Guideline for engine protection
After shop test

Substitute for:										PC	Q-Code	X	X	X	X	X
Modif	-	7-77.252	20.10.2009	A	EAAD088998	30.01.2018										
		Number	Drawn Date		Number	Drawn Date		Number	Drawn Date		Number		Drawn Date			

WIN GD Winterthur Gas & Diesel	Product **RT-flex / X / DF**	**Guideline For Engine Protection** **After shop test**		
Made 28.02.2018 F. Moszner	Main Drw. **H**	Page 1 / 70	Material ID **107.426.585.500**	
Chkd 28.02.2018 M. Frei	Design Group **0345**	Drawing ID **107.426.585**		Rev **A**
Appd 28.02.2018 M. Damani				

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2 Introduction

This document is an overview guide line for the application of corrosion protection coating after shop test of RT-flex and X and DF engines as also for temporally undetermined storage at shipyard / final destination.

For the corrosion protection of the engine and its parts, as well as for the treatment of the cooling water circuits during engine assembling and shop test, the specification 107.215.543i and its amendments are still valid.

The way of application might differ and depend on the expected or agreed engine storage period and the conditions at final destination.

There are normally 3 different timeframes to which the coating thickness as also the regular main inspection intervals are referring.

- normal period storage (up to 6 months)
- long period storage (6 – 12 months)
- undefined period of storage due to unpredictable postponement of ship project (over 12 months)

This guide line covers re-coating after the shop test, as during final assembly of the engine parts and even more during engine running, most of the protective coating will have been flushed away. Therefore a proper re-coating after shop test is crucial.

It was chosen to divide this document in various chapters and sub-chapters in order to have separate steps, thus not losing the principal information by overloading the chapters.

3 Responsibility

The orderer specifies the duration of protection and the special requirements for transport and storage.
The engine manufacturer will be responsible that the specified corrosion protection is executed with care and that packaging is carried out in a professional manner.

Reliable preservation is assured if the drying time of the applied coating is observed and the processes and products described in the following are properly applied.

As transition area of taking over the responsibility for further proper storage and corrosion preservation of the engine, the chapters
9 - Final inspection before delivery (at engine maker)
&
11 - Inspection upon arrival (at shipyard)
and their sub-chapters have been written.

The manufacturers specifications and safety sheets for these cleaning and coating products must be strictly observed. Other processes and products may be applied if they meet the specified requirements.

WinGD Switzerland Ltd. will not accept any liability or responsibility for damage to the engine and its parts which is or has been sustained due to the none-observance of these preserving instructions, e.g. due to insufficient preservation, unsuitable storage or damaged preservation material. Moreover, WinGD Switzerland Ltd will not accept any liability for preservation measures that are carried out by the manufacturer or a third party.

It is in any case the responsibility of the orderer to check the engine and its parts for any corrosive damage promptly upon arrival.
Unless agreed differently in the purchase contract, any claim due to corrosion damage of the engine and its parts has to be made in writing to WinGD Switzerland Ltd. within two weeks from the arrival of the engine and its parts to the final destination defined in the purchase contract.
Any claims made after the two weeks notice period shall not be taken into account. The orderer shall be responsible for the preservation of the engine and its parts for further transport and final storage.

4 Reason for proper corrosion protection

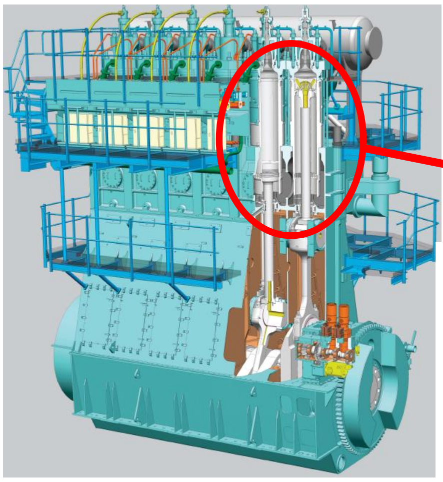
To give you an impression of corroded parts, respectively the possible or impossible access for repairing or replacing of them, the following short extract of pictures will illustrate the reasons for using proper corrosion protection.
Without access by crane, available normally just in engine room condition, or proper storage warehouse, no proper repair or replacement work of heavy parts can be done!

Consequences for fully assembled engines in storage without adequate use of corrosion protection

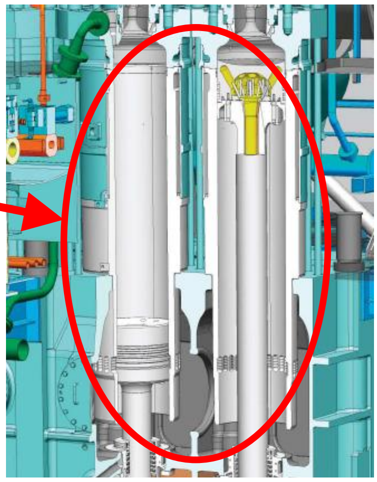
As e.g. the pistons and cylinder liners can be checked only through the scavenge air ports, a cleaning and possible recovery of the parts at time will not be possible. Further corrosion leads to such kind of material pitting that the parts must be exchanged at a later stage.

Heavily corroded: Cylinder liner and piston crown. At last the parts could be pulled or reached to be cleaned and judged for further procedure (replacement).

Repaired (cleaned of upper rust layer) cylinder liner (above) and piston crown (below) surface revealed that the pitting had been so heavy that the parts had to be replaced.



Situation of parts access without crane available



Situation of cyl.liner & piston crown in fully assembled condition.

Be aware: These are just examples!

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Modif											
-	7-77.252	20.10.2009	A	EAAD088998	30.01.2018						
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WIN GD Winterthur Gas & Diesel

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5 Range of application: Engine delivery condition

The intention of this chapter is to provide an overview of different ways and engine stages the corrosion protection, the transport and the storage will be done, as this will affect either the way of corrosion protection application and even more the storage capabilities and additional re-coating work, which is required for long-term storage and unpredictable engine storage-time respectively.

Mainly for reasons of different crane capacities as also engine sizes either at engine maker or at shipyard, there are three different conditions of engine delivery:

- See 5.1: Engine delivered in fully assembled condition.
- See 5.2: Engine delivered in 3 major components (bedplate with crankshaft, column, cylinder jackets with cylinder liner installed).
- See 5.3: Engine fully dismantled after shop test.

5.1 Engine delivered in fully assembled condition

Engine delivered in fully assembled conditions.

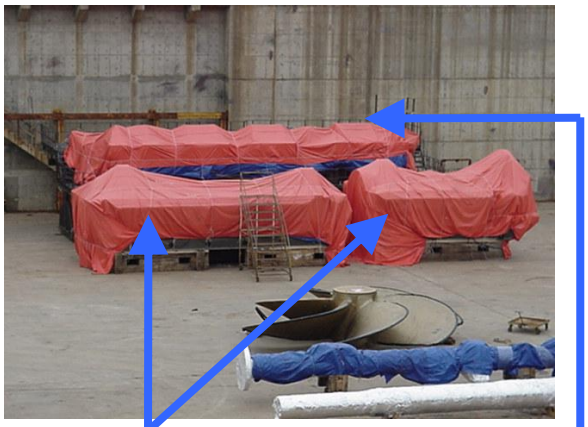
Engine stored in a tent-like warehouse.

Engine stored outside and covered with a waterproof tarpaulin.

- It is recommended to install dehumidifiers for transportation already.
  It has to be assured that they are connected electrically at board side.

5.2 Engine delivered in 3 pre-assembled major parts

In general it has to be mentioned that the storage of single parts, even major parts like bedplate with crankshaft, column with platforms as well as the cylinder jackets and all additional parts like pistons, connecting rods, etc. can be done with less expense of time and work if the protection and packing of the parts was properly done beforehand.
Dehumidifiers have to be placed at each single major part.



Bedplates (2 parts) with crankshaft (in front) and column with fuel pumps (behind)

Cylinder jackets with scavenge air receivers

Connecting rods at cleaning stage at ship-yard. The sea-trial date is fixed.

Cylinder liners at cleaning stage at shipyard.

Main pistons and cylinder covers (still covered and exhaust cage closed by plate)

Turbocharger prepared (openings closed by wooden plates)

5.3 Engine delivered in 3 pre-assembled major parts & crankshaft delivered separately

It quite often occur that the crankshaft has to be dismantled after shop test.
This is mostly the case with bigger bore engines, but it might also be required for medium or small bore engines. The principal reason is the crane load capacity either at engine maker or at the shipyard.

5.4 Engine delivered fully disassembled

Engine fully dismantled after shop test: All parts have been cleaned, protected and covered properly (bedplate, crankshaft, column, cylinder jacket as single components); all platforms and pipes are dismantled, all other parts like cylinder covers and exhaust valves, pistons, cylinder liners, connecting rods, crossheads and so on are packed and protected in wooden boxes.

Example of connecting rod with crosshead at transport packaging stage.
Stored outside just after arrival at shipyard.

6 Climatic conditions for Cleaning – Coating – Storage

As many different climatic conditions are one of the major impacts in relation to the applicable corrosion protection work, this issue has to be clarified more closely.

- High humidity conditions with humidity values as high as 80-85% over nearly the whole year on the one hand, and the corrosion protection liquid properties on the other hand, implicate the recommendation of preferably low humidity values, as otherwise the fast accretion of moisture on the blank surfaces will complicate any proper procedure.

  Therefore WinGD Switzerland Ltd. recommends a relative humidity value below 50% in general.

6.1 For cleaning of machined surfaces – parts in general; before coating

The cleaning work has to be carried out in a well-ventilated room at a temperature between 15˚C (min) and 35˚C (max.). The relative humidity should be less than 50%.

6.2 For application of corrosion protection

The cleaning work has to be carried out in a well-ventilated room at a temperature between 15˚C (min) and 35˚C (max.). The relative humidity should be less than 50%.

6.3 For storage of engine or engine parts

The engine and its parts must be stored in well-ventilated rooms at a temperature between 15˚C (min) and 35˚C (max.). The relative humidity should be less than 50%.

7 Draining & cleaning of engine parts after shop test

The procedure described in this chapter has to be carried out according to chapter 8, taking into account that all painting work (coating of primer & top layer) has been done properly before engine assembly.

The application of corrosion protection has to be checked and renewed on all machined/blank surfaces, as the corrosion protection may be flushed due to the temperatures reached during engine running for shop test, or has melted away during the shop test itself or scraped away during assembly.

As general summary of this chapter 7, the following rule has to be considered stringently:

The clean and dry condition of the machined/blank surfaces is of outmost importance for a proper application of corrosion protection, as the adhesion of all applicants will be as good as cleaning and drying work was performed!

To accelerate the drying time, heaters with dry air fans for heating up the engine interior can be considered.
A heat venting system is probably even more useful in connection with drying of all water pipes and/or water cooling spaces.
Connection flanges at the transition between the venting system and the piping/ cooling spaces might be especially useful, as flange connections are easily adaptable to different engine sizes by the mere use of additional adaptors.

All parts which have been affected by carbon deposits during engine running have to be cleaned carefully, otherwise the carbon deposits will harm the parts, as there remains sulphuric acid which corrodes the material very much, especially during long period of stand still conditions.

7.1 General preparations

- Heaters with dry air fans for heating up the engine internal can be considered due to the amounts of solvents as well as of the corrosion protectors used during a production year, and also to accelerate the drying time, in order to obtain a beneficial economical and environmental effect (one work carried out once) for the engine preservation work.
- A heat venting system is probably even more useful in connection with drying of all water pipes and/or water cooling spaces (see also 7.6).

- Connection flanges at the transition between the venting system and the piping/ cooling spaces might be especially useful, as flange connections are easily adaptable to different engine sizes by the mere use of additional adaptors.

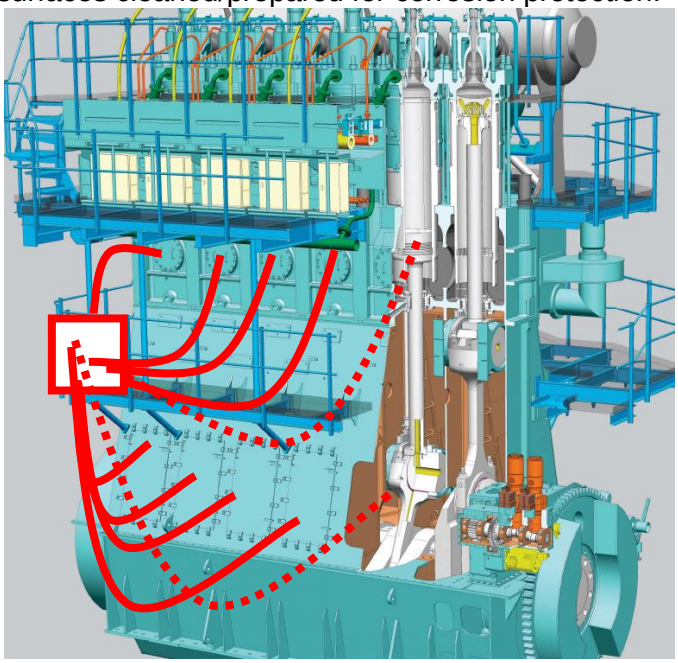
The engine maker and probably also the shipyard(*) should take the following into account:

(*)= It might be interesting for shipyards by reason of unpredictable anchoring of ships after sea-trials due to re-arranged final ship-delivery or other force majeure reasons.

As the cleaning-, and much more, the drying work after a shop test can be of a dangerously annoying stimulus due to the fact that especially the oil will flow repeatedly over already cleaned surfaces, or, as in our case, over machined/blank surfaces, a fast heating and drying-up of the crankcase as well as of the piston underside by a heating fan system should be considered just after shop test.

A thickened oil film is much easier and faster cleaned with much less solvent. Likewise the thickened oil will not flow quickly again over the surfaces cleaned/prepared for corrosion protection.

Sample of hose connection of dehumidifier system.



Heating fan with multi-connectable hose system & adaptable flange connectors.

7.2 Tools & materials to be used for cleaning

The following tools and products are to be used for cleaning work in general:

- Acid-free cotton cloth
- Paper towels
- Wooden or plastic spatula/scraper
- Airgun or airless spray unit (see chapter 15.3.3)
- White spirit (e.g. Shellsol : see chapter 16.1)
- Petroleum
- Kerosene

NOT to be used under any circumstances:

- Metallic scraper

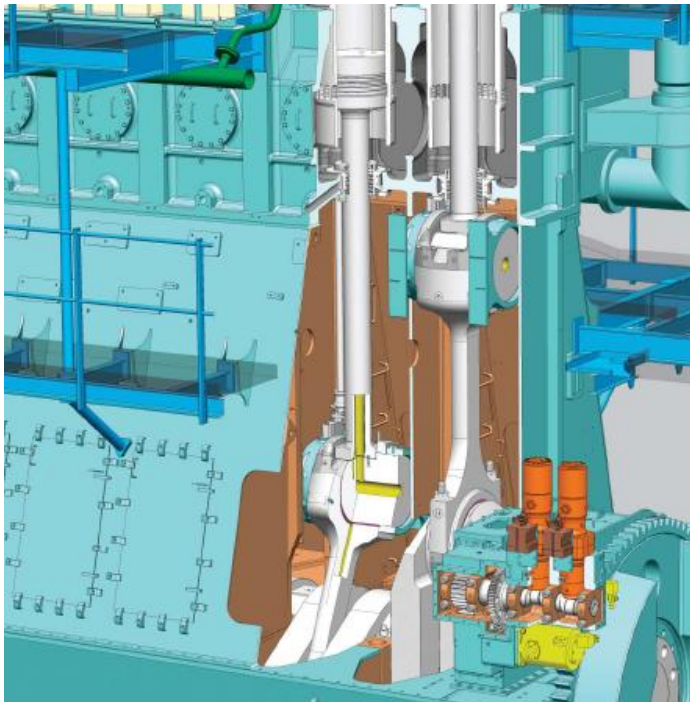
7.3 Crankcase – drying & cleaning

The crankcase can be cleaned and dried in usually three different engine stages:

- **7.3.1 Engine fully assembled**
- **7.3.2 Engine dismantled in 3 major parts** (bedplate with crankshaft)
- **7.3.3 Engine dismantled in 3 major parts** (bedplate without crankshaft)

7.3.1 Engine fully assembled

The engine will not be dismantled for transport and installation at shipyard.
All engine internal parts have to be dried and cleaned after shop test.



