

**X** SERIES



**350X**  
ARESA  
**SERVICE MANUAL**

**mjp**  
MARINE JET POWER

A FORCE TO TRUST

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<b>1 Introduction .....</b>	<b>7</b>
<b>1.1 About This Manual .....</b>	<b>7</b>
1.1.1 General .....	7
1.1.2 Intended Use .....	7
1.1.3 How to Read This Manual .....	7
1.1.4 Skill Level .....	7
1.1.5 Facility Level.....	8
<b>2 Safety.....</b>	<b>9</b>
<b>2.1 Safety Instructions.....</b>	<b>9</b>
2.1.1 General .....	9
2.1.2 Local Regulations .....	9
2.1.3 Symbol Levels .....	9
2.1.4 Symbols .....	10
2.1.5 Personal Safety Equipment.....	11
2.1.6 Disposal .....	11
<b>3 Remote Support Setup.....</b>	<b>12</b>
<b>3.1 VPN Gateway .....</b>	<b>13</b>
<b>3.2 Laptop .....</b>	<b>14</b>
<b>4 Service .....</b>	<b>15</b>
<b>4.1 Preventive Maintenance Schedule.....</b>	<b>15</b>
4.1.1 Daily inspections .....	15
4.1.2 Monthly Inspections and Lubrications .....	15
4.1.3 Running Hours Replacements.....	15
4.1.4 Yearly Inspections, Adjustments and Replacements .....	16
4.1.5 Inspections, Replacements and Overhaul based on Years or Running Hours.....	17
<b>4.2 Mechanical.....</b>	<b>18</b>
4.2.1 Waterjet Unit, Clean .....	18
4.2.2 Intake and pump, Inspect.....	20
4.2.3 Pump Unit, Inspect Impeller Blade Tip Clearance .....	22
4.2.4 Waterjet Unit, Dismount.....	23
4.2.5 Water Lubricated Bearing, Inspect.....	24
4.2.6 Water Lubricated Bearing, Replace .....	26
4.2.7 Pump Unit, Replace the Impeller .....	27
4.2.8 Pump Unit, Adjust Impeller Tip Clearance .....	29
4.2.9 Waterjet Unit, Assemble .....	31
4.2.10 Thrust Bearing, Drainage hole, Clean .....	32
4.2.11 Thrust Bearing Unit, Replace Thrust Bearing and Radial Seals .....	34
4.2.12 Thrust Bearing Unit, Replace Shaft Seal .....	36
4.2.13 Waterjet Unit, Inspect .....	38
4.2.14 Waterjet Unit, Replace the Anodes .....	41
4.2.15 Waterjet Unit, Inspect Bushings and Pin Shafts.....	44
4.2.16 Waterjet Unit, Replace Bushings and Pin Shafts .....	46
4.2.17 Waterjet Unit, Paint During Service .....	50
<b>4.3 Hydraulics .....</b>	<b>54</b>
4.3.1 Hydraulic Cylinders and Hoses, Inspect .....	54
4.3.2 Hydraulic Hoses, Replace.....	56
4.3.3 Hydraulic Reversing Cylinder, Replace .....	58
4.3.4 Hydraulic Steering Cylinder, Replace .....	60
4.3.5 Hydraulic Reversing Cylinder, Replace Seals .....	62
4.3.6 Hydraulic Steering Cylinder, Replace Seals.....	64
4.3.7 Hydraulic Steering Cylinder, Replace Feedback Sensor .....	66
4.3.8 Hydraulic Reversing Cylinder, Replace Feedback Sensor .....	68
4.3.9 Hydraulic and Lubrication System, Replace Breather Filter.....	70
4.3.10 Hydraulic System, Inspect Oil Quality .....	72
4.3.11 Hydraulic System, Add Oil.....	74
4.3.12 Hydraulic Tank, Replace Oil .....	76

## Contents

---

4.3.13 Thrust Bearing, Add Oil.....	79
4.3.14 Thrust Bearing, Replace Oil .....	81
4.3.15 Hydraulic Tank, Inspect Oil Level Switch .....	84
4.3.16 Hydraulic Tank, Replace Oil Level Switch .....	85
4.3.17 Hydraulic System, Inspect Pressure Limit.....	88
4.3.18 Hydraulic System, Adjust Pressure Limit .....	89
4.3.19 Hydraulic System, Inspect Pressure Gauge, Replace Defect Pressure Gauge .....	90
4.3.20 Hydraulic System, Replace Oil Filter .....	92
4.3.21 Hydraulic System, Replace Directional Control Valves .....	94
4.3.22 Hydraulic System, Replace Load Control Valves.....	95
4.3.23 Hydraulic System, Replace Solenoid Coils .....	96
4.3.24 Hydraulic Pump, Inspect.....	97
4.3.25 Hydraulic System, Replace the Pump .....	98
4.3.26 V-Belts, Inspect and Adjust .....	104
4.3.27 V-Belts, Replace .....	107
<b>4.4 Control System.....</b>	<b>110</b>
4.4.1 Control System Components, inspect for wear and damages .....	110
4.4.2 Jet autocalibration .....	113
4.4.3 Control Levers, Calibrate .....	114
4.4.4 Display Panel, Service Menu .....	115
4.4.5 Combinator Controller, Replace .....	118
4.4.6 Command Panel BUS, Replace .....	119
4.4.7 Control System, Inspect and Replace Cables.....	120
4.4.8 Display Panel, Replace.....	121
4.4.9 External Alarm Buzzer, Replace .....	124
4.4.10 Indoor Panels, Lenses and LEDs, Inspect .....	126
4.4.11 Indoor Panels, Lenses and LEDs, Replace .....	127
4.4.12 Main Control Unit, Replace .....	129
4.4.13 Steer Wheel, Replace Steer Controller.....	130
4.4.14 VCS Panel (BUS), Replace .....	131
4.4.15 Control System Components and Waterjet operation test .....	132
<b>5 Spare Part List.....</b>	<b>133</b>
<b>5.1 Control System.....</b>	<b>133</b>
<b>5.2 Hydraulics .....</b>	<b>134</b>
5.2.1 Hydraulic Pump .....	134
5.2.2 Hydraulic Valve Block .....	135
<b>5.3 Mechanics.....</b>	<b>137</b>
5.3.1 Steering Unit.....	137
5.3.2 Steering Unit, Pin shafts .....	139
5.3.3 Steering Unit, Bushings .....	141
5.3.4 Steering Cylinder Mark 2 .....	142
5.3.5 Reversing Cylinder.....	143
5.3.6 Hoses .....	144
5.3.7 Water Lubricated Bearing .....	145
5.3.8 Mechanical Seal .....	146
5.3.9 Bearing and Seals .....	147
5.3.10 Anodes.....	148
<b>6 Fault Indication .....</b>	<b>149</b>
<b>6.1 Troubleshooting .....</b>	<b>149</b>
6.1.1 How to Read.....	149
6.1.2 Troubleshooting Procedure.....	149
<b>6.2 Alarms .....</b>	<b>151</b>
6.2.1 Display Panel, Acknowledge Alarms .....	151
6.2.2 Alarm List .....	153
<b>7 Appendix .....</b>	<b>158</b>
<b>7.1 Paint Program.....</b>	<b>158</b>
7.1.1 General .....	158
7.1.2 Touch Up Paint or Repaint .....	158
<b>7.2 Torque .....</b>	<b>159</b>
7.2.1 Screws and washers .....	159
7.2.2 Specifications for Screws with Nordlock Washer .....	160

7.2.3 Specifications for Screws with Plain Washer.....	161
7.2.4 Specifications for Lock Nuts .....	162
<b>7.3 Impeller Clearance Protocol .....</b>	<b>163</b>
<b>7.4 Oil Contamination Limits .....</b>	<b>165</b>
7.4.1 Water Content per DIN ISO 3733 .....	166
<b>7.5 Weld Specifications .....</b>	<b>167</b>
<b>7.6 Fluids and Lubricants.....</b>	<b>168</b>
7.6.1 Hazardous Substances .....	168
7.6.2 Assembly Adhesives, Sealants and Lubricants .....	168
7.6.3 Oil Specifications .....	169
7.6.4 Grease Specifications .....	170
<b>7.7 Long Term Storage of Equipment .....</b>	<b>172</b>
7.7.1 Preservation of Equipment Before Installation .....	172
7.7.2 Suitable Products For Storage Protection.....	175
<b>7.8 Equipment Disposal .....</b>	<b>176</b>



# 1 Introduction

## 1.1 About This Manual

### 1.1.1 General

This manual is a comprehensive handbook which has been developed to provide information on the equipment supplied by Marine Jet Power (MJP).

### 1.1.2 Intended Use

This manual is intended for crew and maintenance personnel. It can be used on board, in the dockyard or whenever detailed information about the equipment is required. It will serve as a guideline for maintenance of the complete MJP system: mechanical, hydraulic, lubrication and control system.

### 1.1.3 How to Read This Manual

All recommended preventive maintenance tasks are listed in the **Preventive Maintenance Schedule**.

This manual contains both Preventive and Corrective Maintenance tasks. The chapters Mechanical, Hydraulics, Lubrication and Control System have a separate sub chapter for each task.

The preventive and corrective maintenance tasks included in this manual cover maintenance and troubleshooting that can be handled by the vessel's own crew (see maintenance skill levels below).

Note that the qualified maintenance tasks, performed by an Authorized Service Technician trained by Marine Jet Power, are not covered in the **Service Manual**.

When the crew have performed qualified training by Marine Jet Power, a more extensive **Workshop Manual** covering also the qualified maintenance tasks, can be obtained from Marine Jet Power.

Instructions regarding installation of the equipment are described in the **Installation Manual** and instructions for operating the waterjet system are described in the **Operations Manual**.

#### Maintenance Levels

For each task there are two levels specified, skill level and facility level. These two levels determine the maintenance level of a task.

### 1.1.4 Skill Level

The skill levels indicate the skill level required of the person undertaking the maintenance task.

Skill level	Description
Crew	General technical knowledge about the Marine Jet Power system.
Chief Engineer	Basic technical training on the Marine Jet Power system.
Task Specialist	Specific technical training in a specific field: welder, painter, electrician etc. Could also be within mechanical, hydraulic, lubrication or control system.
Authorized Service Technician	Personnel trained in Marine Jet Power certified training course.

### 1.1.5 Facility Level

The facility indicates the recommended operational status of the vessel during the maintenance procedure.  
The facility levels are:

- On equipment / at sea
- Dockside
- Dock, workshop / dry dock
- MJP workshop

## 2 Safety

### 2.1 Safety Instructions

#### 2.1.1 General

Read this manual thoroughly before starting activities.

This document contains personal safety information that applies when working with Marine Jet Power's products. These instructions are mandatory to keep personal safety.

Use all equipment in strict accordance with these instructions, or the instructions supplied by the equipment manufacturer.

#### 2.1.2 Local Regulations

Local regulations, principally national regulations, override the information in this document. When no applicable local regulations are available, use the regulations in this document.

#### 2.1.3 Symbol Levels



##### Warning!

A warning means that injury or death is possible if the instructions are not obeyed.



##### Caution!

A caution means that damage to equipment is possible.

##### Note!

Notes are added to give more information, usually in a procedure.

## 2.1.4 Symbols

Symbol	Type	Description
	General warning or caution	Risk to people or equipment (specified by a supplementary sign).
	Electrical hazard	Avoid potential injury or death from electric shock or burn.
	High pressure	Avoid exposure to hot oil or hot vapour.
	Burn risk	Avoid contact with hot surface.
	Rotating parts	Avoid being caught between rotating parts.
	Hanging loads	Avoid standing or walking under hanging loads.
	Environmental chemical hazard	Avoid pollution of the environment from chemicals. Read the material safety data sheets to find information of the products and contact the manufacturer for more information.
	Personal chemical hazard	Avoid potential injury or death from exposure to chemicals. Read the material safety data sheets to find information of the products and contact the manufacturer for more information.
	Corrosive substances	Avoid material damage and personal injury from exposure to corrosive substances. Read the material safety data sheets to find information of the products and contact the manufacturer for more information.
	Burn risk	—

	Pinch point hazard	Avoid being pinched between moving parts.
	ESD-sensitive electronic component.	Semiconductors and circuit boards can be damaged by electrostatic discharge (ESD). When handling, care must be taken so that the devices are not damaged.

## 2.1.5 Personal Safety Equipment

Personal safety equipment must be used when there is a risk involved.

	Wear hearing protection. Risk of hearing loss and accidental injury from loud noises.
	Wear eye protection. Risk of injury to eyes from flying sparks, metal splatter and slag chips.
	Use safety footwear. Risk of injury to feet from falling objects and heavy equipment.
	Use protective gloves. Risk of injury to hands from chemicals, corrosive substances and sharp edges.
	Wear hard hat. Risk of accidental head injury from falling objects, sharp edges and when working in narrow spaces.

## 2.1.6 Disposal

Discharge of hazardous substances must be done in accordance to local regulations.



Please contact an authorized representative of the manufacturer for information concerning the decommissioning of equipment.

See also 7.8 *Equipment Disposal*

## 3 Remote Support Setup

### Task Summary

The task is to set up a remote support connection to Marine Jet Power to get adequate support.

There are two ways to set up a remote connection. Either via a MJP supplied VPN gateway or via a laptop.

If a laptop is used it is required to have TeamViewer installed as well as RemoteAccessViewer, both of which can be found on the MJP website.

**Note!**

A laptop connections capabilities are significantly limited and should be used for assistance with calibrations, small parameter changes or minor fault finding.

For more in-depth system analysis and fault finding a VPN gateway should be used. This allows the MJP service technician to use all necessary software and monitoring tools without being limited by what is available on a locally connected laptop.

