgKOH/g	Comments
Addinol Lube Oil	Addinol Extra Truck MD 1049 LE	10W-40	X			
APAG Chemie AG	Alpha Advanced Eco-Efficiency low SAPS	10W-40	X			
Aral AG	Aral Mega Turboral LA	10W-40			X	
BayWa AG	Tectrol Super Truck Plus 1040	10W-40			X	
Bucher AG Langenthal	Motorex Focus QTM	10W-40	X			
BP p.l.c.	BP Vanellus Max Drain Eco	10W-40			X	
Cepsa	Cepsa Eurotech LS	10W-40			X	
Chevron	Caltex Delo XLE Multigrade	10W-40	X			
	Texaco Ursa Ultra	10W-40	X			
	Texaco Ursa Ultra X	10W-40	X			
Enoc International Sales L.L.C.	Vulkan green	10W-40	X			
Exxon Mobil	Mobil Delvac 1 LE	5W-30			X	
	Mobil Delvac XHP LE	10W-40			X	
Fuchs	Titan Cargo Maxx	10W-40	X			
Gulf Oil International	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			
LLK finland Oy	Teboil Super XLD-2	5W-30			X	
Meguin	megol Motorenöl UHPD Low Saps	5W-30			X	
OOO LLK International	Lukoil Avantgarde Professional LS	10W-40			X	
Panolin	Panolin Diesel Synth EU-4	10W-40	X			
Petróleos de Portugal	Galp Galaxia Ultra LS	10W-40	X			
Petronas Lubricants International	Petronas Urania Ecotech	10W-40			X	
Prista Oil Ad	Prista UHPD	10W-40	X			
Repsol YPF y Especialidades S.A.	Repsol Diesel Turbo UHPD Mid Saps	10W-40	X			
Shell	Shell Rimula R6 LM	10W-40	X			

TIM-ID: 0000019019 - 001

Manufacturer	Brand name	SAE Viscosi-ty grade	TBN			Comments
			8–10mgKOH/g	10–12 mgKOH/g	>12 mgKOH/g	
SK energy	ZIC XQ 5000	10W-40	X			
SRS Schmierstoff Vertrieb GmbH	SRS Cargolub TLA	10W-40	X			
	SRS Cargolub TLS	5W-30			X	
	SRS Turbo Diesel LA	10W-40	X			
Statoil Lubricants	MaxWay Ultra E6 10W-40	10W-40			X	
Total	Total Rubia TIR 8900	10W-40	X			
	Elf Performance Experty LSX	10W-40	X			
Valvoline	Valvoline ProFleet LS	10W-40			X	
Yacco SAS	Yacco Transpo 65	10W-40			X	

Table 48:

TIM-ID: 0000019019 - 001

8.2 Engine oils for gas engines

8.2.1 Single-grade oils - Category 1 of SAE grade 40 for gas engines in Series 4000 L61/L62

For details and special features, see chapter on “Lubricants”(→ Page 7)

Manufacturer	Brand name	SAE Viscosity grade	TBN			Comments
			5–6mgKOH/g	10–12 mgKOH/g	>12 mgKOH/g	
Castrol Ltd.	Castrol Duratec L	40	X			also suitable for purified biogas
Chevron	Texaco Geotex LA 40	40	X			
Exxon Mobil Corporation	Mobil Pegasus 705	40	X			
	Mobil Pegasus 805	40	X			
Fuchs Europe Schmierstoffe GmbH	Fuchs Titan Ganymet LA	40	X			
Shell	Shell Mysella LA 40	40	X			
SRS Schmierstoff Vertrieb GmbH	SRS Mihagrun LA 40	40	X			
Total	Nateria MH 40	40	X			

Table 49:

TIM-ID: 0000018947 - 001

8.2.2 Single-grade oils - Category 1 of SAE grade 40 for gas engines in Series 4000 L62FB

For details and special features, see chapter on “Lubricants”(→ Page 7)

Manufacturer	Brand name	SAE Viscosity grade	TBN			Comments
			5–6mgKOH/g	10–12 mgKOH/g	>12 mgKOH/g	
Addinol	MG 40 Extra LA	40	X			Low ash performance
	MG 40 Extra Plus	40		X		
Total	Nateria MP 40	40	X			Low ash performance
	Nateria MJ 40	40		X		

Table 50:

TIM-ID: 0000031562 - 001

8.3 Engine oils for two-cycle engines

8.3.1 Series-based usability for two-cycle engine oils

Series	Two-cycle engine oil API CF-2			Comments
	Single-grade oils SAE 40	Single-grade oils SAE 50	Multigrade oils 15W-40	
S 53	yes	restricted[1]	restricted[1]	[1]only short term at low temperatures [2]at coolant outlet temp. > 94 °C
S 71	yes	restricted[1]	restricted[2]	
S 92	yes	restricted[1]	restricted[2]	
S 149	yes[2]	yes	no	

Table 51:

TIM-ID: 0000034422 - 001

8.3.2 Engine oils for two-cycle engines

If the engine oils listed here are not available, two-cycle engine oils may be used, provided they comply with the requirements listed in the table (Engine oil requirements for two-cycle engines (→ Page 18).

Manufacturer	Brand name
Bucher AG Langenthal	Motorex Extra SAE 40
Chevron	Ursa Extra Duty SAE 40
	Ursa Extra Duty SAE 50
ExxonMobil	Exxon XD-3 Monogrades SAE 40
	Mobile Delvac 1240
	Mobile Delvac 1250
Panolin	Extra Diesel DD SAE 40
Shell	Shell Rotella DD+40

Table 52:

TIM-ID: 0000018566 - 001

8.4 Lubricating greases

8.4.1 Lubricating greases for general applications

For details and special features, see chapter on “Lubricants”(→ Page 7)

Manufacturer	Brand name	Comments
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 Gadus S2 V220 2	
Total	Total Multis EP2	
Veedol International	Multipurpose	

Table 53:

TIM-ID: 0000019094 - 001

9 Approved coolants

9.1 Series- and application-based usability of coolant additives

All details are based on the coolant circuit on the engine side.

