

Preservation and Represervation Specifications

Engines and engine-generator sets

- Diesel engines all MTU series
- Gas engines MTU series 4000
- Diesel engine-generator sets with MTU engines of Series 1600, 2000, 4000
- Gas engine-generator sets with MTU engines of Series 400 and 4000
- Series 1600 and 1800 PowerPack®

A001070/03E





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1 Preface

1.1 Notes on the validity and use of the Preservation and Represervation Specifications

Validity of the Preservation Specifications

These Preservation Specifications define the media for preservation/re-preservation (preservatives) and the guidelines for de-preservation and packaging of engines, engine-generator sets and PowerPack® from MTU Friedrichshafen GmbH or MTU Onsite Energy GmbH.

The Preservation Specifications apply to the following products:

- · All diesel and gas engines from MTU Friedrichshafen GmbH
 - Reserve stock engines
 - Installed engines that have not yet been put into service
 - Field engines with extended downtime, e.g. normal out-of-service periods, out-of-service-periods for scheduled maintenance or unscheduled repair work.
- Diesel engine-generator sets with MTU engines of Series 1600, 2000, 4000 from MTU Onsite Energy GmbH
 - Engine-generator sets stored in reserve
 - Installed engine-generator sets that have not yet been put into service
 - Engine-generator sets in the field with long downtimes, e.g. normal out-of-service periods, out-of-service-periods for scheduled maintenance or unscheduled repair work
- Gas engine-generator sets with MTU engines of Series 400 and 4000 from MTU Onsite Energy GmbH
 - Engine-generator sets stored in reserve
 - Installed engine-generator sets that have not yet been put into service
 - Engine-generator sets in the field with long downtimes, e.g. normal out-of-service periods, out-of-service-periods for scheduled maintenance or unscheduled repair work
- PowerPack® with MTU engines of Series 1600 and 1800 from MTU Friedrichshafen GmbH

The preservation / re-preservation scope is the same for all engine models and engine-generator sets.

When preserving complete engine-generator sets, the preservation specifications of component manufacturers, e.g. of the gearbox, generator, preheating unit and couplings, must also be observed.

In addition to these Preservation Specifications, the corresponding documentation of the engine, engine-generator set or PowerPack® must also be observed. Work and tests during an interruption of operation and prior to a renewed startup are to be performed according to this documentation.

The following described measures are limited to engines and engine-generator sets from MTU.

Exception: With the Series 1800 and 1600 engines, in each case the complete PowerPack® is taken into consideration.

Other applicable documents

- · Preservation specifications of the gearbox manufacturer
- Documentation of the engine, engine-generator set or PowerPack
- · Safety data sheets for preservation media
- Current MTU Fluids and Lubricants Specifications

Applicability of this publication

The current amendment status of these Preservation and Re-preservation Specifications is shown in the Revision overview (→ Page 120).

The Preservation and Re-preservation Specifications are modified or supplemented as required. Before using them, make sure you have the latest version. Before using them, contact Customer Service of MTU Friedrichshafen GmbH or MTU Onsite Energy GmbH to make sure you have the latest version of this publication (publication number A001070/..).

Please contact your MTU representative should you have any queries.

Warranty

Use of the approved preservatives, 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 preservatives is responsible for the worldwide standard quality of the named products. MTU Friedrichshafen GmbH and MTU Onsite Energy GmbH accept no responsibility whatsoever for improper or illegal use of the preservatives which they have approved. Users of the products named in these specifications are therefore obliged to inform themselves of the locally valid regulations.

Important

As the re-preservation intervals and the medium also depend on the storage conditions and type of packaging, the warranty shall become invalid in the event of incorrect storage or packaging.

These regulations are derived from the manufacturers' specifications, 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 preservatives is therefore not possible within this publication.

Users of the products named in these Fluids and Lubricants Specifications are therefore obliged to inform themselves of the locally valid regulations. MTU accepts no liability whatsoever for improper or illegal use of the preservatives which it has approved.

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.

Registered trademarks

All brand names are registered trademarks of the manufacturer concerned.

1.2 Safety instructions for handling preservatives

Important

Preservatives for drive systems can be inherently dangerous. Certain regulations must be observed when handling, storing and disposing of these substances.

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

Users of the products named in these specifications are therefore obliged to inform themselves of the locally valid regulations. MTU Friedrichshafen GmbH and MTU Onsite Energy GmbH accept no responsibility whatsoever for improper or illegal use of the preservatives which they have approved.

2 Preservation and Represervation

2.1 Notes on preservation and re-preservation

Preservation

The term "preservation" refers to:

- · Initial preservation in the plant
- · Preservation of an engine, engine-generator set or PowerPack in the field prior to long out-of-service periods

Prior to delivery from the plant, MTU engines are usually initially preserved in accordance with MTV 5073 (does not apply to Series 400 engines). This is generally carried out during the acceptance test on the test bench.

In the event of extended out-of-service periods, machined, non-protected surfaces, for example cylinder liner running faces, are susceptible to corrosion and must therefore be preserved.

Preservation measures are carried out in the same manner as re-preservation. The scope of preservation depends on the duration of the out-of-service period.

Engine-generator sets, PowerPacks and field engines and engines that were put out of service for a scheduled major overhaul must be preserved immediately after their last service period.

Important

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

Preservation must be repeated at regular intervals (re-preservation).

Re-preservation

"Re-preservation" refers to the renewal of already existing preservation at specified time intervals.

The intervals differ for internal and external preservation and - for internal preservation - according to the different media (oil, fuel, coolant) and filling levels. For re-preservation intervals, refer to (→ Page 27) and (→ Page 28)

Important

As the re-preservation intervals and the medium also depend on the storage conditions and type of packaging, the warranty shall become invalid in the event of incorrect storage or packaging.

For storage and transport conditions, see (→ Page 13).

Preservatives

The service life, operational reliability and function of the drive systems are largely dependent on the fluids, lubricants and preservatives employed. The correct selection and treatment of these fluids, lubricants and preservatives are therefore extremely important.

For preservation and re-preservation of MTU engines, only the preservatives approved in these preservation specifications must be used (→ Page 15).

Documentation requirements

(Re-)preservation, de-preservation and monitoring of an engine with climate-compatible packaging must be documented by the person responsible:

- Check sheet for preservation and re-preservation of engines (→ Page 10)
- Check sheet for preservation and re-preservation of engine-generator sets (→ Page 11)
- Check sheet for preservation and re-preservation of PowerPacks (→ Page 13)
- Instruction sheet for de-preservation if climate-compatible packaging is used (→ Page 94)
- Monitoring Sheet for engines with climate-compatible packaging (→ Page 107)

Check sheet for preservation and re-preservation of engines

Important

Engine model designation: Engine No.:

All preservation work that is performed must be recorded on the check sheet shown below. For engines stored with a manufacturer guarantee, the Monitoring Sheet (→ Page 107) must also be filled out and sent back to MTU Friedrichshafen GmbH in due time before putting the engine back into operation.

Correct completion of the preservation tasks as specified in the Preservation Specifications must be certified on this check sheet by the person completing the various tasks.

Acceptance date:

Liigilie model designation.	Tilgille No	Acceptant	c date.
Tasks performed	Date	Name	
Lube oil system			
Preserved with preservation oil Oil brand used:			
Fuel system			
Preserved with preservative fuelFuel filter, prefilter and fuel linesPreservative fuel used:			
Cooling system, filled			
Preserved with treated coolantCoolant not drainedBrand of coolant used:			
Cooling system, unfilled			
 Preserved with an approved corr tion of the coolant circuit Corrosion inhibitor drained Corrosion inhibitor used: 			
Combustion chamber			
Preserved with preservation oil Oil brand used:			
Non-painted parts			
 Painted with corrosion inhibitor Engine openings sealed as specir All parts to be kept free of paint, and starter pinion as well as non-linkage and the uncovered coupl three-phase generator are brush Corrosion inhibitor used: 			
Engine is preserved as specified.			
Re-preservation performed according	ng to instructions.		

Further procedure

- 1. After completing preservation work, put the completed check sheet into a closed plastic sleeve.
- 2. Seal the sleeve at the open side and attach it to the engine so that it is clearly visible.
- 3. Store the check sheet until de-preservation beside the engine and send back to MTU Friedrichshafen GmbH in good time before initial operation.

2.3 Check sheet for preservation and re-preservation of enginegenerator sets

Important

All preservation work that is performed must be recorded on the check sheet shown below. For enginegenerator sets stored with a manufacturer guarantee, the Monitoring Sheet (→ Page 107) must also be filled out and sent back to MTU Onsite Energy GmbH in due time before putting the engine back into opera-

Correct completion of the preservation tasks as specified in the preservation specifications must be confirmed on this check sheet by the person completing the various tasks.

Model designation of the engine- generator set:	Number of the engine-generator set:	Acceptance date:	
Tasks performed	Date	Name	
Lube oil system			
Preserved with preservation oil. Oil brand used:			

Fuel system

- Preserved with preservative fuel.
- Fuel filter, prefilter, cooler and fuel lines have not been drained.

• Opening of lube oil pump, if fitted, is sealed.

Cooling system, filled

- Preserved with prepared coolant. The cooling system is filled to a level which exceeds the filler neck base of the cooler, if fitted.
- · Coolant not drained.
- Coolant brand used:

Cooling system, unfilled

- · Preserved with an approved corrosion inhibitor for internal preservation of the coolant circuit.
- · Corrosion inhibitor is drained
- Corrosion inhibitor used:

Combustion chamber

- Preserved with preservation oil.
- Oil brand used:

External electrical components, if fitted

- · All components with external power supply are de-energized. This applies, for example, to:
 - Battery charger
 - Control panel
 - Circuit breakers spring is released
 - Automatic transfer switch spring is released
 - Components of fuel and cooling systems
- Starter batteries are disconnected and dismounted.

Tasks performed	Date	Name
Non-painted parts		
 Unpainted bare parts, such as flywheel, starter ring gear, starter pinion, bare connections of electrical components are treated with corrosion inhibitor. Corrosion inhibitor used:		
Miscellaneous		
 Remaining engine openings are sealed as specified. Generator bearings are lubricated. Lubricating grease used: 		
Engine-generator set is preserved as specified.		
Re-preservation performed according to specifications.		

Further procedure

- 1. After completing preservation work, put the completed check sheet into a closed plastic sleeve.
- 2. Seal the sleeve at the open side and attach it to the engine-generator set so that it is clearly visible.
- 3. Store the check sheet until de-preservation beside the engine and send back to MTU Onsite Energy GmbH in good time before initial operation.

2.4 Check sheet for preservation and re-preservation of PowerPack®

Important

All preservation work that is performed must be recorded on the check sheet shown below.

Correct completion of the preservation tasks as specified in the preservation specifications must be confirmed on this check sheet by the person completing the various tasks.

Model designation of the Power-Pack®:	Number of the PowerPack® or engine:	Acceptance date:

Tasks performed	Date	Name
Lube oil system		
 Filled with preservation oil in accordance with the Preservation Specifications. Oil brand used: 		
Fuel system		
 Preserved with preservative fuel Fuel filter, prefilter, cooler and fuel lines have not been drained. Preservative fuel used: 		
Cooling system, filled		
 Preserved with treated coolant in accordance with preservation specifications. Fill the cooling system in accordance with the specifications. Coolant not drained Coolant brand used: 		
Cooling system, unfilled		
 Preserved with an approved corrosion inhibitor in accordance with the preservation specifications for internal preservation of the coolant circuit Corrosion inhibitor is drained. Corrosion inhibitor used: 		
RA dosing system, filled		
 Completely filled with reducing agent With re-preservation: Flushed with reducing agent Up to max. 12 months (observe durability of the RA) 		
RA dosing system, unfilled		
Flushed with double-distilled waterRepeat every three years		
External electrical components, if fitted		
 All components with external power supply are de-energized. Battery / CaPoS (Capacitor Power System) discharged. Fuses set to Off 		
Non-painted parts		
 Unpainted bare parts, such as flywheel, starter ring gear, starter pinion, bare connections of electrical components are treated with corrosion inhibitor in accordance with preservation specifications. Corrosion inhibitor used: 		

Tasks performed	Date	Name
Miscellaneous		
Remaining engine/PowerPack® openings are sealed according to the specifications.		
PowerPack® is preserved and painted according to the specifications.		
(Re-)preservation performed according to specifications.		

Further procedure

- 1. After completing preservation work, put the completed check sheet into a closed plastic sleeve.
- 2. Seal the sleeve at the open side and attach to the PowerPack® so that it is clearly visible.
- 3. Store the check sheet at the PowerPack® until de-preservation.

3 Approved Preservatives

Preservatives - Requirements 3.1

These preservation specifications define the preservatives for the preservation and re-preservation of MTU engines.

Preservatives are divided into groups according to their operating areas:

- Initial operation and corrosion inhibitor for internal preservation of the oil circuit
- · Corrosion inhibitors for internal preservation of the coolant circuit
- Corrosion inhibitors for internal preservation of the fuel system
- · Corrosion inhibitor for preservation of the combustion chamber
- · Corrosion inhibitors for external preservation

Test standards for preservatives

The following test standards are used for the evaluation and selection of preservatives for MTU engine-generator sets:

Test standard	Designation
DIN	Deutsches Institut für Normung (Federal German Standards Institute)
EN	Europäische Normung (European Standards)
ISO	International standard
ASTM	American Society for Testing and Materials
IP	Institute of Petroleum

Approval of preservatives

For preservation and re-preservation of MTU engines, only the preservatives approved in these preservation specifications must be used.

The conditions for the approval of preservatives are defined in MTU delivery standards (MTL):

- MTL 5051 for initial operation and preservative oil
- MTL 5052 for corrosion inhibitors for external preservation
- MTL 5048 for corrosion inhibitors/antifreeze for internal preservation of the filled coolant circuit

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

Note on initial operation

Before initial operation, the engine has to be de-preserved (→ Page 93).

3.2 Corrosion Inhibitor for Internal Preservation

3.2.1 Corrosion inhibitors for oil circuit and combustion chamber

The media in the table below, with one exception, are suitable for internal preservation of the oil circuit as well as preservation of the combustion chamber.

CAUTION:

- Shell Rimula R6 ME 5W-30 must not be used to preserve the combustion chamber.
- Titan EM 4599 must only be used for preservation of a gas engine with a maximum runtime of 25 h. All other listed preservative oils for gas engines are only permitted for flushing through in order to preserve the gas engine. When the gas engine is put into operation, the system must be flushed through with approved oil (see valid Fluids and Lubricants Specifications).

Manufacturer	Brand name	Material num- ber	Remarks		ty for en- servation
				Filled	Unfilled
Cepsa Lubricantes S.A.	Cepsa Rodaje Y Pro- teccion SAE 30	-	Full-load engine oil as per Oil Category 1	х	х
Exxon Mobil	Mobilarma 524	-	Preservative oil: Only approved for preservation run	х	х
Fuchs	Titan Universal HD 30 MTU	X00058057 (barrel) X00013236 (tanker)	Full-load engine oil as per Oil Category 2	х	х
	Titan EM 4599	X00069220 (barrel)	Special application: On- ly approved for gas en- gine, engine operation permitted with this oil for maximum 25 h SAE class 40 with in- creased corrosion pro- tection	х	Х
	Titan Cargo Maxx SAE 10W-40	-	Full-load engine oil of Category 3.1 (Low Saps) with additional corro- sion protection		
RS Schmierstoff Vertrieb GmbH	SRS Antikorrol M Plus SAE 30	X00058336 (barrel) X00058338 (tanker)	Only permitted for run- in and series accept- ance (oil category 2)	Х	Х
	SRS Motoröl O-236 SAE 15W-40	X00057300	Full-load engine oil as per Oil Category 2	х	Х
	SRS Antikorrol MLA SAE 10W-40	-	Full-load engine oil of Category 3.1 (Low Saps) with additional corro- sion protection	х	х

x suitable for engine preservation

- unsuitable for engine preservation

Manufacturer	Brand name	Material num- ber	Remarks		ty for en- servation				
				Filled	Unfilled				
Shell	Shell Running-In Oil 7294 SAE 30	_	Preservative oil: Only approved for preservation run	х	х				
	Shell Rimula R6 ME 5W-30	X00009123 X00058058 (barrel)	Special application: On- ly approved for 1800PP series Engine oil as per Oil Cat- egory 3 without im- proved corrosion pro- tection	х	-				
	Shell Rimula R6LM SAE10W-40	X00072386 X00072394 (barrel)	Full-load engine oil of Category 3.1 (Low Saps) with additional corro- sion protection	х	х				
	x suitable for engine preservation - unsuitable for engine preservation								

Table 1: Corrosion inhibitors for the oil circuit and the combustion chamber of diesel and gas engines

3.2.2 Corrosion inhibitor for coolant circuit

Manufac- turer	Brand name	Part No.	Remarks		ty for en- servation
				Filled	Unfilled
BASF	Glysacorr P113* (aqueous)	X00046660	 9 to 11% by volume application concentration Optimum corrosion protection during draining < 40 °C Reduced corrosion protection during hot draining 100 h maximum operating period Not an engine coolant! 	-	х
BASF	Glysacorr P113 Frostschutz* (anti- freeze) (propylene-glycol basis)	X00065818	 40 to 50% by volume application concentration Optimum corrosion protection during draining < 40 °C Reduced corrosion protection during hot draining 100 h maximum operating period Antifreeze protection Up to -16 °C at 40% vol. Up to -28 °C at 50% vol. Not an engine coolant! 	-	х
Valvoline	Zerex P113*) (aqueous)	-	 9 to 11% by volume application concentration Optimum corrosion protection during draining < 40 °C Reduced corrosion protection during hot draining 100 h maximum operating period Not an engine coolant! 	-	х
Valvoline	Zerex P113 anti- freeze* (propylene- glycol based)	-	 40 to 50% by volume application concentration Optimum corrosion protection during draining < 40 °C Reduced corrosion protection during hot draining Antifreeze protection Up to -16 °C at 40% vol. Up to -28 °C at 50% vol. Not an engine coolant! 	-	х

x suitable for engine preservation

⁻ unsuitable for engine preservation

^{*} hereinafter referred to a inhibitor concentration

Manufac- turer	Brand name	Part No.	Remarks		ty for en- servation
				Filled	Unfilled
Houghton Deutsch- land GmbH	Oil 9156* (emulsion)	X00056749	 1 to 2% by volume application concentration The engine must be flushed prior to filling with actual engine coolant Exception: If Oil 9156 is approved as coolant additive for the relevant series (see applicable Fluids and Lubricants Specifications) 	-	x
Others	All corrosion inhibiting antifreezes approved for the respective series in accordance with the applicable Fluids and Lubricants Specifications	-	The engine can then be operated with this engine coolant. Prerequisites: Corrosion inhibiting antifreeze is approved for engine operation Shelf life not expired	X	-

x suitable for engine preservation

Table 2: Corrosion inhibitor for the coolant circuit of diesel and gas engines

Important

In contrast to coolants, inhibitor concentrations also protect the coolant circuit against corrosion when drained.