### Task Interval

Do this task during:

- Corrective maintenance

### Prerequisites

#### Conditions

The control system is up and running.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Chief Engineer	Dockside	30-60 min
<b>Material for VPN Gateway connection</b>		<b>Quantity</b>	
Standard RJ45 Ethernet cable, minimum 1 m		1	
MJP supplied VPN Gateway		1	
24V DC power connection to the gateway screw terminal		1	
<b>Material for Laptop remote connection</b>		<b>Quantity</b>	
Laptop with an internet connection and TeamViewer installed		1	
Standard Ethernet switch		1	
Standard RJ45 Ethernet cable, minimum 1 m		2	

### 3.1 VPN Gateway

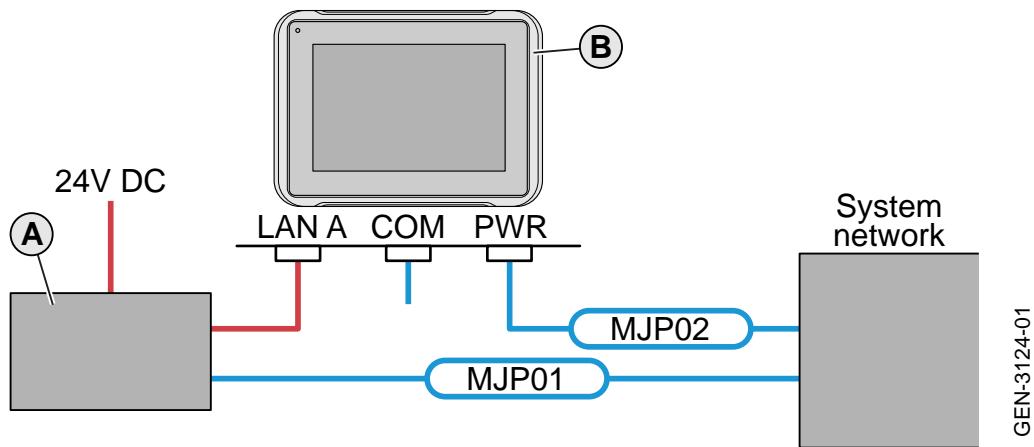


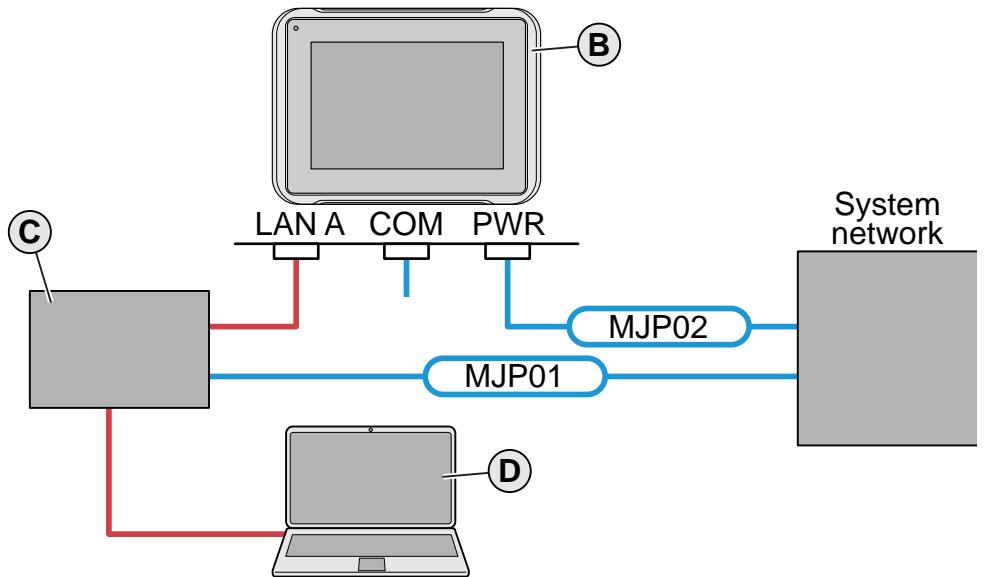
Figure 1

#### Cable setup with VPN Gateway

- 1 To set up the remote connection, unplug the RJ45 Ethernet cable (MJP02) plugged in to Lan A of the MJP Display (B).
- 2 Plug Ethernet cable (MJP02) in to one of the blue ports on the VPN Gateway (A).
- 3 Connect the standard RJ45 Ethernet cable from another of the blue ports on the Gateway to Lan A on the display.
- 4 Connect 24V DC to the screw terminal on the gateway. Polarity is shown on the side of the terminal.
- 5 When done, the result should look like in figure above.
- 6 Once the setup is complete, start a mobile hotspot with SSID “mjpservice” and password “mjpservice”. The gateway will automatically connect to the hotspot and an MJP service technician can remotely connect to the system.
- 7 Task completed.

## 3.2 Laptop

This connection is available if the system have an Ethernet Switch



GEN-3124-02

Figure 2

- 1 To set up the remote connection, unplug the RJ45 Ethernet cable (MJP02) plugged in to Lan A of the MJP Display (B).
- 2 Plug Ethernet cable (MJP02) in to one of the ports on the Ethernet switch (C).
- 3 Connect a standard RJ45 Ethernet cable from another of the ports on the Ethernet switch to Lan A on the display.
- 4 Connect a standard RJ45 Ethernet cable from another of the ports on the Ethernet switch to the laptop (D).
- 5 When done, the result should look like in figure above.
- 6 Once the setup is complete, contact MJP service and provide your TeamViewer information.
- 7 Task completed.

## 4 Service

### 4.1 Preventive Maintenance Schedule

This schedule is intended to provide a general view of the preventive maintenance activities that needs to be carried out during different time intervals.

**Note!**

The maintenance of MJP Products is tightly connected to the warranty of the products.

#### 4.1.1 Daily inspections

Daily inspections		
Task description	Task number	Skill level
Inspect the cylinders and hoses in the hydraulic system.	4.3.1 <i>Hydraulic Cylinders and Hoses, Inspect</i>	Crew
Inspect oil level in the hydraulic system.	See Operation Manual	Crew
Inspect oil temperature in the hydraulic system.	See Operation Manual	Crew
Inspect the working pressure.	See Operation Manual	Crew
Check the condition of the thrust bearing and shaft seal by inspection of leakage and oil level on the bearing housing assembly.	See Operation Manual	Crew

#### 4.1.2 Monthly Inspections and Lubrications

Monthly inspections		
Task description	Task number	Skill level
Clean drain hole in thrust bearing house.	4.2.10 <i>Thrust Bearing, Drainage hole, Clean</i>	Crew

#### 4.1.3 Running Hours Replacements

Running hours replacements			
Task interval	Task description	Task number	Skill level
Every 500 operating hours *	Replace the oil in the thrust bearing system.	4.3.14 <i>Thrust Bearing, Replace Oil</i>	Chief Engineer

\* Replace the oil after the first 50 hours. After that every 500 hours as per maintenance schedule.

#### 4.1.4 Yearly Inspections, Adjustments and Replacements

Yearly inspections, adjustments and replacements		
Task description	Task number	Skill level
Inspect the control system components.	4.4.1 Control System Components, inspect for wear and damages	Chief Engineer
Inspect the waterjet intake for mechanical damages and debris.	4.2.2 Intake and pump, Inspect	Chief Engineer
Measure the impeller tip clearance.	4.2.3 Pump Unit, Inspect Impeller Blade Tip Clearance	Authorized Service Technician
Inspect water lubricated bearing and the bearing sleeve.	4.2.5 Water Lubricated Bearing, Inspect	Chief Engineer or Authorized Service Technician
Inspect the waterjet (pump unit, pin shafts and anodes) for damages and corrosion.	4.2.13 Waterjet Unit, Inspect	Chief Engineer
Inspect the oil level switch on the hydraulic tank.	4.3.15 Hydraulic Tank, Inspect Oil Level Switch	Chief Engineer
Replace hydraulic and lubrication breather filters.	4.3.9 Hydraulic and Lubrication System, Replace Breather Filter	Chief Engineer
Inspect the hydraulic pump.	4.3.24 Hydraulic Pump, Inspect	Chief Engineer
Inspect the hydraulic oil quality on the hydraulic system.	4.3.10 Hydraulic System, Inspect Oil Quality	Crew
Inspect the hydraulic pressure limit.	4.3.17 Hydraulic System, Inspect Pressure Limit	Authorized Service Technician and Crew
Adjust the hydraulic pressure limit.	4.3.18 Hydraulic System, Adjust Pressure Limit	Authorized Service Technician and Crew
Replace the oil filter.	4.3.20 Hydraulic System, Replace Oil Filter	Chief Engineer
Inspect bushings and pin shafts on the waterjet.	4.2.15 Waterjet Unit, Inspect Bushings and Pin Shafts	Chief Engineer
Test that all control system components and waterjets works trouble-free in operation	4.4.15 Control System Components and Waterjet operation test	Authorized Service Technician and Crew
Inspect and adjust the V-belt.	4.3.26 V-Belts, Inspect and Adjust	Chief Engineer

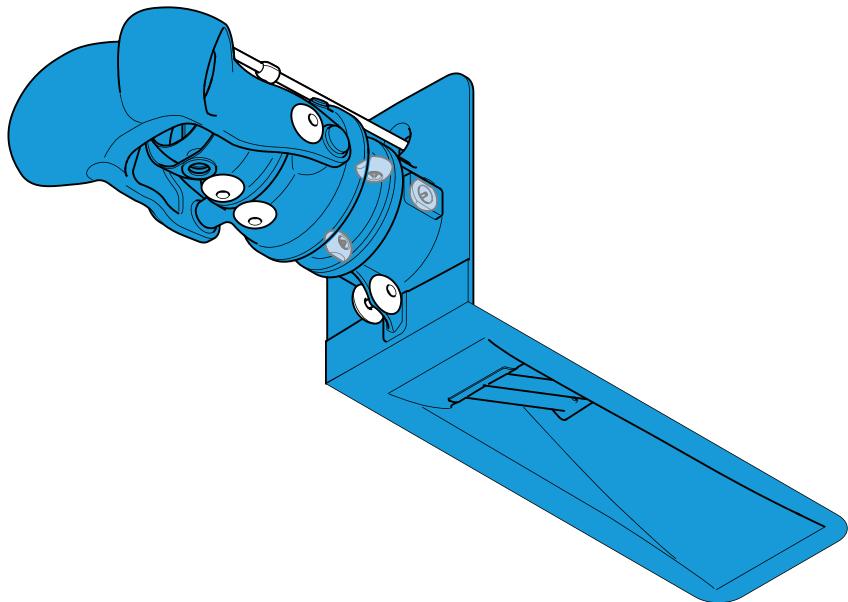
## 4.1.5 Inspections, Replacements and Overhaul based on Years or Running Hours

Years or running hours - inspections, replacements and overhaul			
Task interval	Task description	Task number	Skill level
Every 2 years or every 4000 hours*	Replace seals on the hydraulic reversing cylinder.	4.3.5 Hydraulic Reversing Cylinder, Replace Seals	Authorized Service Technician
Every 2 years or every 4000 hours*	Replace seals on the hydraulic steering cylinder.	4.3.6 Hydraulic Steering Cylinder, Replace Seals	Authorized Service Technician
Every 2 years*	Replace oil in the hydraulic tank.	4.3.12 Hydraulic Tank, Replace Oil	Chief Engineer
Every 5 years or every 8000 operating hours*	Replace thrust bearing and radial seals on the thrust bearing unit.	4.2.11 Thrust Bearing Unit, Replace Thrust Bearing and Radial Seals	Authorized Service Technician
Every 5 years or every 8000 operating hours*	Replace the shaft seal on the thrust bearing unit.	4.2.12 Thrust Bearing Unit, Replace Shaft Seal	Authorized Service Technician
Every 5 years*	Replace hydraulic hoses	4.3.2 Hydraulic Hoses, Replace	Authorized Service Technician
Every 5 year*	Inspect pressure gauge on the hydraulic system.	4.3.19 Hydraulic System, Inspect Pressure Gauge, Replace Defect Pressure Gauge	Chief Engineer
Every 5 years or every 8000 operating hours*	Replace water lubricated bearing	4.2.6 Water Lubricated Bearing, Replace	Authorized Service Technician
Every 5 years or every 8000 hours*	Replace the V-belt.	4.3.27 V-Belts, Replace	Chief Engineer

\*Maximum deviation from interval time / hours is +3 months / +500 h

## 4.2 Mechanical

### 4.2.1 Waterjet Unit, Clean



GEN-2567-02

Figure 3

### Task Summary

The task is to clean the waterjet, steering unit, pump unit and intake.

This is suitable to do before any inspections or mechanical work on the waterjet.

### Task Interval

Do this task during:

- Corrective maintenance, annually / while docked

### Prerequisites

#### Conditions

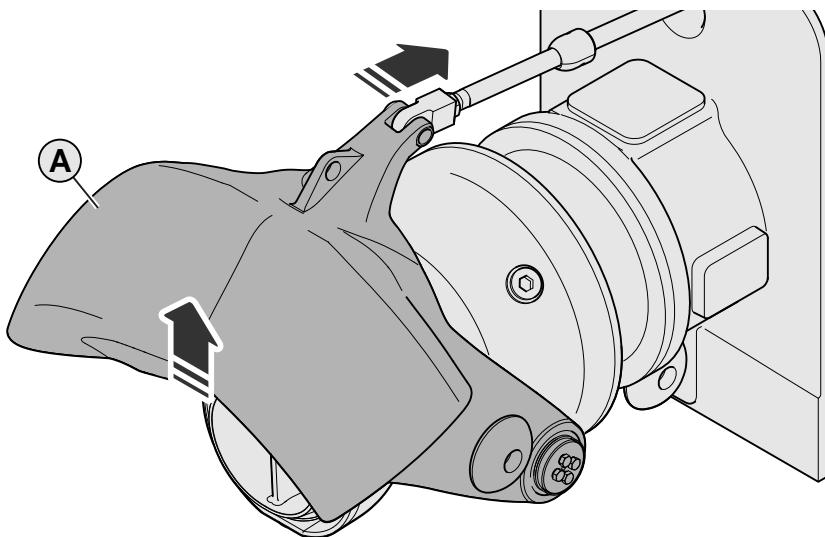
The vessel is dry docked and supported properly.

Necessary scaffolding to access waterjet in a safe manner.

Pressure washer (water) available.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Task Specialist	Dock, workshop / dry dock	40 minutes

## Procedure



GEN-2478-02

Figure 4

- 1 Put the bucket (A) in fully forward position.



**Caution!**

Do not aim high pressured water directly at sealing areas on hydraulic cylinders. This will help to prevent damage to the equipment.

- 2 Clean the inside of the intake and the pump unit, from top to bottom. Make sure to remove all unwanted material.
- 3 Clean the outside of the waterjet unit, from top to bottom. Make sure to remove all unwanted material.
- 4 Task completed.

## 4.2.2 Intake and pump, Inspect

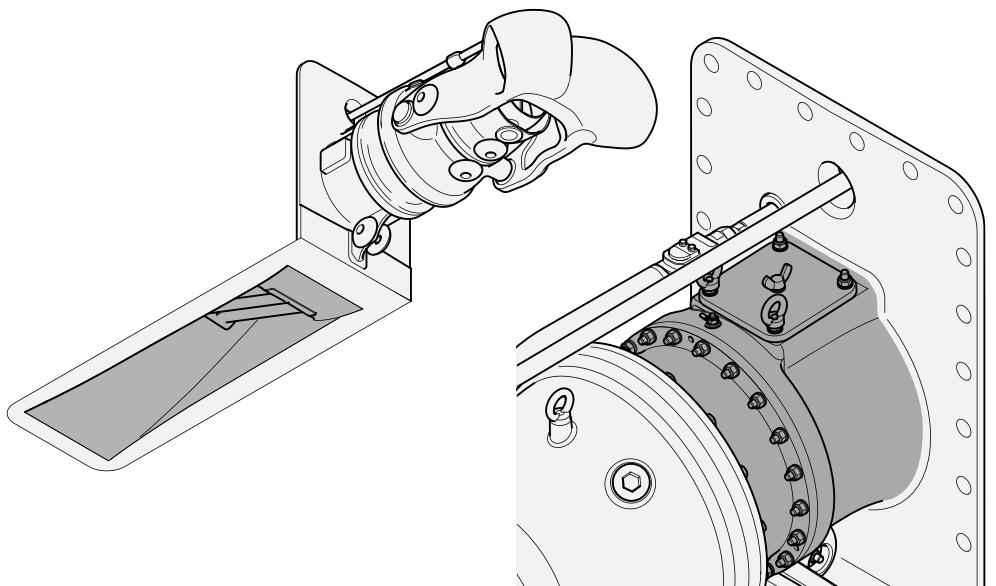


Figure 5

### Task Summary

The task is to inspect the waterjet intake for mechanical damages and debris.