For details and special features, see chapter on “Coolants”(→ Page 20)

Any deviating special agreements between the customer and MTU-Friedrichshafen shall remain valid.

MTU four-cycle engines

X = application approval

– = no application approval

Series	Application	Cooling system containing light metals	Emulsions	Water-soluble corrosion inhibitors		Corrosion inhibiting antifreeze		Comments
			See chapter 9.2	See chapter 9.3	See chapter 9.4	See chapter 9.5	See chapter 9.6	
099	Marine	yes	–	X	–	X[1)]	–	[1)] not permitted at seawater temperature > 20 °C !
183	Marine	yes	–	X	–	X[2)]	–	[2)] not permitted at seawater temperature > 20 °C !
183	Rail		–	X	–	X	–	
396	Marine	yes	–	X	–	X[3)]	–	[3)] not permitted at seawater temperature > 20 °C !
396 TB	Marine	yes	–	X	–	X	–	
	Genset	yes	–	X	–	X	–	
	Rail	yes	–	X	–	X	–	

TIM-ID: 0000034439 - 001

Series	Application	Cooling system containing light metals	Emulsions	Water-soluble corrosion inhibitors		Corrosion inhibiting antifreeze		Comments
			See chapter 9.2	See chapter 9.3	See chapter 9.4	See chapter 9.5	See chapter 9.6	
396 TC	Marine	yes	–	X	–	X[4)]	–	[4)] not permitted at seawater temperature > 20 °C !
	Genset	yes	–	X	–	X	–	
	C&I	yes	–	X	–	X	–	
	Rail	yes	–	X	–	X	–	
396 TE	Marine	yes	–	X	–	X[5)]	–	[5)] not permitted at seawater temperature > 20 °C !
	Genset	yes	–	X	–	X	–	
	C&I	yes	–	X	–	X	–	
	Rail	yes	–	X	–	X	–	
538	Marine	yes	X	–	–	–	–	
595	Marine	yes	X	–	–	–	–	
956-01 / 956-02	Marine	yes	X	X	–	–	–	
	Genset	yes	X	X	–	X	–	
956 TB33	Genset[6)]	yes	X	–	–	–	–	[6)] up to year of manufacture end of 2008, in acc. with identification plate
	Genset[7)]	yes	X	X	–	X	–	[7)] from year of manufacture 2009, in acc. with identification plate
1163-02	Marine	yes	X	X	–	–	–	
	Genset	yes	X	X	–	X	–	
1163-03	Marine	yes	X	–	–	–	–	

TIM-ID: 0000034439 - 001

Series	Applica-tion	Cooling system contain-ing light metals	Emul-sions	Water-soluble corro-sion inhibitors		Corrosion inhibiting antifreeze		Com-ments
			See chapter 9.2	See chapter 9.3	See chapter 9.4	See chapter 9.5	See chapter 9.6	
2000	Marine	yes	–	X	–	X[8)]	–	[8)] not per-mitted at seawater tempera-ture > 25 °C !
	Genset	yes	–	X	–	X	–	
	C&I	no	–	–	X	–	X	
2000-06[9)]	C&I		–	–	–	X	–	[9)]approve products, see note in chapter 9.5

TIM-ID: 0000034439 - 001

Series	Application	Cooling system containing light metals	Emulsions	Water-soluble corrosion inhibitors		Corrosion inhibiting antifreeze		Comments
			See chapter 9.2	See chapter 9.3	See chapter 9.4	See chapter 9.5	See chapter 9.6	
4000-01 / 4000-02 / 4000-03	Marine	partly	–	X	–	X[10)]	–	[10)] not permitted at seawater temperature > 25 °C ! M40, M50 and M90 contain light metals
	Genset	no	–	–	X	–	X	
	C&I	no	–	–	X	–	X	
	Rail	yes: R10, R20	–	X	–	X	–	If the cooling system contains light metals, the coolant approvals for cooling system containing light metals apply
		noR41, R43	–	–	X	–	X	
	Frac	no	–	–	X	–		
	Offshore	partly	–	X	–	X	–	containing light metal: Px1 not containing light metal: Px3
4000-04[11)] T94, T94L	Frac		–	–	–	X	–	[11)]approve products, see note in chapter 9.5

TIM-ID: 0000034439 - 001

Series	Application	Cooling system containing light metals	Emulsions	Water-soluble corrosion inhibitors		Corrosion inhibiting antifreeze		Comments
			See chapter 9.2	See chapter 9.3	See chapter 9.4	See chapter 9.5	See chapter 9.6	
4000-04[12]) R64, R74, R84	Rail		–	–	–	X	–	[12])approve products, see note in chapter 9.5
4000	Gas engine	yes	–	X	–	X	–	
8000	Marine	yes	X	X	–	–	–	

Table 54:

Detroit Diesel four-cycle and two-cycle engines

X = application approval

– = no application approval

Series	Application	Cooling system containing light metals	Emulsions	Water-soluble corrosion inhibitors		Corrosion inhibiting antifreeze		Comments
			See chapter 9.2	See chapter 9.7.3	See chapter 9.8.3	See chapter 9.7.1/9.7.2	See chapter 9.8.1/9.8.2	
S 60	Marine		–	X	–	X	–	Four-cycle engines
S 53		no	–	–	X	–	X	Two-cycle engines
S 71		no	–	–	X	–	X	Two-cycle engines
S 92		no	–	–	X	–	X	Two-cycle engines
S 149		no	–	–	X	–	X	Two-cycle engines

Table 55:

TIM-ID: 0000034439 - 001

9.2 Emulsifiable corrosion-inhibiting oils

For details and special features, see chapter on “Coolants”(→ Page 20)

Emulsifiable corrosion-inhibiting oils

Manufacturer	Brand name	Operating time Hour / Year	Comments / Part No.
Houghton Deutschland GmbH	Oil 9156	6000 / 1	X00056748 (barrel) X00056749 (canister)

Table 56:

TIM-ID: 0000019095 - 001

9.3 Water-soluble corrosion inhibitor concentrates for cooling systems containing light metal

For details and special features, see chapter on “Coolants”(→ Page 20)

