

Technical Publication

Fluids and Lubricants
Specification

A001061/29E

(all MTU-Series and World Engines)



Printed in Germany

© 2004 Copyright MTU Friedrichshafen GmbH

Diese Veröffentlichung einschließlich aller ihrer Teile ist urheberrechtlich geschützt. Jede Verwertung oder Nutzung bedarf der vorherigen schriftlichen Zustimmung der MTU Friedrichshafen GmbH. Das gilt insbesondere für Vervielfältigung, Verbreitung, Bearbeitung, Übersetzung, Mikroverfilmungen und die Einspeicherung und / oder Verarbeitung in elektronischen Systemen, einschließlich Datenbanken und Online-Diensten.

Das Handbuch ist zur Vermeidung von Störungen oder Schäden beim Betrieb zu beachten und daher vom Betreiber dem jeweiligen Wartungs- und Bedienungspersonal zur Verfügung zu stellen.
Änderungen bleiben vorbehalten.

Printed in Germany

© 2004 Copyright MTU Friedrichshafen GmbH

This Publication is protected by copyright and may not be used in any way whether in whole or in part without the prior written permission of MTU Friedrichshafen GmbH. This restriction also applies to copyright, distribution, translation, microfilming and storage or processing on electronic systems including data bases and online services.

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.

Imprimé en Allemagne

© 2004 Copyright MTU Friedrichshafen GmbH

Tout droit réservé pour cet ouvrage dans son intégralité. Toute utilisation ou exploitation requiert au préalable l'accord écrit de MTU Friedrichshafen GmbH. Ceci s'applique notamment à la reproduction, la diffusion, la modification, la traduction, l'archivage sur microfiches, la mémorisation et / ou le traitement sur des systèmes électroniques, y compris les bases de données et les services en ligne.

Le manuel devra être observé en vue d'éviter des incidents ou des endommagements pendant le service. Aussi recommandons-nous à l'exploitant de le mettre à la disposition du personnel chargé de l'entretien et de la conduite.

Modifications réservées.

Impreso en Alemania

© 2004 Copyright MTU Friedrichshafen GmbH

Esta publicación se encuentra protegida, en toda su extensión, por los derechos de autor. Cualquier utilización de la misma, así como su reproducción, difusión, transformación, traducción, microfilmación, grabación y/o procesamiento en sistemas electrónicos, entre los que se incluyen bancos de datos y servicios en línea, precisa de la autorización previa de MTU Friedrichshafen GmbH.

El manual debe tenerse presente para evitar fallos o daños durante el servicio, y, por dicho motivo, el usuario debe ponerlo a disposición del personal de mantenimiento y de servicio.

Nos reservamos el derecho de introducir modificaciones.

Stampato in Germania

© 2004 Copyright MTU Friedrichshafen GmbH

Questa pubblicazione è protetta dal diritto d'autore in tutte le sue parti. Ciascun impiego o utilizzo, con particolare riguardo alla riproduzione, alla diffusione, alla modifica, alla traduzione, all'archiviazione in microfilm e alla memorizzazione o all'elaborazione in sistemi elettronici, comprese banche dati e servizi on line, deve essere espressamente autorizzato per iscritto dalla MTU Friedrichshafen GmbH.

Il manuale va consultato per evitare anomalie o guasti durante il servizio, per cui va messo a disposizione dall'utente al personale addetto alla manutenzione e alla condotta.

Con riserva di modifiche.

Impresso na Alemanha

© 2004 Copyright MTU Friedrichshafen GmbH

A presente publicação, inclusive todas as suas partes, está protegida pelo direito autoral. Qualquer aproveitamento ou uso exige a autorização prévia e por escrito da MTU Friedrichshafen GmbH. Isto diz respeito em particular à reprodução, divulgação, tratamento, tradução, microfilmagem, e a memorização e/ou processamento em sistemas eletrônicos, inclusive bancos de dados e serviços on-line.


Para evitar falhas ou danos durante a operação, os dizeres do manual devem ser respeitados. Quem explora o equipamento economicamente consequentemente deve colocá-lo à disposição do respetivo pessoal da conservação, e à disposição dos operadores.

Salvo alterações.

Amendment Service!

Amendments to this publication will be sent to you in the form of a new publication as and when they are issued provided that you complete and return the receipt section on the reverse of this page.

	<div data-bbox="1278 1406 1461 1630" style="border: 1px solid black; width: 115px; height: 100px; margin: 0 auto;"></div> <p data-bbox="1043 1787 1150 1816">Postcard</p> <p data-bbox="1043 1883 1414 2063">MTU Friedrichshafen GmbH Department SCT 88040 Friedrichshafen GERMANY</p>
--	--



Please use block capitals!



Receipt

Tick one box only!

- Update as (PDF) file by E-mail
- Update as (PDF) file as CD-ROM
- Update in hardcopy form

Publication number: **A001061/29E**

Name

Manufacturer

Department E-mail

Fax Telephone

Street

Postal box number

(Postal code) City

Country

Table of contents

	Page
1	Preface 5
2	Lubricants 6
2.1	Engine Oils 6
2.1.1	Requirements for MTU Approval (diesel engines) 6
2.1.2	Special Features 6
2.1.2.1	Engine Oils for Series 2000 and Series 4000 Engines 6
2.1.2.2	Restrictions for applications with Series 595, 1163 and 8000 6
2.1.3	Engine Oil Requirements for Gas Engines 7
2.1.4	Viscosity Grade Selection 7
2.1.5	Oil Drain Intervals for Diesel Engines 8
2.1.6	Oil Drain Intervals for Gas Engines 8
2.1.7	Special Additives 8
2.1.8	Laboratory Analysis 9
2.1.8.1	General 9
2.1.8.2	Spectrometric Oil Analysis 9
2.1.8.3	Used-oil Analysis 9
2.1.9	Use of High-Sulfur Diesel Fuel 11
2.1.10	Use of Low- Sulfur Diesel Fuel 11
2.1.11	Minimum Requirements for Operational Checks 11
2.2	Lubricating Greases 12
2.2.1	Requirements 12
2.2.2	Lubricating Greases for General Applications 12
2.2.3	High Melting-point Greases 12
2.2.4	Coupling Internal Centerings 12
2.3	Special-Purpose Lubricants 12
2.3.1	Turbochargers 12
2.3.2	Gear Couplings 12
3	Coolants 13
3.1	Requirements 13
3.2	Fresh water 13
3.3	Coolant Additives 13
3.3.1	Emulsifiable Corrosion Inhibiting Oils 13
3.4	Antifreezes with Corrosion Inhibiting Properties 14
3.4.1	General 14
3.4.2	Limitations on the Use of Corrosion-Inhibiting Antifreezes 14
3.4.3	Corrosion-Inhibiting Antifreezes for Special Applications 14
3.5	Water-soluble Corrosion Inhibitors 14
3.5.1	General 14
3.6	Coolant Additives for Aluminum-free Engine Series (Series 2000 C&I, Series 4000 C&I) 15
3.7	Operational Monitoring 15
3.8	Limit Values for Prepared Coolants Table 8 17
3.9	Stability of Coolant Additives in Storage up to Max. 35°C Table 9 17
4	Fuels 18
4.1	Diesel Fuels 18
4.1.1	Selection of a Suitable Diesel Fuel 18
4.1.2	Requirements 19
4.1.3	Low-Sulfur Diesel Fuels 19
4.1.3.1	Approved Anti-Wear Additives Table 11 19
4.1.4	Diesel Fuels in Winter Operation 19
4.1.4.1	Flow improvers 19
4.2	Heating Oil EL 20
4.2.1	Cetane Number 20
4.2.2	Sulfur Content 20
4.3	Supplementary Fuel Additives 20

4.4	Microorganisms in Fuel	21
4.4.1	Approved Biocides Table 12	21
4.5	Fuel for Gas Engines	21
4.5.1	Requirements for Fuel Gas	22
5	Preservatives	24
5.1	Requirements	24
5.2	Types of Preservation	24
5.3	Initial Operation Oils and Corrosion Inhibiting Oils for Internal Preservation.....	24
5.4	Corrosion Inhibitors for External Preservation	24
5.5	Corrosion Inhibiting Oils for Internal Preservation of the Fuel System	24
6	Approved Fluids and Lubricants	25
6.1	Engine Oils	25
6.1.1	Single-grade Oils - Category 1, SAE-grades 30 and 40 for Diesel Engines	25
6.1.2	Single-grade Oils - Category 1, SAE-grade 40 for Gas Engines	26
6.1.3	Multi-grade Oils - Category 1, SAE-grades 10W-30 and 15W-40 for Diesel Engines.....	27
6.1.4	Single-grade Oils - Category 2, SAE-grades 30 and 40 for Diesel Engines	28
6.1.5	Multi-grade Oils - Category 2, SAE-grades 5W-40, 10W-40, 15W-40 and 20W-40 for Diesel Engines .	29
6.1.6	Multi-grade Oils - Category 3, SAE-grades 5W-30, 5W-40 and 10W-40 for Diesel Engines	32
6.2	Lubricating Greases for General Applications	34
6.3	Coolant Additives	35
6.3.1	Emulsifiable Corrosion Inhibiting Oils	35
6.3.2	Corrosion-Inhibiting Antifreeze-Concentrates (valid for all series)	35
6.3.3	Corrosion-Inhibiting Antifreezes, Ready-Mixed (valid for all series).....	36
6.3.4	Corrosion Inhibiting Antifreezes - Concentrates - for Aluminium-Free Series 2000 C&I and 4000 C&I Engines	36
6.3.5	Corrosion Inhibiting Antifreezes - Ready Mix - for Aluminium-Free Series 2000 C&I and 4000 C&I Engines	36
6.3.6	Corrosion-inhibiting Antifreezes for Special Applications	37
6.3.7	Water-Soluble Corrosion Inhibitor Concentrates (valid for all series).....	37
6.3.8	Water-soluble Corrosion Inhibitors - Concentrates - for Aluminum-Free Series 2000 C&I and 4000 C&I Engines	37
6.3.9	Water-soluble Corrosion Inhibitors - Ready Mix - for Aluminum-Free Series 2000 C&I and 4000 C&I Engines	38
6.4	Preservatives.....	39
6.4.1	Initial Operation Oils and Corrosion Inhibiting Oils for Internal Preservation.....	39
6.4.2	Corrosion Inhibitors for External Preservation	39
6.4.3	Corrosion Inhibiting Oils for Internal Preservation of the Fuel System	39
6.4.4	Corrosion Inhibitors for Internal Preservation of the Cooling System.....	40
7	Preservation.....	41
7.1	Warnings	41
7.2	Preface	41
7.2.1	Engine Preservation - Overview.....	42
7.2.2	Overview of Types of Preservation	42
7.3	Short-time Shutdown.....	43
7.4	Shutdown	43
7.4.1	Engine in Installed Condition.....	43
7.4.2	Engine Removed.....	43
7.4.3	Putting Shut-Down Engines into Operation	43
7.5	Preservation of Diesel Engines	44
7.5.1	Preservation of Cooling, Lubrication and Fuel Systems	44
7.5.2	Preservation of the Combustion Chamber.....	45
7.5.3	External Preservation	45
7.5.4	Re-preservation.....	46
7.5.5	De-preservation.....	46
7.6	Preservation of Gas Engines	47
7.6.1	Preservation of Cooling and Lubrication Systems	47
7.6.2	Preservation of the Combustion Chamber.....	47
7.6.3	External Preservation	48

7.6.4	Re-preservation.....	48
7.6.5	De-preservation.....	48
7.7	Special Packing.....	49
7.7.1	General Information on Special Packing.....	49
7.7.2	Maintenance Intervals.....	49
7.7.3	Envelopes of Laminated Material.....	50
7.7.4	Desiccant.....	50
7.7.4.1	Calculation of required desiccant.....	51
7.7.4.2	Calculation Example for Desiccant Units.....	51
7.7.4.3	Humidity Indicator.....	52
7.7.5	Order Nos. for Packing Materials.....	53
7.7.6	Special Packing Procedure for Finished Products.....	53
7.7.6.1	Preparation for Special Packing.....	53
7.7.6.2	Transport Locking Device.....	53
7.7.6.3	Special Packing of an Engine.....	53
7.7.6.4	Installation of Humidity Indicator.....	55
7.7.6.5	Cushioning of Engine Edges and Corners.....	56
7.7.6.6	Location of Desiccant Units.....	56
7.7.6.7	Laminated Aluminum Foil Sealing.....	56
7.7.7	Special Packing Checks.....	57
7.7.7.1	Humidity Check.....	57
7.7.7.2	Desiccant Replacement.....	58
7.7.8	Repair of Special Packing.....	58
7.7.9	Manual Welding Unit.....	58
7.8	Form Sheets.....	59
7.8.1	Preservation Check Sheet.....	59
7.8.2	Monitoring Sheet for Engines in Special Packing.....	61
7.8.3	Check Sheet for De-Preservation of Engines in Special Packing.....	63
8	Flushing and Cleaning Specifications for Engine Coolant Systems.....	65
8.1	General Information.....	65
8.1.1	Test Equipment, Auxiliary Materials and Fluids and Lubricants.....	65
8.2	Approved Cleaning Products.....	66
8.3	Flushing Engine Coolant Systems.....	66
8.4	Cleaning Engine Coolant Systems.....	67
8.5	Cleaning Components.....	67

1 Preface

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

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

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

Test standards for fluids and lubricants:

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

NOTE:

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

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



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

These regulations are contained in the manufacturers' instructions, legal requirements and technical guidelines valid in the individual countries. Great differences can apply from country to country and a generally valid guide to applicable regulations for fluids and lubricants is therefore not possible within this publication.

Users of the products named in these specifications are therefore obliged to inform themselves of the locally valid regulations. MTU accepts no responsibility whatsoever for improper or illegal use of the fluids and lubricants which it has approved.

