Fluids and Lubricants Specifications

Diesel generator sets
with mtu Series 2000 and 4000 engines

A001064/16E

A Rolls-Royce solution

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Export Control Information table	
This document is subject to the following export control information:	
DE:	Not subject to export control.

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1 Preface

1.1 General information

These Fluids and Lubricants Specifications contain general instructions for the proper and safe operation of your product from the manufacturer Rolls-Royce Solutions.

To improve readability, plural pronouns are used here to refer to a singular subject of any gender.

Used symbols and means of representation

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

Important
This field contains product information which is important or useful for the user. It refers to instructions that have to be observed, work that has to be performed and activities that have to be carried out to prevent damage to or destruction of the material.

Note:

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

Fluids and lubricants

The service life, operational reliability and function of the diesel generator sets are largely dependent on the fluids and lubricants used. The correct selection and treatment of these fluids and lubricants are therefore extremely important. This is defined in these Fluids and Lubricants Specifications.

mtu ValueCare portfolio

With mtu ValueCare, Rolls-Royce Solutions offers oils approved and tuned to the engine.

Test standards for fluids and lubricants

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

Monitoring fluids and lubricants

The maintenance of fluids and lubricants includes regular monitoring. Relevant information on how samples should be taken and handled for laboratory use can be found in the Customer Information 'Taking and handling samples for laboratory analyses' (publication number A001080/..). The most recent version can be consulted under:

www.mtu-solutions.com

If you have any questions, your contact person will be happy to help you.

Applicability of this document

These Fluids and Lubricants Specifications apply to fluids and lubricants for diesel generator sets with the following engines:

- Series 2000Gx5
- Series 2000Gx6
- Series 4000Gx3
- Series 4000Gx4

Note: References to other engine series in this document should be disregarded.

Document versioning

The fluids and lubricants specifications are revised or supplemented as necessary. Prior to operation, make sure that the latest version is available (publication number A001064/..). The most recent version can be consulted under:

www.mtu-solutions.com

If you have any questions, your contact person will be happy to help you.

Warranty

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

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

Important

Fluids and lubricants for diesel generator sets can be hazardous materials. Certain regulations must be observed when handling, storing and disposing of these substances.

These regulations are contained in the manufacturers' instructions, such as product-specific safety data sheets, statutory regulations and technical guidelines valid in the individual countries. Great differences may apply from country to country, and a generally valid statement on applicable regulations is therefore not possible within these Fluids and Lubricants Specifications.

Users of the products named in these specifications must therefore undertake to inform themselves of the locally valid regulations. Rolls-Royce Solutions accepts no liability whatsoever for improper or illegal use of the fluids and lubricants which it has approved.

Preservation

The document 'Preservation and Represervation Specifications' (publication number A001070/..) contains all information on:

- Preservation
- Represervation and depreservation
- Permissible preservatives

The most recent version can be consulted under:

www.mtu-solutions.com

2 Lubricants

2.1 Engine oils – General information

Important

Dispose of used fluids and lubricants in accordance with local regulations!
Used oil must never be disposed of via the internal combustion engine!

Requirements for the approval of engine oils by Rolls-Royce Solutions

The conditions of Rolls-Royce Solutions for the approval of engine oils for diesel engines are defined in the delivery standards and available under these numbers:

- MTL 5044: Engine oils for diesel engines; Requirements
- MTL 5051: Initial operation and corrosion inhibitor oil for internal preservation of engines

Engine oil manufacturers are notified in writing if their product is approved.

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

- Oil category 1: Standard quality/single- and multi-grade oils
- Oil category 2: Higher quality/single- and multi-grade oils
- Oil category 2.1: Multi-grade oils with a low ash-forming additive content (low SAPS oils)
- Oil category 3: Highest quality/multi-grade oils
- Oil category 3.1: Multi-grade oils with a low ash-forming additive content (low SAPS oils)

Low SAPS oils are oils with a low sulfur and phosphorus content and an ash-forming additive content of ≤1%.

They are only approved if the sulfur content in the fuel does not exceed 50 mg/kg. When using diesel particulate filters, it is advisable to use these oils to avoid fast coating of the filter with ash particles.

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

Important

The use of engine oils that are not approved by Rolls-Royce Solutions may lead to a failure in being able to meet statutory emission limits. This can be a punishable offense.

Important

Mixing different engine oils is strictly prohibited!
It is possible to change to a different approved engine oil grade during an oil change. The remaining oil quantity in the engine oil system is insignificant in this regard.
This procedure also applies to the Rolls-Royce Solutions engine oils in Europe, the Middle East, Africa, America and Asia.

Important

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

Special properties

mtu ValueCare engine oils for diesel engines

The following mtu ValueCare single- and multi-grade oils are available from Rolls-Royce Solutions in the respective regions:

Manufacturer and sales region	Product name	SAE grade	Oil category	Material number
Rolls-Royce Solutions Europe Middle East Africa	DEO SAE 15W-40 Ultra	15W-40	2	20 l canister: X00084315 210 l barrel: X00084316
	Power Guard® DEO SAE 40	40	2	20 l canister: X00062816 210 l barrel: X00062817
Rolls-Royce Solutions America Inc. America	Power Guard® SAE 15W-40 Off Highway Heavy Duty	15W-40	2.1	5 gallons: 800133 55 gallons: 800134 IBC: 800135
Rolls-Royce Solutions Asia Asia	DEO SAE 15W-40 Ultra	15W-40	2	20 l canister: 60333/P 210 l barrel: 60335/D
Rolls-Royce Solutions Suzhou Co. Ltd. China	Diesel Engine Oil - DEO 15W-40	15W-40	2	16 kg: X00087293 170 kg: X00087294
	Diesel Engine Oil - DEO 10W-40	10W-40	2.1	20 l canister: X00085025
PT. Rolls-Royce Solutions Indonesia Indonesia	DEO SAE 15W-40 Ultra	15W-40	2	20 l canister: 60333/P 210 l barrel: 60335/D
mtu India Pvt. Ltd. India	DEO SAE 15W-40 Ultra	15W-40	2	20 l canister: 60333/P 210 l barrel: 60335/D
	Diesel Engine Oil - DEO 15W-40	15W-40	2	20 l canister: 63333/P 205 l barrel: 65151/P
	Diesel Engine Oil - DEO 40	40	2	20 l canister: 73333/P 205 l barrel: 75151/D

Table 1: mtu ValueCare engine oils for diesel engines

Restrictions for certain applications

- Series 2000 Gx6
- Series 4000 Gx3
- Series 4000 Gx4

Important
Category 1 oils must not be used!

Restrictions when using low SAPS oils

Important
Oil categories 2.1 and 3.1 may be used if the sulfur content in the fuel does not exceed 50 mg/kg.

Selecting viscosity grades

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

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

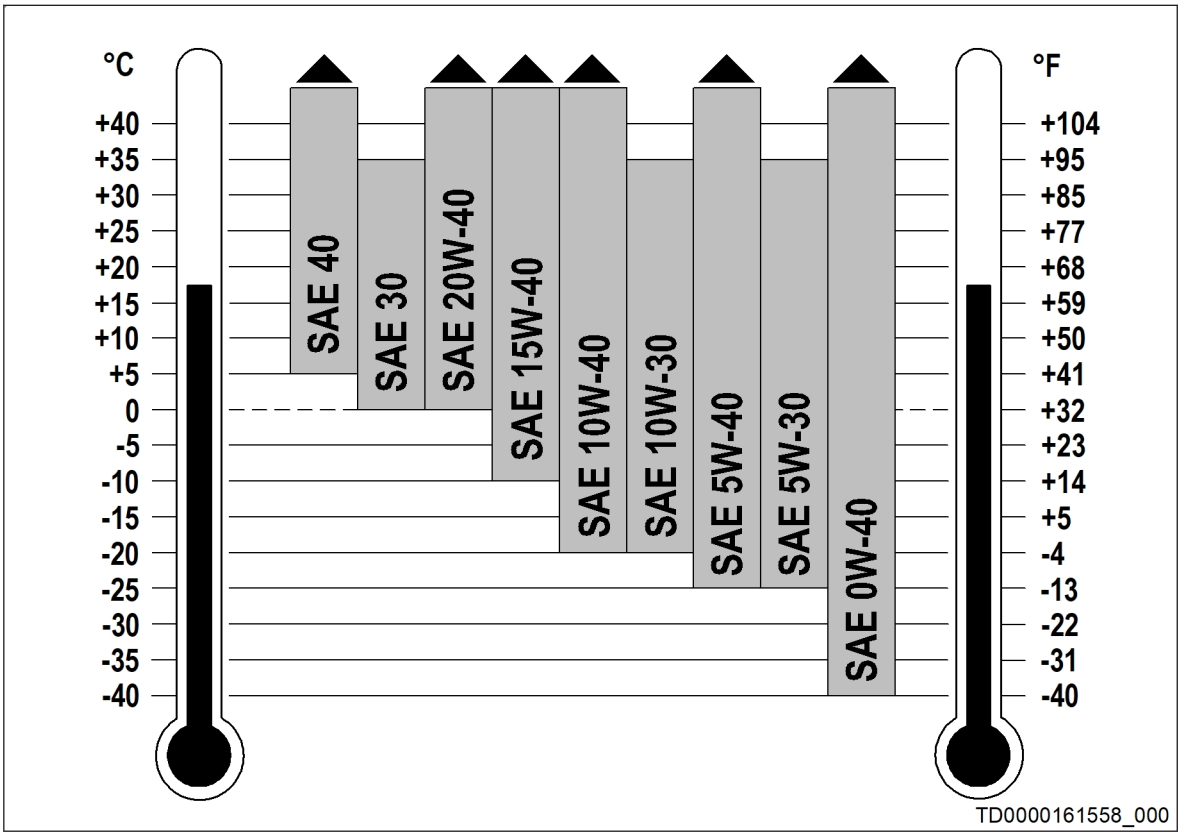

Figure 1: Relationship between viscosity grades and the operating temperature ranges

Oil service life for diesel engines

Oil service life depends on the quality of the engine oil, its conditioning, the operating conditions and the fuel used.

The intervals are guide values based on operational experience and are valid for applications with a standard load profile.

Oil change intervals

Oil category	Without centrifugal oil filter	With centrifugal oil filter
1	250 operating hours	500 operating hours
2	500 operating hours	1000 operating hours
2.1[1)]	500 operating hours	1000 operating hours
3	750 operating hours	1500 operating hours
3.1[1)]	750 operating hours	1500 operating hours
[1)] = To be used in conjunction with fuels with max. 50 mg/kg sulfur content		

Table 2: Oil change intervals

Important
The oil change intervals in table (→ Table 2) are recommended guidelines when using diesel fuels with < 0.5% sulfur content. The defined limit values for the used oil (→ Table 3) must be observed. The oil service life quoted for oils must be confirmed by means of oil analysis.

The oil service life must be determined by oil analysis if one or more of the following difficult operating conditions are encountered:
- Extreme climatic conditions
- High startup frequency
- Frequent and prolonged idling or low-load operation
- High sulfur content in the fuel of 0.5 to 1.5% by weight (See 'Use of high-sulfur diesel fuel')

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

Where engine oils with higher-grade corrosion-inhibiting characteristics are in use, the oil must be changed every three years at the latest.

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

- The first oil sample should be taken from the engine as a 'basic sample' after the engine has run for approximately one hour after being filled with fresh oil.
- Further samples are to be analyzed at specific intervals (see 'Laboratory analyses').
- The appropriate engine inspections are to be carried out before and after the oil analyses.
- After completion of all analyses, and depending on the findings, special agreements can be reached for individual cases.
- Oil samples must always be taken under the same conditions and at the point provided for that purpose ((→ see Operating Instructions)).

Special additives

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

Laboratory analyses

Spectrometric oil analysis

Analysis of the engine oil's additive element content is carried out at Rolls-Royce Solutions to determine the oil brand.

Element contact analyses to assess the degree of engine wear are not part of the standard procedure. These content levels are very much dependent on the following factors, among others:
- Engine equipment status
- Tolerance scatter
- Operating conditions
- Load profile
- Fluids and lubricants
- Assembly materials

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

The measurement of the wear elements can only be regarded as a monitoring task. A sudden increase is an indication that the oil filter must be checked/inspected. If wear particles are found, an EDX analysis can determine their qualitative composition, which helps to identify the affected component.

Used-oil analysis

In order to check the used oil, it is recommended that regular oil analyses be carried out. Oil samples should be taken and analyzed at least once a year and each time the oil is changed. Depending on the application or the operating conditions of the engine, sampling/analysis may have to take place more frequently.

The specified test methods and limit values ('Analytical limit values for used diesel engine oils') (→ Table 3) indicate when the results of an individual oil sample analysis are to be regarded as abnormal.

An abnormal result requires immediate analysis and remedy of the abnormal operating state found.

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

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

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

Analytical limit values for used diesel engine oils

	Test method	Limit values	
Viscosity at 100 °C Max. mm²/s	ASTM D445 DIN 51659-1 DIN 51659-2 DIN 51659-3	SAE 30 SAE 5W-30 SAE 10W-30	15.0
		SAE 40 SAE 5W-40 SAE 10W-40 SAE 15W-40 SAE 20W-40	19.0
Min. mm²/s		SAE 30 SAE 5W-30 SAE 10W-30	9.0
		SAE 40 SAE 5W-40 SAE 10W-40 SAE 15W-40 SAE 20W-40	10.5
Flashpoint °C (COC)	ASTM D92 DIN EN ISO 2592	Min. 190	
Flashpoint °C (PM)	ASTM D93 DIN EN ISO 2719	Min. 140	
Soot content (% by weight)	DIN 51452 CEC-L-82-97	Max. 3,0 (oil category 1) Max. 3,5 (oil category 2, 2.1, 3 and 3.1)	
Total base number (mg KOH/g)	ASTM D2896 ISO 3771 DIN 51639	Min. 50% of the fresh oil value	
Water content (mg/kg)	ASTM D6304 EN 12937 ISO 6296	Max. 2000	
Oxidation (A/cm) [1)]	DIN 51453 [1)]	Max. 25	
Ethylene glycol (mg/kg)	ASTM D2982 ASTM D 4291 ASTM D 7922	Max. difference between fresh oil value and used oil value 100	
Additive element contents	DIN 51399-1 DIN 51399-2 ASTM D5185	To confirm that the fresh oil is identical to the used oils	
[1)] Only possible if there are no ester compounds			

Table 3: Analytical limit values for used diesel engine oils

Use of high-sulfur diesel fuel

The following measures must be taken in the case of diesel fuels with a sulfur content above 0.5%:
- Use of an engine oil with a total base number (TBN) of more than 8 mgKOH/g
- Shortening of the oil service life (see 'Oil change intervals')
- Shortening of the cylinder head TBO for Series 4000 (→ Page 37)

Figure (→ Figure 2) shows the recommended minimum total base numbers for fresh and used oils depending on the sulfur content of the diesel fuel.

The total base numbers for the approved engine oils are listed in chapter 'Approved engine oils' (→ Page 69).

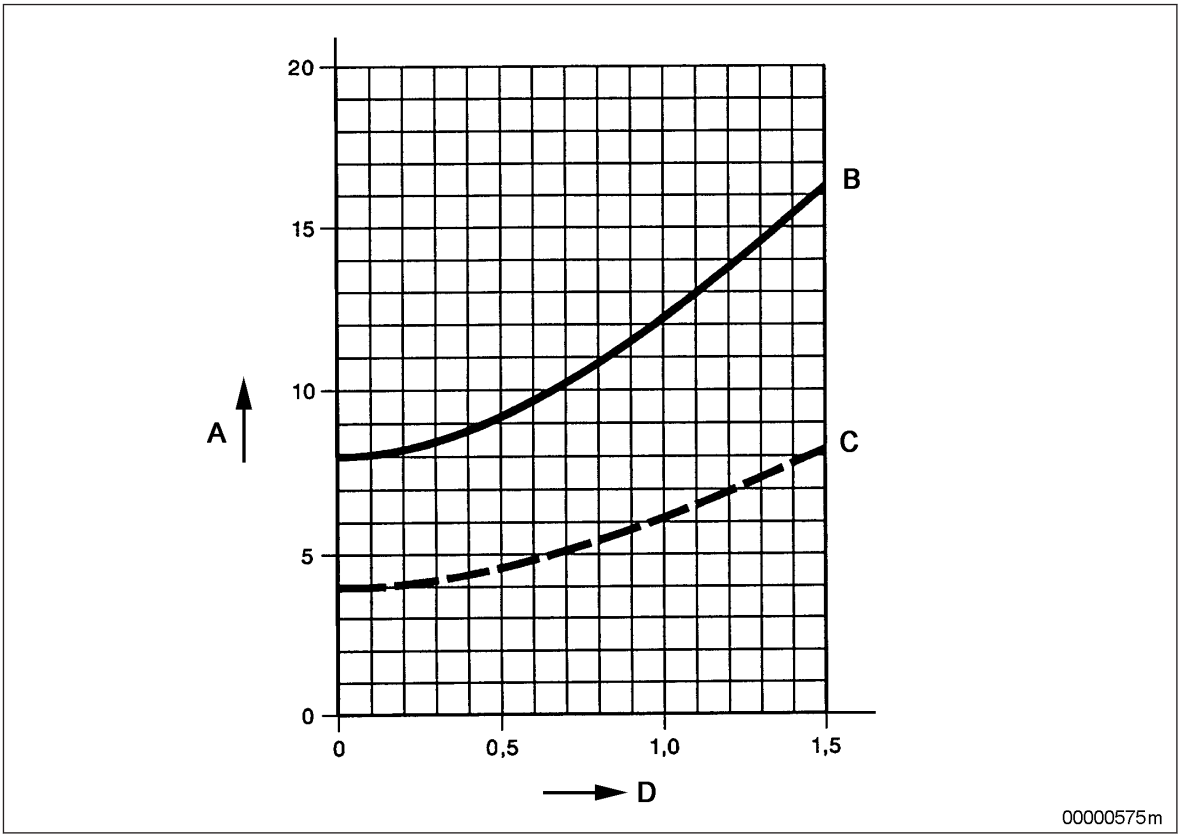

Figure 2: Engine oil total base numbers depending on the diesel fuel's sulfur content

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

Use of low-sulfur diesel fuel

The use of diesel fuels with low sulfur content (< 0.5%) has no effect on the oil service life.

Minimum requirements for operational checks

Oil analyses can be carried out using the test kit, which contains all the equipment required as well as instructions for use.

The following analyses can be conducted:
- Determination of oil dispersancy (spot test)
- Determination of diesel fuel content in the oil
- Determination of water content in the oil

Important

Rolls-Royce Solutions recommends the test kit produced by CM Technologies GmbH (*www.cmtechnologies.de*).

Test package for North America

The mtu Advanced Fluid Management System, which contributes to preventive maintenance through innovative diagnostics, is available in North America.

For the mtu Advanced Fluid Management System for engine oils, see (→ Page 16).

2.2 Fluorescent dyestuffs for detecting leakage in the lube oil circuit

The fluorescent dyestuffs listed below are approved for detecting leakage in the lube oil circuit.

Manufacturer	Product name	Working concentration	Material number	Container size	Storage stability[1)]
Chromatech Europe B.V.	D51000A Chromatint Fluorescent Yellow 175	0.04% - 0.07%	X00067084	16 kg	2 years
Cimcool, Cincinnati	Producto YFD-100	0.5% - 1.0%		5 gallons (canister) 55 gallons (barrel)	6 months

Table 4:

[1)] = Ex-works delivery, based on original and hermetically sealed containers in frost-free storage (> 5 °C).

The fluorescence (light-yellow color tone) of both dyestuffs is made visible with a UV lamp (365 nm).

2.3 Lubricating greases

Requirements

The conditions stipulated by Rolls-Royce Solutions for the approval of lubricating greases are specified in the delivery standard MTL 5050, which can be ordered under this reference number.

Lubricating grease manufacturers are notified in writing if their product is approved.

Lubricating greases for general applications

Lithium-saponified greases are to be used for all lubrication points with the exception of:
- Emergency air-shutoff flaps installed between exhaust turbocharger and intercooler (see Special-purpose lubricants)
- Coupling internal centering

Lubricating greases for applications at high temperatures

High-temperature grease (up to 250 °C) must be used for emergency air-shutoff flaps installed between exhaust turbocharger and intercooler:
- Castrol Braycote Inertox 500-2

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

Greases for internal centerings of couplings

Greases for internal centerings:
- Esso Unirex N3 (stable up to approx. 160 °C)

Special-purpose lubricants

Oils for exhaust 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, mineral-based turbine oils with viscosity grade ISO-VG 68 must be used.

Lubricants for curved tooth couplings

Depending on the application, the following lubricants have been approved for curved tooth couplings:
- - Klüber: Structovis BHD MF (highly viscous lube oil)
- - Klüber: Klüberplex GE11–680 (adhesive transmission lubricant)

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

2.4 mtu Advanced Fluid Management System for engine oils – Test package for North America

A sophisticated system for diagnostics and preventive maintenance is available in North America. This system allows the following:

- Optimized oil change intervals
- Extended engine service life
- Detection of minor problems before they become major problems
- Maximization of diesel generator set's reliability
- Higher resale value of diesel generator set

For full information on the mtu Advanced Fluid Management System available in North America, please contact an authorized Rolls-Royce Solutions service partner.

The following test packages from mtu Advanced Fluid Management System can be ordered from authorized Rolls-Royce Solutions service partners in North America:

- BMP32
  Extended test – monitoring of wear and contamination
- AMP51R
  Extended Test Plus – extension of the oil change intervals

The following engine oil parameters can be determined:

Engine oil parameters	BMP32	AMP51R
24 elementary metals *	✓	✓
percent water *	✓	✓
Viscosity at 40 °C for ISO engine oils	✓	✓
Viscosity at 100 °C for SAE engine oils	✓	✓
Percent fuel dilution **	✓	✓
Percent soot **	✓	✓
Oxidation/nitration	–	✓
Total base number **	–	✓
Total acid number	–	✓

*** Samples of non-engine oils submitted with Order No. BMP32, are only examined spectrometrically for metals and the proportion of water and viscosity are determined.**
**** Samples of non-engine oils submitted with Order No. AMP51R are not examined for fuel dilution, soot content and base number.**

The mtu Advanced Fluid Management System with trend analysis provides information for maximizing system reliability. The following guidelines must be followed to obtain the best results.

Note: The software offered by Rolls-Royce Solutions for online reporting with trend analyses shows the procedure for optimizing evaluation of the gathered information after completion of the analysis.

Note: The mtu Advanced Fluid Management System works together with independent test laboratories accredited according to ISO 17025 A2LA. This accreditation is the highest level of quality obtainable by a test laboratory in North America.

3 Coolants

3.1 Coolants – General information

Coolant

Definition

Coolant	= Coolant additive (concentrate) + freshwater in a predefined mixing ratio Ready for application in the engine

The corrosion-inhibiting effect of coolants is only ensured with the coolant circuit fully filled.

Apart from that, only the corrosion inhibitors approved for internal preservation of the coolant circuit provide proper corrosion protection when the medium is drained. This means that, after draining the coolant, the coolant circuit must be preserved if no more coolant is to be added. Refer to preservation and represervation specifications A001070/.. for a description of the preservation procedure.

The residual volume of corrosion inhibitor for internal preservation of the coolant circuit that remains for technical reasons when the engine is drained is unproblematic if it is carried over into the subsequently filled and approved coolant. Provided it has been preserved with Glysacorr® P113 or Glysacorr® P113 FrostProtect yellow as standard. If an emulsion is used, a flushing procedure is required.

Coolants must be prepared from suitable freshwater and a coolant additive approved by Rolls-Royce Solutions. The coolant must be prepared outside the engine.

Important

Mixtures of various coolant additives and supplementary additives (also in coolant filters and filters downstream of system components) are not permitted!

The conditions for the approval of coolant additives are specified in the following delivery standards (MTL):
- MTL 5047: Emulsifiable corrosion inhibitor oil
- MTL 5048: Antifreeze
- MTL 5049: Water-soluble corrosion inhibitor

Coolant manufacturers are notified in writing if their product is approved.

Preventing damage to cooling system

- When topping up (following loss of coolant), ensure that not only water but also concentrate is added. The specified antifreeze and/or corrosion inhibitor concentration must be attained.
- Do not exceed an antifreeze concentration of 55% by volume (max. antifreeze) corrosion inhibitor. Concentrations in excess of this diminish antifreeze protection and heat dissipation.
- The coolant must not contain any oil or copper residue (in solid or dissolved form).
- The majority of corrosion inhibitors currently approved for internal coolant circuit preservation are water-soluble and do not provide antifreeze protection. Make sure that preserved engines are stored safe from frost because a certain amount of coolant remains in the engine after draining.
- A coolant circuit cannot be drained completely. This means that residual quantities of used coolant or freshwater from the flushing process remain in the engine. These residual quantities can result in the dilution of a coolant to be filled (mixed from a concentrate or use of a ready mixture). This dilution effect is higher the more attachments there are on the engine. Check the coolant concentration in the coolant circuit and adjust as necessary.

Important

All coolants approved in these Fluids and Lubricants Specifications generally relate only to the coolant circuit in mtu engines. In the case of complete drive units, the Fluids and Lubricants Specifications from the component manufacturer must be observed!

Important
For corrosion-related reasons, it is not permissible to operate an engine with pure water without the addition of an approved corrosion inhibitor. Nor is the use of pure glycol or glycol-water mixtures permissible.

Special properties

mtu ValueCare – Coolants and premixes

The following ValueCare products have been removed from the portfolio at Rolls-Royce Solutions:

Manufacturer and sales region	Product name	Material number
	Antifreeze	
Rolls-Royce Solutions GmbH Rolls-Royce Solutions Asia Europe Middle East Africa Asia	Coolant AO 100 Antifreeze Concentrate	Remaining stocks of this product can be used up as long as they are within their shelf life.
	Coolant AS 100 Antifreeze Concentrate	Remaining stocks of this product can be used up as long as they are within their shelf life.
	Coolant AH 100 Antifreeze Concentrate	Remaining stocks of this product can be used up as long as they are within their shelf life.
	Coolant AH 50/50 Antifreeze Premix	Remaining stocks of this product can be used up as long as they are within their shelf life.
	Coolant AH 40/60 Antifreeze Premix	Remaining stocks of this product can be used up as long as they are within their shelf life.
	Coolant AH 35/65 Antifreeze Premix	Remaining stocks of this product can be used up as long as they are within their shelf life.
	Coolant without antifreeze	
	Coolant CS 100 Corrosion Inhibitor Concentrate	Remaining stocks of this product can be used up as long as they are within their shelf life.
	Coolant CS 10/90 Corrosion Inhibitor Premix	Remaining stocks of this product can be used up as long as they are within their shelf life.

Table 5:

The products from Rolls-Royce Solutions America Inc. are still available.

Manufacturer and sales region	Product name	Material number
	Antifreeze	
Rolls-Royce Solutions America Inc. America	Power Cool® Off-Highway Coolant 50/50 Premix	23533531 (5 gallons) 23533532 (55 gallons)
	Power Cool® Universal 50/50 mix	800069 (1 gallon) 800071 (5 gallons) 800084 (55 gallons)
	Power Cool® Universal 35/65 mix	800085 (5 gallons) 800086 (55 gallons)
	Power Cool® 3149 Concentrate	23528572 (55 gallons) 23528571 (1000 l)
	Coolant without antifreeze	
	Power Cool® Plus 6000 Concentrate	23533526 (1 gallon) 23533527 (5 gallons) Colored green

Table 6:

Note:

For ready mixtures, the percentage of coolant additive (concentrate) is always named first. Example:
- Coolant AH 40/60 Antifreeze Premix = 40% by vol. coolant additive/60% by vol. freshwater

Notes on mtu ValueCare coolants

Important
The production and distribution of the coolant CS 100 and CS10/90 will be discontinued by Rolls-Royce Solutions for operational reasons.

The alternative products listed in table (→ Table 7) are compatible when refilling and in the presence of residual quantities when changing coolant.

For all other coolants specified in the Fluids and Lubricants Specifications, refilling is not permitted and flushing is necessary when changing the coolant brand.

mtu ValueCare – Product name	Alternative products	Manufacturer
Coolant CS 100 Corrosion Inhibitor Concentrate	Power Cool® Plus 6000	Rolls-Royce Solutions America Inc.
	Glysacorr G93 green	BASF SE
	Drewgard XTA	Drew Marine
	Fricofin ME	Fuchs SE
	Zerex G93	Valvoline
	OEM Advanced 93	Valvoline
	York 719	YORK SAS
Coolant CS 10/90 Corrosion Inhibitor Premix	No alternative ready mixture available. CS 100 concentrate must be prepared with appropriate freshwater.	