The cylinder covers and the pistons have been removed for their cleaning and corrosion protection work!

All engine internal parts have to be dried and cleaned after shop test.

Either of system oil, like

- piston cooling oil
- crosshead lubrication
- main bearing lubrication
- servo oil rail
- servo oil pumps (Supply Unit)
- Turbocharger lubrication
- all pipe circuits belonging either to the ingoing or outgoing of fluid flow,

or of water residues/deposits of the cooling water system, like

- cylinder liner cooling space
- cylinder cover & exhaust valve cage
- scavenge air receiver/cooler spaces
- all pipe circuits belonging either to the ingoing or outgoing of fluid flow,

or of air of the starting air- or control air system, like

- starting air shut-off valve
- starting air distributor
- starting air valve at cylinder cover
- all pipe circuits belonging either to the ingoing or outgoing of fluid flow,

or of fuel, like

- Injection Control Unit (ICU) - RT-flex engines
- fuel rail
- fuel pumps
- all pipe circuits belonging either to the ingoing or outgoing of fluid flow.

All engine external machined surfaces and/or parts have to be cleaned and dried.

For all machined surfaces a cleaning solvent/white spirit should be used. See 16.1.2.

7.3.2 Engine dismantled in 3 major parts (bedplate with crankshaft)

Column at cleaning stage. Cleaning solvent (white spirit) is used.

Cylinder jacket at cleaning stage. Cleaning solvent (white spirit) is used.

7.3.3 Engine dismantled in 3 major parts (bedplate without crankshaft)

Bedplate delivered as single part

Crankshaft delivered as single part. Already cleaned of corrosion protector by solvent and ready for bedplate assembling. Crank-throw journals protected with rubber and steel plates (8mm thick).

Crankshaft under cleaning / removing work of corrosion protection.

7.4 Main bearings & thrust bearing pads dismantled

If the crankshaft is delivered as single part, also the main bearing shells and bearing covers as well as the thrust bearing pads are to be removed from the bedplate.
Carefully clean them with Shellsol / white spirit.

7.5 Crankshaft delivered as single part

This chapter describes the handling of the separately delivered crankshaft.

7.5.1 Crankshaft cleaning

- Thorough manual cleaning of the entire crankshaft surface with acid-free cotton cloth (no rags), paper towels and clean solvent, e.g. white spirit, Shellsol or a similar product.
- Flushing of all bores with clean solvent.
- **Important:** From this moment the crankshaft must not be touched with bare hands anymore!
- Allow the crankshaft to dry completely.
- Check whether clean and free of rust. Do not touch the cleaned surfaces with bare hands.
- If there are signs of rust, the quality assurance department will decide whether additional work is necessary. If the traces of rust are only slight, they can be removed with emery cloth No. 220 (or finer) and petroleum. Repeat cleaning!

7.6 Cylinder liner & scavenge air cooler: cooling water system

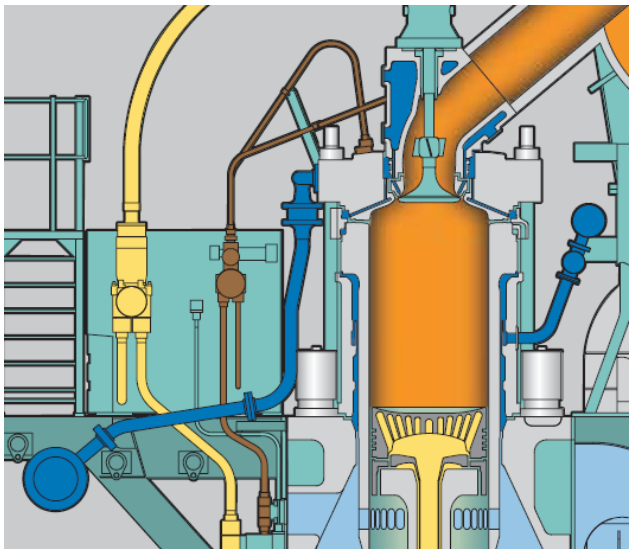
(Cylinder liner – scavenge air cooler – piping for water circulation on engine)

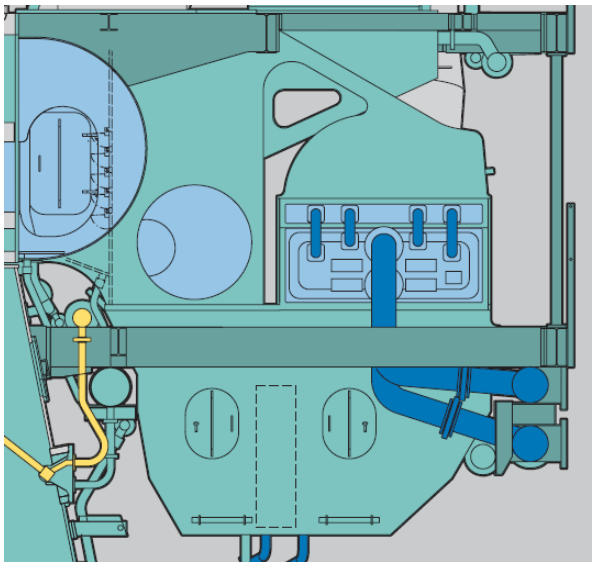
- Make sure that the cooling water circuits have been treated properly by adding a water inhibitor during engine running.
  (water inhibitors see chapter 16.2)

- The cooling water must be drained and dried. It is recommended to blow warm, pre-dried air through the pipes. The cooler has to be sufficiently vented.

or:

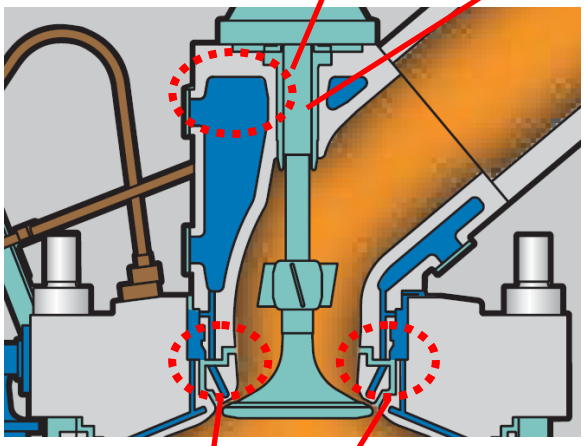
- Drain the water from cylinder liner & scavenge (charge) air cooler when the engine is still warm after shop test (around 60˚C).

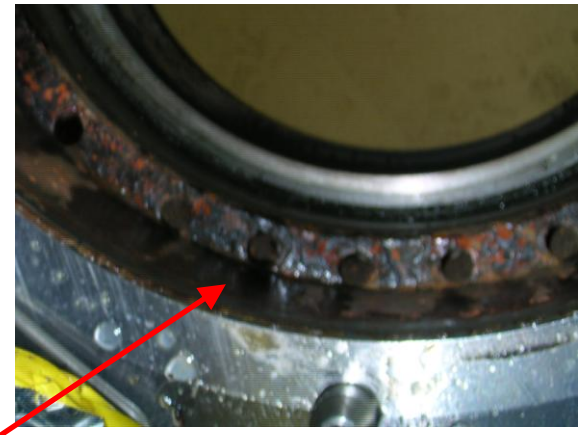


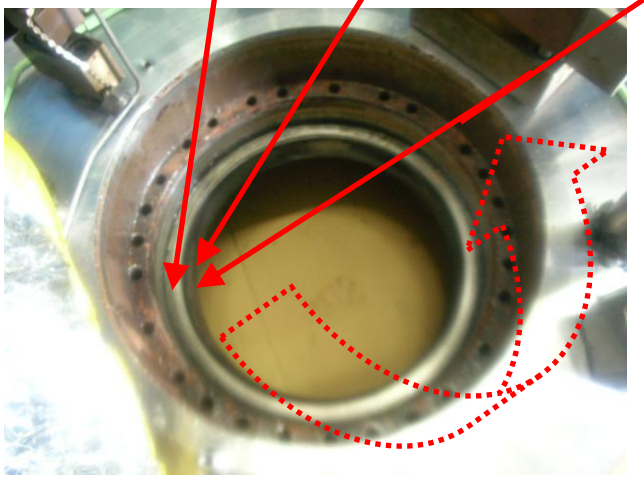


7.7 Consequences

The non-use of proper water inhibitors and soluble oil for proper corrosion protection will lead to severe corrosion, mostly in water cooling spaces which are not traced without additional inspection regulations/requirements. The pictures/sketches below are for reference only.





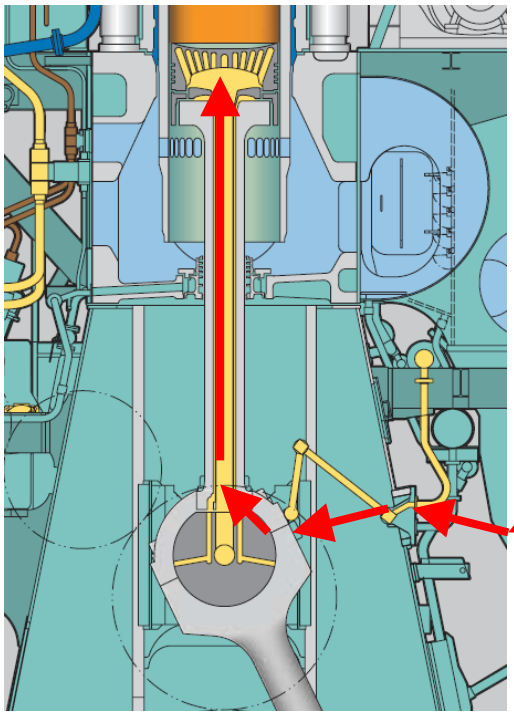


7.8 Cylinder liner & piston

If the engine is not dismantled, make sure that also the piston inner parts, like spraying plate with nozzles, as well as the piston inside itself are protected in a practicable way.
This could be achieved by using either the piston cooling pipe system or the flange connections for lever.

- Piston dismantling after shop test:
After shop test, mainly the piston crowns, the piston rings and probably the piston ring grooves are to be cleaned of combustion residues.
- Gland box piston rod: To be opened and properly cleaned of carbon and dirt oil deposits.

- Cylinder liner dismantling after shop test:
It has to be determined whether the cylinder liners will be dismantled after shop test. The cylinder liners can be cleaned still assembled to the cylinder jacket, as also the pistons will have to be dismantled.



If the engine is not dismantled, make sure that also the piston inner parts, like spraying plate with nozzles, as well as the piston inside itself are protected in a practicable way.

This could be achieved by using either the piston cooling pipe system or the flange connections for lever.

7.9 Cylinder cover

After shop test, the cylinder covers will have to be dismantled, injectors have to be removed to clean the combustion residues in the combustion chamber as well as the exhaust cage. Drain the cooling water carefully (check exhaust cooling water space) and use warm/heated-up air if necessary.

Combustion chamber with carbon deposit after shop test.

Combustion chamber after cleaning.

7.10 Starting- & control air system

- ❑ Drain the complete starting air system including air spring.
- ❑ Remove all starting air valves, open them, clean all parts, oil the parts slightly with rust protection oil and reassemble them.

Option 1
The starting air valves can be refitted in the engine after overhaul.

Option 2 (recommended)
The starting air valves can also be kept separate from the engine. In this case the starting air valves should be stored in a dry place, well preserved and packed in VCI paper. Note that the openings in the cylinder covers need to be closed air-tight with steel flange covers (draft prevention).

- ❑ Dismantle the shut-off valve for starting air, clean all parts and oil them with rust protection oil. Afterwards the valve can be refitted in closed position.

- ❑ Remove the end cover of the main starting air pipe and place silica gel desiccant bags inside. Afterwards refit the cover (as a precaution a marking must be applied outside to indicate that a silica gel desiccant bag has been stored inside).

7.11 Fuel injection system

To achieve the highest level of corrosion protection for the RT-flex and X fuel injection components it is recommended to drain the MDO from the fuel system and to remove the needed parts from the engine as described below. Afterwards the fuel rail and the intermediate accumulator including the fuel pumps need to be filled with system oil or special rust-preventing engine oil.

7.11.1 Fuel Injector

7.11.1.1 Conventional

All fuel injection valves are to be overhauled according to the instructions given in the Maintenance Manual. It is recommended to flush the overhauled fuel injection valves on a test bench using a special calibration fluid (for corrosion protection reasons no MDO should be used). After flushing the injection valves the tension of the springs should be released.
The openings at the cylinder cover are to be sealed air-tight.

7.11.1.2 Directly controlled (l'Orange) including pilot-fuel Injectors

Same Instruction as for conventional Injectors under 7.11.1.1, except for releasing the tension of the spring which is needless. All open ports need to be preserved against corrosion and sealed in order to prevent ingress of foreign particles. Handle cables of the Injector with care.

7.11.1.3 Pilot fuel injector + pre-chamber

Same Instruction as for conventional Injectors under 7.11.1.1, except for releasing the tension of the spring which is needless. All open ports need to be preserved against corrosion and sealed in order to prevent ingress of foreign particles. Handle cables of the Injector with care

7.11.2 Rail Unit

7.11.2.1 ICU

All ICUs need to be removed from the rail / engine; depending on the number of running hours it should be considered to send them to a Wärtsilä reconditioning workshop for overhaul. ICUs must not be recon. Since the shop test can have few hundreds of rhr but an ICU lives more than 30000 rhrs If the ICUs are not due they must be stored in an oil bath during the lay-up period. The openings on the fuel rail need to be sealed with blind flanges so that the fuel system can be completely filled with system oil or special rust-preventing engine oil.

1. After the engine has been shut down on MDO, make sure that the whole fuel system including low pressure circuit, intermediate fuel accumulator and fuel rail is completely drained. The rails have venting and drain valves. In any case, the rail can be emptied by pressurised air and filled in with system oil.

2. Clean all ICUs as well as possible from outside and coat with protection oil against corrosion.

3. Remove all rail valves and fuel quantity sensors from the ICUs. Preserve the fuel quantity sensors and rail valves and store them in a dry place.

4. Remove all ICUs from the engine and store them in an oil bath for corrosion protection. As soon as the ICU is in the oil bath, it is recommended to move the fuel quantity piston by manually carrying out a few strokes.

5. Check if the fuel pumps are filled with oil. Drain them if necessary.

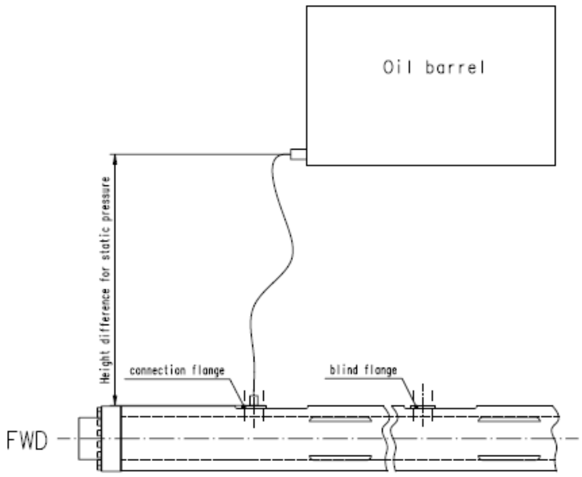
7.11.2.2 Fuel Rail

6. Blank off all openings on the fuel rail with blind flanges, except the one on the forward side. There a flange with a connection needs to be installed to supply oil into the fuel rail.

7. Blank off the control oil supply to the ICU to allow operating the control oil pumps.

8. Fill the fuel rail including rising pipes, intermediate accumulator and fuel pumps with system oil or special rust-preventing engine oil. As soon as the fuel system is completely air-free filled with oil, a small tank (oil barrel) can be connected to compensate slight leakages during the storage. There is a connection in the rails to fill with system oil. In case of X-Engines the connection is in the valve block and in case of Flex Engines in the cover. The job can be done with service pump.

Additional lubrication oil tank connected to the fuel rail to keep it under constant static pressure.



Flange for oil supply to fuel rail and blind flange.