2 Lubricants

2.1 Engine Oils

2.1.1 Requirements for MTU Approval (diesel engines)

The MTU requirements for approval of engine oils for diesel engines are contained in the MTU Factory 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.

The engine-oil manufacturer will be notified in writing after his product has been approved.

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

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

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

2.1.2 Special Features

2.1.2.1 Engine Oils for Series 2000 and Series 4000 Engines

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

Performance Requirements for Series 2000 and Series 4000 Engine Oils

Table 1

Oil category 1	Minimum specification API CG-4/CH-4 and ACEA E2-96
Oil category 2	Specification ACEA E3-96; E5-02
Oil category 3	Specification ACEA E4-99; E5-02

Required Chemical and Physical Properties for Engine Oils

Table 2

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

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

NOTE:

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

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

2.1.2.2 Restrictions for applications with Series 595,1163 and 8000



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

Only Category 2 or 3 single-grade oils are to be used with Series 8000 engines.

2.1.3 Engine Oil Requirements for Gas Engines

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

2.1.4 Viscosity Grade Selection

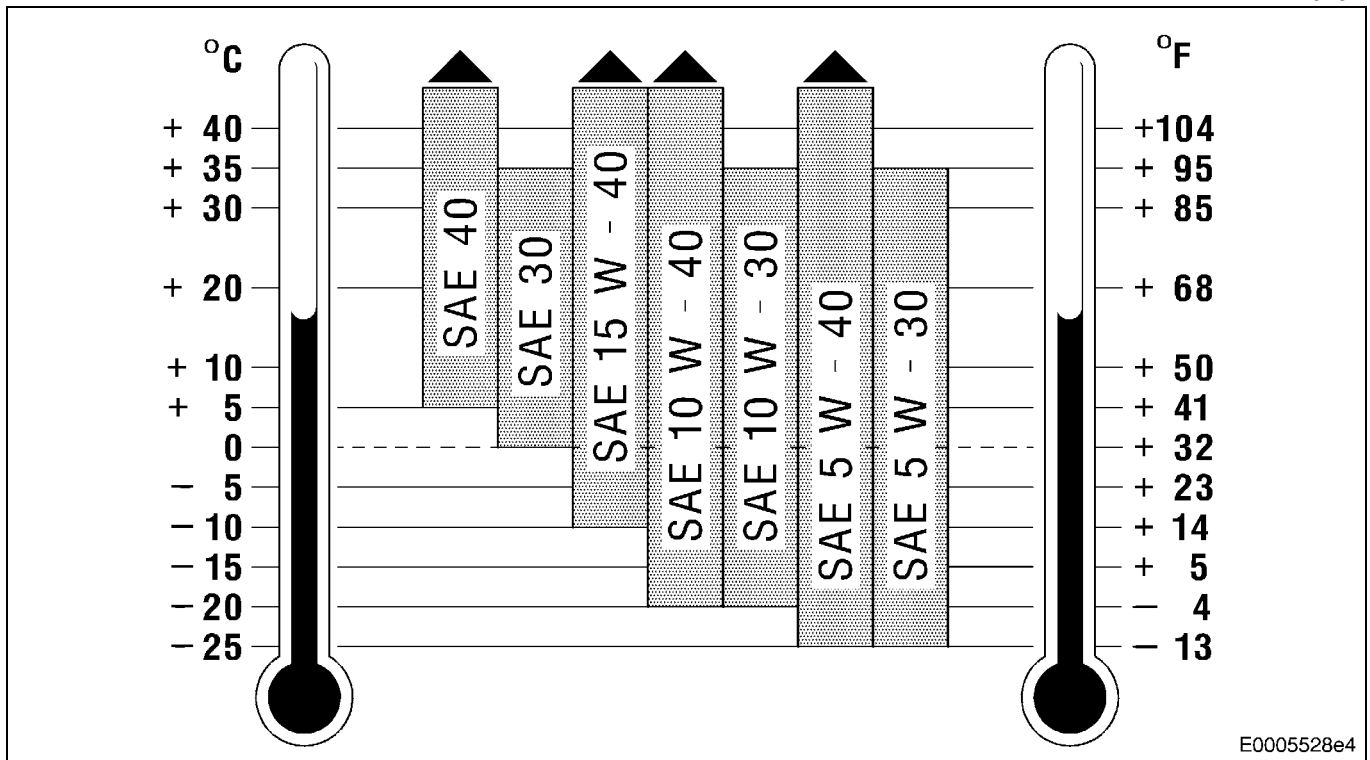
Selection of the viscosity grade is based primarily on the ambient temperature at which the engine is to be started and operated. If the relevant performance criteria are observed, the engines can be operated both with single-grade and multi-grade oils, depending on application. Standard values for the temperature limits in each viscosity grade are shown in Chart 1.

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



Viscosity grade SAE 40 is stipulated for gas engines!

Chart 1



E0005528e4

2.1.5 Oil Drain Intervals for Diesel Engines

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

The intervals quoted (Table 3) are guidelines based on operational experience and are valid for applications with a standard load profile.

Oil drain intervals

Table 3

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

The oil drain intervals in the table are recommended guidelines when using diesel fuels with < 0.5% sulfur content. The limit values for used oil given in Table 4 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 2.1.9 "Use of High-Sulfur Fuel")

New oils are to be chosen that have total base numbers appropriate for the sulfur content of the fuel used (see 2.1.8 "Laboratory Analysis").

In applications with short operating periods the engine oils must be changed every two years at the latest irrespective of the category.

Engine oils with enhanced corrosion-inhibiting properties (see 6.1.1 and 6.4.1) must be changed every 3 years at the latest.

In individual cases the engine oil drain interval can be optimized by regular laboratory analyses and appropriate engine inspections carried out in consultation with the appropriate MTU Service Centre:

The first or "reference" sample of the new oil must be taken from the engine after approximately 1 hour's operation.

Further samples are to be analyzed at specific intervals (see 2.1.8 "Laboratory Analysis").

The appropriate engine inspections are to be carried 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).

2.1.6 Oil Drain Intervals for Gas Engines

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

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

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

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

Optimized operating times are given in the applicable Maintenance Schedules and/or Operating Instructions.

2.1.7 Special Additives

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

2.1.8 Laboratory Analysis

2.1.8.1 General

Engine-oil analyses can be carried out by the MTU laboratory, oil-analysis laboratories or the oil manufacturer.

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

The following data are required:

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

The following must be submitted (for each oil change):

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

2.1.8.2 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

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

2.1.8.3 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 analysed at least once per year and during each oil change and under certain conditions, depending on application and the engine's operating conditions, sampling/analysis should take place more frequently.

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

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

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

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

Some of the signs of oil deterioration are:

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

Analytical Limit Values for Diesel Engine Oils**Table 4**

	Test Method	Limit Value
Viscosity at 100 °C Max. mm ² /s	ASTM D 445 DIN 51562	SAE 30 SAE 5W-30 15.0 SAE 10W-30
		SAE 40 SAE 10W-40 19.0 SAE 15W-40
Min. mm ² /s		SAE 30 SAE 5W-30 9.0 SAE 10W-30
		SAE 40 SAE 10W-40 10.5 SAE 15W-40
Flash point °C (COC)	ASTM D 92 ISO 2592	Min. 190
Flash point °C (PM)	ASTM D 93 EN 22719	Min. 150
Soot	DIN 51452 CEC-L-82-A-97	Max. 2.5% by weight (Oil category 1) Max. 3.0 % by weight (Oil categories 2 and 3)
Total base number (TBN) (mg KOH/g)	ASTM D 2896 ISO 3771	Min. 50% of new-oil value
Water	DIN 51777	Max. 0.2% by volume
Ethylene glycol	ASTM D 2982 DIN 51375	Max. 50 mg/kg
Ageing products (1700-1750 cm ⁻¹)	IR-analysis	Max. 25 A/cm
Nitration products 1630 cm ⁻¹)	IR-analysis	Max. 25 A/cm

Analytical Limit Values for Gas Engine Oils SAE 40**Table 5**

	Test Method	Limit Value
Viscosity at 100 °C Max. mm ² /s Min. mm ² /s	ASTM D 445 DIN 51562	17,5 11,5
Total contamination	DIN 51365	Max. 0.5% by weight
Total base number (mg KOH/g)	ASTM D 2896 ISO 3771	Min. 3
Acid number (mgKOH/g)	ASTM D 664	New oil value +2.5
pH value		Min. 4.5
Water	DIN 51777	Max. 0.2% by volume
Oxidation at 5.8 μm	IR	Max. 20 A/cm
Nitration at 6.1 μm	IR	Max. 20 A/cm
Wear elements (mg/kg) Iron (Fe) Lead (Pb) Aluminum (Al) Copper (Cu) Tin (Sn) Silicon (Si)	RFA, ICP	Max. 30 mg/kg Max. 20 mg/kg Max. 10 mg/kg Max. 20 mg/kg Max. 5 mg/kg Max. 15 mg/kg ¹⁾

¹⁾ = Where landfill gas or other special gas types with higher Si-contents are in use, ensure metal contents >15ppm.

2.1.9 Use of High-Sulfur Diesel Fuel

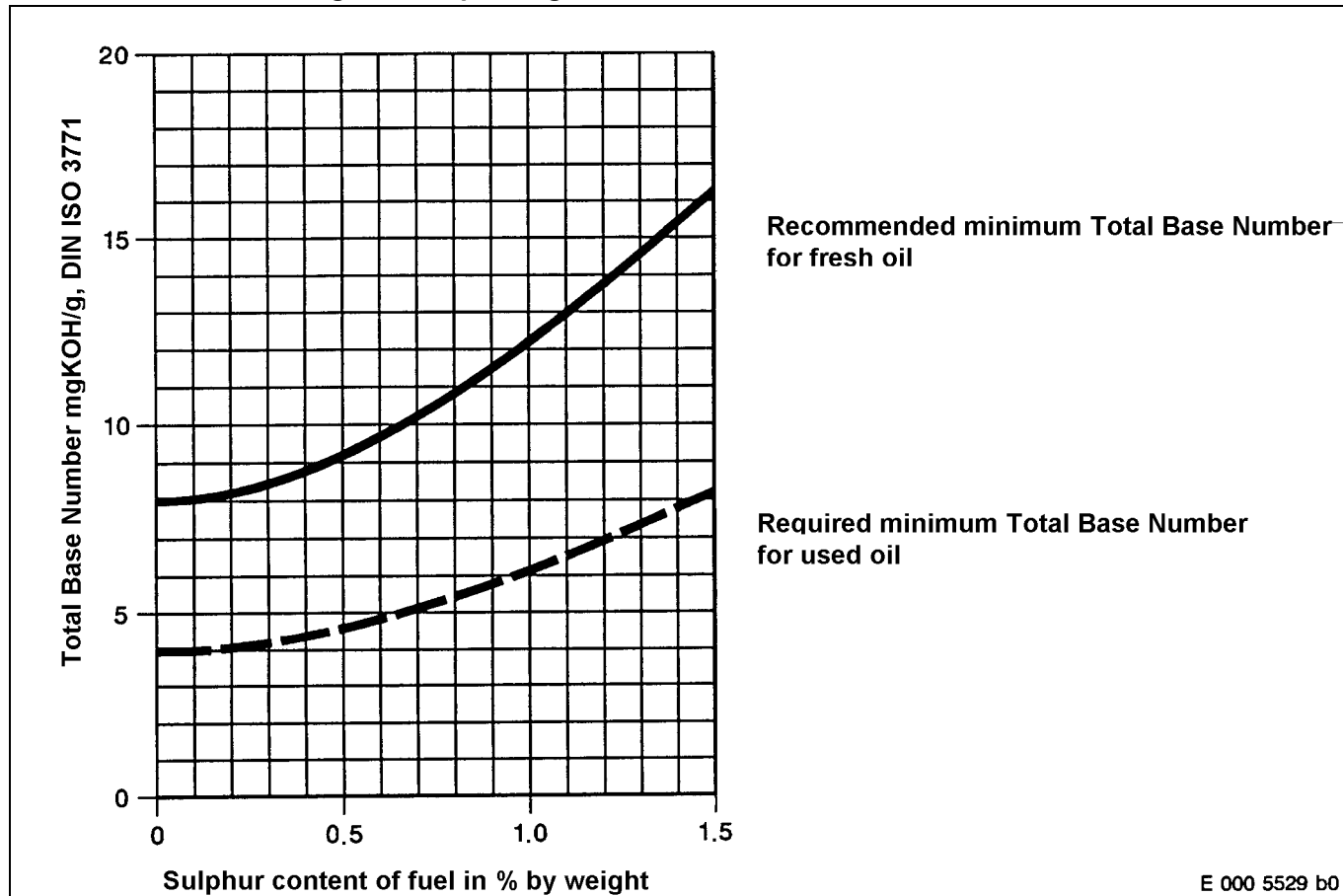
The following measures must be taken in the case of diesel fuels with a sulfur content above 0.5%:

- Use an engine oil with a total base number (TBN) (ASTM D 2896) above 8 mgKOH/g.
- Shortened oil-change intervals (see 2.1.5 Oil Drain Intervals for Diesel Engines).

Chart 2 (Total Base Number) gives the recommended initial TBN for new oil and the recommended minimum TBN for used oil depending on the sulfur content of the diesel fuel.

Total Base Number for engine oil depending on sulfur content of the diesel fuel:

Chart 2



2.1.10 Use of Low- Sulfur Diesel Fuel

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

2.1.11 Minimum Requirements for Operational Checks

Oil analyses can be carried out using the MTU Test Kit. This test kit contains all the necessary equipment and instructions.

