



Fluids and Lubricants Specifications

Fluids and Lubricants Specifications for Series 1600 PowerPack

A001065/04E



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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.

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, work and activities that have to be observed to prevent damage or destruction to the material.

Note:

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

Fluids and lubricants

The useful life, operational reliability and function of the drive units are largely dependent on the fluids and lubricants employed. The correct selection and treatment of these fluids and lubricants are therefore extremely important. This publication specifies which fluids and lubricants are to be used.

mtu ValueCare portfolio

Rolls-Royce Solutions offers approved oils and coolants tailored to meet engine requirements under the mtu ValueCare agreement.

Test standards for fluids and lubricants

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

Table 1:

Monitoring of fluids and lubricants

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

<http://www.mtu-solutions.com>

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

Applicability of this publication

The Fluids and Lubricants Specifications will be amended or supplemented as necessary. Prior to use, ensure that the most recent version is available. The most recent version can be called up under:

<http://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 drive units may be hazardous materials. Certain regulations must be obeyed when handling, storing and disposing of these substances.

These regulations are contained in the manufacturers' instructions, such as product-specific safety data sheets, statutory regulations and technical guidelines valid in the individual countries. Great differences can apply from country to country and a generally valid guide to applicable regulations for fluids and lubricants is therefore not possible within this publication.

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

Preservation

All information on preservation, represervation and depreservation including the approved preservatives is available in the Preservation and Represervation Specifications (publication number A001070/...). The most recent version can be called up under:

<http://www.mtu-solutions.com>

2 Lubricants

2.1 Engine Oils

2.1.1 Requirements and oil change intervals

Important

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

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

The conditions for the approval of engine oils for diesel engines are specified in the delivery standard MTL 5044, which can be ordered under this reference number.

Manufacturers of engine oils are notified in writing if their product is approved.

Diesel engine oils approved for Series 1600 PowerPack® engines are divided into the following Rolls-Royce Solutions quality categories:

- Oil category 2.1: Multi-grade oils with a low ash-forming additive content (low SAPS 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 phosphor content and an ash-forming additive content of $\leq 1\%$. They are only approved if the sulfur content in the fuel does not exceed 50 mg/kg. The use of low-ash oils is prescribed depending on the exhaust gas aftertreatment used (→ Page 35).

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

Important

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

Important

Mixing different engine oils is strictly prohibited!
Changing to another approved oil grade can be done together with an oil change. The remaining oil quantity in the engine oil system is not critical in this regard.
This procedure also applies to the genuine Rolls-Royce Solutions engine oil grades in the regions Europe, Middle East, Africa, America and Asia.

Special features - Rolls-Royce Solutions diesel engine oils

The following multi-grade oils are available depending on the relevant region.

Multi-grade oils from Rolls-Royce Solutions

Manufacturer & sales region	Product name	SAE grade	Oil category	Material number
Rolls-Royce Solutions America Inc. Americas	Power Guard® SAE 15W-40 Off Highway Heavy Duty	15W-40	2.1	5 gallons: 800133 55 gallons: 800134 IBC: 800135

Table 2:

Oil change interval

Important

The oil change interval is 1,000 operating hours or max. 1 year under the condition that engine oils of oil category 3.1 (→ Page 39) and approved fuels (→ Page 24) are used.

The oil change interval is 500 operating hours or max. 1 year under the condition that engine oils of oil category 2.1 (→ Page 35) and approved fuels are used (→ Page 24)

If fuels which have not been approved are used, shorter oil change intervals are to be expected.

Prior to using non-approved fuels, contact Rolls-Royce Solutions to determine the applicable oil change intervals.

Important

When changing to an engine oil in oil category 3.1, note that the improved cleaning effect of these engine oils can result in the loosening of engine contaminants (e.g. carbon deposits).

It may be necessary therefore to reduce the oil change interval and oil filter service life (one time during change).

Used-oil analysis

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

The specified test methods and limit values (Analytical Limit Values for Used Diesel Engine Oils) (→ Table 3) indicate when the results of an individual oil sample analysis are to be regarded as abnormal.

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

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

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

Some of the signs of oil deterioration are:

- Abnormally heavy deposits or precipitates in the engine or engine-mounted parts such as oil filters, centrifugal 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. mm ² /s	ASTM D445 DIN 51562 DIN 51569-1	SAE 5W-30	15.0
		SAE 10W-30	
min. mm ² /s		SAE 5W-40	19.0
		SAE 10W-40	
		SAE 15W-40	
		SAE 20W-40	
		SAE 5W-30	9.0
		SAE 10W-30	
		SAE 5W-40	10.5
		SAE 10W-40	
		SAE 15W-40	
		SAE 20W-40	
Flashpoint °C (COC)	ASTM D92 DIN EN ISO 2592	Min. 190	

	Test method	Limit values
Flashpoint °C (PM)	ASTM D93 DIN EN ISO 2719	Min. 140
Soot content (by weight %)	DIN 51452 CEC-L-82-97	Max. 3.5
Total base number (mg KOH/g)	ASTM D2896 ISO 3771 DIN 51639	Min. 50% of new-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	Max. difference between new-oil value and used-oil value 100
Additive element contents	DIN 51399-1 DIN 51399-2 ASTM D5158	To confirm that the new oil is identical with the oil grade of the used oils

Table 3:

¹⁾ = only possible if there are no ester compounds

Spectrometric oil analysis

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

Analyses of the wear-metal content to determine the degree of engine wear are not part of the Rolls-Royce Solutions standard procedure. These content levels are very much dependent on the following factors, among others:

- Individual engine equipment status
- Tolerance scatter
- Operating conditions
- Duty profile
- Fluids and lubricants
- Miscellaneous assembly materials

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

2.1.2 Viscosity grades

Selection of the viscosity grade is based primarily on the ambient temperature at which the engine is to be started and operated. Figure (→ Figure 1) contains guideline values for the temperature limits of the individual viscosity grades.

The temperature specifications of the SAE grade are always based on fresh oils. During operation, engine oil ages due to soot and fuel residue. This results in significant deterioration of the properties of the engine oil particularly at low outside temperatures. At outside temperatures below $-20\text{ }^{\circ}\text{C}$, Rolls-Royce Solutions strongly recommends the use of engine oil of SAE grade 5W-30 or - if approved - 0W-30.

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

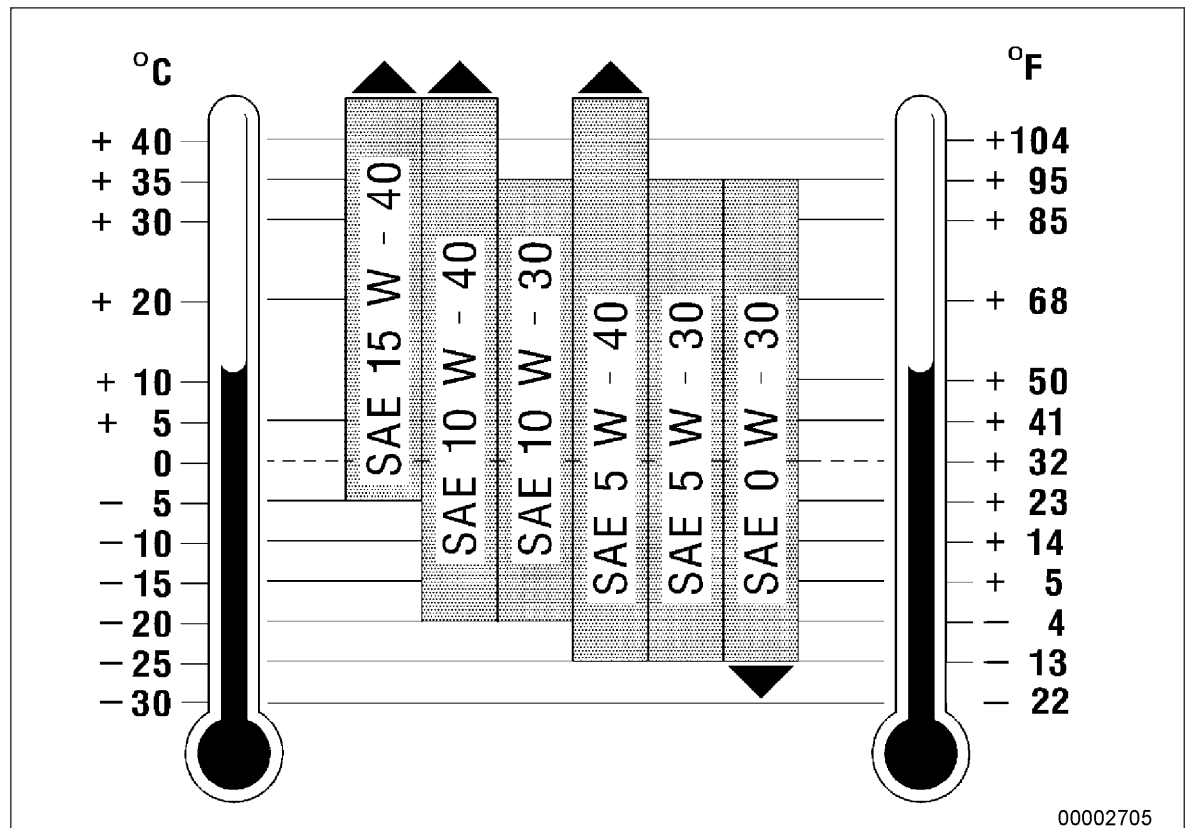


Figure 1: Viscosity grades

2.2 Lubricating Greases

2.2.1 Lubricating greases

Lubricating greases for TSA traction generators

Extract from TSA documentation operating and assembly instructions

TSA publications are updated from time to time. Before using them, make sure you have the latest version. Please contact your Rolls-Royce Solutions representative to clarify.

Important

Mixtures of different lubricating greases are not permitted!

Lubricating grease change intervals based on operating hours/years

Operating hours	Years
2000	1 (12 months)

Table 4:

3 Transmission Oils

3.1 Transmission oils for rail vehicles with ZF transmissions

(Excerpt from the ZF List of Lubricants TE-ML16, Edition 01.01.2022)

The ZF Lists of Lubricants are updated every three months on 01.01., 01.04., 01.07. and 01.10.. Before using them, make sure you have the latest version. The latest version is also available at:

<https://aftermarket.zf.com/de/de/aftermarket-portal/technische-informationen/schmierstoffe-TE-ML-16/>

Assignment of lubricant classes to product groups

Product groups automatic transmissions for rail vehicles	Lubricant classes for service fills ⁽¹⁾ transmissions with/out/with ZF-Intarder
ASRail • 12 AS 2303, 12 AS 2703, 12 AS 3103, 16 AS2603	16K / 16P
EcoLife • 6AP2000R, 6AP2500R	16N / 16Q / 16S

Table 5:

⁽¹⁾ = Approved commercial products (→ Page 45), oil change intervals and low temperature limits (listed below).

Important

Follow the instructions for greasing points in the manual.

