



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®

A001070/04E



A Rolls-Royce
solution

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1 Preface

1.1 Notes on the validity and use of the Preservation and Re-preservation 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 set with MTU engines from the series 1600, 2000 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
- 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 113).

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 products 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 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.

Important

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 25) and (→ Page 26)

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 96), (→ Page 97).

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 represervation of MTU products, 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 95)
- Monitoring Sheet for products with climate-compatible packaging (→ Page 101)

2.2 Check sheet for preservation and re-preservation of engines

Important

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 101) 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.

Engine model designation:	Engine No.:	Acceptance date:

Tasks performed	Date	Name
Lube oil system <ul style="list-style-type: none"> Preserved with preservation oil Oil brand used: 		
Fuel system <ul style="list-style-type: none"> Preserved with preservative fuel Fuel filter, prefilter and fuel lines have not been drained Preservative fuel used: 		
Cooling system, filled <ul style="list-style-type: none"> Preserved with treated coolant Coolant not drained Brand of coolant used: 		
Cooling system, unfilled <ul style="list-style-type: none"> Preserved with an approved corrosion inhibitor for internal preservation of the coolant circuit Corrosion inhibitor drained Corrosion inhibitor used: 		
Combustion chamber <ul style="list-style-type: none"> Preserved with preservation oil Oil brand used: 		
Non-painted parts <ul style="list-style-type: none"> Painted with corrosion inhibitor Engine openings sealed as specified All parts to be kept free of paint, such as flywheel, starter ring gear and starter pinion as well as non-painted sections of the control linkage and the uncovered coupling flange (as appropriate) for the three-phase generator are brush-coated with corrosion-inhibiting oil. Corrosion inhibitor used: 		
Engine is preserved as specified.		
Re-preservation performed according 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 engine-generator sets

Important

All preservation work that is performed must be recorded on the check sheet shown below. For engine-generator sets stored with a manufacturer guarantee, the Monitoring Sheet (→ Page 101) must also be filled out and sent back to MTU Onsite Energy 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 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 <ul style="list-style-type: none"> Preserved with preservation oil. Oil brand used: Opening of lube oil pump, if fitted, is sealed. 		
Fuel system <ul style="list-style-type: none"> Preserved with preservative fuel. Fuel filter, prefilter, cooler and fuel lines have not been drained. Preservative fuel used: 		
Cooling system, filled <ul style="list-style-type: none"> 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 <ul style="list-style-type: none"> Preserved with an approved corrosion inhibitor for internal preservation of the coolant circuit. Corrosion inhibitor is drained Corrosion inhibitor used: 		
Combustion chamber <ul style="list-style-type: none"> Preserved with preservation oil. Oil brand used: 		
External electrical components, if fitted <ul style="list-style-type: none"> All components with external power supply are de-energized. This applies, for example, to: <ul style="list-style-type: none"> 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 dismantled. 		

Tasks performed	Date	Name
Non-painted parts <ul style="list-style-type: none"> Unpainted bare parts, such as flywheel, starter ring gear, starter pinion, bare connections of electrical components are treated with corrosion inhibitor. Corrosion inhibitor used: Generator unpainted flanges, shafts, driver disks and fittings are treated with corrosion inhibitor. Corrosion inhibitor used for generator: 		
Miscellaneous <ul style="list-style-type: none"> 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 <ul style="list-style-type: none"> Filled with preservation oil in accordance with the Preservation Specifications. Oil brand used: 		
Fuel system <ul style="list-style-type: none"> Preserved with preservative fuel Fuel filter, prefilter, cooler and fuel lines have not been drained. Preservative fuel used: 		
Cooling system, filled <ul style="list-style-type: none"> 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 <ul style="list-style-type: none"> 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 <ul style="list-style-type: none"> 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 <ul style="list-style-type: none"> Flushed with double-distilled water Repeat every three years 		
External electrical components, if fitted <ul style="list-style-type: none"> All components with external power supply are de-energized. <ul style="list-style-type: none"> Battery / CaPoS (Capacitor Power System) discharged. Fuses set to Off 		
Non-painted parts <ul style="list-style-type: none"> 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 <ul style="list-style-type: none"> 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

3.1 Preservatives – Requirements

These preservation specifications define the preservatives for the preservation and re-preservation of engines, PowerPack® and engine-generator sets from MTU.

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

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

Note on initial operation

Before initial operation, the engine has to be de-preserved (→ Page 92).

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 number	Remarks	Suitability for engine preservation	
				Filled	Unfilled
MTU Friedrichshafen GmbH	Diesel Engine Oil DEO SAE 10W-40	X00078578 (canister)	Full-load engine oil of Category 3.1 (Low Saps) with additional corrosion protection	x	x
		X00078577 (barrel)			
		X00078576 (IBC)			
Cepsa Lubricantes S.A.	Cepsa Rodaje Y Protección SAE 30	–	Full-load engine oil as per Oil Category 1	x	x
Exxon Mobil	Mobilarma 524	–	Preservative oil: Only approved for preservation run	x	x
Fuchs	Titan Universal HD 30 MTU	X00058057 (barrel) X00013236 (tanker)	Full-load engine oil as per Oil Category 2	x	x
	Titan EM 4599	X00069220 (barrel)	Special application: Only approved for gas engine, engine operation permitted with this oil for maximum 25 h SAE class 40 with increased corrosion protection	x	x
	Titan Cargo Maxx SAE 10W-40	X53564300002 (1000 liters) X53564300003 (205 liters) X53564300004 (20 liters)	Full-load engine oil of Category 3.1 (Low Saps) with additional corrosion protection	x	x
x suitable for engine preservation - unsuitable for engine preservation					

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Manufacturer	Brand name	Material number	Remarks	Suitability for engine preservation	
				Filled	Unfilled
SRS Schmierstoff Vertrieb GmbH	SRS Antikorrol M Plus SAE 30	X00058336 (barrel) X00058338 (tanker)	Only permitted for run-in and series acceptance (oil category 2)	x	x
	SRS Motoröl O-236 SAE 15W-40	X00057300	Full-load engine oil as per Oil Category 2	x	x
	SRS Antikorrol MLA SAE 10W-40	–	Full-load engine oil of Category 3.1 (Low Saps) with additional corrosion protection	x	x
Shell	Shell Running-In Oil 7294 SAE 30	–	Preservative oil: Only approved for preservation run	x	x
	Shell Rimula R6 ME 5W-30	X00009123 X00058058 (barrel)	Special application: Only approved for 1800PP series Engine oil as per Oil Category 3 without improved corrosion protection	x	–
	Shell Rimula R6LM SAE10W-40	X00072386 X00072394 (barrel)	Full-load engine oil of Category 3.1 (Low Saps) with additional corrosion protection	x	x
	Shell Rimula K10 SAE 10W-40	–	Full-load engine oil of Category 3.1 (Low Saps) with additional corrosion protection	x	x
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

Manufacturer	Brand name	Material number	Remarks	Suitability for engine preservation	
				Filled	Unfilled
BASF	Glysacorr P113* (aqueous)	X00046660	9 to 11% by volume application concentration <ul style="list-style-type: none"> • Optimum corrosion protection during draining < 40 °C • Reduced corrosion protection effect during draining ≥ 40 °C • 100 h maximum operating period • Not an engine coolant! 	–	x
BASF	Glysacorr P113 Frostschutz* (antifreeze) (propylene-glycol basis)	X00065818	40 to 50% by volume application concentration <ul style="list-style-type: none"> • Optimum corrosion protection during draining < 40 °C • Reduced corrosion protection effect during draining ≥ 40 °C • 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! 	–	x
Valvoline	Zerex P113*) (aqueous)	–	9 to 11% by volume application concentration <ul style="list-style-type: none"> • Optimum corrosion protection during draining < 40 °C • Reduced corrosion protection effect during draining ≥ 40 °C • 100 h maximum operating period • Not an engine coolant! 	–	x
Valvoline	Zerex P113 anti-freeze* (propylene-glycol based)	–	40 to 50% by volume application concentration <ul style="list-style-type: none"> • Optimum corrosion protection during draining < 40 °C • Reduced corrosion protection effect during draining ≥ 40 °C • Antifreeze protection Up to -16 °C at 40% vol. Up to -28 °C at 50% vol. • Not an engine coolant! 	–	x
x suitable for engine preservation - unsuitable for engine preservation * hereinafter referred to a inhibitor concentration					

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Manufacturer	Brand name	Material number	Remarks	Suitability for engine preservation	
				Filled	Unfilled
Houghton Deutschland GmbH	Oil 9156* (emulsion)	X00056749	2% by volume application concentration <ul style="list-style-type: none"> 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
Various	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: <ul style="list-style-type: none"> Corrosion inhibiting antifreeze is approved for engine operation Shelf life not expired 	x	–
x suitable for engine preservation – unsuitable for engine preservation * hereinafter referred to a inhibitor concentration					

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

Parameters	Minimum	Maximum
Bacteria	–	10 ³ CFU* /ml
Fungi, yeasts	are not permitted	
*CFU : Colony forming unit		

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	Specifi- cation	Material number	Remarks	Suitability for engine preserva- tion	
					Filled	Unfil- led
SRS Schmierst- off Vertrieb GmbH	SRS Calibration Fluid CV	DIN ISO 4113	X00057309	Test oil	x	x
Various	B0 diesel fuel	EN 590 ASTM D 975 grade 2, S15	X00056047	Without biodiesel	x	-
Various	B0 diesel fuel + Anti-wear additive (350-400mg/kg) *	EN 590 ASTM D 975 grade 2, S15	X00056047	Without biodiesel + anti-wear additive	x	-
Various	B7 diesel fuel + Antioxidant agents 0.2% by vol. *	EN 590 ASTM D 975 grade 2, S15		With biodiesel + anti- oxidant agents Max. duration of pres- ervation run: 10 h	x	-
x suitable for engine preservation - unsuitable for engine preservation * see Information						

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

Important
<ul style="list-style-type: none"> For certain series, the use of EN 590 or ASTM D 975 grade 2, S15 (max. sulfur content 15 mg/kg) requires the use of an anti-wear additive. The series affected by this and the approved additives can be obtained from the currently valid A001061. Note that the use of anti-wear additives is not permitted on engines/engine-generator sets with exhaust gas aftertreatment. With the use of fuels containing biodiesel (up to max. 7% by vol.), the addition of the antioxidant agent "Baynox 20% solution" is mandatory. It must be added to the fuel prior to preservation/re-preservation in a concentration of 0.2% by vol.