The following checks can be performed:

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

2.2 Lubricating Greases

2.2.1 Requirements

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

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

2.2.2 Lubricating Greases for General Applications

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

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

2.2.3 High Melting-point Greases

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

- Aero Shell Grease 15
- Optimol Inertox Medium

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

2.2.4 Coupling Internal Centerings

Lubricating grease for internal centerings:

- Esso Unirex N3

2.3 Special-Purpose Lubricants

2.3.1 Turbochargers

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

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

2.3.2 Gear Couplings

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

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

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

3 Coolants

3.1 Requirements

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



Mixing of different coolant additives and supplementary additives is prohibited!

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

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

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

3.2 Fresh water

For coolant preparation, use only clean, clear water with the following values (Table 6): If the limit values for the water are not achieved, its hardness or mineral content can be decreased by adding de-mineralized water.

Table 6

	Min.	Max.
Total earth alkalines ¹⁾ (Water hardness)	0 mmol/l 0°d	2.7 mmol/l 15°d
pH-value at 20°C	6.5	8.0
Chloride ions		100 mg/l
Anion total		200 mg/l

¹⁾ Common designations for water hardness in various countries:

- 1mmol/l = 5.6°d = 1 mg/kg CaCO₃
- 1°d = 17.9 mg/kg CaCO₃, USA hardness
 - = 1.79° French hardness
 - = 1.25° British hardness

3.3 Coolant Additives

3.3.1 Emulsifiable Corrosion Inhibiting Oils

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

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

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

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

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



Under unfavorable conditions, individual cases of bacterial attack may occur in the emulsifiable anti-corrosion oils. In such cases, and after consultation with the MTU chemical laboratory, the emulsion is to be treated with biocides.

Emulsifiable corrosion-inhibiting agents must not be used in engines with TB (plate-core heat exchanger) and TE-cooling systems in the 396 and 183 engine series. In addition, they must not be used in Series 4000 and 8000. Emulsifiable corrosion-inhibiting oils are not permitted for use in engines with coolant temperatures >90 °C, except in test stand runs and tests.

3.4 Antifreezes with Corrosion Inhibiting Properties

3.4.1 General

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

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

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



If a higher level of corrosion inhibiting antifreeze is used, a higher engine temperature will result.

3.4.2 Limitations on the Use of Corrosion-Inhibiting Antifreezes

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

- Series 538, 595 and 956/1163 engines:
These engines are equipped with heating facilities.
Because of their heat exchanger capacity, corrosion inhibiting antifreezes must not to be used.
- Series 099, 183, and 396 engines:
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 engines:
The use of corrosion inhibiting antifreeze in these engines is permitted at seawater temperatures of up to 25°C.
- Series 8000:
The use of corrosion-inhibiting antifreezes is not allowed for these engines.

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

3.4.3 Corrosion-Inhibiting Antifreezes for Special Applications

Propylene glycol-based corrosion-inhibiting antifreezes are stipulated for use in some types of applications. These products have a lower thermal conductivity than the usual ethylene glycol products. This brings about a higher temperature level in the engine. Chart 4 illustrates the determination of the concentration of propylene glycol products.

The product BASF G206, as per section 6.3.6, is available for use at extremely low temperatures (< -40°C). Chart 4 illustrates the determination of the level of concentration.

3.5 Water-soluble Corrosion Inhibitors

3.5.1 General

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

Only water-soluble corrosion inhibitors according to Section 6.3.7 are to be used in Series 8000 engines.

The watersoluble corrosion inhibitors recommended by MTU ensure adequate protection provided the correct concentrations are used. The individual concentration tolerances are given in Section 3.7, "Water-soluble Corrosion Inhibitors", Table 7.

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

NOTE:

Before the first use of water-soluble corrosion inhibitors and after every product change, the system must first be flushed out with water. This also applies to new engines. The necessary work and cleaning agents are described in the MTU Flushing and Cleaning Specification (appended to these Fluids and Lubricants Specifications).

Before longer periods out of operation (> 5 days), e.g. for maintenance work on an open engine, all coolant carrying components must be preserved by adding BASF P107 corrosion inhibitor as per Chapter 7.5.1.

3.6 Coolant Additives for Aluminum-free Engine Series (Series 2000 C&I, Series 4000 C&I)

All coolant additives listed under 6.3 are suitable for aluminum-free Series 2000 C&I and Series 4000 C&I engines. Note the limitations given under "Remarks".



Coolant additives given under 6.3.4, 6.3.5, 6.3.8 and 6.3.9 are not permitted for all other engine series!

3.7 Operational Monitoring

Freshwater examinations and frequent coolant checks are of prime importance in ensuring trouble-free engine operation. Freshwater 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 checks can be performed:

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

Permissible Concentrations

Table 7

	Min. % by vol.	Max. % by vol.
Emulsifiable corrosion inhibiting oils	1.0	2.0
Antifreezes with corrosion-inhibiting properties	35 Freeze protection to approx. -25°C	50 Freeze protection to approx. -40°C
Propylene glycol corrosion-inhibiting antifreeze***	35 Freeze protection to approx. -25°C	50 Freeze protection to approx. -40°C
BASF G206****	35 Freeze protection to approx. -18°C	65 Freeze protection to approx. -65°C
Water-soluble corrosion inhibitors		
- BASF Glyscorr G93-94*	9	11
- Ginouves York 719*		
- Valvoline ZEREX G-93*		
- Artec Havoline Extended Life Corrosion Inhibitor**		
- Artec Heavy Duty Extended Life Corrosion Inhibitor**		
- Caltex Corrosion Inhibitor Concentrate		
- Ondeo Nalco Alfloc 2000	3	4
- Ondeo Nalco Nalcool 2000		
- Ondeo Nalco Nalco 2000		
- Detroit Diesel Power Cool 2000		
- Penray Pencool 2000		
- Ondeo Nalco Alfloc 3477	7	11
- Fleetguard DCA-4L	5	6

* = See reference graph (◆) for water-soluble corrosion inhibitors (Chart 3)

= See reference graph (■) for water-soluble corrosion inhibitors (Chart 3)

*** = See reference graph (●) for propylene glycol corrosion-inhibiting antifreezes (Chart 4)

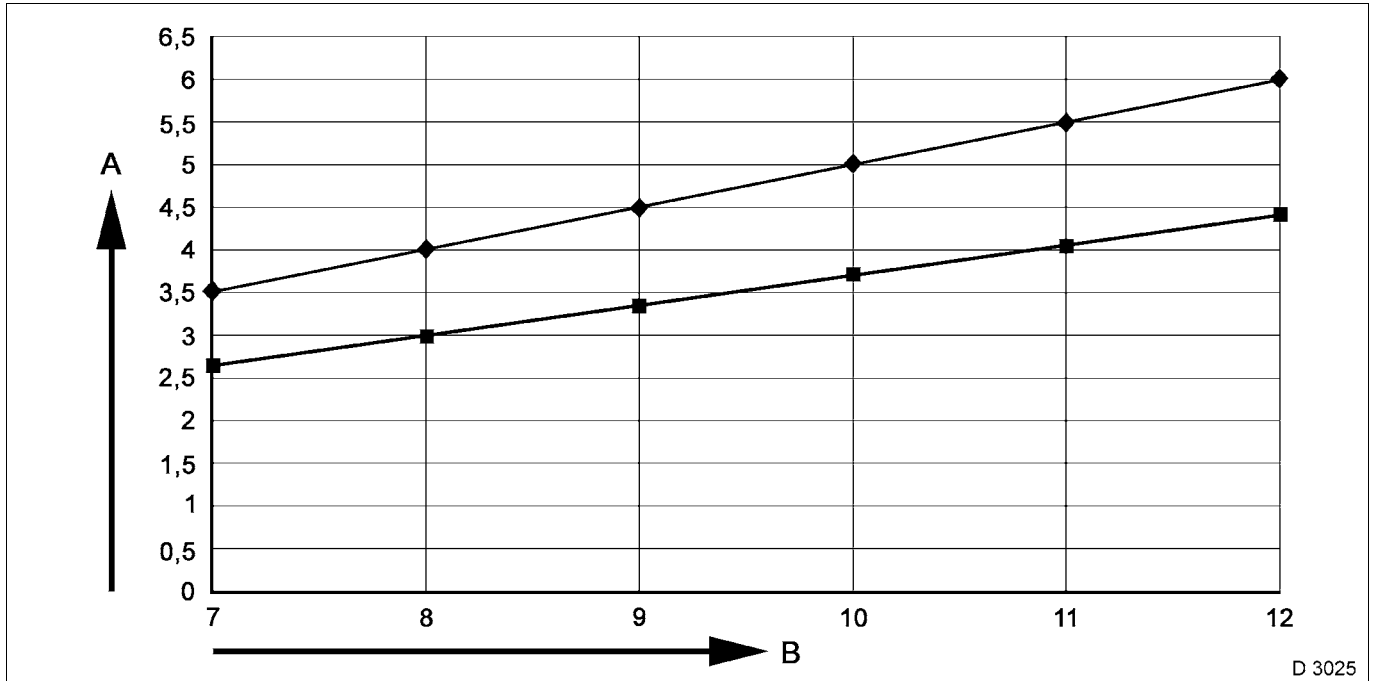
**** = See reference graph (✱) for BASF G206 (Chart 4)

Use Chart 3 together with the hand refractometer to determine concentration of the water-soluble corrosion inhibitors. Calibrate the hand refractometer with clean water at coolant temperature. The coolant temperature should be 20 - 30°C.

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

Reference graph for water-soluble corrosion inhibitors

Chart 3

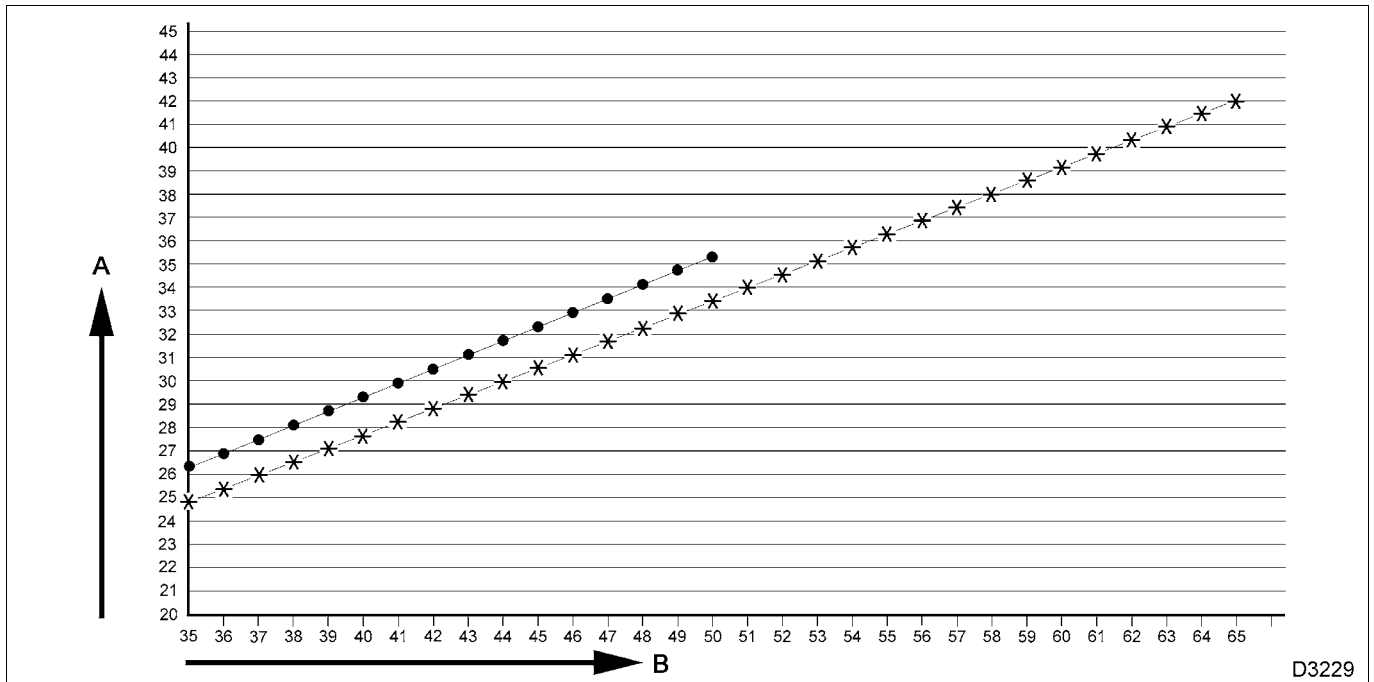


D 3025

A = Degree Brix at 20°C, read off from hand refractometer
 B = Concentration of water-soluble corrosion inhibitor in % by volume.

Reference graph for propylene glycol-based corrosion-inhibiting antifreezes and BASF G206

Chart 4



D3229

A = Degree Brix at 20°C, read off from hand refractometer
 B = % by volume concentration of corrosion-inhibiting antifreeze containing propylene glycol

NOTE:

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

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 spaces are to be cleaned (see the Flushing and Cleaning Specification for Engine Coolant Systems at the end of this specification).

3.8 Limit Values for Prepared Coolants

Table 8

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 inhibitors for engines containing aluminum parts.	Min. 7.0	Max. 9.0
– Water-soluble corrosion inhibitors for engines without aluminum parts.	Min. 7.0	Max. 11.0
Silicium	Min. 25 mg/l	

3.9 Stability of Coolant Additives in Storage up to Max. 35°C

Table 9

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

4 Fuels

4.1 Diesel Fuels

4.1.1 Selection of a Suitable Diesel Fuel

The quality of the fuel is very important for satisfactory engine performance, long engine service life and acceptable exhaust emission levels. The engines can be operated with most diesel fuels sold worldwide. The properties and limit values specified in Table 10 (fuels of comparable quality) ensure optimum engine performance.