Table 7:

Important
The production and distribution of the coolant AH 100, and ready mixtures based on it, will be discontinued by Rolls-Royce Solutions for operational reasons.

The alternative products listed in table (→ Table 8) are compatible when refilling and in the presence of residual quantities when changing coolant.

The products listed in table (→ Table 8) are based on the latest knowledge available at the time of publication of the Fluids and Lubricants Specifications.

For all other coolants specified in the Fluids and Lubricants Specifications, refilling is not permitted and flushing is necessary when changing the coolant brand.

mtu ValueCare – Product name	Alternative products	Manufacturer
Coolant AH 100 Antifreeze Concentrate	Glysantin G48 blue green	BASF SE
	Tectrol Coolprotect	BayWa AG
	Castrol Radicool NF	Castrol
	Classic Kolda UE G48 ®	Classic Schmierstoffe GmbH & Co.KG
	CAR 1 Premium Longlife Kühlerschutz C48	COPARTS Autoteile GmbH
	AVIATICON Finkofreeze F48	Finke Mineralölwerk GmbH
	Fricofin	Fuchs SE
	Alpine C48	Mitan Mineralöl GmbH
	Mobil Antifreeze Extra	Moove Lubricants Limited
	Motorex Coolant G48	Motorex AG
	Nalcool NF48 C	Nalco Water An Ecolab Company
	Antifreeze Long Life NF-300 Concentrate	Raloy Lubricantes
	Zerex G48	Valvoline
	OEM Advanced 48	
	Hoyer Freeze A48	Wilhelm Hoyer B.V. & Co.KG
Coolant AH 35/65 Antifreeze Premix	Power Cool ® Universal 35/65 mix	Rolls-Royce Solutions America Inc.
Coolant AH 40/60 Antifreeze Premix	Castrol Radicool NF Premix (45%)	Castrol

mtu ValueCare – Product name	Alternative products	Manufacturer
Coolant AH 50/50 Antifreeze Premix	Power Cool ® Universal 50/50 mix	Rolls-Royce Solutions America Inc.
	AVIATICON Finkofreeze F48 RM 50/50	Finke Mineralölwerk GmbH
	Fricofin 50	Fuchs SE
	XTAR Super Coolant Hybrid NF 50%	Moeve Commercial S.A.U.
	Mobil Coolant Extra Ready -36 °C	Moove Lubricants Limited
	Motorex Coolant G48 Ready to use (50/50)	Motorex AG
	Antifreeze Long Life NF-300 Ready-to-use (50:50)	Raloy Lubricantes
	Zerex G48 premix 50%	Valvoline
	OEM Advanced 48 premix 50%	
	Hoyer Freeze A48 RM 50:50	Wilhelm Hoyer B.V. & Co.KG

Table 8:

Important

The production and distribution of the coolant AO and/or ready mixtures based on it will be discontinued by Rolls-Royce Solutions for operational reasons.

The alternative products listed in table (→ Table 9), and their ready mixtures listed in chapter (→ Page 109), are compatible when refilling and in the presence of residual quantities when changing coolant.

The products listed in table (→ Table 9) are based on the latest knowledge available at the time of publication of the Fluids and Lubricants Specifications.

For all other coolants specified in the Fluids and Lubricants Specifications, refilling is not permitted and flushing is necessary when changing the coolant brand.

mtu ValueCare – Product name	Alternative products	Manufacturer
Coolant AO 100 Antifreeze Concentrate	Antifreeze APN-S	Avia AG
	Glysantin G30 pink	BASF SE
	Glysantin G30 ECO pink BMB 100	
	Classic Kolda UE G30	Classic Schmierstoff GmbH & Co KG
	Drewgard ZX	Drew Marine
	AVIATICON Finkofreeze F30	Finke Mineralölwerk GmbH
	Fricofin G12 Plus	Fuchs SE
	Alpine C30	Mitan Mineralöl GmbH
	Omera Premium Coolant	MJL Bangladesh Ltd.
	Zerex G30	Valvoline
	OEM Advanced 30	
	Hoyer Freeze A30	Wilhelm Hoyer B.V. & Co.KG

Table 9:

Important
The production and distribution of the coolant AS 100 and/or ready mixtures based on it will be discontinued by Rolls-Royce Solutions for operational reasons.

The alternative products listed in table (→ Table 10), and their ready mixtures listed in chapter (→ Page 109), are compatible when refilling and in the presence of residual quantities when changing coolant.

The products listed in table (→ Table 10) are based on the latest knowledge available at the time of publication of the Fluids and Lubricants Specifications.

For all other coolants specified in the Fluids and Lubricants Specifications, refilling is not permitted and flushing is necessary when changing the coolant brand.

mtu ValueCare – Product name	Alternative products	Manufacturer
Coolant AS 100 Antifreeze Concentrate	Glysantin G40 pink	BASF SE
	Glysantin G40 ECO pink BMB 100	
	Classic Kolda UE G40	Classic Schmierstoff GmbH & Co KG
	AVIATICON Finkofreeze F40	Finke Mineralölwerk GmbH
	Fricofin DP	Fuchs SE
	Roxor Anti-Frost MT-650	LAEMMLE Chemicals AG
	Puma HD Hybrid Coolant	Puma Energy International S.A.
	Zerex G40	Valvoline
	OEM Advanced 40	
	Hoyer Freeze A40	Wilhelm Hoyer B.V. & Co.KG

Table 10:

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3.2 Unsuitable materials in the coolant circuit

Components made of copper, zinc and brass materials

Unless various preconditions are observed, components made of copper, zinc and brass materials in the coolant circuit can cause an electrochemical reaction in conjunction with base metals (e.g. aluminum). As a result, components made of base metals are subject to corrosion or even corrosive pitting. The coolant circuit becomes leaky at these points.

Requirements

Based on current knowledge, the following materials and coatings must not be used in an engine coolant circuit because negative mutual reactions can occur even with approved coolant additives.

Metallic materials

- No galvanized surfaces
  The entire cooling system must be free of zinc components. This also applies to coolant supply and drain lines as well as to storage containers
- No copper-based alloys as material with the use of coolant containing nitrite, with the exception of the following two alloys:
  – CuNi10Fe1Mn corresponds to CW-352-H
  – CuNi30Mn1Fe corresponds to CW-354-H
- Do not use components containing brass in the coolant circuit (e.g. coolers made of CuZn30) if exposed to ammoniacal solutions (e.g. amines, ammonium, ...) and solutions containing nitrite or sulfide. Stress-corrosion cracking is possible in the presence of tensile stress and a critical potential area. “Solutions” refer to cleaning agents, coolants and similar substances.
- Avoid copper materials wherever possible or keep their effective surface area to the bare minimum. If copper materials cannot be avoided, purely organically inhibited coolants from the list of approved coolants should be used wherever possible.

Non-metallic materials

- Do not use EPDM or silicone elastomers if emulsifiable corrosion inhibitor oils are used or other oils are introduced to the coolant circuit.

Coolant filter / filter downstream of plant components

- If such filters are used, only products that do not contain additives may be used.
  Supplementary additives such as silicates, nitrites etc. can diminish the protective effect or useful life of a coolant and, possibly, attack the materials installed in the coolant circuit.

Information:

Consult the relevant Rolls-Royce Solutions specialist department in case of doubt about the use of materials on the engine / externally mounted components in coolant circuits.

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3.3 Freshwater requirements

For preparation of coolant with and without antifreeze

Only clean, clear water with values in accordance with those in the following table can be used for preparing the coolant. If the limit values for the water are exceeded, de-mineralized water can be added to reduce the hardness or mineral content.

Parameter	Minimum	Maximum
Sum of alkaline earth metals *) (water hardness)	0 mmol/l 0°d	2.7 mmol/l 15°d
pH value at 20 °C	5.5	8.0
Chloride ions + fluoride ions		100 mg/l
Sulphate ions		100 mg/l
Bacteria		10^3 CFU (colony forming unit)/ml
Fungi, yeasts	are not permitted!	

*) Common designations for water hardness in various countries:

1 mmol/l = 5.6°d = 100 mg/kg $CaCO_3$

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

3.4 Emulsifiable corrosion-inhibiting oils

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

- Series 2000
- Series 4000

Special approval presently in effect remain valid.

3.5 Antifreeze

The previous versions of these Fluids and Lubricants Specifications used the term 'Corrosion-inhibiting antifreeze'. The term 'Antifreeze' is now used in this edition for reasons of clarity.

Antifreeze is necessary for engines without heating facilities and for operation in areas where below-freezing temperatures may occur.

The BASF SE Glysantin G206 product for Arctic regions is no longer available. Stocks of this product may be used up as long as the shelf life has not expired. Please contact your Rolls-Royce Solutions partner.

Most of the antifreezes approved by Rolls-Royce Solutions are based on ethylene glycol.

Approved antifreezes based on propylene glycol are listed in the relevant chapter (→ Page 122).

Provided that they are used in approved concentrations, antifreezes approved by Rolls-Royce Solutions provide effective protection against corrosion, see section 'Operational monitoring' (→ Page 29).

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

Important

For approved coolant additives for the individual engine series, refer to chapter 'Approved coolants' (→ Page 99).

Special approvals presently in effect remain valid.

Important

Coolant additives containing nitrite must not be used in conjunction with coolers that contain brass!

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

Series 538, 595 and 8000:

The use of antifreezes is not allowed for these engines.

Series 956-01, 956-02, 1163-02, 1163-03, 1163-04:

These engines are fitted with heating units. Because of their cooler capacity, antifreezes must not be used.

Series 099, 183, 396:

Antifreezes may be used with these engines at seawater temperatures up to a maximum of 20 °C max.

Series 2000 and 4000:

On these engines with installed heat exchanger, antifreezes may be used at seawater temperatures up to a maximum of 25 °C. The use of antifreezes is generally not allowed on engines with no installed heat exchanger. Ensure that the heat exchanger not installed on the engine is sufficiently dimensioned.

The specified maximum values for the seawater temperatures apply to all engines on a vessel that are cooled with seawater, e.g. drive motor and onboard power generator.

Important

The maximum admissible antifreeze content for Series 2000, model types 00 to 07 in marine applications is limited to 40% by volume.

The possibility of using antifreezes for the above-mentioned series for other applications (e.g. Generator Set, Rail) is described in the overview in the chapter 'Approved coolants' (→ Page 99).

Note:

Propylene glycol-based antifreezes are stipulated for use in some types of applications. These products have a lower thermal conductivity than the usual ethylene glycol products. This results in a higher temperature level in the engine.

Important

Propylene glycol based coolants (→ Page 122) are approved for Series 4000 model types 01 to 05 used in generator set applications.
Restrictions apply to the use of propylene glycol based coolants for various model types in all other Series 4000 applications. See (→ Page 99)

Flushing with water is required at every change to a different coolant product. For preserved engines (new engines, field engines, reserve stock engines, etc.), a flushing run must be carried out prior to filling with engine coolant if the engines were preserved with an emulsifiable corrosion inhibitor. The necessary work is described in the chapter 'Flushing and cleaning specifications for engine coolant circuits' (→ Page 123).

3.6 Coolant without antifreeze

The previous versions of these Fluids and Lubricants Specifications used the term “water-soluble corrosion inhibitors”. For reasons of clarity, this publication uses the term “Coolant without antifreeze”. Emulsifiable corrosion inhibitor oils are not covered in this chapter. See chapter “Emulsifiable corrosion inhibitor oils” (→ Page 25)

Coolant without antifreeze is required for higher coolant temperatures and large temperature drops in heat exchangers, e.g. in TB systems (with plate-core heat exchanger) and TE systems in Series 099, 183, 2000, 396 and 4000 engines.

Provided that they are used in adequate concentration, coolants without antifreeze approved by Rolls-Royce Solutions provide effective corrosion protection. The relevant concentration range for use is listed in the section on operational monitoring.

Important

For approved coolant additives for the individual engine series, refer to chapter “Approved coolants” (→ Page 99).

Special arrangements presently in effect remain valid.

Important

Coolant additives containing nitrite must not be used in conjunction with coolers that contain brass!

Flushing with water is required at every change to a different coolant product. For preserved engines (new engines, field engines, reserve stock engines, etc.), a flushing run must be carried out prior to filling with engine coolant if the engines were preserved with an emulsifiable corrosion inhibitor. The necessary work is described in the chapter “Flushing and cleaning specifications for engine coolant circuits” (→ Page 123).

3.7 Operational monitoring

Analysis of the freshwater and continuous monitoring of the coolant are essential for trouble-free engine operation. The freshwater and the coolant should be checked at least once a year or each time they are topped up. This can be carried out with the test kit or by an authorized laboratory. The test kit contains all the necessary equipment, chemicals and instructions for use.

Important
Rolls-Royce Solutions recommends the test kit produced by CM Technologies GmbH (*www.cmtechnologies.de*).

Analysis	On-site method (Test kit)	Lab method
Determination of the water hardness	Titration	Determination of the Ca and Mg content by means of ICP and calculation of the hardness in °dH or mmol/l
Determination of the pH value	Litmus paper strips with suitable measuring range	ASTM D 1287
Determination of the chloride content	Titration	IC
Determination of the sulfate content	-	IC
Determination of the silicon content	-	ICP
Determination of additive concentration in aqueous coolant solutions	Brix refractometer, compare degree(s) Brix against table (→ Table 13) and read off concentration in % by volume.	Refractometer method DIN 51423, compare Brix value against table (→ Table 13) and read off % by volume.
Determination of antifreeze concentration	Glycol refractometer, concentration in % by volume can be read off directly	Refractometer method DIN 51423, calculation through refraction index or product-specific factor
Determination of bacterial count for aqueous media	-	Dip slides (tube with culture medium, e.g. by VWR Prolabo No. 535112D or equivalent) incubation time: Four days at 30 °C

Table 11: Minimum requirements and methodology for operational monitoring for coolant

The routine check of the coolant in accordance with table (→ Table 11) identifies minimum requirements. If there are noticeable problems with the coolant with regard to

- Appearance (color, clouding, contamination, etc.)
- Odor

and in the results of the specified examinations, then a laboratory analysis is recommended (see A001080/.. 'Handling of laboratory samples'). In the case of silicon-containing coolants, the silicon content must generally be checked in the laboratory, because no rapid test that can be applied is available.

Orders for freshwater and coolant analysis may be placed with Rolls-Royce Solutions. In specific cases, operational monitoring can cover more checks than those listed in table (→ Table 11). Please contact your Rolls-Royce Solutions partner if necessary.

Important

On Series 4000-04/-05 engines, an additional exhaust gas cooler is installed and the cooling system reacts more sensitively. A regular check of the coolant is therefore very important to ensure trouble-free engine operation. This check must be carried out annually or after 3000 operating hours and every time the coolant is added.
The concentration, pH value and silicon content (only with coolants that contain Si) must be within the values specified in these Fluids and Lubricants Specifications.

Important

Due to thermal stress of the coolant in plants with preheating, a semi-annual analysis of the coolant is recommended.

Permissible concentrations

	Minimum				Maximum
Emulsifiable corrosion inhibitor oils without antifreeze	1% by volume	–	–	–	2% by volume
Antifreeze based on ethylene glycol	35% by volume	40% by volume	45% by volume	50% by volume	55% by volume
With antifreeze protection up to*	-20 °C	-25 °C	-31 °C	-37 °C	-45 °C
Antifreeze based on propylene glycol	35% by volume	–	–	–	50% by volume
With antifreeze protection up to*	-18 °C	–	–	–	-32 °C

Table 12:

* = Antifreeze specifications determined as per ASTM D 1177.

Note:

Concentration ratios may be subject to certain restrictions depending on the customer, series, model and application concerned (refer to the operating instructions of the engine).

Operational monitoring for permissible concentrations – coolant without antifreeze

Permissible concentration range	Manufacturer	Product name/brand name	Reading on hand-held refractometer[1] at 20 °C (= degree(s) Brix)					
		% by volume	7	8	9	10	11	12
9 to 11% by volume	Rolls-Royce Solutions	Coolant CS 100 Corrosion Inhibitor Concentrate	3.5	4.0	4.5	5.0	5.5	6.0
		Coolant CS 10/90 Corrosion Inhibitor Premix	3.5	4.0	4.5	5.0	5.5	6.0
	Rolls-Royce Solutions America Inc.	Power Cool® Plus 6000	3.5	4.0	4.5	5.0	5.5	6.0
	BASF SE	Glysacorr G93 green	3.5	4.0	4.5	5.0	5.5	6.0
	CCI Corporation	A 216	4.9	5.6	6.3	7.0	7.7	8.4
	CCI Manufacturing IL Corporation	A 216	4.9	5.6	6.3	7.0	7.7	8.4
	Detroit Diesel Corporation	Power Cool Plus 6000	4.9	5.6	6.3	7.0	7.7	8.4
	Drew Marine	Drewgard XTA	3.5	4.0	4.5	5.0	5.5	6.0
	ExxonMobil	Mobil Delvac Extended Life Corrosion Inhibitor	4.9	5.6	6.3	7.0	7.7	8.4
	Fuchs SE	Fricofin ME	3.5	4.0	4.5	5.0	5.5	6.0
	Ginouves	York 719	3.5	4.0	4.5	5.0	5.5	6.0
	Old World Industries Inc.	Final Charge Extended Life Corrosion Inhibitor (A 216)	4.9	5.6	6.3	7.0	7.7	8.4
	Penske Power Systems	PowerCool Pyroshield-GF Coolant	4.9	5.6	6.3	7.0	7.7	8.4
	Recochem Inc.	HD Expert™ Endurance WB Prediluted Coolant	4.9	5.6	6.3	7.0	7.7	8.4
	Valvoline	Zerex G93	3.5	4.0	4.5	5.0	5.5	6.0
		OEM Advanced 93	3.5	4.0	4.5	5.0	5.5	6.0
7 to 11% by volume	Arteco	Havoline XLI	2.6	3.0	3.4	3.7	4.1	4.4
	Chevron	Delo XLI Corrosion Inhibitor - Concentrate	2.6	3.0	3.4	3.7	4.1	4.4
	Nalco Water An Ecolab Company	Alfloc™ 3443	1.75	2.0	2.25	2.5	2.75	3.0
		Alfloc™ 3477	1.75	2.0	2.25	2.5	2.75	3.0
	Total	WT Supra	2.6	3.0	3.4	3.7	4.1	4.4

Permissible concentration range	Manufacturer	Product name/brand name % by volume	Reading on hand-held refractometer[1] at 20 °C (= degree(s) Brix) 7 | 8 | 9 | 10 | 11 | 12
3 to 4% by volume	ImproChem	Cool-C18	Please use test kit from manufacturer.
	Nalco Water An Ecolab Company	Nalcool® 2000	

Table 13:

[1] = Concentration determined by means of suitable hand-held refractometer

Calibrate the hand-held refractometer with clean water at coolant temperature. The coolant temperature should be 20 °C. Observe the manufacturer's specifications.

Operational monitoring of admissible concentrations, ethylene-glycol-based antifreeze (MEG)/propylene-glycol-based antifreeze (MPG)

The concentration is determined using a suitable glycol refractometer and direct reading of the scale value in % by volume. Care must be taken to read off from the relevant scale when using hand-held refractometers indicating both MEG and MPG scaling.

3.8 Limit values for coolants

pH value when using:			Method
– Emulsifiable corrosion inhibiting oil	Min. 7.5	Max. 9.5	
– Antifreeze	Min. 7.5	Max. 9.0	
– Coolant without antifreeze for engines containing light metal	Min. 7.5	Max. 9.0	ASTM D 1287, ISO 976
– Coolant without antifreeze for engines free of light metal	Min. 7.5	Max. 11.0	

Table 14:

Silicon content in silicon-containing coolants			Method
Silicon	Min. 25 mg/l		ICP

Table 15:

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

Note:

For a holistic appraisal of a coolant function, apart from the above-mentioned limit values the respective coolant-specific characteristic data and the fresh water quality used must be taken into consideration.

3.9 Coolant concentrates – Storage stability

The storage capability specifications refer to coolant concentrates in original, hermetically sealed packing with storage temperatures up to max. 30 °C.

The instructions of the manufacturer must also be observed.

Coolant concentrate	Limit value	Brand name/comments
Emulsifiable corrosion inhibitor oil	12 months	Quaker Houghton Oil 9156
Antifreeze	Approx. 3 years	Observe manufacturer's instructions.
Coolant without antifreeze	2 years	ImproChem Cool-C18 Nalco Nalcool® 2000
	3 years	BASF Glysacorr G93 green Drew Marine Drewgard XTA Fuchs Fricofin ME Ginouves York 719 Rolls-Royce Solutions GmbH Coolant CS100 Rolls-Royce Solutions America Inc. Power Cool® Plus 6000 Nalco Alfloc™ 3477 Valvoline Zerex G93 Valvoline OEM Advanced 93
	5 years	Arteco Havoline XLI CCI Corporation A216 CCI Manufacturing IL A216 Chevron Delo XLI Corrosion Inhibitor Concentrate Detroit Diesel Corp. Power Cool Plus 6000 ExxonMobil Mobil Delvac Extended Life Corrosion Inhibitor Old World Industries Final Charge Extended Life Corrosion Inhibitor (A216) Total WT Supra

Table 16:

Notice:

For reasons of corrosion protection, do not store in galvanized containers. Take this requirement into account when transferring coolant.

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

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

3.10 Color additives to detect leakage in the coolant circuit

The following listed fluorescent dyes are approved as additives for coolant without antifreeze for the detection of leakages.

Approved color additives

Manufacturer	Product category (TIM)	Material number	Container size	Storage stability[1)]
Chromatech Inc. Chromatech Europe B.V.	D11014 Chromatint Uranine Conc	X00066947	20 kg	2 years
[1)] = Based on original and hermetically sealed containers in frost-free storage (> 5 °C)				

Table 17:

Application:

Add approx. 40 g of dye per 180 l of coolant.

This dye quantity is already very generous and must not be exceeded.

The fluorescence (yellow tone) is easily recognizable in daylight. UV light with a wavelength of 365 nm can be used in darker rooms.

3.11 mtu Advanced Fluid Management System for coolant – Test package for North America

A sophisticated system for diagnostics and preventive maintenance is available in North America. This system allows the following:

- Optimization of the coolant change intervals
- Evaluation of metal migration
- Evaluation of the coolant's corrosive properties
- Detection of the causes of problems in the cooling system in connection with blown cylinder-head gaskets, electrical ground problems, localized overheating and contaminants within and outside the system

For full information on the mtu Advanced Fluid Management System available in North America, please contact an authorized Rolls-Royce Solutions service partner.

The following test packages from mtu Advanced Fluid Management System can be ordered from authorized Rolls-Royce Solutions service partners in North America:

- C-P92
  Basic test – For monitoring the corrosivity of the coolant and for detecting metal migration
- C-P94
  Extended test – Identification of the causes of leaks in the combustion system, grounding problems and contamination in the plant
- C-P93
  Extended Test Plus – Monitoring of corrosivity and metal migration plus HPLC analysis and IC analysis for confirmation of the determined contamination of the corrosion inhibitor

The following coolant parameters can be determined:

Coolant parameters	C-P92	C-P94	C-P93
15 elementary metals	✓	✓	✓
Glycol percentage	✓	✓	✓
Freezing point	✓	✓	✓
Boiling point	✓	✓	✓
pH value	✓	✓	✓
Total hardness	✓	✓	✓
SCA number	✓	✓	✓
Nitrite	✓	✓	✓
Specific conductivity	✓	✓	✓
Carboxylic acid	✓	✓	✓
Sensory parameters (color, oil, fuel, magnetic precipitation, amagnetic precipitation, odor and foam)	✓	✓	✓
Contamination and corrosion inhibitor through IC (chloride, sulfate, nitrite, nitrate, phosphate and glycolate)	–	✓	✓
HPCL	–	–	✓

The mtu Advanced Fluid Management System with trend analysis provides information for maximizing system reliability. The following guidelines must be followed to obtain the best results.

Note: The software offered by Rolls-Royce Solutions for online reporting with trend analyses shows the procedure for optimizing evaluation of the gathered information after completion of the analysis.

Note: The mtu Advanced Fluid Management System works together with independent test laboratories accredited according to ISO 17025 A2LA. This accreditation is the highest level of quality obtainable by a test laboratory in North America.

4 Liquid Fuels

4.1 Diesel fuels – General information

Important

Dispose of used fluids and lubricants in accordance with local regulations!
Used oil must never be disposed of by adding it to the internal combustion engine!

Selecting 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.

Important

Diesel fuels are not available around the world in the quality specified in the tables 'Mandatory fuel specifications' (→ Table 18) 'Mandatory particle limit values' (→ Table 21) or (→ Page 52) ('Mandatory fuel specifications').
The fuel properties depend on many factors, particularly the region, time of year and storage.

Important

If the fuel is to be stored in storage tanks for an extended period of time, we urgently recommend the use of B0 fuel (biodiesel/FAME-free fuel). This recommendation is supported by a 2015 paper published by the German Federal Office for Information Security entitled 'New findings on fuel storage life for standby power systems'. This recommendation applies to the use of both fossil and paraffinic diesel fuel. FAME (fatty acid methyl ester) stands for first-generation biodiesel.
Rolls-Royce Solutions provides project-specific consultation on request.
We recommend determining the oxidation stability (EN ISO 12205 / ASTM D 2274) to check the quality.

Unsuitable fuel usually leads to a reduced useful life of engine components and can also cause engine damage.

Further details on fuel qualities, tank care and filtration are available in the publication 'Useful information on fuels, tank systems and filtration' (publication number A060631/..).

Mandatory fuel specifications

		Test methods		Limit values
		ASTM		
Composition				The diesel fuel must be free of inorganic acids, visible water, solid foreign matter and chlorine compounds.
Total contamination (= fuel-insoluble ingredients)	Max.	D6217	EN 12662	24 mg/kg
Density at 15 °C	Min.	D1298 D4052	EN ISO 3675 EN ISO 12185	0.815 g/ml
	Max.			0.860 g/ml
API gravity at 60 °F	Min.	D287 D4052		42
	Max.			33

[1] = See series-specific injection and exhaust gas aftertreatment systems (→ Page 41) for the definition as to whether an exhaust gas aftertreatment system is installed.
[2] If local legislation permits the use of fuel with a sulfur content > 15 mg/kg. If applicable, the use of fuel with a sulfur content > 15 mg/kg voids compliance with the emissions regulations.
[3] Note: 1% by weight = 10,000 mg/kg = 10,000 ppm

		Test methods		Limit values
		ASTM		
Viscosity at 40 °C	Min.	D445	EN ISO 3104	1.5 mm²/s
	Max.			4.5 mm²/s
Flashpoint (closed crucible)	Min.	D93	DIN EN ISO 27 19	55 °C
Boiling curve:		D86	EN 17306	
– Initial boiling point				160 to 220 °C
– Volume share at 250 °C	Max.			65% by volume
– Volume share at 350 °C	Min.			85% by volume
– Residue and loss	Max.			3% by volume
Fatty acid methyl ester content (FAME) ('Biodiesel')	Max.		EN 14078 Internal mtu procedure	7.0% by volume
Water content: (Absolute, no free water)	Max.	D6304	EN ISO 12937	200 mg/kg
Carbon residue from 10% distillation residue	Max.	D189	EN ISO 10370	0.30% by weight
Oxide ash: [1] – Engines without exhaust gas aftertreatment and without exhaust gas recirculation	Max.	D482	EN ISO 6245	0.01% by weight (100 mg/kg)[3]
Sulfur content: [1] – Engines without exhaust gas aftertreatment and without exhaust gas recirculation	Max.	D5453 D2622	EN ISO 20846 EN ISO 20884	0.5% by weight (5000 mg/kg)[3] (→ Page 39)
Sulfur content: [2] – Deviating, but approved sulfur content for certain products				
– Series 2000 Gx6	Max.			0.05% by weight (500 mg/kg)[3]
– Series 2000 Gx5	Max.			0.05% by weight (500 mg/kg)[3]
Cetane number	Min.	D613	EN ISO 5165 EN ISO 15195	45
Cetane index	Min.	D976	EN ISO 4264	42
Copper corrosion 3 h at 50 °C	Max. degree of corrosion	D130	EN ISO 2160	1a
Oxidation stability (FAME content of ≥ 2% by vol.)	Min.		EN 15751	20 hours

[1] = See series-specific injection and exhaust gas aftertreatment systems (→ Page 41) for the definition as to whether an exhaust gas aftertreatment system is installed.
[2] If local legislation permits the use of fuel with a sulfur content > 15 mg/kg. If applicable, the use of fuel with a sulfur content > 15 mg/kg voids compliance with the emissions regulations.
[3] Note: 1% by weight = 10,000 mg/kg = 10,000 ppm

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		Test methods		Limit values
		ASTM		
Oxidation stability (FAME content of < 2% by vol.)	Max.	D2274	EN ISO 12205	25 g/m³
Lubricity at 60 °C (HFRR value)	Max.	D6079	EN ISO 12156-1	520 µm
Neutralization number	Max.	D974		0.2 mg KOH/g
Microbial contamination				Inadmissible
[1] = See series-specific injection and exhaust gas aftertreatment systems (→ Page 41) for the definition as to whether an exhaust gas aftertreatment system is installed. [2] If local legislation permits the use of fuel with a sulfur content > 15 mg/kg. If applicable, the use of fuel with a sulfur content > 15 mg/kg voids compliance with the emissions regulations. [3] Note: 1% by weight = 10,000 mg/kg = 10,000 ppm				

Table 18: Mandatory fuel specifications

Diesel fuels in winter operation

At low outdoor temperatures, diesel fuel fluidity can be inadequate as a result of paraffin precipitation. It is the fuel supplier's responsibility to provide a fuel that will assure correct engine operation at the expected minimum temperatures under the given geographical and other local conditions.