Water-soluble corrosion inhibitor concentrates for cooling systems containing light metal

Manufacturer	Brand name	Operating time Hour / Year	Comments / Part No.
MTU Friedrichshafen	Coolant CS100	6000 / 2	X00057233 (20 l) X00057232 (210 l)
Tognum America Inc.	Power Cool Plus 6000	6000 / 2	colored green 23533526 23533527
Arteco	Freecor NBI	6000 / 2	
BASF	Glysacorr G93-94	6000 / 2	X00054105 (barrel) X00058062 (canister)
BP Lubricants	Castrol Extended Life Corrosion Inhibitor	6000 / 2	
CCI Corporation	A 216	6000 / 2	
CCI Manufacturing IL Corporation	A216	6000 / 2	X00051509 (208 l)
Chevron	Texcool A – 200	6000 / 2	
Detroit Diesel Corp.	Power Cool Plus 6000	6000 / 2	colored red
Drew Marine	Drewgard XTA	6000 / 2	
ExxonMobil	Mobil Delvac Extended Life Corrosion Inhibitor	6000 / 2	
Ginouves	York 719	6000 / 2	
Old World Industries	A 216	6000 / 2	
Valvoline	ZEREX G-93	6000 / 2	

Table 57:

TIM-ID: 0000019105 - 001

9.4 Water-soluble corrosion inhibitor concentrates for cooling systems not containing light metal

9.4.1 Concentrates

For details and special features, see chapter on “Coolants”(→ Page 20)

Water-soluble corrosion inhibitor concentrates for cooling systems not containing light metal

Manufacturer	Brand name	Operating time Hour / Year	Comments / Part No.
MTU Friedrichshafen	Coolant CS100	6000 / 2	X00057233 (20 l) X00057232 (210 l)
Tognum America Inc.	Power Cool Plus 6000	6000 / 2	colored green 23533526 23533527
Arteco	Freecor NBI	6000 / 2	
	Havoline Extended Life Corrosion Inhibitor [EU Code 32765] (XLI)	6000 / 2	
BASF	Glysacorr G93-94	6000 / 2	X00054062 (canister) X00054105 (barrel)
BP Lubricants	Castrol Extended Life Corrosion Inhibitor	6000 / 2	
CCI Corporation	A 216	6000 / 2	
CCI Manufacturing IL Corporation	A 216	6000 / 2	X00051509 (208 l)
Chevron	Texcool A – 200	6000 / 2	
Detroit Diesel Corp.	Power Cool Plus 2000	6000 / 2	
	Power Cool Plus 6000	6000 / 2	colored red
Drew Marine	Drewgard XTA	6000 / 2	
ExxonMobil	Mobil Delvac Extended Life Corrosion Inhibitor	6000 / 2	
Fleetguard	DCA-4L	2000 / 1	
Ginouves	York 719	6000 / 2	
Nalco	Alfloc (Maxitreat) 3477	6000 / 2	
	Alfloc 2000	6000 / 2	
	Nalco 2000	6000 / 2	
	Nalcool 2000	6000 / 2	
Old World Industries	A 216	6000 / 2	
Penray	Pencool 2000	6000 / 2	
Total	Total WT Supra	6000 / 2	
Valvoline	Zerex G-93	6000 / 2	

Table 58:

TIM-ID: 0000019146 - 001

TIM-ID: 0000019146 - 001

9.4.2 Ready mixtures

For details and special features, see chapter on “Coolants”(→ Page 20)

Water-soluble corrosion inhibitor ready mixtures for cooling systems not containing light metals

Manufacturer	Brand name	Operating time Hour / Year	Comments / Part No.
Nalco	Alfloc (Maxitreat) 3443 (7%)	6000 / 2	

Table 59:

TIM-ID: 0000019447 - 001

9.5 Corrosion inhibitor and antifreeze for cooling systems containing light metal

9.5.1 Corrosion inhibiting antifreeze concentrates

For details and special features, see chapter on “Coolants”(→ Page 20)

	For the Series 2000-06, only coolants marked with an asterisk * can be used!

Concentrates

Manufacturer	Brand name	Operating time Hour / Year	Comments / Part No.
MTU Friedrichshafen	Coolant AH100*	9000 / 5	X00057231 (20 l) X00057230 (210 l)
Tognum America Inc.	Power Cool Off Highway	9000 / 5	235335522 (1 gallon) 235335523 (5 gallons) 235335524 (55 gallons) no approval for Series 4000-04
	Power Cool Universal*	9000 / 5	800070 (5 gallons)
MTU Detroit Diesel Australia	Power Cool - HB500	9000 / 3	no approval for Series 4000-04
Avia	Antifreeze APN*	9000 / 5	
BASF	Glysantin G05	9000 / 5	no approval for Series 4000-04
	Glysantin G48*	9000 / 5	X00058054 (25 l) X00058053 (210 l)
	Glysantin G30	9000 / 3	X00058072 (canister) X00058071 (barrel)
BP Lubricants	ARAL Antifreeze Extra*	9000 / 5	
	Castrol Heavy Duty Extended Life Coolant	9000 / 3	
Castrol	Castrol Antifreeze NF*	9000 / 5	
	Castrol Radicool NF*	9000 / 5	
Clariant	Genatin Super	9000 / 5	no approval for Series 4000-04
Classic Schmierstoff GmbH	Classic Kolda UE G48*	9000 / 5	
CCI Corporation	L 415	9000 / 3	
CCI Manufacturing IL Corporation	C 521	9000 / 3	
Comma Oil & Chemicals	Comma Xstream G30	9000 / 3	
	Comma Xstream G48*	9000 / 5	