Inhibitor concentrations can also contain vapor phase inhibitors. For this reason, ensure that the coolant circuits are always hermetically sealed. This prevents the inhibitors from escaping to the surrounding area, which would result in a reduced corrosion protective effect.

Important

Aqueous corrosion inhibitors and emulsions are not approved for engine preservation when filled. Reason: Lack of antifreeze protection and susceptibility to microbiological attack.

If no corrosion inhibiting antifreeze is approved for a series, an appropriate coolant additive can be selected from the approved of the 4000 series/containing light alloy (see applicable Fluids and Lubricants Specifications A001061/xx). Ensure, however, that prior to engine operation this coolant is replaced by a coolant approved in the Fluids and Lubricants Specifications of the relevant series.

For series that only have application approval for emulsions, storage with filled corrosion inhibiting antifreeze is impermissible.

When mixing coolant or inhibitor concentration, only use clean, clear water of the following quality:

Parameters	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	6.5	8.0
Chloride ions	-	100 mg/l
Sulphate ions	-	100 mg/l
Anions total	-	200 mg/l

⁻ unsuitable for engine preservation

^{*} hereinafter referred to a inhibitor concentration

Parameters	Minimum	Maximum
Bacteria	-	10 ³ CFU*/ml
Fungi, yeasts *CFU : Colony forming unit	Are permissible	

If the limit values for the water are exceeded, demineralized water can be added to reduce the hardness or mineral content.

3.2.3 Corrosion inhibitor for the fuel system

Diesel engines

Manufacturer	Brand name	Material num- ber	Remarks		ty for en- servation
				Filled	Unfilled
SRS Schmierstoff Vertrieb GmbH	SRS Calibration Fluid	X00057309	Test oil as per DIN ISO 4113	х	х
Shell	V – Oil 1404	_	Test oil as per DIN ISO 4113	х	х
-	Diesel fuel B0*)	X00056047	Without biodiesel	х	-
-	Diesel fuel B0*)	X00056047	Without biodiesel		
SRS Schmierstoff Vertrieb GmbH	9 to 13% SRS Anti- korrol M Plus SAE 30	X00058336 X00058338		х	х
_	Diesel fuel B0*)	X00056047	Without biodiesel		
Fuchs	9 to 13% Titan Uni- versal HD MTU	X00058057 X00013236		Х	Х

x suitable for engine preservation

Table 3: Corrosion inhibitor for the fuel system of diesel engines

Important

B0 is diesel fuel in accordance with DIN EN 590 without biodiesel. Diesel fuel according to DIN EN 590 (also referred to as B7) normally contains an additive of 7% biodiesel and must not be used for preserva-

Gas engines (natural gas and biogas)

When the engine is shut down, it can be assumed that the entire fuel system is filled with air only. If, however, there are still small amounts of gas in the engine, they do not have a corrosive effect. Preservation is therefore not required.

However, you should ensure that there is no moisture between mixture cooler and cylinder head. If moisture is detected, the engine must be run 2 to 3 hours in partial load.

The approved gases are listed in the current Fluids and Lubricants Specifications.

⁻ unsuitable for engine preservation

^{*} see Information

3.3 Corrosion inhibitors for external preservation

When preserving the engine exterior shell, all non-painted parts must be treated with a corrosion inhibitor. This forms a waxy protective coating after the solvent has evaporated.

Manufacturer	Brand name	Material number	Remarks
Castrol Ltd.	Rustilo 181	_	Waxy protective coating
	Rustilo Tarp CFX (BFX in USA)	-	Gel-type protective coating
Valvoline Oel	Tectyl 846-K-19	X00057275 X00057276	Waxy protective coating
Dinol	Dinitrol 975	X00067205	Waxy protective coating
Henkel	Teroson WX 210	X00067290	Waxy protective coating, formerly called Multi Wax Spray

Table 4: Corrosion inhibitor for external preservation of diesel or gas engine

Re-preservation requirement

• See Re-preservation intervals (→ Page 24)

3.4 Preservatives for non-engine components

Manufacturer	Brand name	Material number	Remarks
Exxon Mobil Corporation	Mobil Polyrex EM	-	For generator bearings, if required

Re-preservation requirement

• Some generator types must be barred every 6 months (→ Page 30). On this occasion, the lubrication of the bearings should be checked and topped up, if necessary.

4 Represervation Intervals

4.1 Dependency between storage conditions and type of packaging

Preserved engines must be re-preserved to retain the corrosion protection. Only approved preservatives must be used for re-preservation (→ Page 15). The re-preservation intervals depend on the storage conditions and type of packaging.

For storage conditions and packaging type for gas engine-generator sets in the Series 400, see (→ Page 77).

Support

The point in time at which the storage time starts is the day on which the products leave the production plant. This applies to all types of packaging and storage conditions.

A distinction is made between the following storage conditions:

Support	Operating areas			
Normal	 Requirements of the rooms: Clean Closed Dry Heated (free of frost) Room temperature between 10 and 40 °C No strong temperature fluctuations within a few hours Monthly average relative air humidity ≤ 65% 			
Difficult	Storage in an open hall			
Note: All other storage cond	tions (e.g. outdoor storage) are not permitted.			

Packaging

The type of engine packaging depends on the storage and transport conditions.

Type of packaging	Operating areas
Transport packaging (com- mercially available)	 For engines that can be stored under normal storage conditions for a maximum of 6 months Simple transport packaging and weather protection for: Painted engines for surface transport in a container and for air cargo Engines intended for immediate use
Transport packaging (sea transport)	 For engines that can be stored under normal storage conditions for a maximum of 6 months Closed transport packaging for: Painted engines and for sea and surface transport in a container and for air cargo Engines intended for immediate use
Climate-compatible packaging	 For protection of goods susceptible to corrosion in difficult storage conditions Climate-compatible packaging can reduce the effects of difficult storage conditions, although it does not provide frost protection For engines transported by land or sea that are then stored for longer periods Up to 12 months – seaworthy packing Up to 36 months – seaworthy long-term packing Not for engines with filled medium circuits

Interpretation examples 4.2

Important

The change intervals are based on fresh media with current date of manufacture at the time of preservation. If media are already aged, the change interval is reduced by the aging period.

Example: Engine with unfilled medium circuits in climate-compatible packaging

A preserved engine with unfilled medium circuits is to be stored for 60 months in climate-compatible packaging. What are the re-preservation requirements?

In this case, the table for engines with unfilled medium circuits is relevant (→ Page 28).

Unfilled medial circuits → climate-compatible packaging:

- The medium circuits (oil, fuel, coolant) and the combustion chamber must be re-preserved every 36 months.
- The preservation of the engine outer shell (non-painted parts) must be replaced every 36 months.

Before putting a preserved engine with filled medium circuits back into operation, check whether the filled preservatives are approved for engine operation (see valid Fluids and Lubricants Specifications). If not, switch to approved fluids and lubricants.

4.3 Re-preservation intervals for MTU engines

Engines with filled medium circuits 4.3.1

Re-preservation intervals for filled medium circuits, combustion chamber and external preservation

- Climate-compatible packaging is not permissible with filled media circuits except for PowerPack®.
- For definition of storage conditions and packaging types (→ Page 24).
- Example of how to determine re-preservation intervals (→ Page 26).
- · Prior to putting the engine into operation, an oil switch to an oil approved as per MTU Fluids and Lubricants Specifications (A001061/..) must be made.
- · For field engines that have no operation option and which were initially preserved according to the correct MTU process, re-preservation of the fuel system can be omitted.
- The re-preservation intervals mentioned here do not apply to PowerPack®.

Storage conditions and	Re-pre	eservation i	Notes		
type of packaging	6	12	24	36	
Oil circuit, fuel circuit and o	ombustion	chamber			Climate-compatible pack-
Normal storage conditions and transport packaging (commercially available), transport packaging (sea transport)	-	Not appli- cable	Not appli- cable	Not appli- cable	aging is not permissible here (does not apply to PowerPack®!). Storage max. 6 months Preservatives for coolant circuit:
Coolant circuit					All corrosion inhibiting
Normal storage conditions and transport packaging (commercially available), transport packaging (sea transport)	-	Not appli- cable	Not appli- cable	Not appli- cable	antifreezes approved for the respective series in accordance with the ap- plicable Fluids and Lubri- cants Specifications
External preservation (non-	painted par	rts)			
Normal storage conditions and transport packaging (commercially available), transport packaging (sea transport)	-	Not appli- cable	Not appli- cable	Not appli- cable	
– no re-preservation required					

Table 5: Re-preservation intervals for filled medium circuits (oil, fuel, coolant), combustion chamber and external preservation

Engines with unfilled medium circuits 4.3.2

Re-preservation intervals for unfilled medium circuits, combustion chamber and external preservation

- For definition of storage conditions and packaging types (→ Page 24).
- Example of how to determine re-preservation intervals (→ Page 26).
- For field engines that have no operation option and which were initially preserved according to the correct MTU process, re-preservation of the fuel system can be omitted.

Storage conditions and	Re-preservation interval in months				Notes	
type of packaging	6	12	24	36		
Oil circuit, fuel circuit and o	combustion	chamber				
Normal storage conditions and transport packaging (commercially available), transport packaging (sea transport)	-	Not appli- cable	Not appli- cable	Not appli- cable	Storage max. 6 months	
Normal storage conditions and climate-compatible packaging	-	-	-	X		
Difficult storage conditions and climate-compatible packaging	-	-	-	X	Difficult storage conditions without climate-compatible packaging are impermissible.	
Coolant circuit						
Normal storage conditions and transport packaging (commercially available), transport packaging (sea transport)	-	Not appli- cable	Not appli- cable	Not appli- cable	Storage max. 6 months	
Normal storage conditions and climate-compatible packaging	-	-	-	Х		
Difficult storage conditions and climate-compatible packaging	-	-	-	Х	Difficult storage conditions without climate-compatible packaging are impermissible.	
External preservation (non-painted parts)						
Normal storage conditions and transport packaging (commercially available), transport packaging (sea transport)	-	Not appli- cable	Not appli- cable	Not appli- cable	Storage max. 6 months	
X re-preservation required – no re-preservation required						

Storage conditions and	Re-preservation interval in months				Notes
type of packaging	6	12	24	36	
Normal storage conditions and climate-compatible packaging	-	-	-	Х	
Difficult storage conditions and climate-compatible packaging	-	-	-	Х	Difficult storage conditions without climate-compatible packaging are impermissible.
X re-preservation required					

- no re-preservation required

Table 6: Re-preservation intervals for unfilled medium circuits (oil, fuel, coolant), combustion chamber and external preservation

4.4 Re-preservation intervals for non-engine components

The re-preservation intervals for non-engine components depend on the manufacturer and type and apply to storage under the recommended storage conditions.

For re-preservation intervals for gas engine-generator sets in Series 400, see (→ Page 77).

Generator

Manufacturer/type	Re-preserva- tion interval	Recommended storage conditions
Marathon MagnaPlus	-	 Clean, dry area in a closed room with no rapid changes in temperature and air humidity to pre- vent condensation Keep covered
Marathon MagnaMax	Every 6 months	Clean, dry area in a closed room with no rapid
Marathon MagnaPower	Every 6 months	 changes in temperature and air humidity to prevent condensation Room heating elements are required in unheated or damp areas. Keep covered Unpainted flanges, shafts, driver disks and fittings with are treated with corrosion inhibitor
Cummins	Every 6 months	 Clean, dry area in a closed room with no rapid changes in temperature and air humidity to prevent condensation Room heating elements are required in unheated or damp areas Keep covered Unpainted flanges, shafts, driver disks and fittings with are treated with corrosion inhibitor If the generator can be turned, turn the rotor during storage at least 6 times a month.
Leroy Somer (with diesel engine- generator sets)	-	 Storage until return to operation: Store generator in a dry area (< 90% humidity) To prevent damage to the bearings, there must be no strong vibrations at the place of storage. After a long storage period, check the insulation of the generator
Leroy Somer (with gas engine-generator sets)	Every 6 months	 Clean, dry area in a closed room with no rapid changes in temperature and air humidity to prevent condensation Room heating elements are required in unheated or damp areas Keep covered Unpainted flanges, shafts, driver disks and fittings with are treated with corrosion inhibitor The following measures must be carried out for all generators that are stationary for longer than six months: Lubricate the bearings of the stationary generator with double the quantity of lubricant required during standard servicing. Turn the shafting a few revolutions every 6 months. Then apply a quantity of lubricant that corresponds to standard servicing.

Starter battery

Manufacturer/type	Re-preserva- tion interval	Recommended storage conditions
Exide	Every 6 months	 Clean, dry area in a closed room 5 °C to 25 °C Disconnected and removed
Panther	Every 6 months	 Clean, dry area in a closed room 5 °C to 25 °C Disconnected and removed
Varta	Every 12 months	 Clean, dry area in a closed room 5 °C to 25 °C Disconnected and removed
Optima	Every 6 months	 Clean, dry area in a closed room 5 °C to 25 °C Disconnected and removed

5 Diesel engine - preservation and represervation

5.1 With operation option and filled medium circuits

5.1.1 Out-of-service-period up to 1 month

- The following description applies to installed engines.
- Preservation measures are not necessary.
- It is sufficient to close the emergency-air shutoff flaps, if fitted.
- All fluids and lubricants remain in the engine.
- If it is necessary to drain the fluids and lubricants, the procedure for storage with unfilled medium circuits must be followed (→ Page 36).

5.1.2 Service interruption of 1 to 3 months

- The following description applies equally to installed and removed diesel engines.
- If engine removal is planned, the preservation measures must be carried out prior to engine removal.
- If an aqueous corrosion inhibitor is used in the coolant circuit when there is a risk of frost during storage, a switch must be made to corrosion inhibiting antifreeze.
- Before putting the engine into operation, ensure that a switch has been made to an approved coolant. The engine must not be operated with antifreeze if only aqueous coolant additives are approved. The coolant additives approved for an engine or the respective application are shown in the relevant Fluids and Lubricants Specifications.
- Sealing of the openings differs depending on whether the engine is installed or removed.

Preservation	Preservation procedure	
Interior (oil, fuel and cooling system)	 Run engine until operating temperature is reached. Run engine for approx. 30 seconds up to rated speed and shut down when rated speed is reached. The engine must not be started again. All fluids and lubricants remain in the engine. 	
Combustion chamber	No preservation measures required in the combustion chamber in this period	
Non-painted parts (external preservation)	No preservation measures on non-painted parts (external preservation) required in this period.	
Sealing the openings on installed engine	 The following openings must be sealed airtight: Cooling air inlet Combustion-air inlet (close the emergency-air shutoff flaps if they are provided) Exhaust outlet Crankcase breather (where possible; with venting to atmosphere) 	
Sealing the openings on removed engine	The following openings must be sealed airtight: Cooling air inlet Combustion-air inlet (close the emergency-air shutoff flaps if they are provided) Exhaust outlet Crankcase breather (where possible; with venting to atmosphere) Coolant circuit Fuel circuit Lube oil circuit Hydraulic oil circuit Electrical plug connectors	

5.1.3 Service interruption of more than 3 months

- The following description applies equally to installed and removed diesel engines.
- · Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 27)
- If engine removal is planned, the preservation measures must be carried out prior to engine removal.
- If accessibility for the preservation measures in installed state is insufficient, carry out the following meas-
 - Remove engine and set it up on a ground run rig or test bench.
 - Consult with your MTU representative to find a suitable solution.
- Sealing of the openings differs depending on whether the engine is installed or removed.

Preservation	Preservation procedure	
Interior (oil, fuel and cooling system)	 Clean engine if necessary. Leave engine oil in engine if it is an oil approved for preservation (→ Page 16). Otherwise replace filled engine oil with an approved preservative oil, or carry out initial filling with this oil. Fill fuel system with an approved fuel (→ Page 21). If necessary, replace an already filled fuel which is not suitable for engine storage. If necessary, drain coolant and fill with approved corrosion inhibiting antifreeze or leave existing corrosion inhibiting antifreeze in coolant circuit(→ Page 18). Run engine at increased idling speed for approx. 10 minutes. The coolant must have reached operating temperature. Shut down engine. All media remain in the system. These medium circuits must be filled completely. 	
Combustion chamber	 Seal the decompression openings. Fill corrosion inhibitor for initial operation at least up to the "Min" mark.(→ Page 16) Remove end covers for air intake and exhaust gas discharge. Provide access to the charge-air manifold. This can be done by removing flame-start canisters, sensors, covers or pipes. Access to the charge-air manifold must always be established downstream of the intercooler, pressure fine filter / air filter and exhaust turbocharger. Bar warm engine with starting equipment. The engine must not start. To do this: Actuate the stop lever for mechanical governors. With electronic governors, unplug connector X4 from the injector wiring harness. While the engine is being barred, use a fine-atomizing spray gun to spray initial operation corrosion inhibitor into the charge-air pipe openings for approx. 15 seconds (→ Page 16). Seal openings for intake air and exhaust outlet airtight. Seal access to the charge-air pipes. 	
Non-painted parts (external preservation)	Coat or spray non-painted parts of the outer shell with corrosion inhibitor for external preservation (→ Page 22).	

Preservation	Preservation procedure
Sealing the openings on installed engine	The following openings must be sealed airtight: Cooling air inlet Intake air inlet (close the emergency-air shut-off flaps if they are provided) Exhaust outlet Crankcase breather (where possible; with venting to atmosphere)
Sealing the openings on removed engine	The following openings must be sealed airtight: Cooling air inlet Intake air inlet (close the emergency-air shut-off flaps if they are provided) Exhaust outlet Crankcase breather (where possible; with venting to atmosphere) Coolant circuit Fuel circuit Lube oil circuit Hydraulic oil circuit Electrical plug connectors

With operation option and unfilled medium circuits

5.2.1 Service interruption up to 3 months

- The following description applies equally to installed and removed diesel engines.
- If engine removal is planned, the preservation measures must be carried out prior to engine removal.
- Sealing of the openings differs depending on whether the engine is installed or removed.
- The medium circuits must be sealed immediately after draining the media.