The operating company must ensure that the correct fuel required for the corresponding climatic requirements is always used.

In order to prevent operational problems (e.g. clogged filters) during the winter months, diesel fuel with suitable cold-flow characteristics is available on the market. Deviations are possible during transitional periods and in individual countries.

The following parameters define the cold-flow characteristics:

		Test methods		Limit values
		ASTM		
Cold filter plugging point (CFPP)		D6371	DIN EN 116	See comment [1]
Cloud point		D2500	DIN EN 3015	See comment [2]
[1] Filter plugging point or cold filter plugging point (CFPP) denotes the temperature at which a test filter is clogged by precipitated paraffins under defined conditions. This characteristic is used for diesel fuels as per DIN EN 590 to describe the climatic requirements (e.g. summer and winter diesel). As a rule, however, the fuel filters installed on the engine have a significantly higher filtration efficiency than the test filters. [2] The cloud point is the temperature at which a liquid product first becomes turbid in the test glass due to precipitation of paraffin. This must not be higher than the ambient temperature.				

Table 19: Parameters to define the cold-flow characteristics

Rolls-Royce Solutions recommends using the cloud point for the evaluation of the cold-flow characteristics.

Operation of fuels with higher sulfur content:

The engines are certified for operation with the fuels approved in these Fluids and Lubricants Specifications.

The component TBO specified in the maintenance schedule relates to operation of the engine with diesel fuel as per DIN EN 590.

For operation with a high sulfur content in the fuel, the following must be observed:

Series 4000

When a fuel with sulfur content > 3000 mg/kg is used, the times specified in the Maintenance Schedule for component TBO of the cylinder head may be reduced, see following table (→ Table 20).

TBO cylinder head as a function of sulfur content in the fuel

Sulfur content in fuel (mg/kg)	TBO cylinder head (h)
< 3000	According to Maintenance Schedule
3000 - 4500	7000[1)]
4500 - 5000	5000[1)]
[1)] = If the TBO for the cylinder head specified in the Maintenance Schedule is shorter, the shorter TBO shall always apply.	

Table 20: TBO cylinder head as a function of sulfur content in the fuel

Important
If the sulfur content in the fuel is > 0.5% by weight (> 5000 mg/kg), please consult with Rolls-Royce Solutions GmbH (Application).

When engines are operated with diesel fuels with a sulfur content of more than 0.5% by weight, appropriate engine oils must be used. The criteria for the selection of engine oils can be found in the chapter on 'Engine oils' (→ Page 7) under the notes regarding the use of diesel fuels with a higher sulfur content and the Figure Engine oil total base number depending on the diesel fuel's sulfur content.

Note

For safe and efficient engine operation, the specified limit values, in particular for water, total contamination, must be observed for all permissible fuel grades in the table (→ Table 18) at the interface marked in Figure (→ Figure 3) item 6 at the latest.

Important
In addition to the limit values listed in table (→ Table 18) or (→ Page 52), a particle distribution in the fuel in acc. with ISO 4406 must be observed.

Important
The limit values named in the table (→ Table 21) must already be observed in the feed between the last tank before the engine and the prefilter (if necessary, with water separator).

For plants without a prefilter, this refers to the feed between the last tank and the scope of supply of Rolls-Royce Solutions. For the analysis of the fuel quality, an interface (sample extraction cock) must be provided for sample extraction during operation.

For existing plants without an accessible feed, sample extraction in the last tank before the scope of supply of Rolls-Royce Solutions is permissible.

Particle limit values to be observed

Particle distribution	Test method ASTM		Limit values	
			Common Rail	Conventional injection
Particle distribution for fuel between last tank before engine and prefilter (see Figure (→ Figure 3), item 6)	D7619 D7647	Coding of number of particles as per ISO 4406	Max. ISO Code 18/17/14 for 4/6/14 µm particle size	Max. ISO Code 21/20/17 for 4/6/14 µm particle size

Table 21: Particle limit values to be observed

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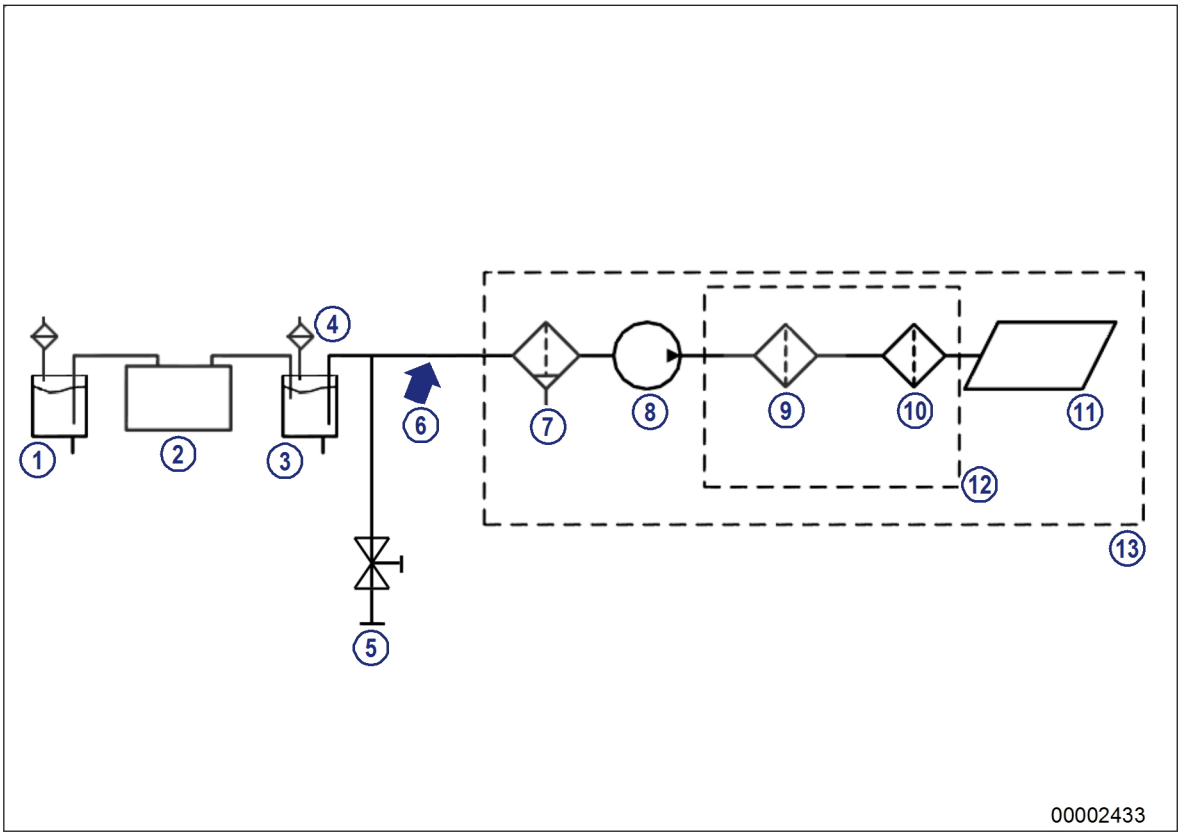

Figure 3: General fuel system diagram for diesel engines

1 Fuel tank
2 Fuel treatment (optional)
3 Last tank before engine
4 Tank vent filter
5 Sample extraction
6 Interface for fuel specification
7 Fuel prefilter with water separator (optional)
8 Fuel low pressure pump
9 Intermediate filter (optional)
10 Primary filter
11 Injection system
12 Engine filter
13 Engine scope of supply

Note:

In case of poor particle distribution, it is necessary to integrate further/more optimized filter stages in the fuel system to achieve the operational life of fuel filters and components of the injection system.

It has been proven that prefilters approved by Rolls-Royce Solutions provide sufficient filtration for the limit values named for this interface.

Damage and disadvantages to engines caused by the use of fuel grades other than those approved by Rolls-Royce Solutions in accordance with (→ Table 18) and (→ Page 52) as well as (→ Page 43) or prefilters, are not deficiencies covered by the warranty of Rolls-Royce Solutions.

Series-based injection and exhaust gas aftertreatment systems (EGAT)

Series	Diesel fuel accumulator injection system (Common Rail)	Conventional injection systems	Exhaust gas aftertreatment (EGAT) system	Exhaust gas recirculation
2000Gx5		Yes	No	No
2000Gx6	Yes		No	No
4000Gx3, Gx4	Yes		No	No

Table 22: Series-based injection and exhaust gas aftertreatment systems (EGAT)

Laboratory analyses

An order for fuel analysis can be placed with Rolls-Royce Solutions.

The following information is required:
- Fuel specification
- Sampling point
- Serial ID of engine from which fuel sample was taken.

The following is to be supplied:
- 1.0 liters of fuel
- 2.0 liters of fuel (with additional determination of cetane number)

For more information on handling laboratory samples, please refer to the publication 'Customer Information (Handling Laboratory Samples (publication number A001080/..).

Test package for North America

The mtu Advanced Fluid Management System, which contributes to preventive maintenance through innovative diagnostics, is available in North America.

mtu Advanced Fluid Management System for fuels, see (→ Page 68).

4.2 Series-dependent approval of fuel grades for mtu engines

4.2.1 Distillate fuels according to EN 590 and ASTM D975

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

Fuel specification Restrictions Series	EN 590:2025-09 Summer and winter quality • Particle distribution for fuel according to the 'Mandatory particle limits' table, see chapter (→ Page 37)	ASTM D975-21 Grade 1-D S 15, S 500, S 5000 • Density: 0.815 to 0.860 g/ml* * Deviating values: Project-specific approval possible. If the density is too low, this can result in a power reduction. Engine operating values may change as a result of power adjustment. • Water content: Max. 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution for fuel according to the 'Mandatory particle limits' table, see chapter (→ Page 37)	ASTM D975-21 Grade 2-D S 15, S 500, S 5000
2000Gx5	Approval granted	Approved if: • Viscosity min. 1.5 mm^2/s • Cetane number min. 45 or • Cetane index min. 42 • Sulfur content max. 500 mg/kg	Approved if: • Cetane number min. 45 or • Cetane index min. 42 • Sulfur content max. 500 mg/kg
2000Gx6	Approval granted		
4000Gx3	Approval granted	Approved if: • Viscosity min. 1.5 mm^2/s • Cetane number min. 45 or • Cetane index min. 42	Approved if: • Cetane number min. 45 or • Cetane index min. 42
4000Gx4	Approval granted		

4.2.2 British Standard

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

Fuel specification Restrictions Series	BS 2869:2017 Part 1 Class A2 • Density: Max. 860 kg/m^3 • Viscosity: Max. 4.5 mm^2/s. If viscosity min. 4.5 mm^2/s: Preheating required • Particle distribution for fuel according to the 'Mandatory particle limits' table, see chapter (→ Page 37)	BS 2869:2017 Part 2 Class D
2000Gx5	No approval	No approval
2000Gx6	No approval	No approval
4000Gx3	Approval granted	Approval granted
4000Gx4	Approval granted	Approval granted

4.2.3 Chinese distillate fuels according to GB 19147-2016, GB 252-2015 and GB 17411-2016

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

Fuel specification	GB 19147-2016 Grade 0 # III: S max. 350 mg/kg IV: S max. 50 mg/kg V: S max. 10 mg/kg VI: S max. 10 mg/kg	GB 252-2015 Grade 0 #	GB 17411-2016 Grade DMX
Restrictions	• Density: 0.815 to 0.860 g/ml* * Deviating values: Project-specific approval possible. If the density is too low, this can result in a power reduction. Engine operating values may change as a result of power adjustment. • Water content: Max. 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution for fuel according to the 'Mandatory particle limits' table, see chapter (→ Page 37) • Neutralization number: Max 0.2 mgKOH/g • Viscosity: at 40 °C: 1.5 to 4.5 mm^2)/s • For grade VI: Proof of fault-free visual findings required		
Series			
2000Gx5	Approval granted	Approval upon request	No approval
2000Gx6	Approval granted	Approval upon request	No approval
4000Gx3	Approval granted	Approval granted	Approval granted
4000Gx4	Approval granted	Approval granted	No approval

4.2.4 Heating oil

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

Fuel specification	DIN 51603-1:2024-11 Heating oil EL standard	DIN 51603-1:2024-11 Heating oil EL low-sulfur and Heating oil EL low-sulfur and low nitrogen	DIN 51603-1:2024-11 Heating oil EL A low-sulfur and Heating oil EL A low-sulfur and low nitrogen (Share of alternative fuels: A5 to A100)
Restrictions	• Cetane number min. 45 or cetane index min. 42 • Lubricity max. 520 µm • Particle distribution for fuel according to the 'Mandatory particle limits' table, see chapter (→ Page 37)		
Series			
2000Gx5	Approved if: • Density at 15 °C min. 0.815 g/ml • Sulfur content max. 500 mg/kg	Approval granted	No approval
2000Gx6	Approved if: • Sulfur content max. 500 mg/kg	Approval granted	No approval
4000Gx3	Approval granted	Approval granted	Approval granted
4000Gx4	Approval granted	Approval granted	Approval granted

4.2.5 Marine distillate fuels according to ISO 8217:2024-05

4.2.5.1 Fossil & paraffinic marine distillate fuels

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

Fuel specification	Marine distillate fuel in accordance with ISO 8217:2024-05		
	DMX	DMA	DMZ
Restrictions	• Water content: 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution for fuel according to the 'Mandatory particle limits' table, see chapter (→ Page 37)		
Series			
2000Gx5	No approval	No approval	No approval
2000Gx6	No approval	No approval	No approval
4000Gx3	No approval	No approval	No approval
4000Gx4	No approval	No approval	No approval

4.2.5.2 FAME-containing marine distillate fuels

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

Fuel specification Restrictions Series	Marine distillate fuel in accordance with ISO 8217:2024-05 DFX | DFA | DFZ • Water content: 200 mg/kg • Total contamination: Max. 24 mg/kg • Particle distribution for fuel according to the 'Mandatory particle limits' table, see chapter (→ Page 37)		
2000Gx5	No approval	No approval	No approval
2000Gx6	No approval	No approval	No approval
4000Gx3	Approved if: Viscosity > 4.5 mm^2/s: • Preheating required	Approved if: • - Viscosity 1.5 to 4.5 mm^2/s Outside the limit range between 1.5 to 4.5 mm/s^2 (40 °C), approval following consultation with Rolls-Royce Solutions is possible, e.g. by limiting the temperature range or preheating. • Density 0.815 to 0.860 g/ml • Cetane number min. 45 or • Cetane index min. 42	
4000Gx4	No approval	No approval	No approval

4.2.6 Aviation turbine fuels

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

Fuel specification Restrictions Series	F-34 / F-35 JP-8	F-44 JP-5	F-63 in accordance with DCSEA 108/A
2000Gx5	No approval		
2000Gx6	No approval		
4000Gx3	No approval		Approval granted
4000Gx4	No approval		Approval granted

4.2.7 NATO diesel fuels

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

Diesel fuel NATO Code F-54

Fuel specification Restrictions Series	NATO Code F-54 in accordance with STANAG 7090 Edition 4 Approval if fuel corresponds to diesel fuel EN 590:2025-09 • Density: Min. 0.815 g/ml • Total contamination: Max. 24 mg/kg • Lubricity: Max. 520 µm • Particle distribution for fuel according to the 'Mandatory particle limits' table, see chapter (→ Page 37)
2000Gx5	Approved if: • Sulfur content max. 500 mg/kg
2000Gx6	
4000Gx3	Approval granted
4000Gx4	Approval granted

Diesel fuel NATO Code F-75

Fuel specification	NATO Code F 75 TL 9140-0003 Version 12 (June 2022)	NATO Code F 75 AFLP 1385 Edition C Version 1 (August 2020)	NATO Code F 75 DEF STAN 91-04 Issue 11 (January 2020)
Comments	- Possible power increase due to density range of 0.815 to 0.880 g/ml		
Restrictions	- Admixture of synthetic paraffinic fuels according to DIN EN 15940 up to 100% permitted for all series where the use of paraffinic diesel fuels is approved (→ Page 52)		
	- Neutralization number: Max 0.2 mgKOH/g - Corrosive effect on copper max. Class 1a - Max. sulfur content, which must be observed, is series- and application-specific according to table 'Mandatory fuel specifications' (→ Page 37) - Particle distribution for fuel according to the 'Mandatory particle limits' table, see chapter (→ Page 37)		
		- Water content: Max. 200 mg/kg	
		- Cetane number min. 45 or centane index min. 42	- Total contamination: Max. 24 mg/kg - Lubricity: Max. 520 µm
Series			
2000Gx5	No approval	No approval	No approval
2000Gx6	No approval	No approval	No approval
4000Gx3	Approval granted	Approval granted	Approval granted
4000Gx4	Approval granted	Approval granted	Approval granted

Diesel fuel NATO Code F-76

Fuel specification	NATO Code F 76 MIL-DTL-16884 Version R (January 2025)	NATO Code F 76 AFLP 1385 Edition C Version (August 2020)	NATO Code F 76 DEF-STAN 91-04 Issue 11 (January 2020)
Restrictions	- Admixture of synthetic paraffinic fuels according to DIN EN 15940 is not permitted - Admixture of SPD (Hydroprocessed synthesized Paraffinic Diesel) up to 50% is permitted for all series where the use of paraffinic diesel fuels is approved (→ Page 52) - Density 0.815 to 0.860 g/ml - Water content: Max. 200 mg/kg - Corrosive effect on copper max. Class 1a - Neutralization number max. 0.2 mgKOH/g - Particle distribution for fuel according to the 'Mandatory particle limits' table, see chapter (→ Page 37) Cetane number min. 45 or cetane index min. 42	- Max. sulfur content, which must be observed, is series- and application-specific according to table 'Mandatory fuel specifications' (→ Page 37)	- Total contamination: Max. 24 mg/kg - Lubricity max. 520 µm
Series			
2000Gx5	Generally not approved, approval upon request	Generally not approved, approval upon request	Generally not approved, approval upon request
2000Gx6	Generally not approved, approval upon request	Generally not approved, approval upon request	Generally not approved, approval upon request
4000Gx3	Approval granted	Approval granted	Approval granted
4000Gx4	Approval granted	Approval granted	Approval granted

4.2.8 Paraffinic diesel fuel in accordance with EN 15940

Standards define paraffinic diesel fuels as being fuels produced by synthesis or hydrogenation processes. They are specified in the EN 15940 standard.

Synthesis

In this case, the term synthesis is used to denote the Fischer-Tropsch reaction. These fuels are therefore also often referred to as Fischer-Tropsch fuels or XtL (X to liquid), with 'X' standing for the type of initial feedstock. Such fuels are produced by first generating a mixture of carbon monoxide and hydrogen, referred to as synthesis gas, from the initial feedstock. This is then used to create the paraffinic fuel via Fischer-Tropsch synthesis by means of chain growth.

Hydrogenation

Hydrogenation is the chemical reaction of the feedstock with hydrogen. The initial feedstock used are vegetable oils/waste fats and waste materials containing oil which do not compete with foodstuff production. This fuel is marketed as an HVO (Hydrotreated Vegetable Oil).

Designations and description of paraffinic fuels

Depending on the initial feedstock, paraffinic fuels are designated, for example, as follows:
- HVO = Hydrotreated Vegetable Oil, feed stock: Biomass
- GtL = Gas to liquid, feed stock: Natural gas, biogas
- BtL = Biomass to liquid, feed stock: Biomass

As a result of the production process, paraffinic fuels consist almost entirely of linear or branched hydrocarbon chains, known as alkanes. They do not contain any sulfur and are almost free of aromatics. Due to their chemical composition, paraffinic fuels have different properties to fossil diesel fuels in terms of higher ignitability and lower density. The result is an overall reduction in untreated emissions.

EN 590 specifies that fatty acid methyl ester (FAME as per EN 14214) can be blended into paraffinic diesel fuel as per EN 15940 by up to 7% by volume.

Paraffinic diesel fuels are specified in ASTM D975 (Grade 1-D and Grade 2-D, S 15) in the U.S., just like fossil diesel fuels. This is possible as this standard does not specify any limit value for density, in contrast to EN 590. These paraffinic diesel fuels can also be used provided that they comply with the fuel specifications listed in table (→ Table 23). In the USA, paraffinic diesel fuels are often referred to as 'R99' fuels or 'renewables'.

The quality of the fuel is very important for satisfactory engine performance, long engine service life and acceptable exhaust emission levels. Paraffinic fuels must therefore satisfy the following characteristic fuel values:

Mandatory fuel specifications

		Test methods		Limit values
		ASTM		
Composition				The diesel fuel must be free of inorganic acids, visible water, solid foreign matter and chlorine compounds.
Total contamination (= fuel-insoluble ingredients)	Max.	D6217	EN 12662	24 mg/kg

[1] Can result in reduced power of engines with unit-pump systems
[2] Note: 1% by weight = 10000 mg/kg = 10000 ppm
[3] Higher cetane number is available from Rolls-Royce Solutions GmbH upon request
[4] Relevant for diesel fuel with a FAME content of ≥ 2% by volume
[5] Relevant for diesel fuel with a FAME content of < 2% by volume

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		Test methods		Limit values
		ASTM		
Density at 15 °C	Min.	D1298 D4052	EN ISO 3675 EN ISO 12185	0.765 g/ml [1]
	Max.			0.860 g/ml
API gravity at 60 °F	Min.	D287 D4052		53
	Max.			33
Viscosity at 40 °C	Min.	D445	EN ISO 3104	1.5 mm²/s
	Max.			4.5 mm²/s
Flashpoint (closed crucible)	Min.	D93	DIN EN ISO 27 19	55 °C
Boiling curve:		D86	EN 17306	
– Initial boiling point				160 to 220 °C
– Volume share at 250 °C	Max.			65% by volume
– Volume share at 350 °C	Min.			85% by volume
– Residue and loss	Max.			3% by volume
Fatty acid methyl ester content (FAME) ('Biodiesel')	Max.		EN 14078 Internal mtu procedure	7.0% by volume
Water content: (Absolute, no free water)	Max.	D6304	EN ISO 12937	200 mg/kg
Carbon residue from 10% distillation residue	Max.	D189	EN ISO 10370	0.30% by weight
Oxide ash: – Engines without exhaust gas aftertreatment and without exhaust gas recirculation	Max.	D482	EN ISO 6245	0.01% by weight (100 mg/kg)
Sulfur content	Max.	D5453 D2622	EN ISO 20848 EN ISO 20884	0.0015% by weight (15 mg/kg)[2]
Cetane number	Min. Max.	D613	EN ISO 5165 EN ISO 15195	45 80 [3]
Cetane index	Min.	D976	EN ISO 4264	42
Copper corrosion 3 h at 50 °C	Max. degree of corrosion	D130	EN ISO 2160	1a
Oxidation stability (Rancimat)[4]	Min.		EN 15751	20 hours
Oxidation stability [5]	Max.	D2274	EN ISO 12205	25 g/m³
Lubricity at 60 °C (HFRR value)	Max.	D6079	EN ISO 12156-1	400 µm

[1] Can result in reduced power of engines with unit-pump systems
[2] Note: 1% by weight = 10000 mg/kg = 10000 ppm
[3] Higher cetane number is available from Rolls-Royce Solutions GmbH upon request
[4] Relevant for diesel fuel with a FAME content of ≥ 2% by volume
[5] Relevant for diesel fuel with a FAME content of < 2% by volume

		Test methods		Limit values
		ASTM		
Neutralization number	Max.	D974		0.2 mg KOH/g
Microbial contamination				Inadmissible

[1] Can result in reduced power of engines with unit-pump systems
[2] Note: 1% by weight = 10000 mg/kg = 10000 ppm
[3] Higher cetane number is available from Rolls-Royce Solutions GmbH upon request
[4] Relevant for diesel fuel with a FAME content of ≥ 2% by volume
[5] Relevant for diesel fuel with a FAME content of < 2% by volume

Table 23: Mandatory fuel specifications

With regard to winter operation and purity requirements for diesel fuel, compliance with the requirements stipulated in the tables 'Cylinder head TBO' and 'Series-related injection/and exhaust gas aftertreatment systems (EGAT)' (→ Page 37) is mandatory, depending on the sulfur content in the fuel.

Approvals for paraffinic diesel fuels

Paraffinic diesel fuels as per EN 15940 or ASTM D975 (Grade 1-D and Grade 2-D, S 15) have been approved for the following Series provided that they comply with the characteristic values specified in the table (→ Table 23):

Engine		Safety [1]	Not certified	Emission level [2]			Comments
Series	Application			EPA	EU	IMO	
2000	Gx5	X*	X*				* approx. 5% reduced power rating
2000	Gx6	X	X	T2			TBO HP pump 400 h
4000	Gx3	X	X	T2			
4000	Gx4	X	X	T2			

[1] Product safety in terms of the risk to life and limb is assured when these fuels are used in the engine.
[2] = When using an EN 15940-compliant fuel or a fuel in accordance with ASTM D975 that meets the fuel specifications to be complied with in accordance with (→ Table 23), the respective legal requirements are met.

Important

Further project-specific approvals are possible upon request from Rolls-Royce Solutions GmbH.

Effects of paraffinic diesel fuels on elastomer components

Paraffinic diesel fuels are compatible with conventional elastomer materials such as FKM (fluorocaoutchouc) and NBR (nitrile butadien rubber). Being free of aromatics, they cause less swelling than fossil diesel fuels containing aromatics. For this reason, the possibility of leakages when transitioning from fossil diesel fuels to paraffinic diesel fuels cannot be completely ruled out.

Procedure for transitioning from fossil to paraffinic diesel fuels

Our experience shows this transition can take place with no problems for scopes of supply of Rolls-Royce Solutions. Despite this, to prevent residual risks, Rolls-Royce Solutions recommends routine inspection of the gaskets to verify leak-tightness in the first four weeks after transitioning to paraffinic diesel fuel.

Notes on operation with water separators

Paraffinic diesel fuel has a greater tendency to discharge free water into water separators compared with conventional fossil diesel fuel. Slightly higher water discharge in water separators in comparison with fossil diesel fuel is normal.

Blending paraffinic diesel fuels with conventional fossil diesel fuels

Paraffinic diesel fuels are known as 'drop-in' diesel fuels.

This means that the end customer can mix paraffinic diesel fuel with conventional fossil diesel fuels in any ratio without having to make any adjustments to the engine or fuel system.

This means that the end customer can fill up with both paraffinic and conventional fossil diesel fuel according to the tables 'Fuel characteristics to be complied with' (→ Page 37) without having to empty/clean the tank beforehand.

'Premium diesel fuels' which comply with EN 590 and also reduce CO_2 emissions by around 20% are also available on the market. Paraffinic diesel fuel in accordance with EN 15940 is already added to these fuels at the manufacturer's facility. The amount of paraffinic diesel fuel added, however, is only high enough to ensure observance of the required minimum density limit value specified in EN 590.