Important

Additives of any kind added later to the oil change the oil in a manner that is unpredictable, and they are therefore not permitted. ZF accepts no liability whatsoever for any damage resulting from the use of such additives.

Oil and filter change intervals for EcoLife transmissions for rail vehicles:

Lubricant classes ⁽¹⁾	Oil and filter change interval [km / years] ^(2,3)
16S	120,000 km / every 2 years
16N / 16Q	180,000 km / every 3 years

Table 6:

⁽¹⁾ = Pay attention to approved trade products and lubricant classes.

⁽²⁾ = Oil change required, depending on what occurs first.

⁽³⁾ = After consultation with the product support department of ZF Friedrichshafen AG, Special Drive Technology, and after an oil analysis has been made (after agreed mileages), longer oil change intervals can be applied to some reference transmissions. The procedure for taking oil samples is described in the respective Service Information.

Application areas of lubricants

The following illustration (→ Figure 2) shows application areas of the various SAE classes in relation to the ambient temperatures to be expected.

The transmission oils have a bottom limit of max. dynamic viscosity (Brookfield) of 150,000 mPas, which roughly corresponds to the viscosity limit at low temperatures.

The upper limit is determined by the load in the transmission and the appearing temperature level during operation. It can be assumed that high ambient temperatures will also result in higher oil sump temperatures. For detailed information on the low temperature behavior of the specific product see at the safety data sheet of the supplier.

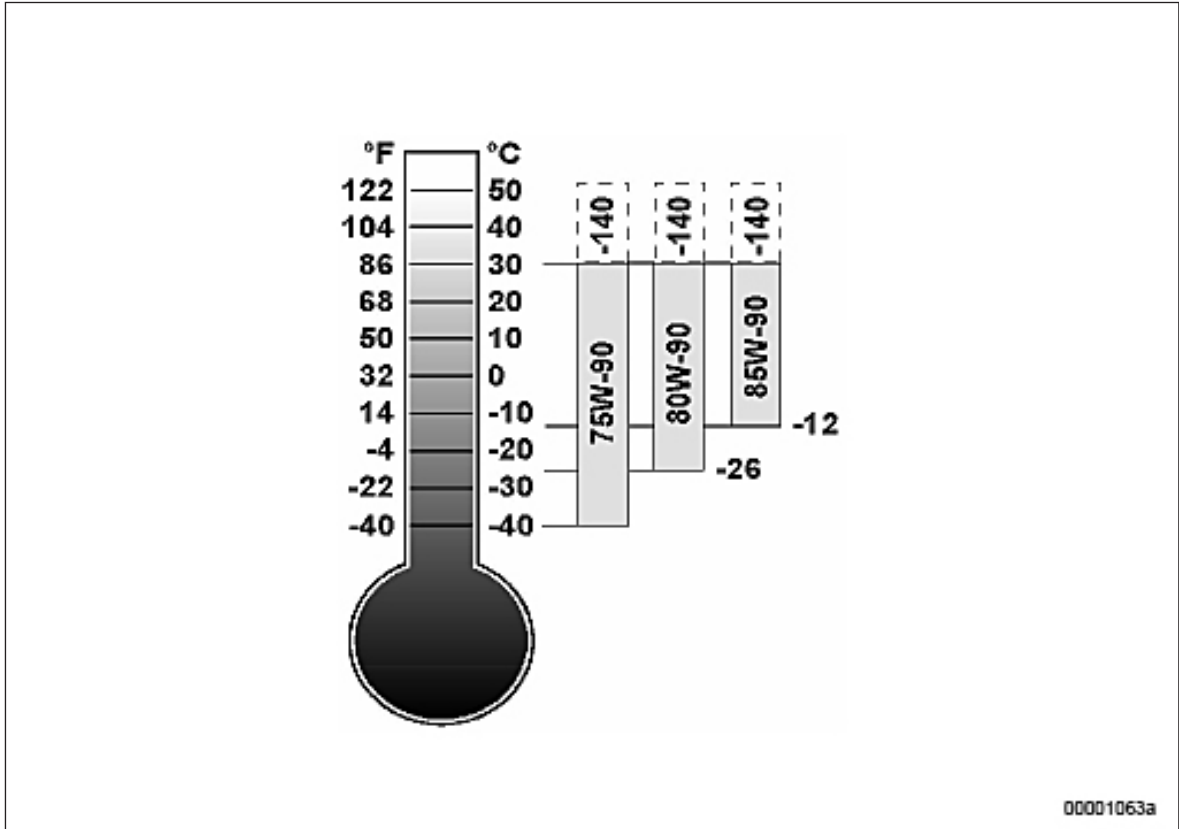


Figure 2: Range of use for hydraulic oil

The user must observe the low temperature limits!

Lubricant classes	Viscosity grades	Use at oil sump temperature as over
16B / 16F / 16G / 16K / 16M / 16N / 16P / 16Q / 16S	75W-80 / 75W-85 / 75W-90 / 75W-110 / 75W-140 / ATF	- 40 °C

Table 7:

3.2 Power transmission oils for Voith turbo transmissions T211 + KB 190

Excerpt from Voith documentation of power transmission oils for Voith turbo transmissions

Voith publications are continuously updated. Before using them, make sure you have the latest version. The latest version is also available at:

<https://voith.com/corp-en/services/power-transmission/download.html?id=2255>

Oil and filter change intervals for Voith turbo transmissions T 211 re4 + KB190

Oil and filter change interval based on running hours ⁽¹⁾	Oil and filter change intervals based on mileage (km)
5,000	300,000

Table 8:

⁽¹⁾ = Running hours are accumulated operating hours at speeds of more than 1 km/h.

Use at low temperatures

The approved transmission oils allow cold starts at temperatures down to -20 °C.

Special measures must be taken if temperatures are lower.

Oil filtration

Ensure oil filtration to purity class 15/11 as per ISO 4406 when filling the transmission with oil. For appropriate filter units please contact Voith Turbo.

The maximum quantity of foreign particles in 100 ml oil for this purity class is:

- 130,000 with particle size > 4 µm (c) (purity class 17)
- 32,000 with particle size > 6 µm (c) (purity class 15)
- 2,000 with particle size > 14 µm (c) (purity class 11)

Approved power transmission oils (→ Page 46).

3.3 Lube oils for Stiebel transfer gearbox type 4685.02

Important

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

Extract from Stiebel documentation (operating instructions for pump drive / transfer gearboxes)

Stiebel publications are updated from time to time. Before using them, make sure you have the latest version. The latest version is also available at:

<https://www.stiebel.de/leistungen/downloads/betriebsanleitungen.html>

Lubricant type:

- Synthetic oil CLP HC DIN 51517-3

Nominal kinematic viscosity 40 °C:

- 150 mm²/s

Ambient temperature:

- -40 to +80 °C

Oil change intervals for transfer gearbox type 4685.02

Operating hours	Years
First oil change after 200 h	
Then every 4000 h	1 year (12 months)

Table 9:

Important

Mixing different lubricants is strictly prohibited!

Approved lubricants for pump drive / transfer gearboxes are listed in chapter 7 (→ Page 46).

4 Hydraulic Oils

4.1 Hydraulic system

Hydraulic system

Important

The oil change interval for the hydraulic system is 4000 operating hours / max. 2 years!

Analytical limit values

	Test method	Limit values	
Water content (mg/kg)	ASTM D6304 EN 12937 ISO 6296	< 1000	
Purity class	ISO 4406	19/17/14	

Table 10:

Approved engine oils for the hydraulic system (→ Page 35) and (→ Page 39).

Important

Mixing different hydraulic oils is strictly prohibited!

5 Coolants

5.1 General information

Definition of coolant

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

Ready mixtures are coolants ready for direct use in the engine. They must not be diluted with freshwater.

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

All approved coolants for the Series 1600 PowerPack® may be used in locomotive and underfloor applications.

Important
Prepare the coolant outside the PowerPack® engine!
Mixing of different coolant additives and supplementary additives is prohibited!

Important
Flush with freshwater before changing from an antifreeze product containing silicon (ready mixture or concentrate) to a silicon-free product! The same applies when changing from a silicon-free product to a product containing silicon.

The quantity of coolant remaining in the PowerPack® coolant circuit during a coolant change is not critical.

The approval conditions for coolant additives are defined in the delivery standard MTL 5048 / antifreezes.

Coolant manufacturers are informed in writing if their product has been approved.

Permissible working concentrations of engine coolants

Working concentration	Coolant additive	Freshwater	Antifreeze ¹⁾ down to approx.
Minimum	40% by volume	60% by volume	-25 °C
	45% by volume	55% by volume	-31 °C
	50% by volume	50% by volume	-37 °C
Maximum	55% by volume	45% by volume	-45 °C

Table 11:

¹⁾ = Antifreeze specifications determined as per ASTM D 1177

The working concentration of a coolant shall be specified by stating the percentage of coolant additive (concentrate) first.

Example:

Coolant concentration 40% by volume = 40% by volume coolant additive + 60% by volume Freshwater

The coolant concentration for any given application depends primarily on the degree of antifreeze protection required.

Calculating antifreeze quantities when refilling

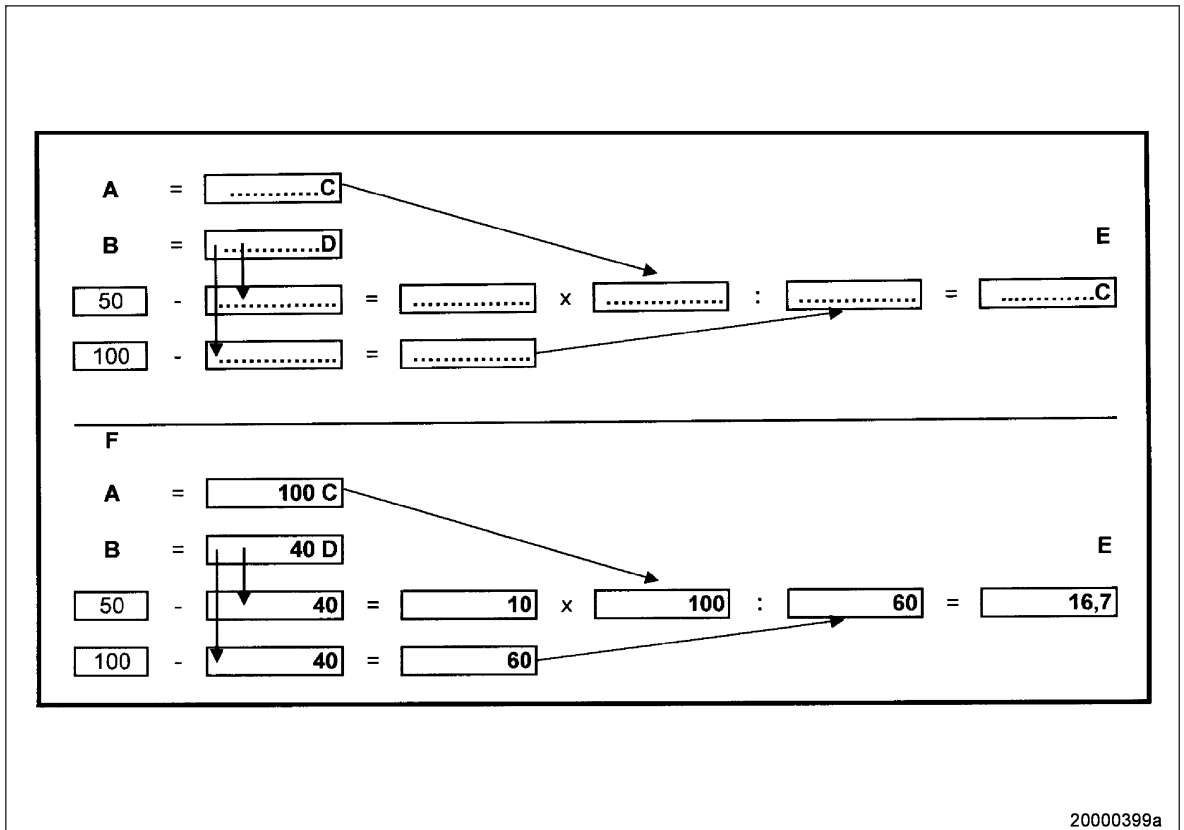


Figure 3: Typical calculation for coolant refill

A Coolant capacity (total)

C liter

E Antifreeze refill quantity

B Measured concentration

D Percent by volume

(this quantity must be drained off if the coolant level is within the specifications!)