7.11.2.3 FLV
Clean all FLVs as well as possible from outside. Remove all FLV from the engine and store them in an oil bath for corrosion protection. Then follow Instruction in 7.11.2.2.

7.11.2.4 PCV + safety valve
Clean the mentioned components as well as possible from outside. Clean and then spray coat.

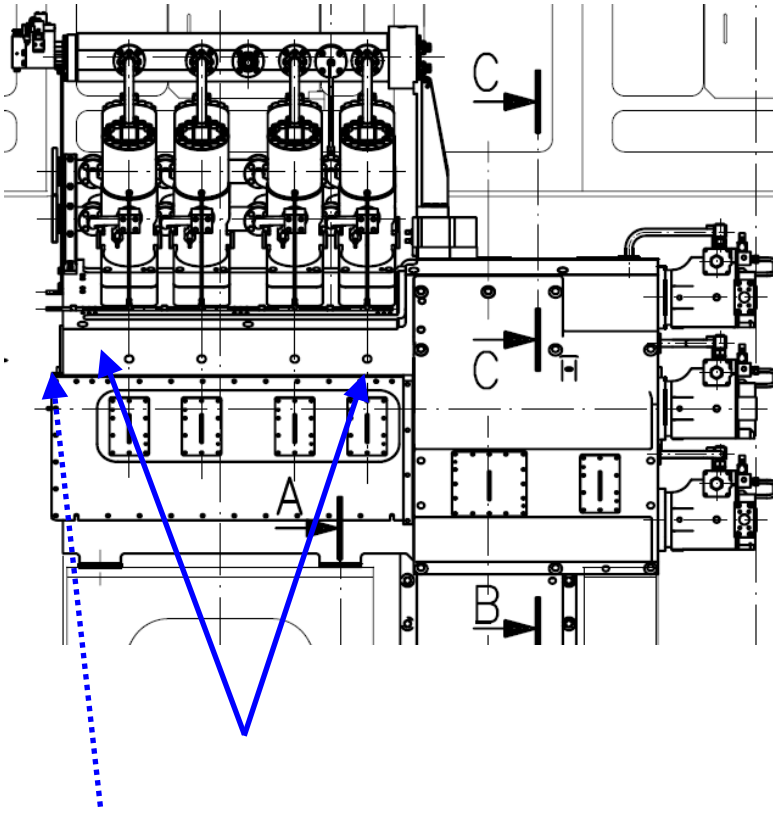
7.11.2.5 Servo-oil rail
Servo-oil rail with hydraulic oil. Clean and then spry external surfaces with rust- preventing oil.

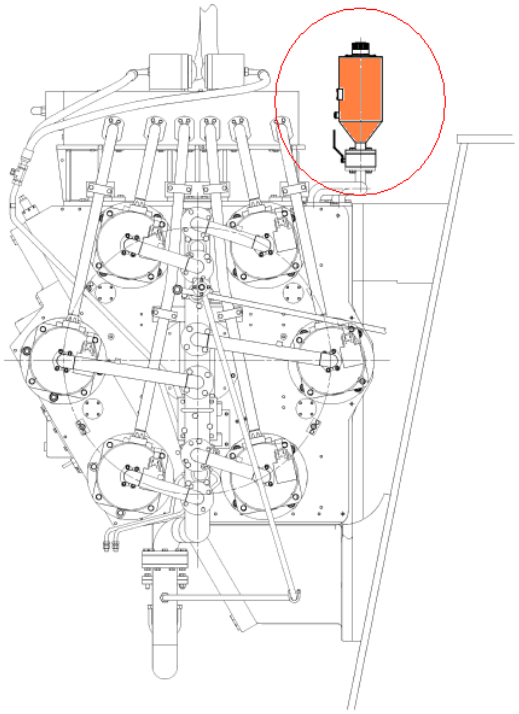
7.11.2.6 VCU
Clean and then spry external surfaces with rust- preventing engine oil.

7.11.2.7 Hydraulic valves
Remove all hydraulic. Preserve rail valves and store them in a dry place.

7.11.2.8 Cylinder lubrication components
Clean and then spray coat cylinder lubrication pumps, pipes and the outstanding parts of the lubricating quills with rust-preventing engine oil. In best case; inject minimum 10 times oil manually, so the injection holes are cleaned.

7.11.3 Supply Unit
Clean and then spray coat the camshaft, bearing covers rollers, roller guides, etc. with rust-preventing engine oil.





Substitute for:								PC	Q-Code	X	X	X	X	X
Modif	-	7-77.252	20.10.2009	A	EAAD088998	30.01.2018								
		Number	Drawn Date		Number	Drawn Date		Number	Drawn Date		Number	Drawn Date		

WinGD Winterthur Gas & Diesel

Product: **RT-flex / X / DF**

Guideline For Engine Protection
After shop test

Made	28.02.2018	F. Moszner	Main Drw. **H**	Page 22 / 70	Material ID **107.426.585.500**	
Chkd	28.02.2018	M. Frei	Design Group **0345**	Drawing ID **107.426.585**		Rev **A**
Appd	28.02.2018	M. Damani				

7.11.3.1 Fuel pump

See Chap. 7.11.2.2 for preservation of internal surfaces. Clean and then spray external surfaces with rust-preventing engine oil. In order fill up the high-pressure pipes and fuel pumps with oil, oil pipe, i.e. with 10 bar pressure can be connected to the check points at fuel inlet pipes can be filled up the high-pressure line till rail.

7.11.3.2 IFA (PCV)

See Chap. 7.11.2.2 for preservation of internal surfaces. Clean and then spray external surfaces with rust-preventing engine oil.

7.11.3.3 Servo-oil pump

Clean and then spray esternal surfaces with rust-preventing engine oil

7.11.3.4 Pilot-fuel supply unit

To achieve the highest level of corrosion protection for the Pilot-fuel supply components it is recommended to drain the MDO from the pilot fuel system and to remove the needed parts from the engine as described below. Afterwards the high pressure pipes including the fuel pump need to be filled with system oil or special rust-preventing engine oil.

7.11.4 High pressure pipes

It is recommended to flush high pressure pipes using either a special calibration fluid or rust-preventing engine oil (for corrosion protection reasons no MDO should be used). Clean and then spray external surfaces with rust-preventing engine oil. After flushing, openings at their ends are to be sealed air-tight.

7.12 Gas supply

No activities required for prevention as main pipes (gas distribution pipe) are made of stainless steel.

8 Corrosion protection of machined surfaces / engine parts

The application of corrosion protection has to be checked and renewed on all machined/blank surfaces, as the corrosion protection may be flushed due to the temperatures reached during engine running for shop test, or has melted away during the shop test itself or scraped away during assembly.

8.1 Overview of the general application range

For exposed parts (engine external), the following description of layer application might be used as “general guidance” regarding corrosion protection application.
(e.g. starting air distributor, manoeuvring linkage, etc.)

Apply a first layer of ”Tectyl 506” to all surfaces using an airless spray unit.
Allow to dry for at least 5 hours at 10°-20°C (3 hrs at 20°-25°C; 2 hrs at >25°C).

A second coating of ”Tectyl 506” must be applied to all surfaces, with the exception of the webs, using an airgun . Do not touch this coating. Allow to dry for at least 36 hours at 10°-20°C (24 hrs at >20°C).

A coating of ”Tectyl 132” must be applied to all crankshaft surfaces by means of an airless spray unit. Allow to dry for at least 36 hours at 10°-20°C (24 hrs at >20°C).

8.2 Application of the corrosion protectors / coating

The climatic properties have been described under in 6.1 & 6.2.
To avoid the accretion of moisture on blank surfaces, the components must show room temperature during the work.
The coating must be applied straight after cleaning to the dried surfaces.
For the recommended coating materials with details of their application see pages 13 to 15
The supplementary product specifications for the coating materials must be strictly observed.

8.3 Checking the quality of the coating

The inspection of the dry coating is made non destructively according to the magnetic-induction method, e.g. with the measuring device "Minitest".
The adhesion of the coating is to be checked with a cross-cut test according to DIN 53 151 (Code GT 1). The damaged coating resulting from this inspection is to be ground over and applied anew.
In case of non-fulfilment of the quality standard, the manufacturer's quality assurance department will decide whether further inspections are necessary and if the coating should be renewed.

8.4 Coating & corrosion protection of the components – General information

The different surface protection measures are listed in the table "Coatings and corrosion protection general". The components and surfaces are shown in groups, thus allowing to be treated by the manufacturers in a corresponding manner.

8.5 Crankshaft corrosion protection at engine shop

8.5.1 Preservation for indoor and temporary storage

- The crankshaft must be free of rust, cleaned thoroughly as instructed in para. 7.1-7.5, and not have been touched since. If this is not fulfilled, repeat cleaning according to 7.5.
- Flush oil bores, threaded holes etc. with ”Dewatering Fluid WA” or "Anticorit DFW" and allow to dry completely (min. 5 hrs at 10° to 20°C; min. 3 hrs at 20° to 25°C; 2 hrs at >25°C).
- Close the bores, threaded holes, etc. with plastic protective plugs (do not use wooden pegs). These protective plugs are not to be removed until just before the crankshaft is fitted in the engine.
- Using an airgun, dewater and neutralize all surfaces with ”Dewatering Fluid WA” or "Anticorit DFW". Do not touch the surface. Allow the waxy protective film to dry for at least 5 hours at 10°-20°C (3 hrs at 20°-25°C; 2 hrs at >25°C) prior to further treatment. It is mandatory to keep to the drying time! The protective film must be touch proof (however, not to be touched with bare hands!). In case of **insufficient** drying, the adhesion of the subsequent coatings is not assured.

- Apply a first layer of ”Tectyl 506” to all surfaces with an airless spray unit. Allow to dry for at least 5 hours at 10°-20°C (3 hrs at 20°-25°C; 2 hrs at >25°C).

- A second coating of ”Tectyl 506” must be applied to all surfaces, with the exception of the webs, using an airgun. Do not touch this coating. Allow to dry for at least 36 hours at 10°-20°C (24 hrs at >20°C).

Duration of protection: indoor storage max. **12** months. Insulation protection must be guaranteed. Before the storage time expires, the preservation must be removed and the crankshaft checked for signs of rust. Afterwards the preservation is to be applied again.

8.5.2 Preservation of crankshafts for land and sea transport

After corrosion treatment, the crankshaft is to be preserved further prior to shipment.
Any dust or layers of dirt are to be removed with dry compressed air or with clean cloths.

- Apply a first layer of ”Tectyl 506” to all surfaces with an airless spray unit. Allow to dry for at least 5 hours at 10°-20°C (3 hrs at 20°-25°C; 2 hrs at >25°C).
- A second coating of ”Tectyl 506” must be applied to all surfaces, with the exception of the webs, using an airgun. Do not touch this coating. Allow to dry for at least 36 hours at 10°-20°C (24 hrs at >20°C).

- A coating of ”Tectyl 132” must be applied to all crankshaft surfaces by means of an airless spray unit. Allow to dry for at least 36 hours at 10°-20°C (24 hrs at >20°C).

Duration of protection: indoor storage max. **12** months, outdoor storage max. **6** months
Insulation protection must be guaranteed.

8.5.3 Additional mechanical protection of the crankshaft pins for open transport

The journals and pins must be wrapped with the following materials:

- one layer of VCI paper (Volatile Corrosion Inhibitor)
- two layers of polyethylene foil
- one layer of Ethafoam foil, 5 mm thick (must not absorb water)
- three layers of Lamiflex laminae
  All layers are to be fixed with chlorine-free adhesive tape.

To avoid damage to the mechanical protection and the preservation material during lifting, the journals are to be protected as follows:
steel shells with a thickness of at least 8 mm are to be fitted.

Instructions to the effect "Do not lift here" are to be posted on all other pins and journals.

- Supplier information :
  Lamiflex lamellae
  Lamiflex AB
  Gasverksvägen 4-6
  611 35 Nyköping - Sweden
  www.lamiflex.se

8.5.4 Additional mechanical protection of the axial surfaces of the thrust bearing flange

- one layer of VCI paper
- two layers of polyethylene foil
- one layer of Ethafoam foil, 5 mm thick
- plywood, 20 mm thick

8.5.5 Mechanical protection of crankshafts for transport in boxes

The crankshaft is to rest on the webs. To avoid damage to the preservation material during lifting, the corresponding journals are to be protected with thick and reinforced rubber.

8.5.6 Packaging

The engine maker is responsible for proper packaging.
The crankshaft must rest on the webs, whatever the kind of transport.
The surfaces of wooden supports must be treated in advance with a **neutralising preservation product**.

8.5.7 Removal of the preservation material prior to fitting and for inspection purposes

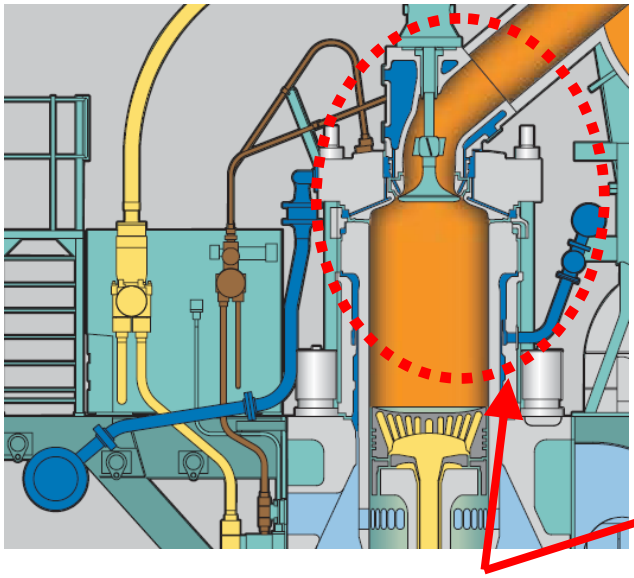
The corrosion protective products can be removed manually with acid-free cotton cloth soaked with petroleum or aromatic-free white spirit. A proven method is to wrap the bearing journals concerned in acid-free cotton cloths, which are then dowsed with a solvent, such as white spirit or Shellsol (for lack of solvents use diesel oil). After a sufficient application time (min. 1 hour), the cloths may be removed. The preservation layers can now been scraped off by means of a wooden spatula.
Attention: metallic scrapers or other means, such as steam- or hot water cleaners, must not be used!
The preservation must be checked before the expiration of the duration of protection and, if necessary, renewed.

8.6 Corrosion protection of cooling water circuits

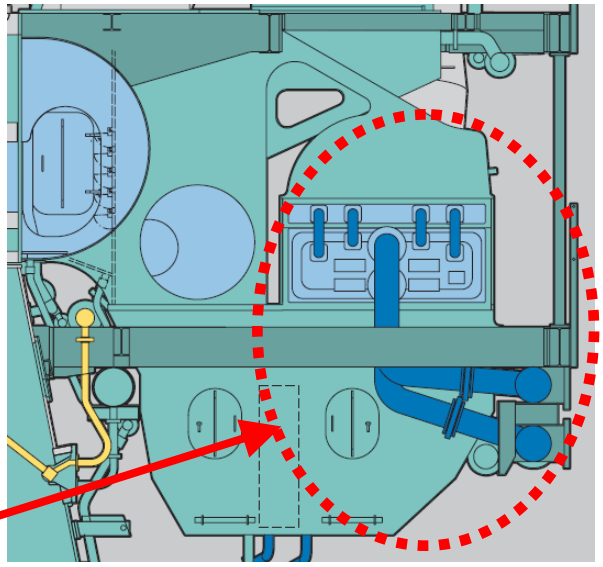
(Cylinder liner – scavenge air cooler – piping for water circulation at engine)

As the cooling water will be drained off after shop test, further treatment against corrosive attack is absolutely essential, i.e. the admixture of a so-called ‘soluble oil’ to the cooling water in order to protect the engine cooling water system. The concentration must be maintained at levels between 0.5 and 0.8 per cent by volume. Prior to the complete shut-down of the system, the circulating cooling water through the engine cooling water system is to be maintained at a pH value between 7 and 9 and the soluble oil inhibitor level increased to 1 per cent by volume. The cylinder temperature is not to exceed 90°C and circulation is to continue for at least three hours, allowing time for the soluble oil inhibitor to coat the internal surfaces.