Fuels of comparable quality with following test results:

Table 10

		Test Method		Limit Value
		ASTM	ISO	
Composition				The diesel fuel must be free of i-norganic acids, visible water, solid foreign matter and chlorous compounds.
Total contamination	Max.		EN 12662	24 mg/kg
Density at 15 °C	Min. Max.	D 1298 D 4052	EN 3675	0.820 g/ml 0.860 g/ml
API at 60 °F	Min. Max.	D 287		41 33
Viscosity at 40 °C	Min. Max.	D 445	EN 3104	1.5 mm ² /s 4.5 mm ² /s
Flash point	Min.	D 93	EN 2719	60 °C
Boiling curve: - Initial boiling point - Recovery at 250 °C - Recovery at 350 °C - Residue and loss	Max. Min. Max.	D 86	3405	160 - 220 °C 65% by volume 85% by volume 3% by volume
Water	Max.		EN 12937	300 mg/kg
Carbon residue of 10% distillation residue	Max.	D 189	EN 10370	0.30 % by weight
Oxide ash	Max.	D 482	EN 6245	0.01 by weight %
Sulfur ¹⁾	Max.	D 2622	EN 20884	0.5 by weight %
Cetane number	Min.	D 613	EN 5165	45
Cetane index	Min.	D 976	EN 4264	42
Copper corrosion 3 hrs at 50 °C	Degree of corrosion Max.	D 130	EN 2160	1a
Oxidation resistance	Max.	D 2274	EN 12205	25 g/m ³
Lubricity at 60°C	Max.		12156-1	0.46 mm
Filter plugging point		D 4359	EN 116	See Note ²⁾
Neutralisation number	Max.	D 974		0.2 mgKOH/g

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

²⁾ It is the fuel supplier's responsibility to provide a fuel that will assure correct engine operation at the expected minimum temperatures and under the given geographical and other local conditions.

4.1.2 Requirements

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

Distillate Fuels

- Diesel fuel as per EN 590
- Grade No. 1-D as per ASTM D 975-03
- Grade No. 2-D as per ASTM D 975-03

Marine Distillate Fuels

- DMX as per ISO 8217

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

- DMA as per ISO 8217 (not for Series 4000, 8000, S60)
- Other qualities available upon request

4.1.3 Low-Sulfur Diesel Fuels

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

A sulfur content of maximum 0.035% by weight has been permitted within the European Union since 1 January 2000. Sulfur contents at or below this level are designated "low in sulfur". We designate diesel fuels with a sulfur content of maximum 10 ppm as "sulfur free". Low sulfur diesel fuels are recommended for environmental reasons. In order to avoid problems with wear, lubricity additives, among other things, are added by the manufacturer.

On older series engines with cylinder heads without valve seat rings, the use of low-sulfur fuel (< 50 ppm) can lead to increased valve seat wear. This wear can be reduced by the addition of anti-wear additives. Approved additives are listed in Table 11 and must be added to the fuel. It is recommended that the additive be added before filling the tank with fuel.

4.1.3.1 Approved Anti-Wear Additives

Table 11

Manufacturer	Brand name	Concentration for use
Liqui Moly Jerg-Wielandstr.4 89081 Ulm Tel. 0731/1420-13 Tel. 0731/1420/-82	Blei-Ersatz	250 mg per 1kg
Tunap Industrie GmbH Bürgermeister-Seidl-Str. 2 82515 Wolfratshausen Tel. 08171/1600-0 Tel. 08171/1600/-91	Tunadd PS	250 mg per 1kg

4.1.4 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 before and after winter and in individual countries. If no frost-resistant diesel fuels are available, paraffin oil or aviation turbine fuel must be added before frosts occur. 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.

4.1.4.1 Flow improvers

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

The effectiveness of 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.

4.2 Heating Oil EL

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

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

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

4.2.1 Cetane Number

DIN 51 603 -1 does not specify the cetane number. If heating oil is used, the cetane number must therefore be quoted by the supplier or measured and be at least 45 as required in the MTU Fluids and Lubricants Specification. The purely calculated cetane index must not be less than 42.

4.2.2 Sulfur Content

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

Consultation with the individual fuel supplier is necessary.

4.3 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 Chapter 4.1.3.1 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 Specification is always the responsibility of the operator.

4.4 Microorganisms in Fuel

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

4.4.1 Approved Biocides

Table 12

Manufacturer	Brand name	Concentration for use
Bode Chemie Melanchthonstr. 27 22525 Hamburg Tel. 040/54006-0 Tel. 040/54006-200	Bakzid	100ml per 100l
Schülke und Mayr 22840 Norderstedt Tel. 040/52100-00 Tel. 04052100/-244	GrotaMAR 71	70ml per 100l

4.5 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 harmful components in the gas and to take appropriate action. This will prevent corrosion damage to the engine.

Gas Types: Suitability for Use in MTU Gas Engines

Table 13

Name	Components	Unit	Limit Value	Series G 183	Series G 2000	Series G 4000	Remarks
Natural gas type H	CH ₄	% by vol.	88.5	X	X	X	
	C ₂ H ₆	% by vol.	4.7				
	C ₃ H ₈	% by vol.	1.6				
	C ₄ H ₁₀	% by vol.	0.2				
	N ₂	% by vol.	5.0				
Sewage gas		% by vol.		X	X		
	CH ₄	% by vol.	65.0				
	CO ₂	% by vol.	35.0				
Landfill gas				X			
	CH ₄	% by vol.	50.0				
	CO ₂	% by vol.	40.0				
	N ₂	% by vol.	10.0				

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



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

4.5.1 Requirements for Fuel Gas

Engine Series-Based Requirements for Fuel Gas

Table 14

Characteristic	Unit	Limit Value	Series G 183	Series G 2000	Series G 4000	Remarks
Methane number		≥ 70	X	X	X	Combustion knock, gas analysis and consultation with MTU-TEG
Calorific value	kWh/m ³ _N	$\geq 5,0$	X			Consultation with manufacturer required in case of lower values.
	kWh/m ³ _N	≥ 6		X		
	kWh/m ³ _N	9.5 - 10.5			X	
Calorific value tolerance	kWh/m ³ _N	$\pm 0,2$	X	X	X	
Calorific value fluctuation frequency	1/hr.	5	X	X	X	Based on whole hour
Settings: Gas pressure at gas regulation system intake	mbar	20 - 100	X	X		Project-specific gas regulating system specifications must be taken into account.
Gas mixer intake	mbar	0	X	X		Project-specific gas regulating system specifications must be taken into account.
Tecjet intake	mbar	100 - 200			X	Project-specific gas regulating system specifications must be taken into account.
Gas pressure tolerance	%	± 5	X	X	X	
Frequency of gas pressure fluctuation	1/hr.	10	X	X	X	Based on whole hour
Gas temperature	°C	10 - 50	X	X	X	Water vapour condensation at $t < 10^{\circ}\text{C}$, thermal ageing of NBR-materials (seals, diaphragms) and effects on elasticity characteristics at $t > 50^{\circ}\text{C}$
Temperature tolerance	%	± 5	X	X	X	
Temperature fluctuation frequency	1/hr.	5	X	X	X	Based on whole hour
Gas moisture	%	< 90	X	X	X	No water vapour condensation in pressure and temperature range
Oil vapours (HC with carbon number > 5)	mg/m ³ _N CH ₄	< 0.4	X	X	X	No condensation in fuel gas and lines carrying fuel gas mixtures; formation of condensed oil mist
HC solvent vapours	g/m ³ _N CH ₄	0	X	X	X	Consultation with manufacturer and analysis necessary

Characteristic	Unit	Limit Value	Series G 183	Series G 2000	Series G 4000	Remarks
Organically fixed silicium (e.g. hydrosilicons, siloxanes, silicons)	mg/m ³ NCH ₄	< 1.0		X	X	Consultation with manufacturer and analysis necessary
	mg/m ³ NCH ₄	< 10	X			
Dust 3-10 µm	mg/m ³ NCH ₄	5		X	X	Consultation with manufacturer and analysis necessary
	mg/m ³ NCH ₄	10	X			
Dust<3µm	mg/m ³ NCH ₄	Analysis	X	X	X	Consultation with manufacturer and analysis necessary
Inorganically fixed silicium	mg/m ³ NCH ₄	< 5	X	X	X	At Si >5 mg/m ³ NCH ₄ ; special attention re. abrasion particles in oil required during oil analysis
Total sulfur	mg/m ³ NCH ₄	1100	X			
	mg/m ³ NCH ₄	2200 (220)*		X	X	
H ₂ S	ppm in CH ₄	750	X			
	ppm in CH ₄	1500 (150)*		X	X	
Chlorine	mg/m ³ NCH ₄	75	X			
	mg/m ³ NCH ₄	100 (10)*		X	X	
Fluorine	mg/m ³ NCH ₄	40	X			
	mg/m ³ NCH ₄	50 (5)*		X	X	
Chlorine + Fluorine	mg/m ³ NCH ₄	75	X			
	mg/m ³ NCH ₄	100 (10)*		X	X	
NH ₃	ppm in CH ₄	70	X	X	X	

* = Figures in brackets are guideline values, given without warranty, where oxidation-type catalytic converters are in use. Analysis and consultation with MTU necessary.

Limit values are based on 100% methane by volume or, where other combustible gases are present, on a net calorific value of 10kWh/m³N under normal conditions.

No warranty is given in respect of impairment and/or damage (corrosion, contamination etc.) resulting from gases or materials the presence of which was not known about and agreed upon on conclusion of contract.

5 Preservatives

5.1 Requirements

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

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

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

5.2 Types of Preservation

See Preservation Specification (Section 7.2.1)

5.3 Initial Operation Oils and Corrosion Inhibiting Oils for Internal Preservation

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

These oils may also be used for running-in and acceptance testing procedures. Some, however, are suitable for continuous operation (See 6.4.1).

5.4 Corrosion Inhibitors for External Preservation

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

5.5 Corrosion Inhibiting Oils for Internal Preservation of the Fuel System

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

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

6 Approved Fluids and Lubricants

6.1 Engine Oils

For details and special features see Sections 2.1 and 2.3

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

Manufacturer	Brand name	SAE Viscosity class	Available in:						Remarks
			Asia	Africa	Australia	America	Europe	NAFTA	
Addinol Lube Oil	Addinol Marine MS4011 Addinol Turbo Diesel MD305 Addinol Turbo Diesel MD405	40 30 40	X X X					X X X	
Aral AG	Aral Basic Turboral	30, 40	X		X	X	X		
Avia	Avia Special HDC	30, 40					X		
BP plc	BP Vanellus C3 Mono Energol DS3-153/154	30, 40 30, 40	X	X	X	X	X	X	X
Castrol Ltd	Castrol MLC	30, 40	X	X	X	X	X	X	X
Cepsa Lubricantes	Cepsa Rodaje Y Proteccion	30		X					Increased corrosion protection
ChevronTexaco	Texaco Ursa Super LA Texaco Ursa LA	30, 40 40		X		X	X		
ENI S.p.A.	Agip Cladium 120	30, 40	X	X			X		Not Series 2000, 4000
Exxon Mobil	Essolube X 4 MŽK Motorenöl LD30	30, 40 30				X	X	X	Increased corrosion protection
Fuchs	Titan Universal HD	30, 40	X	X	X	X	X	X	
Hindustan Petr. Comp. Indien	Hylube MTU	40							
Idemitsu, Singapore	Daphne Marine Oil MT	40	X						
Mexicana De Lubricantes, Mexico	Mexlub CF/CF-2 Akron Extra Fleet	40 40		X X			X X	X X	
Motor Oil (Hellas)	EMO Turbo Champion Plus	30, 40							
ÖMV AG	ÖMV truck 30 ÖMV truck 40	30 40							
Pertamina, Indonesia	Meditran SMX	40							
Petrol Ofisi	Süpersarj MF 30	30							
PTT Public Comp.	PTT Navita MTU Type 1	40							

Manufacturer	Brand name	SAE Viscosity class	Available in:						Remarks
			Asia	Africa	Australia	America	Europe	NAFTA	
Ravensberger Schmierstoffvertrieb GmbH	RAVENOL Standard Truck	30, 40					X		
SRS Schmierstoff Vertrieb GmbH	Wintershall Antikorrol M	30	X	X			X		Increased corrosion protection
	Wintershall Rekord	30, 40	X	X			X		
Shell	Shell Gadinia	30, 40	X	X	X	X	X	X	
	Shell Rimula X Monograde	30, 40	X	X	X	X	X	X	
	Shell Sirius Monograde	30, 40	X	X	X	X	X	X	
Sakson	Parnas Hercules 1	40					X		
United Oil	XD 7000 Extra Duty-3U	30	X		X				
	XD 7000 Extra Duty-4U	40	X		X				

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

Manufacturer	Brand name	SAE Viscosity class	Available in:						Remarks
			Asia	Africa	Australia	America	Europe	NAFTA	
Exxon Mobil	Mobil Pegasus 705	40					X		
Fuchs	Fuchs Titan Ganymet LA	40	X	X	X	X	X	X	
Shell	Shell Mysella LA 40	40					X		
SRS Schmierstoff Vertrieb GmbH	Wintershall Mihagrun LA 40	40	X	X			X		
Total	Nateria MH 40	40					X		

6.1.3 Multi-grade Oils - Category 1, SAE-grades 10W-30 and 15W-40 for Diesel Engines



- ¹⁾ These multi-grade oils can only be used if the crankcase ventilation is led to atmosphere.
²⁾ Engine oils marked ²⁾ are also approved for "Series 60"