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 A001061.

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 and gas engine

Re-preservation requirement

- See Re-preservation intervals (→ Page 25), (→ Page 26).
- Parts to be treated, see (→ Page 43).

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 28). 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

Products preserved in the factory 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.

Storage and storage location conditions

The point in time at which the storage time and the period up to the first re-preservation 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:

- Normal storage conditions
- Difficult storage conditions
- Unsuitable, impermissible storage conditions

Types of packaging

- Transport packaging, commercially available, surface transport
- Transport packaging, seaborne, light
- Climate-compatible packaging in containers or heavy-cargo box
- Long-term climate-compatible packaging in heavy-cargo box

Products with light commercially available transport packaging for surface or sea transport are intended for immediate use and must not be stored longer than 6 months. Re-preservation within this period is not required.

Important:

For information on storage conditions, see (→ Page 96).

For information on packaging types, see (→ Page 97).

4.2 Re-preservation intervals for MTU products

4.2.1 Products with filled medium circuits

The performance of re-preservation must always be documented in the check sheet and the product history.

Notes:

- Climate-compatible packaging is not permissible with filled media circuits except for PowerPack®.
- For definition of storage conditions (→ Page 96) and packaging types (→ Page 97).
- 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®.

Packaging	Re-preservation intervals in months. Valid for filled medium circuits: Oil, fuel, coolant; combustion chamber, external preservation				
	Normal storage conditions				Difficult stor- age conditions
	Combustion chamber	Fuel system	Oil circuit/ Coolant circuit	Outside	Storage under difficult condi- tions in this type of trans- port packaging is not permitted .
Transport pack- aging, commer- cially available, for surface transport	12	24	36	Check every 6 months. Result: OK, no corrosion > a further 6 months storage is permitted. Af- ter a total of 36 months, re-pres- ervation is man- datory.	
Transport pack- aging, sea trans- port, light	12	24	36	Result: Not OK, corrosion > re- move corrosion. If necessary, touch up the paintwork. Re- preservation is mandatory.	
Climate-com- patible packag- ing and long- term climate- compatible packaging	For products with filled medium circuits, not permitted : <ul style="list-style-type: none">• Climate-compatible packaging in container• Climate-compatible packaging in heavy-cargo box• Long-term climate-compatible packaging in heavy-cargo box				

4.2.2 Products with unfilled medium circuits

Note:

- 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.

Packaging	Re-preservation intervals in months. Valid for unfilled medium circuits: Oil, fuel, coolant; combustion chamber, external preservation	
	Normal storage conditions	Difficult storage conditions
Transport packaging, commercial-ly available, surface transport	Maximum permitted storage time: 6 months No re-preservation required	Storage under difficult conditions in this type of transport packaging is not permitted .
Transport packaging, seaborne, light		
Climate-compatible packaging in container	Every 12 months	
Climate-compatible packaging in heavy-cargo box	Every 12 months	
Long-term climate-compatible packaging in heavy-cargo box	Every 36 months	

* The external preservation must be checked and replaced or corrected if necessary.

4.2.3 Special rule 6+6 months

Notes:

- The special rule is only valid for products with **unfilled medium circuits**, which have commercially available transport packaging for surface transport or light transport packaging for sea transport and are not installed and put into operation within 6 months. They must be checked after the first 6 months of storage. If the check is OK, the engine can be stored for a further 6 months without re-preservation.
- The exterior shell and the engine cooling circuit must be checked. When checking the engine cooling circuit, it is sufficient to open an end cover, which has to be removed anyway for engine startup. Carry out the check of the engine cooling circuit quickly. The opening must be sealed again immediately to minimize the entry of air and moisture.
- This rule also applies to products that are installed in an early construction phase, e.g. on a ship or in a building, where they remain until initial startup.
- The result of the findings must be documented in writing.
- The engines then have to be repacked. The packaging type can correspond to the original packaging or higher quality packaging. In any case, the packaging must be selected and designed such that the product survives further storage without damage.

Packaging	Re-preservation Special rule 6+6 months	
	Unfilled medium circuits: Oil, fuel, coolant; combustion chamber, external preservation Normal storage conditions	
	After 6 months storage: Carry out a check for corrosion of the engine exterior shell and coolant circuit	
Transport packaging, commercially available, surface transport	Result: OK, no corrosion	Result: not OK, corrosion
Transport packaging, seaborne, light	further 6 months storage per- mitted – then re-preservation is mandatory	immediate re-preservation or derusting of cooling circuit re- quired. If necessary, touch up the paintwork.

Table 5: Special rule 6+6 months

If longer storage periods and longer re-preservation intervals than 6 months are desired, the products must be packed in the higher-quality, more protective climate-compatible packaging or long-term climate-compatible packaging.

4.3 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 76).

Generator

Manufacturer/type	Re-preservation interval	Recommended storage conditions
Marathon MagnaPlus	–	<ul style="list-style-type: none"> • Clean, dry area in a closed room with no rapid changes in temperature and air humidity to prevent condensation • Keep covered
Marathon MagnaMax	Every 6 months	<ul style="list-style-type: none"> • 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
Marathon MagnaPower	Every 6 months	
Cummins	Every 6 months	<ul style="list-style-type: none"> • 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 <p>If the generator can be turned, turn the rotor during storage at least 6 times a month.</p>
Leroy Somer (with diesel engine-generator sets)	–	<p>Storage until return to operation:</p> <ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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 <p>The following measures must be carried out for all generators that are stationary for longer than six months:</p> <ul style="list-style-type: none"> • 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.

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Starter battery

Manufacturer/type	Re-preservation interval	Recommended storage conditions
Exide	Every 6 months	<ul style="list-style-type: none"> • Clean, dry area in a closed room • 5 °C to 25 °C • Disconnected and removed
Panther	Every 6 months	<ul style="list-style-type: none"> • Clean, dry area in a closed room • 5 °C to 25 °C • Disconnected and removed
Varta	Every 12 months	<ul style="list-style-type: none"> • Clean, dry area in a closed room • 5 °C to 25 °C • Disconnected and removed
Optima	Every 6 months	<ul style="list-style-type: none"> • Clean, dry area in a closed room • 5 °C to 25 °C • Disconnected and removed

5 Diesel engine - preservation and re-preservation

5.1 With operation option and filled medium circuits

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

Note:

- 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 35).

5.1.2 Service Interruption of 1 to 3 Months

5.1.2.1 Service interruption of 1 to 3 months

- Note:
- 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 listed in the relevant Fluids and Lubricants Specifications.
 - Sealing of the openings differs depending on whether the engine is installed or removed.
 - Work sequence details may vary from engine to engine. Contact your MTU representative if you have any questions (Product Support, Development).

Preservation	Preservation procedure
Interior (oil, fuel and cooling system)	<ol style="list-style-type: none">1. Run engine until operating temperature is reached.2. Run engine for approx. 30 seconds at rated speed and then shut down at rated speed. The engine must then not be started any more.3. 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: <ul style="list-style-type: none">• Cooling air inlet• Combustion-air inlet (close the emergency-air shut-off flaps if they are provided)• Exhaust gas outlet• Crankcase breather (where possible; with venting to atmosphere)
Sealing the openings on removed engine	The following openings must be sealed airtight: <ul style="list-style-type: none">• Cooling air inlet• Combustion-air inlet (close the emergency-air shut-off flaps if they are provided)• Exhaust gas outlet• Crankcase breather (where possible; with venting to atmosphere)• Coolant circuit• Fuel circuit• Lube oil circuit• Hydraulic oil circuit• Electrical plug connectors

5.1.2.2 Special operation before shutting down the engine Series 2000Mx6

Due to the high charge-air pressure and the low combustion air temperatures, during operation of the engine of the series 2000Mx6 engines condensate can develop in the charge-air system downstream of the inter-cooler depending on ambient conditions. Condensate can accumulate at high levels, in particular, at rated load. Engine shutdown at rated speed for preservation of the engine is therefore not permitted. To correctly preserve the engines in the series 2000Mx6 in installed state, the following procedure must be carried out. The driving program applies to all drives and engaged engine.

- Warm up engines in the speed range from 1000 to 1200 rpm.
- Then operate the engine as follows:
30 minutes at 600 to 1000 rpm

Important:

During operation for preservation of the engine, even short-term speed jumps above 1400 rpm must be avoided in all circumstances.

Preservation	Preservation procedure
Sealing the openings on installed engine	Seal the following openings airtight: <ul style="list-style-type: none">• Cooling air inlet• Combustion-air inlet (close the emergency-air shut-off flaps if they are provided)• Exhaust gas outlet• Crankcase breather (where possible; with venting to atmosphere)
Sealing the openings on removed engine	Seal the following openings airtight: <ul style="list-style-type: none">• Cooling air inlet• Combustion-air inlet (close the emergency-air shut-off flaps if they are provided)• Exhaust gas outlet• Crankcase breather (where possible; with venting to atmosphere)• Coolant circuit• Fuel circuit• Lube oil circuit• Hydraulic oil circuit• Electrical plug connectors

Table 6: Sealing the openings

5.1.3 Service interruption of more than 3 months

- Note:
- 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 25)
 - 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 measures:
 - 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.
 - Work sequence details may vary from engine to engine. Contact your MTU representative if you have any questions (Product Support, Development).