F Calculation example

Engine coolant or coolant additives

The following engine coolants/coolant additives are available in the framework of mtu ValueCare.

Manufacturer & sales region	Product name	Type
Rolls-Royce Solutions GmbH Rolls-Royce Solutions Asia Pte. Ltd. Europe Middle East Africa	Coolant AH 100 Antifreeze Concentrate	X00057231 (20 l) X00057230 (210 l)
	Coolant AH 50/50 Antifreeze Premix	X00070528 (20 l) X00070527 (1000 l)
	Coolant AH 40/60 Antifreeze Premix	X00070533 (20 l) X00070532 (1000 l) (Sales region: England)
Rolls-Royce Solutions America Inc. Americas	Power Cool® Universal 50/50 mix	800069 (1 gallon) 800071 (5 gallons) 800084 (55 gallons)

Table 12:

Avoiding damage in the coolant system

- For initial filling, an antifreeze concentration of 50% by volume must be ensured.
- For topping up coolant (after a coolant loss) or when the antifreeze concentration falls below 40% by volume, a concentration of 50% by volume must be established in the cooling system.
- An antifreeze concentration lower than 40% by volume is inadmissible to avoid compromising corrosion protection.
- Never exceed an antifreeze concentration of 55% by volume. Use antifreeze. Concentrations in excess of this reduce antifreeze protection and heat dissipation.
- The coolant must not contain any oil or copper residue (in solid or dissolved form).
- The corrosion-inhibiting effect of coolant is only ensured with the coolant circuit fully filled. Otherwise, only the antifreeze approved for internal preservation of the coolant circuit provides proper corrosion protection when the medium was drained. This means that after draining the coolant the cooling circuit must be preserved if no more coolant is to be filled. For the preservation procedure, refer to the Preservation and Represervation Specifications A001070/.. of the engine.
- A coolant circuit can usually not be drained completely, i.e. residual quantities of used coolant or freshwater from a flushing procedure 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 add-on components there are on the engine. Check the coolant concentration in the coolant circuit and adapt it if necessary.

Important

For corrosion-related reasons, it is not permissible to operate an engine with pure water without the addition of an approved corrosion inhibitor!

5.2 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
- 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 sulfate. 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. Use coolants with purely organic inhibitors if copper alloys are involved. The coolant used must therefore only be marked with a cross in the "Organic" column in chapter 8.3 (→ Page 48)

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.

5.3 Requirements imposed on freshwater

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

Freshwater requirements for coolant treatment

	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
Sulfate ions		100 mg/l
Bacteria		10 ³ CFU (colony forming unit)/ml
Fungi, yeasts	are not permitted!	

Table 13:

*) Common designations for water hardness in various countries:

1 mmol/l = 5.6°d = 100 mg/kg CaCO₃

- 1°d = 17.9 mg/kg CaCO₃, USA hardness
- 1°d = 1.79° French hardness
- 1°d = 1.25° English hardness

5.4 Operational checks

Inspection of the freshwater and continuous monitoring of the coolant are essential for trouble-free engine operation. Freshwater and coolant should be checked at least once per year and with each fill-up. Inspections can be carried out using the mtu test kit, or by an authorized laboratory. The mtu test kit contains the necessary equipment, chemicals and instructions for use.

Minimum requirements and methodology for coolant monitoring

Analysis	Method for on-site checks (mtu test kit)	Method for lab analysis
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 for an appropriate 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 antifreeze concentration	Glycol refractometer, concentration in % by volume can be read off directly	Refractometer method DIN 5 1423, calculation through refraction index or product-specific factor

Table 14:

Orders for freshwater and coolant analysis may be placed with Rolls-Royce Solutions. In particular cases, operational monitoring can cover more checks than those listed in table (→ Table 14). Please contact your Rolls-Royce Solutions partner if necessary.

Coolant requirements

Value	Minimum	Maximum
pH value with antifreeze	7.5	9.0
Silicon (valid for coolants containing Si)	25 mg/l	

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.

5.5 Storage capability of coolant concentrates

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

Storage capability

Coolant concentrate	Limit value	Brand name / Remarks
Antifreeze	Approx. 3 years	Observe manufacturer's specifications

Table 16:

Important
For reasons of corrosion protection, do not store in galvanized containers. Take this requirement into account when coolant must be transferred. Store containers in hermetically sealed condition in a cool and dry place. Ensure proper antifreeze protection during the cold season. Further information can be obtained from the product and safety data sheets for the individual coolants.

5.6 Color additives to detect leakage in the coolant circuit

The fluorescent dye listed below is approved as an additive for coolant without antifreeze and antifreeze to detect leakages.

¹⁾ = Based on original and hermetically sealed containers in frost-free storage (> 5 °C)

Approved color additives

Manufacturer	Product name	Material no.	Container size	Storage stability ¹⁾
Chromatech Inc. Chromatech Europe B.V.	D11014 Chromatint Uranine Conc	X00066947	20 kg	2 years

Table 17:

Application:

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

This is a generous amount of dye which is not to be exceeded.

Fluorescence (yellow hue) is clearly visible in daylight. UV light with a wavelength of 365 nm can be used in darker rooms.

6 Liquid Fuels

6.1 Diesel fuels – General information

Important

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

Selecting a suitable diesel fuel

The quality of the fuel has an influence on the engine power, engine lifetime and exhaust gas emissions.

Important

Diesel fuels are not available worldwide in the quality required.
The fuel properties depend on many factors, in particular, region, time of year and storage.

Important

The use of non-approved fuels can result in

- significant deviations in engine performance and serious engine damage.
- failure to comply with statutory exhaust gas emissions.
- shorter oil change intervals.

Consult Rolls-Royce Solutions before using non-approved fuels and to agree the oil change intervals!

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/..).

Fuel specifications to be complied with

		Test method		Limit values
		ASTM		
Composition				The diesel fuel must be free of inorganic acids, visible water, solid foreign matter and chlorous compounds
Total contamination (= elements insoluble in fuel)	max.	D6217	EN 12662	24 mg/kg
Density at 15 °C	min.	D1298	EN ISO 3675	0.820 g/ml
	max.	D4052	EN ISO 12185	0.860 g/ml
API gravity at 60 °F	min.	D287		41
	max.			33
Viscosity at 40 °C	min.	D445	EN ISO 3104	1.5 mm ² /s
	max.			4.5 mm ² /s
Flashpoint (closed crucible)	min.	D93	EN ISO 2719	55 °C (60 °C for SOLAS) ¹⁾
Boiling curve:		D86	EN ISO 3405	
- Initial boiling point				160 to 220 °C
- Volume share at 250 °C	max.			65% by volume
Recovery at 350 °C	min.			85% by volume
- Residue and loss	max.			3% by volume

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		Test method		Limit values
		ASTM		
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: ²⁾ – Engines without exhaust gas aftertreatment or recirculation – Engines with exhaust gas aftertreatment or recirculation	max. max.	D482	EN ISO 6245	0.01% by weight (100 mg/kg) 0.001 % by weight (10 mg/kg)
Sulfur content: ²⁾ – Engines without exhaust gas aftertreatment or recirculation – Engines with exhaust gas aftertreatment or recirculation	max. max.	D5453, D2622	EN ISO 20846 EN ISO 20884	0.05% by weight (500 mg/kg) ²⁾ 0.0015% by weight (15 mg/kg)
Cetane number	min. max.	D613	EN ISO 5165, EN ISO 15195	45 78 ³⁾
Cetane index	min.	D976	EN ISO 4264	42
Copper corrosion 3 hrs. at 50 °C	Max. degree of corrosion	D130	EN ISO 2160	1 a
Oxidation stability (Rancimat)	min.		EN 15751	20 hours
Oxidation stability	max.	D2274	EN ISO 12205	25 g/m ³
Lubricity at 60 °C (HFRR value)	max.	D6079	EN ISO 12156-1	520 µm
Cold filter plugging point (CFPP)		D6371	DIN EN 116	See Note ⁴⁾
Cloud Point		D2500	DIN EN 23015	See Note ⁵⁾
Particle distribution for fuel between last tank before engine and prefilter (see Fig. 4 item 6)		D7619	Coding of number of particles as per ISO 4406	Common rail: max. ISO Code 18/17/14 for 4/6/14 µm particle size
Neutralization number	max.	D974		0.2 mgKOH/g
Total aromatics [(m/m)]	max.		EN 12916 SS 155116	37 ³⁾

Table 18:

¹⁾ For marine applications, a min. flashpoint of 60 °C (SOLAS = Safety of life at sea) applies.

²⁾ Note: 1 by weight % = 10000 mg/kg = 10000 ppm

³⁾ Limit value only applicable to 12V1600 Rx1 EUV

⁴⁾ Filter plugging point or Cold Filter Plugging Point (CFPP) denotes the temperature at which a test filter is blocked under defined conditions by precipitated paraffins. This characteristic is used for diesel fuels as per DIN EN 590 to describe the climatic requirements (e.g. summer and winter diesel).

⁵⁾ The cloud point is the temperature at which a liquid product becomes turbid in the test glass due to precipitation of paraffin. This must not be higher than the ambient temperature.

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 at the interface marked in Fig. 4 item 6, at the latest.

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, a sample extraction point in the last tank before the scope of supply of Rolls-Royce Solutions is permissible.