#### Warning!

Hard hat is required. Be cautious when entering the intake.

### Task Interval

Do this task during:

- Preventive maintenance, yearly.
- Corrective maintenance, at indication of blockage and pump damage.

### Prerequisites

#### Conditions

The vessel is dry docked and supported properly.

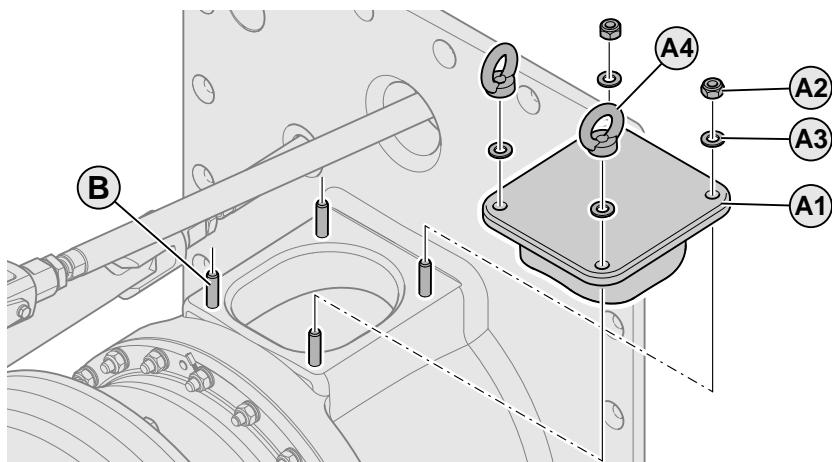
The waterjet is clean, see 4.2.1 *Waterjet Unit, Clean*

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Chief Engineer	Dock, workshop / dry dock	30 minutes

#### Reference document

7.1 *Paint Program*

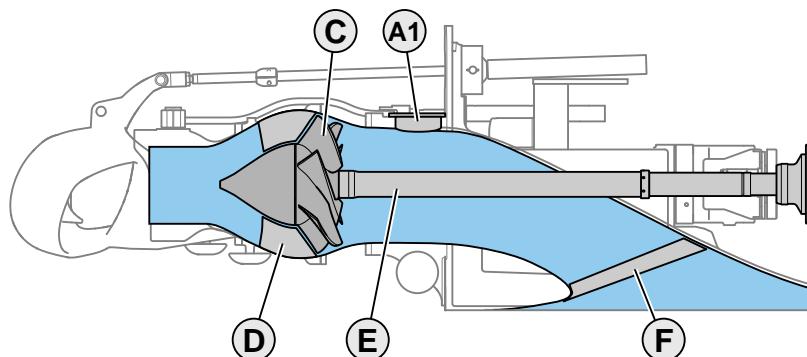
## Procedure



GEN-2562-01

Figure 6

- 1 Open the inspection hatch (A1) on the intake:
  - 1.1 Remove the nuts (A2), washers (A3) and lifting eyes (A4) from the studs (B) on the intake.
  - 1.2 Remove the inspection hatch (A1).



GEN-3040-02

Figure 7

- 2 Inspect the intake and complete waterway for debris through the pump and impeller (C).
- 3 Inspect for any mechanical damages or damages to the paint.
- 4 Inspect the intake for ropes in the impeller (C), around the stator blades (D) or around the shaft (E).
- 5 Inspect the intake for debris in the grid (F).
- 6 Remove any debris or ropes found in the intake.
- 7 Close the inspection hatch (A1) on the intake again:
  - 7.1 Attach the inspection hatch (A1) to the studs (B).
  - 7.2 Apply Loctite® 243 to the nuts (A2) and the lifting eyes (A4).
  - 7.3 Install the nuts (A2), washers (A3) and lifting eyes (A4) to the inspection hatch (A1).
  - 7.4 Tighten the nuts (A2) to torque 34 Nm.
  - 7.5 Firmly tighten the lifting eyes (A4).
- 8 Task completed.

### 4.2.3 Pump Unit, Inspect Impeller Blade Tip Clearance

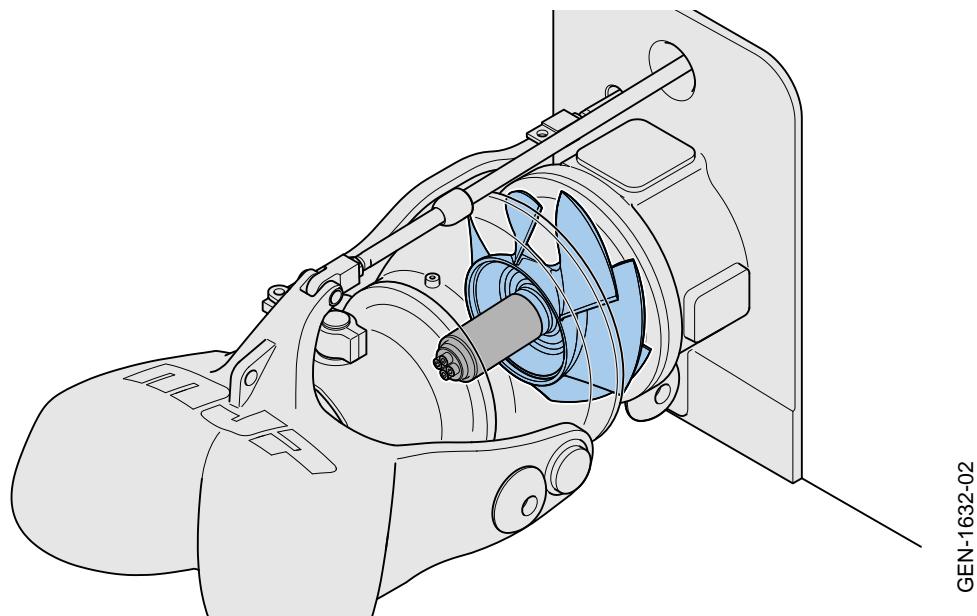


Figure 8

#### Task Summary

The task is to measure the impeller blade tip clearance.

#### Task Interval

Do this task during:

- Preventive maintenance, annually / while docked

#### Prerequisites

##### Conditions

None

Personnel number	Skill level	Maintenance facility level (choose one)	Estimated time
1	Authorized Service Technician	Dock, workshop / dry dock	60 min

##### Consumables

Pencil  
Medium strength thread locking adhesive, Loctite® 243 or equivalent

##### Reference document

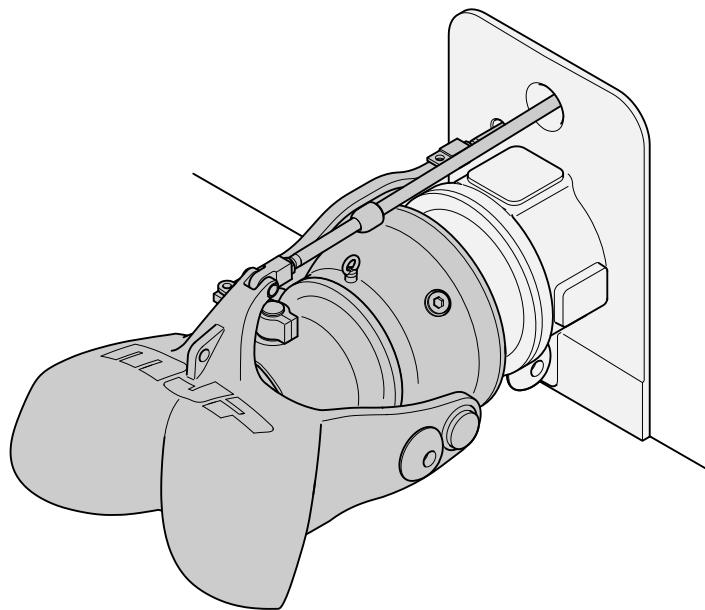
7.3 Impeller Clearance Protocol

#### Procedure

The complete procedure can be found in the **Workshop Manual**.

When the crew have performed qualified training by Marine Jet Power, a more extensive **Workshop Manual** covering also the qualified maintenance tasks, can be obtained from Marine Jet Power.

## 4.2.4 Waterjet Unit, Dismount



GEN-2408-02

Figure 9

### Task Summary

The task is to dismount the waterjet unit when necessary to be able to perform maintenance.

### Task Interval

Prerequisite for other tasks.

### Prerequisites

#### Conditions

Necessary scaffolding to access unit.

The waterjet unit is clean, see 4.2.1 *Waterjet Unit, Clean*

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Authorized Service Technician	Dock, workshop / dry dock	120 minutes

### Procedure

The complete procedure can be found in the **Workshop Manual**.

When the crew have performed qualified training by Marine Jet Power, a more extensive **Workshop Manual** covering also the qualified maintenance tasks, can be obtained from Marine Jet Power.

## 4.2.5 Water Lubricated Bearing, Inspect

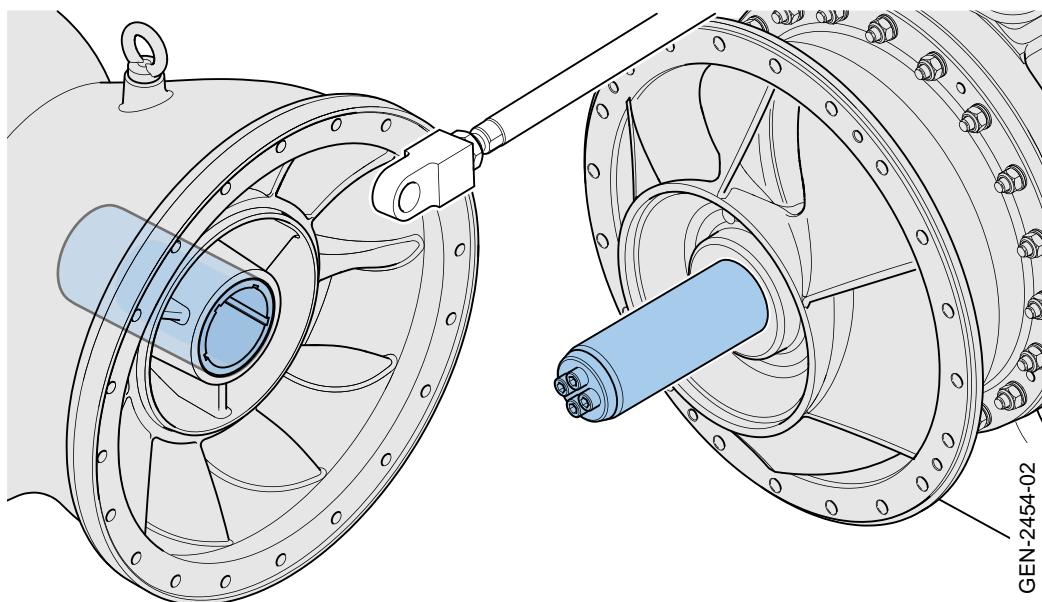


Figure 10

### Task Summary

The task is to inspect the water lubricated bearing and the bearing sleeve.

### Task Interval

Do this task during:

- Preventive maintenance, annually

### Prerequisites

#### Conditions

Necessary scaffolding to access unit.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Chief Engineer only Alternative 1	Dock, workshop / dry dock	15 minutes
1	Authorized Service Technician Alternative 1 / 2	Dock, workshop / dry dock	15 / 60 minutes

## Procedure Alternative 1

- 1 Read the distances recorded in the impeller clearance protocol from *Pump Unit, Inspect Impeller Blade Tip Clearance*. See 7.3 *Impeller Clearance Protocol*.

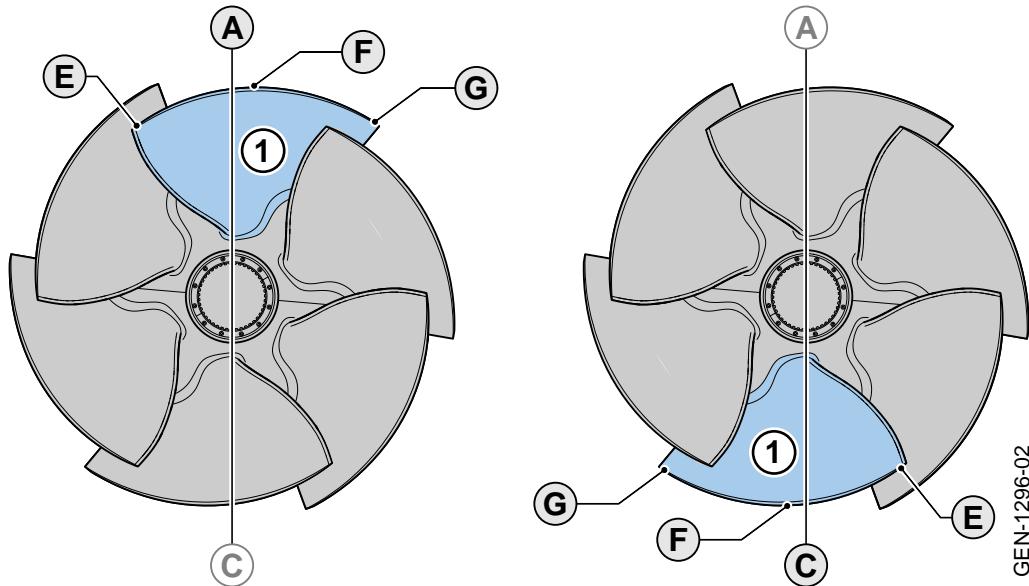


Figure 11

- 2 Use the recordings from one impeller blade (1) at twelve o'clock position (A) and six o'clock position (C).
- 3 If the measured distance between the impeller blade (1) and impeller housing at the twelve o'clock position, and the six o'clock position differs 0,6 millimetres, replace the water lubricated bearing. See 4.2.6 *Water Lubricated Bearing, Replace*.
- 4 Task completed.

## Procedure Alternative 2

The complete procedure can be found in the **Workshop Manual**.

When the crew have performed qualified training by Marine Jet Power, a more extensive **Workshop Manual** covering also the qualified maintenance tasks, can be obtained from Marine Jet Power.