Preservation	Preservation procedure
Interior (oil, fuel and cooling system)	<ol style="list-style-type: none"> 1. Clean engine if necessary. 2. 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. 3. Fill fuel system with an approved fuel (→ Page 21). If necessary, replace an already filled fuel which is not suitable for engine storage. 4. If necessary, drain coolant and fill with approved corrosion inhibiting antifreeze or leave existing corrosion inhibiting antifreeze in coolant circuit (→ Page 18). 5. Run engine at increased idling speed for approx. 10 minutes. The coolant must have reached operating temperature. 6. Shut down engine. 7. All media remain in the system. These medium circuits must be filled completely.
Combustion chamber	<ol style="list-style-type: none"> 1. Seal the decompression openings. 2. Fill corrosion inhibitor for initial operation at least up to the "Min" mark (→ Page 16). 3. Remove end covers for air intake and exhaust gas discharge. 4. 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. 5. Bar warm engine with starting equipment. The engine must not start. To do this: <ul style="list-style-type: none"> • Actuate the stop lever for mechanical governors. • With electronic governors, unplug connector X4 from the injector wiring harness. 6. 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). 7. Seal openings for intake air inlet and exhaust outlet airtight. 8. 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	<p>The following openings must be sealed airtight:</p> <ul style="list-style-type: none"> • Cooling air inlet • Intake air inlet (close the emergency-air shut-off flaps if they are provided) • Exhaust gas outlet • Crankcase breather (where possible; with venting to atmosphere)
Sealing the openings on removed engine	<p>The following openings must be sealed airtight:</p> <ul style="list-style-type: none"> • Cooling air inlet • Intake air inlet (close the emergency-air shut-off flaps if they are provided) • Exhaust gas outlet • Crankcase breather (where possible; with venting to atmosphere) • Coolant circuit • Fuel circuit • Lube oil circuit • Hydraulic oil circuit • Electrical plug connectors

5.2 With operation option and unfilled medium circuits

5.2.1 Service interruption up to 3 months

- Note:
- 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 media circuits must be sealed immediately after draining the media.
 - Work sequence details may vary from engine to engine. Contact your MTU representative if you have any questions (Product Support, Development).

Preservation	Preservation procedure
Interior (oil, fuel and cooling system)	<ol style="list-style-type: none"> 1. Clean engine if necessary. 2. Drain coolant (if present) and dispose of. 3. 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. 4. 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). 5. 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). 6. Run engine at increased idling speed for approx. 10 minutes. The inhibitor concentration must reach operating temperature. 7. Shut down engine. 8. Allow engine to cool down to below 40 °C. 9. Drain engine oil. 10. 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.
Sealing the openings on installed engine	<p>The following openings must be sealed airtight:</p> <ul style="list-style-type: none"> • Cooling air inlet • Combustion-air inlet (close the emergency-air shut-off flaps if they are provided) • Exhaust gas outlet • Crankcase breather (where possible; with venting to atmosphere)
Sealing the openings on removed engine	<p>The following openings must be sealed airtight:</p> <ul style="list-style-type: none"> • Cooling air inlet • Combustion-air inlet (close the emergency-air shut-off flaps if they are provided) • Exhaust gas 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

- Note:
- 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 26).
 - 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 measures:
 - 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.
 - Work sequence details may vary from engine to engine. Contact your MTU representative if you have any questions (Product Support, Development).

Preservation	Preservation procedure
Interior (oil, fuel and cooling system)	<ol style="list-style-type: none"> 1. Clean engine if necessary. 2. Drain coolant (if present) and dispose of. 3. 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. 4. 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). 5. 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). 6. Run engine at increased idling speed for approx. 10 minutes. The inhibitor concentration must reach operating temperature. 7. Shut down engine. 8. Allow engine to cool down to below 40 °C. 9. Drain engine oil. 10. Drain inhibitor concentration.
Combustion chamber	<ol style="list-style-type: none"> 1. Seal the decompression openings. 2. Fill corrosion inhibitor for initial operation at least up to the "Min" mark (→ Page 16). 3. Remove end covers for air intake and exhaust gas discharge. 4. 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 turbo-charger. 5. Bar warm engine with starting equipment. The engine must not start. To do this: <ul style="list-style-type: none"> • Actuate the stop lever for mechanical governors. • With electronic governors, unplug connector X4 from the injector wiring harness. 6. 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). 7. Seal openings for intake air inlet and exhaust outlet airtight. 8. Seal access to the charge-air pipes.

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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).
Sealing the openings on installed engine	<p>The following openings must be sealed airtight:</p> <ul style="list-style-type: none"> • Cooling air inlet • Intake air inlet (close the emergency-air shut-off flaps if they are provided) • Exhaust gas outlet • Crankcase breather (where possible; with venting to atmosphere)
Sealing the openings on removed engine	<p>The following openings must be sealed airtight:</p> <ul style="list-style-type: none"> • Cooling air inlet • Intake air inlet (close the emergency-air shut-off flaps if they are provided) • Exhaust gas outlet • Crankcase breather (where possible; with venting to atmosphere) • Coolant circuit • Fuel circuit • Lube oil circuit • Hydraulic oil circuit • Electrical plug connectors

5.3 Without operation option and filled medium circuits

- Note:
- 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 25).

Preservation	Preservation procedure
Preparation	<ol style="list-style-type: none"> 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	<ol style="list-style-type: none"> 1. Drain old oil if necessary. 2. Remove priming connection from crankcase. 3. Connect oil priming pump. 4. 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). 5. Remove the turbocharger oil return line, which is the last element in the oil circuit to be supplied with oil. 6. Pump oil under pressure into the circuit until it emerges from the oil return line of the turbocharger. 7. Reinstall turbocharger oil return line. This ensures that the entire lube oil circuit is completely filled. 8. Bar engine manually one to two rotations. 9. Leave the oil in the engine.
Coolant circuit	<ol style="list-style-type: none"> 1. Drain remaining coolant (if present) and dispose of. 2. Completely fill coolant circuit with approved corrosion inhibitor concentration suitable for a filled engine (→ Page 18). 3. Open all thermostats so that the inhibitor concentration reaches all areas of the coolant circuit. 4. Leave the inhibitor concentration in the engine. NOTE: Mixing of different inhibitor concentrations is impermissible. 5. Seal all coolant openings airtight.
Fuel system	<ul style="list-style-type: none"> • 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.

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Preservation	Preservation procedure
Combustion chamber	<ol style="list-style-type: none"> 1. Seal the decompression openings. 2. Open air pipe downstream of intercooler. 3. 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). 4. 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)	<ul style="list-style-type: none"> • Coat or spray non-painted parts of the outer shell with corrosion inhibitor for external preservation (→ Page 22).

5.4 Without operation option and unfilled medium circuits

- Note:
- 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 26)
 - CAUTION: Seal off all medium circuits airtight immediately after draining the preservative.

Preservation	Preservation procedure
Preparation	<ol style="list-style-type: none"> 1. If necessary, clean the engine prior to (re-)preservation. 2. Drain and dispose of all media. <p>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.</p>
Lube oil circuit	<ol style="list-style-type: none"> 1. Remove priming connection from crankcase. 2. Connect oil priming pump. 3. 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). 4. Remove the turbocharger oil return line, which is the last element in the oil circuit to be supplied with oil. 5. Pump oil under pressure into the circuit until it emerges from the oil return line of the turbocharger. 6. Reinstall turbocharger oil return line. This ensures that the entire lube oil circuit is completely filled. 7. Bar engine manually one to two rotations. 8. 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. <p>If barring the engine on site is not possible:</p> <ol style="list-style-type: none"> 1. Open the charge-air pipes. 2. Use a fine-atomizing spray gun to spray oil into the charge-air pipe openings for approx. 15 seconds. 3. Close the charge-air pipes. 4. Carefully seal air inlet and exhaust outlet to prevent aeration via the open valves. 5. Open inspection port covers of crankcase (four inspection port covers per engine side). 6. Use a fine-atomizing spray gun to spray oil into each opened inspection port cover for approx. 15 seconds. 7. Close the inspection port cover.

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Preservation	Preservation procedure
Coolant circuit	<ol style="list-style-type: none"> 1. Drain remaining coolant (if present) and dispose of. 2. Completely fill the coolant circuit with an approved inhibitor concentration and then seal hermetically (→ Page 18). 3. Use an external coolant heater to heat up the engine to a min. of 75 °C. 4. Allow engine to cool down to below 40 °C. 5. Drain inhibitor concentration completely. 6. Immediately after draining, seal coolant openings airtight <p>If no circulation is possible (e.g. via a heated pressure testing trolley):</p> <ol style="list-style-type: none"> 1. Open all thermostats (if necessary) so that the medium reaches all areas of the coolant circuit. 2. Leave the inhibitor concentration for 24 hours in the engine. 3. Then drain inhibitor concentration completely. 4. Seal the coolant circuit hermetically against moisture.
Fuel system	<ul style="list-style-type: none"> • 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.
Combustion chamber	<ol style="list-style-type: none"> 1. Seal the decompression openings. 2. Open air pipe downstream of intercooler. 3. 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). 4. Carefully seal air inlet and exhaust outlet. This prevents venting via the opened inlet and exhaust valves at the cylinders in overlap position. <p>Applies for Series 8000:</p> <ol style="list-style-type: none"> 1. Remove injectors (→ Operating Instructions). 2. Use a hose to spray oil via the openings. Duration of spraying is approx. 10 seconds respectively. 3. Replace CE rings of injectors (→ Operating Instructions). 4. Install injectors (→ Operating Instructions).
Non-painted parts (external preservation)	<ul style="list-style-type: none"> • 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 62).
 - 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 44)

Storage with filled medium circuits under normal conditions

1. Execute "lockout/tagout procedure" (→ refer to the Operation and Maintenance Manual).
2. 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 valves.

- 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).
 - Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 25).
 - 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	<ol style="list-style-type: none"> 1. Remove all covers. 2. Connect starter batteries. 3. Put control system into operation.
Interior (oil, fuel and cooling system)	<ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • Parts of the engine outer shell • Flanges • Shafts • Driver disks • Valves and fittings
Lockout gas engine and seal openings	<ol style="list-style-type: none"> 1. Execute "lockout/tagout procedure" (→ refer to the Operation and Maintenance Manual). 2. Seal all openings airtight such as air inlet and outlet. 3. 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 valves.

- 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 69).
 - Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 26)
 - Seal the medium circuits immediately after draining the media.