Attention: The application of soluble oil might be just of helpful use, if the storage period is predicted as being very long (over 12 months). The reason is that the water circuits would have to be flushed at shipside after installation, before being finally connected to board circuit.
If the water circuits - especially the one for cylinder liners and cylinder cover cooling spaces with the cooling bores in the cylinder liner as well as the one in the cylinder cover - and exhaust valve cooling circuit are not flushed, the soluble oil foam, in connection with dust, will lead to clogging of the beforehand described cooling bores.



To carry out corrosion protection of water cooling pipes and spaces properly, …

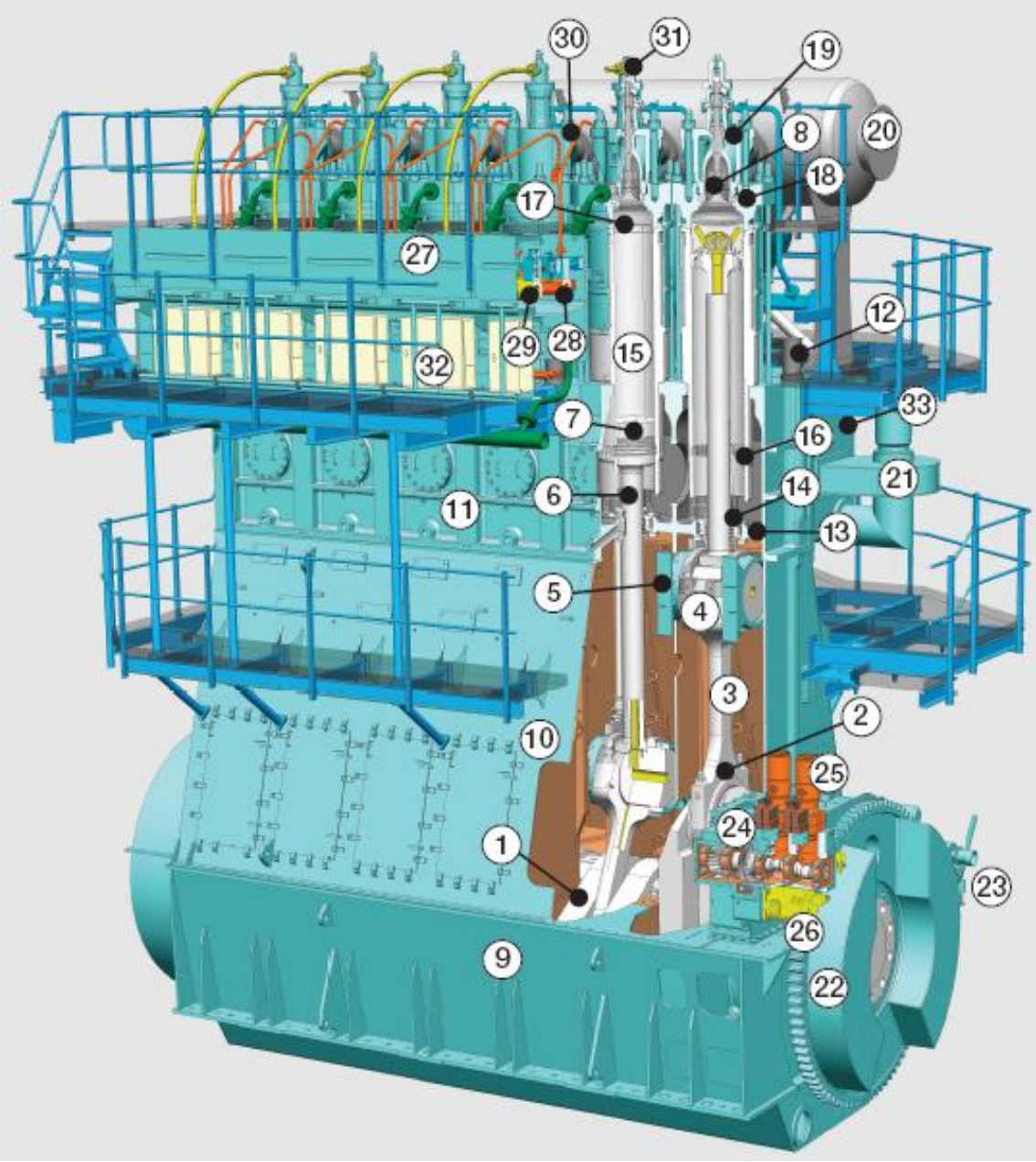


… the application of soluble oil has to be done right after shop test with still connected water circuit.

8.6.1 Electrical equipment

- ❑ Place desiccant bags in all electrical boxes fitted on the engine (e.g. E25, E10, E120 etc…)
- ❑ Make sure that all cable glands are tight. Open holes should be sealed.
- ❑ If applied, place desiccant bags in Boll & Kirch automatic oil filter control box.
- ❑ Make sure that the power supply for the heating of the electric motors is assured (if applicable).

8.7 Overview of the components to be corrosion protected



The next page provides a preliminary overview of corrosion protection liquids which can be used. For a proper evaluation of the correct corrosion protection application and the liquids used, refer to the components given in the chapters overview on page 35-41.
(Attention : valid only for fully assembled engines in storage condition with fully operational dehumidifier.)

- **Tectyl 506 & 132:** First layer with Tectyl 506. **Drying**. Second layer with Tectyl 132.
- **Engine external:** Generally all surfaces not painted with Tectyl 506 & Tectyl 132.
- **Engine internal:** Generally all machined (movable) parts with Tectyl 930.

8.7.1 Quick overview of engine parts and the corresponding corrosion protection liquids

- Refer (please compare) to chapter 16

Pos.	Part	Engine location	Protector type
1.	Crankshaft	Internal	B or F
	Crank web	Internal	B or F
	Crankpin: web journal & main journal	Internal	B or F
	Gear wheels	Internal	B or F
	Thrust bearing pads	Internal	B or F
2.	Bottom end bearing	Internal	B or F
3.	Connecting rod	Internal	B or F
4.	Crosshead bearing	Internal	B or F
5.	Crosshead guide shoes	Internal	B or F
6.	Piston rod	Internal	B or F
7.	Piston	Internal	B or F
8.	Exhaust valve	Internal	B or F
9.	Bedplate	Internal	B or F
10.	Column (Guide rails)	Internal	B or F
11.	Cylinder block	External	C
12.	Tie rods	External	C
13.	Diaphragm	Internal	B or F
14.	Piston rod gland	Internal	B or F
15.	Cylinder liner	Internal	B or F
16.	Scavenge ports	Internal	B or F
17.	Anti-Polishing ring	Internal	B or F
18.	Cylinder cover	External	C
	Combustion space	Internal	B or F
19.	Exhaust valve cage	Internal	B or F
20.	Exhaust manifold	External	----
21.	Auxiliary scavenge air blower	External	Turn elect. motor
22.	Flywheel	External	C & D
23.	Turning gear		
	Electric motor	External	-----
	Wheel pin	External	C & D
24.	RT-flex Supply Unit		
	all flanged units	External	C
25.	High-pressure fuel pumps	External	C
26.	Servo oil pumps	External	C
27.	Rail Unit	External	C
28.	Fuel oil rail with injection units	External	C
29.	Servo oil rail with exhaust valve		
	exhaust valve control units	External	C
30.	High-pressure pipes to fuel injectors	External	C
31.	Exhaust valve drive	Internal	B or F
32.	Electronic cabinets	External	Silica Gel
33.	Scavenge air receiver		
	all relief valves	External	C

8.8 Detailed overview of parts & spaces to be corrosion protected

- Group 1: bedplate and tie rod
- Group 2: cylinder liner and cylinder cover
- Group 3: crankshaft, connecting rod and piston
- Group 4: engine control system and control elements
- Group 5: supply unit, servo oil pump, fuel oil pump and exhaust valve actuator
- Group 6: scavenge air & turbocharger system
- Group 7: platforms (not mentioned in particular)
- Group 8: exhaust manifold; piping systems (see chapter 7.6)
- Group 9: engine monitoring

- Refer (please compare) to chapter 16!
- All corrosion protectors given under "C" are to be removed from engine internal spaces parts before starting the engine.

Group	Component	Comments	Preserving actions
1	Bedplate arrangement	All exposed machined surfaces to be coated	**C** ; 2 layers
1	Bedplate oil drain	Seal drains with a suitably sized steel flange and airtight gasket	**C** ; 1 layer
1	Bedplate free end	Where applicable seal the crankcase vent	**C** ; 2 layers
1	Bedplate driving end	Coat all machined surfaces, in particular the thrust area; remove the thrust bearing saddle drain to prevent any potential clogging and moisture accretion, refit before engine use	**C** ; 2 layers
1	Main bearing shell	All exposed surfaces to be coated	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
1	Main bearing cover	Coat all machined surfaces, pay attention to the stud threads where applicable	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
1	Thrust bearing arrangement	Coat all exposed machined surfaces	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
1	Thrust bearing pads	Coat all machined surfaces, prevent excessive dry turning	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
2	Engine frame assembly parts		**C** ; 2 layers
2	Column doors	Seal all crankcase relief valves, ensure that the valves are corrosion-free	**C** ; 1 layer
2	Casing free end	Coat all machined surfaces	**C** ; 2 layers
2	End casing driving end	Coat all machined surfaces	**C** ; 2 layers

Group	Component	Comments	Preserving actions
2	Oil baffle two-parts driving end	Seal the end baffle, be mindful of any turning and potential damage to this	**C** ; 2 layers
2	Tie rod	Ensure that drain bores are clear, fill with oil at each inspection in order to flush	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
2	Cylinder jacket grouping	Clean after shop trial to remove any corrosive combustion by products	**C** ; 2 layers
2	Supporting ring	Ensure that water is drained completely, in particular in the area of the lower O-rings	**C** (external) or Water inhibitor (internal)
2	Cylinder liner	Ensure that water is drained completely and machined running surface coated If engine is fully assembled: - Layer application through bore of dismantled starting air valve and from piston underside or scavenge ports (piston at BDC – bottom dead centre)	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
2	Cylinder liner holder	Ensure that water is drained completely	**C** ; 2 layers
2	Water guide jacket	Ensure that water is drained completely	**C** ; 2 layers and Water inhibitor (internal)
2	Lubricating quill with accumulator for cylinder lubrication	Fill with cylinder oil and top up for inspection or removal, and store by one layer of "**C**", packed in VCI paper. Openings at water supporting ring to be closed / flanged air-tight.	**C** ; 1 layer VCI paper
2	Lubricating quill for Pulse	Fill with cylinder oil and top up for inspection or removal and store by one layer of "**C**", packed in VCI paper. Openings at water supporting ring to be closed / flanged air-tight.	**C** ; 1 layer VCI paper
2	Gland box piston rod	Ensure that all machined surfaces are coated, pay attention to garter springs	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
2	Compression space	Be sure to coat all machined surfaces. If engine is fully assembled: - Layer application through bore of dismantled starting air valve	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
2	Cylinder cover	Ensure that all water spaces are drained. All fuel injection and starting air valves dismantled for storage. All openings sealed by flange air-tight. Cyl. cover external surface: C ; 2 layers Cyl. cover internal: B / F	**C** ; 2 layers **B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
2	Fuel valve complete (Fuel injectors)	Fuel injectors removed from cyl. cover and cleaned on test bench with "**A**"; packed in VCI after protection application	**A ;** **B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
2	Starting air valve	Remove, clean, and apply protector, then store, packed in VCI paper; flange bore in cylinder cover air-tight	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)

Group	Component	Comments	Preserving actions
2	Relief valve	Remove, clean, and apply protector, then store, packed in VCI paper; flange bore in cylinder cover air-tight	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
2	Indicator valve	Remove and store, close the bore in cyl. cover air-tight by flange. Apply “B” or “F” and store packed in VCI paper.	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
2	Exhaust valve complete	Remove the valve and ensure that cooling spaces are completely drained. Seal off all openings (exhaust chamber to funnel) air-tight. Apply protection to valve seat.	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
2	Valve spindle for exhaust valve	Nymonic valve spindles should not corrode; ensure no damage occurs during transportation. Apply protection.	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
3	Complete crankshaft assembly	Coat all exposed machined surfaces. Grease the flywheel teeth.	See chapter **8.5.1**
3	Vibration damper crankshaft	Viscous fluid dampers are sealed and no access is possible. Spring type dampers can be flushed with system oil; carry out when inspecting the engine at regular intervals.	**C** ; 2 layers
3	Axial detuner	Flush when inspecting periodically	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
3	Turning gear	Ensure that the gearbox is filled and all components are coated	**C** ; 2 layers Grease gear pinion
3	Connecting rod assembly	All machined and uncoated surfaces to be coated as well as the central oil bore	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
3	Bearing shell crankpin	Coat all exposed surfaces	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
3	Upper bearing half of connecting rod top end bearing	Coat all exposed surfaces	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
3	Bearing shell for top end bearing	Coat all exposed surfaces	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
3	Screwed connection piston rod - crosshead	Ensure that the threads are coated, see notes on screw threads	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
3	Crosshead and guide shoe	Coat all machined and other uncoated surfaces	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)

3	Piston assembly parts	Internal parts to be coated; system oil is used but may not adhere as specific products would	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
Group	**Component**	**Comments**	**Preserving actions**
3	Piston cooling and crosshead lubrication	All pipes to be coated. Operate pump with 3-4bar pressure force and connect to flange at column-exhaust entering.	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
4	Pneumatic manoeuvring units	Remove all control valves and store them separately; apply protector and then pack in VCI paper	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
4	Camshaft drive	See specific instructions on the following list	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
4	Drive supply unit	See specific instructions on the following list	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
4	Gear wheel on crankshaft	Coat all teeth and other machined surfaces; coat all uncoated surfaces. Fill bearings when rotating. This item is sensitive to corrosion.	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
4	Intermediate wheel for camshaft drive	Coat all teeth and other machined surfaces; coat all uncoated surfaces. Fill bearings when rotating. This item is sensitive to corrosion.	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
4	Gear wheel on camshaft	Coat all teeth and other machined surfaces; coat all uncoated surfaces. Fill bearings when rotating. This item is sensitive to corrosion.	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
4	Intermediate wheel supply unit	Coat all teeth and other machined surfaces; coat all uncoated surfaces. Fill bearings when rotating. This item is sensitive to corrosion.	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
4	Camshaft/reversing servomotor	Coat all uncoated surfaces, internal components to be filled with system oil; this will not be as effective as a dedicated preserving oil	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
4	Fuel cam	Coat all surfaces, this item is sensitive to corrosion.	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
4	Actuator cam	Coat all surfaces, this item is sensitive to corrosion.	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
4	Vibration damper camshaft	Only viscous fluid dampers are used, no internal access; coat all external surfaces	**C** ; 2 layers
4	Damper casing camshaft	Remove for damper access, coat all surfaces	---
4	Bearing housing(s)	Apply protector "**C**" to all external machined surfaces. All internal parts & surfaces: apply "**B**"/"**F**"	**C** ; 2 layers **B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)

4	Bearing housing ancillary parts	Apply protector "**C**" to all external machined surfaces All internal parts & surfaces: apply "**B**"/"**F**"	**C** ; 2 layers **B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
Group	**Component**	**Comments**	**Preserving actions**
4	Gearing for auxiliary drives	Coat all gears, sensitive to corrosion	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
4	Starting air distributor	External surface: "**C**" ; 2 layers Internal surfaces: "**B**" **/** "**F**" Internal pilot valves to be coated, sensitive to corrosion	**C** ; 2 layers **B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
4	Valve unit for starting air distributor	Remove pneumatic valves and blank all ports/holes air-tight. Apply "**B**" **/** "**F**". Store separately, packed in VCI.	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
4	Shut-off valve starting air	Coat all internal parts, removal is required for access. Apply silica gel, but mark outside.	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
4	Reversing valve	Internal parts coated with system oil, not effective in the long term. To be packed in VCI paper and then stored. Apply "**B**" **/** "**F**" beforehand. Blank openings air-tight.	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
4	Rotation direction safeguard	Internal parts coated with system oil, not effective in the long term. To be packed in VCI paper and then stored. Apply "**B**" **/** "**F**" beforehand. Blank openings air-tight.	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
4	Control air supply	Disconnect supply and seal pipes. Control air usually contains humidity, ensure that all pipes are dry after shop trial. All control valves to be removed. Apply "**B**" **/** "**F**", pack in VCI paper and store. Blank all openings.	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
4	Valve unit reversing interlock	Remove pneumatic valves and blank all ports/holes. Apply "**B**" **/** "**F**", pack in VCI paper and store separately.	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
4	Valve group B by gearing for auxiliary drive	Remove all valves and store them. Apply "**B**" **/** "**F**" and pack in VCI paper. Blank all ports/connecting points.	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
4	Control box local manoeuvring. stand	Remove all valves and store them, packed in VCI paper. Blank all ports/connecting points. Apply "**B**" **/** "**F**".	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
4	Pick-up engine speed/TDC	Sensitive to corrosion, seal or remove; if removed, pack in VCI paper and seal the cable ends	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
4	Control elements unit	Remove all valves and store them; blank all ports/connecting points	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
4	Fuel interlock override device	Remove and seal pipe/ports/connections. Store separately.	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)

4	Local manoeuvring stand	All surfaces to be coated	**C** ; 2 layers
4	Reversing interlock	Remove and seal pipe/ports/connections. Store separately.	