## 4.2.6 Water Lubricated Bearing, Replace

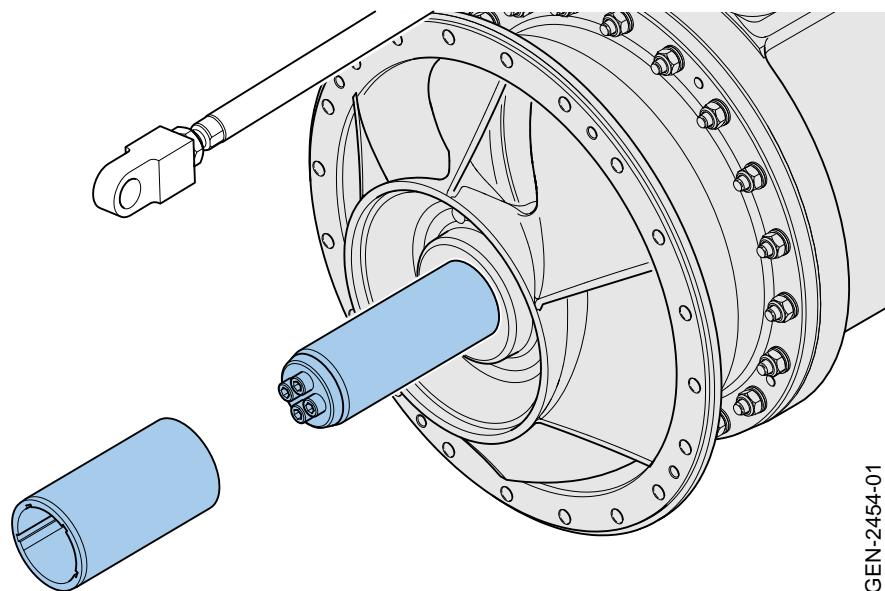


Figure 12

### Task Summary

The task is to replace the water lubricated bearing and the bearing sleeve.

### Task Interval

Do this task during:

- Preventive maintenance every 5 years or 8 000 operating hours
- Corrective maintenance

### Prerequisites

#### Conditions

Necessary scaffolding to access unit.

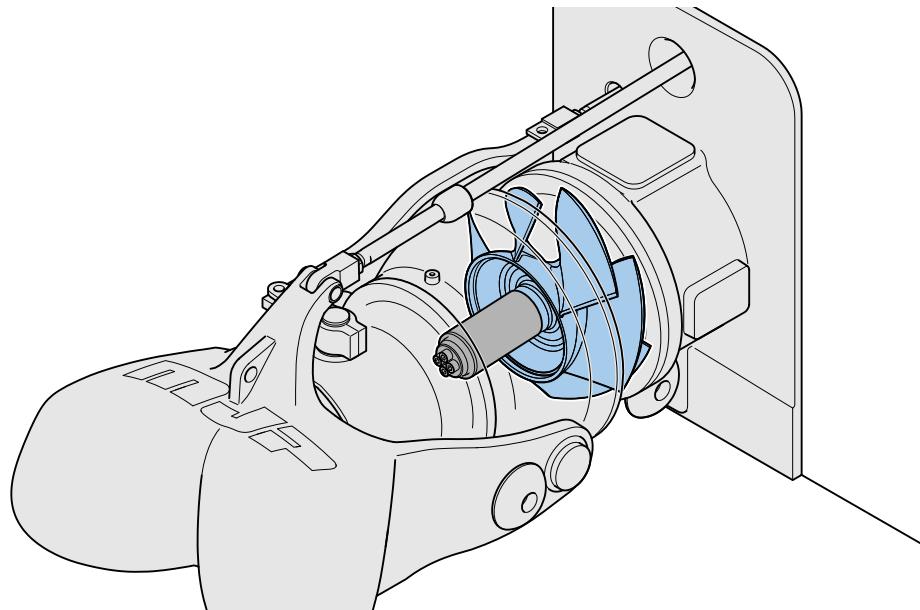
Waterjet unit dismounted. See 4.2.4 *Waterjet Unit, Dismount*

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Authorized Service Technician	Dock, workshop / dry dock	60 minutes
Spare parts		Quantity	Part number
Spare water lubricated bearing kit		1	X350-1101-2-SP

### Procedure

The complete procedure can be found in the **Workshop Manual**.

## 4.2.7 Pump Unit, Replace the Impeller



GEN-1632-02

### Task Summary

The task is to replace the impeller.

### Task Interval

Do this task during:

- Corrective maintenance.

### Prerequisites

#### Conditions

Necessary scaffolding to access unit.  
Waterjet unit dismounted. See 4.2.4 Waterjet Unit, Dismount

Personnel number	Skill level (choose one)	Maintenance facility level (choose one)	Estimated time
1	Task specialist	Dock, workshop / dry dock	60 min
Spare parts		Quantity	Part number
Impeller	1		X350-1103-X (specify right pitch)
Screws for sleeve washer	4		21215
Consumables		Quantity	Part number
Locite 243	-		-
Molykote Dx paste			
Special tools and test equipment		Quantity	Part number
Flange/impeller extractor	1		100-004
M12 nuts	3		-
M12 threaded rod approximately 300 mm long	3		-

#### Reference document

##### 7.3 Impeller Clearance Protocol

### Procedure

The complete procedure can be found in the **Workshop Manual**.

When the crew have performed qualified training by Marine Jet Power, a more extensive **Workshop Manual** covering also the qualified maintenance tasks, can be obtained from Marine Jet Power.

## 4.2.8 Pump Unit, Adjust Impeller Tip Clearance

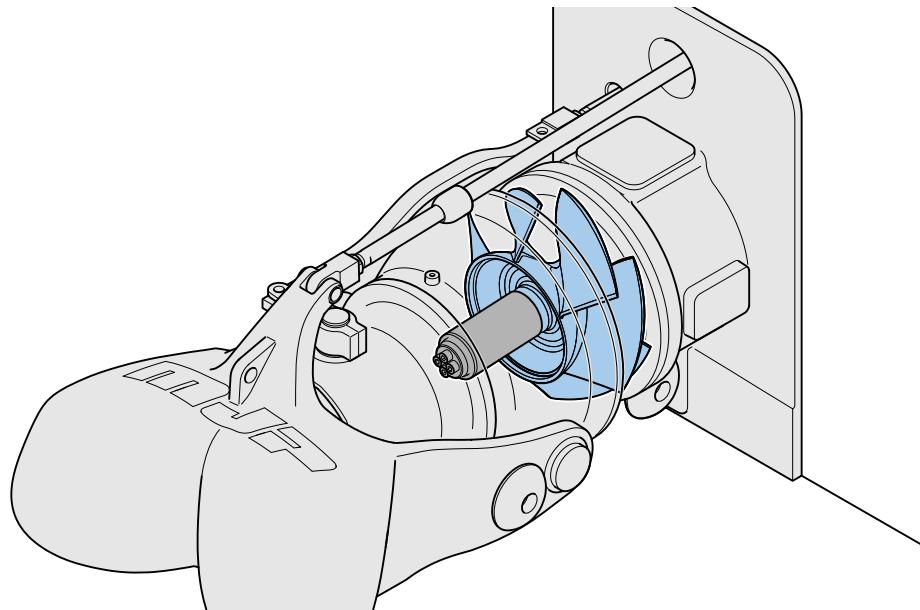


Figure 14

### Task Summary

The task is to adjust the impeller blade tip clearance with shims.

### Task Interval

Do this task during:

- Corrective maintenance / while dry docked

### Prerequisites

#### Conditions

None

Personnel number	Skill level	Maintenance facility level (choose one)	Estimated time
1	Authorized Service Technician	Dock, workshop / dry dock	60 min

Spare parts	Quantity	Part number
Impeller shims 0.5 mm	-	X350-1110-30-05
Impeller shims 1.0 mm	-	X350-1110-30-10
Impeller shims 2.0 mm	-	X350-1110-30-20
Screws for sleeve washer	4	21215

Consumables	Quantity	Part number
Loctite® 243 or equivalent Molykote Dx paste	-	-

Special tools and test equipment	Quantity	Part number
Flange/impeller extractor	1	100-004
M12 nuts	3	—
M12 threaded rod approximately 300 mm long	3	—

**Reference document**

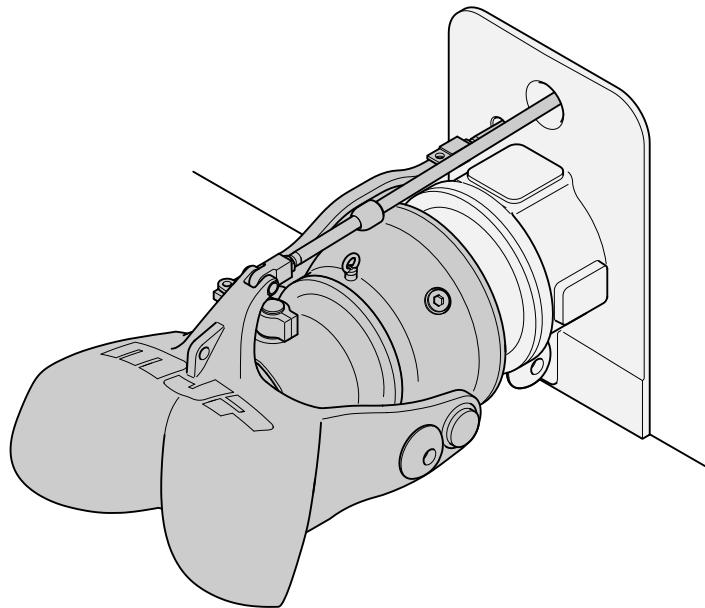
*7.3 Impeller Clearance Protocol*

## Procedure

The complete procedure can be found in the **Workshop Manual**.

When the crew have performed qualified training by Marine Jet Power, a more extensive **Workshop Manual** covering also the qualified maintenance tasks, can be obtained from Marine Jet Power.

## 4.2.9 Waterjet Unit, Assemble



GEN-2408-02

Figure 15

### Task Summary

The task is to assemble the waterjet unit after maintenance.

### Prerequisites

#### Conditions

Necessary scaffolding to access unit.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Authorized service technician	Dock, workshop / dry dock	120 minutes

#### Consumables

Medium strength thread locking adhesive, Loctite® 243 or equivalent

### Procedure

The complete procedure can be found in **Workshop Manual**.

When crew have performed qualified training by Marine Jet Power, a more extensive **Workshop Manual** covering also qualified maintenance tasks, can be obtained from Marine Jet Power.

#### 4.2.10 Thrust Bearing, Drainage hole, Clean

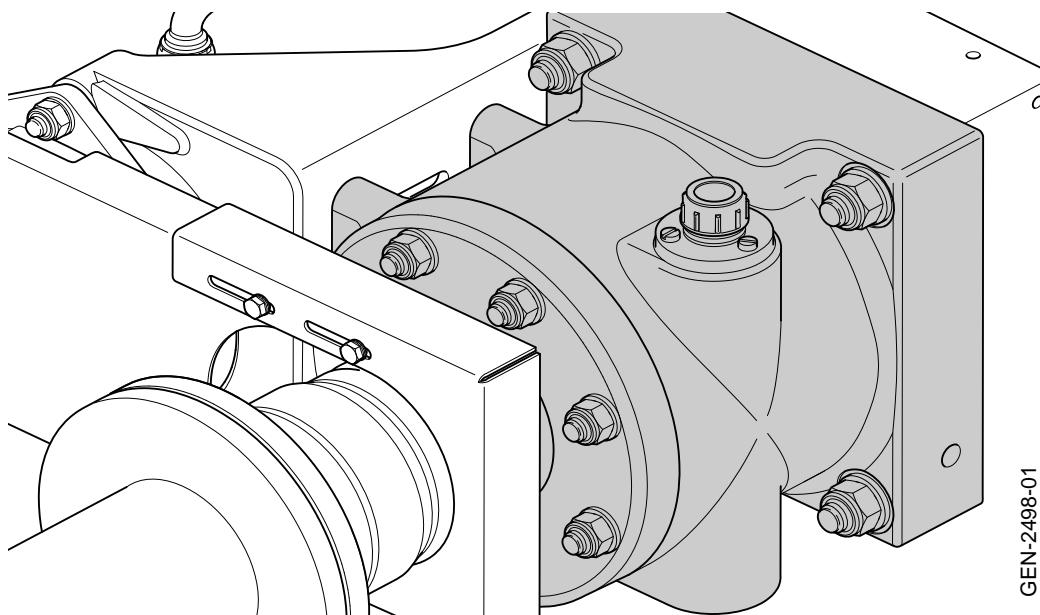


Figure 16

#### Task Summary

The task is to clean the drainage hole.

#### Task Interval

Do this task during:

- Preventive maintenance, monthly

#### Prerequisites

##### Conditions

None

Personnel number	Skill level	Maintenance facility level	Estimated time
1	Crew	Dockside	10 min
Consumables	Quantity	Part number	
Bottle brush Ø10 mm	1	-	

## Procedure

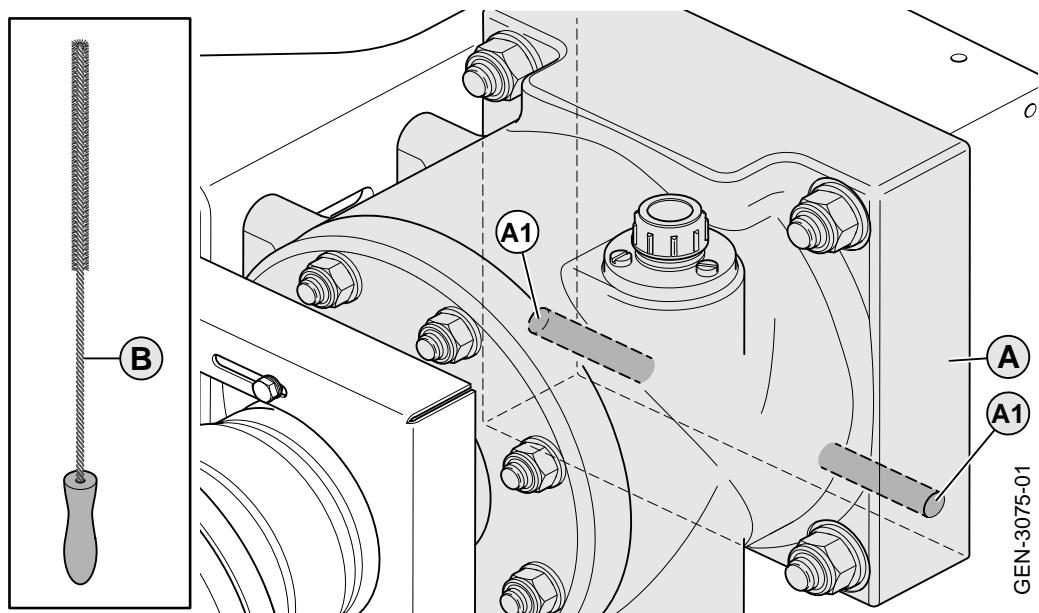


Figure 17

- 1 Clean the holes (A1) with a bottle brush (B) until they are clear and not clogged.
- 2 Task completed.