Manufacturer	Brand name	SAE Viscosity class	Available in:						Remarks
			Asia	Africa	Australia	America	Europe	NAFTA	
Addinol Lube Oil	Addinol Super Star MX1547	15W-40	X				X		²⁾
Avia	Avia HDC Extra UTM	15W-40					X		
Beijing Petroleum	You Ya Wang	15W-40	X						
BP plc	BP Vanellus C5 Global	15W-40					X		²⁾
Castrol Ltd.	Castrol Assuron T Max	15W-40					X		
Chevron Texaco	Texaco Ursa Super LA	15W-40		X			X		
ENI S.p.A.	Agip Multitech S	10W-40					X		
Exxon Mobil	Mobil Delvac MX	15W-40	X	X	X	X			^{1) 2)} and oil change interval of 500 operating hours
	Mobil Delvac MX Extra	10W-40	X				X		
	Essolube XTS -4	10W-40	X				X		
	Exxmar CM Super	15W-40	X	X	X	X	X		
	Essolube XT3	15W-40		X		X			
	Mobil Delvac 1300 Super	15W-40		X		X			^{1) 2)}
Feoso Oil	Super VG Motor Oils	15W-40	X						
Fuchs	Titan Hydromat SL SAE	10W-40					X		
	10W40 Titan Universal HD	15W-40	X	X	X	X	X	X	
Igol, France	Trans Turbo 4X	15W-40					X		
OPET Petrolcülük	Omega Turbo Power	15W-40							¹⁾
ÖMV AG	ÖMV Truck M plus	15W-40					X		
Petroleos de Portugal	Galp Galaxia Super 15W-40	15W-40							
SRS Schmierstoff Vertrieb GmbH	Wintershall Rekord 15/40	15W-40	X	X			X		
	Wintershall Multi Rekord	15W-40	X	X			X		
Singapore Petroleum Comp.	SPC SDM 801	15W-40							
Suomen Petrooli	Teboil Super Power	15W-40					X		
Total	Elf Performance Super D	15W-40	X	X			X	X	
United Oil	XD 9000 Ultra Diesel-U	15W-40	X		X				

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



²⁾ Engine oils marked ²⁾ are also approved for "Series 60"

Manufacturer	Brand name	SAE Viscosity class	Available in:						Remarks
			Asia	Africa	Australia	America	Europe	NAFTA	
Addinol	Addinol Turbo Diesel MD 407	40					X		
Belgin Madeni Yaglar	Lubex Marine M-30 Lubex Marine M-40	30 40							
BP Marine	Energol HPDX	30, 40	X		X	X	X		Up to 1500 hrs permitted for fast ferry applications
Castrol Ltd.	Castrol HLX	30, 40	X		X	X	X	X	
Cepsa Lubricants	Ertoil Koral HDL	30, 40		X			X		²⁾
ChevronTexaco	Texaco Ursa Super TD Texaco Ursa Premium TDX Caltex Delo SHP Caltex Delo Gold [ISOSYN]	30, 40 40 30, 40 30, 40		X			X	X	
Cyclon Hellas	Cyclon D Super	40					X		²⁾
Delek	Delkol Super Diesel	40	X						²⁾
ENI S.p.A.	Agip Sigma GDF	40					X		
Exxon Mobil	Mobil Delvac 1630 Mobil Delvac 1640 Exxmar CM Super	30 40 30, 40				X	X	X	
Hyrax Oil	Hyrax TOP DEO	40	X						
Motor Oil, Hellas	EMO SHPD Plus	30, 40					X		
Panolin AG	Panolin Extra Diesel	40					X		
Petrobras	Marbrax CCD-310-AP Marbrax CCD-410-AP	30 40				X	X		
Petrol Ofisi	Turbosarj Ekstra SAE 40-E PO Turbosarj Extra	40 30,40							²⁾
PTT Public Comp.	PTT Navita MTU Type 2	40							
Shell	Shell Sirius X	30, 40	X	X	X	X	X	X	

Manufacturer	Brand name	SAE Viscosity class	Available in:						Remarks
			Asia	Africa	Australia	America	Europe	NAFTA	
Singapore Petroleum Comp.	SPC 900 SDM 900	40 30, 40	X X						2)
Sonol, Israel	Sonol 2340	40	X						2)
SRS Schmierstoff Vertrieb GmbH	Wintershall Rekord plus	30, 40	X	X			X		
Statoil	Statoil Diesel Way	30, 40					X		2)
Total	Total Rubia TIR XLD	40	X	X			X	X	

6.1.5 Multi-grade Oils - Category 2, SAE-grades 5W-40, 10W-40, 15W-40 and 20W-40 for Diesel Engines



²⁾ Engine oils marked ²⁾ are also approved for "Series 60"

Manufacturer	Brand name	SAE Viscosity class	Available in:						Remarks
			Asia	Africa	Australia	America	Europe	NAFTA	
Addinol Lube Oil	Addinol Diesel Longlife MD1047 Addinol Diesel Longlife MD1548 Addinol Diesel Power MD1547 Addinol Diesel Longlife MD1546 Addinol Diesel Longlife MD1547	10W-40 15W-40 15W-40 15W-40 15W-40	X X X X				X X X X		2) 2) Not Series 4000 2)
API	D Multi Diesel Turbo	15W-40					X		2)
AP Oil International Ltd.	AP X-Super Dieselube Turbo CF-4	15W-40	X						
Aral AG	Aral Multigrade SHPD Aral Mega Turboral	15W-40 10W-40	X				X X		
Bharat Petroleum	MAK MB SHPD 15W-40	15W-40	X	X					
BP plc	BP Vanellus C6 Global BP Vanellus C6 Global Plus	15W-40 10W-40					X X		2)
Castrol Ltd.	Castrol Tecton T	15W-40			X		X		2)

Manufacturer	Brand name	SAE Viscosity class	Available in:						Remarks
			Asia	Africa	Australia	America	Europe	NAFTA	
ChevronTexaco	Caltex Delo SHP Multigrade	15W-40	X	X	X				2)
	Caltex Delo Gold [ISOSYN] Multigrade	15W-40	X	X	X				
	Caltex Delo 400 Multigrade	15W-40	X	X	X				
	Chevron RPM Heavy Duty Motor Oil	15W-40				X		X	
	Chevron Texaco Delo 400	15W-40	X	X	X	X	X	X	2)
	Chevron Delo 400 Multigrade	15W-40	X	X	X	X	X	X	
	Texaco Ursa Super Plus	15W-40				X		X	2)
	Texaco Ursa Super TD	15W-40		X			X	X	
Texaco Ursa Premium TDX	15W-40				X		X		
Delek	Delkol Super Diesel	15W-40	X						
Exxon Mobil	Mobilgard 1 SHC	20W-40	X	X	X	X	X	X	Up to 1500 hrs permitted for fast ferry applications
	Engine Oil 5920	15W-40					X		
Feoso Oil	Ultra VG Motor Oils	15W-40	X						
Fuchs	Titan Unic Plus MC	10W-40	X	X	X	X	X	X	
	Titan Unic Ultra MC	10W-40	X	X	X	X	X	X	
	Titan Formel Plus	15W-40	X	X	X	X	X	X	
	Titan Truck	15W-40	X	X	X	X	X	X	
	Titan Unimax	15W-40				X		X	
Ginouves	York 745	15W-40					X		2)
	York 846	15W-40							
	York 849	15W-40					X		
Igol, France	Trans Turbo 5X	15W-40					X		2)
	Trans Turbo 7X	15W-40					X		
Imperial Oil	Esso XD-3 Extra	15W-40				X			
Indian Oil Corp.	Servo Premium (N)	15W-40	X						2)
Kuwait Petroleum	Q8T720		X	X	X		X		2)
MOL-LUB	MOL Mk-9	15W-40					X		
Motor Oil, Hellas	EMO SHPD Plus	15W-40					X		
OMV AG	OMV truck LD	15W-40					X		2)
Panolin AG	Panolin Universal SFE	10W-40					X		
	Diesel Synth	10W-40					X		
Pennzoil Products	Supreme Duty Fleet Motor Oil	15W-40							
	Longlife EF Heavy Duty Multigrade Engine Oil	15W-40							

Manufacturer	Brand name	SAE Viscosity class	Available in:						Remarks
			Asia	Africa	Australia	America	Europe	NAFTA	
Pertamina	Meditran SMX	15W-40	X						2)
Petrol Ofisi	PO Turbo Dizel Extra	15W-40					X		
Prista	Prista SHPD	15W-40					X		2)
Ravensberger Schmierstoffvertrieb GmbH	RAVENOL Mineralöl Turbo Plus SHPD	15W-40					X		
	RAVENOL Formel Diesel Super	15W-40					X		
Shell	Shell Rimula MV	15W-40	X	X	X	X	X	X	2)
	Shell Rotella T Multigrade	15W-40				X	X	X	2)
	Rimula X CH-4	15W-40	X	X	X	X	X	X	2)
Sinclair Oil Corp.	Sinclair Dura Tec Premium 1000	15W-40				X		X	
Singapore Petroleum Company	SDM 900, SAE 15W40	15W-40	X						2)
Sinopec Shanghai	Haipai 2460	15W-40	X						2)
SRS Schmierstoff Vertrieb GmbH	Wintershall Turbo Diesel	15W-40	X	X			X		
	Wintershall Turbo Rekord	15W-40	X	X			X		
	Wintershall Turbo Diesel plus	15W-40	X	X			X		2)
	Wintershall Multi Rekord top	15W-40	X	X			X		2)
Suomen Petrooli	Teboil Super HPD	15W-40					X		
Total	Antar Milantar PH	15W-40					X		2)
	Antar Milantar PX	15W-40					X		2)
	Elf Performance Trophy DX	15W-40	X	X			X		2)
	Elf Performance Victory	15W-40					X		2)
	Fina Kappa Optima	15W-40					X		2)
	RTO Maxima RD	15W-40					X		2)
	RTO Maxima RLD	15W-40					X		2)
	Total Caprano TDH	15W-40	X	X			X		2)
	Total Caprano TDI	15W-40					X		2)
	Total Rubia TIR 6400	15W-40					X		2)
Total Rubia TIR 7400	15W-40					X		2)	
Statoil	Turbosynt	15W-40							2)

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



²⁾ Engine oils marked ²⁾ are also approved for "Series 60"

Manufacturer	Brand name	SAE Viscosity class	Available in:						Remarks
			Asia	Africa	Australia	America	Europe	NAFTA	
Addinol Lube Oil	Addinol Super Truck MD 0538 Addinol Super Truck MD 1048	5W-30 10W-40	X X					X X	
Aral AG	Aral Super Turboral	5W-30						X	
BP plc	BP Energol IC-MT BP Vanellus E7 Ultra BP Vanellus E7 Supreme BP Vanellus C8 Ultima BP Vanellus E8 Ultra BP Vanellus E4 Plus	10W-40 5W-30 5W-40 5W-30 5W-30 10W-40						X X X X X	
Bucher	Motorex MC Power 3	10W-40							
Castrol Ltd.	Castrol Dynamax Castrol Enduron MT Castrol Enduron Plus Castrol Elixion 5W-30	10W-40 10W-40 5W-40 5W-30	X X					X X	
Cepsa	Cepsa Eurotrans SHPD Cepsa Eurotrans SHPD	5W-30 10W-40						X X	
ChevronTexaco	Ursa Premium FE Ursa Super TDX	5W-30 10W-40						X X	
ENI S.p.A.	Agip Sigma Trucksint TFE Agip Sigma Super TFE Agip Sigma Ultra TFE	5W-40 10W-40 10W-40					X X X	X X X	
Exxon Mobil	Essolube XTS 5 Mobil Delvac XHP Extra Mobil Delvac 1 SHC Mobil Delvac 1	10W-40 10W-40 5W-40 5W-40	X X X X	X				X X X X	²⁾
Fuchs	Titan Cargo SL Titan Cargo MC Titan Cargo LDF	5W-30 10W-40 10W-40	X X X	X X X	X X X	X X X	X X X	X X X	
Ginouves	York 847	10W-40						X	
Gulf Oil	Superfleet ELD	15W-40	X	X	X	X	X	X	X
IB German Oil	High Tech Truck	10W-40						X	
Igol	Trans Turbo 8X	5W-30						X	

Manufacturer	Brand name	SAE Viscosity class	Available in:						Remarks
			Asia	Africa	Australia	America	Europe	NAFTA	
INA	INA Super 2000	10W-40							
Meguin	Megol Motorenöl Super Leichtlauf DIMO Megol Motorenöl Diesel Truck Performance	10W-40 5W-30	X			X	X	X	
MOL-LUB	MOL Synt Diesel	10W-40					X		
Ölwerke Julius Schindler	Econo Veritas Truck FE	5W-30					X		
OMV	OMV super truck	5W-30					X		
Panolin	Panolin Diesel HTE	10W-40					X		
Petroleos de Portugal	Galp Galaxia Ultra EC Galp Galaxia Extreme	10W-40 5W-30	X	X		X	X	X	2)
Ravensberger Schmierstoffvertrieb GmbH	RAVENOL Super Performance Truck RAVENOL Performance Truck	5W-30 10W-40					X	X	
SRS Schmierstoff Vertrieb GmbH	Wintershall TFL Wintershall TFG	5W-30 10W-40	X X	X X			X X		
Shell	Shell Rimula Ultra Shell Rimula Ultra Shell Rimula Ultra E5	5W-30 10W-40 10W-40	X X X	X X X	X X X	X X X	X X X	X X	
Total	Antar Maxolia Elf Performance Experty FE Elf Performance Experty Fina Kappa First RTO Extensia ECO RTO Extensia RXD Total Rubia TIR 8600 Total Rubia TIR 9200 FE	10W-40 5W-30 10W-40 5W-30 5W-30 10W-40 10W-40 5W-30	X	X	X	X	X X X X X X X	X	
Unil Opal	LCM 800	10W-40							
Valvoline International	Valvoline Pro Fleet Extra Valvoline Pro Fleet	5W-30 10W-40					X		
Veedol International	Veedol Dynastar Veedol Dynastar FS	10W-40 5W-40							