Group	Component	Comments	Preserving actions
4	Rod for local manoeuvring stand and pneumatic logic unit	Coat and seal to exclude moisture. All surfaces must be adequately protected.	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
4	Speed indication	Remove and store in VCI paper	----------
4	Speed indication drive	Ensure that all surfaces are coated	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
4	Rotation counter	Remove and store separately in VCI paper. Blank off bore air-tight.	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
5	Governor and booster arrangement	For mechanical and electrical governors remove and store as per makers' instructions	-------
5	Safety cut-out device	Critical component sensitive to corrosion, ensure that no moisture remains	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
5	Fuel pump block	Flush with calibrating fluid and seal; top up when inspecting	External surface **C** ; 2 layers
5	Eccentric shaft injection pump	Sensitive to corrosion, to be lubricated with system oil, but ineffective in the length of time	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
5	Plunger with bush	Seal lower area to prevent air entry. Ensure that fuel pump is cut out. No touching of roller and cam.	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
5	Valves injection pump	See above actions for fuel pump	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
5	Roller guide fuel pump	Assembly to be coated with system oil, not effective in the length of time	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
5	Gear wheel supply unit		**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
5	Pump servo oil	Remove and store separately; seal all ports/pipes and access points	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
5	Supply unit	All internal parts to be coated with system oil, not effective in the length of time. Coat all external surfaces.	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
5	Fuel pump	All internal parts to be coated with system oil. Coat all external surfaces.	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
5	Fuel pump plunger	Seal lower area to prevent air entry. Ensure that fuel pump is cut out. No	**B** (ValvolineTectyl 930) or **F** (Shell Valvata

		touching of roller and cam.	1000)
5	Rail unit	Coat all surfaces. Cabling and sensors are sensitive to corrosion.	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
5	Fuel rail	Coat all surfaces. Cabling and sensors are sensitive to corrosion (as for rail unit).	**C** ; 2 layers
Group	**Component**	**Comments**	**Preserving actions**
5	Injection control unit	See Instructions 107.378.493. To be dismantled and stored in wooden box.	---
5	Actuator (RTA only)	Internal parts to be coated with system oil; coat all external surfaces.	**C** ; 2 layers
5	Roller guide actuator pump	To be cut off. No contact of roller & cam. Assembly to be coated with system oil, not effective over longer periods.	**B** (ValvolineTectyl 930) or **F** (Shell Valvata 1000)
5	Servo oil rail	Coat all surfaces. Cabling and sensors are sensitive to corrosion.	**C** ; 2 layers
5	Exhaust Valve Drive / Partition Device / Assembly	Coat all parts and inspect regularly. Or: to be dismantled and stored in wooden box.	**C** ; 2 layers
5	Regulating linkage arrangement	Coat all parts and inspect regularly	**C** ; 2 layers
5	Regulating linkage air cylinder	Sensitive to internal corrosion	**C** ; 2 layers
5	Positioning unit VIT/FQS	Coat all surfaces. Cabling and sensors are sensitive to corrosion (as for rail unit).	**C** ; 2 layers
6	Scavenge air receiver	The internal and external surfaces should be coated; this is a large area which should be kept dry, use a dehumidifier	is painted
6	Underslung separator	Ensure that water is drained completely	--------
6	Turbocharger	Store as per manufacturers' instructions.	-----
6	Auxiliary blower	The motor and bearings are sensitive to corrosion. Electric motors should be covered and heated where possible. Check winding resistance when inspecting.	------
6	Auxiliary blower switch box	Keep sealed and internal spaces warm, use silica gel	-------
6	Scavenge air cooler	Ensure that the water side is completely drained. This component is less sensitive to corrosion, but care should be taken when transporting.	Inhibitor has been used.
6	Water separator scavenge air	Ensure that the water side is completely drained	-------

Substitute for: | PC | Q-Code | X | X | X | X | X

Modif		Number	Drawn Date		Number	Drawn Date		Number	Drawn Date		Number	Drawn Date
	-	7-77.252	20.10.2009	A	EAAD088998	30.01.2018						

WinGD Winterthur Gas & Diesel

Product **RT-flex / X / DF**

Guideline For Engine Protection

After shop test

Made	28.02.2018	F. Moszner	Main Drw. **H**	Page 37 / 70	Material ID **107.426.585.500**	
Chkd	28.02.2018	M. Frei	Design Group **0345**	Drawing ID **107.426.585**		Rev **A**
Appd	28.02.2018	M. Damani				

6	Scavenge air waste gate	The internal components should be free of corrosive combustion residue. Coat all parts.	**C** ; 2 layers
8	Exhaust gas manifold	Clean and seal	--------
8	Automatic oil filter	See manufacturer's Operation Manual. Drain the system and place silica gel bags to each candle tube.	---------

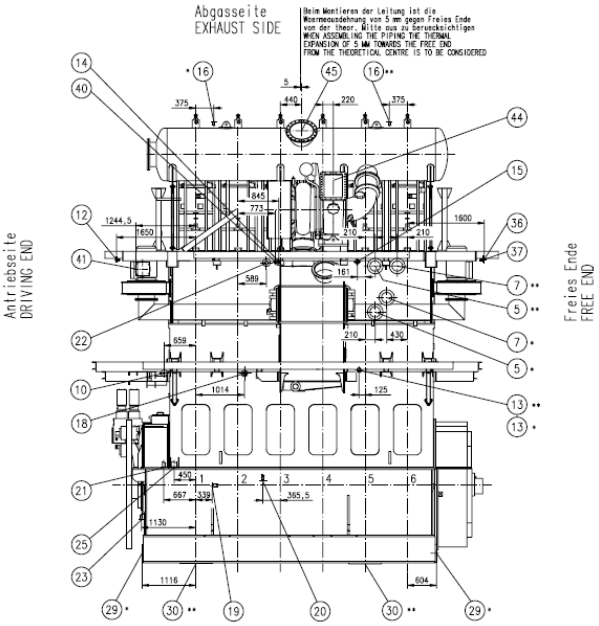
8.9 Corrosion protection of piping

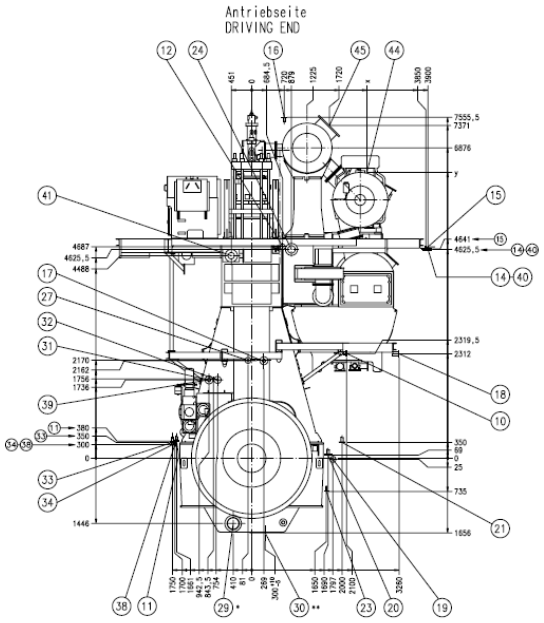
See chapter 7.6 and 107.296.755 (specification for cleaning).

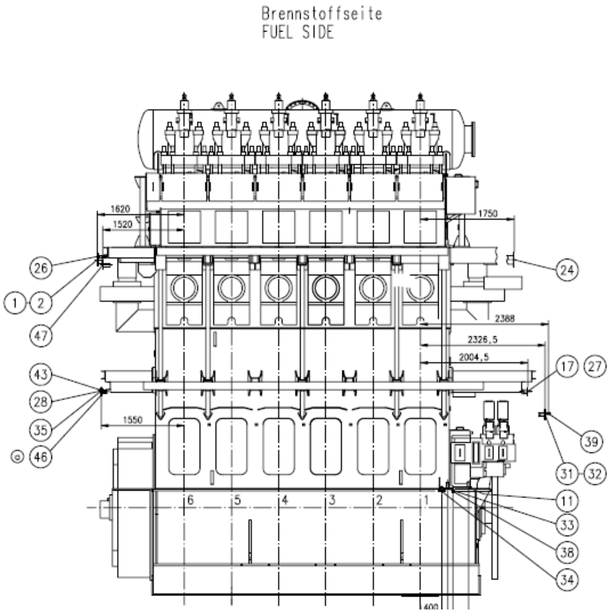
8.10 Overview of flange connections to be sealed air-tight

To provide an overview of the flange connection options, some sketches of the Pipe Connection Plan are given below for your reference. The drawings of each corresponding engine type are available at the Licensees.

The flange geometry can be used to produce proper steel flanges for air-tight sealing after the application of final corrosion preservation.
For checking the positions, see the parts list.
This Pipe Connection Plan differs with every engine type; therefore check carefully and also consider the gas relevant piping in case of DF systems;







30	24x M20; 780; 670	Grundplatte Oelablauf (Vertikal) BEDPLATE OIL DRAIN (VERTICAL)	DN PN	1110	X
31	8x ⌀ 19; 175; 140	Brennstoff Eintritt FUEL OIL INLET	DN 65 PN 16	8702	
32	8x ⌀ 19; 155; 120	Brennstoff Austritt FUEL OIL OUTLET	DN 50 PN 16	8704	
33	4x ⌀ 15; 120; 95	Leckbrennstoffleitung RAIL-UNIT FUEL LEAKAGE PIPE RAIL-UNIT	DN 40 PN 5	8740	
34	4x ⌀ 15; 120; 95	Leckbrennstoffltg. Einspritzventil FUEL LEAKAGE PIPE INJECTION VALVE	DN 40 PN 5	8741	

8.11 Dehumidifier installation

- ❑ Install a real-humidity monitoring system to crankcase and piston underside to record real humidity and temperature during the lay-up period.

The dehumidifier needs to be connected with flexible hoses to the engine as described below. A real humidity of 40% - 50% inside the engine needs to be reached to keep the risk of corrosion low. The execution of the connection may vary depending on the dehumidifier system used and engine type. It is recommended to use a booster fan within the dehumidifier circuit to obtain a constant slight overpressure inside the engine.

1. Connect the dehumidifier to the piston underside, inlet on the AFT side and outlet on the FWD side of the engine (opposite direction is also possible).
2. Connect the dehumidifier to the crankcase, inlet on the AFT side and outlet on the FWD side of the engine (opposite direction is also possible). The flexible hoses can either be connected to the crankcase door openings with a dummy plate, or two relief valves can be removed for the connection.
3. Record humidity values daily of each engine space given on the “Inspection List for Dehumidifier” – see chapter 17.2.

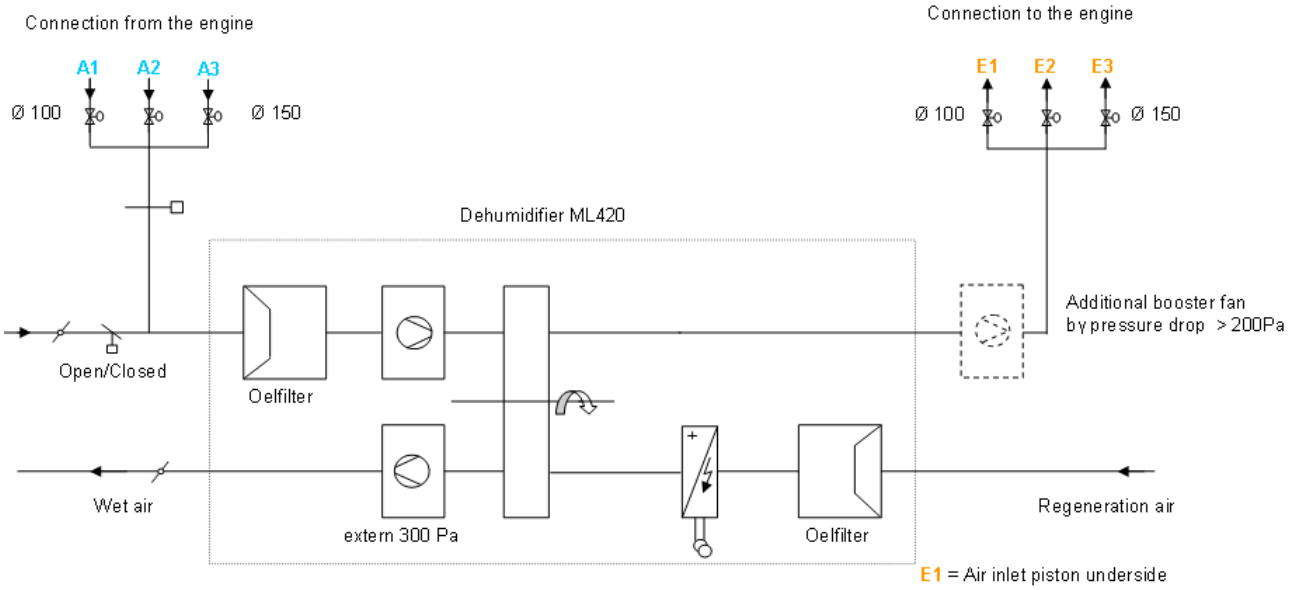
Sample picture of the installation of a Munters M120 dehumidifier

Dehumidifier outlet air taken from the crankcase

Substitute for:												PC	Q-Code	X	X	X	X	X
Modif	-	7-77.252	20.10.2009	A	EAAD088998	30.01.2018												
		Number	Drawn Date		Number	Drawn Date		Number	Drawn Date		Number		Drawn Date					

Winterthur Gas & Diesel	Product **RT-flex / X / DF**		**Guideline For Engine Protection** **After shop test**		
Made 28.02.2018 F. Moszner	Main Drw. **H**	Page 40 / 70	Material ID **107.426.585.500**		
Chkd 28.02.2018 M. Frei	Design Group **0345**	Drawing ID **107.426.585**		Rev **A**	
Appd 28.02.2018 M. Damani					

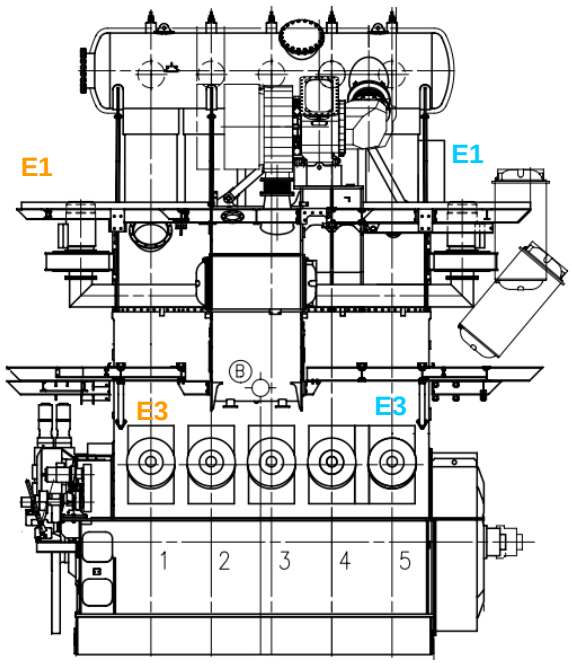
Example for the connection of an ML420 dehumidifier by Munters

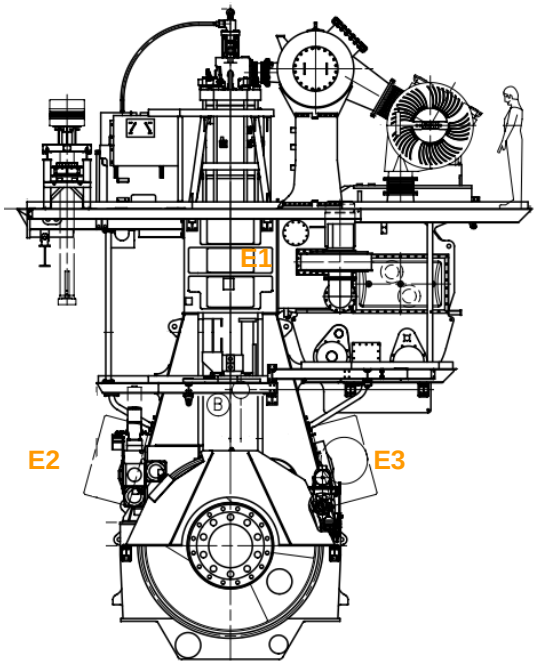


E1 = Air inlet piston underside
E2 = Air inlet supply unit / camshaft drive
E3 = Air inlet crank case

A1 = Air outlet piston underside
A2 = Air outlet supply unit / camshaft drive
E3 = Air outlet crank case

- Distribution with flexible hoses





Note that the dehumidifier's wet air outlet must be led outside the engine room.