5	In
Preservation Interior (oil, fuel and cooling system)	 Clean engine if necessary. Drain coolant (if present) and dispose of. Completely fill coolant circuit with approved corrosion inhibitor concentration (→ Page 18). Note: To bypass the flushing procedure during coolant filling for initial operation, the use of inhibitor concentration "Glysacorr P 113" instead of the emulsifiable corrosion inhibitor oil "Oil 9156" is recommended. Fill fuel system completely. For this purpose, use approved corrosion inhibitor for internal preservation of the fuel system which is suitable for an unfilled engine (→ Page 21). Replace engine oil if necessary. Replace with an approved initial operation and corrosion inhibitor for internal preservation of the oil circuit and which is suitable for an unfilled engine (→ Page 16). Run engine at increased idling speed for approx. 10 minutes. The inhibitor concentration must reach operating temperature. Shut down engine. Allow engine to cool down to below 40 °C. Drain engine oil.
Combustion chamber Non-painted parts (external pres-	10. Drain inhibitor concentration.No preservation measures required in the combustion chamber in this periodNo preservation measures on non-painted parts (external preservation)
ervation) Sealing the openings on installed engine	required in this period. The following openings must be sealed airtight: Cooling air inlet Combustion-air inlet (close the emergency-air shutoff flaps if they are provided) Exhaust outlet Crankcase breather (where possible; with venting to atmosphere)
Sealing the openings on removed engine	The following openings must be sealed airtight: Cooling air inlet Combustion-air inlet (close the emergency-air shutoff flaps if they are provided) Exhaust outlet Crankcase breather (where possible; with venting to atmosphere) Coolant circuit Fuel circuit Lube oil circuit Hydraulic oil circuit Electrical plug connectors

5.2.2 Service interruption of more than 3 months

- The following description applies equally to installed and removed diesel engines.
- Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 28).
- If engine removal is planned, the preservation measures must be carried out prior to engine removal.
- If accessibility for the preservation measures in installed state is insufficient, carry out the following meas-
 - Remove engine and set it up on a ground run rig or test bench.
 - Consult with your MTU representative to find a suitable solution.
- Sealing of the openings differs depending on whether the engine is installed or removed.
- CAUTION: Seal the medium circuits immediately after draining the media.

Preservation	Preservation procedure
Interior (oil, fuel and cooling system)	 Clean engine if necessary. Drain coolant (if present) and dispose of. Completely fill coolant circuit with approved corrosion inhibitor concentration (→ Page 18). NOTE: To bypass the flushing procedure during coolant filling for initial operation, the use of inhibitor concentration "Glysacorr P 113" instead of the emulsifiable corrosion inhibitor oil "Oil 9156" is recommended. Fill fuel system completely. For this purpose, use approved corrosion inhibitors for internal preservation of the fuel system which are suitable for an unfilled engine (→ Page 21). Replace engine oil if necessary. Replace with an approved initial operation and corrosion inhibitor for internal preservation of the oil circuit and which is suitable for an unfilled engine (→ Page 16). Run engine at increased idling speed for approx. 10 minutes. The inhibitor concentration must reach operating temperature. Shut down engine. Allow engine to cool down to below 40 °C. Drain engine oil. Drain inhibitor concentration.
Combustion chamber	 Seal the decompression openings. Fill corrosion inhibitor for initial operation at least up to the "Min" mark. (→ Page 16) Remove end covers for air intake and exhaust gas discharge. Provide access to the charge-air manifold. This can be done by removing flame-start canisters, sensors, covers or pipes. Access to the charge-air manifold must always be established downstream of the intercooler, pressure fine filter / air filter and exhaust turbocharger. Bar warm engine with starting equipment. The engine must not start. To do this: Actuate the stop lever for mechanical governors. With electronic governors, unplug connector X4 from the injector wiring harness. While the engine is being barred, use a fine-atomizing spray gun to spray initial operation corrosion inhibitor into the charge-air pipe openings for approx. 15 seconds (→ Page 16). Seal openings for intake air and exhaust outlet airtight. Seal access to the charge-air pipes.
Non-painted parts (external preservation)	Coat or spray non-painted parts of the outer shell with corrosion inhibitor for external preservation (\rightarrow Page 22).

Preservation	Preservation procedure
Sealing the openings on installed engine	 The following openings must be sealed airtight: Cooling air inlet Intake air inlet (close the emergency-air shut-off flaps if they are provided) Exhaust outlet Crankcase breather (where possible; with venting to atmosphere)
Sealing the openings on removed engine	The following openings must be sealed airtight: Cooling air inlet Intake air inlet (close the emergency-air shut-off flaps if they are provided) Exhaust outlet Crankcase breather (where possible; with venting to atmosphere) Coolant circuit Fuel circuit Lube oil circuit Hydraulic oil circuit Electrical plug connectors

Without operation option and filled medium circuits

- The described procedure is a guideline, which has to be adapted to the specific diesel engine in each case. Work sequence details may vary from engine to engine. Contact your MTU representative if you have any questions.
- For nuclear power station engines, re-preservation on the test bench or on site is recommended.
- Where possible, carry out the individual preservation measures at the same time
- Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 27).

Preservation	Preservation procedure
Preparation	1. Check of local specifications. NOTE: Prior to engine storage with filled medium circuits, clarify whether this is permissible with regard to hazardous goods and environmental protection regulations. 2. If necessary, clean the engine prior to (re-)preservation. NOTE: Only bar the engine after it has been primed. Therefore, first prime the engine with approved corrosion inhibitor and then build up oil pressure, then preserve the coolant circuit as well as the combustion chamber.
Lube oil circuit	 Drain old oil if necessary. Remove priming connection from crankcase. Connect oil priming pump. Use the oil priming pump to pump approved corrosion inhibitor into the oil circuit. Use corrosion inhibitor that is suitable for internal preservation of the unfilled engine. (→ Page 16). Remove the turbocharger oil return line, which is the last element in the oil circuit to be supplied with oil. Pump oil under pressure into the circuit until it emerges from the oil return line of the turbocharger. Reinstall turbocharger oil return line. This ensures that the entire lube oil circuit is completely filled. Bar engine manually one to two rotations. Leave the oil in the engine.
Coolant circuit	 Drain remaining coolant (if present) and dispose of. Completely fill coolant circuit with approved corrosion inhibitor concentration suitable for a filled engine (→ Page 18). Open all thermostats so that the inhibitor concentration reaches all areas of the coolant circuit. Leave the inhibitor concentration in the engine. NOTE: Mixing of different inhibitor concentrations is impermissible. Seal all coolant openings airtight.
Fuel system	 For field engines that have no operation option and which were initially preserved according to the correct MTU process, re-preservation of the fuel system can be omitted. If necessary, replace injectors and parts after the function test prior to putting the engine into operation.

Preservation	Preservation procedure
Combustion chamber	 Seal the decompression openings. Open air pipe downstream of intercooler. When oil pressure has built up, use a fine-atomizing spray gun to spray approved corrosion inhibitor for approx. 15 seconds into the openings of the air pipes. Use the starting system to bar the engine. The engine must not start! Use corrosion inhibitor for internal preservation of the oil circuit (→ Page 16). Carefully seal air inlet and exhaust outlet. This prevents venting via the opened inlet and exhaust valves at the cylinders in overlap position.
Non-painted parts (external preservation)	Coat or spray non-painted parts of the outer shell with corrosion inhibitor for external preservation (→ Page 22).

Without operation option and unfilled medium circuits

- The described procedure is a guideline, which has to be adapted to the specific diesel engine in each case. Work sequence details may vary from engine to engine. Contact your MTU representative if you have any questions.
- For nuclear power station engines, re-preservation on the test bench or on site is recommended.
- Where possible, carry out the individual preservation measures at the same time
- Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions(→ Page 28)
- CAUTION: Seal off all medium circuits airtight immediately after draining the preservative.

Preservation	Preservation procedure
Preparation	If necessary, clean the engine prior to (re-)preservation. Drain and dispose of all media. NOTE: Only bar the engine after it has been primed. Therefore, first prime the engine with approved corrosion inhibitor and then build up oil pressure, then preserve the coolant circuit as well as the combustion chamber.
Lube oil circuit	 Remove priming connection from crankcase. Connect oil priming pump. Use the oil priming pump to pump approved corrosion inhibitor into the oil circuit. Use corrosion inhibitor that is suitable for internal preservation of the unfilled engine. (→ Page 16). Remove the turbocharger oil return line, which is the last element in the oil circuit to be supplied with oil. Pump oil under pressure into the circuit until it emerges from the oil return line of the turbocharger. Reinstall turbocharger oil return line. This ensures that the entire lube oil circuit is completely filled. Bar engine manually one to two rotations. Then drain the oil completely. NOTE: If the engine is warm, allow it to cool down to below 40 °C and then drain oil completely.
Coolant circuit	 Drain remaining coolant (if present) and dispose of. Completely fill the coolant circuit with an approved inhibitor concentration and then seal hermetically (→ Page 18). Use an external coolant heater to heat up the engine to a min. of 75 °C. Allow engine to cool down to below 40 °C. Drain inhibitor concentration completely. Immediately after draining, seal coolant openings airtight
Fuel system	 For field engines that have no operation option and which were initially preserved according to the correct MTU process, re-preservation of the fuel system can be omitted. If necessary, replace injectors and parts after the function test prior to putting the engine into operation.

Preservation	Preservation procedure
Combustion chamber	 Seal the decompression openings. Open air pipe downstream of intercooler. When oil pressure has built up, use a fine-atomizing spray gun to spray approved corrosion inhibitor for approx. 15 seconds into the openings of the air pipes. Use the starting system to bar the engine. The engine must not start! Use corrosion inhibitor for internal preservation of the oil circuit (→ Page 16). Carefully seal air inlet and exhaust outlet. This prevents venting via the opened inlet and exhaust valves at the cylinders in overlap position.
Non-painted parts (external preservation)	Coat or spray non-painted parts of the outer shell with corrosion inhibitor for external preservation (→ Page 22).

6 Series 4000Mx5 gas engines - preservation and re-preservation

6.1 With operation option and filled medium circuits

6.1.1 Service interruption up to 1 month

Note:

- The following description applies to installed gas engines for marine applications.
- · For preservation and re-preservation of Series 4000 gas engines in gas engine-generator sets, see (→ Page 63).
- · Under normal storage conditions, all fluids and lubricants remain in the gas engine. Preservation measures are not necessary.
- Draining of the engine coolant is required under the following conditions:
 - Freezing temperatures are expected and the engine is to remain out of service for an extended period, but engine coolant has no antifreeze additive.
 - The installation area of the gas engine is not heated.
 - The coolant is not maintained at a suitable temperature.
 - The antifreeze concentration is insufficient for the gas engine room temperature.
 - Antifreeze concentration is 50% and engine-room temperature is below -40 °C.

For storage with unfilled medium circuits, see (→ Page 45)

Storage with filled medium circuits under normal conditions

- Execute "lockout/tagout procedure" (→ refer to the Operation and Maintenance Manual).
- Seal air inlet and outlet, if out-of-service time period is longer than one week.

6.1.2 Service interruption of more than one month

Important

Do not let oil penetrate the charge-air pipes. Leads to increased wear or functional failure of the MPI

- The following description applies to installed gas engines for marine applications.
- · For preservation and re-preservation of Series 4000 gas engines in gas engine-generator sets, see (→ Page 64).
- · Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 27).
- All fluids and lubricants remain in the engine.
- If an aqueous corrosion inhibitor is used in the coolant circuit, when there is a risk of frost during storage a switch must be made to corrosion inhibiting antifreeze.
- To protect the cooler during the out-of-service time, add coolant until the coolant level exceeds the filler neck base of the coolant cooler.
- Before putting the gas engine into operation, ensure that a switch has been made to an approved coolant if necessary. For coolant additives approved for operation, see (→ MTU Fluids and Lubricants Specifications for gas engines).

Preservation	Preservation procedure
Preparation	Remove all covers. Connect starter batteries. Put control system into operation.
Interior (oil, fuel and cooling system)	 Run the engine once a month up to operating temperature at a min. of 50% load. All fluids and lubricants remain in the engine. The intake air inlet must be sealed again airtight after the engine has been warmed up. Remove the air filter to do this.
Combustion chamber	No preservation measures required in the combustion chamber in this period
Non-painted parts (external preservation)	Coat or spray non-painted parts with corrosion inhibitor for external preservation (→ Page 22). This includes: • Parts of the engine outer shell • Flanges • Shafts • Driver disks • Valves and fittings
Lockout gas engine and seal open- ings	 Execute "lockout/tagout procedure" (→ refer to the Operation and Maintenance Manual). Seal all openings airtight such as air inlet and outlet. Seal off electric plug connectors against moisture.

6.2 With operation option and unfilled medium circuits

Important

Do not let oil penetrate the charge-air pipes. Leads to increased wear or functional failure of the MPI

- The following description applies to installed gas engines for marine applications.
- For preservation and re-preservation of Series 4000 gas engines in gas engine-generator sets, see (→ Page 70).
- · Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 28)
- Seal the medium circuits immediately after draining the media.

Preservation	Preservation procedure
Preparation	Remove all covers. Connect starter batteries. Put control system into operation.
Interior (oil, fuel and cooling system)	 Clean gas engine if necessary. Drain coolant (if present) and dispose of. Completely fill coolant circuit with approved corrosion inhibitor concentration (→ Page 18). Note: To bypass the flushing procedure during coolant filling for initial operation, the use of inhibitor concentration "Glysacorr P 113" instead of the emulsifiable corrosion inhibitor oil "Oil 9156" is recommended. If there is no preservative oil in the engine, drain the oil pan completely. NOTE: Alternatively, the engine can also be warmed up with normal engine oil. The next step is to use an oil priming pump to pump approx. 100 liters of approved preservative oil via the priming connection into the engine. Now perform steps 2 and 3 as described under "Combustion chamber". Fill engine with approved preservative oil. Run engine at a min. 50% power to warm it up (engine coolant min. 75 °C) NOTE: Alternatively, the engine can also be warmed up with an external coolant heater (min. 75 °C). In this case, an external oil pump must also be used. Allow engine to cool down to below 40 °C. Drain preservative oil out of oil system. Drain preservative out of coolant system. Immediately after draining, seal coolant openings airtight
Combustion chamber	 Unscrew all spark plugs. If the engine was not warmed up with preservative oil, turn all pistons for preservation one after the other to bottom dead center "BDC". Use a fine-atomizing spray gun to carefully spray the combustion chamber surfaces of the pistons and cylinder walls. When doing this, ensure that a large amount of oil does not remain on the piston crown. Screw in spark plugs

Preservation	Preservation procedure
Non-painted parts (external preservation)	Coat or spray non-painted parts with corrosion inhibitor for external preservation (→ Page 22). This includes: • Parts of the engine outer shell • Flanges • Shafts • Driver disks • Valves and fittings
Lockout gas engine and seal openings	 Execute "lockout/tagout procedure" (→ refer to the Operation and Maintenance Manual). Seal all openings airtight such as air inlet and outlet. Seal off electric plug connectors against moisture.

Without operation option and filled medium circuits

Important

Do not let oil penetrate the charge-air pipes. Leads to increased wear or functional failure of the MPI

- The described procedure is a guideline, which has to be adapted to the specific gas engine in each case. Work sequence details may vary from engine to engine. Contact your MTU representative if you have any
- · Where possible, carry out the individual preservation measures at the same time
- · Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions(→ Page 27)
- Preservation of the fuel system of gas engines is not envisaged.

Preservation	Preservation procedure
Preparation	 Check of local specifications NOTE: Prior to engine storage with filled medium circuits, clarify whether this is permissible with regard to hazardous goods and environmental protection regulations. If necessary, clean the engine prior to (re-)preservation. NOTE: Only bar the engine after it has been primed. Therefore, first prime the engine with approved corrosion inhibitor and then build up oil pressure, then preserve the coolant circuit as well as the combustion chamber.
Lube oil circuit	 Drain old oil if necessary. Remove priming connection from crankcase. Connect oil priming pump. Use the oil priming pump to pump approved corrosion inhibitor into the oil circuit. Use corrosion inhibitor that is suitable for internal preservation of the unfilled engine. (→ Page 16). Bar engine manually one to two rotations. The oil can remain in the engine although continuous engine operation in this state is not permissible (max. 25 h). For continuous engine operation, the oil must be replaced with approved engine oil (see valid Fluids and Lubricants Specifications).
Coolant circuit	 Drain remaining coolant (if present) and dispose of. Completely fill coolant circuit with approved corrosion inhibitor concentration (→ Page 18). Open all thermostats so that the inhibitor concentration reaches all areas of the coolant circuit. Leave the inhibitor concentration in the engine. NOTE: Mixing of different inhibitor concentrations is impermissible. Seal all coolant openings airtight.

Preservation	Preservation procedure
Combustion chamber	 Unscrew all spark plugs. Turn all pistons for preservation one after the other to bottom dead center "BDC". Use a fine-atomizing spray gun to carefully spray the combustion chamber surfaces of the pistons and cylinder walls. When doing this, ensure that a large amount of oil does not remain on the piston crown. Screw in spark plugs. NOTE: Spark plugs must be reinstalled just as they were removed. Handle with great care to avoid damaging the coating of the threads. Do not hold on the thread, do not knock them or clean them. Seal intake air inlet and exhaust outlet airtight and reseal if necessary.
Non-painted parts (external preservation)	 Coat or spray non-painted parts of the outer shell with corrosion inhibitor for external preservation (→ Page 22).

Without operation option and unfilled medium circuits

Important

Do not let oil penetrate the charge-air pipes. Leads to increased wear or functional failure of the MPI

- The described procedure is a guideline, which has to be adapted to the specific gas engine in each case. Work sequence details may vary from engine to engine. Contact your MTU representative if you have any questions.
- · Where possible, carry out the individual preservation measures at the same time
- · Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 28).
- Preservation of the fuel system of gas engines is not envisaged.
- Seal the medium circuits immediately after draining the media.