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Manufacturer	Brand name	Operating time Hour / Year	Comments / Part No.
Detroit Diesel Corp.	Power Cool Antifreeze	9000 / 3	no approval for Series 4000-04
	Power Cool Plus Coolant	9000 / 3	
ExxonMobil	Mobil Delvac Extended Life Coolant	9000 / 3	
	Mobil Antifreeze Advanced	9000 / 3	
	Mobil Antifreeze Extra*	9000 / 5	
	Mobil Antifreeze Special	9000 / 5	no approval for Series 4000-04
	Esso Antifreeze Advanced	9000 / 3	
	Esso Antifreeze Extra*	9000 / 5	
Fuchs	Maintain Fricofin*	9000 / 5	
	Maintain Fricofin G12 Plus	9000 / 3	X00058074 (canister) X00058073 (barrel)
Ginouves	York 716*	9000 / 5	
Krafft	Refrigerante ACU 2300	9000 / 3	X00058075 (barrel) no approval for Series 4000-04
Kemetyl	Carix Premium G48*	9000 / 5	
Maziva	INA Antifriz Al Super*	9000 / 5	
Mol-Lub	EVOX Extra G48 Antifreeze concentrate*	9000 / 5	
Nalco	Nalcool 5990	9000 / 3	no approval for Series 4000-04
Nalco Australia	Nalcool NF 48*	9000 / 5	
Old World Industries	Blue Mountain Heavy Duty Extended Life Coolant	9000 / 3	
	Fleetcharge SCA Precharged Heavy Duty Coolant/ Antifreeze	9000 / 3	no approval for Series 4000-04
	Final Charge Global Extended Life Coolant Antifreeze	9000 / 3	
OMV	OMV Coolant Plus*	9000 / 5	
	OMV Coolant SF	9000 / 3	
Ravensberger Schmierstoffvertrieb GmbH	RAVENOL Kühlerfrostschutz silikatfrei	9000 / 3	
Recochem	R542	9000 / 3	no approval for Series 4000-04
Shell	Shell HD Premium	9000 / 3	no approval for Series 4000-04
Sotagal - Mont Blanc	Antigel Power Cooling Concentrate*	9000 / 5	
Total	Glacelf MDX*	9000 / 5	
Valvoline	Zerex G-05	9000 / 5	no approval for Series 4000-04
	Zerex G-48*	9000 / 5	
	Zerex G-30	9000 / 3	

Table 60:

TIM-ID: 0000019149 - 001

9.5.2 Corrosion-inhibiting antifreeze concentrates for special applications

For details and special features, see chapter on “Coolants”(→ Page 20)

Concentrates for special applications

Manufacturer	Brand name	Operating time Hour / Year	Comments / Part No.
BASF	G206	9000 / 3	For use in arctic regions (< -40 °C) no approval for Series 2000-06 no approval for Series 4000-04

Table 61:

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9.5.3 Corrosion-inhibiting antifreeze ready mixtures

For details and special features, see chapter on “Coolants”(→ Page 20)

	For the Series 2000-06, only coolants marked with an asterisk * can be used!

Ready mixtures

Manufacturer	Brand name	Operating time Hour / Year	Comments / Part No.
Tognum America Inc.	Power Cool Plus Marine (30/70)	9000 / 5	23524677 (5 gallons) 23524676 (55 gallons) no approval for Series 4000-04
	Power Cool Universal (35/65)	9000 / 5	800085 (5 gallons) 800084 (55 gallons) no approval for Series 4000-04
	Power Cool Universal (50/50)*	9000 / 5	800069 (1 gallon) 800071 (5 gallons)
	Power Cool Off-Highway 50/50	9000 / 5	23533530 (1 gallon) 23533531 (5 gallons) 23533532 (55 gallons) no approval for Series 4000-04
MTU Detroit Diesel Australia	Power Cool - HB500 Premix 50/50	9000 / 3	no approval for Series 4000-04
Bantleon	Avilub Antifreeze Mix (50%)*	9000 / 5	X00049213 (210 l)
BP Lubricants	Castrol Heavy Duty Extended Life Prediluted Coolant (50/50)	9000 / 3	
Castrol	Castrol Antifreeze NF Premix (45%)*	9000 / 5	
	Castrol Radicool NF Premix (45%)*	9000 / 5	
CCI Corporation	L 415 (50%)	9000 / 3	
CCI Manufacturing IL Corporation	C 521 (50%)	9000 / 3	
Detroit Diesel Corp.	Power Cool Plus Prediluted Coolant (50/50)	9000 / 3	
Exxon Mobil	Mobil Delvac Extended Life Prediluted Coolant (50/50)	9000 / 3	
Old World Industries	Blue Mountain Heavy Duty Extended Life Prediluted Coolant (50/50)	9000 / 3	
	Final Charge Global Extended Life Prediluted Coolant/Antifreeze (50/50)	9000 / 3	
Sotragal – Mont Blanc	L.R.-30 Power Cooling (44%)*	9000 / 5	
	L.R.-38 Power Cooling (52%)*	9000 / 5	
Total	Coolelf MDX (40%)*	9000 / 5	

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Manufacturer	Brand name	Operating time Hour / Year	Comments / Part No.
Tosol-Sintez	Glysantin Alu Protect G30 Ready Mix	9000 / 3	
	Glysantin Alu Protect Plus G48 Ready Mix*	9000 / 5	
Valvoline	Zerex G-05 50/50 Mix	9000 / 5	no approval for Series 4000-04

Table 62:

TIM-ID: 0000019156 - 001

9.6 Corrosion inhibitor and antifreeze for cooling systems not containing light metal

9.6.1 Corrosion inhibiting antifreeze concentrates

For details and special features, see chapter on “Coolants”(→ Page 20)

Corrosion inhibiting antifreeze concentrates

Manufacturer	Brand name	Operating time Hour / Year	Comments / Part No.
MTU Friedrichshafen	Coolant AH100	9000 / 5	X00057231 (20 l) X00057230 (210 l)
Tognum America Inc.	Power Cool Off-Highway	9000 / 5	23533522 (1 gallon) 23533523 (5 gallons) 23533524 (55 gallons)
	Power Cool Universal	9000 / 5	800070 (5 gallons)
MTU Detroit Diesel Australia	Power Cool - HB500	9000 / 3	
	Power Cool - HB800	9000 / 3	
Arteco	Havoline Extended Life Coolant XLC [EU Code 30379]	9000 / 3	
Avia	Antifreeze APN	9000 / 5	
BASF	Glysantin G05	9000 / 5	
	Glysantin G48	9000 / 5	X00058054 (25 l) X00058053 (210 l)
	Glysantin G30	9000 / 3	X00058072 (canister) X00058071 (barrel)
BP Lubricants	Aral Antifreeze Extra	9000 / 5	
	Castrol Heavy Duty Extended Life Coolant	9000 / 3	
Caltex	Caltex Extended Life Coolant [AP Code 510614] (XLC)	9000 / 3	
Castrol	Castrol Antifreeze NF	9000 / 5	
	Castrol Radicool NF	9000 / 5	
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	
Classic Schmierstoff GmbH	Classic Kolda UE G48	9000 / 5	
Comma Oil & Chemicals	Comma Xstream G30	9000 / 3	
	Comma Xstream G48	9000 / 5	