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4.2.9 Biodiesel and biodiesel mixtures

General notes and information

- The standardized general term 'FAME' (fatty acid methyl ester) is used in this document for biodiesel fuel. Pure FAME fuel is also designated as B100.
- Biodiesel mixtures consist of FAME fuels that are mixed with fossil diesel fuel. For instance, B30 denotes a mixture comprising 30% by volume of FAME and 70% by volume of fuel based on crude oil/mineral oil. The use of biodiesel mixtures may have negative effects in terms of engine power, service and maintenance requirements, emissions and useful life.
- Operators of mtu engines therefore need to be clear about the effects that FAME may have on their engines, and must take all of the necessary measures to ensure the reliability and safety of their engines. This chapter provides Rolls-Royce Solutions customers with important information on the use of biodiesel mixtures in mtu engines and explains the potential impact these fuels may have on the Rolls-Royce Solutions warranty. Please read this information carefully before using biodiesel mixtures in mtu engines.
- Statements on pure FAME also apply to biodiesel mixtures, but the effects may be mitigated if biodiesel mixtures are used.
- We can make no comment with regard to the level of FAME resistance of the fuel system, which is not part of our scope of supply.
- FAME is an extremely effective solvent. Prevent FAME or biodiesel mixtures from coming into contact with varnished surfaces to avoid damaging and stripping the varnish.
- FAME is not compatible with all materials. Certain elastomers (including NBR, rubber) are chemically attacked, leakages are likely.
- Materials containing zinc and copper accelerate the aging (oxidation) of the fuel, and thus lead to deposit formation, corrosion and shortened filter service lives.
- Use a suitable tank and line system:
  - Ensure that the system can be filled up to the fill line.
  - Minimize the entry of atmospheric oxygen through the tank vent in the event of temperature fluctuations, etc. (e.g. by installing a pressure relief valve and filter; contact your tank supplier to do this).
  - For this, see also A060631 'Useful information on fuels, tank systems and filtration'
  - It is recommended to use a tank vent with humidity separator.
- The characteristic smell of FAME exhaust gases, especially during long periods of idling, may be perceived as unpleasant. The nuisance caused by smell can be reduced by the use of an oxidation catalyst, which may be installed by the vehicle/equipment manufacturers at their own risk.
- Furthermore, always ensure that the current version of the series-specific Fluids and Lubricants Specifications is available and its contents are observed.
- More extensive preventative measures are additionally required for some applications. Our Customer Support department is available to answer any questions you may have on this topic.
- When using fuels that contain biodiesel, the addition of an antioxidant is recommended. The application concentration and compatibility of the additive with the fuel used must be coordinated between the engine operator and fuel supplier. The 'Mandatory fuel specifications' listed in the tables (not applicable to Series 4000Mx5 IMO II and IMO III) or (for Series 4000Mx5 IMO II and IMO III) (→ Page 37) for the engine must be observed after additive has been added to the diesel fuel.

Important

The warranty from Rolls-Royce Solutions does not cover defects caused by the use of FAME fuels with more than 7% FAME by volume, in particular when using FAME of inferior quality or in the event of non-compliance with our regulations for FAME operation. This also applies to any claims for damages, regardless of the legal grounds and whether direct or indirect, immediate or not immediate.

Important

The use of diesel fuel with a FAME content of max. 7% (e.g. in compliance with EN 590:2022) is unproblematic. Such fuel may also be used in engines which have not been approved for operation with FAME, without affecting oil drain intervals.

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Important

The provisions with regard to requirements placed on fuel may differ depending on legislation and application of the engine. The operator is responsible for ensuring that only fuels which comply with the applicable provisions are used in the engines.

Effects of B100 and biodiesel mixtures on engines

The properties of FAME differ from those of fossil and paraffinic diesel fuels. Some of these properties can have a negative effect on engines. The possible effects are explained below.

Important: THESE EFFECTS ARE NOT FAULTS CAUSED BY THE ENGINE MANUFACTURER OR THAT THE MANUFACTURER IS RESPONSIBLE FOR. THEY ARE THEREFORE EXCLUDED FROM THE ROLLS-ROYCE SOLUTIONS WARRANTY. ROLLS-ROYCE SOLUTIONS SHALL NOT ASSUME ANY LIABILITY FOR COSTS OWING TO THE EFFECTS DESCRIBED BELOW.

- FAME is a solvent. After switching over to B100 or a biodiesel mixture, contamination and certain deposits may become loose in the tank and lines, causing the fuel filter to be subjected to an increased accumulation of these. Filter change intervals must be adjusted accordingly.
- At low temperatures, FAME becomes thicker (increase in viscosity). The use of biodiesel and biodiesel mixtures at low temperatures may therefore cause the fuel filters to become blocked. Install a fuel preheating system if the engine is operated at temperatures below 0 °C (32 °F). This can reduce the negative effect on the fuel supply.
- Compared to conventional diesel fuels according to these Fluids and Lubricants Specifications, FAME has a higher water solubility, meaning that a higher proportion of water should be expected depending on the fuel temperature. This can lead to increased corrosion and faster microbe growth in the fuel system. Due to the higher proportion of water dissolved in B100 or in a biodiesel mixture, reduced water separator performance must be expected, as water separators are primarily for separating free water.
- For systems without a water separator: Retrofit a water separator to reduce the risk of microbe growth and corrosion in the fuel system.
- Regular maintenance of the water separator is mandatory. Separated water must be drained off daily, depending on the water quantity.
- FAME is a natural product and therefore subject to natural aging processes. The consequences of aging are the formation of acids and/or polymers that lead to deposits.
- The formation of acid can lead to corrosion of fuel-carrying components.
- The formation of deposits may cause components to become 'sticky', which potentially restricts their movement.
  - For this, see also section (→ Page 59)→ Effects of B100 and biodiesel mixtures on prolonged engine standstills, temporary shutdown, seasonal use, use in emergency generator sets
- The formation of deposits may have an adverse effect on the interaction of components inside the unit. This results in an increased risk of components failing, and even the breakdown of entire cylinders. The high operating temperatures in the surroundings encourage the formation of mineral deposits, other deposits and encrustations which may render the valve unable to correctly regulate the fuel supply. This means that it is no longer possible for the quantity of fuel required at full load to be injected into the engine, thereby reducing the maximum engine power.
- FAME contains chemical components which can interact with the sensors in the exhaust gas recirculation system in such a way that incorrect data is reported to the engine control system. This can have consequences such as engine operation being adapted to the wrong values and emissions therefore no longer complying with the applicable provisions.

Effects of B100 and biodiesel mixtures on exhaust gas aftertreatment systems

- On engines with exhaust gas aftertreatment systems, the functioning of the catalytic converter may be impaired as biodiesel mixtures can contain a higher proportion of trace elements (e.g. alkaline metals, alkaline earth metals and phosphorus) than conventional diesel fuels according to these Fluids and Lubricants Specifications.
- The above-mentioned trace elements may also result in excess ash formation and accumulations in the soot filters and poisoning of the catalytic converters. Excess ash formation results in a constantly rising exhaust back pressure and can therefore cause a slow reduction in engine power.
- Furthermore, legally prescribed technologies for checking emissions on these engines (e.g. NOx monitoring diagnostics) lead to a significant decrease in engine power.
- This means that the legally prescribed emissions limits are not complied with and the operating license becomes invalid.
- Due to the properties of FAME fuels, hydrocarbons may be deposited in the exhaust gas aftertreatment system during prolonged idling/low-load operation. These stored hydrocarbons may subsequently ignite. This can lead to greatly increased surface temperatures and a sharp rise in exhaust gas temperatures, with corresponding effects on neighboring and downstream components. The full functionality of the exhaust gas aftertreatment system cannot be guaranteed.

Important

Please note that the previous statements in this chapter (→ Page 56) refer exclusively to engines with EXHAUST GAS AFTERTREATMENT SYSTEMS (EGAT systems), which were purchased as a fully integrated system from Rolls-Royce Solutions. When using an exhaust gas aftertreatment system purchased from a third party, the fully integrated system (engine and exhaust gas aftertreatment system) must be approved separately by the third-party provider.

Effects of B100 and biodiesel mixtures on engine oil

- On all engines, lubricating the piston skirts with oil leads to a small amount of fuel entering the engine oil. This is generally of little importance with conventional diesel fuels in accordance with these Fluids and Lubricants Specifications, since the fuel evaporates quickly upon reaching the operating temperature. Its high boiling point means that FAME does not evaporate but remains in the engine oil in its entirety. Aging of the FAME can therefore cause residues to form, cause oil filters to become blocked and ultimately cause the engine to come to a stop, resulting in significantly shorter oil change intervals. Under certain conditions, chemical reactions may take place between FAME and the engine oil. This can lead to engine damage.
- For this reason, high-quality engine oil must be used. Operating the engine with low-quality category 1 oil leads to a more rapid deterioration in oil quality when using fuels containing FAME. For this reason, we recommend using oil of oil category 2 or higher. The approved engine oils can be found in the series-specific Fluids and Lubricants Specifications.
- When using B100 and biodiesel mixtures, the change intervals for engine oil and oil filters must be shortened.
- With biodiesel mixtures (with a maximum FAME content of 30%), the change intervals for engine oil and filters must be halved in comparison to the intervals stated in these Fluids and Lubricants Specifications.
- When using B100, even shorter change intervals for engine oil and oil filters are to be expected.
- In addition to changing the oil and filters on time, the engine oil and filters must be analyzed regularly in order to ensure that the oil quality is correct. Interval: Every 100 operating hours or every 3 months, depending on which comes first. A decision must be made as to whether to further adjust the change intervals on the basis of the results.

Important

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

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Procedure for switching from fossil diesel fuel to B100 or biodiesel mixtures

- Before using FAME-containing fuels (with a FAME content of more than 7%), the engine oil, the oil filter and all fuel filters must be changed.
- After switching to a biodiesel mixture with a maximum FAME content of 30%:
  – Change all fuel filters after 50 operating hours at the latest.
- After switching to a biodiesel mixture with a FAME content of more than 30% (including B100):
  – Change all fuel filters, the engine oil and the engine oil filters after approx. 25 operating hours.

Effects of B100 and biodiesel mixtures on maintenance

The maintenance activities defined in the maintenance schedules must be adhered to. In addition, the following additional maintenance activities and requirements must be observed in order to ensure the quality and availability of your engine:

- When using B100 and biodiesel mixtures, the change intervals for fuel filters must be shortened:
  – When using biodiesel mixtures with a FAME content of more than 7% up to a maximum of 30%, the fuel filters and fuel prefilters must be replaced every 250 operating hours.
  – When using a biodiesel mixture with a FAME content of more than 30% (including B100), the fuel filter must be replaced every time the engine oil is changed.
  – These change intervals can also be further reduced over a prolonged period of time. Depending on how many old deposits are removed from the fuel system by the FAME and flushed into the fuel filters.
- When using biodiesel mixtures with a FAME content of more than 7% up to a maximum of 30%, the following additional recommendations regarding maintenance must be followed:
  – The component TBO of the LP fuel pump, of the O-rings in the LP fuel system and of the valves in the fuel filter head is shortened to TBO/3.
- There has been no experience with the use of biodiesel mixtures with a FAME content of more than 30%. A further shortening of the component TBO is possible.

Effects of B100 and biodiesel mixtures on engine power and fuel consumption

- Compared to conventional diesel fuels according to these Fluids and Lubricants Specifications, FAME has a lower energy density.
- Due to the calorific value, the engine power is reduced by approx. 10% when using B100. This leads to a corresponding increase in fuel consumption as compared to operation with diesel fuel. Engine power corrections are not permissible.
- Operating the engine with B20 results in a power reduction of approximately 2% and an increase in fuel consumption of around 3%.

Effects of B100 and biodiesel mixtures on prolonged engine standstills, temporary shutdown, seasonal use, use in emergency generator sets

- On engines with long downtimes, the formation of deposits (components become 'sticky', movement of these components may be restricted) can result in a situation where the engine can no longer be started.

Important

Rolls-Royce Solutions shall accept no liability in the event that the engine in an emergency generator set cannot be started as a result of the formation of deposits!

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- Corrosion damage to fuel-carrying components is possible due to aging (oxidation) of the fuel.
- For these reasons, prolonged engine standstills and temporary shutdowns should be avoided.
- The following periods are to be understood as prolonged engine standstills:
  - For larger than B7 to B20: More than 1 week
  - For larger than B20 to B35: More than 3 days
  - For larger than B35 to B100: More than 1 day
- For all engines where the engine standstills defined above occur between uses, the fuel system must be flushed with pure, FAME-free, high-quality diesel fuel in accordance with the applicable series-specific Fluids and Lubricants Specifications before the engine is decommissioned.
- All engines used in fire-fighting pumps, fire-extinguishing equipment or police equipment must be thoroughly flushed with pure, FAME-free, high-quality diesel fuel in accordance with the applicable series-specific Fluids and Lubricants Specifications each time they are operated with a biodiesel mixture.
- When flushing, you must ensure that no biodiesel components remain in the fuel system.

Biodiesel B100 according to EN 14214, ASTM D6751 and SNI 71825

- The FAME must comply with EN 14214:2012+A2:2019, ASTM D6751 (2024) and SNI 71825. Operation with fuels of lower quality can lead to damage and malfunctions.
- Either FAME or diesel fuel can be used. The various mixtures of FAME and fossil diesel fuel, which may occur in the fuel tank as a result, present no problems.

Biodiesel mixtures up to a maximum FAME content of 30%

- Biodiesel mixtures consist of FAME fuels that are mixed with fossil diesel fuel. For instance, B30 denotes a mixture comprising 30% FAME and 70% fuel based on crude oil/mineral oil. mtu engines were not specially designed to be operated with biodiesel mixtures.
- The following standards for biodiesel mixtures were assessed:
  1. 3675.K/24/DJM (standard for diesel fuel with 10% FAME content, i.e. B10, in Indonesia)
  2. 28.K/10/DJM.T (standard for diesel fuel with 20% FAME content, i.e. B20, in Indonesia)
  3. 0234.K/10/DJM.S/2019 (standard for diesel fuel with 30% FAME content, i.e. B30, in Indonesia)
  4. EN 16734:2022 (European standard for diesel fuel with 10% FAME content, i.e. B10)
  5. EN 16709:2015+A1:2018 (European standard for diesel fuel with 20% and 30% FAME content, i.e. B20 and B30)
  6. ASTM D7467 (2023) (U.S. standard for diesel fuel with 6% to 20% FAME content, i.e. B6–B20)
- The following requirements must be complied with here:
  1. The B100 used for mixing complies with the specifications EN 14214:2012+A2:2019, ASTM D6751 (2024) or SNI 71825
  2. The distilled diesel fuel used for mixing complies with the specifications approved in this version of the Fluids and Lubricants Specifications. The restrictions specified there must also be complied with.

Approvals for biodiesel greater than B7 to B100 are pure safety approvals, i.e. the product safety of the engine in terms of danger to life and limb is guaranteed with the use of these fuels. This does not include emissions approval. The safety approval applies to the following series/model types/applications, taking into account the measures listed in this chapter (→ Page 56).

Diesel engines approved for the use of fuels with FAME

Series	Application/model type	Safety approval[1)]	Comments
1163	Mx4	x	All years of manufacture
1600	Gx0	x	All years of manufacture
1600	Gx1	x	All years of manufacture
2000	Cx6	x	All years of manufacture
2000	Gx2	x	All years of manufacture
2000	Gx3	x	With metal low-pressure fuel lines
2000	Gx4	x	All years of manufacture
2000	Gx5	x	All years of manufacture

Series	Application/model type	Safety approval[1)]	Comments
2000	Gx6	x	All years of manufacture
2000	Sx6	x	All years of manufacture
4000	Cx0	x	All years of manufacture
4000	Cx1	x	All years of manufacture
4000	Cx2	x	All years of manufacture
4000	Cx3	x	All years of manufacture
4000	Cx5	x	All years of manufacture
4000	Gx1	x	With metal low-pressure fuel lines
4000	Gx2	x	All years of manufacture
4000	Gx3	x	All years of manufacture
4000	Gx4	x	All years of manufacture
4000	Mx0	x	All years of manufacture
4000	Mx1	x	All years of manufacture
4000	Mx3	x	All years of manufacture
4000	Mx4	x	All years of manufacture
4000	Mx5	x	All years of manufacture
4000	Px1	x	All years of manufacture
4000	Px3	x	All years of manufacture
4000	Rx1	x	All years of manufacture
4000	Rx3	x	From year of manufacture 2020 onward/only with rest-of-world fuel filter configuration
4000	Rx4	x	All years of manufacture
4000	Sx1	x	All years of manufacture
4000	Sx3	x	All years of manufacture
4000	Tx4	x	All years of manufacture
4000	Tx5	x	All years of manufacture
8000	Mx1	x	All years of manufacture

Table 24:

[1)] = The product safety of the engine in terms of danger to life and limb is guaranteed with the use of these fuels.

Important

Engines that are not listed in the table above are not suitable for operation with fuels with a FAME content of more than 7% by volume, i.e. no safety approval has been granted. Further project-specific approvals are possible upon request from Rolls-Royce Solutions GmbH.

4.2.10 Pure vegetable oil

Vegetable oils as an alternative to diesel fuel

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

4.3 Fuel additives

Fuel additives

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

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

If additives containing metal (that contain e.g. ferrocene, cerium, etc.) are added with the intention of improving the operating behavior of the engine system and the regeneration behavior of diesel particulate filters, it should be noted that the metal-based additives lead to significantly increased ash formation. This ash covers the active surface of the particulate filters and restricts their functionality. It can also lead to wear in the engine.

The increased formation of additive ash and its negative consequences are particularly critical for emissions-optimized engines with diesel particulate filters.

In any case, it drastically shortens the approved maintenance and cleaning intervals of the diesel particulate filter.

For this reason, the subsequent addition of metal-containing additives to the fuels approved by Rolls-Royce Solutions is not permitted or approved.

Diesel fuels with metal-containing additives are also offered on the market under the EN 590 specification. In this case, the fuels are labeled accordingly as per the EN 590 regulations.

You should also refrain from using fuels labeled like this. Ultimately, they also lead to the phenomena and effects mentioned above.

The anti-wear additives (→ Page 64), biocides (→ Page 64) and cleaning additives are exceptions.

Important
Attention is drawn to the fact that the use of diesel fuels or additives other than those stipulated in these Fluids and Lubricants Specifications is always the responsibility of the operator! Prior to using a fuel additive approved by Rolls-Royce Solutions, the operating company must additionally obtain approval for the use of this additive from the fuel manufacturer, in order to exclude the possibility of any incompatibilities of the additive with the fuel or additives already contained in the fuel from the time of production. Additives must not contain inorganic substances because they can cause damage to the engine and the exhaust gas aftertreatment system.

Diesel fuels with sulfur content < 500 mg/kg

Excessive valve seat wear occurs on engine series featuring cylinder heads without valve seat inserts (both inlet and exhaust valves) when low-sulfur fuel grades are used (sulfur content < 500 mg/kg). This applies to the following engine series:

Series	Use of additives
362	Yes*
493	Yes*
538	Yes
595	Yes
652	Yes*
956	Yes
1163 up to model type 01-03	Yes*

Table 25:

* = If the cylinder head features valve seat inserts, it is not necessary to use an anti-wear additive in the fuel.

If anti-wear additives are mixed in, this wear can be reduced. The approved supplementary additives must be mixed with the fuel in the predefined concentration. The additive must be filled before every refueling.

Approved anti-wear additives

Manufacturer	Brand name	Use concentration
The Lubrizol Corporation 29400 Lakeland Boulevard Wickliffe, Ohio 44092 USA Tel. 01 440-943-4200	ADX 766 M	250 to 350 mg/kg
Tunap Industrie GmbH Bürgermeister-Seidl-Str. 2 82515 Wolfratshausen Tel. +49 (0) 8171 1600-0 Fax +49 (0) 8171 1600-91	Tunadd PS	250 to 350 mg/kg

Table 26:

Important
The use of anti-wear additives is not permitted on engines/plants with exhaust gas aftertreatment!

Microorganisms in fuel

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

The biocides approved by Rolls-Royce Solutions are listed in table (→ Table 27).

Approved biocides

Biocides should have a pure hydrocarbon structure, i.e. should only consist of the following components:
- Carbon
- Hydrogen
- Oxygen
- Nitrogen

They must not contain inorganic substances because they can cause damage to the engine and the exhaust gas aftertreatment system. The application of biocides with halogenated compounds is prohibited due to their effects on the engine system and the environment.

Biocides that contain neither inorganic substances nor halogenated compounds may also be used for engine systems with exhaust gas aftertreatment.

Approval for biocides that meet the above requirements is possible upon request.

Manufacturer	Brand name	Use concentration	Comments
Maintenance Technologies Paddy´s Pad 1056 CC t/a Maintenance Technologies Tel. +27 21 786 4980 Cell +27 82 598 6830	Dieselcure Fuel De-contaminant	1 : 1200 (833 mg/kg)	Observe the safety data sheet of the manufacturer and introduce appropriate protective measures. The service life of the fuel filters can be reduced through the use of a biocide
Adolf Würth GmbH & Co. KG Reinhold Würth-Straße 12-17 74653 Künzelsau Tel. +49 (0) 7940 152248	Dieselcure Fuel De-contaminant	1 : 1200 (833 mg/kg)	
Vink Chemicals GmbH & Co. KG Eichenhöhe 29 21255 Kakenstorf Tel. +49 (0) 4186 887970 E-mail: info@vink-chemicals.com	grotamar 71 grotamar 82 StabiCor 71	0.5 l/ton 1.0 l/1000 l 0.5 l/ton	
Supafuel Marketing CC PO Box 1167 Allens Nek 1737 Johannesburg South Africa Tel. +27 83 6010 846 Fax +27 86 6357 577	Dieselfix / Supafuel	1:1200 (833 mg/kg)	
Wilhelmsen Ships Service AS Willem Barentszstraat 50 3165 AB Rotterdam-Albrtandswaard Tel. +31 10 487 7777 Fax +31 10 487 7888 Netherlands	DieselPower Biocontrol (früher Dieselpower MAR71)	333 ml/ton	

Table 27:

Cleaning additives

Under very unfavorable conditions, e.g. aged fuels, deposits may occur in the injectors. These deposits can be removed with cleaning additives. The additive approved by Rolls Royce Solutions is listed in table (→ Table 28).

Manufacturer	Brand/product name	Use concentration	Notes	Approval for
The Lubrizol Corporation 29400 Lakeland Boulevard Wickliffe, Ohio 44092 USA Tel. +1 440-943-4200	Powerzol ZD 9149	One-time application for injector cleaning in case of deposit formation (push cleaning): 0.3% by volume Continuous application for prevention of coating and deposits: 0.02 to 0.1% by volume	Observe the safety data sheet of the manufacturer and introduce appropriate protective measures! The service life of the fuel filters can be reduced through the use of an additive.	Series 4000 (all applications and types)

Table 28:

Flow improvers

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

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

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

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

4.4 Unsuitable materials in the diesel fuel circuit

Components made of copper and zinc materials

Even small amounts of zinc, lead and copper may leave deposits in diesel fuel injection systems, particularly in modern, state-of-the-art injection systems. For this reason, levels of zinc, lead or copper in tanks, fuel lines and filter elements must not exceed the manufacturer's validated specifications.

Avoid using materials containing these metals as this may initiate catalytic reactions in the fuel leading to undesirable deposits in the injection system.

Requirements

According to the current state of knowledge, the following materials and coatings must not be used in a diesel fuel circuit, especially when using fuels containing biodiesel. Negative interactions can also occur with approved fuels.

Metallic materials

- Zinc, also as surface protection
- Zinc-based alloys
- Copper
- Copper-based alloys with the exception of CuNi10 and CuNi30 (e.g. seawater cooler)
- Tin, also as surface protection
- Magnesium-based alloys

Non-metallic materials

- Elastomers: Nitrile butadiene rubber, natural rubber, chloroprene rubber, butyl rubber, EPDM
- Silicone elastomer
- Fluorosilicone elastomer
- Polyurethane
- Polyvinyl

Information:

Consult the relevant Rolls-Royce Solutions specialist department in case of doubt about the use of materials on the engine / externally mounted components in fuel circuits.

4.5 mtu Advanced Fluid Management System for fuels – Test package for North America

A sophisticated system for diagnostics and preventive maintenance is available in North America. This system allows the following.

For full information on the mtu Advanced Fluid Management System available in North America, please contact an authorized Rolls-Royce Solutions service partner.

The following test packages from mtu Advanced Fluid Management System can be ordered from authorized Rolls-Royce Solutions service partners in North America:

- F-PDFM1
  Basic test – For checking the degree of contamination of the diesel fuel.
  The test determines existing metallic elements and examines the proportion of water and contamination with bacteria and particles.
- F-PDFM2
  Extended test – Includes the basic test plus an examination for determination of the degree of contamination, any possible filter contamination and ignition behavior of the engine.
- F-PDFM3
  Extended Test Plus – Includes the extended text plus a lubricity analysis.
  Maintenance of the correct lubricity has a positive effect on the service life of the components of the engine fuel system.

The following fuel parameters can be determined:

Fuel parameter	F-PDFM1	F-PDFM2	F-PDFM3
24 elementary metals	✓	✓	✓
Viscosity at 40 °C	–	✓	✓
Percent sulfur	–	✓	✓
Water and sediment	✓	✓	✓
Pour point	✓	✓	✓
Thermal stability	✓	✓	✓
Bacteria, fungi and mildew	✓	✓	✓
Flashpoint according to Pensky-Marten	–	✓	✓
Calculated centane index	–	✓	✓
Distillation	–	✓	✓
Cloud point	–	✓	✓
Percentage of water according to Karl Fischer	✓	✓	✓
Particle content	✓	✓	✓
Density according to API	–	✓	✓
Lubricity	–	–	✓

The mtu Advanced Fluid Management System with trend analysis provides information for maximizing system reliability. The following guidelines must be followed to obtain the best results.

Note: The software offered by Rolls-Royce Solutions for online reporting with trend analyses shows the procedure for optimizing evaluation of the gathered information after completion of the analysis.

Note: The mtu Advanced Fluid Management System works together with independent test laboratories accredited according to ISO 17025 A2LA. This accreditation is the highest level of quality obtainable by a test laboratory in North America.

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5 Approved Engine Oils and Lubricating Greases

5.1 Series-dependent usability for engine oils

Series-dependent usability of engine oils by oil categories

Series	Approved engine oils		
	Oil category 1	Oil category 2 and 2.1 (Low SAPS oils)	Oil category 3 and 3.1 (Low SAPS oils)
2000Gx5	• SAE 30/40 single-grade oils (→ Page 70) • Multi-grade oils (→ Page 71)	• Single-grade oils (→ Page 72) • Multi-grade oils (→ Page 75) • Multi-grade oils (Low SAPS) (→ Page 82)	• Multi-grade oils (→ Page 88) • Multi-grade oils (Low SAPS) (→ Page 91)
2000Gx6	No approval	• Single-grade oils (→ Page 72) • Multi-grade oils (→ Page 75) • Multi-grade oils (Low SAPS) (→ Page 82)	• Multi-grade oils (→ Page 88) • Multi-grade oils (Low SAPS) (→ Page 91)
4000Gx3	No approval	• Single-grade oils (→ Page 72) • Multi-grade oils (→ Page 75) • Multi-grade oils (Low SAPS) (→ Page 82)	• Multi-grade oils (→ Page 88) • Multi-grade oils (Low SAPS) (→ Page 91)
4000Gx4	No approval	• Single-grade oils (→ Page 72) • Multi-grade oils (→ Page 75) • Multi-grade oils (Low SAPS) (→ Page 82)	• Multi-grade oils (→ Page 88) • Multi-grade oils (Low SAPS) (→ Page 91)

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

For details and special properties, see the chapter on 'Lubricants for four-stroke cycle engines' (→ Page 7)

Single-grade oils

Important

[1] = No longer included in portfolio. Remaining stocks of this product can be used up as long as they are within their shelf life

Single-grade oils – Category 1, SAE grades 30 and 40 for diesel engines						
Manufacturer	Brand name	SAE viscosity grade	TBN			Comments
			8 to 10 mg KOH/g	10 to 12 mg KOH/g	> 12 mg KOH/g	
Aegean Oil SA	Vigor Super D	40	X			
Castrol Ltd.	Castrol MLC	30, 40		X		
ELDON'S SA	ELDON'S ELONA ULTRA SAE 40	40	X			
LPC S.A.	Cyclon D Prime	30, 40	X			
Motor Oil (Hellas)	EMO Turbo Champion Plus	30, 40	X			
	EMO Turbo Champion	40		X		
Petrobras Distribuidora S.A.	Marbrax CCD-310	30		X		
	Marbrax CCD-410	40		X		
PT. Pertamina Lubricants	Meditiran SMX	40	X			
Repsol Lubricantes y Especialidades, S.A.	REPSOL GIANT 1020	30, 40		X		
Shell International Petroleum Company	Shell Rimula R3+	30, 40	X			

Table 29:

5.3 Multi-grade oils – Category 1, SAE grade 15W-40 for diesel engines

For details and special properties, see the chapter on 'Lubricants for four-stroke cycle engines' (→ Page 7).

Important

[1] = No longer included in the portfolio. Remaining stocks of this product can be used up as long as they are within their shelf life.
[2] = Engine oils marked [2] are also approved for Series 60 engines

Multi-grade oils

Multi-grade oils – Category 1, SAE grade 15W-40 for diesel engines						
Manufacturer	Brand name	SAE viscosity grade	TBN			Comments
			8 to 10 mg KOH/g	10 to 12 mg KOH/g	> 12 mg KOH/g	
Exxon Mobile Corporation	Mobil Delvac XHP 15W-40	15W-40	X			

Table 30:

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

For details and special properties, see the chapter on 'Lubricants for four-stroke cycle engines' (→ Page 7).