Preservation	Preservation procedure
Preparation	<ol style="list-style-type: none"> 1. Remove all covers. 2. Connect starter batteries. 3. Put control system into operation.
Interior (oil, fuel and cooling system)	<ol style="list-style-type: none"> 1. Clean gas engine if necessary. 2. Drain coolant (if present) and dispose of. 3. 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 9 156" is recommended. 4. 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". 5. Fill engine with approved preservative oil. 6. 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. 7. Allow engine to cool down to below 40 °C. 8. Drain preservative oil out of oil system. 9. Drain preservative out of coolant system. 10. Immediately after draining, seal coolant openings airtight
Combustion chamber	<ol style="list-style-type: none"> 1. Unscrew all spark plugs. 2. If the engine was not warmed up with preservative oil, turn all pistons for preservation one after the other to bottom dead center "BDC". 3. 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. 4. Screw in spark plugs

TIM-ID: 0000081599 - 002

Preservation	Preservation procedure
Non-painted parts (external preservation)	<p>Coat or spray non-painted parts with corrosion inhibitor for external preservation (→ Page 22). This includes:</p> <ul style="list-style-type: none"> • Parts of the engine outer shell • Flanges • Shafts • Driver disks • Valves and fittings
Lockout gas engine and seal openings	<ol style="list-style-type: none"> 1. Execute "lockout/tagout procedure" (→ refer to the Operation and Maintenance Manual). 2. Seal all openings airtight such as air inlet and outlet. 3. Seal off electric plug connectors against moisture.

6.3 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 valves.

- Note:
- 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 25)
 - Preservation of the fuel system of gas engines is not envisaged.

Preservation	Preservation procedure
Preparation	<ol style="list-style-type: none"> 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	<ol style="list-style-type: none"> 1. Drain old oil if necessary. 2. Remove priming connection from crankcase. 3. Connect oil priming pump. 4. 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). 5. Bar engine manually one to two rotations. 6. 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	<ol style="list-style-type: none"> 1. Drain remaining coolant (if present) and dispose of. 2. Completely fill coolant circuit with approved corrosion inhibitor concentration (→ Page 18). 3. Open all thermostats so that the inhibitor concentration reaches all areas of the coolant circuit. 4. Leave the inhibitor concentration in the engine. NOTE: Mixing of different inhibitor concentrations is impermissible. 5. Seal all coolant openings airtight.

TIM-ID: 0000071530 - 005

Preservation	Preservation procedure
Combustion chamber	<ol style="list-style-type: none"> 1. Unscrew all spark plugs. 2. Turn all pistons for preservation one after the other to bottom dead center "BDC". 3. 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. 4. 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. 5. Seal intake air inlet and exhaust outlet airtight and reseal if necessary.
Non-painted parts (external preservation)	<ul style="list-style-type: none"> • Coat or spray non-painted parts of the outer shell with corrosion inhibitor for external preservation (→ Page 22).

6.4 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 valves.

- Note:
- 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 26).
 - Preservation of the fuel system of gas engines is not envisaged.
 - Seal the medium circuits immediately after draining the media.

Preservation	Preservation procedure
Preparation	<ol style="list-style-type: none"> 1. If necessary, clean the engine prior to (re-)preservation. 2. Drain and dispose of all media. <p>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.</p>
Lube oil circuit	<ol style="list-style-type: none"> 1. Remove priming connection from crankcase. 2. Connect oil priming pump. 3. 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). 4. Bar engine manually one to two rotations. 5. Then drain the oil completely. 6. 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. <p>If barring the engine on site is not possible:</p> <ol style="list-style-type: none"> 1. Open the charge-air pipes. 2. Use a fine-atomizing spray gun to spray oil into the charge-air pipe openings for approx. 15 seconds. 3. Close the charge-air pipes. 4. Carefully seal air inlet and exhaust outlet to prevent aeration via the open valves. 5. Open inspection port covers of crankcase (four inspection port covers per engine side). 6. Use a fine-atomizing spray gun to spray oil into each opened inspection port cover for approx. 15 seconds. 7. Close the inspection port cover.

TIM-ID: 0000071531 - 006

Preservation	Preservation procedure
Coolant circuit	<ol style="list-style-type: none"> 1. Drain remaining coolant (if present) and dispose of. 2. Completely fill the coolant circuit with an approved inhibitor concentration and then seal hermetically (→ Page 18). 3. Use an external coolant heater to heat up the engine to a min. of 75 °C. 4. Allow engine to cool down to below 40 °C. 5. Drain inhibitor concentration completely. 6. Immediately after draining, seal coolant openings airtight <p>If no circulation is possible (e.g. via a heated pressure testing trolley):</p> <ol style="list-style-type: none"> 1. Open all thermostats (if necessary) so that the medium reaches all areas of the coolant circuit. 2. Leave the inhibitor concentration for 24 hours in the engine. 3. Then drain inhibitor concentration completely. 4. Seal the coolant circuit hermetically against moisture.
Combustion chamber	<ol style="list-style-type: none"> 1. Unscrew all spark plugs. 2. Turn all pistons for preservation one after the other to bottom dead center "BDC". 3. 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. 4. 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. 5. Seal intake air inlet and exhaust outlet airtight and reseal if necessary.
Non-painted parts (external preservation)	<ul style="list-style-type: none"> • Coat or spray non-painted parts of the outer shell with corrosion inhibitor for external preservation (→ Page 22).

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 55)

Storage with filled medium circuits under normal conditions

1. Execute "lockout/tagout procedure" (→ refer to the Operation and Maintenance Manual).
2. 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

- Note:
- 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	<ol style="list-style-type: none"> 1. Remove all covers. 2. Connect starter batteries. 3. Put control system into operation.
Interior (oil, fuel and cooling system)	<ol style="list-style-type: none"> 1. Clean engine-generator set if necessary. 2. Run engine until operating temperature is reached. 3. 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. 4. 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	<ol style="list-style-type: none"> 1. Execute "lockout/tagout procedure" (→ refer to the Operation and Maintenance Manual). 2. 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

- Note:
- Engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 25).
 - Non-engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 28).
 - All fluids and lubricants remain in the diesel engine-generator set.

Preservation	Preservation procedure
Preparations	<ol style="list-style-type: none"> 1. Remove all covers. 2. Connect starter batteries. 3. Put control system into operation.
Interior (oil, fuel and cooling system)	<ol style="list-style-type: none"> 1. Clean engine-generator set if necessary. 2. 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. 3. Fill fuel system with an approved fuel (→ Page 21). If necessary, replace an already filled fuel which is not suitable for engine storage. 4. If necessary, drain coolant and fill with approved corrosion inhibiting antifreeze or leave existing corrosion inhibiting antifreeze in coolant circuit (→ Page 18). 5. Run engine at increased idling speed for approx. 10 minutes. The inhibitor concentration must reach operating temperature. 6. Engine shutdown 7. All media remain in the system. These medium circuits must be filled completely.
Combustion chamber	<ol style="list-style-type: none"> 1. Seal the decompression openings. 2. Fill corrosion inhibitor for initial operation at least up to the "Min" mark (→ Page 16). 3. Remove end covers for air intake and exhaust gas discharge. 4. 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. 5. Bar warm engine with starting equipment. The engine must not start. To do this: <ul style="list-style-type: none"> • Actuate the stop lever for mechanical governors. • With electronic governors, unplug connector X4 from the injector wiring harness. 6. 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). 7. Seal openings for intake air and exhaust outlet airtight. 8. Seal access to the charge-air pipes.
Non-painted parts (external preservation)	<p>Coat or spray non-painted parts of the outer shell with corrosion inhibitor for external preservation (→ Page 22). This includes:</p> <ul style="list-style-type: none"> • Parts of the engine outer shell • Flanges • Shafts • Driver disks • Valves and fittings

TIM-ID: 0000071548 - 002

Preservation	Preservation procedure
Non-engine components (generator and starter batteries)	<ol style="list-style-type: none"> 1. 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. 2. For charge conservation, load starter batteries according to the re-preservation interval .
Lockout engine-generator set and seal openings	<ol style="list-style-type: none"> 1. Execute "lockout/tagout procedure" (→ refer to the Operation and Maintenance Manual). 2. 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

- Note:
- Engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 25).
 - Non-engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 28).
 - 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 52)
Container	<ol style="list-style-type: none"> 1. Store the container in accordance with the foundation requirements. 2. Touch up paint damage on the container or built-in components in a professional manner with suitable paint to prevent corrosion. 3. Remove deposits on the top deck (e.g. leaves, dust) on a regular basis. 4. Grease door seals and hinges prior to placing in storage. 5. Seal cable entries to weather-proof them (if necessary, remove cover panels). 6. Seal exhaust gas outlet openings to weather-proof them. 7. Guarantee draining of condensate from the exhaust system. 8. Seal connecting flanges (dummy cover) to weather-proof them. 9. Close louver dampers for supply and exhaust air. 10. Where possible, keep the container interior free of frost. 11. Avoid condensation and insert desiccant bags if necessary. 12. Disconnect control system electrically. 13. Disconnect starter batteries. 14. Detach isolator switch for starter from engine (if available). <p>NOTES:</p> <ul style="list-style-type: none"> • 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.

7.2 With operation option and unfilled medium circuits

7.2.1 Service interruption up to 3 months

- Note:
- Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 26).
 - CAUTION: Seal the medium circuits immediately after draining the media.

Preservation	Preservation procedure
Preparations	<ol style="list-style-type: none"> 1. Remove all covers. 2. Connect starter batteries. 3. Put control system into operation.
Interior (oil, fuel and cooling system)	<ol style="list-style-type: none"> 1. Clean engine-generator set if necessary. 2. Drain coolant (if present) and dispose of. 3. 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. 4. 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). 5. 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). 6. Run engine at increased idling speed for approx. 10 minutes. The inhibitor concentration must reach operating temperature. 7. Shut down engine. 8. Allow engine to cool down to below 40 °C. 9. Drain engine oil. 10. 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	<ol style="list-style-type: none"> 1. Execute "lockout/tagout procedure" (→ refer to the Operation and Maintenance Manual). 2. 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

- Note:
- Engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 26)
 - Non-engine components: 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	<ol style="list-style-type: none"> 1. Remove all covers. 2. Connect starter batteries. 3. Put control system into operation.
Interior (oil, fuel and cooling system)	<ol style="list-style-type: none"> 1. Clean engine-generator set if necessary. 2. Drain coolant (if present) and dispose of. 3. 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. 4. 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). 5. 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). 6. Run engine at increased idling speed for approx. 10 minutes. The inhibitor concentration must reach operating temperature. 7. Shut down engine. 8. Allow engine to cool down to below 40 °C. 9. Drain engine oil. 10. Drain inhibitor concentration.
Combustion chamber	<ol style="list-style-type: none"> 1. Seal the decompression openings. 2. Fill corrosion inhibitor for initial operation at least up to the "Min" mark (→ Page 16). 3. Remove end covers for air intake and exhaust gas discharge. 4. 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. 5. Bar warm engine with starting equipment. The engine must not start. To do this: <ul style="list-style-type: none"> • Actuate the stop lever for mechanical governors. • With electronic governors, unplug connector X4 from the injector wiring harness. 6. 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). 7. Seal openings for intake air and exhaust outlet airtight. 8. Seal access to the charge-air pipes.