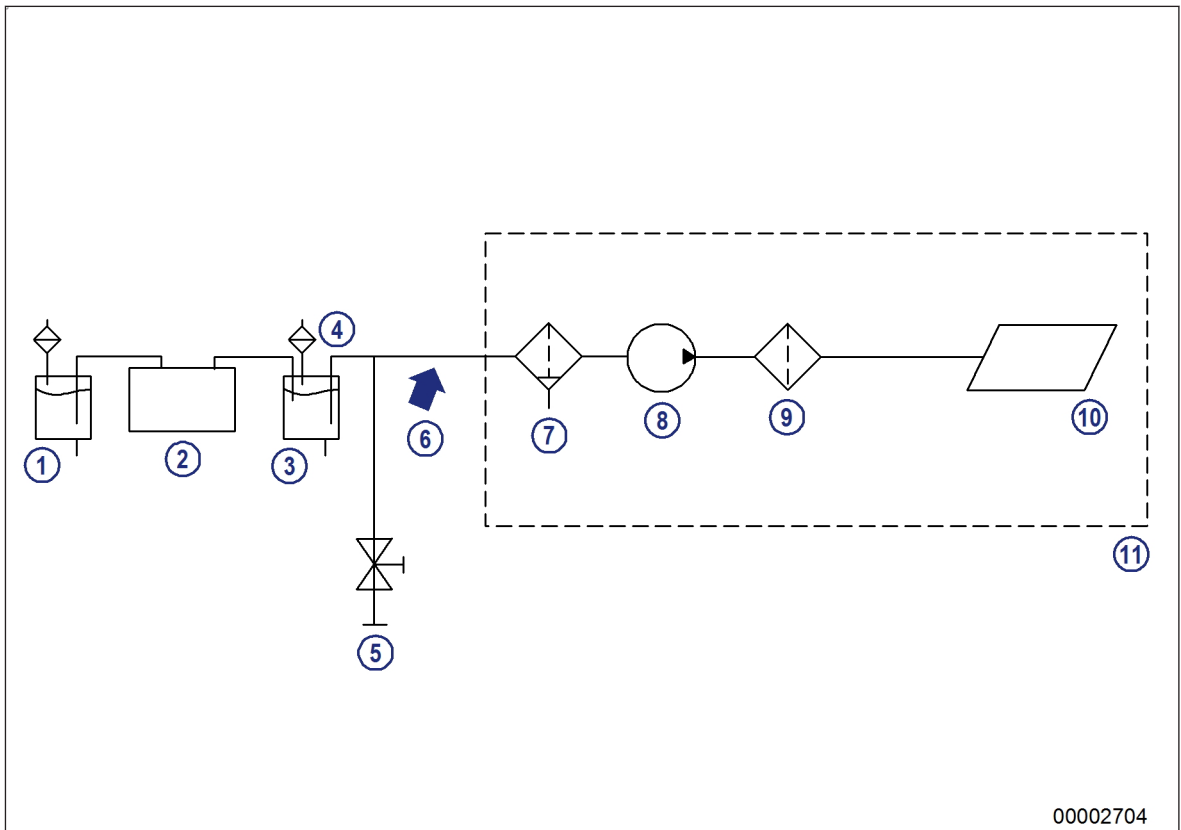


Figure 4: Fuel system diagram

- | | | |
|------------------------------|---------------------------------------|---------------------------|
| 1 Fuel tank | 5 Sample extraction
18/17/14 | 9 Main filter |
| 2 Fuel conditioning (option) | 6 Interface for fuel specification | 10 Injection system |
| 3 Last tank before engine | 7 Fuel prefilter with water separator | 11 Engine scope of supply |
| 4 Tank ventilation filter | 8 LP fuel pump | |

Note:

With poorer 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.

For the limit values named for the interface, it has been validated that prefilters approved by Rolls-Royce Solutions provide sufficient filtration.

Warranty provided by Rolls-Royce Solutions shall not cover damage and harm to engines due to the use of fuel qualities not approved by Rolls-Royce Solutions.

Series-based injection / and exhaust aftertreatment systems

Overview of Series 1600 injection / and exhaust aftertreatment systems

Series	Diesel accumulator injection system (Common rail)	Exhaust aftertreatment system	Exhaust gas recirculation
1600 R70, R70L, R80, R80L	Yes	SCR	No
1600 R71, R71L, R81L, R91	Yes	DOC, DPF, SCR	No

Table 19:

Laboratory analysis

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

The following data is required:

- Fuel specifications
- Sampling point
- Sampling date
- Serial number of engine from which fuel sample was taken
- Laboratory examinations to be carried out
- Customer/contact person

Submit the following:

- 1 liter of fuel
- 2 liters of fuel (with additional determination of cetane number)

Winter operation

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

At low outdoor temperatures, the diesel fuel's fluidity can be inadequate on account of paraffin precipitation. Users must ensure that the fuel specified for the prevailing climatic conditions is always used in order to prevent gelling and avoid the associated malfunctions (e.g. clogged filters).

The CFPP value specified in the EN590 standard is determined using an antiquated measuring method which no longer reflects the current state of the art.

It is therefore unsuitable for determining which fuel to use in order to assure trouble-free operation. The CP value serves better as a basis for establishing the need for measures to be taken by the customer (e.g. pre-heating of the fuel) depending on local climatic conditions.

6.2 Model type-based diesel fuel approvals for Series 1600

Fuel specifications for diesel fuel: DIN EN 590, ASTM D975 and other low-sulfur diesel fuel qualities

Series Stage IIIB engines

Fuel specifications	DIN EN 590: 2017-10 Summer and winter quality	ASTM D975-20c Grade 1-D S 15, S 500, S 5000 ¹⁾	ASTM D975-20c Grade 2-D S 15, S 500, S 5000 ¹⁾	Low-sulfur diesel fuels (S _{max} . 50 mg/kg) whose properties correspond to fuels in acc. with DIN EN 590 2017-10	BS 2869:2017 Part 1 Class 2	B10 diesel fuels according to DIN EN 16734:2019-02	B20 diesel fuels according to DIN EN 16709:2019-02	Paraffinic diesel fuels according to DIN EN 15940:2019-10
Restrictions	- particle distribution for fuel between tank and filter system: max. ISO Code 18/17/14	- proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - particle distribution for fuel between tank and filter system: max. ISO Code 18/17/14	- particle distribution for fuel between tank and filter system: max. ISO Code 18/17/14	- particle distribution for fuel between tank and filter system: max. ISO Code 18/17/14	- particle distribution for fuel between tank and filter system: max. ISO Code 18/17/14	- particle distribution for fuel between tank and filter system: max. ISO Code 18/17/14	- particle distribution for fuel between tank and filter system: max. ISO Code 18/17/14	- particle distribution for fuel between tank and filter system: max. ISO Code 18/17/14
Series	12V 1600: Under-floor: R70, R70L, R80, R80L ²⁾	Approval issued for: - S 15	Approval issued for: - S 15	Approval issued	Project-specific approval from Rolls-Royce Solutions is possible upon request ³⁾	Project-specific approval from Rolls-Royce Solutions is possible upon request ³⁾	Project-specific approval from Rolls-Royce Solutions is possible upon request ³⁾	Project-specific approval from Rolls-Royce Solutions is possible upon request ³⁾

Table 20:

¹⁾ = In the US, diesel fuels are categorized by the ASTM D975 standard into 2 main groups (Grade No 1 and Grade No 2), each of which are subdivided into 3 subgroups of varying sulfur content (S15, S500, S5000 - the number indicates the maximum sulfur content in ppm).

²⁾ = There is a possibility of violating the emission limit values (EU3B) if fuels that deviate from the reference fuel are used.

³⁾ = An agreed validation program under real operating conditions is necessary to gain project-specific approval. The validation program is available upon request from Rolls-Royce Solutions.

Series Stage V engines

Fuel specifications	DIN EN 590: 2017-10 Summer and winter quality	ASTM D975-20c Grade 1-D S 15, S 500, S 5000 ¹⁾	ASTM D975-20c Grade 2-D S 15, S 500, S 5000 ¹⁾	Low-sulfur diesel fuels (Smax. 50 mg/kg) whose properties correspond to fuels in acc. with DIN EN 590 2017-10	BS 2869:2017 Part 1 Class 2	B10 diesel fuels according to DIN EN 16734:2019-02	B20 diesel fuels according to DIN EN 16709:2019-02	Paraffinic diesel fuels according to DIN EN 15940:2019-10
Restrictions	- particle distribution for fuel between tank and filter system: max. ISO Code 18/17/14	- proportion of water: Max. 200 mg/kg - Total contamination: Max. 24 mg/kg - particle distribution for fuel between tank and filter system: max. ISO Code 18/17/14		- particle distribution for fuel between tank and filter system: max. ISO Code 18/17/14	- particle distribution for fuel between tank and filter system: max. ISO Code 18/17/14	- particle distribution for fuel between tank and filter system: max. ISO Code 18/17/14	- particle distribution for fuel between tank and filter system: max. ISO Code 18/17/14	- particle distribution for fuel between tank and filter system: max. ISO Code 18/17/14
Series								
12V 1600: Underfloor: R71, R71L, R81L, R91	Approval issued	Not approved	Not approved	Not approved	Project-specific approval from Rolls-Royce Solutions is possible upon request ²⁾	Project-specific approval from Rolls-Royce Solutions is possible upon request ²⁾	Project-specific approval from Rolls-Royce Solutions is possible upon request ²⁾	Project-specific approval from Rolls-Royce Solutions is possible upon request ²⁾

Table 21:

¹⁾ = In the US, diesel fuels are categorized by the ASTM D975 standard into 2 main groups (Grade No 1 and Grade No 2), each of which are subdivided into 3 subgroups of varying sulfur content (S15, S500, S5000 - the number indicates the maximum sulfur content in ppm).

²⁾ = An agreed validation program under real operating conditions is necessary to gain project-specific approval. The validation program is available upon request from Rolls-Royce Solutions.

6.3 Supplementary fuel additives

Supplementary fuel additives

The engines are designed such that satisfactory 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.

Biocides are an exception.

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.

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. The use of halogenated biocides is prohibited due to their effects on the engine system and the environment.

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

Manufacturer	Brand name	Concentration for use
ISP Biochema Schwaben GmbH Ashland Specialty Ingredients Luitpoldstrasse 32 87700 Memmingen Tel. +49 (0)8331 9580 0 Fax. +49 (0)8331 9580 51	Bakzid	100 ml / 100 l
Maintenance Technologies Paddy's Pad 1056 CC t/a Maintenance Technologies Tel. +27 21 786 4980 Cell +27 82 598 6830	Diesel Cure Fuel decontaminant	1 : 1200 (833 mg/kg)
Adolf Würth GmbH & Co. KG Reinhold Würth-Straße 12-17 74653 Künzelsau Tel. +49 (0)7940 15-2248	Diesel Cure Fuel decontaminant	1 : 1200 (833 mg/kg)
Vink Chemicals GmbH & Co.KG 21255 Kakenstorf Tel. +49 (0)4186 88797-0 Fax. +49 (0)418688797-10	grotamar 71 grotamar 82 StabiCor 71	0.5 l / ton 1.0 l / 1000 l 0.5 l / ton

Manufacturer	Brand name	Concentration for use
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-Albrtand- swaard Tel. +31 10 487 7777 Fax. +31 10 487 7888 Netherlands	DieselPower Biocontrol	333 ml / ton

Table 22:

Flow improvers

Flow improvers can not 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.