Important

[1] = No longer included in the portfolio. Remaining stocks of this product can be used up as long as they are within their shelf life.
For Series 8000 engines, the approved SAE grade 40 engine oils may only be used in conjunction with pre-heating and oil priming (T_{oil} > 30 °C).

Single-grade oils

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

Manufacturer	Product/brand name	SAE viscosity grade	TBN			Comments
			8 to 10 mg KOH/g	10 to 12 mg KOH/g	> 12 mg KOH/g	
Rolls-Royce Solutions GmbH	Power Guard® DEO SAE 40	40	X			20 l canister: X00062816 210 l canister: X00062817
mtu India Pvt Ltd.	Diesel Engine Oil DEO SAE 40	40		X		50 l canister: 73333/P 205 l canister: 75151/D[1] Sale of Indian oil only intended on Indian market
AEGEAN OIL S.A.	AEGEAN VIGOR M SAE40	40	X			
Belgin Madeni Yaglar	Lubex Marine LTM-30	30		X		[1]
	Lubex Marine LTM-40	40		X		[1]
	BELGIN LUBEX MARINE LTX Plus 30	30		X		
	BELGIN LUBEX MARINE LTX Plus 40	40		X		
Castrol Ltd.	Castrol HLX 30	30			X	Approved for fast commercial vessels up to 1500 h, Series 595, 1163 Approved for Series 8000
	Castrol HLX 40	40			X	Approved for fast commercial vessels up to 1500 h, Series 595, 1163 Approved for Series 8000
Chevron Lubricants (Texaco)	Delo Gold	30		X		Approved for Series 8000
	Delo 400	40		X		Approved for Series 8000
	Delo Gold	40		X		
Delek	Delkol Super Diesel MT Mono 40	40	X			
EKO ABEE	EKO MARINE MT 40	40		X		
ELDON`S S.A.	ELDON`S ELONA ULTRA SAE 40	40	X			
ENOC Marketing L.L.C.	ENOC Strata Super Duty	40		X		[1]

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Single-grade oils – Category 2, SAE grades 30 and 40 for diesel engines						
Manufacturer	Product/brand name	SAE viscosity grade	TBN			Comments
			8 to 10 mg KOH/g	10 to 12 mg KOH/g	> 12 mg KOH/g	
Exxon Mobil Corporation	Mobil Delvac Legend 1630	30		X		Not approved for Series 2000 M72 Approved for Series 956 TB31 and Series 8000
	Mobil Delvac Legend 1640	40		X		Not approved for Series 2000 M72 Approved for Series 956 TB31 / TB32 / TB33 / TB34, 1163 TB32 and Series 8000
	Mobilgard ADL 30	30		X		Not approved for Series 2000 M72 Approved for Series 956 TB31 and Series 8000
	Mobilgard ADL 40	40		X		Not approved for Series 2000 M72 Approved for Series 956 TB31 / TB32 / TB33 / TB34, 1163 TB32 and Series 8000
Fuchs Lubrifiant France s. a.	Titan Marine Otan O-278 OMD 113	40			X	
Fuchs Petrolub SE	Titan Universal HD	30, 40	X			
	Titan EM 30 MTU	30	X			Enhanced corrosion protection
	Titan Universal HD SAE 30 mtu	30	X			Enhanced corrosion protection
GS Caltex Corporation	Kixx HD SAE 40	40	X			
	MPA 300 SAE 30	30	X			
	MPA 300 SAE 40	40	X			
Hyrax Oil Sdn Bhd	Hyrax Top Deo	40	X			
Koçak Petrol Ürünleri San. ve. TIC. Ltd.	Speedol Deniz Dizel Motor Yağı	30, 40		X		
Kuwait Petroleum	Q8 T 750	30, 40	X			
LPC s. a.	Cyclon D Super	40		X		
Motor Oil, Hellas	EMO SHPD Plus	30, 40		X		
Motorex AG	Motorex Monolube	30		X		
Paz Lubricants & Chemicals	Paz Marine S 40	40	X			
Petrobras Distribuidora s. a.	Marbrax CCD-310-AP	30		X		
Petrogal, s. a.	Galp Galaxia 40	40		X		
Repsol	Reposol Giant 1030 SAE40	40			X	

Single-grade oils – Category 2, SAE grades 30 and 40 for diesel engines						
Manufacturer	Product/brand name	SAE viscosity grade	TBN			Comments
			8 to 10 mg KOH/g	10 to 12 mg KOH/g	> 12 mg KOH/g	
Shell International Petroleum Company	Shell Sirius X	30			X	Approved for Series 956 TB33 Ɛ =12, 1163 TB32 and Series 8000
	Shell Sirius X	40			X	Approved for Series 8000
Singapore Petroleum Company	SPC SDM 900 SAE 30	30		X		
	SPC SDM 900 SAE 40	40		X		
SRS Schmierstoff Vertriebs GmbH	SRS Rekord plus 30	30		X		
	SRS Rekord plus 40	40		X		
	SRS Antikorrol M plus	30		X		Enhanced corrosion protection Only permitted for running-in and standard production acceptance, max. 10 operating hours; except for Series 4000Tx4/Tx5/Rx4/Rx5: Max. 3.5 operating hours applies here
Total Lubrifiants	Total Caprano MT 30	30			X	
	Total Caprano MT 40	40			X	
	Total Disola MT 30	30	X			1)
	Total Disola MT 40	40	X			
	Total Rubia MT 30	30			X	
	Total Rubia MT 40	40			X	

Table 31:

5.5 Multi-grade oils – Category 2, SAE grades 10W-30, 10W-40, 15W-40 and 20W-40 for diesel engines

For details and special properties, see the chapter on 'Lubricants for four-stroke cycle engines' (→ Page 7).

Important

[1] = No longer included in the portfolio. Remaining stocks of this product can be used up as long as they are within their shelf life.
[2] Engine oils marked [2] are also approved for Series 60 engines.

Multi-grade oils

Multi-grade oils – Category 2, SAE grades 10W-30, 10W-40, 15W-40 and 20W-40 for diesel engines						
Manufacturer	Product/brand name	SAE viscosity grade	TBN			Comments
			8 to 10 mg KOH/g	10 to 12 mg KOH/g	> 12 mg KOH/g	
Rolls-Royce Solutions GmbH	DEO SAE 15W-40 Ultra	15W-40		X		20 l canister: X00084315 210 l barrel: X00084316
Rolls-Royce Solutions Asia Pte. Ltd.	Diesel Engine Oil - DEO SAE 15W-40 Ultra	15W-40		X		20 l canister: 60633/P 210 l canister: 60335/D
Rolls-Royce Solutions Suzhou Co. Ltd. China	Diesel Engine Oil - DEO 15W-40	15W-40		X		16 kg canister: X00087293 170 kg canister: X00087294
PT. Rolls-Royce Solutions Indonesia	Diesel Engine Oil - DEO SAE 15W-40 Ultra	15W-40		X		20 l canister: X00060333/P 210 l canister: 60335/D
mtu India Pvt. Ltd.	Diesel Engine Oil - DEO 15W-40 Ultra	15W-40		X		50 l canister: 63333/P[2] 205 l canister: 65151/D Sale only intended in Indian market
Adnoc Distribution	Adnoc Voyager Plus	15W-40		X		[2]
Aegean Oil S.A.	Vigor Turbo SD 15W-40	15W-40	X			[2]
Addinol Lube Oil GmbH	Addinol Diesel Longlife MD1548	15W-40		X		[2]
	Addinol Diesel Longlife MD1047	10W-40			X	
Aral AG	Aral Turboral	10W-40		X		
	Aral Turboral	15W-40		X		[2]
Avista Oil Deutschland GmbH	Avista pure EVO CI-4 TS SAE 15W-40	15W-40		X		[2]
	Avista pure EVO Q CI-4 SAE 15W-40	15W-40		X		[2]
BayWa AG	Tectrol Turbo 4000	10W-40		X		
	Tectrol Super Truck 1540	15W-40			X	
Belgin Madeni Yaglar	BELGIN LUBEX ROBUS PRO 15W-40	15W-40		X		[2]
	LUBEX MARINE M	15W-40		X		

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Multi-grade oils – Category 2, SAE grades 10W-30, 10W-40, 15W-40 and 20W-40 for diesel engines						
Manufacturer	Product/brand name	SAE viscosity grade	TBN			Comments
			8 to 10 mg KOH/g	10 to 12 mg KOH/g	> 12 mg KOH/g	
BP p.l.c.	BP Vanellus Multi-Fleet Plus	15W-40		X		2)
	BP Vanellus Multi A	15W-40		X		2)
Castrol Ltd.	Castrol CRB Multi 15W-40 CI-4/E7	15W-40		X		2)
	Castrol CRB Turbomax 15W-40 CI-4/E7	15W-40		X X		
	Castrol CRB Turbomax 15W-40 CI-4SLE7	15W-40		X		2)
	Castrol Rivermax CRB 15W-40 CI-4/E7	15W-40		X		2)
	Castrol RX Diesel 15W-40 CI-4/E7	15W-40		X		2)
	Castrol RX Diesel 15W-40 CI-4 Plus/E7	15W-40		X		2)
	Castrol Vecton 15W-40 CI-4/E7	15W-40		X		1) 2)
	Castrol Vecton 15W-40 CI-4 Plus/SL/E7				X	2)
Champion Chemicals N.V.	Champion New Energy	15W-40		X		2)
Chevron Lubricants (Caltex)	Delo Gold Multigrade SAE 15W-40	15W-40	X			
	Delo Gold Ultra	15W-40		X		2)
	Delo Gold Ultra E	10W-40		X		
	Delo Gold Ultra E	15W-40	X			2)
Chevron Lubricants (Texaco)	Ursa Super TD SAE 15W-40	15W-40		X		2)
	Ursa Premium TDX	15W-40		X		2)
	Ursa Heavy Duty	15W-40	X			
CPC Corporation, Taiwan	CPC Superfleet CG4 Motor Oil	15W-40	X			
	CPC MARILUBE OIL 9250M	15W-40	X			
EKO ABEE	Eko Forza plus	15W-40	X			
	Eko Forza Plus 15W-40	15W-40			X	2)
	EKO Marine Plus 15W-40	15W-40	X			2)
	EKO Marine Premium 15W-40	15W-40		X		2)
eni S.p.A.	eni i-Sigma performance E7	15W-40	X			2)
ENOC MARKETING LLC	ENOC VULKAN 770X SUPER	15W-40		X		2)
Eurol B.V.	Eurol Diesel-Guard 15W-40	15W-40		X		
Euroltec	Casoku	15W-40	X			

Multi-grade oils – Category 2, SAE grades 10W-30, 10W-40, 15W-40 and 20W-40 for diesel engines						
Manufacturer	Product/brand name	SAE viscosity grade	TBN			Comments
			8 to 10 mg KOH/g	10 to 12 mg KOH/g	> 12 mg KOH/g	
Exxon Mobil Corporation	Mobilgard HSD 15W-40 CH-4	15W-40	X			
	Mobilgard HSD 15W-40 CI-4	15W-40		X		2)
	Mobilgard 1 SHC	20W-40			X	Approved for fast commercial vessels up to 1500 h, 396, 1163
	Mobil Delvac Advanced City Logistcs	15W-40	X			
	Mobil Delvac Advanced City Logistcs OE		X			
	Mobil Delvac Legend 15W-40 Heavy Duty	15W-40		X		2)
	Mobil Delvac Legend CH-4 15W-40 Heavy Duty	15W-40	X			
	Mobil Delvac Modern 10W-40 Super Defense	10W-40		X		
	Mobil Delvac Modern 15W-40 Extreme Defense	15W-40		X		2)
	Mobil Delvac Modern 15W-40 Extreme Defense Mine V2	15W-40		X		2)
	Mobil Delvac Modern 15W-40 Super Defense	15W-40	X			2)
	Mobil Delvac Modern 15W-40 Super Defense Mine V2	15W-40		X		2)
	Mobil Delvac Modern 15W-40 Super Defense V3	15W-40	X			
	Mobil Delvac Modern 15W-40 Super Defense V4	15W-40	X			
	Mobil Delvac MX	15W-40		X		2)
	Mobil Delvac MX OE 15W-40	15W-40	X			
	Mobil Delvac MX City Logistics OE 15W-40	15W-40	X			
	Mobil Delvac MX Extra	10W-40		X		
	Mobil Delvac Super 1300 C	15W-40	X			
	Mobil Delvac Super 1400	15W-40	X			
Finke Mineralölwerk GmbH	AVIATICON Turbo Super	15W-40	X			2)
	AVIATICON Turbo D 10W-40	10W-40		X		
Fuchs	TITAN SHPD SAE 15W-40	15W-40		X		2)

Multi-grade oils – Category 2, SAE grades 10W-30, 10W-40, 15W-40 and 20W-40 for diesel engines						
Manufacturer	Product/brand name	SAE viscosity grade	TBN			Comments
			8 to 10 mg KOH/g	10 to 12 mg KOH/g	> 12 mg KOH/g	
Fuchs Petrolub SE	Fuchs Titan Truck	15W-40	X			2)
	Fuchs Titan Truck Plus	10W-30		X		1)
	Fuchs Titan Truck Plus	15W-40		X		2)
	Fuchs Titan Universal HD-R 15W-40	15W-40			X	
	Fuchs Titan Universal HD	15W-40	X			
	Pentotruck	15W-40		X		2)
	Pentoturbo SAE 15W-40	15W-40		X		2)
	Titan Universal HD SAE 15W-40	15W-40		X		2)
Glide Technology SDN BHD	MonsterGlide Hyper F SAE 15W-40 API CI-4/SL	15W-40		X		2)
GS Caltex India Pvt. Ltd.	Kixx HD 1 SAE 10W-40	10W-40		X		
	Kixx HD 1 SAE 15W-40	15W-40		X		2)
GUANGXI BEIHAI YUCHAI PETRONAS HIGH QUALITY LUBE CO. LTD	HanHu Generator Set Oil CH-4 15W-40	15W-40	X			2)
	HanHu Long Drain Diesel Engine Oil CI-4 15W-40	15W-40	X			2)
Gulf Oil International	Gulf Super Duty VLE	15W-40	X			
	Gulf Superfleet LE	10W-40		X		
	Gulf Superfleet Supreme	10W-40		X		
	Gulf Superfleet Supreme	15W-40		X		2)
Gulf Oil Marine Ltd.	GulfSea Power MX 15W-40	15W-40		X		2)
Hellenic Fuels and Lubricants Single Member Industrial and Commercial S.A. (EKO ABOEE)	EKO FORZA PREMIUM 15W-40	15W-40		X		2)
Hindustan Petroleum	HP MILCY MTU 15W-40	15W-40		X		1) 2)
Hyrax Oil Sdn Bhd	Hyrax Admiral 15W-40	15W-40	X			2)
INA Maziva Ltd.	INA Super Max	15W-40		X		2)
Indian Oil Corporation Limited	Servo Premium 15W-40 API CI4 Plus	15W-40		X		2)
	Servo Premium (N) 15W-40	15W-40		X		2)
Kuwait Petroleum	Q8 T 750	15W-40	X			2)
	Q8 T 800	10W-40	X			2)
Kocak Petrol Ürünleri San	Speedol SHPD Tirot 15W-40	15W-40		X		
LAUGFS Lubricants Limited	D-TRON ACTIVTECH, SAE 15W-40, API CI-4	15W-40		X		

Multi-grade oils – Category 2, SAE grades 10W-30, 10W-40, 15W-40 and 20W-40 for diesel engines						
Manufacturer	Product/brand name	SAE viscosity grade	TBN			Comments
			8 to 10 mg KOH/g	10 to 12 mg KOH/g	> 12 mg KOH/g	
Liqui Moly GmbH	Liqui Moly Marine 4T Motor Oil	15W-40		X		2)
	Liqui Moly Touring High Tech SHPD	15W-40		X		1) 2)
Lotos Oil	Turdus SHPD	15W-40		X		2)
LPC S.A.	Cyclon D Super	15W-40	X			
	Cyclon Granit Maximum	15W-40		X		2)
	Cyclon Granit SYN SHPD PLUS 10W-40	10W-40			X	
Lubricants UK Limited	Castrol CRB Rivermax 15W-40	15W-40		X		2)
	Castrol RX Diesel 15W-40	15W-40		X		2)
	Castrol VECTON 15W-40	15W-40		X		2)
Moeve Commercial, S.A.U.	Traction Max SAE 15W-40	15W-40		X		1) 2)
MOL-LUB Ltd.	Mol Dynamic Transit 10W-40	10W-40		X		1)
Motor Oil, Hellas	EMO SHPD Plus	15W-40		X		
Novergy Chemicals, Corp.	Chronus Eco Classic Heavy Duty Diesel Multigrade Oil API CI-4 SAE 15W-40	15W-40		X		2)
Orlen Oil	Platinum Ultor Plus	15W-40			X	1) 2)
PETROBRAS DISTRIBUIDORA S.A.	LUBRAX NAUTICA DIESEL	15W-40		X		2)
	LUBRAX TOP TURBO	15W-40		X		2)
PetroChina Lubricant Company	Tianwei CH-4 15W-40 diesel engine oil	15W-40	X			2)
Petrol Ofisi A.Ş	Petrol Ofisi Maximus Turbo Diesel Extra	15W-40		X		2)
Petronas Lubricants International	Petronas Urania 3000	15W-40		X		2)
	Petronas Urania LD7	15W-40		X		
Petronas Lubricants Italy S.p.A.	PETRONAS ARBOR ALFATECH 15W-40	15W-40			X	2)
	PETRONAS Urania PRIME 15W-40	15W-40			X	2)
Prista Oil Holding EAD	Pro Auto HDEO E7 15W-40	15W-40		X		2)
PRO OIL S.A. (PTY) LTD.	PRO SYNTEC 15W-40 CI-4/SL PLUS	15W-40		X		2)
PT Pertamina Lubricants	Meditran SX	15W-40		X		2)
	Meditran SMX 15W-40	15W-40		X		
	Meditran SX Plus	15W-40		X		
Puma Energy S.A.	Puma HD Plus	15W-40		X		2)
Qatar Lubricants Company Ltd.	QALCO Topaz HMF	15W-40	X			

Multi-grade oils – Category 2, SAE grades 10W-30, 10W-40, 15W-40 and 20W-40 for diesel engines						
Manufacturer	Product/brand name	SAE viscosity grade	TBN			Comments
			8 to 10 mg KOH/g	10 to 12 mg KOH/g	> 12 mg KOH/g	
Raloy Lubricantes, S.A. de C.V.	Raloy Diesel Power SAE 15W-40 API CI-4 Plus/SL	15W-40		X		2)
Ravensberger Schmierstoffvertrieb GmbH	RAVENOL Expert SHPD	10W-40		X		
	RAVENOL Turbo Plus SHPD	15W-40		X		
Repsol Lubricantes y Especialidades, S.A.	REPSOL GIANT 7530 15W-40	15W-40		X		2)
	REPSOL GIANT 7540 15W-40	15W-40		X		2)
	REPSOL GIANT 7410 15W-40	15W-40	X			2)
Rock Oil Company	TRUCK-GUARD 15W-40	15W-40		X		
ROLF Lubricants GmbH	Rolf Krafton M5 U 15W-40	15W-40		X		
ROWE Mineralölwerk GmbH	ROWE Hightec Formula GT SAE 10W-40 HC	10W-40		X		
	ROWE Hightec Turbo HD 15W-40 Plus	15W-40		X		2)
Shell International Petroleum Company	Shell Fleet CI-4	10W-40		X		
	Shell HD3	10W-30		X		
	Shell HD4 CHN	15W-40		X		2)
	Shell HD5 Plus	10W-40		X		
	Shell Rimula Light Duty LD5 Multi	10W-40		X		
	Shell Rimula R3 MV	15W-40	X			2)
	Shell Rimula R3 Turbo	15W-40		X		2)
	Shell Rimula R3 X	15W-40	X			2)
	Shell Rimula R4	15W-40		X		2)
	Shell Rimula R4 Multi	15W-40		X		2)
	Shell Rimula R4 Plus	15W-40		X		2)
	Shell Rimula R4 X	15W-40		X		2)
	Shell Rimula RT4 X	15W-40		X		2)
	Shell Rimula Select R5	10W-40		X		
	Shell Rimula R5 E	10W-40		X		
	Shell Rimula T4	15W-40		X		2)
	Shell Sirius S4	15W-40		X		2)
	Eicher Premium Plus Diesel Engine Oil	15W-40		X		2)
Singapore Petroleum Company Limited	SPC SDM 900 SAE 15W-40	15W-40		X		
Sinopec Lubricant Co., Ltd.	Sinopec Tulux T500	15W-40		X		2)

Multi-grade oils – Category 2, SAE grades 10W-30, 10W-40, 15W-40 and 20W-40 for diesel engines						
Manufacturer	Product/brand name	SAE viscosity grade	TBN			Comments
			8 to 10 mg KOH/g	10 to 12 mg KOH/g	> 12 mg KOH/g	
SRS Schmierstoff Vertrieb GmbH	SRS Motorenöl O-236	15W-40	X			2) Enhanced corrosion protection
	SRS Multi Rekord top	15W-40		X		2)
	SRS Multi Rekord plus	15W-40	X			
	SRS Turbo Rekord NG	15W-40		X		2)
	SRS Cargolub TFE	10W-40		X		
	SRS Cargolub TFX	10W-40		X		
TotalEnergies	Caprano TDH 15W-40	15W-40		X		1)
	Caprano TDI FE 10W-30	10W-30		X		
	Caprano TDI 15W-40	15W-40		X		2)
	Disola W 15W40	15W-40		X		
	Hitachi Genuine Engine Oil 15W40 DH-1	15W-40		X		2)
	Hitachi Engine Oil DH-1 15W-40	15W-40		X		2)
	RUBIA TIR 7400 SAE 15W-40	15W-40		X		
	Rubia Works 1000 15W-40	15W-40		X		2)
	Rubia Works 1000 FE 10W-30	10W-30		X		1')
	TP MAX 10W-40	10W-40		X		
	Tractagri HDX 15W-40	15W-40		X		2)
UMW Grantt International Sdn Bhd	GRANTT QUASAR SAE 15W-40 API CI-4	15W-40		X		2)
Valvoline Ellis Enterprises B.V.	All Fleet Plus 15W-40	15W-40		X		2)
	Premium Blue 7800 15W-40	15W-40		X		2)
Valvoline EMEA	All-Fleet Extra SAE 15W-40	15W-40	X			2)
Veedol International Limited	VEEDOL DIESEL STAR EXTRA15W-40	15W-40		X		2)
Vibra Energia S.A.	LUBRAX TOP TURBO	15W-40		X		2)
	LUBRAX NAUTICA DIESEL	15W-40		X		2)
Wilhelm Hoyer B.V. & Co. KG	Hoyer Truck S-TD 10W-40	10W-40		X		
	Hoyer Truck M-TS 15W-40	15W-40		X		2)
Wolf Oil Corporation NV.	Wolf Vitaltech 15W40	15W-40		X		2)
YPF S.A.	Extravida XV 200	15W-40		X		
	Extravida XVI 200	15W-40		X		2)

Table 32:

5.6 Multi-grade oils – Category 2.1 (Low SAPS oils), SAE grades 5W-30, 10W-30, 0W-40, 5W-40 10W-40 and 15W-40 for diesel engines

For details and special properties, see the chapter on 'Lubricants for four-stroke cycle engines' (→ Page 7)

Important

[1] = No longer included in the portfolio. Remaining stocks of this product can be used up as long as they are within their shelf life.
[2] Engine oils marked [2] are also approved for Series 60 engines.

Multi-grade oils

Multi-grade oils – Category 2.1 (Low SAPS oils), SAE grades 5W-30, 10W-30, 0W-40, 5W-40 10W-40 and 15W-40 for diesel engines

Manufacturer	Product/brand name	SAE viscosity grade	TBN			Comments
			8 to 10 mg KOH/g	10 to 12 mg KOH/g	> 12 mg KOH/g	
Rolls-Royce Solutions America Inc.	Power Guard® SAE 15W-40 Off-Highway Heavy Duty	15W-40	X			5 gallons: 800133 55 gallons: 800134 IBC: 800135 Available from Rolls-Royce Solutions America Inc. 2)
Rolls-Royce Solutions Suzhou Co. Ltd. China	Diesel Engine Oil - DEO SAE 10W-40	10W-40	X			20 l canister: X00085025
Advanced Lubrication Specialties, Inc.	Advantage Premium Plus	15W-40		X		1) 2)
	Advantage Ultra Premium Plus	5W-40		X		1)
Atlantic Grease & Lubricants FZC	Atlantic Super Top Fleet HD-V Diesel Engine Oil SAE 15W-40 CK-4	15W-40		X		
Aramco Lubricants and Retail Company	Orizon HD vF 15W-40	15W-40	X			1) 2)
	Orizon HD vH 15W-40	15W-40	X			1) 2)
BayWa AG	TECTROL SUPER TRUCK PLUS XL 1040	10W-40		X		

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Multi-grade oils – Category 2.1 (Low SAPS oils), SAE grades 5W-30, 10W-30, 0W-40, 5W-40 10W-40 and 15W-40 for diesel engines						
Manufacturer	Product/brand name	SAE viscosity grade	TBN			Comments
			8 to 10 mg KOH/g	10 to 12 mg KOH/g	> 12 mg KOH/g	
Castrol Ltd.	Castrol CRB Mining 15W-40 CK-4	15W-40	X			2)
	Castrol CRB Turbomax 10W-40 CK-4/E9	10W-40	X			
	Castrol CRB Turbomax 10W-40 CK-4/E11	10W-40	X			
	Castrol CRB Turbomax 15W-40 CK-4/E11	15W-40	X			2)
	Castrol Rivermax 15W-40 CK-4/E9	15W-40	X			2)
	Castrol RX Super 15W-40 CJ-4/E9	15W-40	X			2)
	Castrol Vecton 10W-40 CK-4/E11	10W-40	X			
	Castrol Vecton 15W-40 CK-4/E11	15W-40	X			2)
	Castrol Vecton 15W-40 CK-4/E9	15W-40	X			2)
Champion Chemicals N.V.	Champion OEM specific 10W40 MS Extra	10W-40	X			
Chevron Lubricants (Chevron)	Delo 400 LE Synthetic	5W-40		X		
	Delo 400 MGX	15W-40	X			2)
	Delo 400 SDE	15W-40	X			2)
	Delo 400 SLK SAE 10W-30	10W-30	X			
	Delo 400 SLK SAE 15W-40	15W-40	X			2)
	Delo 400 SLK Syn-Blend SAE 10W-40	10W-40	X			
	Delo 400 XLE	10W-30		X		
	Delo 400 XSP	5W-40		X		
Classic Schmierstoff GmbH & Co. KG	Frerk Turbodiesel Classic 15W-40	15W-40	X			
CPC Corporation Taiwan	CPC Superfleet CK-4 Motor Oil 15W-40	15W-40	X			2)

Multi-grade oils – Category 2.1 (Low SAPS oils), SAE grades 5W-30, 10W-30, 0W-40, 5W-40 10W-40 and 15W-40 for diesel engines						
Manufacturer	Product/brand name	SAE viscosity grade	TBN			Comments
			8 to 10 mg KOH/g	10 to 12 mg KOH/g	> 12 mg KOH/g	
ExxonMobil Corporation	Mobil Delvac 1 ESP	0W-40		X		
	Mobil Delvac 1 ESP	5W-40		X		
	Mobil Delvac Extreme	15W-40		X		
	Mobil Fleet	15W-40	X			2)
	Mobil Delvac HDEO 15W-40	15W-40	X			2)
	Mobil Delvac MX ESP 10W-40	10W-40	X			
	Mobil Delvac MX ESP V2 15W-40	15W-40	X			2)
	Mobil Delvac Modern 15W-40 Advanced Protection V1	15W-40		X		2)
	Mobil Delvac Modern 15W-40 Advanced Protection Mine	15W-40	X			
	Mobil Delvac Modern 15W-40 Advanced Fleet	15W-40	X			2)
	Mobil Delvac Modern 15W-40 Advanced Protection Mine V2	15W-40		X		2)
	Mobil Delvac Modern 15W-40 Complete Protection	15W-40	X			2)
	Mobil Delvac Modern 15W-40 Extended Performance	15W-40	X			2)
	Mobil Delvac Modern 10W-40 Full Protection	10W-40	X			
	Mobil Delvac Modern 15W-40 Full Protection Mine V1	15W-40	X			2)
	Mobil Delvac Modern 15W-40 Full Protection Mine V2	15W-40		X		2)
	Mobil Delvac Modern 15W-40 Full Protection V2	15W-40	X			
	Mobil Delvac Ultra 5W-40 Extended Performance	5W-40		X		
	Mobil Delvac Ultra 5W-40 Extended Performance Mine	5W-40		X		
	Mobil Delvac Ultra 5W-40 Ultimate Protecton V1	5W-40		X		
	Mobilgard 1 HSD 5W-40	5W-40		X		
eni S.P.A.	eni i-sigma top MS 15W40	15W-40	X			2)