Substitute for:											PC	Q-Code	X	X	X	X	X
Modif	-	7-77.252	20.10.2009	A	EAAD088998	30.01.2018											
		Number	Drawn Date		Number	Drawn Date		Number	Drawn Date		Number		Drawn Date				

WinGD Winterthur Gas & Diesel

Product: **RT-flex / X / DF**

Guideline For Engine Protection

After shop test

Made	28.02.2018	F. Moszner	Main Drw. **H**	Page 41 / 70	Material ID **107.426.585.500**	
Chkd	28.02.2018	M. Frei	Design Group **0345**			
Appd	28.02.2018	M. Damani		Drawing ID **107.426.585**		Rev **A**

8.12 Turbocharger

Generally the turbocharger manufacturer operation manual has to be consulted to carry out any kind of work. It has to be assumed that all cast- or flange-contact surfaces have been corrosion protected properly with Tectyl 506 as first layer and Tectyl 132 as second layer.

- It is of outmost importance that the turbochargers be sealed against moisture penetration, and also the sealing of the exhaust silencer by proper application of so-called VCI (**V**olatile **C**orrosion **I**nhibitor) foil has to be assured.

- It is strongly recommended that reliable re-commissioning of the turbocharger needs to be carried out by an authorised service branch the manufacturers. This is mostly by reason of detecting the proper condition (e.g. VTR 4: concentricity of rotor, condition of bearing space and bearing, as also the proper measuring of the clearances thereof), if necessary carrying out further action and finally, assuring readiness for operation.

9 Final Delivery Inspection (at engine maker)

Sample of a cover sheet of the Final Delivery Inspection
The cover sheet is accompanied by the checking list given in chapter 17.4.

9.1 Final Delivery Inspection (at engine maker)

Detailed information as follows:

Engine Type:

Corrosion-protective products applied

Conditions for storage

Indoors in dry conditions, protected against dirt and damage.

Duration of protection

After a period of X months, calculated from the date of shipment, the corrosion protection material is to be removed and the engine/engine parts inspected for signs of rust. After this, the preservation is to be renewed in accordance with the enclosed specification no. 107.426.585.

Inspection and removal of the preservation material

Final delivery inspection at engine maker

Inspection carried out on (Date YYYY-MM-DD :) ____-__-__:

- Engine / engine parts are checked according to the detailed parts list as attached.
  See inspection parts list in chapter 17.4.
  The complete preservation is to be inspected for damage.

Removal of the preservation material prior to fitting and for inspection purposes after the period of protection has expired

The corrosion-protective products can be removed manually with acid-free cotton cloth soaked with petroleum or aromatic-free white spirit. Mechanical means, steam or hot water cleaners are not to be used.
The following products are recommended: white spirit, Shellsol
If necessary, the preservation must be renewed.

Engine manufacturer's information

Date of preservation:
Date of shipment:
Name of manufacturer:
Stamp of quality department and name of inspector:
Documentation:
Hand over the Guideline for Engine Protection 107.426.585
together with the signed Final Delivery Inspection sheet (chapter 9)
to shipyard inspector

10 Protection condition during transport to shipyard

As the engine and/or its parts have been checked at engine maker, see 9.0, and therefore the engine and/or its parts and the packaging are assumed to be in proper condition, the engine with connected dehumidifiers has to be checked on a daily basis for proper operation.
As transportation can take even several weeks and/or the discharge at arrival port may be postponed due to unexpected occurrences, the further inspection procedure has to be guaranteed.

11 Inspection upon arrival (at shipyard)

The inspection is to be carried out within **two weeks** after the engine/engine parts have arrived to the final destination. Any shortcomings because of an improper preservation are to be reported in writing to WinGD Switzerland Ltd within this time limit. **After this time limit, no claims about corrosion damage of the engine and the engine parts respectively shall be taken into account.** See also chapter 9.

Sample of a cover sheet of the Final Delivery Inspection.

The cover sheet is accompanied by the checking list given in chapter 17.4.

To be provided by the shipyard

Engine Type:

11.1 Sample sheet: Inspection of engine upon arrival at the destination

Inspection carried out on (Date YYYY-MM-DD :)____-__-__:

- Engine / engine parts are checked according to the detailed parts list as attached.

See inspection parts list in chapter 17.4.
The complete preservation is to be inspected for damage.

Copy of the Final Delivery Inspection with the filled-out recording sheets is available.
Yes / No

Removal of the preservation material prior to fitting and for inspection purposes after the period of protection has expired

The corrosion-protective products can be removed manually with acid-free cotton cloth soaked with petroleum or aromatic-free white spirit. Mechanical means, steam or hot water cleaners are not to be used.
The following products are recommended: white spirit, Shellsol

If necessary, the preservation must be renewed.

Manufacturer's information
Date of preservation:
Date of shipment:
Name of manufacturer:
Stamp of quality department and name of inspector:

12 Storage conditions at shipyard

The stored engine and/or engine parts will be checked.

12.1 Installation and/or maintaining of dehumidifier operation

The dehumidifier should have been installed already since final corrosion protector application has been carried out, if the climatic conditions (humidity) required this.
If not done so, install according to chapter 8.11. Check the dehumidifier and record the humidity values daily.

12.2 Installation of turning gear power supply

The main power source required for generally all turning gear types is AC 440V – 60Hz.
Please check beforehand on type plate of turning gear or verify with engine maker.

If the engine has been delivered fully assembled or part-wise (bedplate with crankshaft installed), it is necessary to turn the crankshaft once a week by minimum of 3-4 turns.
If so, check if the

- main bearings,
- connecting rod bottom end bearing,
- crosshead bearing,
- guide rails; the 4 guide shoes respectively of each cylinder,
- cylinder liners,
- pistons (either through the starting air valve bores at the cylinder covers, or through the scavenge ports),
- gear wheel drive,
- RT-flex engines: camshaft bearings

have been greased with Tectyl 930 or Valvata 1000.

13 Regular Re-inspection & re-coating of machined surfaces / engine parts at yard condition

13.1 Once a week

(if possible at yard stage!)

- Operate the main engine system oil pump for 20 minutes while turning the engine. During this time the cylinder lubrication should be operated manually. The engine should be stopped each time in another position. Note that the dehumidifying system needs to be turned off prior to starting the lube oil pumps. Two hours after stopping the lube oil pumps the dehumidifier may be turned on again.

  Important! The number of pulses / turns required to keep the cylinder liner surface properly lubricated must be verified by visual inspections of the liner surface and piston ring package from the piston underside space.

  CLU-4 type lubricating system/flex-lub-lubrication system (if possible at yard stage!)
  Operate the manual/emergency cylinder lubrication for 10 – 15 minutes. During this time, keep the engine turning with the turning gear.

  Retrofit Pulse and Pulse Lubricating System (RPLS & PLS)
  (if possible at yard stage!)
  Start the main lube oil pump and rotate the engine with the turning gear. Start the oil supply pump and set the delivery pressure to 12-14 bar by means of the oil supply unit's pressure regulating valve. Actuate manual cylinder lubrication. At such low pressure (normally 50 bar), the cylinder oil will not be injected but will flow along the liner wall. Give each cylinder approx. 100 pulses. During this time, keep the engine turning with the turning gear.

  Pulse Feed Lubricating System (if possible at yard stage!)
  Start the main lube oil pump and rotate the engine with the turning gear. Start the control oil pump, or the Servo Oil Service pump on engines without control oil pumps, in order to provide hydraulic pressure for driving the dosage pumps. The lubricating system servo oil pressure has to be adjusted to 12 to 14 bar by means of the pressure regulating valves which are, depending on the execution, either located inside or just outside the rail unit. Start manual lubrication to individual cylinders. At such low pressure (normally 50 bar), the cylinder oil will not be injected but will flow along the liner wall. Give each cylinder approx. 100 pulses. During this time keep the engine turning with the turning gear.

Pulse Jet Lubrication System (if possible at yard stage!)
Start the main lube oil pump and rotate the engine with the turning gear. Start the control oil pump, or the so-called service pump on engines without control oil pumps, in order to provide hydraulic pressure for driving the dosage pumps. The servo oil pressure needs not be reduced. Start manual lubrication to individual cylinders. Give each cylinder approx. 100 pulses.

- In case the cooling water system has not been drained, the cooling water pumps need to be operated for around 20 minutes to get some circulation in the cooling system.
- Check the level of the corrosion-protective oil which has been filled into the fuel system (if required refill).
- The fuel linkage needs to be moved by hand; re-lubricate it if required.
- Check the recorded relative humidity and temperature inside the engine on the data logger.
- Open the drain cock of the turbocharger gas outlet casing for one minute (water check).
- Re-spray rust-preventive coating on piston rods if required.

Please note: Always use pumps alternately, a long standstill could lead to detriments (if there is no power supply to some pumps, they should be turned by hand on a weekly basis):

  - LO pumps
  - X head pumps
  - booster pumps
  - water pumps

13.2 Every two weeks

- Open the crankcase (on one side) and piston underside doors and check for condensation and rust traces, particularly on:
  - thrust bearings
  - gear wheels
  - guide rails
  - camshaft
  - cams and rollers
  - pistons
  - piston rods
  - cylinder liners
  - fuel rail- & servo oil rail units

If necessary re-spray coating on blank parts in the crankcase that are not covered with system oil when the engine is turned over.

- Open and close the main starting shut-off valve from time to time. Make sure that the supply from the starting air bottles is depressurised.

- Check the dehumidifying system and clean/replace the filter(s).

- Inspect the exhaust manifold for any moisture deposits or corrosion.
- Turn the rotor of the turbocharger(s) at an angle of 90° to avoid bending of the shaft.

- Turn the auxiliary scavenge air blower(s) by hand a few revolutions to avoid detriments.

13.3 Every month

- Lift a crosshead pin and check for signs of corrosion. Spray-coat again all mentioned parts with rust-preventing engine oil. For re-assembling use steam engine cylinder oil.

- Remove a main bearing cover and check the journal pin for signs of corrosion. Spray-coat again all mentioned parts with rust-preventing engine oil. For re-assembling use steam engine cylinder oil.

- Replace the silica gel desiccant bags inside the control boxes.

- Replace the silica gel desiccant bags inside the main starting air pipe.

- Replace the silica gel desiccant in the automatic filter candles.

- If the fuel injectors, the starting air valves, the indicator cocks, the injection control units

(ICU) have not been removed after shop test for single part storage, they must be removed and checked

- Check by analysis the following liquid media **(if possible at yard stage!)** :

  - cooling water
  - system oil
  - MDO in the fuel system of the engine

13.4 Overview parts inspection time-frame

Main inspection parts	Period of Inspection						
	Daily	Every week	Every two week	Monthly	Every 3 month	Every 4 - 6 month	Remark
De-Humidifier	●						
Bedplate				●	(3)	(4)	
Column				●	(3)	(4)	
Guide Rails Column		●			(3)	(4)	
Crankshaft		●			(3)	(4)	
Main Bearings				(5)	(3)	(4)	
Connecting Rod		●			(3)	(4)	
Bottom End Bearing				(5)	(3)	(4)	
Cross-Head Bearing				(5)	(3)	(4)	
Piston Head		●			(3)	(4)	
Piston Rod		●			(3)	(4)	
Gland Box Springs		●			(3)	(4)	
Cams & Camshaft		●			(3)	(4)	
Cyl. Liner Inside		●			(3)	(4)	
Cyl. Liner Outside		●			(3)	(4)	
Fuel rail pipe		●			(3)	(4)	
Servo rail pipe		●			(3)	(4)	
Exhaust Valve drive		●			(3)	(4)	
Injection Control Unit		●			(3)	(4)	
Starting Air Distributor		●			(3)	(4)	
Rotation Direction Safeguard		●			(3)	(4)	
Engine turning			●				
Ancillary Parts (*) installed at engine				(1)	(2)		
Ancillary Parts (*) stored in VCI paper & closed woodenbox					(1)	(2)	
(*) = Fuel Injection valves; Starting Air valves ; Indicator cock valve ; Injection Control Unit (ICU)							

(1) = Max. humidity 75% & dry condition at storage place

(2) = Max. humidity 50% & dry condition at storage place

(3) = Max. humidity 75% - dry condition - single part

(4) = Max. humidity 50% - dry condition - single part

(5) = To be opened for inspection

14 Recovery of corroded parts

If there are signs of rust, the quality assurance department will decide whether additional work is necessary. If the traces of rust are only slight, they can be removed with emery cloth No. 220 (or finer) and petroleum. Repeat cleaning!
If the parts are too heavily corroded, contact your next WinGD Ltd. Service Branch for further decision.

15 Tools needed for storage

15.1 Dehumidifier

It is up to the engine maker or shipyard to decide which tools are used, as long as the technical properties/specifications are complying with the samples attached.

15.1.1 Introduction

The requirements on a dehumidifier system always depend on the engine type/size (volume to be dried) and the storage location (temperature and real humidity). On the following pages three recommended dehumidifier products are shown which are able to cover the WinGD 2-stroke engine portfolio, even in subtropical areas. The main task of a dehumidifier system is to maintain the real humidity inside the engine between 40% and 50%, in order to keep the level of corrosion as low as possible.

15.1.2 Engine volume overview

The list below can be used as a rough reference for the volume (crankcase, piston underside and camshaft housing) which needs to be dried in the engine.
~ Volume per cylinder in m³ (crankcase & scavenge air space & camshaft housings)

W-X35B	4 m³
W-X40B	6 m³
W-X46	11 m³
W-X52	15m³
W-x62	24 m³
W-X62-B	24 m³
W-X72	37 m³
W-X72-B	37 m³
W-X82-B	56 m³
W-X92	65 m³

Example for the definition of the air volume to be dried in a 6X72 engine

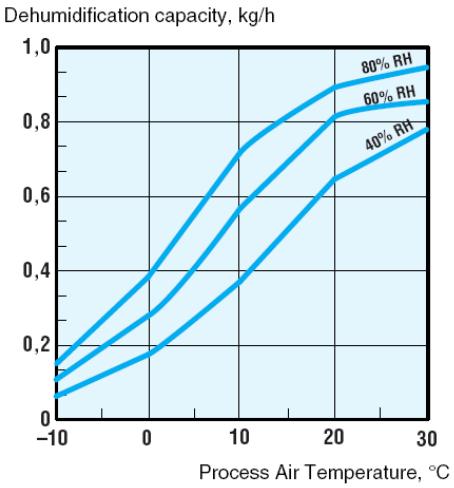
6 x 60 m³ = <u>360 m³ total air volume</u> inside the engine

Depending on the lay-up location, temperature, humidity and engine type, the capacity of the dehumidifier system needs to be defined case by case.