#### 4.2.11 Thrust Bearing Unit, Replace Thrust Bearing and Radial Seals

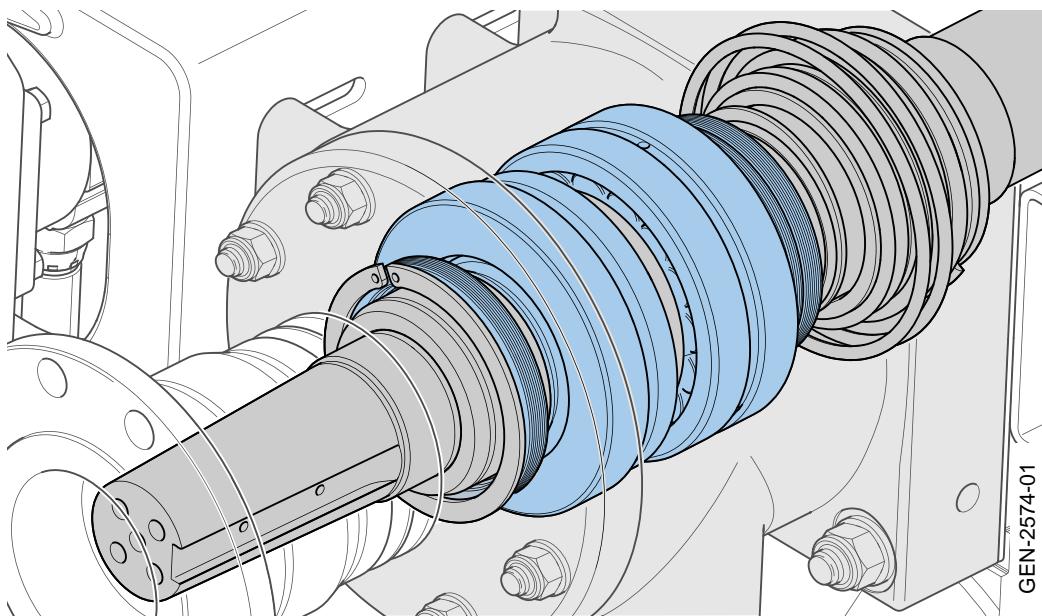


Figure 18

#### Task Summary

The task is to replace the thrust bearing and the radial seals.

Due to easy access when this task is being performed, it is recommended that the shaft seal, the O-rings and the circlip also are replaced.

#### Task Interval

Do this task during:

- Preventive maintenance, every 5th year or 8 000 operating hours.
- Corrective maintenance

## Prerequisites

### Conditions

Intermediate shafting removed to create space in front of the waterjet.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Authorized Service Technician	Dock, workshop / dry dock	120 minutes

Spare parts	Quantity	Part number
Spare Bearing and Seals Kit	1	X350-1111-SP
Special tools and test equipment	Quantity	Part number
Flange / Impeller extractor	1	100-004

### Recommended replacement

4.2.12 *Thrust Bearing Unit, Replace Shaft Seal*

4.3.14 *Thrust Bearing, Replace Oil*

4.3.20 *Hydraulic System, Replace Oil Filter*

## Procedure

The complete procedure can be found in the **Workshop Manual**.

When the crew have performed qualified training by Marine Jet Power, a more extensive **Workshop Manual** covering also the qualified maintenance tasks, can be obtained from Marine Jet Power.

#### 4.2.12 Thrust Bearing Unit, Replace Shaft Seal

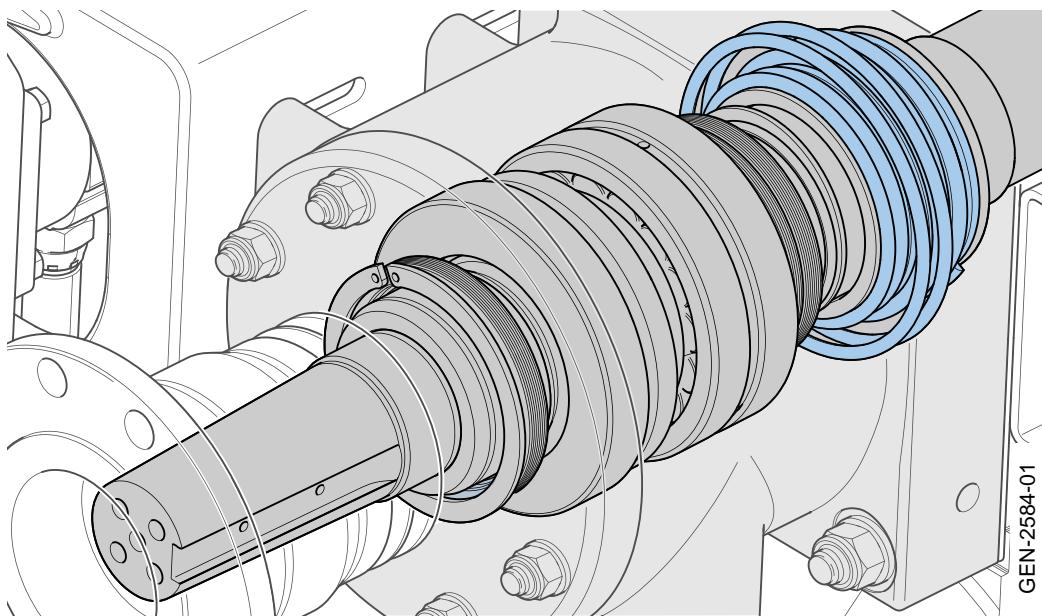


Figure 19

#### Task Summary

The task is to replace the shaft seal, the O-rings and the static face.

#### Task Interval

Do this task during:

- Preventive maintenance, every 5th year or 8 000 operating hours.
- Corrective maintenance.

## Prerequisites

### Conditions

Intermediate shafting removed to create space in front of the waterjet.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Authorized Service Technician	Dock, workshop / dry dock	60 minutes
Spare parts		Quantity	Part number
Spare Mechanical seal kit		1	X350-1110-SP
Consumables		Quantity	Part number
Loctite SF 7063 Parts Cleaner / CRC Brakleen		-	-
Wiping cloth (lint-free)		-	-
Molykote 111 compound		-	-
Special tools and test equipment		Quantity	Part number
Circlip plier		1	-
Reference document			
4.3.27 V-Belts, Replace			
4.2.11 Thrust Bearing Unit, Replace Thrust Bearing and Radial Seals			

## Procedure

The complete procedure can be found in the **Workshop Manual**.

When the crew have performed qualified training by Marine Jet Power, a more extensive **Workshop Manual** covering also the qualified maintenance tasks, can be obtained from Marine Jet Power.

## 4.2.13 Waterjet Unit, Inspect

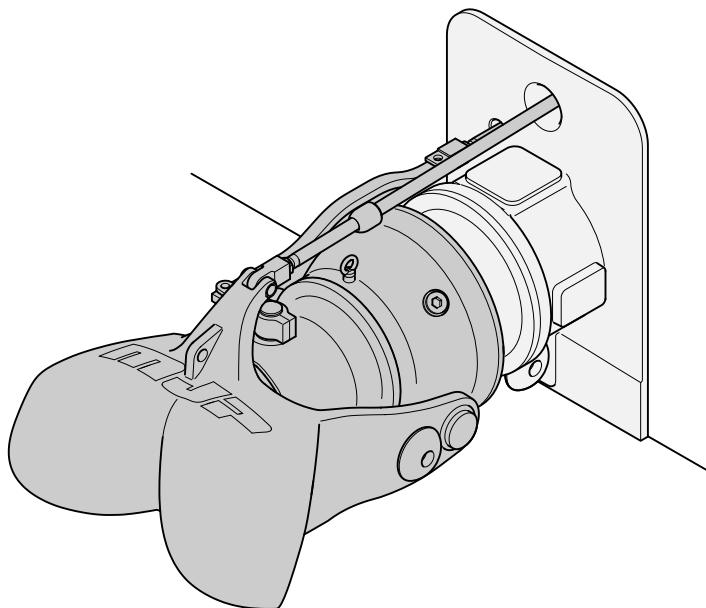


Figure 20

### Task Summary

The task is to inspect the waterjet (pump unit, pin shafts and anodes) for damages or corrosion.

### Task Interval

Do this task during:

- Preventive maintenance, annually / while docked.

### Prerequisites

#### Conditions

The vessel is dry docked and supported properly.

The intake is clean. See 4.2.1 Waterjet Unit, Clean

Necessary scaffolding to access intake.

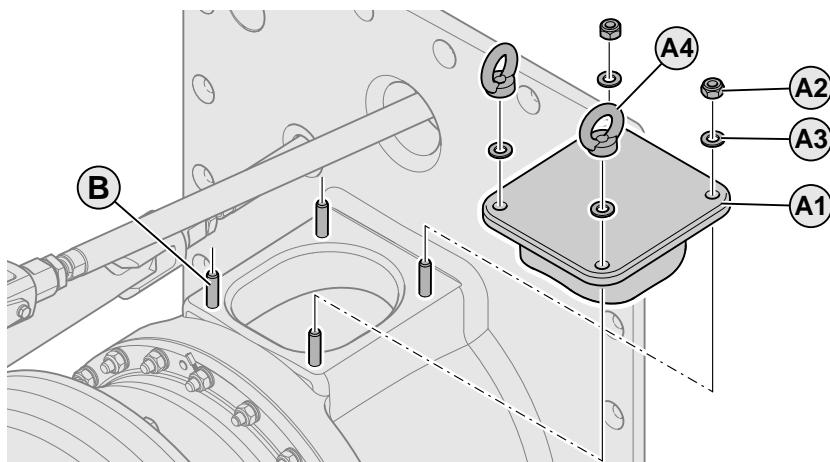
Number of personnel	Skill level	Maintenance facility level (choose one)	Estimated time
1	Chief Engineer	Dock, workshop / dry dock	30 minutes

#### Reference document

7.1 Paint Program

7.2 Torque

## Procedure



GEN-2562-01

Figure 21

- 1 Open the inspection hatch (A1) on the intake (B):
  - 1.1 Remove the nuts (A2), washers (A3) and lifting eyes (A4).
  - 1.2 Remove the inspection hatch (A1).
- 2 Carefully inspect the impeller condition. Grind out small dents or scratches. If a large renovation is needed, contact MJP.
- 3 Inspect blade tip clearance and adjust if needed. See *4.2.8 Pump Unit, Adjust Impeller Tip Clearance*
- 4 Inspect the intake. Repair damage to bars, geometry (grind out) or paint. See *7.1 Paint Program*

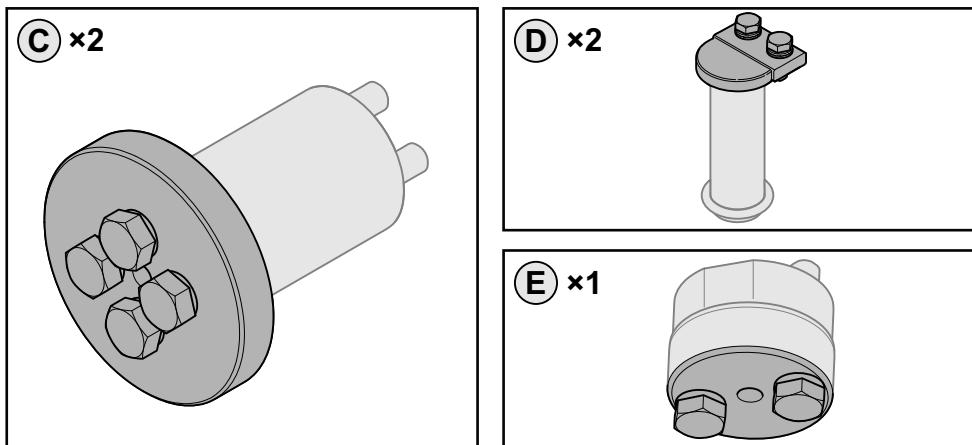


**Caution!**

Even small paint defects can be onset to rapid corrosion seriously affecting the product life time.

**Note!**

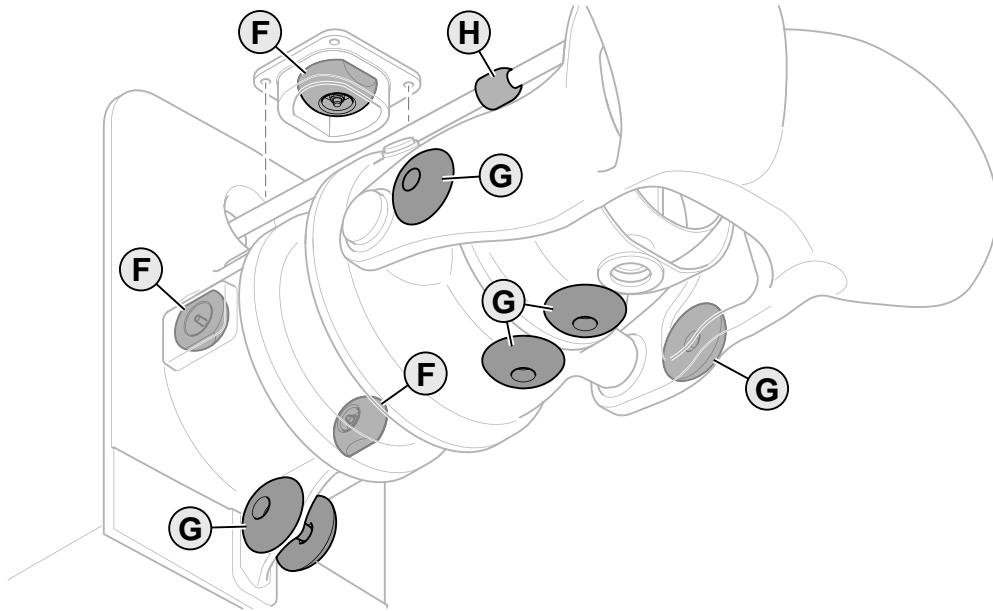
The grid is easily damaged during operation keeping large objects out of the pump. Damage to the grill paint can cause heavy corrosion on grid and intake and defects in grill geometry can cause pump damage, loss of performance and even cavitation onset.



GEN-2493-03

Figure 22

- 5 Inspect the tightening torque on the pin shafts (C), (D) and (E). See *7.2 Torque*.

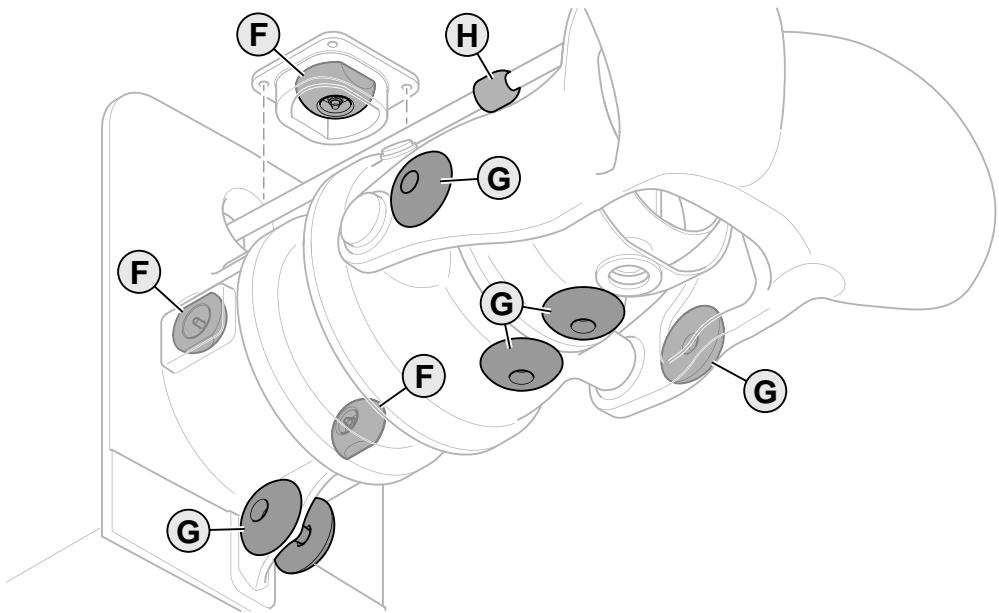


GEN-2494-05

Figure 23

- 6 Inspect the anodes (F), (G) and (H). If consumed to more than 50%, change the anodes. See *4.2.14 Waterjet Unit, Replace the Anodes*.
- 7 Inspect the paint for damages or exfoliation. If damaged or exfoliated, repaint according to *7.1 Paint Program*.
- 8 Close the inspection hatch (A1) on the intake again:
  - 8.1 Apply Loctite® 2701 to the studs (B) on the intake.
  - 8.2 Attach the inspection hatch (A1) to the studs (B).
  - 8.3 Apply Loctite® 243 to the nuts (A2) and the lifting eyes (A4).
  - 8.4 Install the washers (A3) nuts (A2) and lifting eyes (A4) to the inspection hatch (A1).
  - 8.5 Tighten the nuts (A2) to torque 34 Nm.
  - 8.6 Firmly tighten the lifting eyes (A4).
- 9 Task completed.