TIM-ID: 0000071550 - 002

Preservation	Preservation procedure
Non-painted parts (external preservation)	<p>Coat or spray non-painted parts of the outer shell with corrosion inhibitor for external preservation (→ Page 22). This includes:</p> <ul style="list-style-type: none"> • Parts of the engine outer shell • Flanges • Shafts • Driver disks • Valves and fittings
Non-engine components (generator and starter batteries)	<ol style="list-style-type: none"> 1. 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. 2. For charge conservation, load starter batteries according to the re-preservation interval .
Lockout engine-generator set and seal openings	<ol style="list-style-type: none"> 1. Execute "lockout/tagout procedure" (→ refer to the Operation and Maintenance Manual). 2. 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

- Note:
- 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 25).
 - Non-engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 28).

Preservation	Preservation procedure
Preparation	<ol style="list-style-type: none"> 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-generator set prior to (re-)preservation. 3. 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	<ol style="list-style-type: none"> 1. Drain old oil if necessary. 2. Remove priming connection from crankcase. 3. Connect oil priming pump. 4. 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). 5. Remove the turbocharger oil return line, which is the last element in the oil circuit to be supplied with oil. 6. Pump oil under pressure into the circuit until it emerges from the oil return line of the turbocharger. 7. Reinstall turbocharger oil return line. This ensures that the entire lube oil circuit is completely filled. 8. Bar engine manually one to two rotations. 9. Leave the oil in the engine.
Coolant circuit	<ol style="list-style-type: none"> 1. Drain remaining coolant (if present) and dispose of. 2. Completely fill coolant circuit with approved corrosion inhibitor concentration suitable for a filled engine (→ Page 18). 3. Open all thermostats so that the inhibitor concentration reaches all areas of the coolant circuit. 4. Leave the inhibitor concentration in the engine. NOTE: Mixing of different inhibitor concentrations is impermissible. 5. Seal all coolant openings airtight.
Fuel system	<ul style="list-style-type: none"> • 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.

TIM-ID: 0000071505 - 003

Preservation	Preservation procedure
Combustion chamber	<ol style="list-style-type: none"> 1. Seal the decompression openings. 2. Open air pipe downstream of intercooler. 3. 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). 4. 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)	<p>Coat or spray non-painted parts with corrosion inhibitor for external preservation (→ Page 22). This includes:</p> <ul style="list-style-type: none"> • Parts of the engine outer shell • Flanges • Shafts • Driver disks • Valves and fittings
Non-engine components (generator and starter batteries)	<ol style="list-style-type: none"> 1. 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. 2. For charge conservation, load starter batteries according to the re-preservation interval.

7.4 Without operation option and unfilled medium circuits

- Note:
- 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 26).
 - Non-engine components: 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	<ol style="list-style-type: none"> 1. If necessary, clean the engine-generator set prior to (re-)preservation. 2. Drain and dispose of all media. 3. 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	<ol style="list-style-type: none"> 1. Remove priming connection from crankcase. 2. Connect oil priming pump. 3. 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). 4. Remove the turbocharger oil return line, which is the last element in the oil circuit to be supplied with oil. 5. Pump oil under pressure into the circuit until it emerges from the oil return line of the turbocharger. 6. Reinstall turbocharger oil return line. This ensures that the entire lube oil circuit is completely filled. 7. Bar engine manually one to two rotations. 8. 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. <p>If barring the engine on site is not possible:</p> <ol style="list-style-type: none"> 1. Open the charge-air pipes. 2. Use a fine-atomizing spray gun to spray oil into the charge-air pipe openings for approx. 15 seconds. 3. Close the charge-air pipes. 4. Carefully seal air inlet and exhaust outlet to prevent aeration via the open valves. 5. Open inspection port covers of crankcase (four inspection port covers per engine side). 6. Use a fine-atomizing spray gun to spray oil into each opened inspection port cover for approx. 15 seconds. 7. Close the inspection port cover.

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Preservation	Preservation procedure
Coolant circuit	<ol style="list-style-type: none"> 1. Drain remaining coolant (if present) and dispose of. 2. Completely fill the coolant circuit with an approved inhibitor concentration and then seal hermetically (→ Page 18). 3. Use an external coolant heater to heat up the engine to a min. of 75 °C. 4. Allow engine to cool down to below 40 °C. 5. Drain inhibitor concentration completely. 6. Immediately after draining, seal coolant openings airtight <p>If no circulation is possible (e.g. via a heated pressure testing trolley):</p> <ol style="list-style-type: none"> 1. Open all thermostats (if necessary) so that the medium reaches all areas of the coolant circuit. 2. Leave the inhibitor concentration for 24 hours in the engine. 3. Then drain inhibitor concentration completely. 4. Seal the coolant circuit hermetically against moisture.
Fuel system	<ul style="list-style-type: none"> • 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.
Combustion chamber	<ol style="list-style-type: none"> 1. Seal the decompression openings. 2. Open air pipe downstream of intercooler. 3. 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). 4. 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)	<p>Coat or spray non-painted parts with corrosion inhibitor for external preservation (→ Page 22). This includes:</p> <ul style="list-style-type: none"> • Parts of the engine outer shell • Flanges • Shafts • Driver disks • Valves and fittings
Non-engine components (generator and starter batteries)	<ol style="list-style-type: none"> 1. 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. 2. For charge conservation, load starter batteries according to the re-preservation interval.

8 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 69)

Storage with filled medium circuits under normal conditions

1. Execute "lockout/tagout procedure" (→ refer to the Operation and Maintenance Manual).
2. 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

- Note:
- Engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 25).
 - Non-engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 28).
 - 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	<ol style="list-style-type: none"> 1. Remove all covers. 2. Connect starter batteries. 3. Put control system into operation.
Interior (oil, fuel and cooling system)	<ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • Parts of the engine outer shell • Flanges • Shafts • Driver disks • Valves and fittings
Non-engine components (generator and starter batteries)	<ol style="list-style-type: none"> 1. 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. 2. For charge conservation, load starter batteries according to the re-preservation interval.
Lockout of gas engine-generator set and sealing of openings for maintenance	<ol style="list-style-type: none"> 1. Execute "lockout/tagout procedure" (→ refer to the Operation and Maintenance Manual). 2. Seal all openings airtight such as air inlet and outlet. 3. Seal off electric plug connectors against moisture.

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

- Note:
- Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 28).
 - 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	<ol style="list-style-type: none"> 1. Do not drain media circuits. 2. To prevent frost damage, fill coolant circuits with a water-glycol mixture. 3. Circulate the water/antifreeze volume several times in the circuit so that the complete circuit is flushed. 4. 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	<ol style="list-style-type: none"> 1. Ensure that the media circuit is completely filled. 2. Ensure that the media circuit is filled with a sufficient volume of water-glycol mixture. 3. Circulate the water/antifreeze volume several times in the circuit so that the complete circuit is sufficiently flushed. 4. Run the exhaust gas heat exchanger up to operating temperature before shutting it down. 5. Ensure that there is no more moisture on the exhaust gas side. 6. Seal the exhaust inlet and exhaust outlet such that moisture can not penetrate.
Gas train	<p>Ensure that components of the gas train are always stored in a temperature range from -15 °C to 40 °C.</p> <p>With viton diaphragms, the storage temperature is > 0 °C.</p>
Generator, safety temperature limiter, safety pressure limiter, three-way 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	<ol style="list-style-type: none"> 1. Coat or spray metallic components of the safety valve with corrosion inhibitor for external preservation (→ Page 22) 2. Before putting into operation, clean metallic components of the safety valve

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Preservation	Preservation procedure
Biogas compressor	<ol style="list-style-type: none"> 1. Remove blower at the inlet and outlet from the flange or insert blanking plates. 2. Dry blower and flush with an inert gas. After flushing, ensure that the blower is sealed airtight. 3. Check blower for ease of movement and turn it. <ul style="list-style-type: none"> • With a changing room temperature, once a month • With a constant room temperature, every second month 4. 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	<ol style="list-style-type: none"> 1. Clean the neutralization system. 2. Replace used up or missing granulate. 3. Keep flushing until clear water emerges at the outlet of the neutralization system. 4. 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

- Note:
- Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 28).
 - 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	<ol style="list-style-type: none"> 1. Do not drain media circuits. 2. To prevent frost damage, fill coolant circuits with a sufficient amount of water-glycol mixture. 3. Circulate the water/antifreeze volume several times in the circuit so that the complete circuit is flushed. 4. 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	<ol style="list-style-type: none"> 1. Ensure that the media circuit is completely filled. 2. Ensure that the media circuit is filled with a sufficient volume of water-glycol mixture. 3. Circulate the water/antifreeze volume several times in the circuit so that the complete circuit is sufficiently flushed. 4. Run the exhaust gas heat exchanger up to operating temperature before shutting it down. 5. Ensure that there is no more moisture on the exhaust gas side. 6. If necessary, clean the exhaust side. 7. Seal the exhaust inlet and exhaust outlet such that moisture can not penetrate.
Gas train	<p>Ensure that components of the gas train are always stored in a temperature range from -15 °C to 40 °C.</p> <p>Seal openings airtight.</p> <p>With viton diaphragms, the storage temperature is > 0 °C.</p>
Catalytic converter	<p>When storing for longer than 1 year:</p> <ol style="list-style-type: none"> 1. Remove catalytic converter 2. Clean catalytic converter 3. Store catalytic converter in a dry place
Generator	<ol style="list-style-type: none"> 1. 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 2. Relubricate bearings during the first run to put the generator into operation if the following conditions are met: <ul style="list-style-type: none"> • Generator stored between 6 and 12 months • Generator turned during period six times a month 3. 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.