Preservation	Preservation procedure
Preparation	If necessary, clean the engine prior to (re-)preservation. Drain and dispose of all media. NOTE: Only bar the engine after it has been primed. Therefore, first prime the engine with approved corrosion inhibitor and then build up oil pressure, then preserve the coolant circuit as well as the combustion chamber.
Lube oil circuit	 Remove priming connection from crankcase. Connect oil priming pump. Use the oil priming pump (approx. 100 liters) to pump approved corrosion inhibitor into the oil circuit. Use corrosion inhibitor that is suitable for internal preservation of the unfilled engine. (→ Page 16). Bar engine manually one to two rotations. Then drain the oil completely. Open the inspection cover and check whether the crankshaft and conrod are coated with oil. If necessary, re-preserve with a fine atomizing spray gun.
Coolant circuit	 Drain remaining coolant (if present) and dispose of. Completely fill the coolant circuit with an approved inhibitor concentration and then seal hermetically (→ Page 18). Use an external coolant heater to heat up the engine to a min. of 75 °C. Allow engine to cool down to below 40 °C. Drain inhibitor concentration completely. Immediately after draining, seal coolant openings airtight

Combustion chamber	1. Unscrew all spark plugs.
	Turn all pistons for preservation one after the other to bottom dead center "BDC".
	 Use a fine-atomizing spray gun to carefully spray the combustion chamber surfaces of the pistons and cylinder walls. When doing this, ensure that a large amount of oil does not remain on the piston crown. Screw in spark plugs NOTE: Spark plugs must be reinstalled just as they were removed. Handle with great care to avoid damaging the coating of the threads. Do not hold on the thread, do not knock them or clean them. Seal intake air inlet and exhaust outlet airtight and reseal if necessary.
Non-painted parts (external preservation)	• Coat or spray non-painted parts of the outer shell with corrosion inhibitor for external preservation (→ Page 22).

Preservation procedure

7 Diesel engine-generator sets - preservation and re-preservation

7.1 With operation option and filled medium circuits

7.1.1 Out-of-service-period up to 1 month

Note:

- The following description applies to installed diesel engine-generator sets.
- · Under normal storage conditions, all fluids and lubricants remain in the engine-generator set. Preservation measures are not necessary.
- · The drainage of engine coolant and charge-air coolant (if applicable) will be necessary if any of the following conditions apply:
 - Freezing temperatures are expected and the engine is to remain out of service for an extended period, but the engine coolant has no antifreeze additive.
 - The installation area of the engine-generator set is not heated.
 - The coolant is not maintained at a suitable temperature.
 - The antifreeze concentration is insufficient for the engine-generator set room temperature.
 - Antifreeze concentration is 50% and engine-room temperature is below -40 °C.

See storage with unfilled media circuits (→ Page 56)

Storage with filled medium circuits under normal conditions

- Execute "lockout/tagout procedure" (→ refer to the Operation and Maintenance Manual).
- Seal air and exhaust sides, if out-of-service time remains for more than one week.

7.1.2 Service interruption of 1 to 3 months

- If an aqueous corrosion inhibitor is used in the coolant circuit when there is a risk of frost during storage, a switch must be made to corrosion inhibiting antifreeze.
- To protect the coolant cooler during the out-of-service time, the coolant level must exceed the filler neck base of the coolant cooler.
- Before putting the engine into operation, ensure that a switch has been made to an approved coolant if necessary. The engine must not be operated with antifreeze if only aqueous coolant additives are approved. The coolant additives approved for an engine or the respective application are shown in the relevant Fluids and Lubricants Specifications.

Preservation	Preservation procedure
Preparations	Remove all covers. Connect starter batteries. Put control system into operation.
Interior (oil, fuel and cooling system)	 Clean engine-generator set if necessary. Run engine until operating temperature is reached. Run engine for approx. 30 seconds up to rated speed and shut down when rated speed is reached. The engine must not be started again. All fluids and lubricants remain in the engine-generator set.
Combustion chamber	No preservation measures required in the combustion chamber in this period
Non-painted parts (external preservation)	No preservation measures on non-painted parts (external preservation) required in this period.
Lockout engine-generator set and seal openings	 Execute "lockout/tagout procedure" (→ refer to the Operation and Maintenance Manual). Seal all openings tight against moisture, such as air inlet and outlet, and electrical plug connectors.

7.1.3 Service interruption of more than 3 months

- Engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (\rightarrow Page 27).
- Non-engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 30).
- All fluids and lubricants remain in the diesel engine-generator set.

Preservation	Preservation procedure
Preparations	Remove all covers. Connect starter batteries. Put control system into operation.
Interior (oil, fuel and cooling system)	 Clean engine-generator set if necessary. Leave engine oil in engine if it is an oil approved for preservation (→ Page 16). Otherwise replace filled engine oil with an approved preservative oil, or carry out initial filling with this oil. Fill fuel system with an approved fuel (→ Page 21). If necessary, replace an already filled fuel which is not suitable for engine storage. If necessary, drain coolant and fill with approved corrosion inhibiting antifreeze or leave existing corrosion inhibiting antifreeze in coolant circuit (→ Page 18). Run engine at increased idling speed for approx. 10 minutes. The inhibitor concentration must reach operating temperature. Engine shutdown All media remain in the system. These medium circuits must be filled completely.
Combustion chamber	 Seal the decompression openings. Fill corrosion inhibitor for initial operation at least up to the "Min" mark (→ Page 16). Remove end covers for air intake and exhaust gas discharge. Provide access to the charge-air manifold. This can be done by removing flame-start canisters, sensors, covers or pipes. Access to the charge-air manifold must always be established downstream of the charge-air cooler, pressure fine filter / air filter and exhaust turbocharger. Bar warm engine with starting equipment. The engine must not start. To do this: Actuate the stop lever for mechanical governors. With electronic governors, unplug connector X4 from the injector wiring harness. While the engine is being barred, use a fine-atomizing spray gun to spray initial operation corrosion inhibitor into the charge-air pipe openings for approx. 15 seconds (→ Page 16). Seal openings for intake air and exhaust outlet airtight. Seal access to the charge-air pipes.
Non-painted parts (external preservation)	Coat or spray non-painted parts of the outer shell with corrosion inhibitor for external preservation (→ Page 22). This includes: • Parts of the engine outer shell • Flanges • Shafts • Driver disks • Valves and fittings

Preservation	Preservation procedure
Non-engine components (generator and starter batteries)	 Keep generator bearings lubricated. According to the re-preservation interval, bar the engine manually to rotate the shaft several turns for distributing the grease in the bearings. For charge conservation, load starter batteries according to the represervation interval.
Lockout engine-generator set and seal openings	 Execute "lockout/tagout procedure" (→ refer to the Operation and Maintenance Manual). Seal all openings tight against moisture, such as air inlet and outlet, and electrical plug connectors.

7.1.4 Container service interruption of more than 6 months

- · Engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 27).
- · Non-engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 30).
- All fluids and lubricants remain in the diesel engine-generator set.
- · If an aqueous corrosion inhibitor is used in the coolant circuit, when there is a risk of frost during storage a switch must be made to corrosion inhibiting antifreeze.
- · To protect the coolant cooler during the out-of-service time, add coolant until the coolant level exceeds the filler neck base.
- Before putting the engine into operation, ensure that a switch has been made to an approved coolant if necessary. For coolant additives approved for operation, see (→ MTU Fluids and Lubricants Specifications for diesel engine-generator sets).

Preservation	Preservation procedure
Diesel engine-generator set	See (→ Page 53)
Container	 Store the container in accordance with the foundation requirements. Touch up paint damage on the container or built-in components in a professional manner with suitable paint to prevent corrosion. Remove deposits on the top deck (e.g. leaves, dust) on a regular basis. Grease door seals and hinges prior to placing in storage. Seal cable entries to weather-proof them (if necessary, remove cover panels). Seal exhaust gas outlet openings to weather-proof them. Guarantee draining of condensate from the exhaust system. Seal connecting flanges (dummy cover) to weather-proof them. Close louver dampers for supply and exhaust air. Where possible, keep the container interior free of frost. Avoid condensation and insert desiccant bags if necessary. Disconnect control system electrically. Disconnect starter batteries. Detach isolator switch for starter from engine (if available). NOTES: All shaft ends, parts and surfaces must be provided as of delivery with a seawater-resistant and drip-proof anti-rust coating that provides protection for a year. After this period has elapsed, the existing protective coating must be renewed once a year with Castrol SafeCoat DW33.

With operation option and unfilled medium circuits

Service interruption up to 3 months 7.2.1

- Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 28).
- CAUTION: Seal the medium circuits immediately after draining the media.

Preservation	Preservation procedure
Preparations	Remove all covers. Connect starter batteries. Put control system into operation.
Interior (oil, fuel and cooling system)	 Clean engine-generator set if necessary. Drain coolant (if present) and dispose of. Completely fill coolant circuit with approved corrosion inhibitor concentration (→ Page 18). Note: To bypass the flushing procedure during coolant filling for initial operation, the use of inhibitor concentration "Glysacorr P 113" instead of the emulsifiable corrosion inhibitor oil "Oil 9156" is recommended. Fill fuel system completely. For this purpose, use approved corrosion inhibitor for internal preservation of the fuel system which is suitable for an unfilled engine (→ Page 21). Replace engine oil if necessary. Replace with an approved initial operation and corrosion inhibitor for internal preservation of the oil circuit and which is suitable for an unfilled engine(→ Page 16). Run engine at increased idling speed for approx. 10 minutes. The inhibitor concentration must reach operating temperature. Shut down engine. Allow engine to cool down to below 40 °C. Drain engine oil. Drain inhibitor concentration.
Combustion chamber	No preservation measures required in the combustion chamber in this period
Non-painted parts (external preservation)	No preservation measures on non-painted parts (external preservation) required in this period.
Lockout engine-generator set and seal openings	 Execute "lockout/tagout procedure" (→ refer to the Operation and Maintenance Manual). Seal all openings tight against moisture, such as air inlet outlet and electrical plug connectors.

7.2.2 Service interruption of more than 3 months

- Engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 28)
- Non-engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 30)
- CAUTION: Seal the medium circuits immediately after draining the media.

Preservation	Preservation procedure
Preparations	Remove all covers. Connect starter batteries. Put control system into operation.
Interior (oil, fuel and cooling system)	 Clean engine-generator set if necessary. Drain coolant (if present) and dispose of. Completely fill coolant circuit with approved corrosion inhibitor concentration (→ Page 18). NOTE: To bypass the flushing procedure during coolant filling for initial operation, the use of inhibitor concentration "Glysacorr P 113" instead of the emulsifiable corrosion inhibitor oil "Oil 9156" is recommended. Fill fuel system completely. For this purpose, use approved corrosion inhibitors for internal preservation of the fuel system which are suitable for an unfilled engine (→ Page 21). Replace engine oil if necessary. Replace with an approved initial operation and corrosion inhibitor for internal preservation of the oil circuit and which is suitable for an unfilled engine(→ Page 16). Run engine at increased idling speed for approx. 10 minutes. The inhibitor concentration must reach operating temperature. Shut down engine. Allow engine to cool down to below 40 °C. Drain engine oil. Drain inhibitor concentration.
Combustion chamber	 Seal the decompression openings. Fill corrosion inhibitor for initial operation at least up to the "Min" mark (→ Page 16). Remove end covers for air intake and exhaust gas discharge. Provide access to the charge-air manifold. This can be done by removing flame-start canisters, sensors, covers or pipes. Access to the charge-air manifold must always be established downstream of the charge-air cooler, pressure fine filter / air filter and exhaust turbocharger. Bar warm engine with starting equipment. The engine must not start. To do this: Actuate the stop lever for mechanical governors. With electronic governors, unplug connector X4 from the injector wiring harness. While the engine is being barred, use a fine-atomizing spray gun to spray initial operation corrosion inhibitor into the charge-air pipe openings for approx. 15 seconds (→ Page 16). Seal openings for intake air and exhaust outlet airtight. Seal access to the charge-air pipes.

Preservation	Preservation procedure
Non-painted parts (external preservation)	Coat or spray non-painted parts of the outer shell with corrosion inhibitor for external preservation (→ Page 22). This includes: • Parts of the engine outer shell • Flanges • Shafts • Driver disks • Valves and fittings
Non-engine components (generator and starter batteries)	 Keep generator bearings lubricated. According to the re-preservation interval, bar the engine manually to rotate the shaft several turns for distributing the grease in the bearings. For charge conservation, load starter batteries according to the represervation interval.
Lockout engine-generator set and seal openings	 Execute "lockout/tagout procedure" (→ refer to the Operation and Maintenance Manual). Seal all openings tight against moisture, such as air inlet and outlet and electrical plug connectors.

7.3 Without operation option and filled medium circuits

- The described procedure is a guideline, which has to be adapted to the specific diesel engine-generator set in each case. Work sequence details may vary from engine-generator set to engine-generator set. Contact your MTU representative if you have any questions.
- Re-preservation on the test bench is recommended.
- Where possible, the individual preservation measures should be carried out at the same time.
- Engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 27).
- Non-engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 30).

Preservation	Preservation procedure
Preparation	 Check of local specifications. NOTE: Prior to engine storage with filled medium circuits, clarify whether this is permissible with regard to hazardous goods and environmental protection regulations. If necessary, clean the engine-generator set prior to (re-)preservation. Prime the engine. NOTE: Only bar the engine after it has been primed. Therefore, first prime the engine and then build up oil pressure, then preserve the coolant circuit as well as the combustion chamber.
Lube oil circuit	 Drain old oil if necessary. Remove priming connection from crankcase. Connect oil priming pump. Use the oil priming pump to pump approved corrosion inhibitor into the oil circuit. Use corrosion inhibitor that is suitable for internal preservation of the unfilled engine. (→ Page 16). Remove the turbocharger oil return line, which is the last element in the oil circuit to be supplied with oil. Pump oil under pressure into the circuit until it emerges from the oil return line of the turbocharger. Reinstall turbocharger oil return line. This ensures that the entire lube oil circuit is completely filled. Bar engine manually one to two rotations. Leave the oil in the engine.
Coolant circuit	 Drain remaining coolant (if present) and dispose of. Completely fill coolant circuit with approved corrosion inhibitor concentration suitable for a filled engine (→ Page 18). Open all thermostats so that the inhibitor concentration reaches all areas of the coolant circuit. Leave the inhibitor concentration in the engine. NOTE: Mixing of different inhibitor concentrations is impermissible. Seal all coolant openings airtight.
Fuel system	 For field engines that have no operation option and which were initially preserved according to the correct MTU process, re-preservation of the fuel system can be omitted. If necessary, replace injectors and parts after the function test prior to putting the engine into operation.

Preservation	Preservation procedure
Combustion chamber	 Seal the decompression openings. Open air pipe downstream of intercooler. When oil pressure has built up, use a fine-atomizing spray gun to spray approved corrosion inhibitor for approx. 15 seconds into the openings of the air pipes. Use the starting system to bar the engine. The engine must not start! Use corrosion inhibitor for internal preservation of the oil circuit (→ Page 16). Carefully seal air inlet and exhaust outlet. This prevents venting via the opened inlet and exhaust valves at the cylinders in overlap position.
Non-painted parts (external preservation)	Coat or spray non-painted parts with corrosion inhibitor for external preservation (→ Page 22). This includes: • Parts of the engine outer shell • Flanges • Shafts • Driver disks • Valves and fittings
Non-engine components (generator and starter batteries)	 Keep generator bearings lubricated. According to the re-preservation interval, bar the engine manually to rotate the shaft several turns for distributing the grease in the bearings. For charge conservation, load starter batteries according to the represervation interval.

7.4 Without operation option and unfilled medium circuits

- The described procedure is a guideline, which has to be adapted to the specific diesel engine-generator set in each case. Work sequence details may vary from engine-generator set to engine-generator set. Contact your MTU representative if you have any questions.
- Re-preservation on the test bench is recommended.
- Where possible, carry out the individual preservation measures at the same time
- Engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 28).
- Non-engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 30).
- CAUTION: Seal off all medium circuits airtight immediately after draining the preservative.

Preservation	Preservation procedure
Preparation	 If necessary, clean the engine-generator set prior to (re-)preservation. Drain and dispose of all media. Prime the engine. NOTE: Only bar the engine after it has been primed. Therefore, first prime the engine and then build up oil pressure, then preserve the coolant circuit as well as the combustion chamber.
Lube oil circuit	 Remove priming connection from crankcase. Connect oil priming pump. Use the oil priming pump to pump approved corrosion inhibitor into the oil circuit. Use corrosion inhibitor that is suitable for internal preservation of the unfilled engine. (→ Page 16). Remove the turbocharger oil return line, which is the last element in the oil circuit to be supplied with oil. Pump oil under pressure into the circuit until it emerges from the oil return line of the turbocharger. Reinstall turbocharger oil return line. This ensures that the entire lube oil circuit is completely filled. Bar engine manually one to two rotations. Then drain the oil completely. NOTE: If the engine is warm, allow it to cool down to below 40 °C and then drain oil completely.
Coolant circuit	 Drain remaining coolant (if present) and dispose of. Completely fill the coolant circuit with an approved inhibitor concentration and then seal hermetically (→ Page 18). Use an external coolant heater to heat up the engine to a min. of 75 °C. Allow engine to cool down to below 40 °C. Drain inhibitor concentration completely. Immediately after draining, seal coolant openings airtight
Fuel system	 For field engines that have no operation option and which were initially preserved according to the correct MTU process, re-preservation of the fuel system can be omitted. If necessary, replace injectors and parts after the function test prior to putting the engine into operation.

Preservation	Preservation procedure
Combustion chamber	 Seal the decompression openings. Open air pipe downstream of intercooler. When oil pressure has built up, use a fine-atomizing spray gun to spray approved corrosion inhibitor for approx. 15 seconds into the openings of the air pipes. Use the starting system to bar the engine. The engine must not start! Use corrosion inhibitor for internal preservation of the oil circuit (→ Page 16). Carefully seal air inlet and exhaust outlet. This prevents venting via the opened inlet and exhaust valves at the cylinders in overlap position.
Non-painted parts (external preservation)	Coat or spray non-painted parts with corrosion inhibitor for external preservation (→ Page 22). This includes: • Parts of the engine outer shell • Flanges • Shafts • Driver disks • Valves and fittings
Non-engine components (generator and starter batteries)	 Keep generator bearings lubricated. According to the re-preservation interval, bar the engine manually to rotate the shaft several turns for distributing the grease in the bearings. For charge conservation, load starter batteries according to the represervation interval.

Gas engine-generator sets with Series 4000 engines - preservation and re-preservation

8.1 With operation option and filled medium circuits

8.1.1 Service interruption up to 1 month

Note:

- The following description applies to installed gas engine-generator sets.
- · Under normal storage conditions, all fluids and lubricants remain in the engine-generator set. Preservation measures are not necessary.
- Draining of the engine coolant is required under the following conditions:
 - Freezing temperatures are expected and the engine is to remain out of service for an extended period, but engine coolant has no antifreeze additive.
 - The installation area of the engine-generator set is not heated.
 - The coolant is not maintained at a suitable temperature.
 - The antifreeze concentration is insufficient for the engine-generator set room temperature.
 - Antifreeze concentration is 50% and engine-room temperature is below -40 °C.

For storage with unfilled medium circuits, see (→ Page 70)

Storage with filled medium circuits under normal conditions

- Execute "lockout/tagout procedure" (→ refer to the Operation and Maintenance Manual).
- Seal air inlet and outlet, if out-of-service time period is longer than one week.