Multi-grade oils – Category 2.1 (Low SAPS oils), SAE grades 5W-30, 10W-30, 0W-40, 5W-40 10W-40 and 15W-40 for diesel engines						
Manufacturer	Product/brand name	SAE viscosity grade	TBN			Comments
			8 to 10 mg KOH/g	10 to 12 mg KOH/g	> 12 mg KOH/g	
Finke Mineralölwerke GmbH	AVIATICON Finko Premium Truck LA Plus 10W-40	10W-40		X		
	AVIATICON Turbo LA Plus	10W-40	X			1) 2)
	AVIATICON Turbo LA Premium 10W-40	10W-40	X			
	AVIATICON Turbo Premium ECO LA 10W-30	10W-30	X			
	AVIATICON Turbo Super Premium 15W-40	15W-40	X			2)
Fuchs Petrolub SE	Fuchs Titan Cargo SAE 10W-40	10W-40	X			
	Fuchs Titan Cargo SAE 10W-30	10W-30	X			
	Titan Cargo SAE 15W-40	15W-40	X			2)
	FUCHS TITAN CARGO MAXX II SAE 5W-30	5W-30			X	
	TITAN CARGO MAXX II SAE10W-40	10W-40			X	Enhanced corrosion protection
	TITAN CARGO SAE 5W-40	5W-40		X		
	TITAN CARGO UHPD SAE 15W-40	15W-40	X			2)
	PENTOTRUCK PRO SAE 15W-40	15W-40	X			2)
Gulf Oil International	Gulf Supreme Duty XLE	15W-40	X			1) 2)
Hitachi Construction Machinery Co, Ltd.	Hitachi Engine Oil 10W-40 DH-2	10W-40	X			
Kuwait Petroleum	Q8 Formula Truck 7000 FE	10W-30	X			
LIQUI MOLI GmbH	LIQUI MOLI Top Tec Truck 4450	15W-40	X			2)
Meguin GmbH & Co. KG	megol Motorenoel Global Truck SHPD	15W-40	X			2)
Petro-Canada	Duron HP	15W-40	X			2)
	Duron SHP	15W-40	X			
Petronas Lubricants International	Petronas Urania 3000 LS 10W-30	10W-30	X			
	Petronas Urania 3000 LS 15W-40	15W-40	X			2)
Phillips 66 Lubricants	Guardol ECT 10W-30	10W-30	X			
	Kendall Super-D XA 10W-30	10W-30	X			
	Kendall Super-D XA 15W-40	15W-40	X			2)
Raloy Lubricantes, S.A. de C.V.	Raloy Gas Engine Oil SAE 15W-40 API CK-4/SN (GN 20092)	15W-40		X		2)

Multi-grade oils – Category 2.1 (Low SAPS oils), SAE grades 5W-30, 10W-30, 0W-40, 5W-40 10W-40 and 15W-40 for diesel engines						
Manufacturer	Product/brand name	SAE viscosity grade	TBN			Comments
			8 to 10 mg KOH/g	10 to 12 mg KOH/g	> 12 mg KOH/g	
Repsol Lubricantes Y Especialidades, S.A.	REPSOL GIANT 7630 LS 15W-40	15W-40	X			2)
	REPSOL GIANT 7630 LS-FE 10W-30	10W-30	X			2)
	REPSOL GIANT 7640 LS 15W-40	15W-40		X		2)
Shell International Petroleum Company	Shell HD5 Offroad	10W-40	X			
	Shell Fleet CK-4	10W-30	X			
	Shell Fleet CK-4	10W-40	X			
	Shell Fleet CK-4	15W-40	X			2)
	Shell Rimula R4 L	15W-40	X			
	Shell Rimula R4 MV	15W-40	X			2)
	Shell Rimula RT4L	15W-40		X		2)
	Shell Rimula R5 LE	10W-30	X			
	Shell Rimula R5 LE	10W-40	X			
	Shell Rimula R6 LE	5W-40		X		
	Shell Rimula K6	15W-40	X			2)
	Shell Rimula K8	10W-30	X			
	Shell Rimula K8	10W-40	X			
	Shell Rotella Fleet	15W-40		X		2)
	Shell Rotella T3 Fleet	15W-40	X			2)
	Shell Rotella T4 Triple Protection	15W-40	X			2)
	Shell Rotella T5	10W-30	X			
	Shell Sirius S4L	15W-40	X			2)
SINOPEC Lubricant Co., Ltd.	Sinopec Tulux T700	15W-40	X			2)
SK Enmove Co., Ltd.	ZIC ZS 9000 10W-40	10W-40			X	
	ZIC ZS ULTRA 5W30	5W-30			X	
SRS Schmierstoff Vertrieb GmbH	SRS Turbo Rekord ultra	15W-40	X			2)
	SRS Turbo Rekord ultra V	10W-30	X			
Sunoco Lubricants	Super C	15W-40		X		1) 2)
	Super C Gold	15W-40		X		1) 2)
	Super C Gold Elite	5W-40		X		1)
The United Oil Company	Duralene Dura-Max 15W-40	15W-40		X		1) 2)
	Duralene Dura-Syn HD	5W-40		X		1)

Multi-grade oils – Category 2.1 (Low SAPS oils), SAE grades 5W-30, 10W-30, 0W-40, 5W-40 10W-40 and 15W-40 for diesel engines						
Manufacturer	Product/brand name	SAE viscosity grade	TBN			Comments
			8 to 10 mg KOH/g	10 to 12 mg KOH/g	> 12 mg KOH/g	
TotalEnergies Lubrifiants	Caprano TDK 15W-40	15W-40		X		2)
	Caprano TDK FE 10W-30	10W-30	X			
	Hitachi Engine Oil 10W-40 DH-2	10W-40	X			
	Rubia Optima 1100 15W-40	15W-40	X			2)
	Rubia Works 4000 10W-40	10W-40	X			
	Rubia Works 4000 15W-40	15W-40	X			2)
	Rubia Works 4000 FE 10W-30	10W-30	X			
Valvoline	Valvoline All-Fleet Superior LE 10W-30	10W-30	X			
Wilhelm Hoyer B.V. & Co. KG	Hoyer Truck S-PT 10W-30	10W-30	X			
	Hoyer Truck S-PT 10W-40	10W-30		X		
	Hoyer Truck S-TL 10W-40	10W-40	X			
Wolf Oil Corporation N.V.	Wolf Officialtech 10W40 MS Extra	10W-40	X			
	Wolf Officialtech 15W40 MS Extra	15W-40	X			2)

Table 33:

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

For details and special properties, see the chapter on 'Lubricants for four-stroke cycle engines' (→ Page 7).

Important

[1] = No longer included in the portfolio. Remaining stocks of this product can be used up as long as they are within their shelf life.

Multi-grade oils

Multigrade oils – Category 3 of SAE grades 5W-30, 5W-40 and 10W-40 for diesel engines						
Manufacturer	Brand name	SAE viscosity grade	TBN			Comments
			8 to 10 mg KOH/g	10 to 12 mg KOH/g	> 12 mg KOH/g	
Addinol Lube Oil GmbH	Addinol Super Truck MD 1049	10W-40			X	
Aral AG	Aral Mega Turboral 10W-40	10W-40			X	
	Aral Super Turboral 5W-30	5W-30			X	
Avista Oil Deutschland GmbH	Avista pure EVO E4	10W-40			X	
	Avista pure EVO SWE	5W-30			X	
	Avista pure EVO SWE	10W-40			X	
BayWa AG	Tectrol Super Truck 1040	10W-40			X	
BP p.l.c.	BP Energol IC-MT 10W-40	10W-40			X	
Castrol Ltd.	Castrol CRB Turbomax 10W-40 E4/E7	10W-40			X	
	Castrol Vecton 10W-40 E4/E7	10W-40			X	
	Castrol Vecton Long Drain	10W-40			X	[1]
	Castrol Vecton Long Drain 5W-30 E7	5W-30			X	
	Castrol Vecton Long Drain 10W-40 E7	10W-40			X	
	Castrol Vecton Long Drain 10W-40 E4/E7	10W-40			X	
Champion Chemicals N.V.	Champion New Energy 10W40 Ultra	10W-40			X	
Chevron Lubricants (Caltex)	Delo Gold Ultra T SAE 10W-40	10W-40			X	[1]
Chevron Lubricants (Texaco)	Ursa Premium FE	5W-30			X	
Deutsche Ölwerke Lubmin GmbH	AVENO HC PT Diesel	10W-40			X	
Devexport	Cubalub Extradiesel 10W-40	10W-40			X	
eni S.P.A.	eni i-Sigma top 10W-40	10W-40			X	
	eni i-Sigma performance E4	10W-40			X	
Enoc Marketing LLC	Enoc Vulcan 760X Syntech 10W-40	10W-40			X	

Multigrade oils – Category 3 of SAE grades 5W-30, 5W-40 and 10W-40 for diesel engines						
Manufacturer	Brand name	SAE viscosity grade	TBN			Comments
			8 to 10 mg KOH/g	10 to 12 mg KOH/g	> 12 mg KOH/g	
Exxon Mobil Corporation	Mobil Delvac Modern 10W-40 Super Defense V1	10W-40			X	Not approved for Series 2000 M72
	Mobil Delvac Modern 10W-40 Super Defense V2	10W-40			X	
	Mobil Delvac XHP Extra 10W-40	10W-40			X	Not approved for Series 2000 M72
	Mobil Delvac 1 5W-40	5W-40			X	
	Mobil Delvac Ultra 5W-40 Ultimate Defense	5W-40			X	
	Mobil Delvac Ultra 5W-40 Ultimate Defense Mine	5W-40			X	
Exol Lubricants Ltd.	Taurus Extreme M3	10W-40			X	
Finke Mineralölwerk GmbH	AVIATICON Finko Truck LD 10W-40	10W-40			X	
Fuchs Petrolub SE	Fuchs Titan Cargo SL	5W-30			X	
	Fuchs Titan Cargo MC SAE 10W-40	10W-40			X	
	Titan Cargo LD3 EVO SAE 10W-40	10W-40			X	
Gulf Oil International	Gulf Fleet Force synth.	5W-30			X	1)
	Gulf Superfleet ELD	10W-40			X	1)
	Gulf Superfleet ULD	10W-40			X	1)
	Gulf Superfleet XLD	10W-40			X	1)
	Gulf Superfleet Synth ELD	10W-40			X	1)
INA MAZIVA Ltd.	INA Super E7 SAE 10W-40	10W-40			X	
Kuwait Petroleum	Q8 T 860 10W-40	10W-40			X	
	Q8 T 860 S	10W-40			X	
Mol-Lub	MOL Dynamic Synt Diesel E4 10w-40	10W-40			X	
Motorex AG	MC Power Plus SAE 10W/40	10W-40			X	
Paz Lubricants & Chemicals	Paz Perfect E4	10W-40			X	
Petronas Lubricants International	Petronas Urania 5000 F 5W-30	5W-30			X	
	Petronas Urania 5000 10W-40	10W-40			X	
Ravensberger Schmierstoff Vertrieb GmbH	RAVENOL Performance Truck	10W-40			X	
Repsol Lubricantes y Especialidades S.A.	REPSOL GIANT 9540 LL 10W-40	10W-40			X	
	REPSOL GIANT 9550 FE-LL 5W-30	5W-30			X	
Rock Oil Company	Truck-Guard 5W-30	5W-30			X	2)
	Truck-Guard 10W-40	10W-40			X	

Multigrade oils – Category 3 of SAE grades 5W-30, 5W-40 and 10W-40 for diesel engines						
Manufacturer	Brand name	SAE viscosity grade	TBN			Comments
			8 to 10 mg KOH/g	10 to 12 mg KOH/g	> 12 mg KOH/g	
Rolf Lubricants GmbH	Rolf Krafton S7 M	10W-40			X	
	Rolf Krafton S7 M 10W-40	10W-40			X	
SCT Vertriebs GmbH	Fanfaro TRD E4 UHPD	10W-40		X		
	Mannol TS-6 UHPD Eco	10W-40		X		
	Pemco Diesel G-6 Eco UHPD	10W-40		X		
Shell International Petroleum Company	Shell Rimula R5 M	10W-40			X	
	Shell Rimula R6 M	10W-40			X	
	Shell Rimula R6 ME	5W-30			X	
	Shell Rimula R6 ME E4	5W-30			X	
	Shell Rimula R6 ME Extra	5W-30			X	
	Shell Rimula R6 MS	10W-40			X	
	Shell Rimula Select R6	10W-40			X	
SRS Schmierstoff Vertrieb GmbH	SRS Cargolub TFG	10W-40			X	1)
	SRS Cargolub TFG plus	10W-40			X	
	SRS Cargolub TFG ultra	10W-40			X	
TotalEnergies Lubrifiant	RUBIA TIR 8600 10W-40	10W-40			X	
Valvoline Ellis Enterprises B.V.	All-Fleet Extra 10W-40	10W-40			X	
Valvoline EMEA	Valvoline All Fleet Superior SAE 10W-40	10W-40			X	
Wilhelm Hoyer B.V. & Co. KG	Hoyer Truck S-DL 10W-40	10W-40			X	
	Hoyer Truck S-LS 10W-40	10W-40			X	
Wolf Oil Corporation	Wolf Vitaltech 10W-40 Ultra	10W-40			X	

Table 34:

5.8 Multi-grade oils – Category 3.1 (low SAPS oils), SAE grades 5W-30, 10W-30 and 10W-40 for diesel engines

For details and special properties, see the chapter on 'Lubricants for four-stroke cycle engines' (→ Page 7).

Important

[1] = No longer in portfolio. Remaining stocks of this product can be used up as long as they are within their shelf life.

Multi-grade oils

Multi-grade oils – Category 3.1 (low SAPS oils), SAE grades 5W-30, 10W-30 and 10W-40 for diesel engines						
Manufacturer	Brand name	SAE viscosity grade	TBN			Comments/material number
			8 to 10 mg KOH/g	10 to 12 mg KOH/g	> 12 mg KOH/g	
Addinol Lube Oil GmbH	Addinol Professional 0530 E8/E11	5W-30		X		
	Addinol Professional 1040 E8/E11	10W-40	X			
Aral AG	Aral Mega Turboral LA 10W-40	10W-40	X			
	Aral Super Turboral LA 5W-30	5W-30		X		
Avista Oil Deutschland GmbH	Avista pure EVO GER SAE 10W-40	10W-40	X			
	Avista pure EVO CK-4 SAE 5W-30	5W-30	X			
	Avista pure EVO CK-4 SAE 10W-30	10W-30	X			
	Avista pure EVO CK-4 SAE 10W-40	10W-40	X			
	Avista pure EVO PRIME SWE SAE 5W-30	5W-30			X	
BayWa AG	TECTROL SUPER TRUCK PLUS XL 1040	10W-40			X	
Belgin Madeni Yağlar	BELGIN LUBEX ROBUS GLOBAL LA 10W-40	10W-40		X		
	BELGIN LUBEX ROBUS MASTER LA 10W-40	10W-40		X		
Castrol Ltd.	Castrol Vecton Long Drain 5W-30 E6/E9	5W-30	X			
	Castrol Vecton Long Drain 10W-30 E8/E11	10W-30		X		
	Castrol Vecton Long Drain 10W-40 CK-4/E6	10W-40		X		
	Castrol Vecton Long Drain 10W-40 CK-4/E8	10W-40	X			
	Castrol Vecton Long Drain 10W-40 E6/E9	10W-40		X		
	Castrol Vecton Long Drain 10W-40 E8/E11	10W-40	X			
	Castrol Vecton Fuel Saver 5W-30 E6/E9	5W-30	X			[1]

Multi-grade oils – Category 3.1 (low SAPS oils), SAE grades 5W-30, 10W-30 and 10W-40 for diesel engines						
Manufacturer	Brand name	SAE viscosity grade	TBN			Comments/material number
			8 to 10 mg KOH/g	10 to 12 mg KOH/g	> 12 mg KOH/g	
Champion Chemicals N.V.	Champion OEM Specific 10W-40 UHPD MS	10W-40		X		
	Champion OEM Specific 10W40 Ultra MS	10W-40		X		
	Champion OEM Specific 10W40 UHPD Extra	10W-40		X		
Chevron Lubricants (Chevron)	Delo 400 RDE	10W-30		X		
	Delo 400 RDS	10W-40		X		
	Delo 400 XLE	15W-40	X			
	Delo 400 XLE LD 10W-40	10W-40		X		
	Delo 400 XLE HD	10W-40			X	
	Delo 400 XSP	5W-30	X			
	Delo 400 XSP-SD	5W-30	X			
CLASSIC Schmierstoff GmbH & Co. KG	Frerk Turbodiesel Xtreme 10W-40	10W-40	X			
Deutsche Ölwerke Lubmin GmbH	AVENO Low SAPS HD Premium 10W-40	10W-40		X		
	AVENO Low SAPS HD Supreme 5W-30	5W-30	X			
	AVENO Universal UHPD	10W-40	X			
	Ravenol Euro VI Truck 10W-40	10W-40	X			
eni S.P.A.	eni i-sigma special TMS 5W-30	5W-30	X			
	eni i-sigma top MS 10W-40	10W-40		X		
Enoc Marketing L.L.C.	Enoc Vulcan 990X ELXD 10W-40	10W-40		X		
Exol Lubricants Ltd.	Taurus Euro	10W-40		X		1)

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Multi-grade oils – Category 3.1 (low SAPS oils), SAE grades 5W-30, 10W-30 and 10W-40 for diesel engines						
Manufacturer	Brand name	SAE viscosity grade	TBN			Comments/material number
			8 to 10 mg KOH/g	10 to 12 mg KOH/g	> 12 mg KOH/g	
Exxon Mobil Corporation	Mobil Delvac 1 ESP	5W-30		X		1)
	Mobil Delvac 1 5W-30 Advanced Synthetic	5W-30		X		
	Mobil Delvac 1 LE 5W-30	5W-30			X	
	Mobil Delvac HD 10W-40	10W-40		X		
	Mobil Delvac Ultra 5W-30 Ultimate Protection	5W-30			X	
	Mobil Delvac Ultra 5W-30 Ultimate Protection V2	5W-30			X	
	Mobil Delvac XHP ESP	10W-40			X	
	Mobil Delvac XHP ESP S	10W-40			X	
	Mobil Delvac XHP ESP 10W-40 V2	10W-40		X		
	Mobil Delvac XHP Ultra LE	5W-30		X		
	Mobil Delvac Modern 10W-40 Advanced Protection	10W-40		X		
	Mobil Delvac Modern 5W-30 Advanced Protection V3	5W-30	X			
	Mobil Delvac Modern 10W-40 Advanced Protection V3	10W-40		X		
	Mobil Delvac Modern 10W-40 Advanced Protection V4	10W-40		X		
	Mobil Delvac Modern 10W-40 Extended Protection Plus	10W-40			X	
	Mobil Delvac Modern 10W-40 Full Protection V4	10W-40		X		
	Mobil Delvac Modern OE 10W-40 Advanced Protection V1	10W-40		X		
Finke Mineralölwerk GmbH	AVIATICON Finko Super Truck LA Plus	10W-40		X		1)
	AVIATICON Premium Truck LA Plus 5W-30	5W-30		X		
	AVIATICON Finko Premium Truck LA Plus 10W40	10W-40		X		

Multi-grade oils – Category 3.1 (low SAPS oils), SAE grades 5W-30, 10W-30 and 10W-40 for diesel engines						
Manufacturer	Brand name	SAE viscosity grade	TBN			Comments/material number
			8 to 10 mg KOH/g	10 to 12 mg KOH/g	> 12 mg KOH/g	
Fuchs Petrolub SE	Titan Cargo Flex LD 5W-30	5W-30		X		
	Titan Cargo Flex LD 10W-40	10W-40		X		
	Titan Cargo Maxx	10W-30		X		
	Titan Cargo Maxx	10W-40			X	Enhanced corrosion protection Limited operational availability
	Titan Cargo Maxx II	5W-30			X	
	Titan Cargo Maxx II	10W-40			X	Enhanced corrosion protection
	PENTOTRUCK ULTRA SAE 10W-30	10W-30	X			
Gulf Oil International	Gulf Superfleet ULE	10W-40	X			1) Enhanced corrosion protection
	Gulf Superfleet Synth ULE	5W-30	X			
	Gulf Superfleet XLE	10W-30	X			
	Gulf Superfleet Synth XLE	10W-30		X		1)
	Gulf Superfleet Universal	5W-30			X	1)
	Gulf Superfleet Universal	10W-40			X	1)
Hi-Tec Oils	Fleetmaster Euro HD 10W-40	10W-40		X		
INA Maziva d.o.o.	INA Super 2009 5W-30	5W-30	X			
Kuwait Petroleum Research & Technology	Q8 T 904	10W-40		X		1)
	Q8 Formula Truck 8900 FE 5W-30	5W-30			X	
MOL-LUB Ltd.	MOL Dynamic Mistral XT 5W-30	5W-30	X			1)
	MOL Dynamic Mistral 10W-40	10W-40	X			1)
Motorex AG	Motorex / York Focus QTM	10W-40	X			
	Motorex York Nexus FE SAE 5W-30	5W-30			X	1)
MPM International Oil Company B.V.	Motor Oil 10W-40 Premium Synthetic Ultra High Performance Diesel	10W-40		X		
Neste	Neste Turbo+ LSA S4 5W-30	5W-30	X			
Oel-Brack AG	Midland maxtra	10W-40		X		1)
OMV Petrol Ofisi A.Ş	Maximus HD-E		X			
Orlen Oil	Orlen Oil Ultor Progress 10W-40			X		
	Platinum Ultor Complete	10W-40	X			1)

Multi-grade oils – Category 3.1 (low SAPS oils), SAE grades 5W-30, 10W-30 and 10W-40 for diesel engines						
Manufacturer	Brand name	SAE viscosity grade	TBN			Comments/material number
			8 to 10 mg KOH/g	10 to 12 mg KOH/g	> 12 mg KOH/g	
Petro-Canada Lubricants Inc.	Duron SHP E6	10W-40		X		
	Duron UHP E6	5W-30			X	1)
	Duron UHP E6	10W-40			X	1)
	Duron UHP E6 10W40	10W-40	X			1)
	Duron UHP E8 5W-30	5W-30			X	
	Duron UHP E8-X 5W-30	5W-30			X	
	Duron UHP E8 10W-40	10W-40			X	
	Duron UHP E8-X 10W-40	10W-40			X	
Petronas Lubricants	PETRONAS Urania 5000 LS 10W-40	10W-40		X		
	PETRONAS Urania LSF 5W-30	5W-30	X			
Ravensberger Schmierstoffvertrieb GmbH	RAVENOL Ultra Synthetik Truck 5W-30	5W-30	X			
Repsol Lubricantes y Especialidades, S.A.	REPSOL GIANT 9630 LS-LL 10W-40	10W-40	X			
	REPSOL GIANT 9640 LS-FE-LL 5W-30	5W-30	X			
	REPSOL GIANT 9660 LS-FE-LL 5W-30	5W-30			X	
Rowe Mineralölwerk GmbH	Rowe Hightec Truckstar SAE 10W-40 HC-LA	10W-40		X		1)
Shell International Petroleum Company	Shell Fleet Pro CK-4	10W-40			X	
	Shell Rimula K10	10W-40			X	Enhanced corrosion protection
	Shell Rimula R6 LM	10W-40		X		Enhanced corrosion protection
	Shell Rimula R6 LME	5W-30		X		
	Shell Rimula R6 LME Plus	5W-30		X		
	Shell Rimula Ultra	5W-30			X	
	Shell Sirius S6 LM	10W-40			X	
SINOPEC Lubricant Co., Ltd.	SINOPEC TULUX T700 Plus	10W-40		X		
SK Enmove Co., Ltd.	ZIC ZS 9000 10W-40	10W-40			X	
	ZIC ZS Ultra 5W-30	5W-30			X	
SRS Schmierstoff Vertrieb GmbH	SRS Cargolub TLA plus	10W-40		X		
	SRS Cargolub TLS plus	5W-30		X		
	SRS Cargolub TLS top	5W-30	X			
	SRS Cargolub Leichtlauf-Motorenöl LA	10W-40		X		
	SRS Turbo-Rekord top FE	10W-40		X		1)

Multi-grade oils – Category 3.1 (low SAPS oils), SAE grades 5W-30, 10W-30 and 10W-40 for diesel engines						
Manufacturer	Brand name	SAE viscosity grade	TBN			Comments/material number
			8 to 10 mg KOH/g	10 to 12 mg KOH/g	> 12 mg KOH/g	
TotalEnergies Lubrifiant	DISOLA LONG LIFE 10W-40	10W-40		X		
	Rubia Optima 3100 10W-40	10W-40		X		
	Rubia Works 3000 FE 5W-30	5W-30			X	
	Rubia Works 5000 FE 5W-30	5W-30			X	
	Rubia Works 5000 FE 10W-30	10W-30		X		
	Rubia Works 5000 10W-40	10W-40		X		
	Star Max Gen 6 FE 10W-30	10W-30		X		
Valvoline Ellis Enterprises B.V.	Profleet LS Plus 10W-40	10W-40		X		
Veedol International Limited	VEEDOL MARATRON EXTRA LSP 10W-40	10W-40		X		
Wilhelm Hoyer B.V. & Co. KG	Hoyer Truck S-PT 5W-30	5W-30	X			
	Hoyer Truck S-PT 10W-40	10W-40		X		
Wolf Oil Corporation N.V.	Wolf Officialtech 10W40 Ultra MS	10W-40		X		
	Wolf Officialtech 10W40 UHPD Extra	10W-40		X		
	Wolf Officialtech 10W40 UHPD MS	10W-40		X		
	Wolf Officialtech 10W40 UHPD S	10W-40		X		1)

Table 35:

5.9 Lubricating Greases

5.9.1 Lubricating greases for general applications

For details and special features, see chapter "Lubricating greases" (→ Page 15)

Manufacturer	Brand name	Notes
Aral AG	Mehrzweckfett Arallub HL2	
BP p.l.c.	Energrease LS2	
Castrol Ltd.	Spheerol AP2	
Chevron	Multifak EP2	
SRS Schmierstoff Vertrieb GmbH	SRS Wiolub LFK2	
Shell Deutschland GmbH	Shell Gadus S2 V220 2	
Total	Total Multis EP2	
Veedol International	Multipurpose	

Table 36:

5.9.2 Lubricating greases for diesel generator set components

Lubricating greases for generators

The generator manufacturers lubricate the bearings before shipment.

Lubricant must be added when the unit is put into operation.

Important
The specifications on the generator plate are always applicable.

The following information is attached to the generators by the manufacturer:
- Lubricating grease to be used
- Volume of lubricating grease
- Lubricating interval

The applicable Maintenance Schedule must be complied with.

Refer to the Operating Instructions for more details.

Important
The temperature of the generator bearings should be monitored during the initial operating hours.

Important
Poor lubrication may lead to excessive temperatures and damage to the bearings.

Important
Mixtures of different lubricating greases are not permitted!

Generator manufacturer	Grease
Leroy-Somer *) LSA 52.3, LSA 53.2, LSA 54.2	Mobil Polyrex™ EM: grade NLGI 2
Leroy-Somer *) LSA 49.3, LSA 50.2	ESSO Unirex N3: grade NLGI 3
Marathon	Mobil Polyrex™ EM: grade NLGI 2
Stamford *)	KLUEBER ASONIC GHY72
	KLÜBERQUIET BQ 72-72
Mecc Alte	SKF LGMT 2
*) NOTE: Refer to the nameplate on the generator for the relevant lubricating grease.	

Table 37: Lubricating greases for generators

For information about lubricating greases for generators made by other manufacturers, please contact the service partners from Rolls-Royce Solutions.

Lubricating greases for coolant coolers

Component	Grease
For fan wheel bearings and belt pulley bearings on the Series 4000 coolant cooler	Mobil Polyrex EM (NLGI2)
For belt tensioners on the Series 4000 coolant cooler	Rocol RTD-Compound

Table 38: Lubricating greases for coolant coolers

6 Approved Coolants

6.1 Series-dependent usability of coolant additives

All details are based on the coolant circuit on the engine side, no allowance is made for external add-on components.

For details and special features, see 'Coolants – General information' (→ Page 17) and 'Unsuitable materials in the coolant circuit' (→ Page 23).