6.4 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 shall 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

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

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.

6.5 Measures prior to engine out-of-service periods >1 month

General information

Diesel fuel according to EN 590 is currently permitted biodiesel shares of the 1st generation (FAME) of up to 7%. In case of long engine standstill, these biodiesel shares result in deposits. These deposits can cause problems when the engine is put back into operation; damage to components in the fuel circuit is possible.

To prevent deposits and resultant damage to the fuel system due to the 7% biodiesel share in the diesel fuel, the following measures are therefore required if the engine is to be taken out of service for a period of up to 6 months:

- The engine must be operated once a month for approx. 15 mins, at approx. 900 rpm with cut-in auxiliary consumers to reliably flush the fuel system.
- Prior to this, it is essential to check the perfect operation of the engine, in particular, with regard to the coolant and oil level. If the fuel systems have water separators, they must be drained prior to engine start. During engine start and engine operation, the operating parameters must be monitored carefully.
- Before putting engines that were placed in storage with B7 fuel back into operation, testing of the fuel is necessary to check its usability and quality (as per EN 590). If fuels do not comply with EN 590, they must be replaced.

Note:

Systems on the vehicle side with fuel supply can also be damaged due to deposits from the biodiesel shares. Adequate flushing is also required for these systems.

The monthly engine start can be omitted if the engine was flushed for at least 30 mins. prior to shutdown with FAME-free fuel (B0 fuel). For this purpose, the commercially available EN 590 fuel with 7% FAME is removed from the tank and then B0 fuel without FAME is filled. Ensure that all fuel-carrying parts of the engine system take part in the flushing procedure.

Fuels that currently meet the requirements of the die B0 specifications are, for example, ARAL Ultimate Diesel and BP Ultimate Diesel.

Note:

The bio share in the fuel is highly hygroscopic, which means that the bio share dehydrates the surrounding area and binds the water. This also results in an increased proportion of water in the tank during long out-of-service periods and the associated problems such as a coating formation, bacterial attack or corrosion which can cause damage to the vehicle/engine and fuel filtration system when the engine is put back into operation.

7 NO_x Reducing Agent AUS 32 for Series 1600 SCR Exhaust Gas Aftertreatment Systems

7.1 General information and storage

General information

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

In addition to ensuring compliance with exhaust emissions, reducing agents are used to safeguard the functionality of the exhaust gas aftertreatment system throughout its useful life. The reason for this is that the reducing agent is used to cool some of the component parts of the exhaust gas aftertreatment system (e.g. the reducing agent dosing units). Furthermore, some of the component parts of the exhaust gas aftertreatment system (e.g. the reducing agent supply units) may become clogged and damaged as a result of crystallization. Basically, the exhaust gas aftertreatment system may only be operated with a sufficient quantity of reducing agent filled in the reducing agent tank. To avoid damaging the system, only downtimes lasting less than < 24 h are acceptable from a technical point of view. Longer downtimes > 24 h without using reducing agent will damage the component parts of the exhaust gas aftertreatment system.

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

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

The test methods to determine the quality and characteristics of the reducing agent are specified in the standards DIN 70071 / ISO 222 41-2.

Important

SCR systems from Rolls-Royce Solutions are designed for a concentration of 32.5% urea. The use of NO_x reducing agents with other concentrations of urea (AUS 40, AUS 48) is not approved!

Important

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

Storage of reducing agent

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

The reducing agent crystallizes at -11 °C.

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

8 Approved Fluids and Lubricants

8.1 Approved Engine Oils

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

For details and special features, see chapter “Lubricants for four-cycle engines” (→ Page 6)

Multi-grade oils

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/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 through Rolls-Royce Solutions America Inc.
Advanced Lubrication Specialties, Inc.	Advantage Premium Plus	15W-40	X			
	Advantage Ultra Premium Plus	5W-40		X		
BP p.l.c.	BP Vanellus Eco	15W-40	X			
Canroyal Oil Lubricants / Dist.	Canroyal Synthetic Diesel Engine Oil	15W-40	X			
Castrol Ltd.	Castrol CRB Mining 15W-40	15W-40	X			
	Castrol CRB Mining 15W-40 CK-4		X			
	Castrol CRB Turbo G4 15W-40	15W-40	X			
	Castrol Hypuron	10W-30		X		
	Castrol RX Super 15W-40 CJ-4/E9	15W-40	X			
Champion Chemicals N.V.	Champion OEM Specific 15W40 MS	15W-40	X			
Chevron Lubricants (Chevron)	Delo 400 LE	15W-40	X			
	Delo 400 MGX	15W-40	X			
	Delo 400 SDE	15W-40	X			
	Delo 400 XLE	10W-30		X		
	Delo 400 XLE	15W-40		X		
Chevron Lubricants (Texaco)	Ursa Ultra LE	15W-40	X			
ExxonMobil Corporation	Mobil Delvac 1 ESP	0W-40	X			
	Mobil Delvac 1 ESP	5W-40		X		
	Mobil Delvac 1300 Super F2	15W-40	X			
	Mobil Fleet 15W-40	15W-40	X			
eni S.P.A.	eni i-Sigma top MS	15W-40	X			

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Finke Mineralölwerk GmbH	AVIATICON Turbo Premium ECO LA 10W-30	10W-30	X			
Fuchs Europe	Fuchs Titan Cargo	15W-40	X			
Fuchs Petrolub SE	Fuchs Titan Cargo	10W-30	X			
	Fuchs Titan Cargo	15W-40	X			
Gulf Oil International	Gulf Supreme Duty XLE	15W-40	X			
	Gulf Supreme Duty XLE	10W-30	X			
Hitachi	Hitachi Genuine Engine Oil 10W-40 DH-2	10W-40	X			
Kuwait Petroleum	Q8 T 760	10W-30	X			
Lotos Oil	Turdus Powertec 1100	15W-40	X			
Morris Lubricants	Versimax HD6	15W-40	X			
Motorex AG	Motorex Focus CF	15W-40	X			
MPM International Oil Company B.V.	Motor Oil 15W-40 Extra High Performance	15W-40	X			
Neste Markkinointi Oy Lubricants	Neste Turbo+ NEX 10W-40	10W-40	X			
OOO "LLK-International"	Lukoil Avantgarde Professional LA	10W-30	X			
	Lukoil Avantgarde Professional LA	10W-40	X			
	Lukoil Avantgarde Professional LA	15W-40	X			
Panolin AG	Panolin Universal LA-X	15W-40	X			
Pennzoil Products	Pennzoil Long-Life Gold	15W-40		X		
Petro-Canada	Duron -E	15W-40	X			
Phillips 66 Lubricants	Guardol ECT	10W-30	X			
	Guardol ECT	15W-40	X			
	Kenndall Super-D XA	10W-30	X			
	Kenndall Super-D XA	15W-40	X			
Prolube Lubricants	Prolube Ultraplus	15W-40	X			
Repsol Lubricantes Y Especialidades, S.A.	Repsol Diesel Turbo THPD Mid Saps	15W-40	X			

Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Shell International Petroleum Company	Shell Rimula Super	15W-40		X		
	Shell Rimula RT4L	15W-40		X		
	Shell Rotella T	15W-40		X		
	Shell Rotella T3	15W-40		X		
	Shell Rotella T3 Fleet	15W-40	X			
	Shell Rotella T5	10W-30	X			
	Shell Rotella T5	10W-40	X			
	Shell Rotella T6	5W-40		X		
	Shell Rimula R5 LE	10W-30	X			
	Shell Rimula R5 LE	10W-40	X			
	Shell Rotella T Triple Protection	15W-40		X		
	Shell Rimula R4 MV	15W-40	X			
	Shell Rimula R4 L	15W-40	X			
	Shell Sirius S4 L	15W-40	X			
SRS Schmierstoff Vertrieb GmbH	SRS Turbo Rekord plus	15W-40	X			
	SRS Turbo Rekord plus FE	10W-40	X			
Sunoco Lubricants	Super C	15W-40		X		
	Super C Gold	15W-40		X		
	Super C Gold Elite	5W-40		X		
The United Oil Company	Duralene Dura-Max 15W-40	15W-40		X		
	Duralene Dura-Syn HD	5W-40		X		
Total Lubrificants	Hitachi Genuine Engine Oil 10W-40 DH-2	10W-40	X			
	Total Rubia TIR 7900	15W-40	X			
	Total Rubia Works 2000	10W-40	X			
	Total Star Max FE	10W-30	X			
	Total Rubia Works 2000 FE 10W-30	10W-30	X			
Trinidad & Tobago National Petroleum Marketing Company Ltd. (NPMC)	Ultra Duty 15W-40 Engine Oil	15W-40	X			
Valvoline Europe	All Fleet Superior LE-X SAE 10W-40	10W-40	X			
	All Fleet Extra SAE LE 15W-40	15W-40	X			
Valvoline EMEA	Valvoline All Fleet Extra LE SAE	15W-40	X			
	All-Fleet Extra LE NTI	15W-40	X			
	Premium Blue 8 100 15W-40	15W-40	X			

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Manufacturer	Brand name	SAE viscosity class	TBN			Remarks
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Valvoline USA	All Fleet Plus	15W-40	X			
Verco International	April Superpro RXL 1 Gold Plus	15W-40	X			

Table 23:

8.1.2 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 features, see chapter “Lubricants for four-stroke cycle engines” (→ Page 6)