8.1.2 Service interruption of more than one month

- · Engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 27).
- · Non-engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 30).
- All fluids and lubricants remain in the gas engine-generator set.
- · If an aqueous corrosion inhibitor is used in the coolant circuit, when there is a risk of frost during storage a switch must be made to corrosion inhibiting antifreeze.
- To protect the cooler during the out-of-service time, add coolant until the coolant level exceeds the filler neck base of the coolant cooler.
- Before putting the gas engine-generator set into operation, ensure that a switch has been made to an approved coolant if necessary. For coolant additives approved for operation, see (→ MTU Fluids and Lubricants Specifications for gas engine-generator sets).

Preservation	Preservation procedure
Preparation	Remove all covers. Connect starter batteries. Put control system into operation.
Interior (oil, fuel and cooling system)	 Run the engine once a month up to operating temperature at a min. of 50% load. All fluids and lubricants remain in the engine. After the engine has been warmed up, the intake air inlet must be sealed again airtight; the air filter must be removed to do this.
Combustion chamber	No preservation measures required in the combustion chamber in this period
Non-painted parts (external preservation)	Coat or spray non-painted parts with corrosion inhibitor for external preservation (→ Page 22). This includes: • Parts of the engine outer shell • Flanges • Shafts • Driver disks • Valves and fittings
Non-engine components (generator and starter batteries)	 Keep generator bearings lubricated. According to the re-preservation interval, bar the engine manually to rotate the shaft several turns for distributing the grease in the bearings. For charge conservation, load starter batteries according to the represervation interval.
Lockout of gas engine-generator set and sealing of openings for maintenance	 Execute "lockout/tagout procedure" (→ refer to the Operation and Maintenance Manual). Seal all openings airtight such as air inlet and outlet. Seal off electric plug connectors against moisture.

8.1.3 Non-engine components - Service interruption up to 6 months

- · Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 30).
- · Storage conditions must be dust-free, dry and frost-free. Avoid the formation of condensate. Avoid temperatures > 50 $^{\circ}$ C and strong temperature fluctuations.
- All fluids and lubricants remain in the gas engine-generator set.
- · If an aqueous corrosion inhibitor is used in the coolant circuit, when there is a risk of frost during storage a switch must be made to corrosion inhibiting antifreeze.
- · To protect the cooler during the out-of-service time, add coolant until the coolant level exceeds the filler neck base of the coolant cooler.
- Before putting the gas engine-generator set into operation, ensure that a switch has been made to an approved coolant if necessary. For coolant additives approved for operation, see (→ MTU Fluids and Lubricants Specifications for gas engine-generator sets).

Preservation	Preservation procedure
Pumps	 Do not drain media circuits. To prevent frost damage, fill coolant circuits with a water-glycol mixture. Circulate the water/antifreeze volume several times in the circuit so that the complete circuit is flushed. To prevent rotary seals from jamming, put the pumps into operation once a month with the system filled
Piping	When the piping is being drained, provide spare rotary seal and replace prior to putting into operation.
Exhaust gas heat exchanger	 Ensure that the media circuit is completely filled. Ensure that the media circuit is filled with a sufficient volume of water-glycol mixture. Circulate the water/antifreeze volume several times in the circuit so that the complete circuit is sufficiently flushed. Run the exhaust gas heat exchanger up to operating temperature before shutting it down. Ensure that there is no more moisture on the exhaust gas side. Seal the exhaust inlet and exhaust outlet such that moisture can not penetrate.
Gas train	Ensure that components of the gas train are always stored in a temperature range from -15 $^{\circ}$ C to 40 $^{\circ}$ C. With viton diaphragms, the storage temperature is > 0 $^{\circ}$ C.
Generator, safety temperature limiter, safety pressure limiter, threeway valve, fire detector, gas detector	General information applies
Expansion tank	In case of a temporary shutdown, ensure that the condensate collecting tank remains in the expansion tank. Further measures are required in case of frost.
Safety valve	 Coat or spray metallic components of the safety valve with corrosion inhibitor for external preservation (→ Page 22) Before putting into operation, clean metallic components of the safety valve

Preservation	Preservation procedure
Biogas compressor	 Remove blower at the inlet and outlet from the flange or insert blanking plates. Dry blower and flush with an inert gas. After flushing, ensure that the blower is sealed airtight. Check blower for ease of movement and turn it. With a changing room temperature, once a month With a constant room temperature, every second month A shutdown may result in overlapping with the maintenance interval for the shaft seals. They should be replaced every 16,000 operating hours or every 2 years to keep the blower gastight.
Neutralization system	 Clean the neutralization system. Replace used up or missing granulate. Keep flushing until clear water emerges at the outlet of the neutralization system. Store neutralization system after it is cleaned.
Exhaust flaps, louver dampers	Move valves and fittings that remain continuously in the same position once or twice a year.

8.1.4 Non-engine components - Service interruption of more than one 6 months

- · Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 30).
- · Storage conditions must be dust-free, dry and frost-free. Avoid the formation of condensate. Avoid temperatures > 50 °C and strong temperature fluctuations.
- All fluids and lubricants remain in the gas engine-generator set.
- If an aqueous corrosion inhibitor is used in the coolant circuit, when there is a risk of frost during storage a switch must be made to corrosion inhibiting antifreeze.
- To protect the cooler during the out-of-service time, add coolant until the coolant level exceeds the filler neck base of the coolant cooler.
- · Before putting the gas engine-generator set into operation, ensure that a switch has been made to an approved coolant if necessary. For coolant additives approved for operation, see (→ MTU Fluids and Lubricants Specifications for gas engine-generator sets).

Preservation	Preservation procedure
Pumps	 Do not drain media circuits. To prevent frost damage, fill coolant circuits with a sufficient amount of water-glycol mixture. Circulate the water/antifreeze volume several times in the circuit so that the complete circuit is flushed. To prevent rotary seals from jamming, put the pumps into operation once a month with the system filled
Piping	When the piping is being drained, provide spare rotary seal and replace prior to putting into operation.
Exhaust gas heat exchanger	 Ensure that the media circuit is completely filled. Ensure that the media circuit is filled with a sufficient volume of water-glycol mixture. Circulate the water/antifreeze volume several times in the circuit so that the complete circuit is sufficiently flushed. Run the exhaust gas heat exchanger up to operating temperature before shutting it down. Ensure that there is no more moisture on the exhaust gas side. If necessary, clean the exhaust side. Seal the exhaust inlet and exhaust outlet such that moisture can not penetrate.
Gas train	Ensure that components of the gas train are always stored in a temperature range from -15 °C to 40 °C. Seal openings airtight. With viton diaphragms, the storage temperature is > 0 °C.
Catalytic converter	When storing for longer than 1 year: 1. Remove catalytic converter 2. Clean catalytic converter 3. Store catalytic converter is a dry place
Generator	 If the generator is placed in storage for longer than 6 months and is not turned, replace the generator bearings before putting it back into operation Relubricate bearings during the first run to put the generator into operation if the following conditions are met: Generator stored between 6 and 12 months Generator turned during period six times a month If the generator is placed in storage for longer than 24 months and is turned 6 times a month, replace the bearings before putting it back into operation.

Preservation	Preservation procedure
Safety temperature limiter, safety pressure limiter, three-way valve, fire detector, gas detector, expansion tank, safety valve	General information applies
Biogas compressor	 Remove blower at the inlet and outlet from the flange or insert blanking plates. Dry blower and flush with an inert gas. After flushing, ensure that the blower is sealed airtight. Check blower for ease of movement and turn it. With a changing room temperature, once a month With a constant room temperature, every second month A shutdown may result in overlapping with the maintenance interval for the shaft seals. They should be replaced every 16,000 operating hours or every 2 years to keep the blower gastight.
Neutralization system	 Clean the neutralization system. Replace used up or missing granulate. Keep flushing until clear water emerges at the outlet of the neutralization system. Store neutralization system after it is cleaned.
Exhaust flaps, louver dampers	 Move valves and fittings that remain continuously in the same position three to four times a year. Check servomotors twice a year. In case of a long storage period, check servomotors in the factory prior to operation.
Gearbox unit (interior)	 Standard preservation as of delivery of the gearbox is sufficient (under normal transport condition, storage in dry rooms) for a period of 6 months. After a further 6 months, flush out through the inspection port cover at all accessible areas so that all surfaces are covered with preservation agent. After the test run and before seaworthy packaging is fitted, flush the gearbox from the inside.
Gearbox unit (exterior)	 All shaft ends, parts and surfaces must be provided as of delivery with a seawater-resistant and drip-proof anti-rust coating that provides protection for a year. After this period has elapsed, the existing protective coating must be renewed once a year with Castrol SafeCoat DW33.

8.1.5 Container - Service interruption of more than one month

- · Engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 27).
- · Non-engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 30).
- All fluids and lubricants remain in the gas engine-generator set.
- · If an aqueous corrosion inhibitor is used in the coolant circuit, when there is a risk of frost during storage a switch must be made to corrosion inhibiting antifreeze.
- · To protect the cooler during the out-of-service time, add coolant until the coolant level exceeds the filler neck base of the coolant cooler.
- Before putting the engine into operation, ensure that a switch has been made to an approved coolant if necessary. For coolant additives approved for operation, see (→ MTU Fluids and Lubricants Specification for gas engine-generator sets.)

Preservation	Preservation procedure
Gas engine-generator set	See (→ Page 64)
Container	 Store the container in accordance with the foundation requirements. Touch up paint damage on the container or built-in components in a professional manner with suitable paint to prevent corrosion. Remove deposits on the top deck (e.g. leaves, dust) on a regular basis. Grease door seals and hinges prior to placing in storage. Seal cable entries to weather-proof them (if necessary, remove cover panels). Seal exhaust gas outlet openings to weather-proof them. Guarantee draining of condensate from the exhaust system. Seal connecting flanges on gas and condensate connections to weather-proof them (dummy cover). Storage at max. 40 °C. With viton diaphragms, the storage temperature is > 0 °C. Close louver dampers for supply and exhaust air. Keep the container interior free of frost. Avoid condensation and insert desiccant bags if necessary. Guarantee electric supply for the following components: Generator anti-condensation heating Compartment heater Disconnect MMC electrically. Disconnect starter batteries. Detach isolator switch for starter from engine (if available). NOTES: All shaft ends, parts and surfaces must be provided as of delivery with a seawater-resistant and drip-proof anti-rust coating that provides protection for a year. After this period has elapsed, the existing protective coating must be renewed once a year with Castrol SafeCoat DW33.

With operation option and unfilled medium circuits

- Engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 28)
- Non-engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 30)
- CAUTION: Seal the medium circuits immediately after draining the media.

Preservation	Preservation procedure
Preparations	Remove all covers. Connect starter batteries. Put control system into operation.
Interior (oil, fuel and cooling system)	 Clean engine-generator set if necessary. Drain coolant (if present) and dispose of. Completely fill coolant circuit with approved corrosion inhibitor concentration (→ Page 18). Note: To bypass the flushing procedure during coolant filling for initial operation, the use of inhibitor concentration "Glysacorr P 113" instead of the emulsifiable corrosion inhibitor oil "Oil 9156" is recommended. If there is no preservative oil in the engine, drain the oil pan completely. NOTE: Alternatively, the engine can also be warmed up with normal engine oil. The next step is to use an oil priming pump to pump approx. 100 liters of approved preservative oil via the priming connection into the engine. Now perform steps 2 and 3 as described under "Combustion chamber". Fill engine with approved preservative oil. Run engine at a min. 50% power to warm it up (engine coolant min 75 °C) NOTE: Alternatively, the engine can also be warmed up with an external coolant heater (min. 75 °C). In this case, an external oil pump must also be used. Allow engine to cool down to below 40 °C. Drain preservative oil out of oil system. Drain preservative out of coolant system. Immediately after draining, seal coolant openings airtight
Combustion chamber	 Unscrew all spark plugs. If the engine was not warmed up with preservative oil, turn all pistons for preservation one after the other to bottom dead center "BDC". Use a fine-atomizing spray gun to carefully spray the combustion chamber surfaces of the pistons and cylinder walls. When doing this, ensure that a large amount of oil does not remain on the piston crown. Screw in spark plugs
Non-painted parts (external preservation)	Coat or spray non-painted parts of the outer shell with corrosion inhibitor for external preservation (→ Page 22). This includes: • Parts of the engine outer shell • Flanges • Shafts • Driver disks • Valves and fittings

Preservation	Preservation procedure
Non-engine components (generator and starter batteries)	 Keep generator bearings lubricated. According to the re-preservation interval, bar the engine manually to rotate the shaft several turns for distributing the grease in the bearings. For charge conservation, load starter batteries according to the represervation interval.
Lockout engine-generator set and seal openings	 Execute "lockout/tagout procedure" (→ refer to the Operation and Maintenance Manual). Seal all openings airtight such as air inlet and outlet. Seal off electric plug connectors against moisture.

Without operation option and filled medium circuits

Note:

- The described procedure is a guideline, which has to be adapted to the specific gas engine-generator set in each case. Work sequence details may vary from engine-generator set to engine-generator set. Contact your MTU representative if you have any questions.
- Re-preservation on the test bench is recommended.
- Where possible, the individual preservation measures should be carried out at the same time.
- Engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 27).
- Non-engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 30).

Preparatory steps

Preservation	Preservation procedure
Preparation	 Check of local specifications. NOTE: Prior to engine storage with filled medium circuits, clarify whether this is permissible with regard to hazardous goods and environmental protection regulations. If necessary, clean the engine-generator set prior to (re-)preservation. NOTE: Only bar the engine after it has been primed. Therefore, first prime the engine with approved corrosion inhibitor and then build up oil pressure, then preserve the coolant circuit as well as the combustion chamber.
Lube oil circuit	 Drain old oil if necessary. Remove priming connection from crankcase. Connect oil priming pump. Use the oil priming pump to pump approved corrosion inhibitor into the oil circuit. Use corrosion inhibitor that is suitable for internal preservation of the unfilled engine. (→ Page 16). Bar engine manually one to two rotations. The oil can remain in the engine although continuous engine operation in this state is not permissible (max. 25 h). For continuous engine operation, the oil must be replaced with approved engine oil (see valid Fluids and Lubricants Specifications).
Coolant circuit	 Drain remaining coolant (if present) and dispose of. Completely fill coolant circuit with approved corrosion inhibitor concentration (→ Page 18). Open all thermostats so that the inhibitor concentration reaches all areas of the coolant circuit. Leave the inhibitor concentration in the engine. NOTE: Mixing of different inhibitor concentrations is impermissible. Seal all coolant openings airtight.
Combustion chamber	 Unscrew all spark plugs. Turn all pistons for preservation one after the other to bottom dead center "BDC". Use a fine-atomizing spray gun to carefully spray the combustion chamber surfaces of the pistons and cylinder walls. When doing this, ensure that a large amount of oil does not remain on the piston crown. Screw in spark plugs Seal intake air inlet and exhaust outlet airtight and reseal if necessary.

Preservation	Preservation procedure
Non-painted parts (external preservation)	Coat or spray non-painted parts with corrosion inhibitor for external preservation (→ Page 22). This includes: • Parts of the engine outer shell • Flanges • Shafts • Driver disks • Valves and fittings
Non-engine components (generator and starter batteries)	 Keep generator bearings lubricated by observing the re-preservation interval(→ Page 30). To do this, bar the engine manually to rotate the shaft several turns for distributing the grease in the bearings. Starter batteries in accordance with the re-preservation interval (→ Page 30): Charge for float charge Check and grease battery terminals With acid batteries, check the acid level and top up as required.

8.4 Without operation option and unfilled medium circuits

Note:

- The described procedure is a guideline, which has to be adapted to the specific gas engine-generator set in each case. Work sequence details may vary from engine-generator set to engine-generator set. Contact your MTU representative if you have any questions.
- Re-preservation on the test bench is recommended.
- Where possible, carry out the individual preservation measures at the same time
- Engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 28).
- Non-engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 30).

Preparatory steps

Preservation	Preservation procedure
Preparation	 If necessary, clean the engine-generator set prior to (re-)preservation. Drain and dispose of all media. NOTE: Only bar the engine after it has been primed. Therefore, first prime the engine with approved corrosion inhibitor and then build up oil pressure, then preserve the coolant circuit as well as the combustion chamber.
Lube oil circuit	 Remove priming connection from crankcase. Connect oil priming pump. Use the oil priming pump (approx. 100 liters) to pump approved corrosion inhibitor into the oil circuit. Use corrosion inhibitor that is suitable for internal preservation of the unfilled engine. (→ Page 16). Bar engine manually one to two rotations. Then drain the oil completely. NOTE: If the engine is warm, allow it to cool down to below 40 °C and then drain oil completely.
Coolant circuit	 Drain remaining coolant (if present) and dispose of. Completely fill the coolant circuit with an approved inhibitor concentration and then seal hermetically (→ Page 18). Use an external coolant heater to heat up the engine to a min. of 75 °C. Allow engine to cool down to below 40 °C. Drain inhibitor concentration completely. Immediately after draining, seal coolant openings airtight
Combustion chamber	 Unscrew all spark plugs. Turn all pistons for preservation one after the other to bottom dead center "BDC". Use a fine-atomizing spray gun to carefully spray the combustion chamber surfaces of the pistons and cylinder walls. When doing this, ensure that a large amount of oil does not remain on the piston crown. Screw in spark plugs Seal intake air inlet and exhaust outlet airtight and reseal if necessary.

Preservation	Preservation procedure
Non-painted parts (external preservation)	Coat or spray non-painted parts with corrosion inhibitor for external preservation (→ Page 22). This includes: • Parts of the engine outer shell • Flanges • Shafts • Driver disks • Valves and fittings
Non-engine components (generator and starter batteries)	 Keep generator bearings lubricated. According to the re-preservation interval, bar the engine manually to rotate the shaft several turns for distributing the grease in the bearings. For charge conservation, load starter batteries according to the represervation interval.

Gas engine-generator sets with Series 400 engines - preservation and re-preservation

9.1 Preface

This chapter applies to the preservation of gas engines, CHP gas engine-generator sets (modules/gensets) of the 400 Series.