6.2 Lubricating Greases for General Applications

See Section 2.2 for details and special features

Manufacturer	Brand name	Remarks
Aral AG	Mehrzweckfett Arallub HL2	
BP plc	Energrease LS2	
Castrol Ltd.	Spheerol AP2	
ChevronTexaco	Multifak EP2	
Exxon Mobil	Beacon 2 Mobilux 2 Mobilgrease XHP 222	
SRS Schmierstoff Vertrieb GmbH	Wintershall Wiolub LFK 2	
Shell	Shell Retinax EP2	
Total	Multis EP 2	
Veedol International	Multipurpose	

6.3 Coolant Additives

See Section 3 for details and special features

6.3.1 Emulsifiable Corrosion Inhibiting Oils

Manufacturer	Brand name	Operating time Hours / Years	Remarks
Shell	Shell Oil 9156	6000 / 1	Not Series 183, 396, with plate-core heat exchangers Not for TE-cooling systems Not Series 4000, 8000

6.3.2 Corrosion-Inhibiting Antifreeze-Concentrates (valid for all series)

Manufacturer	Brand name	Operating time Hours / Years	Remarks
Addinol	Antifreeze Super	9000 / 5	
Arteco	Freecor SPC	9000 / 3	
BASF	Glysantin G05 Glysantin Antikorrosion Glysantin G48 Glysantin Protect Plus Glysantin G30 Glysantin Alu Protect Premium	9000 / 5 9000 / 5 9000 / 5 9000 / 5 9000 / 3 9000 / 3	
Bucher	Motorex Antifreeze G05 Motorex Antifreeze Protect G48 Motorex Antifreeze Protect Plus G30	9000 / 5 9000 / 5 9000 / 3	
Clariant	Genatin super	9000 / 3	
Detroit Diesel	Power Cool Antifreeze	9000 / 3	
Deutsche BP	Aral Antifreeze Extra Castrol Antifreeze NF Veedol Antifreeze NF	9000 / 5 9000 / 5 9000 / 5	
Fuchs	Fricofin	9000 / 5	
Ginouves	York 716	9000 / 5	
Ineos C2272	C 2272	9000 / 3	
Krafft	Refrigerante ACU 2300	9000 / 3	
Maziva	INA Antifriz Al Super	9000 / 5	
Mercedes Benz US	Mercedes Q1 03 0002	9000 / 5	
Nalco	Nalcool 5990	9000 / 3	
Old World	Fleetcharge SCA Precharged Heavy Duty Coolant/ Antifreeze	9000 / 3	
OMV	OMV Coolant Plus	9000 / 5	
Panolin – Switzerland	Anti-Frost MT-325	9000 / 5	
Ravensberger Schmierstoffvertrieb GmbH	RAVENOL Kühlerfrostschutz silikafrei	9000 / 3	
Recochem	R542	9000 / 3	
Shell	Glyco Shell Glyco Shell SF	9000 / 5 9000 / 3	
Total	Glacelf MDX	9000 / 5	
Valvoline	Zerex G-05 Zerex G-48 Zerex G-30	9000 / 5 9000 / 5 9000 / 3	

6.3.3 Corrosion-Inhibiting Antifreezes, Ready-Mixed (valid for all series)

Manufacturer	Brand name	Operating time Hours / Years	Remarks
BASF	Kühlstoff G05-24/50 (50%)	9000 / 5	
Deutsche BP	ARAL Easyfreeze Extra (50%)	9000 / 5	
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	

6.3.4 Corrosion Inhibiting Antifreezes - Concentrates - for Aluminium-Free Series 2000 C&I and 4000 C&I Engines

Manufacturer	Brand name	Operating time Hours / Years	Remarks
Arteco	Havoline Extended Life Coolant [EU Code 30379] (XLC)	9000 / 3	
Caltex	Caltex Extended Life Coolant [Code 510614] (XLC)	9000 / 3	
ChevronTexaco	Havoline Dexcool Extended Life Antifreeze [US Code 227994]	9000 / 3	
CCI	L 415	9000 / 3	
CCI Manufacturing IL Corp.	C 521	9000 / 3	
Detroit Diesel	Power Cool Plus	9000 / 3	
Krafft	Energy Plus K-140	9000 / 3	
Nalco	Nalcool 4070	9000 / 3	
Old World	Final Charge Global Extended Life Coolant/Antifreeze	9000 / 3	
Recochem	Turbo Power R 824M	9000 / 3	
Total	Elf Glacelf Auto Supra	9000 / 3	
	Glacelf Supra	9000 / 3	
	Organifreeze	9000 / 3	

6.3.5 Corrosion Inhibiting Antifreezes - Ready Mix - for Aluminium-Free Series 2000 C&I and 4000 C&I Engines

Manufacturer	Brand name	Operating time Hours / Years	Remarks
Arteco	Havoline Extended Life Coolant + B2 50/50 OF01 [EU Code 33073] (50%)	9000 / 3	
	Havoline Extended Life Coolant + B2 40/60 OF01 [EU Code 33069] (40%)	9000 / 3	
	Havoline Extended Life Coolant + B2 35/65 OF01 [EU Code 33074] (40%)	9000 / 3	
Caltex	Caltex Extended Life Coolant + B2 35/65 OF01 [EU Code 33074] (35%)	9000 / 3	
	Caltex Extended Life Coolant Pre-Mixed 50/50 [Code 510609] (50%)	9000 / 3	
CCI	L 415 (50%)	9000 / 3	
CCI Manufacturing IL Corp.	C 521 (50%)	9000 / 3	

Manufacturer	Brand name	Operating time Hours / Years	Remarks
ChevronTexaco	Havoline Dexcool Extended Life Prediluted 50/50 Antifreeze Coolant [US Code 227995] (50%)	9000 / 3	
Detroit Diesel	Power Cool Plus Pre-Diluted 50/50 Extended Life Diesel Engine Coolant/Antifreeze	9000 / 3	
Fuchs Australien	Titan HDD Premix Coolant (50%)	9000 / 3	
Nalco	Nalcool 4100 (50%)	9000 / 3	
Old World	Final Charge Global 50/50 Pre-Diluted Extended Life Coolant/Antifreeze	9000 / 3	
Total	Coolelf Supra (40%)	9000 / 3	

6.3.6 Corrosion-inhibiting Antifreezes for Special Applications

Manufacturer	Brand name	Operating time Hours / Years	Remarks
BASF	G206	9000 / 3	For use in arctic regions (< -40°C)

6.3.7 Water-Soluble Corrosion Inhibitor Concentrates (valid for all series)

Manufacturer	Brand name	Operating time Hours / Years	Remarks
BASF	Glysacorr G93-94	6000 / 2	
Ginouves	York 719	6000 / 2	
Valvoline	ZEREX G-93	6000 / 2	

6.3.8 Water-soluble Corrosion Inhibitors - Concentrates - for Aluminum-Free Series 2000 C&I and 4000 C&I Engines

Manufacturer	Brand name	Operating time Hours / Years	Remarks
Arteco	Havoline Extended Life Corrosion Inhibitor [EU Code 32765] (XLI)	6000 / 2	
Caltex	XL Corrosion Inhibitor Concentrate [Code510533]	6000 / 2	
Chevron Texaco	Texaco Extended Life Corrosion Inhibitor Nitrite free [US Code 236514] Texaco HD Extended Life Corrosion Inhibitor Nitrite free [US Code 221642]	6000 / 2	
Detroit Diesel	Power Cool 2000	6000 / 2	
Fleetguard	DCA-4L	2000 / 1	
Nalco	Alfloc (Maxitreat) 3477 Alfloc 2000 Nalco 2000 Nalcool 2000	6000 / 2 6000 / 2 6000 / 2 6000 / 2	
Penray	Pencool 2000	6000 / 2	
Total	Total WT Supra	6000 / 2	

6.3.9 Water-soluble Corrosion Inhibitors - Ready Mix - for Aluminum-Free Series 2000 C&I and 4000 C&I Engines

Manufacturer	Brand name	Operating time Hours / Years	Remarks
Caltex	Caltex XL Corrosion Inhibitor [Code 510534] (10%)	6000 / 2	
Nalco	Alfloc (Maxitreat) 3443 (7%)	6000 / 2	

6.4 Preservatives

See Section 5 for details and special features

6.4.1 Initial Operation Oils and Corrosion Inhibiting Oils for Internal Preservation

Manufacturer	Brand name	Remarks
BP plc	Motorenschutzöl MEK SAE 30	
Cepsa Lubricants	Cepsa Rodaje Y Proteccion SAE 30	Full-load engine oil as per oil Category 1
Exxon Mobil	MZK Motorenöl LD30	Full-load engine oil as per oil Category 1
	Mobilarma 524	Only suitable for pre-preservation run! (7.5)
Fuchs Europe	Titan Universal HD SAE 30	Full-load engine oil as per oil Category 1
SRS Schmierstoff Vertrieb GmbH	Wintershall Antikorrol M SAE 30	Full-load engine oil as per oil Category 1
Shell	Shell Running-In Oil 7294 SAE 30	
	Shell Ensis Engine Oil SAE 30	

6.4.2 Corrosion Inhibitors for External Preservation

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

6.4.3 Corrosion Inhibiting Oils for Internal Preservation of the Fuel System

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

6.4.4 Corrosion Inhibitors for Internal Preservation of the Cooling System

Manufacturer	Brand name	Remarks
BASF	Glysacorr P 107	10%
Exxon Mobil	Kutwell 40	2%
Shell	Shell Oil 9156	2%

7 Preservation

7.1 Warnings

Please note the following warnings in bold type:

CAUTION!

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

ATTENTION!

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

NOTE:

If a certain feature has to be noted when carrying out work.

7.2 Preface

Machined and unprotected surfaces, such as those in the cylinder liners, are subject to corrosion and have to be preserved during long out-of-service periods. The applicable engine documentation must also be considered together with this Preservation Specification. The gearbox manufacturer's preservation specification must be referred to when complete drive systems are taken out of service.

This specification describes the following types of preservation (according to the length of the out-of-service period, see Section 7.2.2):

- Out-of-Service
(For 1 to 3 months)
- Preservation
(Out-of-service from 3 to max. 36 months)
- Special packing
(Out-of-service for more than 36 months)

and the following storage conditions:

- Normal ambient conditions (no frost, clean surroundings, relative humidity below 50%).
- Difficult ambient conditions (high humidity, salty air, strongly varying temperatures, dust, etc.).
- Unsuitable ambient conditions (outside storage, in moist rooms, etc.). In such cases it is impossible to store engines without special packing.

NOTE:

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

Do not use natural rubber sealing material, as it is not proof against ageing.

Only MTU-approved fluids and lubricants are to be used for preservation and re-preservation. (See Section 6 "Approved Fluids and Lubricants").

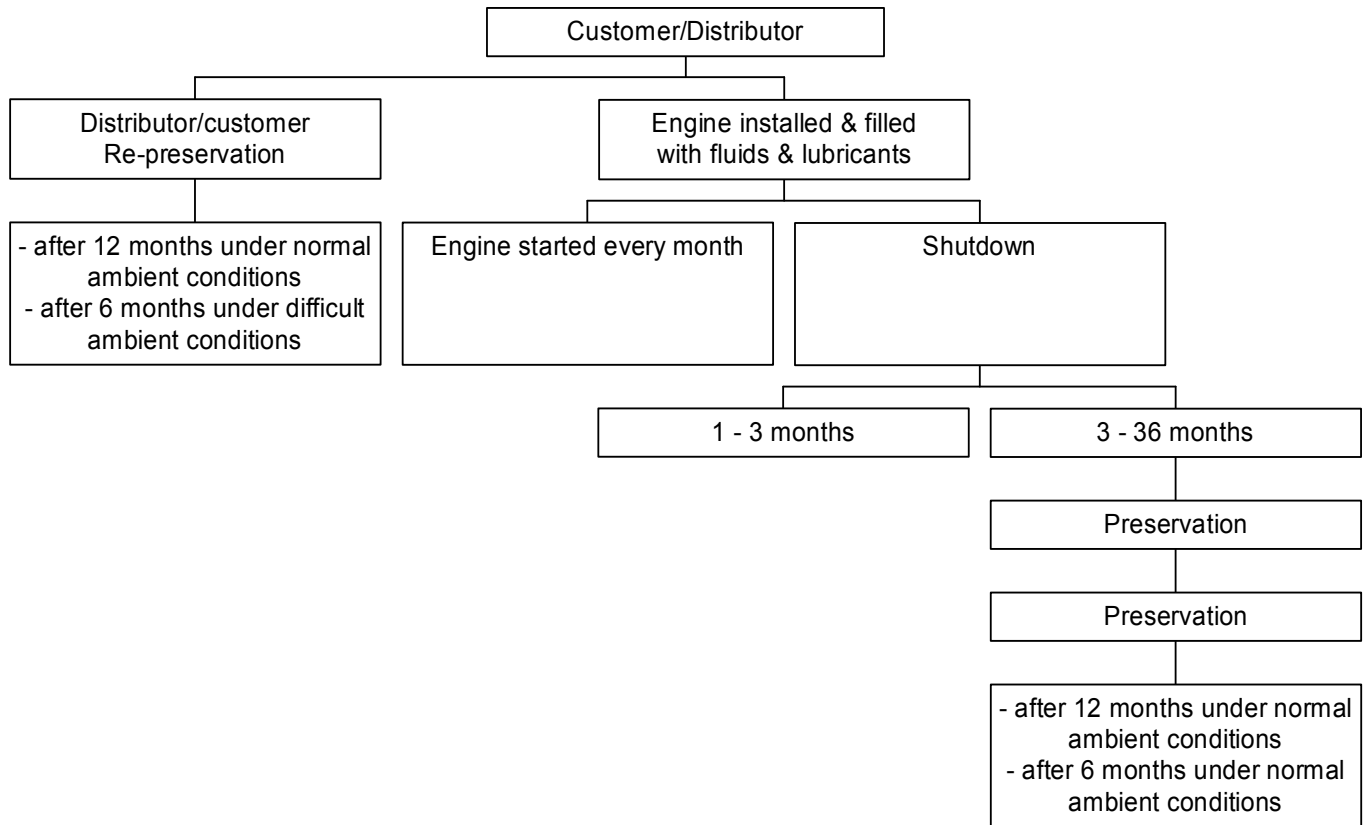
Engines that are to be shutdown for more than one month are to be preserved immediately after operation.