TIM-ID: 0000072086 - 003

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	<ol style="list-style-type: none"> 1. Remove blower at the inlet and outlet from the flange or insert blanking plates. 2. Dry blower and flush with an inert gas. After flushing, ensure that the blower is sealed airtight. 3. Check blower for ease of movement and turn it. <ul style="list-style-type: none"> • With a changing room temperature, once a month • With a constant room temperature, every second month 4. 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	<ol style="list-style-type: none"> 1. Clean the neutralization system. 2. Replace used up or missing granulate. 3. Keep flushing until clear water emerges at the outlet of the neutralization system. 4. Store neutralization system after it is cleaned.
Exhaust flaps, louver dampers	<ol style="list-style-type: none"> 1. Move valves and fittings that remain continuously in the same position three to four times a year. 2. Check servomotors twice a year. 3. In case of a long storage period, check servomotors in the factory prior to operation.
Gearbox unit (interior)	<ol style="list-style-type: none"> 1. Standard preservation as of delivery of the gearbox is sufficient (under normal transport condition, storage in dry rooms) for a period of 6 months. 2. 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. 3. After the test run and before seaworthy packaging is fitted, flush the gearbox from the inside.
Gearbox unit (exterior)	<ol style="list-style-type: none"> 1. 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. 2. 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

- Note:
- Engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 25).
 - Non-engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 28).
 - 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 63)
Container	<ol style="list-style-type: none"> 1. Store the container in accordance with the foundation requirements. 2. Touch up paint damage on the container or built-in components in a professional manner with suitable paint to prevent corrosion. 3. Remove deposits on the top deck (e.g. leaves, dust) on a regular basis. 4. Grease door seals and hinges prior to placing in storage. 5. Seal cable entries to weather-proof them (if necessary, remove cover panels). 6. Seal exhaust gas outlet openings to weather-proof them. 7. Guarantee draining of condensate from the exhaust system. 8. 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. 9. Close louver dampers for supply and exhaust air. 10. Keep the container interior free of frost. 11. Avoid condensation and insert desiccant bags if necessary. 12. Guarantee electric supply for the following components: <ul style="list-style-type: none"> • Generator anti-condensation heating • Compartment heater 13. Disconnect MMC electrically. 14. Disconnect starter batteries. 15. Detach isolator switch for starter from engine (if available). <p>NOTES:</p> <ul style="list-style-type: none"> • 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.

TIM-ID: 0000072084 - 003

8.2 With operation option and unfilled medium circuits

- Note:
- Engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 26)
 - Non-engine components: 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	<ol style="list-style-type: none"> 1. Remove all covers. 2. Connect starter batteries. 3. Put control system into operation.
Interior (oil, fuel and cooling system)	<ol style="list-style-type: none"> 1. Clean engine-generator set if necessary. 2. Drain coolant (if present) and dispose of. 3. 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. 4. 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". 5. Fill engine with approved preservative oil. 6. 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. 7. Allow engine to cool down to below 40 °C. 8. Drain preservative oil out of oil system. 9. Drain preservative out of coolant system. 10. Immediately after draining, seal coolant openings airtight
Combustion chamber	<ol style="list-style-type: none"> 1. Unscrew all spark plugs. 2. If the engine was not warmed up with preservative oil, turn all pistons for preservation one after the other to bottom dead center "BDC". 3. 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. 4. Screw in spark plugs
Non-painted parts (external preservation)	<p>Coat or spray non-painted parts of the outer shell with corrosion inhibitor for external preservation (→ Page 22). This includes:</p> <ul style="list-style-type: none"> • Parts of the engine outer shell • Flanges • Shafts • Driver disks • Valves and fittings

Preservation	Preservation procedure
Non-engine components (generator and starter batteries)	<ol style="list-style-type: none"> 1. 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. 2. For charge conservation, load starter batteries according to the re-preservation interval .
Lockout engine-generator set and seal openings	<ol style="list-style-type: none"> 1. Execute "lockout/tagout procedure" (→ refer to the Operation and Maintenance Manual). 2. Seal all openings airtight such as air inlet and outlet. 3. Seal off electric plug connectors against moisture.

8.3 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 25).
 - Non-engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 28).

Preparatory steps

Preservation	Preservation procedure
Preparation	<ol style="list-style-type: none"> 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-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	<ol style="list-style-type: none"> 1. Drain old oil if necessary. 2. Remove priming connection from crankcase. 3. Connect oil priming pump. 4. 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). 5. Bar engine manually one to two rotations. 6. 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	<ol style="list-style-type: none"> 1. Drain remaining coolant (if present) and dispose of. 2. Completely fill coolant circuit with approved corrosion inhibitor concentration (→ Page 18). 3. Open all thermostats so that the inhibitor concentration reaches all areas of the coolant circuit. 4. Leave the inhibitor concentration in the engine. NOTE: Mixing of different inhibitor concentrations is impermissible. 5. Seal all coolant openings airtight.
Combustion chamber	<ol style="list-style-type: none"> 1. Unscrew all spark plugs. 2. Turn all pistons for preservation one after the other to bottom dead center "BDC". 3. 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. 4. Screw in spark plugs 5. Seal intake air inlet and exhaust outlet airtight and reseal if necessary.

Preservation	Preservation procedure
Non-painted parts (external preservation)	<p>Coat or spray non-painted parts with corrosion inhibitor for external preservation (→ Page 22). This includes:</p> <ul style="list-style-type: none"> • Parts of the engine outer shell • Flanges • Shafts • Driver disks • Valves and fittings
Non-engine components (generator and starter batteries)	<ol style="list-style-type: none"> 1. Keep generator bearings lubricated by observing the re-preservation interval(→ Page 28). To do this, bar the engine manually to rotate the shaft several turns for distributing the grease in the bearings. 2. Starter batteries in accordance with the re-preservation interval (→ Page 28): <ul style="list-style-type: none"> • 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 26).
 - Non-engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 28).

Preparatory steps

Preservation	Preservation procedure
Preparation	<ol style="list-style-type: none"> 1. If necessary, clean the engine-generator set prior to (re-)preservation. 2. Drain and dispose of all media. <p>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.</p>
Lube oil circuit	<ol style="list-style-type: none"> 1. Remove priming connection from crankcase. 2. Connect oil priming pump. 3. 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). 4. Bar engine manually one to two rotations. 5. Then drain the oil completely. 6. 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. <p>If barring the engine on site is not possible:</p> <ol style="list-style-type: none"> 1. Open the charge-air pipes. 2. Use a fine-atomizing spray gun to spray oil into the charge-air pipe openings for approx. 15 seconds. 3. Close the charge-air pipes. 4. Carefully seal air inlet and exhaust outlet to prevent aeration via the open valves. 5. Open inspection port covers of crankcase (four inspection port covers per engine side). 6. Use a fine-atomizing spray gun to spray oil into each opened inspection port cover for approx. 15 seconds. 7. Close the inspection port cover.

Preservation	Preservation procedure
Coolant circuit	<ol style="list-style-type: none"> 1. Drain remaining coolant (if present) and dispose of. 2. Completely fill the coolant circuit with an approved inhibitor concentration and then seal hermetically (→ Page 18). 3. Use an external coolant heater to heat up the engine to a min. of 75 °C. 4. Allow engine to cool down to below 40 °C. 5. Drain inhibitor concentration completely. 6. Immediately after draining, seal coolant openings airtight <p>If no circulation is possible (e.g. via a heated pressure testing trolley):</p> <ol style="list-style-type: none"> 1. Open all thermostats (if necessary) so that the medium reaches all areas of the coolant circuit. 2. Leave the inhibitor concentration for 24 hours in the engine. 3. Then drain inhibitor concentration completely. 4. Seal the coolant circuit hermetically against moisture.
Combustion chamber	<ol style="list-style-type: none"> 1. Unscrew all spark plugs. 2. Turn all pistons for preservation one after the other to bottom dead center "BDC". 3. 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. 4. 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. 5. Seal intake air inlet and exhaust outlet airtight and reseal if necessary.
Non-painted parts (external preservation)	<p>Coat or spray non-painted parts with corrosion inhibitor for external preservation (→ Page 22). This includes:</p> <ul style="list-style-type: none"> • Parts of the engine outer shell • Flanges • Shafts • Driver disks • Valves and fittings
Non-engine components (generator and starter batteries)	<ol style="list-style-type: none"> 1. 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. 2. For charge conservation, load starter batteries according to the re-preservation interval.

9 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/ engine-generator sets) 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 re-preservation 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	<ul style="list-style-type: none">• Frost-free, closed and heated rooms, clean• Max. temperature fluctuations between 10 and 40 °C• Monthly average relative air humidity ≤ 65%
Difficult conditions	<ul style="list-style-type: none">• 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 76).

Preserve plant corresponding to the storage conditions (table for case A) (→ Page 76).

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.
 3. Spray the combustion chambers with preservative oil with an underbody protection gun through the spark plug bore (→ Page 16).
 4. 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.
6. Screw in spark plugs.
 7. Spray drained mixture cooler with preservative oil.
 8. Spray heating water system with preservative oil.
 9. 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/anti-freeze).
- Preservation takes place according the specified service lives, depending on the storage conditions (→ Page 76).
- Preserve plant corresponding to the service interruption and storage conditions (table for case A) (→ Page 76).

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

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

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

6. Screw in spark plugs.
7. 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 76).

Re-preservation sequence

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

1. Remove all seals from the genset
2. 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 85)

Storage with filled medium circuits under normal conditions

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

10.1.2 Service interruption of more than 6 months

- 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 25).
 - Non-engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 28).
 - All fluids and lubricants remain in the PowerPack®.