A distinction is made between the following 3 designs of gas engine-generator sets:

- · GC (Genset Combined): Module with heat recovery and integrated exhaust gas heat exchanger
- GR (Genset Reduced): Engine-generator set with heat recovery
- GB (Genset Basic): Engine-generator set without heat recovery

For the measures, a distinction is made between:

- Preservation:
 - Preservation is carried out after the factory test run at MTU Friedrichshafen GmbH (case A) and before long service interruptions (case B).
- Re-preservation:
 - When the service life of the preservation has elapsed, carry out re-preservation at appropriate intervals.
- · Return to operation

9.2 Storage conditions, service lives for preservation and represervation intervals

Storage conditions

The preservation measures depend on the storage conditions. A distinction is made between the following storage conditions:

Storage conditions	Operating areas
Normal	 Frost-free, closed and heated rooms, clean Max. temperature fluctuations between 10 and 40 °C Monthly average relative air humidity ≤ 65%
Difficult conditions	 Dust and dirt Dew point undershot >20% of the month Monthly average relative air humidity > 65%
Note: All other storage conditions (e.g. outdoor storage) are not permitted	

Service lives of preservative

For preservation, a distinction is made between 2 cases:

- Case A: Preservation after completion of factory test run
- Case B: Preservation following shutdown of a plant in operation

Case A: Factory preservation	
Storage conditions	Service life
Normal	12 months
Difficult conditions	6 months

Preservation measures as in case B are necessary if the service interruption of the engines and modules/ gensets of Series 400 exceeds the periods specified in the table.

Case B: Preservation after shutdown from operation		
Storage conditions	Service interruptions	Service life
Normal	> 3 months	12 months
Difficult conditions	> 1 month	6 months

Re-preservation intervals

Re-preservation takes place after the service lives listed in the table for case A and case B have elapsed.

Re-preservation intervals	
Storage conditions	Re-preservation interval
Normal	6 months
Difficult conditions	3 months

9.3 Preservation after completion of factory trial run and delivery conditions

Note: Precondition for preservation:

- The test run has been carried out with the prescribed coolant (mixture of water and corrosion inhibitor/ antifreeze).
- · Preservation takes place according the specified service lives, depending on the storage conditions (→ Page 77).

Preserve plant corresponding to the storage conditions (table for case A) (\rightarrow Page 77).

Case A: Preservation procedure following completion of the factory test run

- 1. Warm up the genset/module and shut down with dry exhaust gas heat exchanger.
- 2. Unscrew spark plugs.
- Spray the combustion chambers with preservative oil with an underbody protection gun through the spark plug bore (→ Page 16).
- Bar engine manually one revolution.
- 5. Spray combustion chambers once again with preservative oil.

Result: The liners and piston rings are coated with the preservative oil.

- Screw in spark plugs. 6.
- 7. Spray drained mixture cooler with preservative oil.
- 8. Spray heating water system with preservative oil.
- Seal mixture cooler, heating water system and inlet to gas train airtight.
- 10. Seal air inlet and exhaust outlet of module/genset airtight (blanking plate in exhaust system).
- 11. Screw dipstick into crankcase to seal it.
- 12. Drain condensate line and seal airtight.
- 13. For deliveries with unfilled engine coolant and cooling circuit, seal boiler fill and drain valves airtight.

Delivery conditions for engine-generator sets with filled engine coolant and oil circuit

- Permitted for deliveries up to an ambient temperature above -18 °C
- Standard delivery within Europe for design types GC and GR

Delivery conditions for engine-generator sets with unfilled engine coolant and oil circuit

- Specified for deliveries at ambient temperatures below -18 °C
- · Corrosion protection is guaranteed after the factory test run by coating with the prescribed coolant.
- The cooling system must remain airtight to prevent drying up and corrosion.

9.4 Preservation following shutdown of a plant in operation

Note: Precondition for preservation:

- · Operation has been carried out with the prescribed coolant (mixture of water and corrosion inhibitor/antifreeze).
- · Preservation takes place according the specified service lives, depending on the storage conditions (→ Page 77).
- Preserve plant corresponding to the service interruption and storage conditions (table for case A) (→ Page 77).

Case B: Sequence for preservation following shutdown of a plant in operation

- Warm up the genset/module and shut down with dry exhaust gas heat exchanger.
- Unscrew spark plugs
- Spray the combustion chambers with preservative oil with an underbody protection gun through the spark plug bore
- Bar engine manually one revolution. 4.
- Spray combustion chambers once again with preservative oil (→ Page 16)

Result: The liners and piston rings are coated with the preservative oil.

- Screw in spark plugs. 6.
- If the mixture cooler and heating water system are filled with coolant, preservation measures are not required. The same applies to the gas train.
- 8. Seal air inlet and exhaust outlet of module/genset airtight (blanking plate in exhaust system).
- 9. Screw dipstick into crankcase to seal it
- 10. Drain condensate line and seal airtight

Note:

11. In a frost-free environment (container plants), the cooling circuits are provided with antifreeze so that draining of the coolants is not required up to -18 °C.

9.5 Re-preservation

Note:

· Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 77).

Re-preservation sequence

- 1. Remove the catalytic converter prior to re-preservation.
- Result: Catalytic converter is protected against preservative oil.
 - 2. Unscrew spark plugs
 - Spray the combustion chambers with preservative oil with an underbody protection gun through the spark plug bore
 - 4. Bar engine manually one revolution.
 - Spray combustion chambers once again with preservative oil (→ Page 16)
- Result: The liners and piston rings are coated with the preservative oil.
 - Screw in spark plugs. 6.
 - 7. Visually check all openings on the genset for leaks.
 - Replace closures on openings if necessary.

9.6 Special measures during the preservation phase

Component	Measure
Generator	Turn the generator once manually every 6 months. This prevents bearing damage at the generator. Relubrication is not possible.
Battery	Regularly charge any battery that is present or, alternatively, remove and service separately.

9.7 Return to operation

Sequence for return to operation

- Remove all seals from the genset
- Fill drained operating materials in accordance with the Fluids and Lubricants Specifications.
- 3. Unscrew spark plugs.
- 4. Bar engine once by hand.
- 5. Bar the engine using the starter.
- Result: Preservative oil is blown out.
 - 6. Install spark plugs
 - 7. Start engine.
 - 8. Short-term operation until engine is free of preservative oil.
 - 9. Install catalytic converter

10 PowerPacks with series 1600 and 1800 engine - preservation and re-preservation

10.1 With operation option and filled medium circuits

10.1.1 Service interruption up to 6 months

Note:

- The following description applies to the rail PowerPack®.
- · Under normal storage conditions, all fluids and lubricants remain in the PowerPack®. Preservation measures are not necessary.
- · Drainage of engine coolant and, if necessary, charge-air coolant will be necessary if any of the following conditions apply:
 - Freezing temperatures are expected and the engine is to remain out of service for an extended period, but engine coolant has no antifreeze additive.
 - The installation area of the PowerPack® is not heated.
 - The coolant is not maintained at a suitable temperature.
 - The antifreeze concentration is insufficient for the PowerPack® installation room temperature.
 - Antifreeze concentration is 50% and engine-room temperature is below -40 °C.

See Storage with unfilled medium circuits (→ Page 56)

Storage with filled medium circuits under normal conditions

- Execute "lockout/tagout procedure" (→ refer to the Operation and Maintenance Manual).
- Seal air inlet and outlet if out-of-service time period is longer than one week.

Service interruption of more than 6 months 10.1.2

Note:

- The following description applies to rail PowerPacks.
- Engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 27).
- Non-engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 30).
- All fluids and lubricants remain in the PowerPack®.

Preservation	Preservation procedure
Preparation	Remove all covers. Connect starter batteries. Put control system into operation.
Interior (oil, fuel and cooling system)	 Clean PowerPack® if necessary. Leave engine oil in engine if it is an oil approved for preservation (→ Page 16). Otherwise replace filled engine oil with an approved preservative oil, or carry out initial filling with this oil. Fill fuel system with an approved fuel (→ Page 21). If necessary, replace an already filled fuel which is not suitable for engine storage. If necessary, drain coolant and fill with approved corrosion inhibiting antifreeze or leave existing corrosion inhibiting antifreeze in coolant circuit (→ Page 18). Run engine at increased idling speed for approx. 10 minutes. The inhibitor concentration must reach operating temperature. Engine shutdown All media remain in the system. These medium circuits must be filled completely.
Combustion chamber	 Seal the decompression openings. Fill corrosion inhibitor for initial operation at least up to the "Min" mark (→ Page 16). Remove end covers for air intake and exhaust gas discharge. Provide access to the charge-air manifold. This can be done by removing flame-start canisters, sensors, covers or pipes. Access to the charge-air manifold must always be established downstream of the intercooler, pressure fine filter / air filter and exhaust turbocharger. Bar warm engine with starting equipment. The engine must not start. To do this: Actuate the stop lever for mechanical governors. With electronic governors, unplug connector X4 from the injector wiring harness. While the engine is being barred, use a fine-atomizing spray gun to spray initial operation corrosion inhibitor into the charge-air pipe openings for approx. 15 seconds (→ Page 16). Seal openings for intake air and exhaust outlet airtight. Seal access to the charge-air pipes.
Non-painted parts (external preservation)	Coat or spray non-painted parts with corrosion inhibitor for external preservation (→ Page 22). This includes: • Parts of the engine outer shell • Flanges • Shafts • Driver disks • Valves and fittings

Preservation	Preservation procedure
Non-engine components (generator and starter batteries)	 Keep generator bearings lubricated. According to the re-preservation interval, bar the engine manually to rotate the shaft several turns for distributing the grease in the bearings. For charge conservation, load starter batteries according to the represervation interval.
Lockout of PowerPack® and sealing of openings for maintenance	 Execute "lockout/tagout procedure" (→ refer to the Operation and Maintenance Manual). Seal all openings tight against moisture, such as air inlet and outlet, and electrical plug connectors.

10.2 With operation option and unfilled medium circuits

10.2.1 Service interruption up to 6 months

Note:

- The following description applies to the rail PowerPack®.
- Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 28).

Ι	mportant
5	Seal the medium circuits immediately after draining the media.

Preservation	Preservation procedure
Preparation	Remove all covers. Connect starter batteries. Put control system into operation.
Interior (oil, fuel and cooling system)	 Clean PowerPack® if necessary. Drain coolant (if present) and dispose of. Completely fill coolant circuit with approved corrosion inhibitor concentration (→ Page 18). Note: To bypass the flushing procedure during coolant filling for initial operation, the use of inhibitor concentration "Glysacorr P 113" instead of the emulsifiable corrosion inhibitor oil "Oil 9156" is recommended. Fill fuel system completely. For this purpose, use approved corrosion inhibitors for internal preservation of the fuel system which are suitable for an unfilled engine (→ Page 21). Replace engine oil if necessary. Replace with an approved initial operation and corrosion inhibitor for internal preservation of the oil circuit and which is suitable for an unfilled engine(→ Page 16). Run engine at increased idling speed for approx. 10 minutes. The inhibitor concentration must reach operating temperature. Shut down engine. Allow engine to cool down to below 40 °C. Drain engine oil. Drain inhibitor concentration.
Combustion chamber	No preservation measures required in the combustion chamber in this period
Non-painted parts (external preservation)	No preservation measures on non-painted parts (external preservation) required in this period
Lockout of PowerPack® and seal- ing of openings for maintenance	 Execute "lockout/tagout procedure" (→ refer to the Operation and Maintenance Manual). Seal all openings tight against moisture, such as air inlet, air outlet and electrical plug connectors.

Service interruption of more than 6 months 10.2.2

Note:

- The following description applies to rail PowerPacks.
- Engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 28)
- Non-engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 30)

Important

Seal the medium circuits immediately after draining the media.

Preservation	Preservation procedure
Preparation	Remove all covers. Connect starter batteries. Put control system into operation.
Interior (oil, fuel and cooling system)	 Clean PowerPack® if necessary. Drain coolant (if present) and dispose of. Completely fill coolant circuit with approved corrosion inhibitor concentration (→ Page 18). NOTE: To bypass the flushing procedure during coolant filling for initial operation, the use of inhibitor concentration "Glysacorr P 113" instead of the emulsifiable corrosion inhibitor oil "Oil 9156" is recommended. Fill fuel system completely. For this purpose, use approved corrosion inhibitors for internal preservation of the fuel system which are suitable for an unfilled engine (→ Page 21). Replace engine oil if necessary. Replace with an approved initial operation and corrosion inhibitor for internal preservation of the oil circuit and which is suitable for an unfilled engine(→ Page 16). Run engine at increased idling speed for approx. 10 minutes. The inhibitor concentration must reach operating temperature. Shut down engine. Allow engine to cool down to below 40 °C. Drain engine oil. Drain inhibitor concentration.
Combustion chamber	 Seal the decompression openings. Fill corrosion inhibitor for initial operation at least up to the "Min" mark (→ Page 16). Remove end covers for air intake and exhaust gas discharge. Provide access to the charge-air manifold. This can be done by removing flame-start canisters, sensors, covers or pipes. Access to the charge-air manifold must always be established downstream of the intercooler, pressure fine filter / air filter and exhaust turbocharger. Bar warm engine with starting equipment. The engine must not start. To do this: Actuate the stop lever for mechanical governors. With electronic governors, unplug connector X4 from the injector wiring harness. While the engine is being barred, use a fine-atomizing spray gun to spray initial operation corrosion inhibitor into the charge-air pipe openings for approx. 15 seconds (→ Page 16). Seal openings for intake air and exhaust outlet airtight. Seal access to the charge-air pipes.

Preservation	Preservation procedure
Non-painted parts (external preservation)	Coat or spray non-painted parts with corrosion inhibitor for external preservation (→ Page 22). This includes: • Parts of the engine outer shell • Flanges • Shafts • Driver disks • Valves and fittings
Non-engine components (generator and starter batteries)	 Keep generator bearings lubricated. According to the re-preservation interval, bar the engine manually to rotate the shaft several turns for distributing the grease in the bearings. For charge conservation, load starter batteries according to the represervation interval.
Lockout of PowerPack® and sealing of openings for maintenance	 Execute "lockout/tagout procedure" (→ refer to the Operation and Maintenance Manual). Seal all openings tight against moisture, such as air inlet and outlet and electrical plug connectors.

10.3 Without operation option and filled medium circuits

Note:

- The described procedure is a guideline, which has to be adapted to the specific rail PowerPack®. Work sequence details may vary from PowerPack® to PowerPack®. Contact your MTU representative if you have any questions.
- Re-preservation on the test bench is recommended.
- Where possible, the individual preservation measures should be carried out at the same time.
- Engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 27).
- Non-engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 30).

Preservation	Preservation procedure
Preparation	 Check of local specifications. NOTE: Prior to engine storage with filled medium circuits, clarify whether this is permissible with regard to hazardous goods and environmental protection regulations. If necessary, clean the PowerPack® prior to (re-)preservation. Prime the engine. NOTE: Only bar the engine after it has been primed. Therefore, first prime the engine and then build up oil pressure, then preserve the coolant circuit as well as the combustion chamber.
Lube oil circuit	 Drain old oil if necessary. Remove priming connection from crankcase. Connect oil priming pump. Use the oil priming pump to pump approved corrosion inhibitor into the oil circuit. Use corrosion inhibitor that is suitable for internal preservation of the unfilled engine. (→ Page 16). Remove the turbocharger oil return line, which is the last element in the oil circuit to be supplied with oil. Pump oil under pressure into the circuit until it emerges from the oil return line of the turbocharger. Reinstall turbocharger oil return line. This ensures that the entire lube oil circuit is completely filled. Bar engine manually one to two rotations. Leave the oil in the engine.
Coolant circuit	 Drain remaining coolant (if present) and dispose of. Completely fill coolant circuit with approved corrosion inhibitor concentration suitable for a filled engine (→ Page 18). Open all thermostats so that the inhibitor concentration reaches all areas of the coolant circuit. Leave the inhibitor concentration in the engine. NOTE: Mixing of different inhibitor concentrations is impermissible. Seal all coolant openings airtight.
Fuel system	 For field engines that have no operation option and which were initially preserved according to the correct MTU process, re-preservation of the fuel system can be omitted. If necessary, replace injectors and parts after the function test prior to putting the engine into operation.

Preservation	Preservation procedure		
Combustion chamber	 Seal the decompression openings. Open air pipe downstream of intercooler. When oil pressure has built up, use a fine-atomizing spray gun to spray approved corrosion inhibitor for approx. 15 seconds into the openings of the air pipes. Use the starting system to bar the engine. The engine must not start! Use corrosion inhibitor for internal preservation of the oil circuit (→ Page 16). Carefully seal air inlet and exhaust outlet. This prevents venting via the opened inlet and exhaust valves at the cylinders in overlap position. 		
Non-painted parts (external preservation)	Coat or spray non-painted parts with corrosion inhibitor for external preservation (→ Page 22). This includes: • Parts of the engine outer shell • Flanges • Shafts • Driver disks • Valves and fittings		
Non-engine components (generator and starter batteries)	 Keep generator bearings lubricated. According to the re-preservation interval, bar the engine manually to rotate the shaft several turns for distributing the grease in the bearings. For charge conservation, load starter batteries according to the represervation interval. 		

10.4 Without operation option and unfilled medium circuits

Note:

- The described procedure is a guideline, which has to be adapted to the specific rail PowerPack®. Work sequence details may vary from PowerPack® to PowerPack®. Contact your MTU representative if you have any questions.
- Re-preservation on the test bench is recommended.
- Where possible, carry out the individual preservation measures at the same time
- Engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 28).
- Non-engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 30).
- CAUTION: Seal off all medium circuits airtight immediately after draining the preservative.

Preservation	Preservation procedure
Preparation	 If necessary, clean the PowerPack® prior to (re-)preservation. Drain and dispose of all media. Prime the engine. NOTE: Only bar the engine after it has been primed. Therefore, first prime the engine and then build up oil pressure, then preserve the coolant circuit as well as the combustion chamber.
Lube oil circuit	 Remove priming connection from crankcase. Connect oil priming pump. Use the oil priming pump to pump approved corrosion inhibitor into the oil circuit. Use corrosion inhibitor that is suitable for internal preservation of the unfilled engine. (→ Page 16). Remove the turbocharger oil return line, which is the last element in the oil circuit to be supplied with oil. Pump oil under pressure into the circuit until it emerges from the oil return line of the turbocharger. Reinstall turbocharger oil return line. This ensures that the entire lube oil circuit is completely filled. Bar engine manually one to two rotations. Then drain the oil completely. NOTE: If the engine is warm, allow it to cool down to below 40 °C and then drain oil completely.
Coolant circuit	 Drain remaining coolant (if present) and dispose of. Completely fill the coolant circuit with an approved inhibitor concentration and then seal hermetically (→ Page 18). Use an external coolant heater to heat up the engine to a min. of 75 °C. Allow engine to cool down to below 40 °C. Drain inhibitor concentration completely. Immediately after draining, seal coolant openings airtight
Fuel system	 For field engines that have no operation option and which were initially preserved according to the correct MTU process, re-preservation of the fuel system can be omitted. If necessary, replace injectors and parts after the function test prior to putting the engine into operation.