Refer to the engine documentation for tasks and checks to be carried out when shutting down an engine and before re-operating an engine.

Engines also have to be preserved if they are shutdown for a planned major overhaul and the period between shutdown and overhaul is over one month.

New engines or engines which have undergone a major overhaul must be preserved immediately after the test-stand run. Preservation is not necessary only if the engine is to be put into service (but only under normal ambient operating conditions) within one month of the test-stand run.

7.2.1 Engine Preservation - Overview



7.2.2 Overview of Types of Preservation

Shutdown period	Tasks
Shutdown From 1 to 3 months	See Section 7.4
Shutdown From 3 to 36 months	<u>Preservation</u> see Sections 7.5 and 7.6
	<u>Re-preservation</u> Every 12 months under normal ambient conditions Every 6 months under difficult ambient conditions See Section 7.5.4
Shutdown More than 36 months or earlier if required	<u>Special packing</u> See Section 7.6.4
	<u>Checking the humidity indicators</u> Check every 3 to 4 months See Section 7.7.4.3

7.3 Short-time Shutdown

Short-time shutdown of the engine means a period of maximum one month in installed condition. Close the emergency air shut-off flaps if they are provided. No further special preservation measures are otherwise necessary.

7.4 Shutdown

Shutdown of the engine means for a period of 1 to 3 months.

Task description

Run engine up to operating temperature, then run up to rated speed for about 30 seconds and then shutdown at rated speed. The engine is not to be started again. This procedure must also be carried out before removing the engine for a shutdown period.

7.4.1 Engine in Installed Condition

The following openings are to be securely sealed on engines in installed condition.

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

7.4.2 Engine Removed

The following system inlets and outlets/connections are always to be securely sealed off on removed engines.

- Coolant
- Fuel
- Engine oil
- Hydraulic oil
- Electrical plug connectors

7.4.3 Putting Shut-Down Engines into Operation

Task description

Remove all sealing covers fitted under Section 7.4.1. The engine can then be put into operation according to the engine documentation.

7.5 Preservation of Diesel Engines

General

Preservation must be carried out on engines to be shutdown for a period of more than three months and a maximum of 36 months.

New engines or those which have undergone a major overhaul by MTU are always preserved as standard procedure.

For shutdown periods of over one month, we recommend that, for your own protection, you confirm the preservation work as contained in the checklist, see Section 7.8.1.

For engines stored with the manufacturer's warranty, the Monitoring Sheet is to be filled out and returned to MTU in good time before the engine is returned to service, see Section 7.8.2.

NOTE:

If there is insufficient space to access the engine for all preservation work (e.g. charge-air pipe inaccessible) then the engine must be removed and mounted on an engine base or test stand to complete the work.

7.5.1 Preservation of Cooling, Lubrication and Fuel Systems

Task description

- Clean engine if necessary.
- Fill cooling system with coolant consisting of corrosion-inhibitor oil and water (see Section 6.4.4)
- Fill up with corrosion-inhibitor oil at least to the "Min." mark, see Section 6.4.
- Prepare preservation fuel consisting of diesel fuel and 10-12% preservation oil (corrosion-inhibitor oil for internal preservation) or 100% corrosion-inhibitor oil for internal preservation of the fuel system (see Section 6.4)
- Run engine for about 10 minutes at high idle with preservation fuel. The coolant temperature must reach at least operating temperature.
- Shutdown engine.

Prior to breaks in operation for periods of between 5 and 30 days with the coolant drained, coolant-carrying components must be protected by the addition of BASF P107 corrosion-inhibiting additive (see 3.5.1) as follows:

- 10% of the coolant volume is replaced by BASF P107 (concentrate).
The engine is operated for between 30 minutes and max. 10 hours.
After switching off the engine, the coolant is drained off and disposed of.
- **Preservation is not required where emulsifiable corrosion-inhibiting oil is used!**



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

7.5.2 Preservation of the Combustion Chamber

Task description

- Clear access to the charge-air pipe. This may require removal of the flame-start canisters, sensors, covers or pipes. Access to the charge-air pipe must be available after the intercooler, after the pressure fine filter/air filter and after the turbocharger.
- Turn the warm engine over with the starting system.

ATTENTION!

It must be ensured when turning the engine over that the engine cannot start. With mechanical governors, the shut-down lever must be at the STOP position during turn-over. With electronic governors, switch off the power supply and turn the engine over either with the emergency start or another suitable method.

- While the engine is being turned, use a fine-atomizing spray gun to spray preservation oil into the charge-air pipe openings for about 15 seconds.
- Re-seal the openings to the charge-air pipes.

NOTE:

Refer to the engine documentation.

7.5.3 External Preservation

Seal off all openings against humidity:

- Cooling-air inlet
- Combustion-air inlet
- Exhaust outlet

The following supply and return systems and openings are always to be securely sealed off on removed engines.

- Coolant
 - Fuel
 - Engine oil
 - Hydraulic oil
 - Electrical connections
 - Crankcase vent (with venting to atmosphere).
1. Coat or spray unpainted parts with corrosion-inhibitor oil for external preservation (see Section 6.4).
 2. Complete the checksheet on completion of preservation, see Section 7.8.1. Place the checksheet in a sealed plastic sleeve and attach it to the engine in a clearly visible location.

7.5.4 Re-preservation

Task description

- Remove sealed covers from combustion-air inlet and exhaust outlet.
- Preserve combustion space, see Section 7.5.2.
- Re-seal the inlet and outlet against humidity.
- Make a visual check of the engine for corrosion. If necessary, clean the affected places and recoat with corrosion-inhibiting oil.

7.5.5 De-preservation

Task description

- Clean engine if necessary.
- Remove all sealing covers as fitted under Section 7.5.3.
- Drain off remaining corrosion-inhibiting oil.
- Fill up with engine oil.
- Bar engine manually.
- Prepare engine for operation.
- Renew coolant

NOTE:

Put engine into operation according to the engine documentation.

7.6 Preservation of Gas Engines

General

Preservation must be carried out on engines to be shut down for a period of more than three months and a maximum of 36 months.

New engines or those which have undergone a major overhaul by MTU are always preserved as standard procedure.

In the interests of safety and for your own protection, for shutdown periods lasting longer than a month, we recommend that the preservation work carried out is noted on the checksheet (see Section 7.8.1).

For engines stored with the manufacturer's warranty, the monitoring sheet should be completed and returned to MTU in good time before commissioning / initial start-up (see Section 7.8.2).

NOTE:

If there is not enough space to access the engine for preservation work whilst it is in place (e.g. charge air pipe inaccessible) then the engine must be removed and mounted on an engine base or a test stand for preservation work.

7.6.1 Preservation of Cooling and Lubrication Systems

Task description

- Clean engine if necessary.
- Fill cooling system with coolant consisting of 2 % emulsifiable corrosion-inhibitor oil and water, see Section 6.3.1.
- Fill up with corrosion-inhibitor oil at least to the "Min." mark (see Section 6.4.1).
- Run the engine at half load for 15 minutes.
- Switch off the engine and drain off the fluids and lubricants (lubrication oil pan and oil filter cartridges).



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

7.6.2 Preservation of the Combustion Chamber

Task description

- Fill up with corrosion-inhibitor oil at least to the "Min." mark (see Section 6.4.1).
- Clear access to the charge-air pipe. This may require removal of sensors, covers or pipes. Access to the charge-air pipe must be available after the intercooler, after the pressure fine filter/air filter and after the turbocharger.
- Use the starting system to turn the engine over.
- Drain fluids and lubricants.

ATTENTION!

It must be ensured when turning the engine over that the engine cannot start. To ensure this, the gas supply must be reliably interrupted by closing the gas line.

- While the engine is being turned, use a fine-atomizing spray gun to spray preservation oil into the charge-air pipe openings for about 15 seconds.
- The engine must not be turned over by means of the starting system unless the engine (at least up to the "Min." mark) and the oil filters are filled with lube oil (corrosion-inhibitor oil).
- Re-seal the openings to the charge-air pipes.

NOTE:

Refer to the engine documentation.

7.6.3 External Preservation

Seal off all openings against humidity:

- Cooling-air inlet
- Combustion-air inlet
- Fuel gas inlet
- Exhaust outlet

The following supply and return systems and openings are always to be securely sealed off on removed engines.

- Coolant
 - Engine oil
 - Electrical connections
 - Crankcase vent (with venting to atmosphere).
1. Coat or spray unpainted parts with corrosion-inhibitor oil for external preservation (see Section 6.4).
 2. Complete the checksheet on completion of preservation, see Section 7.8.1. Place the checksheet in a sealed plastic sleeve and attach it to the engine in a clearly visible location.

7.6.4 Re-preservation

Task description

- Remove sealed covers from combustion-air inlet and exhaust outlet.
- Preserve combustion chamber, see Section 7.6.2.
- Re-seal the combustion air inlet and exhaust outlet against humidity.

Make a visual check of the engine for corrosion. If necessary, clean the affected places and recoat with corrosion-inhibiting oil.

7.6.5 De-preservation

Task description

- Clean engine if necessary.
- Remove all sealing covers as fitted under Section 7.5.3.
- Drain off remaining corrosion-inhibiting oil.
- Fill up with engine oil.
- Bar engine manually.
- Prepare engine for operation.
- Renew coolant

NOTE:

Put engine into operation according to the engine documentation.

7.7 Special Packing

Special packing must be carried out, immediately following preservation if possible, on engines which are to be shut down for more than 36 months or which are to be transported by sea or in polar or tropical regions (see Sections 7.5 and 7.6). For shorter periods, it is usually an advantage to protect the engine against corrosion with special packing.

7.7.1 General Information on Special Packing

Engines / drive plants must be specially packed for transportation by sea or in polar/tropical regions and before long-term storage. This means that the engine must be preserved according to Section 7.5 or 7.6 (completely drain off coolant and preservation oil) and enclosed in special packing.

The following types of special packing are available:

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

The engine is sealed in a semi- (water vapor) permeable foil and the air is then drawn off with a vacuum cleaner. Desiccant is used to achieve a specific relative humidity inside the envelope. The climatic packing of bonded-layer material hinders the formation of condensed water on the metal surface and resulting corrosion.

7.7.2 Maintenance Intervals

Every 3 to 4 months

- Check humidity indicators (see Section 7.7.4.3).

NOTE:

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

Storage beyond 10 years (as of year of manufacture on nameplate) but before commissioning:

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

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

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

NOTE:

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

7.7.3 Envelopes of Laminated Material

This envelope is made up of tightly bonded layers of aluminum composite which has very limited permeability to water vapor and gas.

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

- Temperature range for applications from +70°C to -55°C.
- Water vapor permeability (WVP): 0.1 g/m² per day at 38° C and 80% relative humidity (compared with PVC soft foil WVP 6 g/m² per day)

7.7.4 Desiccant

Desiccant, mostly silica gel, is the name usually given to water-absorbing materials as used in the special packing. The agent is in packs (units) of highly permeable (for water vapor) and strong material (e.g. natron crêpe paper) and is placed in the special transport packing.

Desiccant pack



Fig. 1

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

- MTU-No. 49542 desiccant 125 g = 4 units
- MTU-No. 49543 desiccant 250 g = 8 units
- MTU-No. 49544 desiccant 500 g = 16 units
- MTU No. 49545 desiccant 1000 g = 32 units

7.7.4.1 Calculation of required desiccant

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

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

Procedure

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

NOTE:

If the laminated aluminum foil is replaced or repaired after being damaged, the calculation for the required desiccant (DU) must be carried out again, see Section 7.7.4.1.

7.7.4.2 Calculation Example for Desiccant Units

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

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

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

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

7.7.4.3 Humidity Indicator

Humidity indicators can be inserted into the foil envelope to show the saturation level of the desiccant. The indicators signalize by changing colour that the specified level of relative humidity has been exceeded. An increase of the relative humidity because of leaks or damage means a risk of corrosion for the engine.

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

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

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

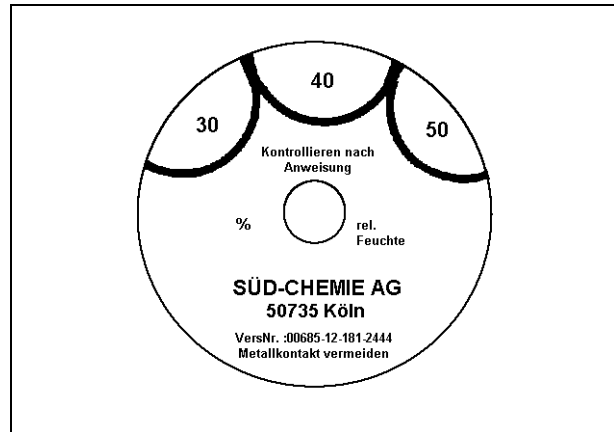


Fig. 2

Relative humidity above 30 %

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

Relative humidity above 40 %

New desiccant required. The new desiccant must be distributed as evenly as possible in the upper section of the packing envelope (see Section 7.7.7.2). For the number of desiccant units required for the special packing see Section 7.7.4.1.