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 class	TBN			Comments / material number
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Addinol Lube Oil	Addinol Extra Truck MD 1049 LE	10W-40	X			
Aral AG	Aral Mega Turboral LA	10W-40	X			
	Aral Super Turboral LA	5W-30	X			
Atak Madeni Yağ Pas.San.Tic.Aş	Alpet Turbot MMS	10W-40		X		
Avia AG	Avia Multi LSP Extra	10W-40		X		
Avista Oil Deutschland GmbH	Avista pure EVO GER	10W-40		X		
	Avista pure EVO CK-4	5W-30	X			
	Avista pure EVO CK-4	10W-30	X			
	Avista pure EVO CK-4	10W-40	X			
	Avista pure EVO PRIME 5W-30	5W-30		X		
BayWa AG	Tectrol Super Truck Plus XL 1040	10W-40	X			
Belgin Madeni Yağlar	BELGIN LUBEX ROBUS MASTER LA 10W-40	10W-40		X		
BP p.l.c.	BP Vanellus Max Drain Eco	10W-40			X	
	BP Vanellus Max Eco 10W-40	10W-40			X	
BVG Vertriebsgesellschaft AG	Alpha Advanced Eco-Efficiency low SAPS	10W-40	X			
Castrol Ltd.	Castrol Vecton Long Drain 10W-30 E6/E9	10W-30	X			
	Castrol Vecton Long Drain 10W-40 E6/E9	10W-40	X			
	Castrol Vecton Fuel Saver 5W-30 E6/E9	5W-30	X			
Cepsa Comercial Petroleo, S.A.U.	Cepsa Eurotech LS 10W40 Plus	10W-40			X	
	Traction Pro LS	10W-40			X	
Champion Chemicals N.V.	Champion OEM Specific 10W40 Ultra MS	10W-40		X		
	Champion OEM Specific 10W40 UHPD	10W-40			X	
Chevron Lubricants (Caltex)	Delo XLE Multigrade	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 class	TBN			Comments / material number
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Chevron Lubricants (Chevron)	Delo 400 RDE	10W-30		X		
	Delo 400 RDS	10W-40		X		
	Delo 400 XLE	15W-40	X			
	Delo 400 XLE HD	5W-30			X	
	Delo 400 XLE HD	10W-40			X	
	Delo 400 XLE SYN-HD	10W-40			X	
	Delo 400 XLE Synthetic	5W-30	X			
	Delo 400 LE Synthetic	5W-30	X			
	Delo 400 XSP	5W-30	X			
	Delo 400 XSP-SD	5W-30	X			
Chevron Lubricants (Texaco)	Ursa Ultra X	10W-30		X		
CONDAT Lubrificants	Vicam Planet 10W40	10W-40			X	
Deutsche Ölwerke Lubmin GmbH	AVENO Universal UHPD	10W-40				
De Oliebron B.V.	Tor Turbosynth LSP Plus	10W-40			X	
Ellis Enterprises B.V.	Valvoline Profleet LA	5W-30	X			
	Profleet LA	5W-30	X			
eni S.p.a.	eni i-Sigma top MS	10W-40	X			
Enoc Marketing L.L.C.	Enoc Vulkan Green	10W-40			X	
Exol Lubricants Ltd.	Taurus Euro	10W-40		X		
Exxon Mobil Corporation	Mobil Delvac 1 ESP	5W-30		X		
	Mobil Delvac 1 LE	5W-30	X			
	Mobil Delvac 1 LE	5W-30			X	
	Mobil Delvac HD	10W-40		X		
	Mobil Delvac XHP ESP	10W-40			X	
	Mobil Delvac XHP ESP M	10W-40			X	
	Mobil Delvac XHP ESP S	10W-40			X	
	Mobil Delvac XHP LE	10W-40			X	55 gallons: 800141
	Mobil Delvac XHP Ultra LE	5W-30		X		
Finke Mineralölwerk GmbH	AVIATICON Finko Super Truck LA Plus	10W-40		X		
Fuchs Petrolub SE	Titan Cargo Maxx	5W-30			X	
	Titan Cargo Maxx	10W-40			X	Enhanced corrosion protection
	Fuchs Titan Cargo EU6	5W-30	X			
	Fuchs Titan Cargo LA	5W-30	X			
	PENTOTRUCK ULTRA SAE 10W-30	10W-30	X			

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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 class	TBN			Comments / material number
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Gazpromneft Lubricants Ltd.	G-Profi GT LA	10W-40			X	
Gulf Oil International	Gulf Superfleet ULE	10W-40	X			Enhanced corrosion protection
	Gulf Superfleet Synth ULE	5W-30	X			
	Gulf Superfleet XLE	10W-30	X			
	Gulf Superfleet XLE	10W-40	X			
	Gulf Superfleet Synth XLE	10W-30		X		
	Gulf Superfleet Synth XLE	10W-40	X			
	Gulf Superfleet Universal	5W-30			X	
	Gulf Superfleet Universal	10W-40			X	
Helios Lubeoil	Helios Premium KMXX 10W-40	10W-40	X			
Huiles Berliet S.A.	RTO Extensia FP	10W-40	X			
Igol	PRO 200 X	10W-40	X			
INA Maziva d.o.o.	INA Super 2009 5W-30	5W-30	X			
	INA Super 2009	10W-40			X	
Kuwait Petroleum R&T	Q8 905	10W-40	X			
	Q8 T 904	10W-40		X		
	Q8 T 904 FE	10W-30	X			
	Q8 T 905	10W-40	X			
	Q8 T 910	5W-30	X			
	Q8 Formula Truck 8500	10W-40	X			
	Q8 Formula Truck 8500 FE	10W-30	X			
	Q8 Formula Truck 8700 FE	5W-30	X			
	Q8 Formula Truck 8900 FE	5W-30	X			
LLK finland Oy	Teboil Super XLD-2	5W-30			X	
Meguin GmbH & Co. KG	megol Motorenoel Low Saps	10W-40		X		
MOL-LUB Ltd.	MOL Dynamic Mistral XT5W-30	5W-30	X			
	MOL Dynamic Mistral 10W-40	10W-40	X			
Morris Lubricants	Ring Free Ultra	10W-40		X		
	Fendt Power Grade 10W-40	10W-40		X		
	Versimax HD8	10W-40	X			
Motorex AG	Motorex Focus QTM	10W-40	X			
	Motorex / York Focus QTM	10W-40	X			
	Motorex / York Nexus FE SAE 5W-30	5W30			X	
	Motorex Nexus FE SAE 5W-30	5W30	X			

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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 class	TBN			Comments / material number
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
MPM International Oil Company B.V.	Motor Oil 10w-40 Premium Synthetic Ultra High Performance Diesel	10W-40		X		
Neste Markkinointi Oy Lubricants	Neste Turbo+ LSA 5W-30	5W-30	X			
Oel-Brack AG	Midland maxtra	10W-40		X		
OMV Petrol Ofisi A.Ş	Maximus HD-E	5W-30	X			
OOO LLK International	Lukoil Avantgarde CNG	10W-40	X			
	Lukoil Avantgarde Professional LE	5W-30			X	
	Lukoil Avantgarde Professional LE	10W-40			X	
	Lukoil Avantgarde Professional LS	5W-30	X			
	Lukoil Avantgarde Professional LS	10W-40			X	
	Lukoil Avantgarde Professional LS5	5W-30	X			
	Lukoil Avantgarde Professional LS5	10W-40	X			
	Lukoil Avantgarde Professional XLE	5W-30			X	
	Lukoil Avantgarde Professional XLE	10W-40			X	
Orlen Oil	Platinum Ultor Complete	10W-40	X			
	Platinum Ultor Optimo	10W-30	X			
	Platinum Ultor Progress	10W-40		X		
	Mogul Diesel L-SAPS	10W-40		X		
Oscar Lubricants LLC	Oscar Zircon Novus	10W-40	X			
Panolin	Panolin Diesel Synth EU-4	10W-40	X			
	Panolin Ecomot	5W-30		X		
	Panolin Ecomot	10W-30	X			
	Panolin Ecomot	10W-40	X			
Petro-Canada Lubricants Inc.	Duron SHP E6	10W-40		X		
	Duron UHP 5W30	5W-30	X			
	Duron UHP E6	5W-30			X	
	Duron UHP E6	10W-40			X	
	Duron UHP E6 10W40	10W-40	X			
Petrogal, S.A.	Galp Galaxia Ultra LS	10W-40	X			
Petrolube Lubricants	Euromax	10W-40		X		

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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 class	TBN			Comments / material number
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
Petronas Lubricants International	Petronas Urania 5000 E	5W-30			X	
	Petronas Urania 5000 E	10W-40			X	
	Petronas Urania 5000 LS-FX	5W-30		X		
	Petronas Urania 5000 LSF 5W-30	5W-30	X			
	Petronas Urania 5000 LS 10W-40	10W-40	X			
	Petronas Urania FE LS	5W-30			X	
	Petronas Urania Ecotech	10W-40			X	
PHI OIL GmbH	Motodor LSP Gold 5W30	5W-30			X	
	Motodor LSP Silver	10W-40		X		
Prista Oil Ad	Prista UHPD	10W-40	X			
Ravensberger Schmierölvertrieb GmbH	Ravenol Euro VI Truck	10W-40	X			
	Ravenol Euro VI Truck SAE 10W-40	10W-40		X		
Repsol Lubricantes y Especialidades, S.A.	Repsol Diesel Turbo UHPD MID SAPS	10W-40	X			
	Repsol DieselTurbo VHPD Mid Saps	5W-30		X		
RN-Lubricants LLC	Rosneft Revolux D6	10W-40		X		
	Rosneft Revolux D6 Plus	5W-30			X	
	Rosneft Revolux D6 Plus	10W-40			X	
Rowe Mineralölwerk GmbH	Rowe Hightec Truckstar SAE 10W-40 HC-LA	10W-40		X		
Shell International Petroleum Company	Shell Fleet Pro CK-4	5W-30		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	

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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 class	TBN			Comments / material number
			8 to 10 mgKOH/g	10 to 12 mgKOH/g	>12 mgKOH/g	
SRS Schmierstoff Vertrieb GmbH	SRS Antikorrol MLA	10W-40		X		Enhanced corrosion protection
	SRS Cargolub TLA	10W-40	X			
	SRS Cargolub TLA plus	10W-40		X		
	SRS Cargolub TLS	5W-30			X	
	SRS Cargolub TLS plus	5W-30		X		
	SRS Cargolub TLS top	5W-30	X			
	SRS Turbo Diesel LA	10W-40	X			
	SRS Cargolub low-friction engine oil LA	10W-40		X		
	SRS Turbo-Rekord top FE	10W-40		X		
	SRS Turbo-Rekord ultra FE	10W-40	X			
Total Lubrifiants	Total Rubia TIR 8900	10W-40	X			
	Total Rubia Works 2500	10W-40	X			
	Total Rubia Works 3000	10W-40		X		
	Total Rubia Works 3000 FE	5W-30			X	
Valvoline EMEA	Valvoline ProFleet LS	5W-30			X	
	Valvoline ProFleet LS	10W-40	X			
	ProFleet LS NTI	10W-40	X			
Veedol International Limited	VEEDOL MARATRON EXTRA LSP 10W-40	10W-40		X		
Wibo Schmierstoffe GmbH	Wibokraft Ultra AF 10W40	10W-40		X		
Wolf Oil Corporation N.V.	Wolf Officialtech 10W40 Ultra MS	10W-40		X		
	Wolf Officialtech 10W40 UHPD	10W-40			X	

Table 24:

8.2 Approved Transmission Oils

8.2.1 Fluids and lubricants for ZF transmissions

Mechanical manual-shift transmissions from ZF Co. Friedrichshafen:

The current, permissible fluids and lubricants for ZF transmissions can be downloaded free-of-charge from the following Internet address:

[https://aftermarket.zf.com/de/de/aftermarket-portal/technische-informationen/schmierstoffe/ TE-ML 16](https://aftermarket.zf.com/de/de/aftermarket-portal/technische-informationen/schmierstoffe/TE-ML_16)

Lubricant class 16Q

Manufacturer	Product name
ZF Friedrichshafen AG, Friedrichshafen/D	ZF-Ecofluid Life Plus

Table 25:

8.2.2 Fluids and lubricants for Voith transmissions T 211.re.4 + KB190 (General List of Lubricants 120-00059010_EN, Edition 15 dated 2020-04-02)

Voith hydrodynamic transmissions:

Before using them, make sure the fluids and lubricants listed below are still approved. The latest version is available at: www.voith.com/brochures/2255

Important
Use Voith approved transmission oils only when filling the turbo transmission. The use of other oil grades and blends or contaminated oils is prohibited. No liability whatsoever will be accepted if oils for which Voith has not granted approval are used in the turbo transmission.