Preservation	Preservation procedure		
Combustion chamber	 Seal the decompression openings. Open air pipe downstream of intercooler. When oil pressure has built up, use a fine-atomizing spray gun to spray approved corrosion inhibitor for approx. 15 seconds into the openings of the air pipes. Use the starting system to bar the engine. The engine must not start! Use corrosion inhibitor for internal preservation of the oil circuit (→ Page 16). Carefully seal air inlet and exhaust outlet. This prevents venting via the opened inlet and exhaust valves at the cylinders in overlap position. 		
Non-painted parts (external preservation)	Coat or spray non-painted parts with corrosion inhibitor for external preservation (→ Page 22). This includes: • Parts of the engine outer shell • Flanges • Shafts • Driver disks • Valves and fittings		
Non-engine components (generator and starter batteries)	 Keep generator bearings lubricated. According to the re-preservation interval, bar the engine manually to rotate the shaft several turns for distributing the grease in the bearings. For charge conservation, load starter batteries according to the represervation interval. 		

11 Depreservation

11.1 De-preservation of diesel and gas engines

De-preservation prior to operation 11.1.1

Note:

- · Before putting a preserved diesel engine or gas engine back into operation, the preservation agent must be removed.
- · De-preservation of the diesel engine is not required on installed field engines with out-of-service periods up to 3 months. Only the end covers must be removed.
- · De-preservation is not required for installed gas engines that can be put into operation with filled medium circuits.
- · Before putting the engine into operation, ensure that a switch has been made to an approved coolant if necessary. The engine must not be operated with antifreeze if only aqueous coolant additives are approved. For coolant additives approved for operation, see (→ MTU Fluids and Lubricants Specifications).

De-preservation procedure prior to operation

- Clean engine if necessary. 1.
- 2. Remove all covers.
- Drain corrosion inhibitor oil if necessary.
- Replace oil filter (elements). This step is not required for new deliveries; it is necessary after one year at the
- 5. Only for diesel engines: Replace fuel filter (elements). This step is not required for new deliveries; it is necessary after one year at the latest.
- Fill with engine oil. 6.
- Ensure that the bearings to be supplied from the engine oil circuit are well lubricated. 7.
- Bar engine manually.
- 9. Prepare engine for putting it back into operation.
- 10. Drain inhibitor concentration if necessary.
- Fill with or renew coolant. 11.

Notes on operation

Put engine into operation according to the engine documentation.

Important

Special information on gas engine:

The preservative oil has a significantly higher ash content than continuous operation oil. Prior to operation, the preserved engine must therefore be flushed with continuous operation oil as per the Fluids and Lubricants Specifications.

Instruction sheet for engine de-preservation in climate-compatible packaging 11.1.2

Important

Before opening the packaging, please read this instruction sheet and follow the instructions without fail, in particular the notes on when it is necessary to notify MTU Friedrichshafen GmbH and MTU Onsite Energy

Instru	action sheet for de-preservation of engines			
1.	Read off the humidity values on the humidity indicator and enter them on the monitoring card. Humidity indicator (→ Page 98) Monitoring Sheet (→ Page 107) Evaluation: a If all three fields on the humidity indicator show blue, everything is OK. b If fields 30 and 40 have turned partly or completely pink, examine the packaging for damage. If the packaging is damaged, notify MTU. c If all three fields are pink, do not open the packaging material and report to MTU.			
2.	If the humidity values are OK and if there are no other visible defects, remove the laminated aluminum foil from the engine.			
3.	Check engine externally when foil has been removed. Enter date and findings of check in Monitoring Sheet.			
4.	Visually check all rubber hose connections. The connections must not be brittle or swollen.			
5.	In the event of objections, contact MTU without delay and wait for further messages. In the meantime, do not prepare or modify the engine for installation, but store it so that it is dry and covered.			
6.	Enter the date of de-preservation on the Monitoring Sheet.			
7.	Do not remove the seals of the engine opening until just prior to use. The relates to: • Turbocharger inlet • Exhaust manifold outlet • Coolant inlet and outlet • Connecting flanges for vent lines at coolant distribution pipes			
8.	For initial operation, please observe the engine documentation.			

11.2 De-preservation of diesel and gas engine-generator sets

11.2.1 De-preservation prior to operation

Note: For de-preservation and return to operation of gas engine-generator sets Series 400, see (→ Page 82).

Important

De-preservation is not required on an installed engine-generator set with out-of-service period up to 3 months. In this case:

- · Remove all covers.
- · If the lockout/tagout procedure was carried out during preservation, work through the procedure for returning to operation, (→ Operation and Maintenance Manual).

Note: Before putting the engine-generator set into operation:

- Remove the preservation agent.
- Ensure that a switch has been made to a coolant approved for operation. The engine-generator set must not be operated exclusively with antifreeze if only aqueous coolant additives are approved.
- · Carry out an oil change involving changeover to an oil approved for the operating conditions. For coolant additives and oils approved for operation, see (→ MTU Fluids and Lubricants Specifications).

De-preservation procedure prior to operation

- Clean engine-generator set if necessary. 1.
- 2. Remove all covers.
- Drain corrosion inhibitor oil if necessary. 3

Note: This step is not required for new deliveries; it is necessary after one year at the latest.

4. Replace oil filter (elements).

Note: This step is not required for new deliveries; it is necessary after one year at the latest.

- 5. Only with diesel engine-generator sets: Replace fuel filter (elements).
- Fill with engine oil.
- 7. Ensure that the bearings to be supplied from the engine oil circuit are well lubricated.
- Bar engine manually.
- Drain inhibitor concentration if necessary.
- 10. Fill with or renew engine coolant.
- For diesel engine-generator sets with TB engine: Fill with or renew charge-air coolant.

Final steps

After a long-term storage (one year or longer), prepare the generator:

Generator type	Action
MagnaPlus	 Test, clean and dry the generator. In areas where the generator has been subject to vibration, inspect bearing(s) and replace, if necessary.
MagnaMax/MagnaPower Leroy Somer	 Add grease to the bearings. Refer to the "Operation and Maintenance Manual" for amount of grease and task description. In areas where the generator has been exposed to damp, humid conditions, check the insulation resistance and dry windings, if necessary.

- Mount and connect starter batteries.
- Work through procedure described in chapter "Operation" (→ Operation and Maintenance Manual).

11.3 PowerPacks - de-preservation

De-preservation prior to operation 11.3.1

Note: Before putting the PowerPack® into operation:

- Remove the preservation agent.
- Ensure that a switch has been made to a coolant approved for operation. The PowerPack® must not be operated exclusively with antifreeze if only aqueous coolant additives are approved.
- · Carry out an oil change involving changeover to an oil approved for the operating conditions.
- Fill with reducing agent.

For coolant additives and oils approved for operation, see (→ MTU Fluids and Lubricants Specifications).

De-preservation procedure prior to operation

- Clean PowerPack® if necessary. 1.
- Remove all covers.
- Drain corrosion inhibitor oil if necessary.

This step is not required for new deliveries; it is necessary after one year at the latest. Note:

- 4. Replace oil filter (elements).
- Note: This step is not required for new deliveries; it is necessary after one year at the latest.
 - 5. Replace fuel filter (elements).

This step is not required for new deliveries; it is necessary depending on the corresponding maintenance in-Note:

- Replace components if necessary in accordance with the maintenance schedule (e.g. elastomer parts, hoses, coupling).
- 7. Fill with engine oil.
- Ensure that the bearings to be supplied from the engine oil circuit are well lubricated.
- 9. Bar engine manually.
- 10. Drain inhibitor concentration if necessary.
- 11. Fill with or renew engine coolant.

Final steps

- 1. Install starter batteries, charge batteries and Capos.
- Work through procedure described in chapter "Operation" (→ Operation and Maintenance Manual).

12 Packaging

12.1 Types of packaging

The type of engine packaging depends on the storage and transport conditions.

At MTU Friedrichshafen GmbH MTU Onsite Energy GmbH, a distinction is made between the following types of packaging:

Type of packaging	Operating areas
Transport packaging (commercially available)	 For engines and engine-generator sets that can be stored under normal storage conditions for a maximum of 6 months As transit packaging for: Painted engines for surface transport in a container Engines and engine-generator sets intended for immediate use
Transport packaging (sea transport)	 For engines and engine-generator sets that can be stored under normal storage conditions for a maximum of 6 months As transit packaging for: Painted engines for sea and surface transport in a container Engines and engine-generator sets intended for immediate use
Climate-compatible packaging Engines and engine-generator sets	 For protection of goods susceptible to corrosion in difficult storage conditions Climate-compatible packaging can reduce the effects of difficult storage conditions, although it does not provide frost protection For engines transported by land or sea that are then stored for longer periods Up to 12 months - seaworthy packing Up to 36 months - seaworthy long-term packing Not for engines with filled medium circuits

Notes:

- Ensure that the applied (engine) paintwork has completely hardened prior to this.
- The climate-compatible packaging must be applied directly after preservation.
- · If climate-compatible packaging is used, where possible all media (fuel, oil, coolant) should be drained completely out of the respective medium circuit.
- Check the humidity indicator in the packaging every 3 to 4 months. The result must be documented in the Monitoring Sheet and, if necessary, measures initiated (→ Page 107). In case of high moisture levels, the packaging must be checked and replaced if necessary.
- In the case of long-term storage of engines and engine-generator sets, for example, for 3, 5 or 10 years in climate-compatible packaging, regular re-preservation in accordance with the specified intervals is nevertheless necessary(→ Page 27) (→ Page 28).
- Incorrect storage will render the warranty invalid.
- Existing special agreements still retain their validity.
- The customer must provide details on the storage location and planned storage duration. The packaging type is selected on this basis.
- · For the customer, the prescribed type of packaging is binding. If the customer insists on a different type of packaging, his attention must be drawn to the fact that the warranty for consequential damage in such a case shall become void.
- The following descriptions refer to the use of climate-compatible packaging for the storage of preserved engines.

12.2 Climate-compatible packaging - Design

The following packing aids are used for the climate-compatible packaging:

- A Outer layers of bonded-layer material (e.g. laminated aluminum foil)
- B Water-absorbing desiccant (e.g. silica gel)
- C Humidity indicator

The packaged products are shrink-wrapped in composite foil and the enclosed air is extracted. When desiccant packs are placed in the packaging, the residual moisture is reduced to a desired relative air humidity. The climate packaging prevents condensation on the metal surface and thus any resulting corrosion damage.

A – Outer layers of bonded-layer material

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

The laminated aluminum foil used at MTU consists of polyethylene and aluminum with the following properties:

- Temperature range for the application +70 °C to −55° C
- Water vapor permeability: 0.1 g/m² per day at 38 °C and 80% relative humidity (in comparison, PVC flexible foil WVP: 6 g/m² per day)

For composite foils used at MTU, refer to the list of consumables (→ Page 101).

B - Desiccant

Desiccant, normally silica gel, is the common term for an agent that absorbs water and is used in climate packaging. The desiccant is in packs of highly-permeable (for water vapor) and strong material (e.g. natron crepe paper) which are placed in the transport package.

Example of a desiccant pack



For desiccant packs used at MTU, refer to the list of consumables (→ Page 101).

Calculation of the required desiccant units

The amount of desiccant units to be used in packaging for shipping depends on the climatic conditions and on storage at the destination.

The minimum quantity of desiccant units to be used is to be calculated as follows:

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Climatic zone	Desiccant units (DU) per area of composite foil in m² (A)	+	DUs per kg packag- ing aid (PA)	=	Desiccant units (DU)
A Europe (apart from Russia)	6 x A	+	17 x APM	=	DUs per shipping package
B USA Canada Mediterranean region Near East	8 x A	+	20 x PA	=	DUs per shipping package
C Russia South and Central America Middle East and Far East Africa, Australia	17 x A	+	20 x PA	=	DUs per shipping package

Table 7: Calculation of desiccant units

Procedure:

- 1. Measure surface A of the laminated aluminum foil for the packaging.
- 2. Weigh the packing aids (PAs), such as wood, corrugated cardboard etc., required to support and pad the engine within the laminated aluminum foil.
- 3. Determine in and through which climatic zones the engine is to be sent and stored in the packaging.
- 4. Calculate the required desiccant units (DUs).

Note: If the laminated aluminum foil is damaged after replacing it or touching it up, perform the following calculation of the DUs again.

Calculation example for desiccant units:

· Packaging for climatic zone C • Area of composite foil: 10 m² • Weight of packing aids: 3 kg

Calculation:	17 DU x 10	+	20 DU x 3	=	DUs per shipping package
	170 DUs	+	60 DUs	=	230 DUs

Result: 230 desiccant units (DUs) are required for adequate protection of the engine.

C - Humidity indicator

To monitor the degree of saturation of the desiccant, a humidity indicator is attached to the aluminum foil packaging.

Humidity indicators show when the specified relative air humidity is exceeded by changing color. The increase in relative air humidity, e.g. if the packaging is not airtight or the laminated aluminum foil is damaged, poses a risk of corrosion to the engine.

A vision panel with humidity indicator is screwed into the laminated aluminum foil, which must be as far away from the desiccant as possible. The vision panel allows the relative air humidity within the laminated aluminum foil or any changes to be checked at all times.

Example of a humidity indicator



Note: The air humidity inside the packaging must be checked regularly every 3 to 4 months (→ Page 107). Measures to be carried out in case of changes to the relative air humidity are listed in the following table.

Reading the humidity indicator

Range	Discoloration as an indicator of the rela- tive air humidity	Measures to be initiated
30	Pink discoloration: Relative humidity above 30%	Shorten checking periodCheck humidity indicator every 4 weeks
40	Pink discoloration: Relative humidity above 40%	 Replace desiccant, ensure the amount is correct; Calculation: (→ Page 98) Distribute new desiccant evenly in the packaging area Extract air from the packaging and reseal composite foil (→ Page 106)
50	Pink discoloration: Relative humidity above 50%	 Check packaged products Re-preserve the engine Replace desiccant, ensure the amount is correct; Calculation: (→ Page 98) Distribute new desiccant evenly in the packaging area Extract air from the packaging and reseal composite foil (→ Page 106)

Note: The humidity indicator regenerates itself automatically. Replacement following opening and sealing of the packaging area is not required.

Climate-compatible packaging - Installation

Preconditions

- ☑ If the engine is not new or not thoroughly overhauled by MTU (both are already preserved), preservation in accordance with this publication is required before the climate packaging can be used.
- All engine fluids and lubricants must be drained as completely as possible.
- Check whether a transport locking device is prescribed for the engine. If so, lock crankshaft and engine mount according to the engine documentation.

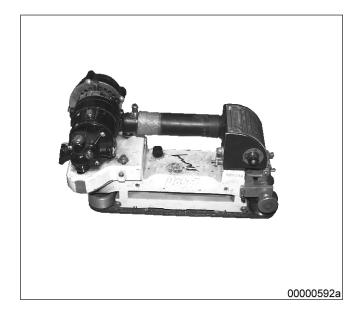
Special tools, Material, Spare parts

Designation / Use	Part No.	Oty.
Manual foil-sealing device (commercially available)		
Hard-rubber pads		
Loctite 5970 sealant, permanently elastic	50773	
Laminated aluminum foil, 1.00 m wide	49576	
Laminated aluminum foil, 1.25 m wide	49577	
Laminated aluminum foil, 1.50 m wide	49579	
PE foam foil, 1.25 m wide, 4 mm thick	49578	
Vision panel	20448	
Vision panel with humidity indicator	20447	
Desiccant, 125 g = 4 units	49542	
Desiccant, 250 g = 8 units	49543	
Desiccant, 500 g = 16 units	49544	
Desiccant, 1000 g = 32 units	49545	

Manual foil sealing device

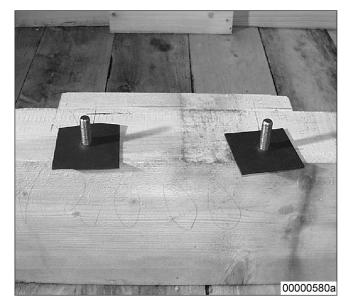
- Various manual foil-sealing device models are available on the market. One supplier, e.g.:
 - Willi Kopp e.K. Verpackungssysteme Ulmer Straße 51 - 53 73262 Reichenbach / Fils Deutschland / Germany

Model: Manual sealing device HSD 95 Cello



Packing the engine

- Use a hollow punch to knock out a passage for the anchor bolts.
- 2. Place hard rubber plates on the transport trestle in the area of the anchor bolts.



In the area of the bolt entry, thoroughly coat the hard rubber plates with permanently elastic sealant.



- 4. Use a hollow punch to knock out a passage in the laminated aluminum foil for the anchor bolts.
- 5. Place laminated aluminum foil in position and, in the area of the bolt entry, thoroughly coat with permanently elastic sealant.



Place the hard rubber plates once again on the laminated aluminum foil in the area of the bolt entry.



- Place foam foil on the hard rubber plates to provide additional protection for the laminated aluminum foil.
- Mount engine on transport trestle and bolt on 8. engine mounting.

Result: The complete system is firmly press-fitted and compact.



Padding the edges and corners of the engine block

Cushion edges and corners of the engine block that could damage the laminated aluminum foil with foam foil.



Applying the desiccant

Note: The desiccant units must not come into direct contact with corrosive engine components.

- 1. Insert the calculated number of desiccant units. Calculation example: (→ Page 98).
- The desiccant units must be fastened in the upper third of the sealed cover and attached to the engine block, freely suspended if pos-
- 3. Use suitable fastening materials for the desiccant units (e.g. string or adhesive tape) to prevent damage to the desiccant units, the engine or the laminated aluminum foil.

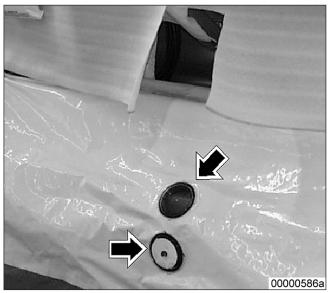


Installation of humidity indicator and vision panel

- The holes for the humidity indicator and the vision panel are to be cut into the laminated aluminum foil at a point that is clearly visible and as far away from the desiccant units as possible.
- 2. The vision panel is to be fastened in such a way that the engine number can be checked.