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Manufacturer	Brand name	Operating time Hour / Year	Comments / Part No.
Detroit Diesel Corp.	Power Cool Antifreeze	9000 / 3	
	Power Cool Plus Coolant	9000 / 3	
ExxonMobil	Mobil Delvac Extended Life Coolant	9000 / 3	
	Mobil Antifreeze Advanced	9000 / 3	
	Mobil Antifreeze Extra	9000 / 5	
	Mobil Antifreeze Special	9000 / 5	
	Esso Antifreeze Advanced	9000 / 3	
	Esso Antifreeze Extra	9000 / 5	
Fuchs	Maintain Fricofin	9000 / 5	
	Maintain Fricofin G12 Plus	9000 / 3	X00058074 (canister) X00058073 (barrel)
Fuchs Australia	Titan HDD Coolant Concentrate	9000 / 3	
Ginouves	York 716	9000 / 5	
Krafft	Refrigerante ACU 2300	9000 / 3	X00058075 (barrel)
	Energy Plus K-140	9000 / 3	
Kemetyl	Carix Premium G48	9000 / 5	
Maziva	INA Antifriz Al Super	9000 / 5	
Mol-Lub	EVOX Extra G48 Antifreeze concentrate	9000 / 5	
Nalco	Nalcool 4070	9000 / 3	
	Nalcool 5990	9000 / 3	
Nalco Australia	Nalcool NF 48	9000 / 5	
OAO	Cool Stream Premium C	9000 / 3	
Old World Industries	Blue Mountain Heavy Duty Extended Life Coolant	9000 / 3	
	Fleetcharge SCA Precharged Heavy Duty Coolant/ Antifreeze	9000 / 3	
	Final Charge Global Extended Life Coolant Antifreeze	9000 / 3	
OMV	OMV Coolant Plus	9000 / 5	
	OMV Coolant SF	9000 / 3	
Ravensberger Schmierstoffvertrieb GmbH	RAVENOL Kühlerfrostschutz silikatfrei	9000 / 3	
Recochem	R542	9000 / 3	
	R824M	9000 / 3	
Shell	Shell HD Premium	9000 / 3	
	Shell HD Premium N	9000 / 3	
Sotragal – Mont Blanc	Antigel Power Cooling Concentrate	9000 / 5	
Total	Glacelf Auto Supra	9000 / 3	
	Glacelf MDX	9000 / 5	
	Glacelf Supra	9000 / 3	

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Manufacturer	Brand name	Operating time Hour / Year	Comments / Part No.
Valvoline	Zerex G-05	9000 / 5	
	Zerex G-48	9000 / 3	
	Zerex G-30	9000 / 5	

Table 63:

TIM-ID: 0000019158 - 001

9.6.2 Corrosion-inhibiting antifreeze concentrates for special applications

For details and special features, see chapter on “Coolants”(→ Page 20)

Concentrates for special applications

Manufacturer	Brand name	Operating time Hour / Year	Comments / Part No.
BASF	G206	9000 / 3	For use in arctic regions (< -40 °C)

Table 64:

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9.6.3 Corrosion-inhibiting antifreeze ready mixtures

For details and special features, see chapter on “Coolants”(→ Page 20)

Corrosion-inhibiting antifreeze ready mixtures

Manufacturer	Brand name	Operating time Hour / Year	Comments / Part No.
Tognum America Inc.	Power Cool Plus Marine (30/70)	9000 / 5	23524677 (5 gallons) 23524676 (55 gallons)
	Power Cool Universal (35/65)	9000 / 5	800085 (5 gallons) 800084 (55 gallons)
	Power Cool Universal (50/50)	9000 / 5	800069 (1 gallon) 800071 (5 gallons)
	Power Cool Off-Highway 50/50	9000 / 5	23533530 (1 gallon) 23533531 (5 gallons) 23533532 (55 gallons)
MTU Detroit Diesel Australia	Power Cool - HB500 Premix 50/50	9000 / 3	
	Power Cool - HB800 Premix 50/50	9000 / 3	
Arteco	Halvoline Extended Life Coolant + B2 50/50 OF01 [EU Code 33073] (50%)	9000 / 3	
	Halvoline Extended Life Coolant + B2 40/60 OF01 [EU Code 33069] (40%)	9000 / 3	
	Halvoline Extended Life Coolant + B2 35/65 OF01 [EU Code 33074] (35%)	9000 / 3	
Bantleon	Avilub Antifreeze Mix (50%)	9000 / 5	X00049213 (210 l)
BP Lubricants	Castrol Heavy Duty Extended Life Prediluted Coolant (50/50)	9000 / 3	
Caltex	Caltex Extended Life Coolant Pre-Mixed 50/50 [AP Code 510609] (50%)	9000 / 3	
Castrol	Castrol Antifreeze NF Premix (45%)	9000 / 5	
	Castrol Radicool 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 Prediluted 50/50 Antifeeze Coolant [US Code 227995]	9000 / 3	
Detroit Diesel Corp.	Power Cool Plus Prediluted Coolant (50/50)	9000 / 3	
ExxonMobil	Mobil Delvac Extended Life Prediluted Coolant (50/50)	9000 / 3	
Fleetguard	PG XL (40%)	9000 / 3	Propylene glycol
Fuchs Australia	Titan HDD Premix Coolant (50%)	9000 / 3	
Nalco	Nalcool 4100 (50%)	9000 / 3	