## 4.2.14 Waterjet Unit, Replace the Anodes



GEN-2494-05

Figure 24

### Task Summary

The task is to replace anodes on waterjet unit.

### Task Interval

Do this task during:

- Corrective maintenance, if anodes are consumed to 50% or more.

### Prerequisites

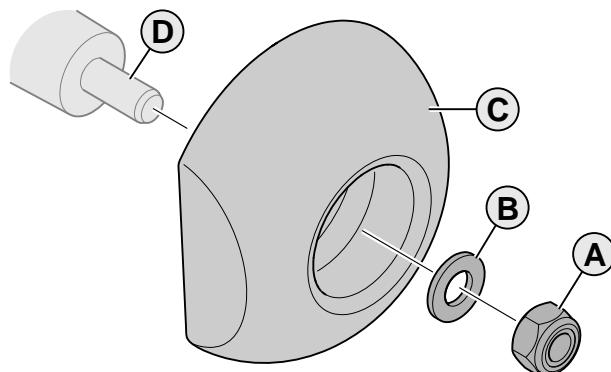
#### Conditions

None

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Chief Engineer	Dockside	60 minutes

Spare parts	Quantity	Part number
Spare Anode Kit (Zink) (Alu) (Magn)	1 per jet	X350-1350-01 (Zn) X350-1350-02 (Mg) X350-1350-03 (Al)

## Procedure



GEN-2243-01

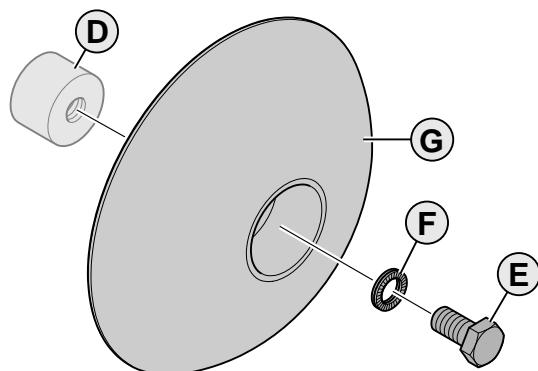
Figure 25

- 1 Remove anodes:
  - 1.1 Remove lock nuts (A) and washers (B) from anode mounts (D).
  - 1.2 Remove anodes (C) from anode mounts.
- 2 Clean anode mounts (D).

**Caution!**

Before you install new anodes, make sure that the anode mounts is clean from oxide, paint and dirt. This will help prevent damage to the equipment.

- 3 Install the new anodes:
  - 3.1 Apply Loctite® 243 to the new lock nuts.
  - 3.2 Install the new anodes to the anode mounts (D).
  - 3.3 Install the new washers and lock nuts to the anode mounts (D).
  - 3.4 Tighten the new nuts to torque 31-34 Nm.



GEN-0382-02

Figure 26

- 4 Remove the anodes:
  - 4.1 Remove the screws (E) and lock washers (F) from the anode mounts (D).
  - 4.2 Remove the anodes (G) from the anode mounts.
- 5 Clean the anode mounts (D).

**Caution!**

Before you install the new anode, make sure that the anode mounts is clean from oxide, paint and dirt. This will help prevent damage to the equipment.

## 6 Install the new anodes:

- 6.1 Apply Loctite® 243 to the new screws.
- 6.2 Install the new anodes to the anode mounts (D).
- 6.3 Install the new lock washers (F) and screws to the anode mounts (D).
- 6.4 Tighten the new screws to torque 31-34 Nm.

## 7 For anodes in anode pockets:

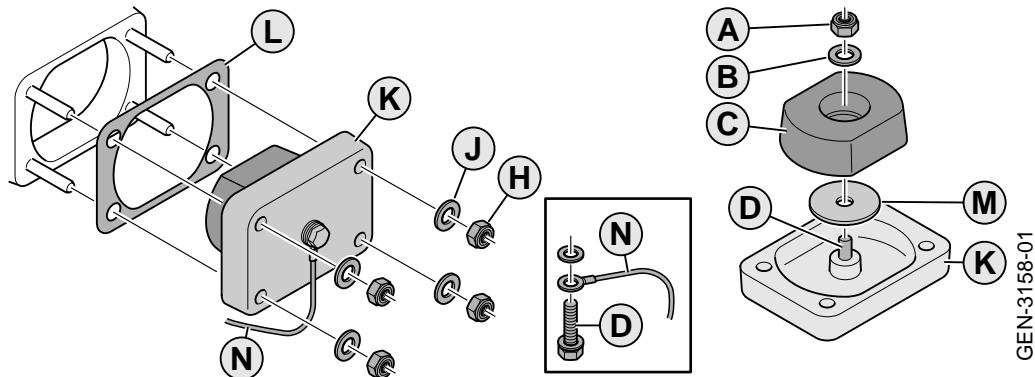


Figure 27

- 7.1 Remove lock nuts (H) and washers (J) from the anode pocket lid (K).
- 7.2 Remove anode pocket lid (K) from the mount.
- 7.3 Remove lock nut (A) and washer (B) from the anode mounts (D).
- 7.4 Remove anode (C) from the anode pocket lid, keep the washer (M).
- 7.5 Replace earth cable (N) on screw (D) on lid (K).

## 8 Clean the anode mounts (D).

**Caution!**

Before you install the new anode, make sure that the anode mount is clean from oxide, paint and dirt. This will help prevent damage to the equipment.

## 9 Install the new anode:

- 9.1 Apply Loctite® 243 to the new lock nut (A).
- 9.2 Install the new anode to the anode mount (D) on top of the washer (M).
- 9.3 Install the new washer and lock nut to the anode mount.
- 9.4 Tighten the new nut to torque 31-34 Nm.
- 9.5 Inspect the paper gasket (L). If damaged, replace the gasket.
- 9.6 Apply Loctite® 243 to the lock nuts (H).
- 9.7 Install the paper gasket (L) and the anode pocket lid (K) to the mount.
- 9.8 Install the washers (J) and lock nuts (H) to the mount.
- 9.9 Tighten the nuts to torque 31-34 Nm.

## 10 Task completed.

#### 4.2.15 Waterjet Unit, Inspect Bushings and Pin Shafts

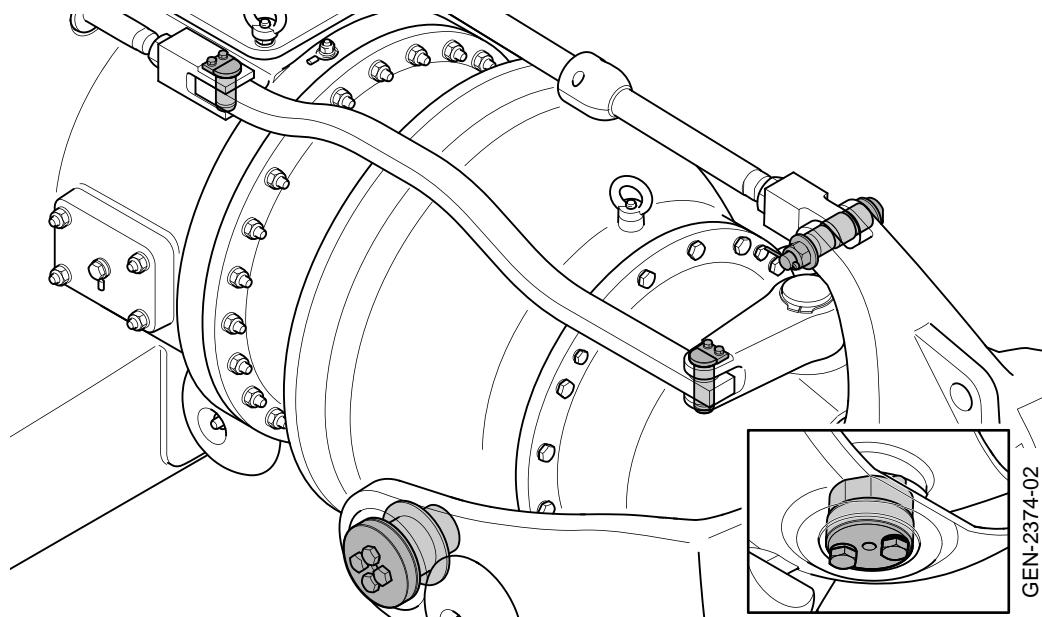


Figure 28

#### Task Summary

The task is to inspect bushings and pin shafts on the waterjet unit.

#### Task Interval

Do this task during:

- Preventive maintenance, annually

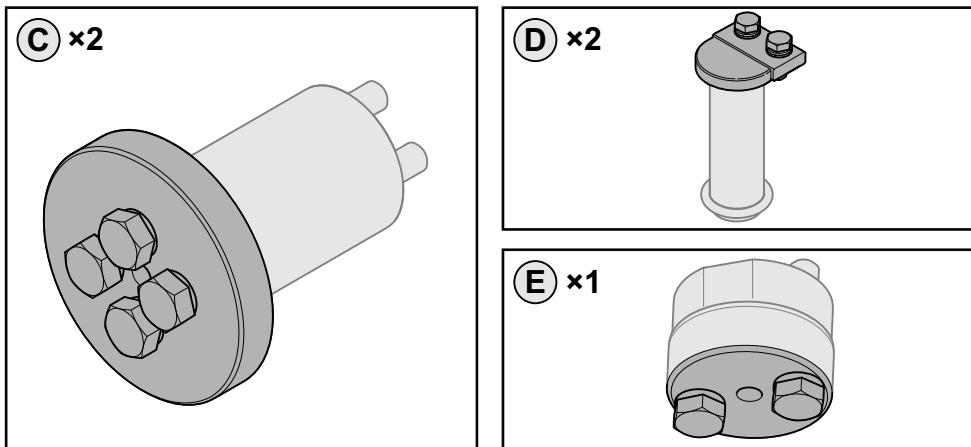
#### Prerequisites

##### Conditions

Necessary scaffolding to access unit.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Chief Engineer	Dock, workshop / dry dock	1 hour

## Procedure



GEN-2493-03

Figure 29

- 1 Locate all joints (C), (D) and (E) on the steering unit.
- 2 Insert a crow bar and press / bend at each joint. If the parts attached to the joint are moving radially from the bushing or pin, change bushings and pin shafts. See *4.2.16 Waterjet Unit, Replace Bushings and Pin Shafts*.
- 3 Task completed.

## 4.2.16 Waterjet Unit, Replace Bushings and Pin Shafts

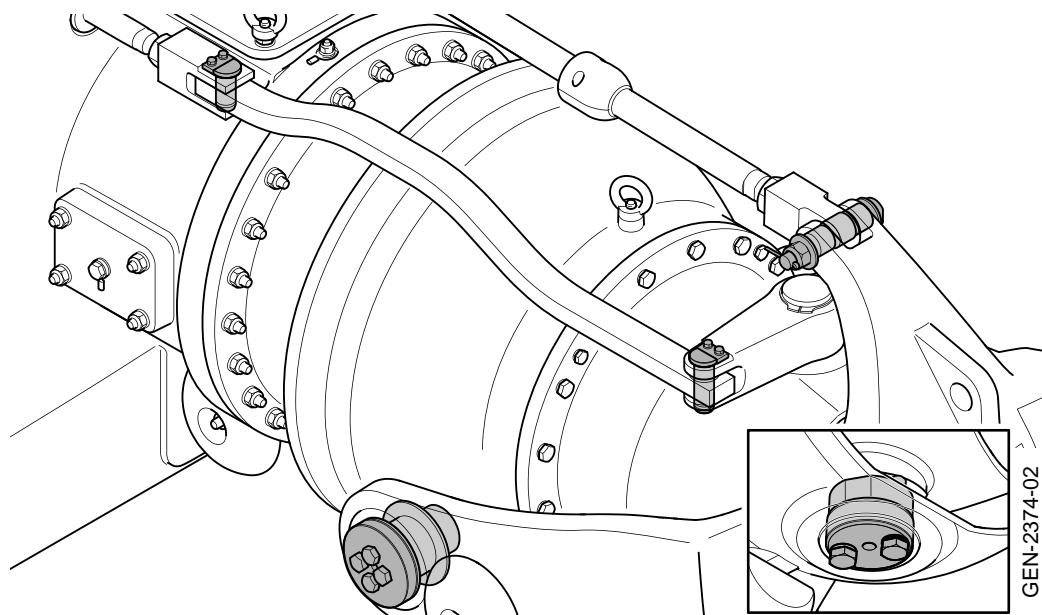


Figure 30

### Task Summary

The task is to replace all bushings and pin shafts on waterjet unit.



#### Warning!

Before you disassemble waterjet unit, make sure to wear protective equipment. This will help prevent injury to personnel.