Important
In the case of an engine coolant circuit with no light metal components but with add-on components containing light metal (e.g. external cooling system or preheater), the coolant approvals for cooling systems containing light metal shall apply. If you have any doubts about a coolant application, consult your contact person at Rolls-Royce Solutions.

Any deviating special agreements between the customer and Rolls-Royce Solutions remain valid.

Series	Coolant system containing light metal	Coolant without antifreeze
2000Gx5 2000Gx6	Yes	• Concentrates for cooling systems containing light metal, see (→ Page 100) • Ready mixtures for cooling systems containing light metal, see (→ Page 102)
4000Gx3 4000Gx4	No	• Concentrates for cooling systems free of light metal, see (→ Page 103) • Ready mixtures for cooling systems free of light metal, see (→ Page 105)

Series	Coolant system containing light metal	Antifreeze
2000Gx5 2000Gx6	Yes	• Concentrates for cooling systems containing light metal, see (→ Page 106) • Ready mixtures for cooling systems containing light metal, see (→ Page 109)
4000Gx3 4000Gx4	No	• Concentrates for cooling systems free of light metal, see (→ Page 115) • Ready mixtures for cooling systems free of light metal, see (→ Page 118) • Ready mixture based on propylene glycol for series not containing light metal, see (→ Page 122)

Series	Coolant system containing light metal	Antifreeze for intercoolers (TB)
2000Gx6 with optional intercooler (TB)	Yes	• Concentrates for cooling systems containing light metal, see (→ Page 112) • Ready mixtures for cooling systems containing light metal (50/50 mixes), see (→ Page 112)

6.2 Coolants without antifreeze for cooling systems containing light metal

6.2.1 Coolant without antifreeze – Concentrates for cooling systems containing light metal

For details and special properties, see the chapter on "Coolants" (→ Page 17).

Important
For Series 1163-03 and 1163-04 marine engines, only coolants marked with an asterisk * in the product/ brand name may be used.

Coolant without antifreeze – Concentrates

Manufacturer	Product/brand name	Inhibitors							Runtime Hours/years	Comments/ material no.
		Organic	Silicon	Nitrite	Phosphate	Molybdate	Borates	2-EHS		
Rolls-Royce Solutions GmbH	Coolant CS100 Corrosion Inhibitor Concentrate*		X					X	6000/2	No longer included in portfolio. Remaining stocks of this product can be used up as long as they are within their shelf life.
Rolls-Royce Solutions America Inc.	Power Cool® Plus 6000 Concentrate*		X					X	6000/2	Colored green 23533526 (1 gallon) 23533527 (5 gallons) Available from Rolls-Royce Solutions America Inc.
BASF SE	Glysacorr G93 green*		X					X	6000/2	X00054105 (barrel) X00058062 (canister)
CCI Corporation	A 216	X				X			6000/2	
CCI Manufacturing IL Corporation	A 216	X				X			6000/2	X00051509 (208 l)
Detroit Diesel Corp.	Power Cool Plus 6000	X				X			6000/2	Colored red
Drew Marine	Drewgard XTA*		X					X	6000/2	
ExxonMobil	Mobil Delvac Extended Life Corrosion Inhibitor	X				X			6000/2	
Fuchs SE	Fricofin ME*		X					X	6000/2	
Old World Industries Inc.	Final Charge Extended Life Corrosion Inhibitor (A 216)	X				X			6000/2	

Manufacturer	Product/brand name	Inhibitors							Runtime Hours/years	Comments/ material no.
		Organic	Silicon	Nitrite	Phosphate	Molybdate	Borates	2-EHS		
Valvoline	ZEREX G93*		X					X	6000/2	
	OEM Advanced 93*		X					X	6000/2	
YORK SAS	York 719*		X					X	6000/2	

6.2.2 Coolant without antifreeze – Ready mixtures for cooling systems containing light metal

For details and special properties, see the chapter on "Coolants" (→ Page 17).

Important
For Series 1163-03 and 1163-04 marine engines, only coolants marked with an asterisk * in the product name may be used.

Coolant without antifreeze – Ready mixtures

Manufacturer	Product name	Inhibitors							Runtime Hours/years	Comments/ material no.
		Organic	Silicon	Nitrite	Phosphate	Molybdate	Borates	2-EHS		
Rolls-Royce Solutions GmbH	Coolant CS10/90 Corrosion Inhibitor Premix*		X					X	6000/2	No longer included in portfolio. Remaining stocks of this product can be used up as long as they are within their shelf life.
Penske Power Systems	PowerCool Pyroshield-GF Coolant	X				X			6000/2	
Recochem Inc.	HD Expert™ Endurance WB Prediluted Coolant	X				X			6000/2	

6.3 Coolants without antifreeze for cooling systems free of light metal

6.3.1 Coolant without antifreeze – Concentrates for cooling systems not containing light metal

For details and special properties, see the chapter on "Coolants" (→ Page 17).

Coolant without antifreeze – Concentrates

Manufacturer	Product/brand name	Inhibitors							Runtime Hours/years	Comments/ material no.
		Organic	Silicon	Nitrite	Phosphate	Molybdate	Borates	2-EHS		
Rolls-Royce Solutions GmbH	Coolant CS100 Corrosion Inhibitor Concentrate		X					X	6000/2	No longer included in portfolio. Remaining stocks of this product can be used up as long as they are within their shelf life.
Rolls-Royce Solutions America Inc.	Power Cool® Plus 6000 Concentrate		X					X	6000/2	Colored green 23533526 (1 gallon) 23533527 (5 gallons) Available from Rolls-Royce Solutions America Inc.
Arteco NV	Havoline XLI	X						X	6000/2	
BASF SE	Glysacorr G93 green		X					X	6000/2	X00054105 (barrel) X00058062 (canister)
CCI Corporation	A 216	X				X			6000/2	
CCI Manufacturing IL Corporation	A 216	X				X			6000/2	X00051509 (208 l)
Chevron	Delo XLI Corrosion Inhibitor - Concentrate	X						X	6000/2	
Detroit Diesel Corp.	Power Cool Plus 6000	X				X			6000/2	Colored red
Drew Marine	Drewgard XTA		X					X	6000/2	
ExxonMobil	Mobil Delvac Extended Life Corrosion Inhibitor	X				X			6000/2	
Fuchs SE	Fricofin ME		X					X	6000/2	
ImproChem	COOL-18		X	X			X		6000/2	
Nalco Water An Ecolab Company	Alfloc™ 3477	X						X	6000/2	
	Nalcool® 2000		X	X			X		6000/2	
Old World Industries Inc.	Final Charge Extended Life Corrosion Inhibitor (A 216)	X				X			6000/2	

Manufacturer	Product/brand name	Inhibitors							Runtime Hours/years	Comments/ material no.
		Organic	Silicon	Nitrite	Phosphate	Molybdate	Borates	2-EHS		
Total Lubrifiants	Total WT Supra	X						X	6000/2	
Valvoline	Zerex G93		X					X	6000/2	
	OEM Advanced 93		X					X	6000/2	
YORK SAS	York 719		X					X	6000/2	

6.3.2 Coolant without antifreeze – Ready mixtures for cooling systems not containing light metal

For details and special properties, see the chapter on 'Coolants' (→ Page 17)

Coolant without antifreeze – Ready mixtures

Manufacturer	Product/brand name	Inhibitors							Operating time Hours/year	Comments/ Material number
		Organic	Silicon	Nitrite	Phosphate	Molybdate	Borates	2-EHS		
Rolls-Royce Solutions GmbH	Coolant CS 10/90 Corrosion Inhibitor Premix		X					X	6000 / 2	No longer included in portfolio. Remaining stocks of this product can be used up as long as they are within their shelf life.
Nalco Water An Ecolab Company	Alfloc ™ 3443 (7%)	X						X	6000 / 2	
Penske Power Systems	PowerCool Pyroshield-GF Coolant	X				X			6000 / 2	
Recochem Inc.	HD Expert™ Endurance WB Prediluted Coolant	X				X			6000 / 2	

6.4 Antifreezes for cooling systems containing light metal

6.4.1 Antifreeze – Concentrates for cooling systems containing light metal

For details and special properties, see the chapter on 'Coolants – General information' (→ Page 17).

Antifreeze – Concentrates

Manufacturer	Product/brand name	Inhibitors							Operating time Hours/year	Comments/ Material number
		Organic	Silicon	Nitrite	Phosphate	Molybdate	Borates	2-EHS		
Rolls-Royce Solutions GmbH	Coolant AO 100 Antifreeze Concentrate	X							9000 / 3	No longer included in portfolio. Remaining stocks of this product can be used up as long as they are within their shelf life.
	Coolant AH 100 Antifreeze Concentrate	X	X				X	X	9000 / 5	No longer included in portfolio. Remaining stocks of this product can be used up as long as they are within their shelf life.
	Coolant AS 100 Antifreeze Concentrate	X	X						9000 / 3	No longer included in portfolio. Remaining stocks of this product can be used up as long as they are within their shelf life.
Avia AG	Antifreeze APN - S	X							9000 / 3	
BASF SE	Glysantin G05		X	X			X		9000 / 5	
	Glysantin G48 blue green	X	X				X	X	9000 / 5	X00058054 (25 l) X00058053 (210 l)
	Glysantin G30 pink	X							9000 / 3	X00058072 (canister) X00058071 (barrel)
	Glysantin G30 ECO pink BMB 100	X							9000 / 3	
	Glysantin ® G40 pink	X	X						9000 / 3	X00066724 (20 l) X00066725 (210 l)
	Glysantin ® G40 ECO pink BMB 100	X	X						9000 / 3	
BayWa AG	Tectrol Coolprotect	X	X				X	X	9000 / 5	
Castrol	Castrol Radicool NF	X	X				X	X	9000 / 5	
CCI Corporation	L 415	X				X			9000 / 3	

Manufacturer	Product/brand name	Inhibitors							Operating time Hours/year	Comments/ Material number
		Organic	Silicon	Nitrite	Phosphate	Molybdate	Borates	2-EHS		
Classic Schmierstoff GmbH & Co. KG	Classic Kolda UE G30®	X							9000 / 3	
	Classic Kolda UE G48®	X	X				X	X	9000 / 5	
	Classic Kolda UE G40 ®	X	X						9000 / 3	
COPARTS Autoteile GmbH	CAR 1 Premium Longlife Kühlerschutz C48	X	X				X	X	9000 / 5	
Daimler Trucks North America	Alliance OAT Extended Life Coolant	X				X			9000 / 3	
Detroit Diesel Corp.	Power Cool Plus Coolant	X				X			9000 / 3	
	Power Cool Diesel Engine Coolant		X	X					9000 / 3	
Drew Marine	Drewgard ZX	X							9000 / 3	
ExxonMobil	Mobil Delvac Extended Life Coolant	X				X			9000 / 3	
	Mobil Heavy Duty Coolant		X	X					9000 / 3	
	Mobil Mining Coolant		X	X					9000 / 3	
Finke Mineralölwerk GmbH	AVIATICON Finkofreeze F30	X							9000 / 3	
	AVIATICON Finkofreeze F48	X	X				X	X	9000 / 5	
	AVIATICON Finkofreeze F40	X	X						9000 / 3	
Fuchs SE	Fricofin	X	X				X	X	9000 / 5	
	Fricofin G12 Plus	X							9000 / 3	
	Fricofin DP	X	X						9000 / 3	
Krafft S.L.U.	Refrigerante ACU 2300		X	X			X		9000 / 3	X00058075 (barrel)
LAEMMLE Chemicals AG	Roxor Anti-Frost MT-650	X	X						9000 / 3	
Mitan Mineralöl GmbH	Alpine C30	X							9000 / 3	
	Alpine C48	X	X				X	X	9000 / 5	
MJL Banglasdesh Ltd.	Omera Premium Coolant	X							9000 / 3	
Moove Lubricants Limited	Mobil Antifreeze Extra	X	X				X	X	9000 / 5	
Motorex AG	Motorex Coolant G48	X	X				X	X	9000 / 5	
Nalco Water An Ecolab Company	Nalcool NF 48 C	X	X				X	X	9000 / 5	
Navistar Inc.	Fleetrite Nitrite-Free Extended Life Coolant	X				X			9000 / 3	

Manufacturer	Product/brand name	Inhibitors							Operating time Hours/year	Comments/ Material number
		Organic	Silicon	Nitrite	Phosphate	Molybdate	Borates	2-EHS		
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Coolant	X				X			9000 / 3	
	Fleet Charge SCA Precharged Coolant / Antifreeze		X	X					9000 / 3	
	Final Charge Global Extended Life Coolant Antifreeze	X				X			9000 / 3	
	Peak Heavy Duty Coolant		X	X					9000 / 3	
Penske Power Systems	Power Cool - HB500	X	X				X		9000 / 3	
Puma Energy International S.A.	Puma HD Hybrid Coolant	X	X						9000 / 3	
Raloy Lubricantes	Antifreeze Long Life NF-300 Concentrate	X	X				X	X	9000 / 5	
Recochem Inc.	HD Expert™ Endurance	X				X			9000 / 3	
	R542	X	X				X		9000 / 3	
Valvoline	Zerex G05		X	X			X		9000 / 5	
	Zerex G48	X	X				X	X	9000 / 5	
	Zerex G30	X							9000 / 3	
	Zerex G40	X	X						9000 / 3	Material number (USA): 800180 (drum)
	OEM Advanced 05		X	X			X		9000 / 5	
	OEM Advanced 30	X							9000 / 3	
	OEM Advanced 48	X	X				X	X	9000 / 5	
	OEM Advanced 40	X	X						9000 / 3	
Volvo Trucks	Road Choice Nitrite-Free OAT Extended Life Coolant	X				X			9000 / 3	
Wilhelm Hoyer B.V. & Co.KG	Hoyer Freeze A30	X							9000 / 3	
	Hoyer Freeze A48	X	X				X	X	9000 / 5	
	Hoyer Freeze A40	X	X						9000 / 3	

Table 39:

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6.4.2 Antifreeze – Ready mixtures for cooling systems containing light metal

For details and special properties, see the chapter on 'Coolants – General information' (→ Page 17).

Ready mixtures for cooling systems containing light metal

Manufacturer	Product/brand name	Inhibitors							Operating time Hours/year	Comments/ Material number
		Organic	Silicon	Nitrite	Phosphate	Molybdate	Borates	2-EHS		
Rolls-Royce Solutions GmbH	Coolant AH 35/65 Antifreeze Premix	X	X				X	X	9000 / 5	No longer included in portfolio. Remaining stocks of this product can be used up as long as they are within their shelf life.
	Coolant AH 40/60 Antifreeze Premix	X	X				X	X	9000 / 5	No longer included in portfolio. Remaining stocks of this product can be used up as long as they are within their shelf life.
	Coolant AH 50/50 Antifreeze Premix	X	X				X	X	9000 / 5	No longer included in portfolio. Remaining stocks of this product can be used up as long as they are within their shelf life.
Rolls-Royce Solutions America Inc.	Power Cool® Universal 35/65 mix	X	X				X	X	9000 / 5	800085 (5 gallons) 800086 (55 gallons)
	Power Cool® Universal 50/50 mix	X	X				X	X	9000 / 5	800071 (5 gallons) 800084 (55 gallons)
	Power Cool® Off-Highway Coolant 50/50 Premix		X	X			X		9000 / 5	23533531 (5 gallons) 23533532 (55 gallons)
A. Roth GmbH & Co KG	CRO Coolant Plus -25 °C Ready	X							9000 / 3	
BayWa AG	Tectrol Coolprotect Mix 3000	X							9000 / 3	Antifreeze protection down to -24 °C
BASF SE	Glysantin G30 RM/50 ECO pink BMB 100	X							9000 / 3	
	Glysantin ® G40 RM/50 ECO pink BMB 100	X	X						9000 / 3	(50% by vol.)
Castrol	Castrol Radicool NF Premix (45 %)	X	X				X	X	9000 / 5	
CCI Corporation	L 415 (50 %)	X				X			9000 / 3	

Manufacturer	Product/brand name	Inhibitors							Operating time Hours/year	Comments/ Material number
		Organic	Silicon	Nitrite	Phosphate	Molybdate	Borates	2-EHS		
Daimler Trucks North America	Alliance 50/50 Prediluted OAT Extended Life Coolant	X				X			9000 / 3	
Detroit Diesel Corp.	Power Cool Plus Prediluted Coolant (50/50)	X				X			9000 / 3	
	Power Cool Prediluted 50/50 Diesel Engine Coolant		X	X					9000 / 3	
Exxon Mobil	Mobil Delvac Extended Life Prediluted Coolant (50/50)	X				X			9000 / 3	
	Mobile Heavy Duty 50/50 Prediluted Coolant		X	X					9000 / 3	
	Mobile Mining 50/50 Prediluted Coolant		X	X					9000 / 3	
Fast Chemical SRL	Fast Coolant G30 50%	X							9000 / 3	
Finke Mineralölwerk GmbH	AVIATICON Finkofreeze F48 RM 50/50	X	X				X	X	9000 / 5	
	AVIATICON Finkofreeze F30 RM 40:60 +	X							9000 / 3	
Friedrich Scharr KG	Unil Metis RTU GC-26	X							9000 / 3	
	Unil Metis RTU GC-38	X							9000 / 3	
Fuchs SE	Fricofin 50	X	X				X	X	9000 / 5	
	Fricofin DP 50	X	X						9000 / 3	(50% by vol.)
Moeve Commercial S.A.U.	XTAR Super Coolant Hybrid NF 50%	X	X				X	X	9000 / 5	
Moove Lubricants Limited	Mobil Coolant Extra Ready -36 °C	X	X				X	X	9000 / 5	
Motorex AG	Motorex Coolant G48 Ready to use (50/50)	X	X				X	X	9000 / 5	
Navistar Inc.	Fleetrite 50/50 Prediluted Nitrite-Free Extended Life Coolant	X				X			9000 / 3	
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Prediluted Coolant (50/50)	X				X			9000 / 3	
	Final Charge Global Extended Life Prediluted Coolant/Antifreeze (50/50)	X				X			9000 / 3	
	Fleet Charge SCA Precharged 50/50 Prediluted Coolant		X	X					9000 / 3	

Manufacturer	Product/brand name	Inhibitors							Operating time Hours/year	Comments/ Material number
		Organic	Silicon	Nitrite	Phosphate	Molybdate	Borates	2-EHS		
Penske Power Systems	Power Cool - HB500 Premix 35/65	X	X				X		9000 / 3	
	Power Cool - HB500 Premix 50/50	X	X				X		9000 / 3	
Puma Energy International S.A.	Puma HD Hybrid Coolant 5050	X	X						9000 / 3	(50% by vol.)
Raloy Lubricantes	Antifreez Long Life NF-300 Ready-to-Use (50:50)	X	X				X	X	9000 / 5	
Recochem	HD Expert ™ Endurance 50-50 Prediluted	X				X			9000 / 3	
	R 542 35/65	X	X				X		9000 / 3	
SMB Sotragal Mont-Blanc	Liquide de refroidissement -37 °C FRICOTECH MBT SMB AUTO	X	X						9000 / 3	(50% by vol.) Antifreeze protection down to -37 °C
Valvoline	Zerex G05 50/50 Mix		X	X			X		9000 / 5	
	Zerex G48 premix 50%	X	X				X	X	9000 / 5	
	OEM Advanced 48 premix 50%	X	X				X	X	9000 / 5	
Volvo Trucks	Road Choice 50/50 Prediluted Nitrite-Free OAT Extended Life Coolant	X				X			9000 / 3	
Wilhelm Hoyer B.V. & Co.KG	Hoyer Freeze A30 RM 40:60	X							9000 / 3	
	Hoyer Freeze A48 RM 50:50	X	X				X	X	9000 / 5	

Table 40:

6.4.3 Antifreeze – Approved coolants for Series 2000Gx6 generator sets with intercooler option (TB)

For more information, details and special properties, see chapter 'Coolants – General information' (→ Page 17)

The intercooler (TB) has water/charge-air cooling. The charge-air cooler is installed on the base frame of the generator set and integrated in the charge-air coolant circuit (LT circuit).

The following tables listed the approved concentrates and ready mixtures for use in the charge-air coolant circuit.

They must meet the following requirements:
- Antifreeze
- For cooling systems containing light metal
- Silicon-free
- For ready mixtures: 50% by volume application concentration.

Antifreeze – Concentrates for Series 2000Gx6 with intercooler option (TB)

Manufacturer	Product/brand name	Inhibitors							Operating time Hours/year	Comments/ Material number
		Organic	Silicon	Nitrite	Phosphate	Molybdate	Borates	2-EHS		
Rolls-Royce Solutions GmbH	Coolant AO 100 Antifreeze Concentrate	X							9000 / 3	No longer included in portfolio. Remaining stocks of this product can be used up as long as they are within their shelf life.
Avia AG	Antifreeze APN - S	X							9000 / 3	
BASF SE	Glysantin G30 pink	X							9000 / 3	X00058072 (canister) X00058071 (barrel)
	Glysantin G30 ECO pink BMB 100	X							9000 / 3	
CCI Corporation	L 415	X				X			9000 / 3	
Classic Schmierstoff GmbH & Co. KG	Classic Kolda UE G30®	X							9000 / 3	
Daimler Trucks North America	Alliance OAT Extended Life Coolant	X				X			9000 / 3	
Detroit Diesel Corp.	Power Cool Plus Coolant	X				X			9000 / 3	
Drew Marine	Drewgard ZX	X							9000 / 3	
ExxonMobil	Mobil Delvac Extended Life Coolant	X				X			9000 / 3	
Finke Mineralölwerk GmbH	AVIATICON Finkofreeze F30	X							9000 / 3	
Fuchs SE	Fricofin G12 Plus	X							9000 / 3	
Mitan Mineralöl GmbH	Alpine C30	X							9000 / 3	
MJL Banglasdesh Ltd.	Omera Premium Coolant	X							9000 / 3	
Navistar Inc.	Fleetrite Nitrite-Free Extended Life Coolant	X				X			9000 / 3	

Manufacturer	Product/brand name	Inhibitors							Operating time Hours/year	Comments/ Material number
		Organic	Silicon	Nitrite	Phosphate	Molybdate	Borates	2-EHS		
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Coolant	X				X			9000 / 3	
	Final Charge Global Extended Life Coolant Antifreeze	X				X			9000 / 3	
Recochem Inc.	HD Expert™ Endurance	X				X			9000 / 3	
Valvoline	Zerex G30	X							9000 / 3	
	OEM Advanced 30	X							9000 / 3	
Volvo Trucks	Road Choice Nitrite-Free OAT Extended Life Coolant	X				X			9000 / 3	
Wilhelm Hoyer B.V. & Co.KG	Hoyer Freeze A30	X							9000 / 3	

Table 41: Antifreeze – Concentrates for Series 2000Gx6 with intercooler option (TB)

Antifreeze – Ready mixtures for Series 2000Gx6 with intercooler option (TB)

Manufacturer	Product/brand name	Inhibitors							Operating time Hours/ year	Comments/ Material number
		Organic	Silicon	Nitrite	Phosphate	Molybdate	Borates	2-EHS		
BASF SE	Glysantin G30 RM/50 ECO pink BMB 100	X							9000 / 3	
CCI Corporation	L 415 (50 %)	X				X			9000 / 3	
Daimler Trucks North America	Alliance 50/50 Prediluted OAT Extended Life Coolant	X				X			9000 / 3	
Detroit Diesel Corp.	Power Cool Plus Prediluted Coolant (50/50)	X				X			9000 / 3	
Exxon Mobil	Mobil Delvac Extended Life Prediluted Coolant (50/50)	X				X			9000 / 3	
Fast Chemical SRL	Fast Coolant G30 50 %	X							9000 / 3	
Friedrich Scharr KG	Unil Metis RTU GC-38	X							9000 / 3	
Navistar Inc.	Fleetrite 50/50 Prediluted Nitrite-Free Life Coolant	X				X			9000 / 3	
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Prediluted Coolant (50/50)	X				X			9000 / 3	
	Final Charge Global Extended Life Prediluted Coolant/Antifreeze (50/50)	X				X			9000 / 3	

Manufacturer	Product/brand name	Inhibitors							Operating time Hours/ year	Comments/ Material number
		Organic	Silicon	Nitrite	Phosphate	Molybdate	Borates	2-EHS		
Recochem	HD Expert ™ Endurance 50-50 Prediluted	X				X			9000 / 3	
Volvo Trucks	Road Choice 50/50 Prediluted Nitrite-Free OAT Extended Life Coolant	X				X			9000 / 3	

Table 42: Antifreeze – Ready mixtures for Series 2000Gx6 with intercooler option (TB)

6.5 Antifreezes for cooling systems free of light metal

6.5.1 Antifreeze – Concentrates for cooling systems free of light metal

For details and special properties, see the chapter on 'Coolants – General information' (→ Page 17)

Antifreeze – Concentrates

Manufacturer	Product/brand name	Inhibitors							Operating time Hours/year	Comments/ Material number
		Organic	Silicon	Nitrite	Phosphate	Molybdate	Borates	2-EHS		
Rolls-Royce Solutions GmbH	Coolant AO 100 Anti-freeze Concentrate	X							9000 / 3	No longer included in portfolio. Remaining stocks of this product can be used up as long as they are within their shelf life.
	Coolant AH 100 Anti-freeze Concentrate	X	X				X	X	9000 / 5	No longer included in portfolio. Remaining stocks of this product can be used up as long as they are within their shelf life.
	Coolant AS 100 Anti-freeze Concentrate	X	X						9000 / 3	No longer included in portfolio. Remaining stocks of this product can be used up as long as they are within their shelf life.
Arteco NV	Havoline XLC (1040112)	X						X	9000 / 3	
Avia AG	Antifreeze APN - S	X							9000 / 3	
BASF SE	Glysantin G05		X	X			X		9000 / 5	
	Glysantin G48 blue green	X	X				X	X	9000 / 5	X00058054 (25 l) X00058053 (210 l)
	Glysantin G30 pink	X							9000 / 3	X00058072 (canister) X00058071 (barrel)
	Glysantin G30 ECO pink BMB 100	X							9000 / 3	
	Glysantin ® G40 pink	X	X						9000 / 3	X00066724 (20 l) X00066725 (210 l)
	Glysantin ® G40 ECO pink BMB 100	X	X						9000 / 3	
BayWa AG	Tectrol Coolprotect	X	X				X	X	9000 / 5	
Castrol	Castrol Radicool NF	X	X				X	X	9000 / 5	

Manufacturer	Product/brand name	Inhibitors							Operating time Hours/year	Comments/ Material number
		Organic	Silicon	Nitrite	Phosphate	Molybdate	Borates	2-EHS		
Classic Schmierstoff GmbH & Co. KG	Classic Kolda UE G30®	X							9000 / 3	
	Classic Kolda UE G48®	X	X				X	X	9000 / 5	
	Classic Kolda UE G40 ®	X	X						9000 / 3	
CCI Corporation	L415	X				X			9000 / 3	
Chevron	Delo XLC Antifreeze/ Coolant-Concentrate	X						X	9000 / 3	
COPARTS Autoteile GmbH	CAR1 Premium Longlife Kühlerschutz C48	X	X				X	X	9000 / 5	
Daimler Trucks North America	Alliance OAT Extended Life Coolant	X				X			9000 / 3	
Detroit Diesel Corp.	Power Cool Plus Coolant	X				X			9000 / 3	
	Power Cool Diesel Engine Coolant		X	X					9000 / 3	
Drew Marine	Drewgard ZX	X							9000 / 3	
ExxonMobil	Mobil Delvac Extended Life Coolant	X				X			9000 / 3	
	Mobil Heavy Duty Coolant		X	X					9000 / 3	
	Mobil Mining Coolant		X	X					9000 / 3	
Finke Mineralölwerk GmbH	AVIATICON Finkofreeze F30	X							9000 / 3	
	AVIATICON Finkofreeze F48	X	X				X	X	9000 / 5	
	AVIATICON Finkofreeze F40	X	X						9000 / 3	
Fuchs SE	Fricofin	X	X				X	X	9000 / 5	
	Fricofin G12 Plus	X							9000 / 3	
	Fricofin LL	X						X	9000 / 3	
	Fricofin DP	X	X						9000 / 3	
Krafft S.L.U.	Refrigerante ACU 2300		X	X			X		9000 / 3	X00058075 (barrel)
LAEMMLE Chemicals AG	Roxor Anti-Frost MT-650	X	X						9000 / 3	
Mitan Mineralöl GmbH	Alpine C30	X							9000 / 3	
	Alpine C48	X	X				X	X	9000 / 5	
MJL Bangladesh	Omera Premium Coolant	X							9000 / 3	
Mol-Lub Ltd.	EVOX Premium Concentrate	X						X	9000 / 3	
Moove Lubricants Limited	Mobil Antifreeze Extra	X	X				X	X	9000 / 5	
Motorex AG	Motorex Coolant G48	X	X				X	X	9000 / 5	