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Manufacturer	Brand name	Operating time Hour / Year	Comments / Part No.
Old World Industries	Blue Mountain Heavy Duty Extended Life Prediluted Coolant (50/50)	9000 / 3	
	Final Charge Global Extended Life Predilluted Coolant / Antifreeze (50/50)	9000 / 3	
Sotragal – Mont Blanc	L.R.-30 Power Cooling (44%)	9000 / 5	
	L.R.-38 Power Cooling (52%)	9000 / 5	
Total	Coolelf MDX (40%)	9000 / 5	
	Coolelf Supra (40%)	9000 / 3	
	Coolelf GF NP (50%)	9000 / 3	
Tosol-Sintez	Glysantin Alu Protect G30 Ready Mix	9000 / 3	
	Glysantin Alu Protect G48 Ready Mix	9000 / 5	
Valvoline	Zerex G-05 50/50 Mix	9000 / 5	

Table 65:

TIM-ID: 0000019159 - 001

9.7 Coolant additives for Series 60 engines

9.7.1 Corrosion inhibiting antifreeze concentrates for Series 60 engines

For details and special features, see chapter on “Coolants”(→ Page 20)

Corrosion inhibiting antifreeze concentrates

Manufacturer	Brand name	Operating time Hour / Year	Comments / Part No.
Tognum America Inc.	Power Cool Off-Highway	9000 / 5	23533522 (1 gallon) 23533523 (5 gallons) 23533524 (55 gallons)
MTU Detroit Diesel Australia	Power Cool - HB500	9000 / 3	
BASF	Glysantin G05	9000 / 5	
	Glysantin G30	9000 / 3	X00058072 (canister) X00058071 (barrel)
BP Lubricants	Castrol Heavy Duty Extended Life Coolant	9000 / 3	
Comma Oil & Chemicals	Comma Xstream G30	9000 / 3	
Detroit Diesel Corp.	Power Cool Antifreeze	9000 / 3	
	Power Cool Plus Coolant	9000 / 3	
ExxonMobil	Mobil Delvac Extended Life Coolant	9000 / 3	
	Mobil Antifreeze Advanced	9000 / 3	
	Mobil Antifreeze Special	9000 / 5	
	Esso Antifreeze Advanced	9000 / 3	
Fuchs	Maintain Fricofin G 12 Plus	9000 / 3	X00058074 (canister) X00058073 (barrel)
Nalco	Nalcool 5990	9000 / 3	
Old World Industries	Blue Mountain Heavy Duty Extended Life Coolant	9000 / 3	
	Fleet Charge SCA precharged heavy duty coolant / Antifreeze	9000 / 3	
	Final Charge Global Extended Life Coolant/Antifreeze	9000 / 3	
OMV	OMV Coolant SF	9000 / 3	
Ravensberger Schmierstoffvertrieb GmbH	RAVENOL Kühlerfrostschutz silikatfrei	9000 / 3	
Recochem	R 542	9000 / 3	
Shell	Shell HD Premium	9000 / 3	
Valvoline	Zerex G 05	9000 / 5	
	Zerex G 30	9000 / 3	

Table 66:

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9.7.2 Corrosion inhibiting antifreeze ready mixtures for Series 60 engines

For details and special features, see chapter on “Coolants”(→ Page 20)

Corrosion-inhibiting antifreeze ready mixtures

Manufacturer	Brand name	Operating time Hour / Year	Comments / Part No.
Tognum America Inc.	Power Cool Plus Marine (30/70)	9000 / 5	23524677 (5 gallons) 23524676 (55 gallons)
	Power Cool Off Highway 50/50	9000 / 5	23533530 (1 gallon) 23533531 (5 gallons) 23533532 (55 gallons)
MTU Detroit Diesel Australia	Power Cool - HB500 Premix 50/50	9000 / 3	
BP Lubricants	Castrol Heavy Duty Extended Life Prediluted Coolant (50/50)	9000 / 3	
Detroit Diesel Corp.	Power Cool Plus Prediluted Coolant (50/50)	9000 / 3	
ExxonMobil	Mobil Delvac Extended Life Prediluted Coolant (50/50)	9000 / 3	
Old World Industries	Blue Mountain Heavy Duty Extended Life Prediluted Coolant (50/50)	9000 / 3	
	Final Charge Global Extended Life Prediluted Coolant/Antifreeze (50/50)	9000 / 3	
Tosol-Sintez	Glysantin Alu Protect G30 Ready Mix	9000 / 3	
Valvoline	Zerex G-05 50/50 Mix	9000 / 5	

Table 67:

TIM-ID: 0000034533 - 001

9.7.3 Corrosion inhibiting antifreeze concentrates for Series 60 engines

For details and special features, see chapter on “Coolants”(→ Page 20)

Water-soluble corrosion inhibitor concentrates

Manufacturer	Brand name	Operating time Hour / Year	Comments / Part No.
MTU Friedrichshafen	Coolant CS100	6000 / 2	X00057233 (20 l) X00057232 (210 l)
Tognum America Inc.	Power Cool Plus 6000	6000 / 2	colored green 23533526 23533527
BASF	Glysacorr G93-94	6000 / 2	X00054105 (barrel) X00058062 (canister)
Drew Marine	Drewgard XTA	6000 / 2	
Ginouves	York 719	6000 / 2	
Valvoline	ZEREX G-93	6000 / 2	

Table 68:

TIM-ID: 0000034532 - 001

9.8 Coolant additives for two-cycle engines

9.8.1 Corrosion-inhibiting antifreeze concentrates for two-cycle engines

Corrosion inhibiting antifreeze concentrates

Manufacturer	Brand name	Operating time Hour / Year	Comments / Part No.
MTU Friedrichshafen	Coolant AH100	9000 / 5	X00057231 (20 l) X00057230 (210 l)
Tognum America Inc.	Power Cool 3149	9000 / 5	23528572 23528571
	Power Cool Universal	9000 / 5	800070 (5 gallons)
MTU Detroit Diesel Australia	Power Cool - HB500	9000 / 3	
Avia	Antifreeze APN	9000 / 5	
BASF	Glysantin G30	9000 / 3	X00058072 (canister) X00058071 (barrel)
	Glysantin G48	9000 / 5	X00058054 (25 l) X00058053 (210 l)
BP Lubricants	Aral Antifreeze Extra	9000 / 5	
	Castrol Heavy Duty Extended Life Coolant	9000 / 3	
Castrol	Castrol Antifreeze NF	9000 / 5	
	Castrol Radicool NF	9000 / 5	
CCI Corporation	L 415	9000 / 3	
CCI Manufacturing IL Corporation	C 521	9000 / 3	
Classic Schmierstoff GmbH	Classic Kolda UE G48	9000 / 5	
Comma Oil & Chemicals	Comma Xstream G30	9000 / 3	
	Comma Xstream G48	9000 / 5	
Detroit Diesel Corp.	Power Cool Antifreeze	9000 /3	
	Power Cool Plus Coolant	9000 / 3	
ExxonMobil	Mobil Delvac Extended Life Coolant	9000 / 3	
	Mobil Antifreeze Advanced	9000 / 3	
	Mobil Antifreeze Extra	9000 / 5	
	Esso Antifreeze Advanced	9000 / 3	
	Esso Antifreeze Extra	9000 / 5	
Fuchs	Maintain Fricofin	9000 / 5	
	Maintain Fricofin G12 Plus	9000 / 3	X00058074 (barrel) X00058073 (canister)
Ginouves	York 716	9000 / 5	

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Manufacturer	Brand name	Operating time Hour / Year	Comments / Part No.
Kemetyl	Carix Premium G48	9000 / 5	
Maziva	INA Antifriz Al Super	9000 / 5	
Mol-Lub	EVOX Extra G48 Antifreeze concentrate	9000 / 5	
Nalco	Nalcool 5990	9000 / 3	
Nalco Australia	Nalcool NF 48	9000 / 5	
Old World Industries	Blue Mountain Heavy Duty Extended Life Coolant	9000 / 3	
	Fleet Charge SCA precharged heavy duty coolant / Antifreeze	9000 / 3	
	Final Charge Global Extended Life Coolant/Antifreeze	9000 / 3	
OMV	OMV Coolant Plus	9000 / 5	
	OMV Coolant SF	9000 / 3	
Ravensberger Schmierstoffvertrieb GmbH	RAVENOL Kühlerfrostschutz silikatfrei	9000 / 3	
Recochem	R 542	9000 / 3	
Shell	Shell HD Premium	9000 / 3	
Sotragal – Mont Blanc	Antigel Power Cooling Concentrate	9000 / 5	
Total	Glacelf MDX	9000 / 5	
Valvoline	Zerex G-30	9000 / 3	
	Zerex G-48	9000 / 5	

Table 69:

TIM-ID: 0000034540 - 001

9.8.2 Corrosion-inhibiting antifreeze ready mixtures for two-cycle engines

Corrosion-inhibiting antifreeze ready mixtures

Manufacturer	Brand name	Operating time Hour / Year	Comments / Part No.
Tognum America Inc.	Power Cool Universal (35/65)	9000 / 5	800085 (5 gallons) 800084 (55 gallons)
	Power Cool Universal (50/50)	9000 / 5	800069 (1 gallon) 8000 71 (5 gallons)
MTU Detroit Diesel Australia	Power Cool - HB500 Premix 50/50	9000 / 3	
Bantleon	Avilub Antifreeze Mix (50%)	9000 / 5	X00049213 (210l)
BP Lubricants	Castrol Heavy Duty Extended Life Prediluted Coolant (50/50)	9000 / 3	
Castrol	Castrol Antifreeze NF Premix (45%)	9000 / 5	
	Castrol Radicool NF Premix (45%)	9000 / 5	
CCI Corporation	L 415 (50%)	9000 / 3	
CCI Manufacturing IL Corporation	C 521 (50%)	9000 /3	
Detroit Diesel Corp.	Power Cool Antifreeze premix 50/50	9000 / 3	
	Power Cool Plus Prediluted Coolant (50/50)	9000 / 3	
ExxonMobil	Mobil Delvac Extended Life Prediluted Coolant (50/50)	9000 / 3	
Sotragal – Mont Blanc	L.R.-30 Power Cooling (44%)	9000 / 5	
	L.R.-38 Power Cooling (52%)	9000 / 5	
Old World Industries	Blue Mountain Heavy Duty Extended Life Prediluted Coolant (50/50)	9000 / 3	
	Final Charge Global Extended Life Prediluted Coolant / Antifreeze (50/50)	9000 / 3	
Tosol-Sintez	Glysantin Alu Protect G30 Ready Mix	9000 - 3	
	Glysantin Alu Protect Plus G48 Ready Mix	9000 / 5	
Total	Coolelf MDX (40%)	9000 / 5	

Table 70:

TIM-ID: 0000034556 - 001

9.8.3 Water-soluble corrosion inhibitor concentrates for two-cycle engines

Water-soluble corrosion inhibitor concentrates

Manufacturer	Brand name	Operating time Hour / Year	Comments / Part No.
MTU Friedrichshafen	Coolant CS100	6000 / 2	X00057233 (20 l) X00057232 (210 l)
Tognum America Inc.	Power Cool Plus 6000	6000 / 2	colored green 23533527 23533526
Arteco	Freeco NBI	6000 / 2	
BASF	Glysacorr G93-94	6000 / 2	X00058062 (canister) X00054105 (barrel)
BP Lubricants	Castrol Extended Life Corrosion Inhibitor	9000 / 2	
CCI Corporation	A 216	6000 / 2	
CCI Manufacturing IL Corporation	A 216	6000 / 2	X00051509 (208 l)
Chevron	Texcool A – 200	6000 / 2	
Detroit Diesel Corp.	Power Cool Plus 6000	6000 / 2	colored red
	Power Cool 2000	6000 / 2	
	Power Cool 3000	4000 / 2	
Drew Marine	Drewgard XTA	6000 / 2	
ExxonMobil	Mobil Delvac Extended Life Corrosion Inhibitor	6000 / 2	
Ginouves	York 719	6000 / 2	
Old World Industries	A 216	6000 / 2	
Penray	Pencool 2000	6000 / 2	
	Pencool 3000	4000 / 2	
Valvoline	ZEREX G-93	6000 / 2	

Table 71:

TIM-ID: 0000019161 - 001

10 Flushing and Cleaning Specifications for Engine Coolant Circuits

10.1 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 96). Otherwise there is a danger of corrosion!