15.2 Tools for dehumidification & corrosion protector application

Below is a recommendation for three types of absorption dehumidifiers made by the Munters company. The marine industry has already had positive experience with these dehumidifiers.

15.2.1 Munters M120



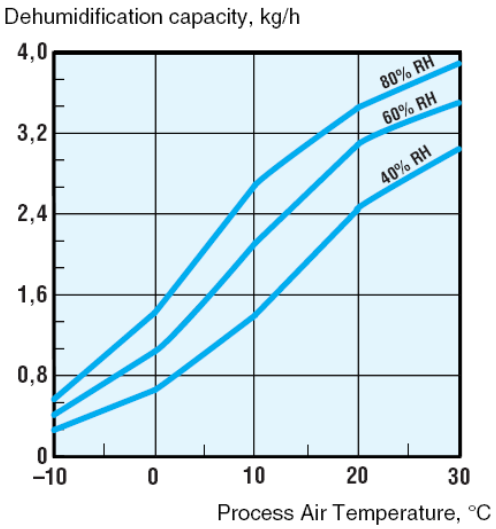
Process air

Rated airflow (m³/h)	120
Available static pressure 50Hz (Pa)	200
Available static pressure 60Hz (Pa)	360

Miscellaneous

- Operating temperature (ºC) -40/+40
- Available for different voltage supplies from 115V to 240V

15.2.2 Munters ML420



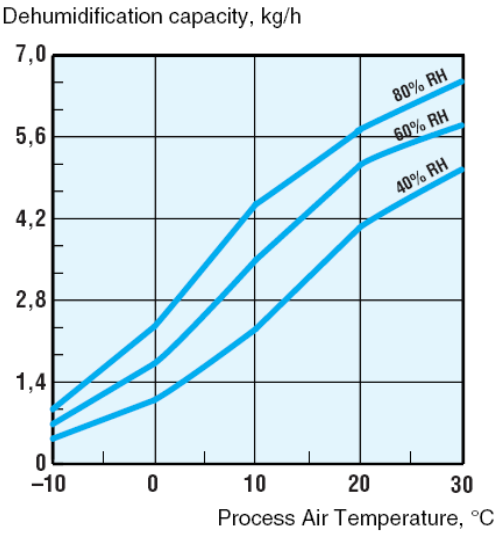
Process air

Rated airflow (m³/h)	420
Available static pressure (Pa)	200

Miscellaneous

- Operating temperature (ºC) -20/+40
- Available for different voltage supplies from 220V to 500V

15.2.3 Munters ML690



Process air

Rated airflow (m³/h)	690
Available static pressure (Pa)	300

Miscellaneous

- Operating temperature (ºC) -20/+40
- Available for different voltage supplies from 220V to 500V

15.3 Accessories

- Booster fan
- Oil filter elements (to assure the efficiency of the dehumidifier)
- Controller
- Pipe distributor with flaps
- Flexible hose Ø 80 mm
- Flexible hose Ø 125 mm
- Flexible hose Ø 160 mm
- Flexible hose Ø 200 mm
- Connecting T-pieces
- Transport frame

15.3.1 Humidity and temperature control

During the lay-up a humidity and temperature data logger must be fitted to the crankcase, piston underside and camshaft housing/supply unit, in order to monitor the conditions inside the engine and check proper working of the dehumidifier system. Below is a recommendation for a tool which can be used for this purpose.

15.3.2 HygroLog NT3

- Relative humidity, temperature, dew point or other calculated parameter
- Multi-probe capability, wide selection of probes to satisfy every application
- Measurements from 0 to 100%RH and -50..200°C /-58..392°F (with external probe)
- Optional internal humidity-temperature probe, protected against unauthorized removal
- Monitoring of up to two external contacts (door, relay contact, etc.)
- Optional LC display and multi-function keypad
- Large recording capacity with removable flash memory card
- Operates with a 9 VDC standard or rechargeable battery
- Data download without interrupting the measurements

15.3.3 Equipment for preservation oil spraying

To spray coat engine components and blank metal parts, a portable oil sprayer may be used. There are different types and executions of oil sprayers. Below two examples are shown for reference only.

Airless spray unit, made e.g. by Wagner (www.wagner-group.com)

Airgun, e.g. type 405T, made by Gloria (www.gloriagarten.de)

16 Overview of liquids & application properties

Below a sample list has been compiled of fluids to be used for various applications, which have been summarized. Note that the fluids have been divided in various categories; they are referred to in the subsequent component tables. Where applicable the application method is referred to. The list is not complete: where the products referred to are not available locally, a suitable replacement can be used; however, the basic properties should remain the same. In all cases where cabling and sensors are concerned the compatibility of the preserving agent with the relevant cabling should be confirmed.
Please contact WinGD Switzerland Ltd.

Product*	Description	Class	Application method
Shell calibration fluid S9365	Calibrating fluid for testing fuel injectors and pumps	**A**	Used in conjunction with a test pump/bench
Shell Ensis Engine Oil 30 Valvoline Tectyl 930 Mobilarma 524 Total Osyris DWY 3500/5500	Mineral oils with excellent rust prevention properties Used for coating engine parts including cylinder liners, piston rods, gears, etc. Only used for	**B**	Spray coating or brush. Where spraying is used, a manual pump is preferred. Any air pumps must use

	engine storage.		moisture-free air.
Tectyl 502 EH Tectyl 506 H Tectyl 132 Chevron Rustproof Compound L Shell Ensis DW2462 Mobilarma 798 Castrol Safecoat DW33	Solvent cutback, soft-wax based, corrosion-preventive compound. Can be used to protect external blank metal parts, for example fuel pump blocks, rails, cylinder covers, etc.	**C**	Brush.
Pyroshield LE 5182 Klüberfluid CF Ultra	High-pressure grease which can be used for lubricating flywheel teeth.	**D**	Brush.
Mobilcut 200 Shell Dromus B / BX Total Lactuca MS 5000	Soluble oil inhibitors which are used to protect emptied cooling water spaces.	**E**	Added to cooling water.
Castrol Cresta SHS Chevron Cylinder oil 1000 Shell Valvata Oil 1000 Mobil 600 W Super Cylinder Oil Total Cyl 1000	High-viscosity steam engine cylinder oils with excellent corrosion protection and resistance to wiping. Used for bearing shells	**F**	Brush.

16.1 Cleaning and degreasing agents

(inodorous aliphatic hydrocarbons, free of aromatics)

White spirit is the generic term for the following Shell products:
- Shellsol TD
- Shellsol T

Valvoline product: Solvent FP68

Properties	**Shellsol TD**	**Shellsol T**	**Solvent FP68**
Boiling range, at 760 mm Hg beginning at °C ending at °C	 172 195	 185 212	 194 251
Density at 20°C in kg/m^3	735	760	790
Colour SAYBOLT	+ 30	+ 30	+ 30
Aromatic content vol. %	≤ 0,2	≤ 0,2	≤ 0,5
Sulphur content weight %	≤ 0,005	≤ 0,005	≤ 0,005
Copper corrosion	1	1	1

Aniline point °C	84	84.5	75
Viscosity at 20°C in cst.	1.62	1.85	1.84
Relative evaporation time			
(ether = 1)	110	130	800
Flash point Abel °C	46	56	72
Drop ignition temperature°C	-	330	-
Danger class BVD	Fe-II/B	F-III/B	B-III
Transport danger class RID/ADR	IIIa2301/a	IIIa2301/a	Cl. 3 Pt. 32c
Poison class	5	5	free
Max. permissible concentration ppm	500	500	500
mg/m^3	3200	3400	2000

Toxicology: Only at very high vapour concentrations: will have narcotic effects and may cause dizziness.

Application: Solvents, thinning, cleaning and degreasing agents for lacquers and paints. Non-fluorescent dielectric material for non-destructive testing.

Manufacturers: Royal Dutch Shell plc Shellsol TD and T
Carel van Bylandtlaan 30
NL – 2596 HR DEN HAAG
www.shell.com

Valvoline Europe, Solvent FP68
Pesetastraat 5
NL – 2991 XT, Barendrecht
www.valvolineeurope.com

16.2 Corrosion inhibitors for WinGD 2-stroke diesel engines

For closed cooling water circuits

Approved and recommended for use in WinGD 2-stroke diesel engines

Product brand name	Supplier	Main reagent
Liquidewt	Ashland Drew Marine	Nitrite/borate
Maxigard	Ashland Drew Marine	Nitrite/borate/organic
CorrShield OR4411	GE Betz	Organic compounds
Q8 Corrosion Inhibitor Long-Life	Kuwait Petroleum	Organic compounds
D.C.W.T. Non Chromate	Marichem Marigases	Nitrite/borate
Marisol CW	Maritech	Nitrite/borate
Nalfleet EWT 9-108	Nalco / Nalfleet	Nitrite

RD 25 Complex	Rohm and Haas	Molybdate/phosphate
Havoline XLI	Texaco	Organic compounds
WT Supra	Total	Organic compounds
Colorcooling	Uniservice	Nitrite
Anticorr	Uniservice	Phosphonate
NCLT	Uniservice	Nitrite
Cooltreat AL	Unitor Chemicals	Organic compounds
Dieselguard NB	Unitor Chemicals	Nitrite/borate
Rocor NB Liquid	Unitor Chemicals	Nitrite/borate

The condition of the cooling water before treatment should be as follows:
min. pH 6.5
max. 10 °dH (corresponds to 180 mg/l CaCO3)
max. 80 mg/l chloride
max. 150 mg/l sulphate

The dosage of the corrosion inhibitor and the maintenance of its concentration in service should be carried out according to the supplier's instructions. The supplier company undertakes all responsibility for the performance of the water treatment in service to the exclusion of any liability of WinGD Switzerland Ltd.

16.3 Overview of some corrosion protection product specifications

16.4 Dewatering Fluid WA

Type of corrosion-protective product **Dewatering with corrosion protection**
Waxy, dry protective film

Name of product: **Dewatering Fluid WA**

Article No:
Specification No:
Substitute for Spec. No:

General and physical properties:
Oil-based corrosion preventive

Protection against:
Humidity, perspiration, shower-proof

		Application-method		Thinner %	Viscosity	Spraying pressure	Nozzle mm	k / Oh
Application Temperature:	15°C to 35°C	Brush	Yes					
Humidity:		Roller	Yes					
Colour:	like Vaseline	Dipping	Yes					
Degree of gloss:	mat	Spraying: low press.	Yes					
Covering power:		high press.	Yes					
Density:	810 kg/m^3 at 15°C	Airless	Yes					
Content of solids:	15.5 %	Electro-static	Yes					
Viscosity:		Drying: Air	dust-free	set to touch	completely dry	Recoatable after: spraying		
Danger class:	A-II	20°		1 h		no	no	
Poison class:	free BAG T Nr. 611 500	Oven	Time no	Temperature of component:				
Flash point:	40°C in closed pot	Forced	Time no	Temperature of component:				
Identification duty:	ADR/SDR Cl. 3 Pt. 31 c							

Shelf life:	12 months cool/dry	Technical data:	
Mixing ratio: 1)	2)	Cross-cut test DIN 53151	
With hardener:		Hardness acc. to:	
Pot life:		Steel ball jet: DIN 53154	
Coverage:	180 m^2/l	Mandrel bend test: DIN 53152	
with dry film thickness of	0.8 microns 3)	Ericcson cupping index IE: DIN 53156	
Temperature range:	- 20°C to + 60°C	Salt-spray test: DIN 50021	DIN 50'907 150 hrs
Dry film melting-point:		Kesternich test: DIN 50018	
1) Weight 2) Volume 3) On smooth surface		Condensed water climate: ASTM-D-148, DIN 51359	DIN 51'359 150 hrs

Surface preparation: Grease-free surface. May be applied to moist surface.

Features: Highly water displacing, liquid repellent
films on metal surfaces, displaces liquids and moisture out of pocket holes

Duration of protection: Indoor storage 9 - 12 months / shed storage 4 - 8 months

Removal, cleaning: Normally not necessary. Considered as coat structure for further preservation.
Removal with white spirit or petroleum.

Supplier: Valvoline Oil Co. Ltd., Hardturmstr. 175, P.O. Box, CH-8005 Zurich, Switzerland
Tel. +41 (0) 1/446 50 50

The data given are mean values based on practical experience. Application according to the supplier's specification and at user's risk with regard to climatic and specific conditions.

16.5 Tectyl 506

Type of corrosion-protective product **Waxy, dry, grip-dry protective film for long-term preservation and external protection**

Name of product: **TECTYL 506**

Article No:
Specification No:
Substitute for Spec. No:

General and physical properties:
Oil-based corrosion preventive

Protection against:
Atmospheric influences incl. rain, snow, etc., aggressive industrial atmosphere and gases such as SO_2

		Application-method		Thinner %	Viscosity	Spraying pressure	Nozzle mm	k / Oh
Application Temperature:	10°C to 35°C	Brush	Yes					
Humidity:		Roller	No					
Colour:	brown	Dipping	No					
Degree of gloss:	wax-like, consistent	Spraying: low press.	Yes					
Covering power:		high press.	Yes					
Density:	870 kg/m^3 at 20°C	Airless	Yes					
Content of solids:	54 %	Electro-static	Yes					
Viscosity:								
Danger class:	A-II	Drying: Air	dust-free	set to touch	completely dry	Recoatable after: spraying		
Poison class:	free BAG T Nr. 16889	20°C	2hrs	3 hrs	4 hrs			
Flash point:	41°C in closed pot	Oven	Time		Temperature of component:			
Identification duty:	ADR/SDR Cl. 3 Pt. 31 c	Forced	Time		Temperature of component:			

Shelf life:	12 months cool/dry	Technical data:	
Mixing ratio: 1)	2)	Cross-cut test DIN 53151	
With hardener:		Hardness acc. to:	
Pot life:		Steel ball jet: DIN 53154	
Coverage:	16 m^2/l	Mandrel bend test: DIN 53152	
with dry film thickness of	35 microns 3)	Ericcson cupping index IE: DIN 53156	
Temperature range:	- 40°C to + 120°C	Salt-spray test: DIN 50021	5 % 80 days
Dry film melting-point:		Kesternich test: DIN 50018	
1) Weight 2) Volume 3) On smooth surface		Condensed water climate: ASTM-D-148, DIN 51359	> 100 days

Surface preparation: Dry, dust-free, oil- and grease-free surface; surface treated with Dewatering Fluid WA

Features: Non water displacing

Duration of protection: Indoor storage up to 4 years / outdoor storage up to 2 years

Removal, cleaning: With petroleum, aromatic-free white spirit, alkaline soaker; steam or hot-water cleaner with corrosion protection additive

Supplier: Valvoline Oil Co. Ltd., Hardturmstr. 175, P.O. Box, CH-8005 Zurich, Switzerland
Tel. +41 (0) 1/446 50 50

The data given are mean values based on practical experience. Application according to the supplier's specification and at user's risk with regard to climatic and specific conditions.