Preservation	Preservation procedure
Preparation	<ol style="list-style-type: none"> 1. Remove all covers. 2. Connect starter batteries. 3. Put control system into operation.
Interior (oil, fuel and cooling system)	<ol style="list-style-type: none"> 1. Clean PowerPack® if necessary. 2. 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. 3. Fill fuel system with an approved fuel (→ Page 21). If necessary, replace an already filled fuel which is not suitable for engine storage. 4. If necessary, drain coolant and fill with approved corrosion inhibiting antifreeze or leave existing corrosion inhibiting antifreeze in coolant circuit (→ Page 18). 5. Run engine at increased idling speed for approx. 10 minutes. The inhibitor concentration must reach operating temperature. 6. Engine shutdown 7. All media remain in the system. These medium circuits must be filled completely.
Combustion chamber	<ol style="list-style-type: none"> 1. Seal the decompression openings. 2. Fill corrosion inhibitor for initial operation at least up to the "Min" mark (→ Page 16). 3. Remove end covers for air intake and exhaust gas discharge. 4. 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 turbo-charger. 5. Bar warm engine with starting equipment. The engine must not start. To do this: <ul style="list-style-type: none"> • Actuate the stop lever for mechanical governors. • With electronic governors, unplug connector X4 from the injector wiring harness. 6. 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). 7. Seal openings for intake air and exhaust outlet airtight. 8. Seal access to the charge-air pipes.
Non-painted parts (external preservation)	<p>Coat or spray non-painted parts with corrosion inhibitor for external preservation (→ Page 22). This includes:</p> <ul style="list-style-type: none"> • Parts of the engine outer shell • Flanges • Shafts • Driver disks • Valves and fittings

Preservation	Preservation procedure
Non-engine components (generator and starter batteries)	<ol style="list-style-type: none"> 1. 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. 2. For charge conservation, load starter batteries according to the re-preservation interval.
Lockout of PowerPack® and sealing of openings for maintenance	<ol style="list-style-type: none"> 1. Execute "lockout/tagout procedure" (→ refer to the Operation and Maintenance Manual). 2. 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 26).

Important

Seal the medium circuits immediately after draining the media.

Preservation	Preservation procedure
Preparation	<ol style="list-style-type: none"> 1. Remove all covers. 2. Connect starter batteries. 3. Put control system into operation.
Interior (oil, fuel and cooling system)	<ol style="list-style-type: none"> 1. Clean PowerPack® if necessary. 2. Drain coolant (if present) and dispose of. 3. 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. 4. 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). 5. 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). 6. Run engine at increased idling speed for approx. 10 minutes. The inhibitor concentration must reach operating temperature. 7. Shut down engine. 8. Allow engine to cool down to below 40 °C. 9. Drain engine oil. 10. 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 sealing of openings for maintenance	<ol style="list-style-type: none"> 1. Execute "lockout/tagout procedure" (→ refer to the Operation and Maintenance Manual). 2. Seal all openings tight against moisture, such as air inlet, air outlet and electrical plug connectors.

10.2.2 Service interruption of more than 6 months

- 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 26)
 - Non-engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 28)

Important	
Seal the medium circuits immediately after draining the media.	
Preservation	Preservation procedure
Preparation	<ol style="list-style-type: none"> 1. Remove all covers. 2. Connect starter batteries. 3. Put control system into operation.
Interior (oil, fuel and cooling system)	<ol style="list-style-type: none"> 1. Clean PowerPack® if necessary. 2. Drain coolant (if present) and dispose of. 3. 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 9 156" is recommended. 4. 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). 5. 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). 6. Run engine at increased idling speed for approx. 10 minutes. The inhibitor concentration must reach operating temperature. 7. Shut down engine. 8. Allow engine to cool down to below 40 °C. 9. Drain engine oil. 10. Drain inhibitor concentration.
Combustion chamber	<ol style="list-style-type: none"> 1. Seal the decompression openings. 2. Fill corrosion inhibitor for initial operation at least up to the "Min" mark (→ Page 16). 3. Remove end covers for air intake and exhaust gas discharge. 4. 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 turbo-charger. 5. Bar warm engine with starting equipment. The engine must not start. To do this: <ul style="list-style-type: none"> • Actuate the stop lever for mechanical governors. • With electronic governors, unplug connector X4 from the injector wiring harness. 6. 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). 7. Seal openings for intake air and exhaust outlet airtight. 8. Seal access to the charge-air pipes.

TIM-ID: 0000087656 - 001

Preservation	Preservation procedure
Non-painted parts (external preservation)	<p>Coat or spray non-painted parts with corrosion inhibitor for external preservation (→ Page 22). This includes:</p> <ul style="list-style-type: none"> • Parts of the engine outer shell • Flanges • Shafts • Driver disks • Valves and fittings
Non-engine components (generator and starter batteries)	<ol style="list-style-type: none"> 1. 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. 2. For charge conservation, load starter batteries according to the re-preservation interval.
Lockout of PowerPack® and sealing of openings for maintenance	<ol style="list-style-type: none"> 1. Execute "lockout/tagout procedure" (→ refer to the Operation and Maintenance Manual). 2. 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 25).
 - Non-engine components: Re-preservation takes place according to the specified re-preservation intervals depending on the storage conditions (→ Page 28).

Preservation	Preservation procedure
Preparation	<ol style="list-style-type: none"> 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 PowerPack® prior to (re-)preservation. 3. 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	<ol style="list-style-type: none"> 1. Drain old oil if necessary. 2. Remove priming connection from crankcase. 3. Connect oil priming pump. 4. 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). 5. Remove the turbocharger oil return line, which is the last element in the oil circuit to be supplied with oil. 6. Pump oil under pressure into the circuit until it emerges from the oil return line of the turbocharger. 7. Reinstall turbocharger oil return line. This ensures that the entire lube oil circuit is completely filled. 8. Bar engine manually one to two rotations. 9. Leave the oil in the engine.
Coolant circuit	<ol style="list-style-type: none"> 1. Drain remaining coolant (if present) and dispose of. 2. Completely fill coolant circuit with approved corrosion inhibitor concentration suitable for a filled engine (→ Page 18). 3. Open all thermostats so that the inhibitor concentration reaches all areas of the coolant circuit. 4. Leave the inhibitor concentration in the engine. NOTE: Mixing of different inhibitor concentrations is impermissible. 5. Seal all coolant openings airtight.
Fuel system	<ul style="list-style-type: none"> • 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.

TIM-ID: 0000088580 - 002

Preservation	Preservation procedure
Combustion chamber	<ol style="list-style-type: none"> 1. Seal the decompression openings. 2. Open air pipe downstream of intercooler. 3. 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). 4. 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)	<p>Coat or spray non-painted parts with corrosion inhibitor for external preservation (→ Page 22). This includes:</p> <ul style="list-style-type: none"> • Parts of the engine outer shell • Flanges • Shafts • Driver disks • Valves and fittings
Non-engine components (generator and starter batteries)	<ol style="list-style-type: none"> 1. 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. 2. For charge conservation, load starter batteries according to the re-preservation 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 26).
 - Non-engine components: 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	<ol style="list-style-type: none"> 1. If necessary, clean the PowerPack® prior to (re-)preservation. 2. Drain and dispose of all media. 3. 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	<ol style="list-style-type: none"> 1. Remove priming connection from crankcase. 2. Connect oil priming pump. 3. 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). 4. Remove the turbocharger oil return line, which is the last element in the oil circuit to be supplied with oil. 5. Pump oil under pressure into the circuit until it emerges from the oil return line of the turbocharger. 6. Reinstall turbocharger oil return line. This ensures that the entire lube oil circuit is completely filled. 7. Bar engine manually one to two rotations. 8. 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	<ol style="list-style-type: none"> 1. Drain remaining coolant (if present) and dispose of. 2. Completely fill the coolant circuit with an approved inhibitor concentration and then seal hermetically (→ Page 18). 3. Use an external coolant heater to heat up the engine to a min. of 75 °C. 4. Allow engine to cool down to below 40 °C. 5. Drain inhibitor concentration completely. 6. Immediately after draining, seal coolant openings airtight
Fuel system	<ul style="list-style-type: none"> • 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.

TIM-ID: 0000088579 - 003

Preservation	Preservation procedure
Combustion chamber	<ol style="list-style-type: none"> 1. Seal the decompression openings. 2. Open air pipe downstream of intercooler. 3. 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). 4. 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)	<p>Coat or spray non-painted parts with corrosion inhibitor for external preservation (→ Page 22). This includes:</p> <ul style="list-style-type: none"> • Parts of the engine outer shell • Flanges • Shafts • Driver disks • Valves and fittings
Non-engine components (generator and starter batteries)	<ol style="list-style-type: none"> 1. 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. 2. For charge conservation, load starter batteries according to the re-preservation interval.

11 Depreservation

11.1 De-preservation of diesel and gas engines prior to operation

- 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

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

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.

11.2 De-preservation of diesel and gas engine-generator sets prior to operation

Note: For de-preservation and return to operation of gas engine-generator sets Series 400, see (→ Page 81).

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 re-turning 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

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

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).
6. Fill with engine oil.
7. Ensure that the bearings to be supplied from the engine oil circuit are well lubricated.
8. Bar engine manually.
9. Drain inhibitor concentration if necessary.
10. Fill with or renew engine coolant.
11. For diesel engine-generator sets with TB engine: Fill with or renew charge-air coolant.

Final steps

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

Generator type	Action
MagnaPlus	<ul style="list-style-type: none">• 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	<ul style="list-style-type: none">• 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.

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

11.3 De-preservation of PowerPacks® prior to operation

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

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

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. Replace fuel filter (elements).

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

6. Replace components if necessary in accordance with the maintenance schedule (e.g. elastomer parts, hoses, coupling).
7. Fill with engine oil.
8. 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.
2. Work through procedure described in chapter "Operation" (→ Operation and Maintenance Manual).

11.4 Instruction sheet for de-preservation of MTU products in climate-compatible packaging

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 GmbH.

Instruction sheet for de-preservation of products

1.	Read off the humidity values on the humidity indicator and enter them on the monitoring card. Humidity indicator (→ Page 98) Monitoring Sheet (→ Page 101) 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 product.
3.	Check product 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 complaints, 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 openings until just prior to use. The relates to: <ul style="list-style-type: none">• 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 product documentation.