### Task Interval

Do this task during:

- Condition based/Corrective maintenance

### Prerequisites

#### Conditions

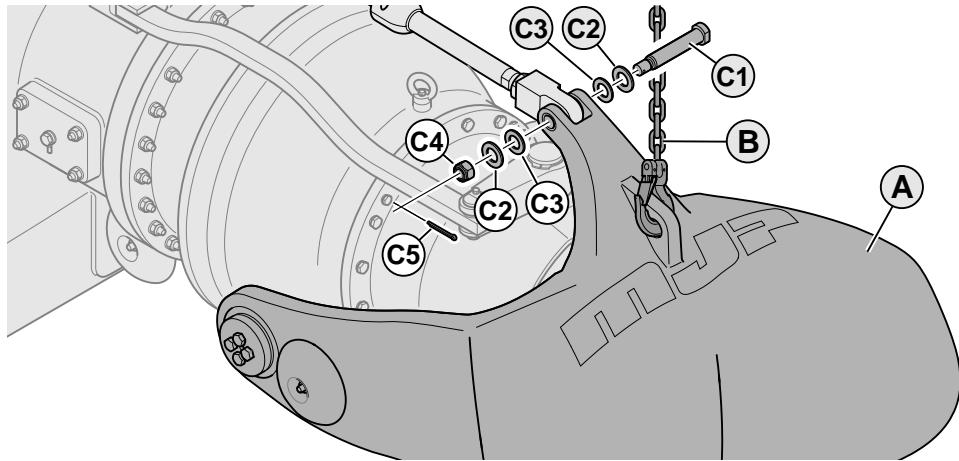
Sliding hammer available

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Chief Engineer	Dock, workshop / dry dock	3 hours

Spare parts	Quantity	Part number
Spare Bushing Kit	1 per jet	X350-1208-SP
Spare Pinshaft Kit	1 per jet	X350-1205-SP

Consumables	Quantity	Part number
Anti seize paste	-	-
Thread locking paste	-	-

## Procedure



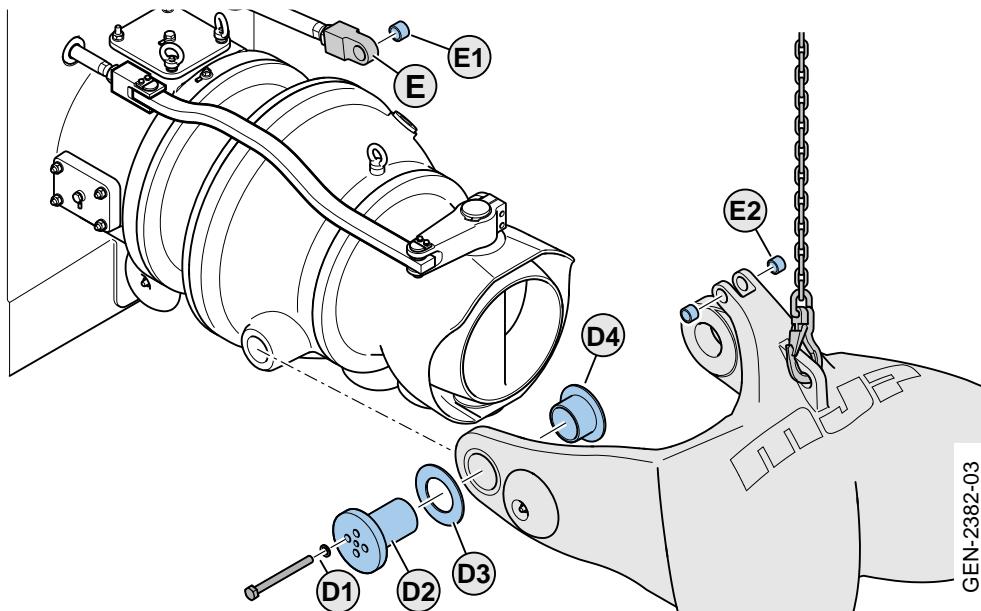
GEN-2381-01

Figure 31

- 1 Use a lifting device (B) to secure bucket (A).
- 2 Remove split cotter pin (C5) from pin shaft (C1).
- 3 Remove lock nut (C4) from pin shaft (C1).
- 4 Remove pin shaft (C1), washers (C2) and insulating washers (C3).

**Note!**

On assembly, apply Molykote DX paste to screw (C1) and tighten nut (C4) to torque 110 Nm.



GEN-2382-03

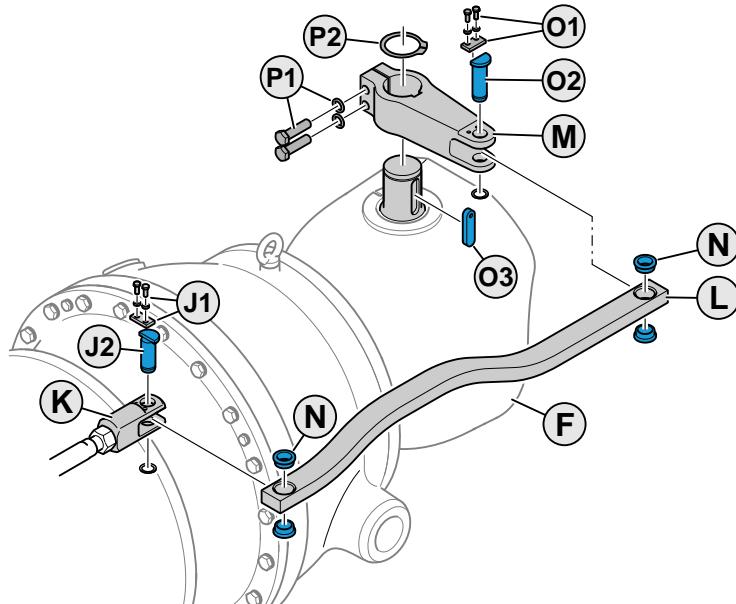
Figure 32

- 5 Remove screws and washers (D1) from pivot pins (D2).

**Note!**

On assembly, apply Molykote DX paste to screws (D1) and tighten to torque 39 Nm.

- 6 Remove pivot pins (D2) and washers (D3) from diffuser assembly.
- 7 Remove bucket.
- 8 Remove bushings (D4) from bucket.
- 9 Use a plastic mallet to gently install new bushings (D4) on bucket.
- 10 Remove bushings (E2) from bucket and bushing (E1) from reversing rod clevis (E).
- 11 Install new bushings (E2) to bucket and bushing (E1) to reversing rod clevis (E).



GEN-2383-03

Figure 33

- 12 Remove screw and washer (J1) from pin shaft (J2).

**Note!**

On assembly, apply Molykote DX paste to screw (J1) and tighten to torque 8.4 Nm.

- 13 Use a sliding hammer to remove pin shaft (J2) from reversing rod clevis (K).
- 14 Remove screw and washer (O1) from pin shaft (O2).

**Note!**

On assembly, apply Molykote DX paste to screw (O1) and tighten to torque 8.4 Nm.

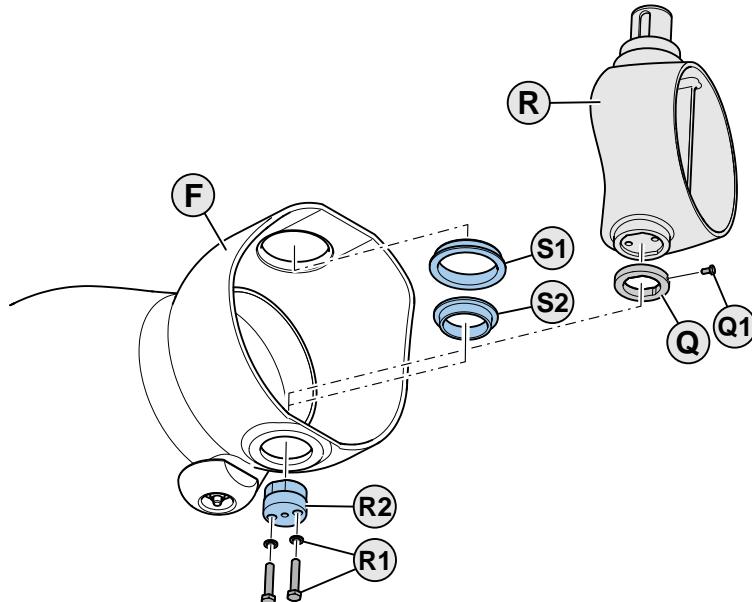
- 15 Use a sliding hammer to remove pin shaft (O2) from steering tiller arm (M).
- 16 Remove push rod (L) from reversing rod clevis (K) and steering tiller arm (M).
- 17 Remove bushings (N) from push rod (L).
- 18 Use a plastic mallet to gently install new bushings on push rod (L).
- 19 Remove screws and washers (P1) from steering tiller arm (M).

**Note!**

On assembly, apply Molykote DX paste to screw (P1) and tighten to torque 39 Nm.

- 20 Remove retaining ring (P2) from steering tiller arm (M).

- 21 Remove steering tiller arm (M) from diffuser assembly (F).
- 22 Remove steel key (O3).



GEN-2384-01

Figure 34

- 23 Remove lock screw (Q1) from spacer (Q).

**Note!**

On assembly, apply Molykote DX paste to screw (Q1) and tighten to torque 7 Nm.

- 24 Remove screws and washers (R1) from steering pin shaft (R2).

**Note!**

On assembly, apply Molykote DX paste to screw (R1) and tighten to torque 39 Nm.

- 25 Remove steering pin shaft (R2) from diffuser assembly (F).
- 26 Remove spacer (Q) and steering nozzle (R) from diffuser assembly.
- 27 Remove bushings (S1-S2) from diffuser assembly (F).
- 28 Use a plastic mallet to gently install new bushings on diffuser assembly.
- 29 Apply Molykote® D paste or equivalent on all new pin shafts.
- 30 Assemble steering unit in reverse order. See notes in this instruction for torque specifications.
- 31 Apply Molykote® D paste or equivalent to screws before installation.
- 32 Task completed.

## 4.2.17 Waterjet Unit, Paint During Service

### Task Summary

The task is to paint the waterjet unit when in need of a touch up.

**Note!**

MJP recommends to paint the waterjet unit with anti-fouling paint. The anti-fouling paint must be suitable for use on aluminium and stainless steel components and compatible with the epoxy paint finish of the unit.



**Caution!**

Do not use metallic based paint with anti-fouling properties, it can cause galvanic corrosion and damage the equipment.

### Task Interval

Do this task during:

- Corrective maintenance, annually / while docked

### Prerequisites

#### Conditions

The boat is dry docked and supported properly.

The waterjet unit is clean and dry. See 4.2.1 Waterjet Unit, Clean

Piston rods and hoses / surrounding areas are masked adequately to avoid unintentional painting.

Necessary scaffolding to access unit in a safe manner.

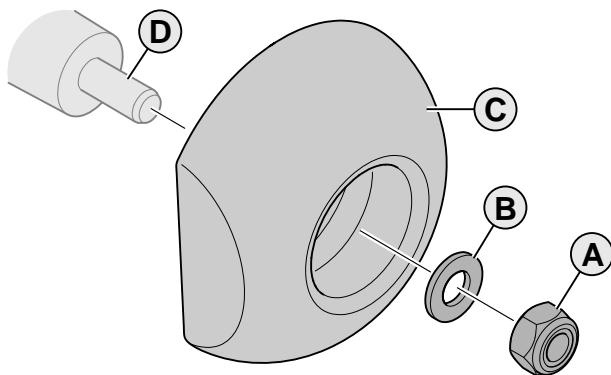
Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Task specialist	Dock, workshop / dry dock	30 minutes

Consumables	Quantity	Part number
Paint. See reference document.	-	-
Emulsion cleaner	-	-

#### Reference document

7.1 Paint Program

## Procedure



GEN-2243-01

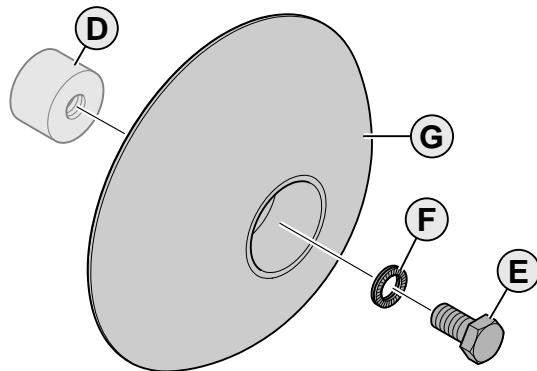
Figure 35

- 1 Remove the anodes:

**Note!**

These are the internal anodes, remove only if the inside of the intake is painted.

- 1.1 Remove the lock nuts (A) and washers (B) from the anode mounts (D).
- 1.2 Remove the anodes (C) from the anode mounts.



GEN-0382-02

Figure 36

- 2 Remove the anodes:

- 2.1 Remove the screws (E) and lock washers (F) from the anode mounts (D).
- 2.2 Remove the anodes (G) from the anode mounts.

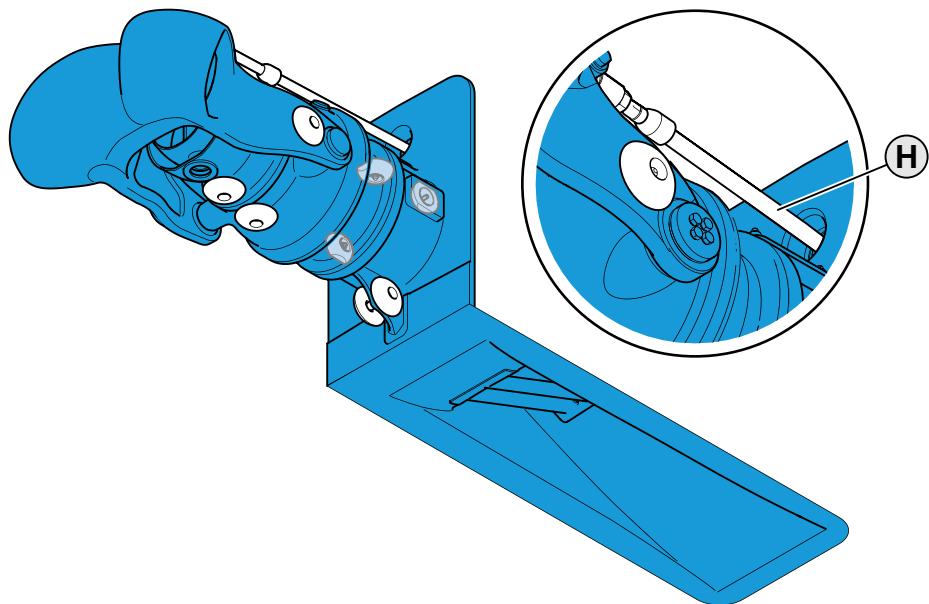
- 3 Clean the anode mounts (D).



**Caution!**

Before you install the new anodes, make sure that the anode mount is clean from oxide, paint and dirt. This will help prevent damage to the equipment.

- 4 Remove oil and grease with an emulsion cleaner.
- 5 Clean the entire area with high pressure fresh water in order to remove salts and other impurities.
- 6 Let the surface dry.
- 7 Remove dust from all areas.



GEN-2568-03

Figure 37

- 8 Make sure to mask the cylinder rod and the cylinder openings (H), in the impeller house, to protect it from paint.
- 9 Paint the waterjet surfaces and the inside of the intake.

**Caution!**

Do not paint the anodes, anode mount (D) surface or threads. The paint can decrease the corrosion protection from the anodes. This can cause damage to the equipment.

**Caution!**

Make sure that the anti-foul paint does not come in contact with the cylinder rod. This can cause damage to the equipment.

**Caution!**

Do not paint the impeller. This can cause damage to the equipment.

**Caution!**

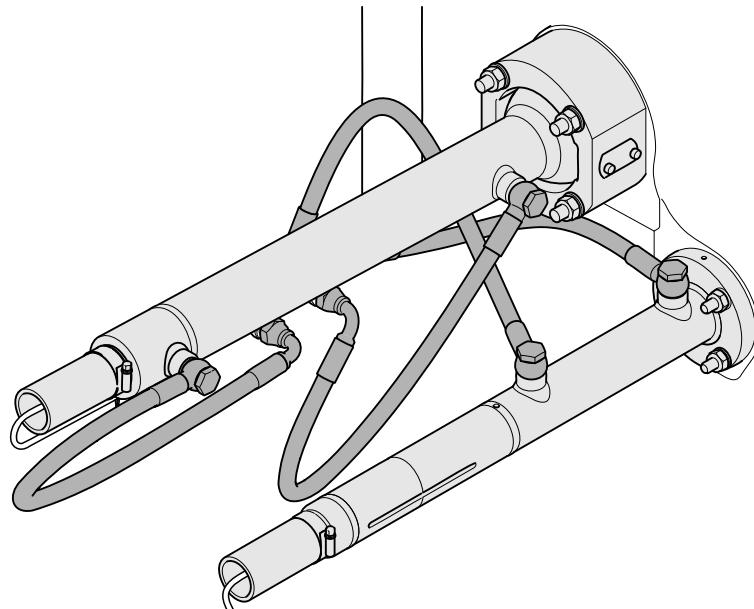
Do not paint interceptors if installed. This can cause damage to the equipment.