Substitute for:											PC	Q-Code	X	X	X	X	X
Modif	-	7-77.252	20.10.2009	A	EAAD088998	30.01.2018											
		Number	Drawn Date		Number	Drawn Date		Number	Drawn Date		Number	Drawn Date					

WinGD Winterthur Gas & Diesel

Product **RT-flex / X / DF**

Guideline For Engine Protection
After shop test

Made	28.02.2018	F. Moszner	Main Drw. **H**	Page 60 / 70	Material ID **107.426.585.500**
Chkd	28.02.2018	M. Frei	Design Group **0345**		
Appd	28.02.2018	M. Damani		Drawing ID **107.426.585**	Rev **A**

16.6 Tectyl 5006W

Type of corrosion-protective product	**Waxy, dry, grip-dry protective film for long-term preservation and external protection**
Name of product: **TECTYL 5006W**	Article No: Specification No: Substitute for Spec. No:

General and physical properties: Oil-based corrosion preventive emulsifiable with water	Protection against: In dry state resistant to atmospheric influences such as rain, snow and aggressive industrial atmosphere and gases such as SO_2

Application Temperature:	10°C to 35°C	Application-method		Thinner %	Viscosity	Spraying pressure	Nozzle mm	k / Oh
Humidity:		Brush	Yes					
Colour:	milky white	Roller	Yes					
Degree of gloss:	wax-like, consistent	Dipping	Yes					
Covering power:		Spraying: low press.	Yes					
Density:	1090 kg/m^3 at 20°C	high press.	Yes					
Content of solids:	40 %	Airless	Yes					
Viscosity:	DIN 4 - 20°C - 30 sec.	Electro-static	Yes					
Danger class:	none	Drying: Air	dust-free	set to touch	completely dry	Recoatable after: spraying		
Poison class:	none	20°	1,5h	2 hrs	3 hrs	no	no	
Flash point:	none (emulsion)	Oven	Time 1 ½ h		Temperature of component:	max. 60°C		
Identification duty:	no	Forced	Time 1 ½ h		Temperature of component:	max. 60°C		

Shelf life:	cool/dry + 5°C to + 35°C	Technical data:	
Mixing ratio: 1)	2)	Cross-cut test DIN 53151	
With hardener:		Hardness acc. to:	
Pot life:		Steel ball jet: DIN 53154	
Coverage:	10 m^2/l	Mandrel bend test: DIN 53152	
with dry film thickness of	40 microns 3)	Ericcson cupping index IE: DIN 53156	
Temperature range:	- 30°C to + 120 °C	Salt-spray test: DIN 50021	5 % > 240 hrs
Dry film melting-point:		Kesternich test: DIN 50018	
1) Weight 2) Volume 3) On smooth surface		Condensed water climate: ASTM-D-148, DIN 51359	> 240 hrs

Surface preparation:	Dust-free, oil- and grease-free surface. May be applied to moist surface. Surface treated with Dewatering Fluid WA.
Features:	Storage: protect against frost. Treated parts should only be taken outside when completely dry.
Duration of protection:	Indoor storage up to 4 years / outdoor storage up to 2 years
Removal, cleaning:	With petroleum, aromatic-free white spirit, alkaline soaker, steam or hot-water cleaner with corrosion protection additive
Supplier:	Valvoline Oil Co. Ltd., Hardturmstr. 175, P.O. Box, CH-8005 Zurich, Switzerland Tel. +41 (0) 1/446 50 50

The data given are mean values based on practical experience. Application according to the supplier's specification and at user's risk with regard to climatic and specific conditions.

16.7 Tectyl 5805W

Type of corrosion-protective product Dry protective coat for short-term preservation

Name of product: **TECTYL 5805 W**

Article No:
Specification No:
Substitute for Spec. No:

General and physical properties:
Oil-based corrosion preventive emulsifiable with water

Protection against:
Industrial atmosphere in case of indoor storage. Not resistant against atmospheric influences such as rain, etc.

Application Temperature:	10°C to 35°C
Humidity:	
Colour:	yellowish
Degree of gloss:	oily
Covering power:	
Density:	900 kg/m^3 at 20°C
Content of solids:	none
Viscosity:	17 mm^2/s at 40°C
Danger class:	none
Poison class:	none
Flash point:	140°C
Identification duty:	none

Application-method		Thinner %	Viscosity	Spraying pressure	Nozzle mm	k / Oh
Brush	No					
Roller	No					
Dipping	Yes					
Spraying: low press.	Yes					
high press.	Yes					
Airless	Yes					
Electro-static	No					

Drying: Air	dust-free	set to touch	completely dry	Recoatable after: spraying	
20°C			2 hrs		

Oven — Time ½ h — Temperature of component: max. 60°C

Forced — Time ½ h — Temperature of component: max. 60°C

Shelf life:	12 months cool/dry
Mixing ratio: 1)	1:4 2) 1:10
With hardener:	
Pot life:	
Coverage:	150 - 400 m^2/l
with dry film thickness of	1 - 2 microns 3)
Temperature range:	- 10°C to + 50°C
Dry film melting-point:	

1) Weight 2) Volume 3) On smooth surface

Technical data:	
Cross-cut test DIN 53151	
Hardness acc. to:	
Steel ball jet: DIN 53154	
Mandrel bend test: DIN 53152	
Ericcson cupping index IE: DIN 53156	
Salt-spray test: DIN 50021	
Kesternich test: DIN 50018	
Condensed water climate: ASTM-D-148, DIN 51359	Mixture 1:3 > 10 days

Surface preparation: Dust-free, oil- and grease-free surface. May be applied to moist surfaces.

Features: Storage: protect against frost. Mixable in every ratio with water, results in milky emulsion

Duration of protection: Indoor storage up to 6 months, depending on mixture ratio

Removal, cleaning: If required, with petroleum, aromatic-free white spirit, alkaline soaker, steam or hot-water cleaner with corrosion protection additive

Supplier: Valvoline Oil Co. Ltd. Hardturmstr. 175, P.O. Box, CH-8005 Zurich, Switzerland
Tel. +41 (0) 1/446 50 50

The data given are mean values based on practical experience. Application according to the supplier's specification and at user's risk with regard to climatic and specific conditions.

16.8 Tectyl 910 / Tectyl 930

Type of corrosion-protective product Rust-preventing oil for preservation and lubrication

Name of product: **TECTYL 910 / TECTYL 930**

Article No:
Specification No:
Substitute for Spec. No:

General and physical properties:
Oil-based corrosion preventive.
Stays oil, does not become gummy.
MIL-L-21260 B+C, API SF/CD

Protection against:
Atmospheric influences such as aggressive air, etc.
Not resistant to mechanical loads and rain, etc.

		Application-method		Thinner %	Viscosity	Spraying pressure	Nozzle mm	k / Oh
Application Temperature:	0°C to 50°C	Brush	Yes					
Humidity:		Roller	Yes					
Colour:	yellow-brown	Dipping	Yes					
Degree of gloss:	wet gloss	Spraying: low press.	Yes					
Covering power:		high press.	Yes					
Density:	880 - 890 kg/m^3 at 15°C	Airless	Yes					
Content of solids:	none	Electro-static	Yes					
Viscosity:	910: VG46 930: VG100							
Danger class:	none	Drying: Air	dust-free	set to touch	completely dry	Recoatable after: spraying		
Poison class:	free BAG T No. 611 500							
Flash point:	218-230°C in closed pot	Oven	Time		Temperature of component:			
Identification duty:		Forced	Time		Temperature of component:			

Shelf life:	24 months cool/dry	Technical data:	
Mixing ratio: 1)	2)	Cross-cut test DIN 53151	
With hardener:		Hardness acc. to:	
Pot life:		Steel ball jet: DIN 53154	
Coverage:	910:140 930:110 m^2/l	Mandrel bend test: DIN 53152	
with dry film thickness of	5 - 7 microns 3)	Ericcson cupping index IE: DIN 53156	
Temperature range:	- 20°C to + 50°C	Salt-spray test: DIN 50021	passed 20 hrs
Dry film melting-point:		Kesternich test: DIN 50018	
1) Weight 2) Volume 3) On smooth surface		Condensed water climate: ASTM-D-148, DIN 51359	Jan-791 720 hrs without findings

Surface preparation: Dry, dust- and grease-free surface

Features:

Duration of protection: Indoor storage 6 - 24 months, depending on climatic conditions

Removal, cleaning: Normally not necessary. If required, with white spirit.

Supplier: Valvoline Oil Co. Ltd. Hardturmstr. 175, P.O. Box, CH-8005 Zurich, Switzerland
Tel. +41 (0) 1/446 50 50

The data given are mean values based on practical experience. Application according to the supplier's specification and at user's risk with regard to climatic and specific conditions.

16.9 Tectyl 175GW ; Tectyl 185 GW ; Tectyl 132

Type of corrosion-protective product term	**Waxy and resinous, dry, grip-dry protective film for long-preservation and external protection**

Name of product: **TECTYL 175GW; 185 GW; 132**

Article No:
Specification No:
Substitute for Spec. No:

General and physical properties:
Oil-based corrosion preventive

Protection against:
Extreme atmospheric influences, aggressive industrial atmosphere and gases such as SO_2 and acid vapours. Absolutely resistant in water.

Application Temperature: 10°C to 35°C
Humidity:
Colour: yellow
Degree of gloss: waxy
Covering power:
Density: 950 kg/m^3 at 20°C
Content of solids: 65 ± 3 %
Viscosity:
Danger class: A-II
Poison class: free BAGT No. 611 500
Flash point: 43°C in closed pot
Identification duty: ADR/SDR cl. 3 zif. 31c
Shelf life: 12 months cool/dry storage
Mixing ratio: 1) 2)
With hardener:
Pot life:
Coverage: 5 m^2/l
with dry film thickness of 100 microns 3)
Temperature range: - 23°C to + 175°C
Dry film melting-point:
1) Weight 2) Volume 3) On smooth surface

Application-method		Thinner %	Viscosity	Spraying pressure	Nozzle mm	k / Oh
Brush	yes					
Roller	no					
Dipping	no					
Spraying: low press.	no					
high press.	no					
Airless	yes					
Electro-static	yes					

Drying: Air	dust-free	set to touch	completely dry	Re-coatable after: spraying	
20°C	2 h	5 h	10 h		

Oven — Time — Temperature of component:

Forced — Time — Temperature of component:

Technical data:	
Cross-cut test DIN 53151	
Hardness acc. to:	
Steel ball jet: DIN 53154	
Mandrel bend test: DIN 53152	
Ericcson cupping index IE: DIN 53156	
Salt-spray test: DIN 50021	5 % at 75 microns, 1500 h
Kesternich test: DIN 50018	
Condensed water climate: ASTM-D-148, DIN 51359	

Surface preparation: Dry, dust-free, oil- and grease-free surface; surface treated with Dewatering Fluid WA and TECTYL 506 or 5006W

Features: Non water displacing.

Duration of protection: Indoor storage up to 5 years / outdoor storage up to 3 years. Immersion-resistant in water.

Removal, cleaning: With petroleum, aromatic-free white spirit, alkaline soaker; steam or hot-water cleaner with corrosion protection additive

Supplier: Valvoline Oil Co. Ltd., Hardturmstr. 175, P.O. Box, 8005 Zurich, Switzerland
Tel. +41 (0) 1/446 50 50

The data given are mean values based on practical experience. Application according to the supplier's specification and at user's risk with regard to climatic and specific conditions.

Substitute for: | PC | Q-Code | X | X | X | X | X |

Modif	Number	Drawn Date		Number	Drawn Date		Number	Drawn Date		Number	Drawn Date
-	7-77.252	20.10.2009	A	EAAD088998	30.01.2018						

WinGD Winterthur Gas & Diesel

Product: **RT-flex / X / DF**

Guideline For Engine Protection
After shop test

Made	28.02.2018	F. Moszner	Main Drw. **H**	Page 64 / 70	Material ID **107.426.585.500**
Chkd	28.02.2018	M. Frei	Design Group **0345**	Drawing ID **107.426.585**	Rev **A**
Appd	28.02.2018	M. Damani			

17 Overview of regular inspection lists during engine storage

Mainly four lists have to be used during engine storage:

- 17.1 Inspection List for general parts purpose
- 17.2 Inspection List for dehumidifier
- 17.3 Inspection List for time-dependant inspections or moving of parts
- 17.4 Inspection List for final delivery inspection
  (carried out at engine maker / see chapter 9)
  Same list to be used for “Inspection upon arrival”
  (carried out at shipyard / see chapter 11)

17.1 Inspection List for general parts purpose

The below-mentioned inspection record list for the inspection of engine and/or parts is for reference only, as every person responsible for storage may create his/her own list, as long as the 7 items given in the list below are mentioned in a way or other and clearly identified respectively.

If possible the temperature and humidity should be recorded in the same daytime period						
Part inspected	**Re-coated Yes/No**	**Temp. ˚C**	**Humidity %**	**Signature**	**Date**	**Remark** (e.g. rust visible)

17.2 Inspection List for daily dehumidifier inspection

Humidity record sheet

Date	Total hour	Temp (°C)	Humidity (%rh) Crankcase	Humidity (%rh) Piston underside	Humidity (%rh) Camshaft housing

17.3 Inspection List for time-dependant inspections or moving of parts

Repeated treatment record sheet

Date		Treatment	Comments
Once a week		Engine turned with main lube oil pump running Lubrication of the cylinder liners Check oil level in the fuel system Operation of the cooling water pumps Move the fuel regulating linkage Temperature and humidity recording Inspection/re-coating of blank metal parts	
Once a month		Inspection of the crankcase Inspection of the piston underside Inspection of the exhaust manifold Open/close main starting shut-off valve Check dehumidifying system (filter, hoses, etc.) Turn the rotor of the turbocharger(s) by 90° Turn the auxiliary blower(s) by hand	
After three months		Inspection of a cross head bearing pin Inspection of a main bearing journal pin Replacement of the silica gel desiccant bags Analysis of the cooling water Analysis of the system oil	

17.4 Inspection List for final delivery inspection / inspection upon arrival

- Final delivery inspection (carried out at engine maker / see chapter 9)
- Inspection upon arrival (carried out at shipyard / see chapter 11)

This parts list can/should be used for:
Final delivery inspection (at engine maker) &
Inspection upon arrival (at shipyard)

No.	Part - Designation	Inspected Yes/No	Re-coated Yes/No	Signature	Date	Remark (e.g. rust visible)
1	Crankshaft					
2	Main bearing shell					
3	Main bearing cover					
4	Jacking bolt main bearing (For RTA52U ; RTA62U-B ; RTA72U-B ; RTA84T-D only)					
5	Crank web					
6	Crankpin : web journal & main journal					
7	Gear wheels					
8	Thrust bearing					
9	Thrust bearing pads					
10	Bottom end bearing					
11	Connecting rod					
12	Crosshead bearing					
13	Crosshead guide shoes					
14	Piston rod					
15	Piston					
16	Exhaust valve					
17	Bedplate: machined surfaces					
18	Column: machined surfaces					
19	Column (guide rails)					
20	Cylinder block					
21	Tie rods					
22	At cyl. block top					
23	At bedplate bottom					
24	Diaphragm					
25	Piston rod gland					
26	Cylinder liner					
27	Scavenge ports					
28	Anti-Polishing ring					

29	SAC cooler					
30	Cylinder cover					
31	Fuel injectors					
32	Combustion space					
33	Starting air valve					
34	Starting air shut-off valve					
35	Exhaust valve cage					
36	Exhaust manifold					
37	Scavenge air receiver					
38	Auxiliary scavenge air blower					
39	Flywheel					
40	Turning gear					
41	Electric motor					
42	RTA fuel pump block					
43	Starting air distributor					
44	Camshaft/reversing servomotor					
45	Linkage local manoeuvring stand					
46	RT-flex Supply Unit					
47	All flanged SU parts					
48	High-pressure fuel pumps					
49	Servo oil pumps					
50	Rail unit box					
51	Fuel oil rail					
52	Injection Control Unit (ICU)					
53	Servo oil rail					
54	Exhaust valve drive					
55	High-pressure pipes to fuel injectors					
56	Electronic cabinets					
57	All relief valves					
58	Turbocharger					
59	Pilot fuel pump					
60	Pilot injection valve					
61	Gas distributor pipe					
62	Gas pipe Engine inlet					

18 Engine tools

The engine tools should be stored in a clean, well ventilated and dry place; in addition, they need to be protected against corrosion. It is advisable to check the condition and completeness of the engine tools to avoid any problems during commissioning and engine hand over.

19 Spare parts

All spare parts must be firmly secured to prevent any movement. Metal-to-metal contact is to be avoided during storage of any components. All open ports, adapters, pipes, etc. are to be sealed in order to prevent ingress of foreign particles.

All spare parts have to be protected against corrosion. Large components should be treated with 'Valvoline' Tectyl 506 or a suitable equivalent. Smaller components, with the exception of electronic equipment, may be wrapped in a corrosion-protective VCI paper.

20 Health protection and safety at work

The official statutes and regulations for occupational hygiene and technical equipment measures are to be stringently observed, and the working conditions with cleaning agents and corrosion protective products have to be allowed for.

Samples of safety mask & safety goggle which are to be used:

Safety mask with exchangeable filter system.

Must be used during corrosion protection application or use of cleaning solvent inside closed spaces (inside the engine)

Safety goggle with closed side frame.

Must be used during corrosion protection application or use of cleaning solvent inside closed spaces (inside the engine)

21 Disposal

The generation of waste should be avoided or minimized wherever possible.
Avoid dispersal of spilled material, their contact with soil and further runoff, waterways, drains and sewers. Disposal of these products, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional or local