Manufacturer	Product/brand name	Inhibitors							Operating time Hours/year	Comments/ Material number
		Organic	Silicon	Nitrite	Phosphate	Molybdate	Borates	2-EHS		
Nalco Water An Ecolab Company	Nalcool NF 48 C	X	X				X	X	9000 / 5	
Navistar Inc.	Fleetrite Nitrite-Free Extended Life Coolant	X				X			9000 / 3	
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Coolant	X				X			9000 / 3	
	Fleetcharge SCA Precharged Coolant / Antifreeze		X	X					9000 / 3	
	Final Charge Global Extended Life Coolant Antifreeze	X				X			9000 / 3	
	Peak Heavy Duty Coolant		X	X					9000 / 3	
Penske Power Systems	Power Cool - HB500	X	X				X		9000 / 3	
	Power Cool - HB800	X	X	X			X		9000 / 3	
Puma Energy International S.A.	Puma HD XLC Coolant	X						X	9000 / 3	
	Puma HD Hybrid Coolant	X	X						9000 / 3	
Raloy Lubricantes	Antifreeze Long Life NF-300 Concentrate	X	X				X	X	9000 / 5	
Recochem Inc.	HD Expert ™ Endurance	X				X			9000 / 3	
	R542	X	X				X		9000 / 3	
	R824M	X	X	X			X		9000 / 3	
Total Lubrifiants	Glacelf Auto Supra	X						X	9000 / 3	
	Glacelf Supra	X						X	9000 / 3	
Valvoline	Zerex G05		X	X			X		9000 / 5	
	Zerex G30	X							9000 / 3	
	Zerex G48	X	X				X	X	9000 / 5	
	Zerex G40	X	X						9000 / 3	Material number (USA): 800180 (drum)
	OEM Advanced 05		X	X			X		9000 / 5	
	OEM Advanced 30	X							9000 / 3	
	OEM Advanced 48	X	X				X	X	9000 / 5	
	OEM Advanced 40	X	X						9000 / 3	
Volvo Trucks	Road Choice Nitrite-Free OAT Extended Life Coolant	X				X			9000 / 3	
Wilhelm Hoyer B.V. & Co.KG	Hoyer Freeze A30	X							9000 / 3	
	Hoyer Freeze A48	X	X				X	X	9000 / 5	
	Hoyer Freeze A40	X	X						9000 / 3	

Table 43:

6.5.2 Antifreeze – Ready mixtures for cooling systems free of light metal

For details and special properties, see the chapter on 'Coolants – General information' (→ Page 17)

Ready mixtures for cooling systems free of light metal

Manufacturer	Brand name	Inhibitors							Operating time Hours/year	Comments/ Material number
		Organic	Silicon	Nitrite	Phosphate	Molybdate	Borates	2-EHS		
Rolls-Royce Solutions GmbH	Coolant AH 35/65 Anti-freeze Premix	X	X				X	X	9000 / 5	No longer included in portfolio. Remaining stocks of this product can be used up as long as they are within their shelf life.
	Coolant AH 40/60 Anti-freeze Premix	X	X				X	X	9000 / 5	No longer included in portfolio. Remaining stocks of this product can be used up as long as they are within their shelf life.
	Coolant AH 50/50 Anti-freeze Premix	X	X				X	X	9000 / 5	No longer included in portfolio. Remaining stocks of this product can be used up as long as they are within their shelf life.
Rolls-Royce Solutions America Inc.	Power Cool® Universal 35/65 mix	X	X				X	X	9000 / 5	800085 (5 gallons) 800086 (55 gallons)
	Power Cool® Universal 50/50 mix	X	X				X	X	9000 / 5	800071 (5 gallons) 800084 (55 gallons)
	Power Cool® Off-Highway Coolant 50/50 Premix		X	X			X		9000 / 5	23533531 (5 gallons) 23533532 (55 gallons)
A. Roth GmbH & Co KG	CRO Coolant Plus -25 °C Ready	X							9000 / 3	
Arteco NV	Halvoline XLC Pre-mixed 50/50 (1033073)	X						X	9000 / 3	
	Halvoline XLC Pre-mixed 40/60 (1033069)	X						X	9000 / 3	
	Halvoline XLC + B2 35/65 (OF13) (2000214)	X						X	9000 / 3	

Manufacturer	Brand name	Inhibitors							Operating time Hours/year	Comments/ Material number
		Organic	Silicon	Nitrite	Phosphate	Molybdate	Borates	2-EHS		
BASF SE	Glysantin G30 RM/50 ECO pink BMB 100	X							9000 / 3	
	Glysantin ® G40 RM/50 ECO pink BMB 100	X	X						9000 / 3	(50% by vol.)
BayWa AG	Tectrol Coolprotect Mix 3000	X							9000 / 3	Antifreeze protection down to -24 °C
Castrol	Castrol Radicool NF Premix (45 %)	X	X				X	X	9000 / 5	
CCI Corporation	L 415 (50 %)	X				X			9000 / 3	
Daimler Trucks North America	Alliance 50/50 Prediluted OAT Extended Life Coolant	X				X			9000 / 3	
Detroit Diesel Corp.	Power Cool Plus Prediluted Coolant (50/50)	X				X			9000 / 3	
	Power Cool Prediluted 50/50 Diesel Engine Coolant		X	X					9000 / 3	
ExxonMobil	Mobil Delvac Extended Life Prediluted Coolant (50/50)	X				X			9000 / 3	
	Mobile Heavy Duty 50/50 Prediluted Coolant		X	X					9000 / 3	
	Mobile Mining 50/50 Prediluted Coolant		X	X					9000 / 3	
Fast Chemical SRL	Fast Coolant G30 50%	X							9000 / 3	
Finke Mineralölwerk GmbH	AVIATICON Finkofreeze F48 RM 50/50	X	X				X	X	9000 / 5	
	AVIATICON Finkofreeze F30 RM 40:60 +	X							9000 / 3	
Friedrich Scharr KG	Unil Metis RTU GC-26	X							9000 / 3	
	Unil Metis RTU GC-38	X							9000 / 3	
Fuchs SE	Fricofin 50	X	X				X	X	9000 / 5	
	Fricofin LL 50	X						X	9000 / 3	
	Fricofin DP 50	X	X						9000 / 3	(50% by vol.)
Kuwait Petroleum Research & Technology BV	Q8 Antifreeze Long Life Premixed (50/50)	X						X	9000 / 3	
	Q8 Mahler Cool premixed 4060	X						X	9000 / 3	
	Q8 Mahler Cool premixed 5050	X						X	9000 / 3	
Moeve Commercial, S.A.U.	Xtar Super Coolant Hybrid NF 50%	X	X				X	X	9000 / 5	

Manufacturer	Brand name	Inhibitors							Operating time Hours/year	Comments/ Material number
		Organic	Silicon	Nitrite	Phosphate	Molybdate	Borates	2-EHS		
Moove Lubricants Limited	Mobil Coolant Extra Ready Mixed -36 °C	X	X				X	X	9000 / 5	
Motorex AG	Motorex Coolant G48	X	X				X	X	9000 / 5	
Navistar Inc.	Fleetrite 50/50 Prediluted Nitrite-Free Extended Life Coolant	X				X			9000 / 3	
Old World Industries Inc.	Blue Mountain Heavy Duty Extended Life Prediluted Coolant (50/50)	X				X			9000 / 3	
	Final Charge Global Extended Life Predilluted Coolant / Antifreeze (50/50)	X				X			9000 / 3	
	Fleet Charge SCA Precharged 50/50 Prediluted Coolant		X	X					9000 / 3	
Penske Power Systems	Power Cool - HB500 Premix 50/50	X	X				X		9000 / 3	
	Power Cool - HB500 35/65	X	X				X		9000 / 3	
	Power Cool - HB800 Premix 50/50	X	X	X			X		9000 / 3	
	Power Cool - HB800 35/65	X	X	X			X		9000 / 3	
Puma Energy International S.A.	Puma HD XLP Coolant	X						X	9000 / 3	50% Premix
	Puma HD Hybrid Coolant 5050	X	X						9000 / 3	(50% by vol.)
Raloy Lubricantes	Antifreeze Long Life NF-300 Ready-to-Use (50:50)	X	X				X	X	9000 / 5	
Recochem	HD Expert ™ Endurance 50-50 Prediluted	X				X			9000 / 3	
	R542 35/65	X	X				X		9000 / 3	
	Turbo Power R824 M 35/65	X	X	X			X		9000 / 3	
SMB Sotragal Mont-Blanc	Liquide de refroidissement -37 °C FRICOTECH MBT SMB AUTO	X	X						9000 / 3	(50% by vol.) Antifreeze protection down to -37 °C
Total Lubrifiants	Coolelf Auto Supra -26 °C	X						X	9000 / 3	40/60 Premix
	Coolelf Auto Supra -37 °C	X						X	9000 / 3	50/50 Premix
	Coolelf Supra (40 %)	X						X	9000 / 3	
	Coolelf Supra GF NP (50 %)	X						X	9000 / 3	

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Manufacturer	Brand name	Inhibitors							Operating time Hours/year	Comments/ Material number
		Organic	Silicon	Nitrite	Phosphate	Molybdate	Borates	2-EHS		
Valvoline	Zerex G05 50/50 Mix		X	X			X		9000 / 5	
	Zerex G48 premix 50%	X	X				X	X	9000 / 5	
	OEM Advanced 48 pre-mix 50%	X	X				X	X	9000 / 5	
Volvo Trucks	Road Choice 50/50 Pre-diluted Nitrite-Free OAT Extended Life Coolant	X				X			9000 / 3	
Wilhelm Hoyer B.V. & Co.KG	Hoyer Freeze A30 RM 40:60	X							9000 / 3	
	Hoyer Freeze A48 RM 50:50	X	X				X	X	9000 / 5	

Table 44:

6.5.3 Antifreeze – Ready mixtures based on propylene glycol for engine series not containing light metal

Important
Propylene glycol based coolants (→ Page 122) are approved for Series 4000 model types 01 to 05 used in generator set applications. Restrictions apply to the use of propylene glycol based coolants for various model types in all other Series 4000 applications. See (→ Page 99) For Series 4000C01 to C03 and 4000R01 to R03 only an application concentration of 40% is admissible. A 50/50 mixture must not be used.

Antifreeze, ready mixture

Manufacturer	Brand name	Inhibitors							Operating time Hours/year	Comments/ Material number
		Organic	Silicon	Nitrite	Phosphate	Molybdate	Borates	2-EHS		
Fleetguard	PG XL (40%) ready mixture		X	X	X	X	X		9000 / 3	
	ES Compleat PG Premix 50/50		X	X	X	X	X		9000 / 3	

Table 45:

7 Flushing and Cleaning Specifications for Engine Coolant Circuits

7.1 General information

Over time, sludge deposits from aging coolant additives can accumulate in the coolant circuits. Reduced cooling capacity, clogged vent lines and drain points and dirty coolant level sight glasses may be the result.

Inadequate water quality or incorrect preparation can also heavily contaminate the coolant circuit.

If such malfunctions occur, the coolant circuit must be flushed out with freshwater, repeatedly if necessary.

If these flushing processes are insufficient or if the coolant circuit is too heavily contaminated, the coolant circuit and all affected assemblies must be cleaned.

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

Only products approved by Rolls-Royce Solutions or equivalent products at the specified concentrations may be used for cleaning, see (→ Page 125). The specified cleaning procedure is mandatory.

Immediately after flushing or cleaning, fill the coolant circuits with prepared engine coolant as stipulated in the current Fluids and Lubricants Specifications. Otherwise, there is a danger of corrosion!

Important

Fluids and lubricants (e.g. treated engine coolant), used flushing water, cleaning agents and cleaning solutions can be hazardous substances. Certain regulations must be observed when handling, storing and disposing of these substances.
These regulations are contained in the manufacturer's instructions, statutory requirements and technical guidelines valid in the individual countries. Great differences can apply from country to country, and a generally valid statement on applicable regulations is therefore not possible within these flushing and cleaning specifications.
Users of products named in relevant specifications are therefore obliged to inform themselves of locally applicable regulations and ensure strict compliance. Rolls-Royce Solutions GmbH accepts no liability whatsoever for improper or illegal use of the fluids and lubricants/cleaning agents which it has approved.

Important

Oil heat exchangers from engines with bearing or piston seizures or friction damage must be scrapped!

Test equipment, auxiliary materials, and fluids and lubricants

Test kit or electrical pH meter

Important

Rolls-Royce Solutions recommends the test kit produced by CM Technologies GmbH (*www.cmtechnologies.de*).

Required auxiliary materials:
- Compressed air
- Superheated steam

Required fluids and lubricants:
- Freshwater
- Treated engine coolant

7.2 Freshwater requirements for cleaning solutions and flushing water

Important
Only clean, clear water with values in accordance with those in the following table must be used for preparing cleaning solutions. If the limit values for the water are exceeded, hardness or mineral content can be decreased by adding demineralized water. The cleaning agent concentrates used for the preparation of the cleaning solution must not contain more than 100 mg/l chloride and/or 100 mg/l sulfate.

Item	Minimum	Maximum
Total earth alkalines[1)] (water hardness)	0 mmol/l 0°d	2.7 mmol/l 15°d
pH value at 20 °C	5.5	8.0
Chloride ions		100 mg/l
Sulphate ions		100 mg/l
Total chloride + sulfate ions		200 mg/l
Bacteria		10^3 CFU (colony forming unit)/ml
Fungi, yeasts	Not permitted!	

Table 46: Values for freshwater

[1)] = Common designations for water hardness in various countries: 1 mmol/l = 5.6°d = 100 mg/kg $CaCO_3$

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

7.3 Approved cleaning agents/disinfecting agents

Approved cleaning agents

Manufacturer	Product category	Application concentration		Order number
For coolant circuits:				
Kluthe	Hakutex 111 [1)]	2% by volume	Liquid	X00065751
	Decorrdal 20-1 [2)]	10% by volume	Liquid	X00086731
	Hakupur 50-706-3 [3)]	2% by volume	Liquid	X00055629
For coolant circuit assemblies:				
Henkel	Bonderite C-AK FD [4)]	1 to 10% by weight	Powder	[5)]
	Bonderite C-MC 11120 [6)]	2 to 10% by weight	Powder	[5)]
Kluthe	Hakutex 60 mtu [7)]	100% by volume	Liquid	X00070585 (25 kg)

Table 47:

Approved disinfecting agents

Manufacturer	Product category	Application concentration		Order number
For a coolant circuit contaminated with bacteria, fungi or yeast:				
Thor	Acticide MV14 [8, 9)]	0.01% by volume	Liquid	X00079756 (20 l)
	Acticide MV [9, 10)]	0.1% by volume	Liquid	X00088729 (5 l)

Table 48:

[1)] = With slight corrosion (tested at Rolls-Royce Solutions)

[2)] = With serious corrosion, not certified for aluminum materials

[3)] = For oily and greasy residues. Not suitable for galvanized surfaces

[4)] = For lime deposits containing oil and grease

[5)] = Not stocked by Rolls-Royce Solutions.

[6)] =
For heavy lime deposits, preferred

[7)] = Solvent cold cleaner for oily and greasy residues

[8)] = Bacteria contamination ≥ 10^5, contamination with fungi and yeast not permitted
Note application cases (→ Page 130).

[9)] =
- Storage temperature 10-30 °C
- Protect against heat and solar radiation
- Minimum shelf life 18 months
- Use personal protective equipment (PPE)

For application in the field. The smaller canister is easier to handle.
Note application cases (→ Page 130).

[10)] = For application in the field. The smaller canister is easier to handle.
Note application cases (→ Page 130).

Important
The technical data sheets and safety data sheets of the product must be observed!

The cleaners are available worldwide through the subsidiaries of the manufacturers or their trading partners.

7.4 Engine coolant circuits – Flushing

1. Drain engine coolant.
2. Use test kit or electrical pH meter to measure pH value of freshwater.

   Important

   Rolls-Royce Solutions recommends the test kit produced by CM Technologies GmbH (*www.cmtechnologies.de*).

3. Fill coolant circuit with freshwater.

   Important

   Do not pour cold water into a hot engine!
   Refer to engine operating instructions for additional information

4. Preheat, start and run engine until warm.
5. Run engine for approx. 30 minutes at increased speed.
6. Stop engine.
7. Take flushing water sample at engine coolant sample extraction valve.
8. Drain flushing water.
9. Use test kit or electrical pH meter to measure pH value of flushing water sample and compare with pH value of freshwater.
10. If pH value difference is still too large even after flushing four to five times: Clean coolant circuit, see (→ Page 127) (→ Page 129)

7.5 Engine coolant circuits – Cleaning

1. Mix cleaner to the specified concentration with freshwater. Always use warm freshwater (45 °C) if the engine is warm.
2. Cleaning agents for coolant circuits are prepared in warm freshwater as a concentrated solution, see (→ Page 125).
3. In the case of powdered products, stir until the cleaning agent is completely dissolved and without sediment.
4. Pour pre-solution together with freshwater into the coolant circuit.
5. Start engine and run until warm.
6. Select temperature and duration of reaction time according to the specifications in the technical data sheets of the manufacturer.
7. Stop engine.
8. Drain off cleaning agents and flush engine coolant circuit with freshwater.
9. Take flushing water sample at engine coolant sample extraction valve.
10. Use test kit or electrical pH meter to measure pH value of flushing water sample and compare with pH value of freshwater.

Important

Rolls-Royce Solutions recommends the test kit produced by CM Technologies GmbH (*www.cmtechnologies.de*).
Refer to engine operating instructions for additional information

7.6 Removal of heavy corrosion in coolant circuits using Decorrdal 20-1

1. Drain all coolant from engine coolant circuit.
2. Fill engine coolant circuit with fresh water and flush the cooling system.
3. Drain flush water completely.
4. Fill coolant circuit completely with a water solution containing 10% Decorrdal 20-1.
5. Start engine and run to operating temperature, 20 minutes.
6. Perform cleaning cycle with the engine running, with circulating Decorrdal 20-1, duration: 4 hours.
7. Vent the coolant circuit several times while running the cleaning cycle to ensure complete filling.
8. Allow the engine to cool down to approx. 45 °C.
9. When the temperature reaches 45 °C, drain Decorrdal 20-1.
10. First flushing cycle: Fill the coolant circuit with 10% Glysacorr P113 solution in water immediately after draining the cleaning solution.
11. Operate the engine for 30 minutes, vent the coolant circuit several times.
12. Allow the engine to cool down to 45 °C.
13. Drain the Glysacorr P113 flushing solution completely.
14. Second flushing cycle: Fill coolant circuit again with a fresh water solution containing 10% Glysacorr P113.
15. Operate the engine for 30 minutes, vent the coolant circuit several times.
16. Allow the engine to cool down to 35 °C.
17. Drain the Glysacorr P113 flushing solution completely.
18. Fill engine with coolant.
19. Rust removal is complete.
20. Put engine into operation.

Important

The engine coolant circuit must always be vented properly to ensure complete filling. This applies when filling the engine with water, cleaning agent, corrosion inhibitor and coolant as well as in engine operation with one of the mentioned media.
In zones where air is present, neither rust removal nor preservation take place, and corrosion occurs again.
All crankcase openings, hose connection openings, etc. must be closed immediately if no longer required. There is a risk of corrosion in the area of the openings.

7.7 Cleaning engine coolant circuit assemblies

1. Remove, disassemble and clean assemblies in the engine coolant circuit that are exposed to heavy sludge deposits e.g. expansion tanks, preheating units, heat exchangers (coolant cooler, oil heat-exchanger, charge-air cooler, charge-air preheater, fuel preheater etc.) and lower sections of pipework.
2. Before cleaning, examine degree of contamination on water sides.
3. In case of lime deposits that contain oil and grease, degrease the water side first.
4. Deposits in charge-air coolers caused by oil mist can be removed using Kluthe Hakutex 60.
5. Remove hard lime deposits with a decalcifying product. In the event of stubborn lime deposits, if necessary a 10% inhibited hydrochloric acid solution may have to be used.
6. Dissolve deposits on and in heat-exchanger elements in a heated cleaning bath. Observe the manufacturer's specifications and use only approved detergents in the permissible concentration, see (→ Page 125)

Important

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

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

Important

In order to avoid damage:
Do not use hard or sharp-edged tools (steel brushes, scrapers, etc.) (oxide protective layer).
The pressure of the water jet must not be ≤ 60 bar (to avoid damage, e.g. of the cooler fins).

8. After cleaning, blow through the heat exchanger elements with low-pressure steam in the direction opposite to operational flow, rinse with clear water (until pH-value difference is < 1) and blow dry with compressed or hot air.
9. Check that all components are in perfect condition, repair or replace as necessary.
10. Flush oil and engine coolant sides of heat-exchanger elements with corrosion-inhibiting oil. This step may be omitted if the heat exchanger is installed and taken into service immediately after cleaning.
11. After installing all assemblies, flush engine coolant circuit once, see (→ Page 126).
12. Check coolant system for leaks during initial operation of engine.

Important

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

7.8 Coolant circuits contaminated with bacteria, fungi or yeast

Disinfection and prevention

Microbiologically contaminated systems:

The disinfecting agent is added to the contaminated coolant.

The prerequisite for effective disinfection of the engine coolant system is that the disinfecting agent has a sufficiently long reaction time and can reach all areas of the cooling system. All external storage tanks and pipes must also be reached by the disinfecting agent.

Important

When using Acticide MV 14 (→ Page 125), the engine coolant does not need to be changed. Flushing/refilling only takes place after express recommendation by the chemical laboratory.

Dwell time:	Not less than 12 hours
Temperature:	Maximum temperature 55 °C (higher temperatures destroy the disinfecting agent)

Prevention:

If an engine is to be shut down for a long period, disinfecting agent can be added as a preventive measure. Before the engine is put back into operation, always ensure that the coolant is still in good condition. During return to operation, the coolant containing disinfecting agent can remain in the system and be reused.

The dosing (→ Page 125) and work safety specifications must be strictly observed.

Flushing

When the coolant is drained, the coolant circuit must be flushed with freshwater. The coolant circuit must be flushed as long as visible contamination can be detected, and the flushing water has the same pH value as the freshwater used (maximum deviation of pH value < 1).

Refilling

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

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

8 Cleaning the Product Externally

8.1 General

If, over the course of time, contaminants such as oil deposits and leaves have accumulated on the engine, it may be necessary to clean it. Clean the engine only superficially and with great care.

Wash-cleaning the engine can – at the worst – have the opposite effect if carried out incorrectly.

To prevent damage, observe the following before starting work and applying cleaning agents:
- Protect electrical components (battery-charging generator, plug connections, ignition cables, etc.) and the intake area from undesirable water ingress into plug connections or the combustion chamber.

Only clean freshwater (no river water or sea water) must be used for spray-washing.

Check all plug connections and, if necessary, blow out with compressed air after cleaning to avoid misfiring and other electrical issues.

Only products approved by Rolls-Royce Solutions at the specified concentrations can be used for cleaning. The specified cleaning procedure is mandatory.

Important

Cleaning must be carried out with pressure washers at an operating pressure of ≤ 60 bar to avoid damaging the cooler and the engine. High-pressure cleaners with an operating pressure > 60 bar are not permitted.
After washing, the equipment must be thoroughly flushed with freshwater. The specifications in the chapter "Fresh water requirements for cleaning solutions and flushing water" (→ Page 124) are also applicable here.
The technical data sheets and safety data sheets of the product must be observed!
Fluids and lubricants (e.g. treated engine coolant), used flushing water, cleaning agents and cleaning solutions can be hazardous substances. Certain regulations must be obeyed when handling, storing and disposing of these substances.
These regulations are contained in the manufacturer's instructions, statutory requirements and technical guidelines valid in the individual countries. Great differences can apply from country to country, and a generally valid statement on applicable regulations is therefore not possible within these flushing and cleaning specifications.
Users of the products named in these specifications must therefore undertake to inform themselves of the locally valid regulations. Rolls-Royce Solutions accepts no liability for improper or illegal use of the fluids and lubricants or cleaning agents which it has approved.

Test equipment, auxiliary materials, and fluids and lubricants

Important

Rolls-Royce Solutions recommends the test kit produced by CM Technologies GmbH (*www.cmtechnologies.de*).

Test kit or electrical pH meter
- Freshwater
- Superheated steam
- Compressed air

8.2 Approved cleaning agents

Manufacturer	Product name	Working concentration		Order no.
For remote cooler on air side:				
Kluthe GmbH	Hakupur 50-136 [1)]	2% by volume	Liquid	X00056700
For cleaning painted, contaminated surfaces externally:				
Kluthe GmbH	Hakupur 449 [3)]	1% by volume	Liquid	X00071179[2)]

Table 49: Approved cleaning agents

[1)] Cleaning agent for cleaning with pressure cleaner (Parameters: Pressure: ≤ 60 bar, gentle spray jet, distance from nozzle to object at least 25 cm, cleaning agent temperature: 80 °C).

[2)] Not stocked by Rolls-Royce Solutions GmbH.

[3)] The cleaner is unsuitable for components made of aluminum materials (e.g. Al coolers) and must not be used.

Important
The technical data sheets and safety data sheets of the product must be observed!

The cleaning agents are available world-wide through the branches of the manufacturers or their trading partners.

9 Revision Overview

9.1 Revision overview

Revision overview

This overview shows the revisions in the latest version.

Chapter	Description of revision	
General information	Description updated	(→ Page 5)
Engine oils – General information	Description updated	(→ Page 7)
mtu Advanced Fluid Management System for engine oils – Test package for North America	Description updated	(→ Page 16)
Coolants – General information	Description updated	(→ Page 17)
mtu Advanced Fluid Management System for coolant – Test package for North America	Description updated	(→ Page 26)
Diesel fuels – General information	Description updated	(→ Page 37)
Distillate fuels according to EN 590 and ASTM D975	Description updated	(→ Page 43)
British Standard	Description updated	(→ Page 44)
Chinese distillate fuels according to GB 19147-2016, GB 252-2015 and GB 17411-2016	Description updated	(→ Page 45)
Heating oil	Description updated	(→ Page 46)
Fossil & paraffinic marine distillate fuels	Added	(→ Page 47)
FAME-containing marine distillate fuels	Added	(→ Page 48)
Aviation turbine fuels	Description updated	(→ Page 49)
NATO diesel fuels	Description updated	(→ Page 50)
Paraffinic diesel fuel in accordance with EN 15940	Description updated	(→ Page 52)
Biodiesel and biodiesel mixtures	Description updated	(→ Page 56)
Fuel additives	Description updated	(→ Page 63)
mtu Advanced Fluid Management System for fuels – Test package for North America	Description updated	(→ Page 68)
Single-grade oils – Category 1, SAE grades 30 and 40 for diesel engines	Description updated	(→ Page 70)
Multi-grade oils – Category 1, SAE grade 15W-40 for diesel engines	Description updated	(→ Page 71)
Single-grade oils – Category 2, SAE grades 30 and 40 for diesel engines	Description updated	(→ Page 72)

Chapter	Description of revision	
Multi-grade oils – Category 2, SAE grades 10W-30, 10W-40, 15W-40 and 20W-40 for diesel engines	Description updated	(→ Page 75)
Multi-grade oils – Category 2.1 (Low SAPS oils), SAE grades 5W-30, 10W-30, 0W-40, 5W-40 10W-40 and 15W-40 for diesel engines	Description updated	(→ Page 82)
Multigrade oils – Category 3 of SAE grades 5W-30, 5W-40 and 10W-40 for diesel engines	Description updated	(→ Page 88)
Multi-grade oils – Category 3.1 (low SAPS oils), SAE grades 5W-30, 10W-30 and 10W-40 for diesel engines	Description updated	(→ Page 91)
Lubricating greases for diesel generator set components	Description updated	(→ Page 98)
Series-dependent usability of coolant additives	Description updated	(→ Page 99)
Coolant without antifreeze – Ready mixtures for cooling systems free of light metal	Description updated	(→ Page 105)
Antifreeze – Concentrates for cooling systems containing light metal	Description updated	(→ Page 106)
Antifreeze – Ready mixtures for cooling systems containing light metal	Description updated	(→ Page 109)
Antifreeze – Approved coolants for Series 2000Gx6 generator sets with intercooler option (TB)	Description updated	(→ Page 112)
Antifreeze – Concentrates for cooling systems free of light metal	Description updated	(→ Page 115)
Antifreeze – Ready mixtures for cooling systems free of light metal	Description updated	(→ Page 118)
General information	Description updated	(→ Page 123)
Approved cleaning agents/disinfecting agents	Description updated	(→ Page 125)

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