	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

TIM-ID: 0000019196 - 001

10.2 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	X00057277 (25 kg)
For assemblies:				
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	X00056750 (25 kg)
Novamax	Euron 13084[)]	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	X00054106 (10 kg)
Schülke & Mayr GmbH	Grotanol SR1[6)]	1% by volume	Liquid	X00057297 (10 kg) X00057598 (200 kg)
Troy Chemical Company	Troyshield SC1[6)]	1% by volume	Liquid	7)

Table 72:

1) Not suitable for galvanized surfaces	5) Bacteria contamination up to 10^4
2) For greasy lime deposits	6) Bacteria contamination up to $>10^4$, contamination with fungi and yeast
3) Preferred for heavy lime deposits	7) Not stocked by MTU
4) For heavy lime deposits	

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10.3 Engine coolant circuits – Flushing

1. Drain engine coolant.
2. Measure pH-value of the fresh water (MTU test kit or electric pH-value measuring device).
3. Fill coolant circuit with fresh water.

	Never pour cold water into a hot engine!

4. Preheat, start and run engine until warm.
5. Run engine for approx. 30 minutes at increased speed.
6. Take flush-water sample (engine-coolant-sample extraction cock).
7. Shut down engine.
8. Drain flush water.
9. Measure pH value of flush-water sample using the MTU test kit or electric pH value measuring device and compare with the pH value of the fresh water.
   a) pH value difference < 1: Fill system with treated coolant and start engine.
   b) pH value difference > 1: Fill system with fresh flush water and repeat flushing process.
   c) If the pH value difference is still > 1 after 4 to 5 flushing operations: Clean coolant circuit (→ Page 128) and also clean assemblies if necessary (→ Page 129).

	Refer to the engine Operating Instructions for additional information.

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10.4 Engine coolant circuits – Cleaning

1. Prepare concentrated solution of detergent for coolant circuits (→ Page 126) in warm, fresh water.
2. In the case of powdered products, stir until the detergent is completely dissolved and without sediment.
3. Pour solution together with fresh water into coolant circuit.
4. Start engine and run until warm.
5. Run engine for approx. 2 hours at increased speed.
6. Shut down engine.
7. Drain off cleaning agents and flush the engine coolant circuit with fresh water.
8. Take flush-water sample (engine-coolant-sample extraction cock).
9. Measure pH value of flush-water sample using the MTU test kit or electric pH value measuring device and compare with the pH value of the fresh water.
   a) pH value difference **<** 1: Fill system with treated coolant and start engine.
   b) pH value difference **>** 1: Clean assemblies (→ Page 129).

	Refer to the engine Operating Instructions for additional information.

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10.5 Cleaning assemblies

1. Remove, disassemble and clean assemblies that are exposed to heavy sludge deposits e.g. expansion tanks, preheating units, heat exchangers (coolant cooler, oil heat-exchanger, intercooler, charge-air pre-heater, fuel preheater etc.) and lower sections of pipework.
2. Before cleaning, examine degree of contamination on water sides.
3. If greasy lime deposits are found, first degrease the water side.
4. Stubborn deposits caused by oil mist in intercoolers can be removed with Kluthe Hakutex 60.
5. Remove hard lime deposits with a decalcifying product. In the event of stubborn lime deposits, a 10% inhibited hydrochloric acid solution may have to be used.
6. Dissolve deposits on and in heat-exchanger elements in a heated cleaning bath. Use only approved detergents (→ Page 126) in the permissible concentration and observe the manufacturer's specifications!

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

7. Clean individual components such as housings, covers, pipes, sight glasses, heat-exchanger elements 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 pressure of the water jet too high (may damage cooler fins, for example).

8. 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.
9. Check that all components are in perfect condition, repair or replace as necessary.
10. 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.
11. After installing all assemblies, flush engine coolant circuit once (→ Page 127).
12. Check coolant system for leaks during initial operation of engine.

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

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10.6 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 (→ Page 126) 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.

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 the circuit, make sure the system is free of contaminants.

Refill must be performed directly after flushing to avoid the risk of corrosion!

TIM-ID: 0000019202 - 002

11 Overview of Changes

11.1 Revision overview from version A001061/34 to A001061/35

Seq. No.	Page	Subject	Action	Measure
1	05	Preface	revised	Internet address
2	07	Lubricants for four-stroke engines	revised	complete chapter
3	15	Lubricating greases	added	separate subsection
4	16	Lubricants for gas engines	added	separate subsection
5	18	Engine oils for two-cycle engines	revised	complete chapter
6	20	Coolant	revised	complete chapter divided into subsections
7	32	Diesel fuels	revised or added	complete chapter divided into subsections content changes with diesel fuel approvals added: Diesel fuels for engines with exhaust aftertreatment
8	53	Biodiesel	revised	Table Note changes to content
9	56	Approved anti-wear additives	revised	Concentration for use
10	57	Heating oil EL	Cetane number Sulfur content Lubricity Valve wear	paragraph omitted paragraph omitted paragraph omitted paragraph omitted
11	58	Fuel additives / microorganisms in fuel	Approved biocides added	grotamar 82
12	59	Fuel for gas engines	revised	complete chapter
13	67	NO_x reducing agent AUS 32 for SCR after-treatment systems	added	complete chapter

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Seq. No.	Page	Subject	Action	Measure
14	69	Approved engine oils and lubricating greases	revised	complete chapter
15	96	Approved coolants	revised	complete chapter
16		Preservation specifications	omitted	complete chapter New publication no. : A001070/...
17	125	Flushing and Cleaning Specifications for Engine Coolant Systems	revised	complete chapter
18	133	Appendix A	added	complete chapter

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12 Appendix A

12.1 Index

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