Relative humidity above 50 %

Check condition of packed engine, re-preserve engine (see Sections 7.5.4 and 7.6.4) and repack engine (see Section 7.7.6).

NOTE:

The humidity indicator regenerates itself; replacement is not necessary.

7.7.5 Order Nos. for Packing Materials

Details required when ordering from MTU:

MTU No. 20447 Humidity indicator

MTU No. 20448 Viewing window

MTU-No. 49542 desiccant 125 g = 4 units

MTU-No. 49543 desiccant 250 g = 8 units

MTU-No. 49544 desiccant 500 g = 16 units

MTU No. 49545 desiccant 1000 g = 32 units

MTU No. 49576 Laminated aluminum foil 1.00 m wide

MTU No. 49577 Laminated aluminum foil 1.25 m wide

MTU No. 49579 Laminated aluminum foil 1.50 m wide

MTU No. 49578 PE (polyethylene) foam foil 1.25 m wide, 4 mm thick

7.7.6 Special Packing Procedure for Finished Products

7.7.6.1 Preparation for Special Packing

Provided that the engine is not new or has not undergone a major overhaul by MTU (and has already been preserved), preservation (see Sections 7.5 and 7.6) must be carried out before special packing takes place. Coolant and preservation oil must be completely drained.

7.7.6.2 Transport Locking Device

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

7.7.6.3 Special Packing of an Engine

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

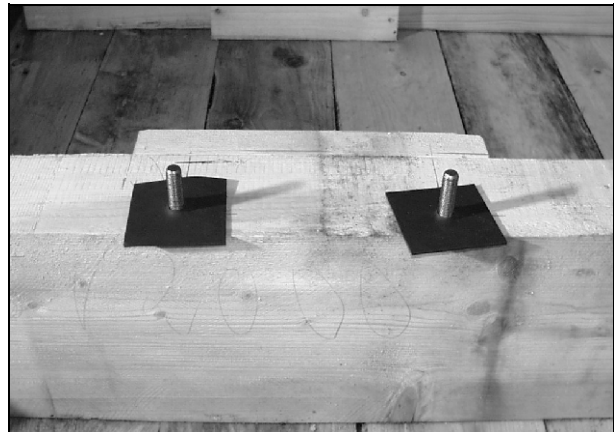


Fig. 3

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



Fig. 4

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



Fig. 5

Position the second hard-rubber pads.

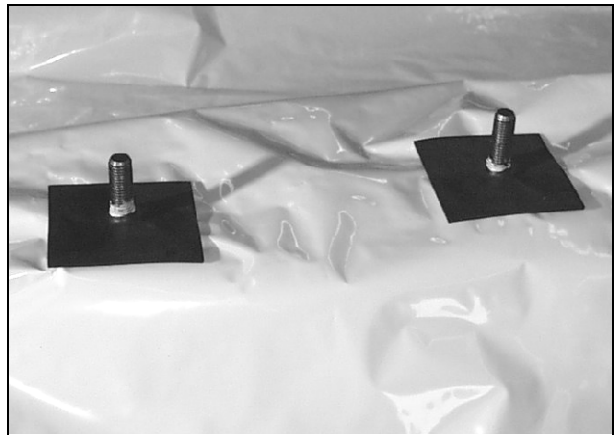


Fig. 6

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



Fig. 7

7.7.6.4 Installation of Humidity Indicator

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

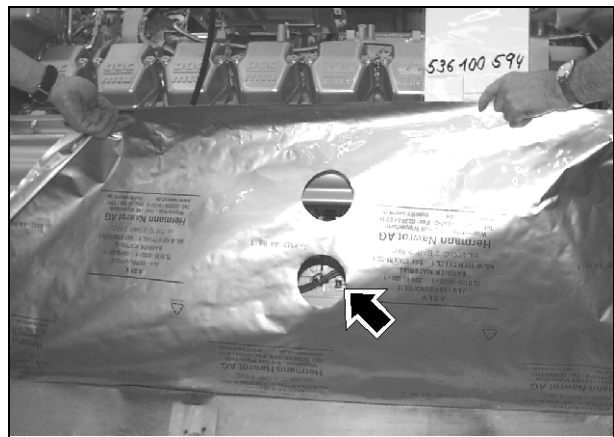


Fig. 8

Screw in the humidity indicator and the viewing window.

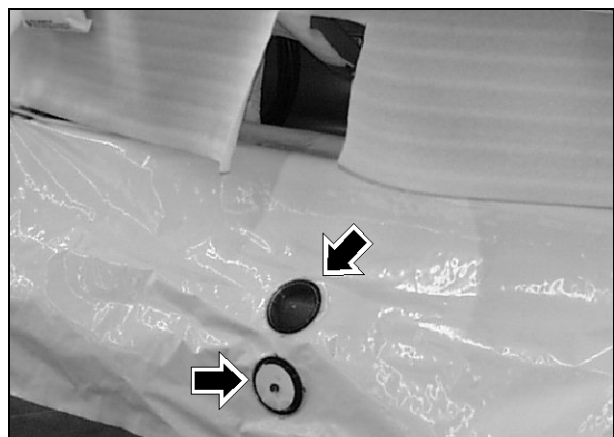


Fig. 9

7.7.6.5 Cushioning of Engine Edges and Corners

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



Fig. 10

7.7.6.6 Location of Desiccant Units

Use the formula (see Section 7.7.4.1) to calculate the required number of desiccant units and put them in place. The desiccant units must be arranged in the upper third of the envelope and attached to the engine, hanging free wherever possible. Ensure that the desiccant units are so attached (with string, adhesive tape or other suitable material) that no damage can be caused to the desiccant units, the engine or the laminated aluminum foil.



Fig. 11

NOTE:

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

7.7.6.7 Laminated Aluminum Foil Sealing

Use a manual foil-welding unit to seal the laminated-foil envelope, (see Section 7.7.9).

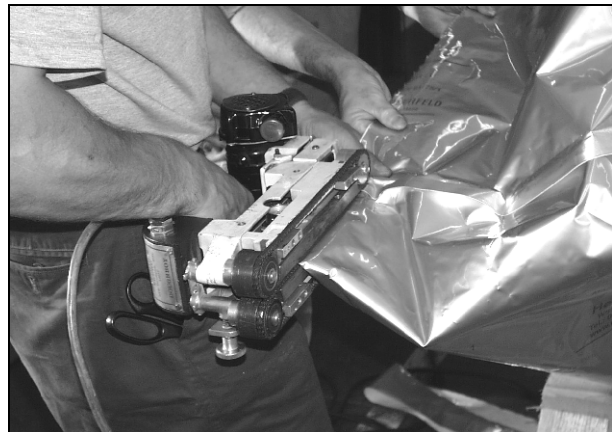


Fig. 12

Prior to finally sealing the envelope, use a vacuum pump (e.g. vacuum cleaner) to extract the entrapped air.



Fig. 13

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



Fig. 14

NOTE:

Extraction of the entrapped air also reduces the humidity within the envelope thus creating a favorable initial humidity status. Extraction of the air also verifies that the envelope is free from leaks. If the envelope is not correctly sealed, it will re-expand within 30 minutes.

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

7.7.7 Special Packing Checks

7.7.7.1 Humidity Check

The humidity within the envelope is to be regularly checked every 3 to 4 months, (see Section 7.7.4.3). The results of the check are to be entered on the Monitoring Sheet (see Section 7.8.2). If the engine is covered by warranty, return the Monitoring Sheet, (see Section 7.8.2) to MTU Friedrichshafen after initial operation of the engine.

ATTENTION!

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

The condition of the laminated aluminum foil is to be checked minutely at every customs, stock or storage check. Corrosion protection is no longer guaranteed if the foil is damaged.

7.7.7.2 Desiccant Replacement

Open the upper section of the envelope and remove the old desiccant. Replace with the same amount of new desiccant in the upper section of the envelope (see Section 7.7.6.6). Re-weld the envelope and extract air (see Section 7.7.6.7).

7.7.8 Repair of Special Packing

If the laminated aluminum foil is damaged, the damaged area can be cut out and a new section welded into position. If repairs have to be carried out, the envelope must be stocked with new desiccant (see Section 7.7.7.2) and the air must be drawn off again (see Section 7.7.6.7). Incorrect repairs with, e.g. adhesive tape, are not acceptable because the partial vacuum in the envelope cannot be maintained. In order to ensure correct repair procedures, the specified packing materials (see Section 7.7.5) and the manual welding unit (see Section 7.7.9) have to be used.

7.7.9 Manual Welding Unit

A supplier of foil-welding units is, for example:

W. Kopp Verpackungsmaschinen
Stettener Straße 111-117

D-73732 Esslingen- Waeldenbronn

Designation: HSD 95 Cello manual sealing unit

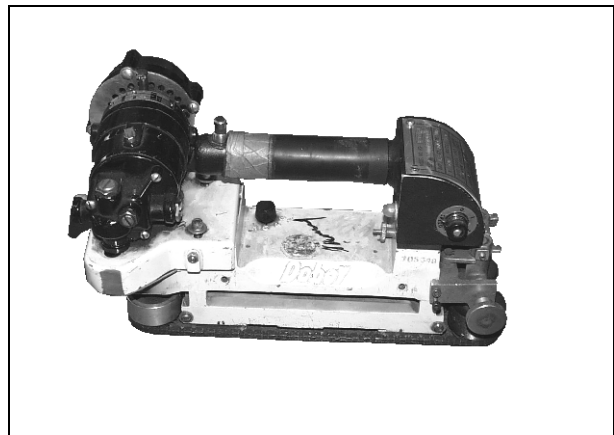


Fig. 15

7.8 Form Sheets

7.8.1 Preservation Check Sheet

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

7.8.2 Monitoring Sheet for Engines in Special Packing

Engine model: Engine No.: Date of delivery:

The following checks are to be completed before, during and at the end of the engine storage period. Correct execution is to be confirmed with date and signature.

NOTE:

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

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

Important NOTE: Inform MTU during the warranty period:

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

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

7.8.3 Check Sheet for De-Preservation of Engines in Special Packing

Check Sheet for Engine De-preservation

ATTENTION!

Before opening the envelope, read and follow this Check Sheet carefully, especially the instructions referring to any necessary reporting to MTU.

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

8 Flushing and Cleaning Specifications for Engine Coolant Systems

8.1 General Information

These cleaning instructions are for cooling systems in MTU diesel engines.

Sludge deposits from ageing coolant additive can eventually accumulate in the cooling systems. Results can be reduced cooling capacity, clogged vent lines and drain cocks plus dirty coolant-level sight glasses.

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

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

If these flushing measures are not enough or the system is too heavily contaminated, the system and affected parts must be cleaned.

Flushing is to be carried out using only clean fresh water (no river or seawater).

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

Immediately after flushing or cleaning, fill the cooling systems with engine coolant as specified in the current MTU Fluids and Lubricants Specification A001061, see Section 6.3.



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

These regulations are contained in the manufacturers' instructions, legal requirements and technical guidelines valid in the individual countries. Great differences can apply from country to country and a generally valid guide to applicable regulations for fluids and lubricants is therefore not possible within this publication.

Users of the products named in these specifications are therefore obliged to inform themselves of the locally valid regulations. MTU accepts no responsibility whatsoever for improper or illegal use of the fluids and lubricants / cleaning agents which it has approved.

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

8.1.1 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

8.2 Approved Cleaning Products

Manufacturer	Brand name	Concentration for use		Order No.
For coolant systems:				
Henkel	P3-Neutrasel 5262	2% by volume	Liquid	⁴⁾
Henkel	P3-Saxin	2 % by weight	Powder	⁴⁾
Novamax	Grisiron 5716	2 % by weight	Powder	⁴⁾
Nalco	Maxi Clean 2	2% by volume	Liquid	40495
For sub-assemblies:				
Henkel	P3-FD ¹⁾	3 to 5% by weight	Powder	⁴⁾
Henkel	Porodox ²⁾	5 to 10% by weight	Powder	⁴⁾
Kluthe	Hakutex 60	100% by volume	Liquid	50602
Novamax	Euron 1308 ³⁾	5 to 10% by weight	Powder	⁴⁾

¹⁾ For greasy lime deposits

²⁾ Preferred for heavy lime deposits

³⁾ For heavy lime deposits

⁴⁾ Not stocked by MTU

8.3 Flushing Engine Coolant Systems

Drain engine coolant.

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

Fill coolant system with fresh water.

- **Never pour cold water into a hot engine!**

Preheat, start and run engine until warm.

Run engine for approx. 30 minutes at increased speed.

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

Shut down engine and drain flush water.

Measure pH-value of the flush water (MTU Test Kit or electric pH-value measuring device).

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

Fill system with treated coolant and start engine.

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

Fill system with fresh flush water and repeat flushing process.

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

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

For further information, see Operating Instructions of respective engine.

8.4 Cleaning Engine Coolant Systems

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

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

Pour solution together with fresh water into coolant system.

Start engine and run until warm.

Run engine for approx. 2 hours at increased speed.

Shut down engine.

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

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

Measure pH-value of the flush water (MTU Test Kit or electric pH-value measuring device).

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

Fill system with treated coolant and start engine.

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

Clean components.

For further information, see **Operating Instructions of respective engine**.

8.5 Cleaning Components

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

Before cleaning, examine degree of contamination on water sides.

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

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

Remove hard lime deposits with a decalcifying product.

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

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

Use only approved detergents in the permissible concentration.

When preparing cleaning bath, refer to manufacturer's instructions!

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

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

In order to avoid damage:

- Do not use hard or sharp-edged tools; wire brushes, scrapers and similar (oxide protective layer)
- Do not set the pressure of the water jet too high (may damage cooler fins, for example).

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

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

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

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

After re-installing all components, flush engine-coolant system once.

Check coolant system for leaks during initial operation of engine.

For further information, see the Maintenance Manual of respective engine.