Approved power transmission oils for Voith turbo transmissions T 211 re.4 + KB190

Manufacturer	Product name	Index	Suitable for low temperatures ^{*)} down to
Addinol	SGL 18	1	-25 °C
ARAL	ARAL Degol BG 32		-20 °C
Caltex	Torque Fluid 32	2	-25 °C
Castrol	Castrol Alpha VT 32	1	-25 °C
	Castrol Hyspin HL-XP 32	2	-25 °C
Chevron Texaco	Textran V 32	2	-25 °C
Exxon Mobil	Mobilfluid 125	2	-20 °C
Finke	Aviaticon ML 32 SG	1	-25 °C
Fuchs-Europe	Renofluid TF 1500	1	-25 °C
INA Maziva	INA Fluid V 32	2	-25 °C
	INA Fluid VT 32	1	-25 °C
Q8	Q8 Auto R 26	2	-25 °C
Shell	Shell Tegula V 32	1	-25 °C
SRS	SRS Wiolan HF 32 DB	1	-25 °C
	SRS Wiolan HF 32 synth	3	-40 °C
Total	Total Azolla VTR 32		-20 °C
Voith Turbo s,r,l.	Turbo Transmission Fluid	1	-25 °C
	Turbo Transmission Fluid Synth	3	-40 °C

Table 26:

Explanation of the Index column:

1 = Increased thermal-oxidation resistance

2 = Oil is not suitable for all electronically-controlled turbo transmissions except for T 211...

3 = Especially increased thermal-oxidation resistance (synthetic oil)

^{*)} = Minimum admissible oil sump temperature. Other requirements for operation of the turbo transmission are specified in the Operating Instructions.

8.2.3 Fluids and lubricants for Stiebel transfer gearbox type 4685.02

Transfer gearbox from Stiebel-Getriebebau GmbH & Co KG:

Before using them, make sure the fluids and lubricants listed below are still approved. Please contact your Rolls-Royce Solutions representative to clarify.

Important

Fill the transfer gearbox with lube oil approved by Stiebel GmbH & Co. KG only. The use of other oil grades and blends or contaminated oils is prohibited!

Operating the transfer gearbox with any oil which has not been approved by Stiebel GmbH & Co. KG will void the warranty for the transfer gearbox!

Approved lubricants for Stiebel transfer gearbox type 4685.02

Manufacturer	Product name
Avia	AVIA SYNTOGEAR PE 150
Bantleon	AVIA SYNTOGEAR PE 150
	AVILUB GEAT PAO 150
Castrol	Alphasyn EP 150
	Optigear Synthetic PD 150
Fuchs	Renolin Unisyn CLP 150
Klüber Lubrication	Klübersynth GEM-4-150-N
Lukoil	LUKOIL STEELO S 150
Mobil	Mobil SHC Gear 150
Shell	Shell Omala S4 GX 150
Total	CARTER SH 150

Table 27:

8.3 Approved Coolants

8.3.1 Antifreeze – Concentrates on ethylene glycol basis

For details and special information, see chapter on “Coolants” (→ Page 16).

Antifreeze concentrates on ethylene glycol basis

Manufacturer	Brand name	Inhibitors					Runtime Hours / Years	Comments / Material number
		Organic	Silicon	Nitrite	Phosphate	Molybdate		
Rolls-Royce Solutions GmbH	Coolant AH100 Antifreeze Concentrate	X	X				9000 / 5	X00057231 (20 l) X00057230 (210 l) also available from Rolls-Royce Solutions Asia
Alliance Automotive Service GmbH	NAPA Premium Kühlerschutz N48	X	X				9000 / 5	
Avia AG	Antifreeze APN	X	X				9000 / 5	
	Antifreeze APN - S	X					9000 / 3	
BASF SE	Glysantin® G30 pink	X					9000 / 3	X00058072 (canister) X00058071 (barrel)
	Glysantin® G40 pink	X	X				9000 / 3	X00066724 (20 l) X00066725 (210 l)
	Glysantin® G48 blue green	X	X				9000 / 5	X00058054 (25 l) X00058053 (210 l)
BayWa AG	Tectrol Coolprotect	X	X				9000 / 5	
BP Lubricants	Aral Antifreeze Extra	X	X				9000 / 5	
Castrol	Castrol Radicool NF	X	X				9000 / 5	
Classic Schmierstoff GmbH + Co KG	Classic Kolda UE G48	X	X				9000 / 5	
CCI Corporation	L 415	X				X	9000 / 3	
Comma Oil & Chemicals Ltd.	Comma Xstream® G30® Antifreeze Coolant Concentrate	X					9000 / 3	
	Comma Xstream® G48® Antifreeze Coolant Concentrate	X	X				9000 / 5	
COPARTS Autoteile GmbH	CAR1 Premium Longlife Kühlerschutz C48	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	
Drew Marine	Drewgard ZX	X					9000 / 3	

Manufacturer	Brand name	Inhibitors					Runtime Hours / Years	Comments / Material number
		Organic	Silicon	Nitrite	Phosphate	Molybdate		
ExxonMobil	Mobil Delvac Extended Life Coolant	X				X	9000 / 3	
	Mobil Antifreeze Advanced	X					9000 / 3	
	Mobil Antifreeze Extra	X	X				9000 / 5	
	Esso Antifreeze Advanced	X					9000 / 3	
	Esso Antifreeze Extra	X	X				9000 / 5	
Finke Mineralölwerk GmbH	AVIATICON Finkofreeze F30	X					9000 / 3	
	AVIATICON Finkofreeze F40	X	X				9000 / 3	
	AVIATICON Finkofreeze F48	X	X				9000 / 5	
Fuchs Petrolub SE	Maintain Fricofin	X	X				9000 / 5	
	Maintain Fricofin G12 Plus	X					9000 / 3	X00058074 (canister) X00058073 (barrel)
Gazpromneft Lubricants Ltd.	G - Energy Antifreeze SNF	X					9000 / 3	
INA Maziva Ltd.	INA Antifriz AI Super	X	X				9000 / 5	
Kuttenkeuler GmbH	Kuttenkeuler Antifreeze ANF KK48	X	X				9000 / 5	
	Glycostar®ST48	X	X				9000 / 5	
LLK International (Lukoil Lubricants Co.)	Lukoil Antifreeze HD G 12 K	X					9000 / 3	
Lukoil Lubricants Europe GmbH	Lukoil Coolant Plus	X	X				9000 / 5	
	Lukoil Coolant SOT	X	X				9000 / 3	
	Lukoil Coolant SF	X					9000 / 3	
Mitan Mineralöl GmbH	Alpine C30	X					9000 / 3	
	Alpine C48	X	X				9000 / 5	
MJL Bangladesh Ltd.	Omera Premium Coolant	X					9000 / 3	
Nalco Water An Eco-lab Company	Nalcool NF 48C	X	X				9000 / 5	
Mofin Deutschland GmbH & Co. KG	MOFIN Kühlerschutz M40 Extra	X	X				9000 / 3	
	MOFIN Kühlerschutz M48 Premium Protect	X	X				9000 / 5	
Motorex AG	Motorex Coolant G48	X	X				9000 / 5	
	Motorex Coolant M4.0 Concentrate	X	X				9000 / 3	
Navistar Inc.	Fleetrite Nitrite-Free Extended Life Coolant	X				X	9000 / 3	

Manufacturer	Brand name	Inhibitors					Runtime Hours / Years	Comments / Material number
		Organic	Silicon	Nitrite	Phosphate	Molybdate		
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	
Panolin AG	Panolin Anti-Frost MT325	X	X				9000 / 5	
Penske Power Systems	Power Cool - HB500 Coolant Concentrate	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				9000 / 5	
Recochem Inc.	HD Expert™ Endurance	X				X	9000 / 3	
	R542	X	X				9000 / 3	
SMB - Sotagal / Mont Blanc	Antigel Power Cooling Concentrate	X	X				9000 / 5	
Total Lubrifiants	Glacelf MDX	X	X				9000 / 5	
Valvoline	OEM Advanced 30	X					9000 / 3	
	OEM Advanced 40	X	X				9000 / 3	
	OEM Advanced 48	X	X				9000 / 5	
	Zerex G-30	X					9000 / 3	
	Zerex G-40	X	X				9000 / 3	
	Zerex G-48	X	X				9000 / 5	
Volvo Trucks	Road Choice Nitrite-Free OAT Extended Life Coolant	X				X	9000 / 3	
York SAS	York 716	X	X				9000 / 5	

Table 28:

8.3.2 Antifreeze – Ready mixtures on ethylene glycol basis

For details and special information, see chapter on “Coolants” (→ Page 16).

Antifreeze – Ready mixtures on ethylene glycol basis

Manufacturer	Brand name	Inhibitors					Runtime Hours / Years	Comments / Material number
		Organic	Silicon	Nitrite	Phosphate	Molybdate		
Rolls-Royce Solutions GmbH	Coolant AH 50/50 Antifreeze Premix	X	X				9000 / 5	X00070528 (20 l) X00070527 (1000l) (Sales region: England)
	Coolant AH 40/60 Antifreeze Premix	X	X				9000 / 5	X00070533 (20 l) X00070532 (1000l) (Sales region: England, Spain)
Rolls-Royce Solutions America Inc.	Power Cool® Universal 50/50 mix	X	X				9000 / 5	800071 (5 gallons) 800084 (55 gallons)
Bantleon GmbH	Avilub Antifreeze Mix (50%)	X	X				9000 / 5	X00049213 (210l)
BayWa AG	Tectrol Coolprotect Mix-3000	X					9000 / 3	Antifreeze protection down to -24 °C
Castrol	Castrol Radicool NF Premix (45%)	X	X				9000 / 5	
CCI Corporation	L 415 (50%)	X				X	9000 / 3	
Cepsa Comercial Petróleo S.A.U.	XTAR Super Coolant Hybrid NF 50%	X	X				9000 / 5	
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	
Finke Mineralölwerk GmbH	AVIATICON Finkofreeze F48 RM 50/50	X	X				9000 / 5	
	AVIATICON Finkofreeze F30 RM 40:60 +	X					9000 / 3	
LLK International Lukoil Lubricants Co.	Lukoil Antifreeze HD G 12 (50%)	X					9000 / 3	
Motorex AG	Motorex Coolant G48 ready to use (50/50)	X	X				9000 / 5	
	Motorex Coolant M4.0 Ready to use	X	X				9000 / 3	Antifreeze protection down to -38 °C
Navistar Inc.	Fleetrite 50/50 Prediluted Nitrite-Free Extended Life Coolant	X				X	9000 / 3	