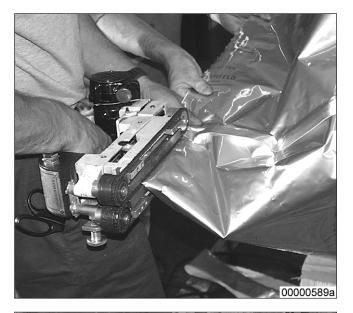
Screw the humidity indicator and vision panel into the laminated aluminum foil.



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Sealing the laminated aluminum foil

1. Seal the laminated aluminum foil using the manual foil-sealing device (\rightarrow Page 101).



Prior to final sealing of the laminated aluminum foil, use a vacuum pump (e.g. vacuum cleaner) to extract the entrapped air in the packaging. Avoid excessively tight fitting of the laminated aluminum foil because stress during transportation can result in chafing of the laminated aluminum foil.

Result:

- The vacuum created results in the laminated aluminum foil to lie lightly against the engine.
- Extracting the air removes the humidity in the air, thus reducing the humidity within the packaging.



Check for leaks

Note: If the packaging is not sufficiently tight, it will lose its tension within 30 minutes and expand.

If the packaging is not airtight, the leak can be detected by blowing air into the packaging and resealing the packaging.



12.4 Climate-compatible packaging - Check and repair

Special tools, Material, Spare parts

Designation / Use	Part No.	Qty.
Manual foil-sealing device (commercially available)		
Laminated aluminum foil, 1.00 m wide	49576	
Laminated aluminum foil, 1.25 m wide	49577	
Laminated aluminum foil, 1.50 m wide	49579	
Desiccant, 125 g = 4 units	49542	
Desiccant, 250 g = 8 units	49543	
Desiccant, 500 g = 16 units	49544	
Desiccant, 1000 g = 32 units	49545	

Note: When checking the climate packaging, the laminated aluminum foil must not be damaged. Open the transport box (if available) with utmost care. The condition of the laminated aluminum foil must be inspected thoroughly during customs, stock or storage checks. Protection against corrosion is not guaranteed if the aluminum composite foil is damaged.

Checking the air humidity

- Check humidity level regularly every 3 to 4 months.
- Enter findings in Monitoring Sheet (→ Page 107). If the engine's warranty period is still valid, send the Monitoring Sheet to MTU Friedrichshafen GmbH after commissioning.

Replacing desiccant

- Open the laminated aluminum foil at the upper area and remove the desiccant.
- Place the same amount of new desiccant in the upper area.
- Extract air and reseal laminated aluminum foil with manual foil-sealing device (→ Page 101)until airtight.

Repair of climate-compatible packaging

If the laminated aluminum foil is damaged, the damaged section can be cut out and replaced by a repair Note: piece. Incorrect repair work, e.g. using adhesive tape, is not permitted since it would not maintain the vacuum in the packaging.

- 1. Cut out damaged laminated aluminum foil section.
- Seal new laminated aluminum foil section with manual foil-sealing device.
- Place new desiccant in packaging.
- Prior to final sealing of the laminated aluminum foil, use a vacuum pump (e.g. vacuum cleaner) to extract the entrapped air in the packaging.
- Reseal laminated aluminum foil with manual foil-sealing device.

12.5 Monitoring Sheet for engines with climate-compatible packaging

The following checks are to be made before, during and at the end of the engine storage period and correct execution must be confirmed by date and signature.

Note: For new products, the delivery date must always be entered.

Engine model:	Engine No.:	Delivery date:		
Date of scheduled initial operation of engine:				

No.	Task	Date	Name
1	Visual inspection of special packaging for damage Relative air humidity: %		
2	Relative air humidity: %		
3	Relative air humidity: %		
4	Relative air humidity: %		
5	Relative air humidity: %		
6	Relative air humidity: %		
7	Relative air humidity: %		
8	Relative air humidity: %		
9	Relative air humidity: %		
10	Relative air humidity: %		
11	Relative air humidity: %		
12	Relative air humidity: %		
13	Inspection of the hygrometer before opening the packaging Relative air humidity: %		
14	De-preservation completed		

No.		Name of person responsible
1		
2		
3		
4		
5		

Important note on the warranty period

Important

Notify MTU Friedrichshafen GmbH and MTU Onsite Energy GmbH:

- if two or all three fields of the humidity indicator are pink
- if, during de-preservation of the engine, external signs of corrosion or damage to the rubber hose connections are detected
- in due time before initial operation of the engine

13 Exhaust aftertreatment system - preservation and re-preservation

13.1 Introduction

This chapter covers the preservation of the exhaust aftertreatment system (hereinafter referred to as the EAS).

The EAS usually consists of:

- DPF diesel particulate filter
- DOC (Diesel Oxidation Catalyst)
- SCR (Selective Catalytic Reduction)

Depending on the application, the EAS is compiled to meet the requirements:

- DOC and DPF
- Only SCR
- · Only DOC
- · Combined-cycle plant consisting of DOC, DPF and SCR

Both during operation as well as in the framework of the preservation and re-preservation of MTU series SCR systems, only reducing agents approved by MTU Friedrichshafen GmbH must be used. An overview of the approved reducing agents is provided in the current MTU Fluids and Lubricants Specifications.

Note: The method of preservation, re-preservation and return to operation for EAS systems from MTU applies to all applications and series.

13.2 DPF system and DOC system

The housing of the DOC and / or DPF do not require preservation and re-preservation.

For the housings and the catalytic converter / diesel particulate filter, it is sufficient during disassembly to seal the openings (flanges of exhaust pipework) to prevent the entry of contamination from the air.

Ideally, installed sensor systems and attachments remain installed in the system structure during long out-ofservice periods and are serviced or replaced in accordance with the Maintenance Schedule.

Further measures are not required.

13.3 SCR System

13.3.1 Housing of the SCR system

The housing of the SCR does not require preservation and re-preservation.

For the housings and the catalytic converters, it is sufficient during disassembly to seal all openings (flanges of exhaust pipework) to prevent the entry of contamination from the air.

Ideally, installed sensor systems and attachments remain installed in the system structure during long out-ofservice periods and are serviced or replaced in accordance with the Maintenance Schedule.

Depending on the application, the system is protected against external influences by suitable packaging material (optional).

During long out-of-service periods, decommissioning or commissioning, components that carry reducing agent must be prepared accordingly and must be flushed at regular intervals with a suitable medium.

Important

The entry of air and contamination into the system that conveys reducing agent leads to the crystallization or encrustation of system-related components which can endanger or impair functioning of the system.

13.3.2 RA dosing system

The reducing agent (RA) is usually an aqueous urea solution (32.5% or 40%) for dosing into the exhaust gas.

Elements of an RA dosing system:

- Pre-feed module (PFM): Part of the dosing system that provides defined reducing agent quantities and pressure for the reducing agent system installed downstream.
- Supply unit (VE): VE conveys reducing agent under increased pressure to the dosing unit. The supply unit adjusts automatically to the operating pressure and activates the dosing unit automatically.
- · Dosing unit: The dosing unit injects the exactly required volume of reducing agent into the exhaust line. The exhaust line is cooled by the reducing agent and contains the required sensors.
- RA lines: Consist of urea-resistant EPDM (ethylene-propylene diene monomer rubber) and are flexible and can be heated electrically as an option.
- RA tank

Important

When decommissioning, the complete RA dosing system must be filled with reducing agent for storage. Alternatively, the reducing agent system can also be filled with distilled water with a specified electrical conductivity of max. 1.0 µS/cm (standard 3696, type 2). The use of distilled water is recommended for outof-service periods >18 months.

Decommissioning of a complete system (no disassembly of system components)

During decommissioning of a complete system for a long out-of-service period, the RA dosing system must be filled with reducing agent. Filling can also take place with the currently available reducing agent. To guarantee complete filling, circulation of the reducing agent in the system circuit without dosing into the exhaust gas is recommended.

To guarantee system functions after a long period out of operation, the following criteria must be met before and after the out-of-service period:

- The RA dosing system must be filled with reducing agent.
- · No air entry in the closed system.
- No contamination entry in the closed system.
- Protection against heat or strong solar radiation.
- The storage temperature for reducing agent must not exceed 50 °C.
- The re-preservation intervals and performance of flushing operations must be observed.

Important

Check the durability of reducing agents in accordance with the manufacturers' specifications. Example: AdBlue® is durable for up to 12 months after production at product temperatures below 25 °C. If the used AdBlue® is already older, fresh AdBlue® must be used for return to operation (→ Page 117).

Decommissioning with partial disassembly of system components

Decommissioning of the EAS system with partial disassembly of reducing agent conveying system components is not recommended. When connecting elements are opened or separated before and after a preservation or re-preservation measure, air and/or contamination can enter the system.

If decommissioning with partial disassembly of reducing agent conveying system components is absolutely necessary, contact MTU Service.

The following conditions must be guaranteed:

- · A suitable interface for opening or separating connecting elements must be defined so that all components that convey reducing agent can be flushed (prerequisite: separate customer provision of reducing
- It must be possible to activate the pump units that convey reducing agent (operation of pumps without reducing agent dosing into the exhaust gas, e.g. in SCR service mode).

Note: Only decommission with partial disassembly of components that convey reducing agent when accompanied / commissioned by MTU Customer Support.

Important

Only decommission with partial disassembly of components that convey reducing agent when accompanied / commissioned by MTU Service.

13.3.4 Preservation and re-preservation

To guarantee the RA dosing system functions after a long out-of-service period, depending on the storage conditions the system must be flushed at defined intervals (prevents crystallization or encrustation that blocks system-related components, e.g. valves).

To prevent blockages in the system, in the framework of re-preservation the (old) medium in the system must be replaced with one from the factory.

Refer to the following table for the replacement intervals as a function of storage conditions.

Storing RA dosing system with reducing agent filling

Applies to Series 1600, Series 2000, Series 4000

Storage condi-	Re-preservation interval in months Note			
tions*	6	12	24	
Normal		Flushing operation: • Series 1600: 15 min • Series 2000: 20 min • Series 4000: 25 min	Flushing operation: • Series 1600: 15 min • Series 2000: 20 min • Series 4000: 25 min	Depending on application and series If the packaging is damaged, it has to be replaced
			Filter replacement, supply units** Filter replacement, pre-feed module*** Filter replacement, RA tank	
Difficult		Flushing operation: • Series 1600: 15 min • Series 2000: 20 min • Series 4000: 25 min	Flushing operation: • Series 1600: 15 min • Series 2000: 20 min • Series 4000: 25 min	
			Filter replacement, supply units** Filter replacement, pre-feed module*** Filter replacement, RA tank	
Unsuitable	Flushing operation: • Series 1600: 15 min • Series 2000: 20 min • Series 4000: 25 min		Flushing operation: • Series 1600: 15 min • Series 2000: 20 min • Series 4000: 25 min	
* 6 6 1	ation on storage, see	(- P 24)	Filter replacement, supply units** Filter replacement, pre-feed module*** Filter replacement, RA tank	

^{*} for further information on storage, see (→ Page 24)
** supply unit
*** pre-feed module

Storage condi-	Re-pres	Note		
tions*	6	12	24	
Normal	-	RA** flushing operation approx. 15 min.	Filter replacement	If the packaging is damaged, it has to be replaced. Filter replacement: • Screen filter of RA tank • Supply unit filter
Difficult	RA** flushing operation approx. 15 min.	-	Filter replacement	

^{*} for further information on storage, see (→ Page 24)

Carrying out reducing agent flushing operation or re-preservation

Applies to Series 1600, Series 2000, Series 4000

Preconditions for carrying out flushing operation or re-preservation:

- Before these measures are performed, at least one visual check of the system must be carried out.
- The medium or fluid in the deactivated system is liquid and not frozen. The temperature of the medium in the tank and the system circuit > freezing temperature of the medium (cf. manufacturer's specifications or MTU Fluids and Lubricants Specifications)
- The system is self-contained. There are no leaks in the system
- · A sufficient amount of suitable brand-new medium or fluid is provided. Fill the RA tank so that the intake points in the tank are sufficiently covered with reducing agent. Replace unsuitable, old medium.
- Provide or guarantee an external central power supply (24 V DC / 15 A)
- Service dongle is connected.

Sequence of flushing operation:

- 1. Drain existing reducing agent from the RA tank.
- 2. Dispose of reducing agent in accordance the specifications.
- 3. Replace existing reducing agent with fresh reducing agent.
- 4. Fill the tank so that the intake points in the tank are sufficiently covered with reducing agent.

During flushing operation, the RA dosing system is put into operation with the help of an external power supply. The reducing agent pumps installed in the system start automatically and circulate the flushing medium. After the defined flushing period has elapsed, the system is switched off and preserved in accordance with the manufacturer's specifications.

Important

If a system is placed in storage with protective packaging or is decommissioned, the packaging has to be replaced with new packaging following a re-preservation measure.

Storing RA dosing system without reducing agent filling and with climatecompatible packaging

Applies to Series 1600

^{**} RA = reducing agent, normally an aqueous reducing agent (32.5% or 40%)

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Storage condi-	Re-preservation interval in months			Note	
tions*	6	12	24	36	
Normal Difficult	-	-	-	Flushing with distilled water**	If the packaging is damaged, it has to be replaced.

^{*} for further information on storage, see (→ Page 24)

Draining RA dosing system

Applies to Series 1600

To store the RA dosing system 36 months without re-preservation, introduce the following measures:

- 1. Drain the complete reducing agent.
- 2. Flush the complete RA dosing system with double-distilled water (quality: evaporation residue < 2 mg/L) until there is no more reducing agent in the system (<0.1%). Contact your MTU representative if you have any questions on details of the flushing operation work sequence.
- 3. After flushing, drain the water completely or dry the system.
- 4. Seal all openings tightly.
- 5. Pack the complete system in climate-compatible packaging.

Important

For flushing operation and draining of the RA dosing system, the Service dongle must be connected. Execution according to drawing for XZ57541000013. Contact your MTU representative if you have any questions.

Preservation of RA dosing system with double-distilled water

Applies to Series 1800 3B

Preconditions for carrying out preservation of the RA dosing system:

- Initial filling in assembly with double-distilled water in the RA tank (65 liters).
- · Test run carried out with double-distilled water.
- PowerPack® is stopped and starting disabled.

To preserve the RA dosing system with double-distilled water, introduce the following measures:

- 1. Remove reducing agent lines from RA tank.
- 2. Allow double-distilled water to flow out of RA tank, filter and lines.
- 3. Remove reducing agent lines at supply unit and pump module and apply compressed air to them.
- 4. Remove filter housing cover at pump module in depressurized state and drain (width across flats 46 mm).
- 5. Apply compressed air to reducing agent lines from pump module to RA tank.
- 6. Apply compressed air to pump module at the three reducing agent connections.
- 7. Check reducing agent lines and connections for penetration of dirt.
- 8. Refit reducing agent lines and connections.
- 9. Apply a thin coat of MB silicone grease to the O-ring-gasket of the filter housing cover.
- 10. Screw in filter housing cover and tighten to specified tightening torque 32+/-2.5 Nm.

Important

Execution according to drawing for XZ50443200097. Contact your MTU representative if you have any questions.

^{**} Note: For further storage after 36 months, flush the RA dosing system again with double-distilled water (approx. 5 min. with approx. 8 liters). Contact your MTU representative if you have any questions on details of the flushing operation work sequence. After complete draining of the flushing liquid and drying of the RA dosing system, tightly seal all openings and pack the PowerPack® or the engine again in the climate-compatible packaging.

13.3.5 Putting into operation

Preconditions for carrying out commissioning:

- Before these measures are performed, at least one visual check of the system must be carried out.
- The medium or fluid in the deactivated system is liquid and not frozen. The temperature of the medium in the tank and the system circuit > freezing temperature of the medium (cf. manufacturer's specifications or MTU Fluids and Lubricants Specifications)
- The system is self-contained. There are no leaks in the system
- · A sufficient amount of suitable brand-new medium or fluid is provided. Fill the tank so that the intake points in the tank are sufficiently covered with reducing agent. Replace unsuitable, old medium.
- · Replace the filter units depending on the out-of-service duration in case of contact with reducing agent

In the framework of commissioning, the RA dosing system is flushed independently of engine operation.

13.3.6 Sensors

The SCR system contains the following sensors:

- NOx sensor
- · Lambda sensor
- Humidity sensor (optional)

Sensors do not require preservation and re-preservation.

Observe the following points:

- · Only touch sensor with clean hands on the protective jacket. The sensor must not be contaminated, which also includes the thread grease.
- When screwed in, the sensor can not be contaminated from the outside. From the inside, i.e. in the pipes, preservation agent must not be allowed to penetrate the sensor. Protest the sensor here or remove and store separately.
- Do not paint the sensors
- The humidity sensor makes the humidity measurement via an electronic chip that is protected by PTFE braid. This braid and the chip underneath it must not be contaminated.
- Storage conditions:
 - Dry
 - Dust-free
 - Not in the vicinity of volatile gases or substances
- Avoid freezing due to condensation. Ice can destroy the measuring cell.
- Permissible storage temperature: -40 °C up to max. +125 °C
- · Maximum recommended storage time: 2 years
- For further information on how sensors are removed and reinstalled, see (→ Maintenance Manual).

13.4 Catalytic converter for gas engine-generator set of Series 4000 and 400

After a downtime of more than one year, the catalytic converter must be removed and, if necessary, cleaned, dried and placed in storage.

14 Revision Overview

14.1 Revision - Overview

Changes to previous edition

Complete revision of versions A001070/02 to A001070/03:

- PowerPack® of Series 1600 and 1800 taken into consideration in the various chapters
- Preface updated
- Chapter "SCR system" updated
- Contact person/Service partner added

15 Appendix A

15.1 Contact person/Service partner

Service

The worldwide network of the sales organization with subsidiaries, sales offices, representatives and customer service centers ensure fast and direct support on site and ensure the high availability of our products.

Local Support

Experienced and qualified specialists place their knowledge and expertise at your disposal.

For locally available support, go to the Internet site: http://www.mtu-solutions.com

24 h Hotline

With our 24 h hotline and high flexibility, we are your contact around the clock: during each operating phase, preventive maintenance and corrective operations in case of a malfunction, for information on changes in conditions of use and for supplying spare parts.

Your contact person in our Customer Assistance Center:

E-mail: service.de@ps.rolls-royce.com

Spare Parts Service

Quick, easy and correct identification of the spare part required for your system. The right spare part at the right time at the right place.

With this aim in mind, we can call on a globally networked parts logistics system.

Your contact at Headquarters:

Germany:

- Tel: +49 821 74800
- Fax: +49 821 74802289
- E-mail: spareparts-oeg@ps.rolls-royce.com

Worldwide:

- Tel: +49 7541 9077777
- Fax: +49 7541 9077778
- E-mail: spareparts-oeg@ps.rolls-royce.com

16 Appendix B

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