12 Storage conditions and types of packaging

12.1 Storage conditions

The aim should always be storage under normal storage conditions.

Storage	Operating areas
Normal storage conditions	<p>Requirements of the rooms:</p> <ul style="list-style-type: none">• Clean (no contamination, tire-wear particles, road salt, grit, sand, etc.)• Dry, frost-free, heated if necessary.• Closed hall. Windows and gates/doors are closed. They must not be permanently opened. <p>Storage conditions:</p> <ul style="list-style-type: none">• Room temperature $\geq +10\text{ }^{\circ}\text{C}$ to $\leq +40\text{ }^{\circ}\text{C}$ (temperatures outside this range are not permitted).• Maximum relative air humidity $\leq 65\%$. Air humidity of up to $\leq 75\%$ is permitted on a maximum of 20 days in a calendar year.• No contamination by corrosive substances, such as sulfur dioxide and/or chlorides.• Dew point is not undershot – i.e. no high temperature fluctuations within a short time.
Difficult storage conditions	<p>Requirements of the rooms:</p> <ul style="list-style-type: none">• Clean (no contamination, tire-wear particles, road salt, grit, sand, etc.).• Dry, frost-free.• The building can be open on one side. The open side must not face the cardinal direction from which the most severe weather is to be expected. Windows or doors can be opened.• In a hall with one side open, or with opened windows or doors, the stored items must not be exposed directly to the weather, e.g. solar radiation, rain, snow or dust. <p>Storage conditions:</p> <ul style="list-style-type: none">• Room temperature $\geq +10\text{ }^{\circ}\text{C}$ to $\leq +40\text{ }^{\circ}\text{C}$ (temperatures outside this range are not permitted).• Relative air humidity up to $\leq 95\%$.• Dew point is not undershot – i.e. no high temperature fluctuations within a short time.
Unsuitable, impermissible storage conditions	<ul style="list-style-type: none">• In general, if the criteria named under normal and difficult storage conditions are not met.• Storage out of doors is not permitted.

Notes:

- Goods must not be stored in the direct vicinity of heaters or other heat radiation sources. This applies, in particular, to elastomers and components that contain elastomers.
- In all storage locations and in all storage rooms: Continuous monitoring, recording and saving of temperature and air humidity at intervals of 60 minutes.
- Storage of the data for at least 36 months.

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12.2 Types of packaging

Note:

Protection of the products is only guaranteed if the packaging is not damaged. This applies, in particular, to closed packaging.

Type of packaging	Operating areas
Transport packaging, commercially available, surface transport	<ul style="list-style-type: none"> • Normal storage conditions • For engines and engine-generator sets intended for immediate use • Storage time max. 6 months • Simple, open transport packaging and weather protection for <ul style="list-style-type: none"> – painted engines and engine-generator sets for surface transport in a container and for air cargo
Transport packaging, seaborne, light	<ul style="list-style-type: none"> • Normal storage conditions • For engines and engine-generator sets intended for immediate use • Storage time max. 6 months • Simple, closed transport packaging and weather protection for <ul style="list-style-type: none"> – painted engines and engine-generator sets for sea and surface transport in a container and for air cargo
Climate-compatible packaging (desiccant + humidity incator) in container or heavy-cargo box	<ul style="list-style-type: none"> • Difficult storage conditions • No antifreeze protection • Storage time max. 12 months • Hermetically sealed transport packaging for <ul style="list-style-type: none"> – painted engines and engine-generator sets dispatched per surface transport or sea transport and then stored for a long period • Not for engines with filled medium circuits
Long-term climate-compatible packaging (desiccant + humidity incator) in container or heavy-cargo box	<ul style="list-style-type: none"> • Difficult storage conditions • No antifreeze protection • Storage time max. 36 months • Hermetically sealed transport packaging for <ul style="list-style-type: none"> – painted engines and engine-generator sets dispatched per surface transport or sea transport and then stored for a long period • 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 101). 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 25), (→ Page 26).
- 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.

12.3 Climate-compatible packaging - Check and monitoring

12.3.1 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 months and documented (Monitoring Sheet for products with climate-compatible packaging).
- Measures to be carried out in case of changes to the relative air humidity are listed in the following table.

Reading the humidity indicator

Area	Discoloration as an indicator of the relative air humidity	Measures to be initiated
30	Pink discoloration: Relative humidity above 30%	<ul style="list-style-type: none"> • Shorten checking period • Check humidity indicator every 4 weeks
40	Pink discoloration: Relative humidity above 40%	<ul style="list-style-type: none"> • Replace desiccant, ensure the same amount is added. • Distribute new desiccant evenly in the packaging area • Extract air from the packaging and reseal laminated foil.
50	Pink discoloration: Relative humidity above 50%	<ul style="list-style-type: none"> • Check packaged products • Re-preserve the engine • Replace desiccant, ensure the same amount is added. • Distribute new desiccant evenly in the packaging area • Extract air from the packaging and reseal laminated foil.

Note:

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

12.3.2 Climate-compatible packaging – Check and repair

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 laminated aluminum foil is damaged.

Checking the air humidity

1. Check humidity level regularly every 3 months.
2. Enter findings in Monitoring Sheet (→ Page 101). If the engine's warranty period is still valid, send the Monitoring Sheet to MTU Friedrichshafen GmbH after commissioning.

Replacing desiccant

1. Open the laminated aluminum foil at the upper area and remove the desiccant.
2. Place the same amount of new desiccant in the upper area.
3. Extract air and reseal laminated aluminum foil with manual foil-sealing device until airtight.

Repair of climate-compatible packaging

Note: If the laminated aluminum foil is damaged, the damaged section can be cut out and replaced by a repair 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.
2. Seal new laminated aluminum foil section with manual foil-sealing device.
3. Place new desiccant in packaging.
4. 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.
5. Reseal laminated aluminum foil with manual foil-sealing device.

12.3.3 Monitoring Sheet for MTU products with climate-compatible packaging

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

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

Product type:	Product no.:	Delivery date:
Date of scheduled initial operation of product:		

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.	Possible necessary correction work (e.g. on the aluminum foil or transport box)	Date of performance	Name of person responsible
1			
2			
3			
4			
5			

Important note on the warranty period

Important
<p>Notify MTU Friedrichshafen GmbH and MTU Onsite Energy GmbH:</p> <ul style="list-style-type: none"> if two or all three fields of the humidity indicator are pink if, during de-preservation of the product, external signs of corrosion or damage to the rubber hose connections are detected in due time before initial operation of the product

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-of-service 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-of-service 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

13.3.3 Shutting down

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 out-of-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 110).

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 agent)
- 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 conditions ¹	Re-preservation interval in months			Note
	6	12	24	
Normal	–	RA flushing operation ² : <ul style="list-style-type: none">• Series 1600: 15 min• Series 2000: 20 min• Series 4000: 25 min	Filter replacement, SUs ³ Filter replacement, PFM ⁴ Filter replacement, RA tank ²	If the packaging is damaged, it has to be replaced.
Difficult	RA flushing operation ² : <ul style="list-style-type: none">• Series 1600: 15 min• Series 2000: 20 min• Series 4000: 25 min	–	Filter replacement, SUs ³ Filter replacement, PFM ⁴ Filter replacement, RA tank ²	

¹ for further information on storage, see (→ Page 96)

² RA = reducing agent, normally an aqueous urea solution (32.5% or 40%)

³ SU = supply unit

⁴ PFM = pre-feed module

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 climate-compatible packaging

Applies to Series 1600

Storage conditions*	Re-preservation interval in months				Note
	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 96)

** 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.

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.

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. Protect 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 Predecessor version – Revision overview

Changes to previous edition

Complete revision of versions A001070/03 to A001070/04:

Seq. No.	Chapter	Subject	Action
1	1.1	Preface	Revised
2	2.1	Notes on preservation and re-preservation	Revised
3	3.1	Preservatives – Requirements	Revised
4	3.2.1	Corrosion inhibitors for oil circuit and combustion chamber	Revised
5	3.2.2	Corrosion inhibitor for coolant circuit	Revised
6	3.2.3	Corrosion inhibitor for the fuel system	Revised
7	4.1	Dependency between storage conditions and type of packaging	Revised
8	4.2.1	Products with filled medium circuits	Revised
9	4.2.2	Products with unfilled medium circuits	Revised
10	4.2.3	Special rule 6+6 months	New chapter added
11	5.1.2.1	Service interruption of 1 to 3 months	Revised
12	5.1.2.2	Special operation before shutting down the engine Series 2000Mx6	New chapter added
13	5.1.3	Service interruption of more than 3 months	Revised
14	5.2.1	Service interruption up to 3 months	Revised
15	5.2.2	Service interruption of more than 3 months	Revised
16	5.3	Diesel engines – Without operation option and filled medium circuits	Revised
17	5.4	Diesel engines – Without operation option and unfilled medium circuits	Revised
18	6.4	Gas engines – Without operation option and unfilled medium circuits	Revised
19	7.4	Diesel engine-generator sets – Without operation option and unfilled medium circuits	Revised
20	8.4	Gas engine-generator sets – Without operation option and unfilled medium circuits	Revised
21	10.4	PowerPacks – Without operation option and unfilled medium circuits	Revised
22	11	De-preservation	Chapter structure changed
23	11.4	Instruction sheet for depreservation	Revised
24	12.1	Storage conditions	Revised
25	12.2	Types of packaging	Revised
26	12.3.1	Humidity indicator	Revised
27	12.3.2	Climate-compatible packaging – Check and repair	Revised

Seq. No.	Chapter	Subject	Action
28	12.3.3	Monitoring Sheet for products with climate-compatible packaging	Revised
29	13.3.4	Preservation and re-preservation	Revised

Chapters removed from previous edition

The chapter number relate to the predecessor version A001070/03.

Seq. No.	Chapter	Subject	Action
1	4.2	Interpretation examples	Removed
2	12.2	Climate-compatible packaging – Design	Removed
3	12.3	Climate-compatible packaging – Installation	Removed

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

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