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Manufacturer	Brand name	Inhibitors					Runtime Hours / Years	Comments / Material number
		Organic	Silicon	Nitrite	Phosphate	Molybdate		
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	
Penske Power Systems	Power Cool - HB500 Premix 50/50	X	X				9000 / 3	
Puma Energy International S.A.	Puma HD Hybrid Coolant 5050	X	X				9000 / 3	
Raloy Lubricantes	Antifreeze Long Life NF-300 Ready-to-Use (50/50)	X	X				9000 / 5	
Recochem	HD Expert™ Endurance 50-50 Prediluted	X				X	9000 / 3	
SMB - Sotragal / Mont Blanc	L.R.-30 Power Cooling (44%)	X	X				9000 / 5	
	L.R.-38 Power Cooling (52%)	X	X				9000 / 5	
Total Lubrifiantes	Coolelf MDX -26°C	X	X				9000 / 5	
	Coolelf MDX -37°C	X	X				9000 / 5	
Tosol-Sintez	Glystantin Alu Protect G30 Ready Mix	X					9000 / 3	
	Glystantin Alu Protect Plus G48 Ready Mix	X	X				9000 / 5	
Valentin Energie GmbH	Valentin Coolant Plus -25 °C Ready	X					9000 / 3	
Valvoline	Zerex G-48 premix 50%	X	X				9000 / 5	
	OEM Advanced 48 premix 50%	X	X				9000 / 5	
Volvo Trucks	Road Choice 50/50 Prediluted Nitrite-Free OAT Extended Life Coolant	X				X	9000 / 3	
YPF S.A. Argentina	Kriox MTL50	X				X	9000 / 3	

Table 29:

8.4 Approved Lubricating Greases

8.4.1 Lubricating greases for TSA traction generators

For details and special features, see chapter on “Lubricating greases”(→ Page 9)

TSA publications are updated from time to time. Before using them, make sure you have the latest version. Please contact your Rolls-Royce Solutions representative to clarify.

Important

Use TSA-approved grease only. The use of other types of grease, grease blends or contaminated lubricating grease is prohibited.

Operating the generator with any grease which has not been approved by TSA will void the warranty for the generator!

Manufacturer	Brand name	Notes
Schaeffler AG	FAG Arcanol Tempo 90	

Table 30:

9 Flushing and Cleaning Specifications for Engine Coolant Circuits

9.1 General information

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

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

If such conditions occur, the coolant circuit is to be flushed out with freshwater, repeatedly if necessary.

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

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

Only products approved by Rolls-Royce Solutions or corresponding products (→ Page 55) at the specified concentrations may be used for cleaning. The specified cleaning procedure is to be complied with.

Immediately after flushing or cleaning, fill the coolant circuits with treated engine coolant as stipulated in these Fluids and Lubricants Specifications (→ Page 16). 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 materials. 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. Considerable differences can apply from country to country so that no generally valid statement on the applicable regulations for fluids and lubricants etc. can be made in this publication.

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

Important

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

Test equipment, auxiliary materials and fluids and lubricants

mtu test kit or electrical pH-value measuring instrument

- Freshwater
- Prepared engine coolant
- Superheated steam
- Compressed air

9.2 Approved cleaning agents

Manufacturer	Product name	Working concentration		Order no.
For coolant systems:				
Kluthe	Hakutex 111 ^{1, 5)}	2% by volume	Liquid	X00065751
	Decorrdal 20-1 ⁸⁾	10% by volume	Liquid	⁷⁾
	Hakupur 50-706-3 ⁴⁾	2% by volume	Liquid	X00055629
For cooling circuit assemblies:				
Henkel	Bonderite C-AK FD ²⁾	1 to 10% by weight	Powder	⁷⁾
	Bonderite C-MC 11120 ³⁾	2 to 10% by weight	Powder	⁷⁾
Kluthe	Hakutex 60 mtu ⁹⁾	100% by volume	Liquid	X00070585 (25 kg)
For coolant systems contaminated with bacteria, fungi or yeast (so-called system cleaners):				
Vink Chemicals	Grotan WS Plus ⁵⁾	0.15% by volume	Liquid	X00065326 (10 kg)
	Grotanol SR2 ⁶⁾	0.5% by volume	Liquid	X00069827 (10 kg)

Table 31:

¹⁾ For light lime deposits, light corrosion

²⁾ For lime deposits containing oil and grease

³⁾ Preferred for heavy lime deposits

⁴⁾ For oily and greasy residues. Not suitable for galvanized surfaces

⁵⁾ Bacteria contamination up to 10^4

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

⁷⁾ Not stocked by Rolls-Royce Solutions

⁸⁾ With serious corrosion; not permitted for aluminum materials

⁹⁾ Solvent cold cleaner for oily and greasy residues

Important

Do not use components containing brass in the cooling 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.

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.

9.3 Engine coolant circuits - Flushing

1. Drain engine coolant.
2. Measure the pH value of the freshwater using the mtu test kit or an electrical pH value measuring device.
3. Fill freshwater into the coolant circuit.

Important

Never pour cold water into a hot engine!

4. Preheat the engine, start it up and run until warm.
5. Run engine at increased speed for approx. 30 minutes.
6. Take flushing liquid sample at engine-coolant-sample extraction cock.
7. Shut down engine.
8. Drain flushing liquid.
9. Measure pH value of flushing liquid sample using the mtu test kit or electrical pH value measuring device and compare with the pH value of the freshwater.
 - a) pH value difference < 1 : Fill system with treated coolant and start engine.
 - b) pH value difference > 1 : Fill with fresh flushing liquid and repeat flushing cycle.
 - c) If the pH value difference is still > 1 even after flushing 4 to 5 times the coolant circuit must be cleaned, see (→ Page 57). The assemblies may also need cleaning, see (→ Page 59).

Important

Refer to the engine operating instructions for additional information.

9.4 Engine coolant circuits - Cleaning

1. Mix cleaner to the specified concentration with freshwater. 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 55).
3. In the case of powdered products, stir until the cleaning agent is completely dissolved and without sediment.
4. Pour solution together with freshwater into coolant circuit.
5. Start engine and run until warm.
6. Select temperature and duration of residence time according to the specifications of the technical data sheets of the manufacturer.
7. Shut down engine.
8. Drain off cleaning agents and flush the engine coolant circuit with fresh water.
9. Take flushing liquid sample at engine-coolant-sample extraction cock.
10. Measure pH value of flushing liquid sample using the mtu test kit or electrical pH value measuring device and compare with the pH value of the freshwater.
 - a) pH value difference < 1: Fill system with treated coolant and start engine.
 - b) pH value difference > 1: Clean assemblies, see (→ Page 59).

Important

Refer to the engine operating instructions for additional information.

9.5 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.

9.6 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 55)

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 56).
12. Check coolant system for leaks during initial operation of engine.

Important

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

9.7 Coolant circuits contaminated with bacteria, fungi or yeast

System cleaning

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

Therefore, the predefined amount of the approved system cleaner must be added to the contaminated coolant in the system, see (→ Page 55). Use a circulating pump to provide continuous mixture flow through the coolant system for at least 24 hours or max. 48 hours.

Flushing

When the coolant and system cleaner have been drained, the cooling circuit must be flushed with fresh water. Flushing must be carried out until no more contaminants are visible and the flushing liquid has the same pH-value as the fresh water used (max. pH-value difference < 1).

Refill

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

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

9.8 Cleaning the Product Externally

9.8.1 General information

If, in the course of time, contaminants such as oil deposits and leaves have accumulated on the engine, it might be necessary to clean it. This should be done with due care and only on the surface.

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

Before getting started and using cleaning agents, electrical components (battery-charging generator, plug connections, ignition cables etc.) and the air intake should be protected with covers to avoid water ingress into the plug connections or combustion chambers, which could cause damage.

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

All plug connections should be checked and, if necessary, blown out with compressed air after cleaning to avoid misfiring and other electrical problems.

Only products approved by Rolls-Royce Solutions GmbH at the specified concentrations may be used for cleaning. The specified cleaning procedure is to be complied with.

Important

Cleaning must be carried out with pressure washers at an operating pressure of ≤ 60 bar to avoid damage to the cooler and the engine. High-pressure cleaners with an operating pressure > 60 bar are not permitted.

After the clean-washing procedure, the equipment must be thoroughly rinsed with freshwater. The specifications in the chapter "Fresh water requirements for cleaning solutions and flushing water" are applicable. The technical data sheets and safety data sheets of the product must be observed!

Important

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

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

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

Test equipment, auxiliary materials and fluids and lubricants

mtu test kit or electrical pH-value measuring instrument

- Freshwater
- Superheated steam
- Compressed air

9.8.2 Approved cleaning agents

Manufacturer	Product name	Working concentration		Order no.
For remote cooler on air side:				
Kluthe GmbH	Hakupur 50 K ¹⁾	0.5% by volume - 5% by volume	Liquid	X00070940 ²⁾
For cleaning painted, contaminated surfaces externally:				
Kluthe GmbH	Hakupur 449 ¹⁾	1% by volume	Liquid	X00071179 ²⁾

Table 32:

¹⁾ Cleaning agent for cleaning with high-pressure cleaning device (parameter: 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

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.

10 Revision Overview

10.1 Revision overview

Important

This publication is applicable to Series 1600 PowerPack® engines.
 All information on other mtu and MTU-DD series engines is provided in the Fluids and Lubricants Specifications publication no. A001061/..., for Series 1800 PowerPack® in A001062/..., and for Series 1600 in A001063/....

Revision overview

The table lists the changes to version A001065/03 in version A001065/04.

Revision overview from version A001065/03 to A001065/04

Seq. No.	Page	Subject	Action	Action
1	(→ Page 6)	Requirements and oil change intervals	Revised	Complete chapter
2	(→ Page 10)	Lubricating greases	Revised	Heading Oil change intervals ... changed
3	(→ Page 11)	Transmission oils for rail vehicles with ZF transmissions	Revised	Complete chapter
4	(→ Page 16)	General information (coolants)	Revised	Complete chapter
5	(→ Page 19)	Unsuitable materials in the coolant circuit	Revised	Complete chapter
6	(→ Page 20)	Requirements imposed on freshwater	Revised	Complete chapter
7	(→ Page 24)	Diesel fuels – General information	Revised	Complete chapter
8	(→ Page 28)	Model type-based diesel fuel approvals, Series 1600	Revised	Complete chapter
9	(→ Page 35)	Multi-grade oils – Category 2.1 (Low SAPS oils), SAE grades 0W-30, 10W-30, 5W-40, 10W-40 and 15W-40	Revised	Complete chapter
10	(→ Page 39)	Multi-grade oils – Category 3.1 (Low SAPS oils), SAE grades 5W-30, 10W-30 and 10W-40 for diesel engines		
11	(→ Page 48)	Antifreeze – Concentrates on ethylene glycol basis	Revised	Complete chapter
12	(→ Page 51)	Antifreeze – Ready mixtures on ethylene glycol basis	Revised	Complete chapter
13	(→ Page 63)	Revision overview	Revised	Revisions from Version 03 to 04

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