- 10 Install the anodes (C) again:
  - 10.1 Apply Loctite® 243 to the lock nuts (A).
  - 10.2 Install the anodes (C) to the anode mounts (D).
  - 10.3 Install the washers and the lock nuts to the anode mounts (D).
  - 10.4 Tighten the nuts to torque 31-34 Nm.
- 11 Install the anodes (G) again:
  - 11.1 Apply Loctite® 243 to the screws.

- 11.2 Install the anodes to the anode mounts (D).
  - 11.3 Install the lock washers (F) and screws (E) to the anode mounts (D).
  - 11.4 Tighten the screws to torque 31-34 Nm.
- 12 Task completed.

## 4.3 Hydraulics

### 4.3.1 Hydraulic Cylinders and Hoses, Inspect



GEN-2244-02

Figure 38

#### Task Summary

The task is to do a general inspection of the hydraulic cylinders and the hoses.

#### Task Interval

Do this task during:

- Preventive maintenance, during daily operation

#### Prerequisites

##### Conditions

Main engine running.

Number of personnel	Skill level	Maintenance facility level	Estimated time
2	Crew	On equipment / at sea	10 minutes

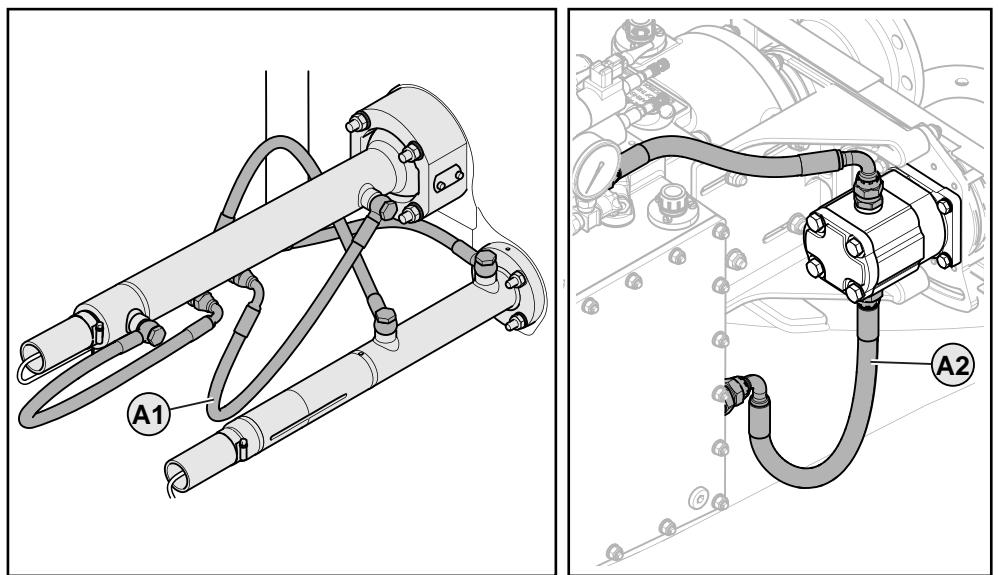
##### Reference document

4.3.2 Hydraulic Hoses, Replace

4.3.4 Hydraulic Steering Cylinder, Replace

4.3.3 Hydraulic Reversing Cylinder, Replace

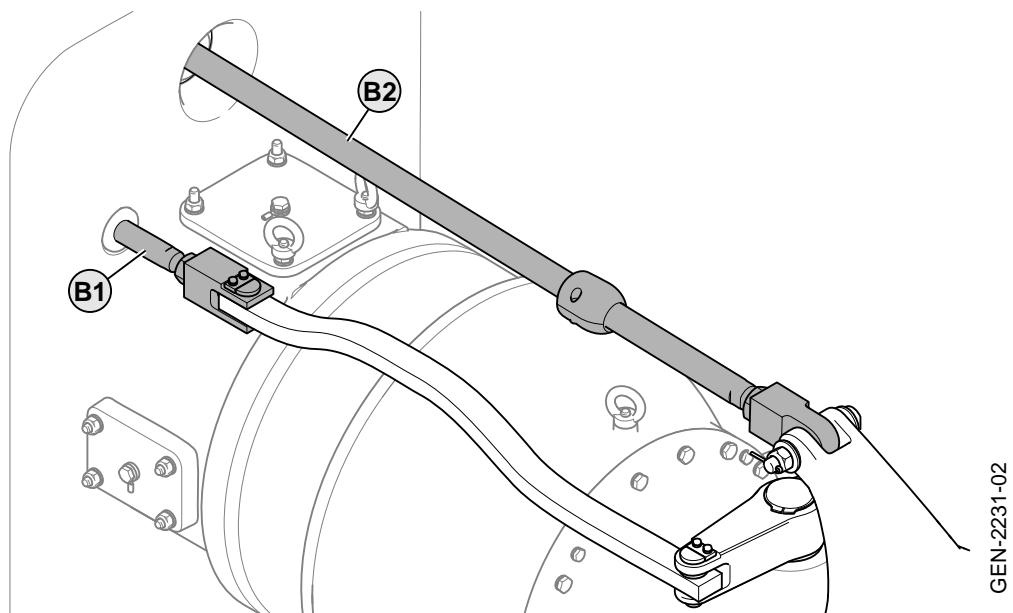
## Procedure



GEN-2245-03

Figure 39

- 1 Inspect the bilge water for oil leaks from hoses and cylinders.
- 2 Inspect all connections for leakage. Repair any leakage immediately.
- 3 Inspect the hoses (A1-A2) for mechanical wear. Replace damaged hoses.
- 4 Operate the hydraulic system (steering and reversing) while inspecting all hoses for leakage. Replace damaged hoses. See *4.3.2 Hydraulic Hoses, Replace*.



GEN-2231-02

Figure 40

- 5 Inspect the piston rods (B1) and (B2) for leakage, visible damage and wear. Replace damaged cylinders. See *4.3.4 Hydraulic Steering Cylinder, Replace* and *4.3.3 Hydraulic Reversing Cylinder, Replace*.
- 6 Task complete.

### 4.3.2 Hydraulic Hoses, Replace

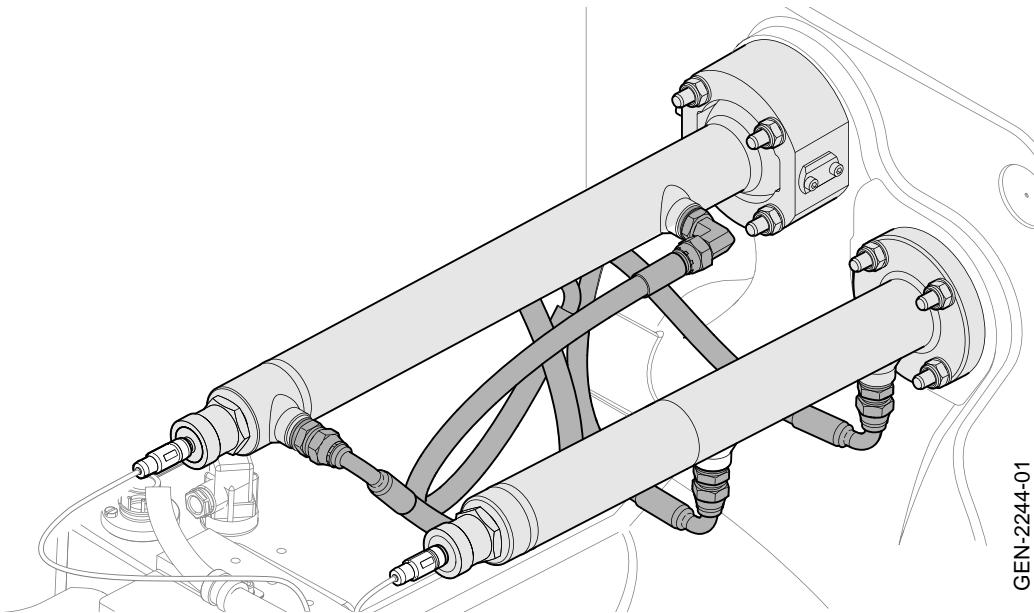


Figure 41

#### Task Summary

The task is to replace the hydraulic hoses.



##### Warning!

Pressurized system! There may be residual pressure in the cylinders.

#### Task Interval

Do this task during:

- Corrective maintenance, while docked
- Preventive maintenance, every 5th year

## Prerequisites

### Conditions

The vessel is docked and system is completely shut down.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Authorized Service Technician	Dry docked	40 minutes

Spare parts	Quantity	Part number
Spare Hose kit	1	X350-1420-E-SP
Consumables	Quantity	Part number
Cloth	-	-

### Reference document

Hydraulic System, Inspect Oil Level in Operation Manual.

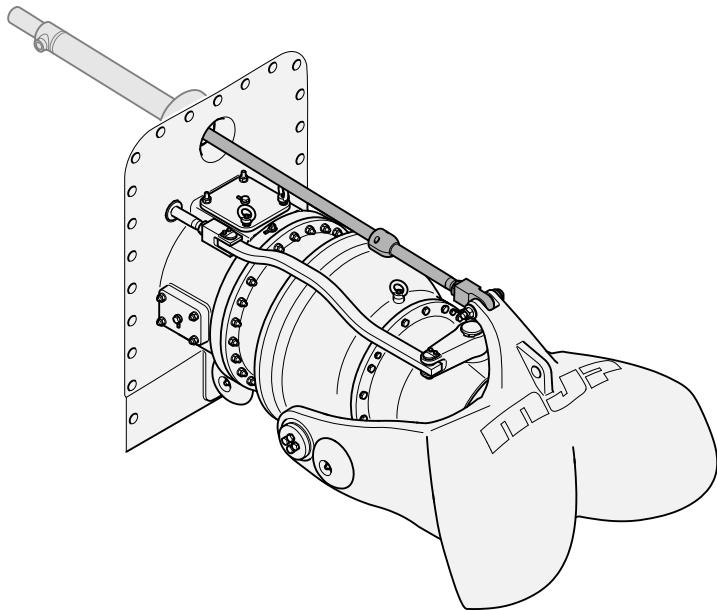
Check the hydraulic pressure. See Hydraulic System, Inspect Working Pressure in Operation Manual.

## Procedure

The complete procedure can be found in the **Workshop Manual**.

When the crew have performed qualified training by Marine Jet Power, a more extensive **Workshop Manual** covering also the qualified maintenance tasks, can be obtained from Marine Jet Power.

### 4.3.3 Hydraulic Reversing Cylinder, Replace



GEN-2073-02

Figure 42

#### Task Summary

The task is to replace the hydraulic reversing cylinder.



##### Warning!

To make sure that the job is performed in a safe manner, dry docking of the vessel is highly recommended.



##### Warning!

Pressurized system! There may be residual pressure in the cylinders.

#### Task Interval

Do this task during:

- Corrective maintenance, while docked.

## Prerequisites

### Conditions

The system is completely shut off.

Sliding hammer available.

Personnel number	Skill level	Maintenance facility level	Estimated time
1	Authorized Service Technician	Dockside / Dry docked	120 minutes
Spare parts	Quantity	Generation	Part number
Hydraulic reversing cylinder	1	Mk1	41987
Consumables	Quantity	Part number	
Cloth	-	-	
Protection plugs	4	-	
Insulating tape	-	-	
Sling	1	-	
Acid-free Vaseline	-	-	

### Reference document

#### 7.2 Torque

Hydraulic System, Inspect Oil Level in Operation Manual.

Hydraulic System, Inspect Working Pressure in Operation Manual.

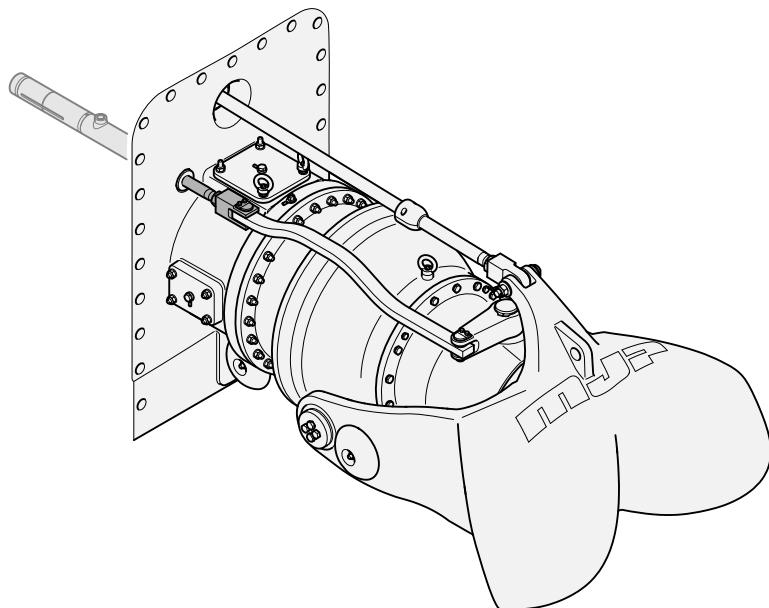
#### 4.4.2 Jet autocalibration

## Procedure

The complete procedure can be found in the **Workshop Manual**.

When the crew have performed qualified training by Marine Jet Power, a more extensive **Workshop Manual** covering also the qualified maintenance tasks, can be obtained from Marine Jet Power.

#### 4.3.4 Hydraulic Steering Cylinder, Replace



GEN-22224-02

Figure 43

#### Task Summary

The task is to replace the hydraulic steering cylinder.



##### Warning!

To make sure that the job is performed in a safe manner, dry docking of the vessel is highly recommended.



##### Warning!

Pressurized system! There may be residual pressure in the cylinders.



##### Caution!

Authorized Service Technician is required for the calibration of the position sensor.

#### Task Interval

Do this task during:

- Corrective maintenance, while docked.

## Prerequisites

### Conditions

The system is completely shut off.

Sliding hammer available.

Personnel number	Skill level	Maintenance facility level	Estimated time
1	Authorized Service Technician	Dockside / Dry docked	120 minutes
Spare parts	Quantity	Generation	Part number
Hydraulic steering cylinder, Mark 2	1	Mk2	42043
Consumables	Quantity	Part number	
Cloth	-	-	
Protection plugs	4	-	
Insulating tape	-	-	
Sling	1	-	
Acid-free Vaseline	-	-	

### Reference document

#### 7.2 Torque

Hydraulic System, Inspect Oil Level in Operation Manual.

Hydraulic System, Inspect Working Pressure in Operation Manual.

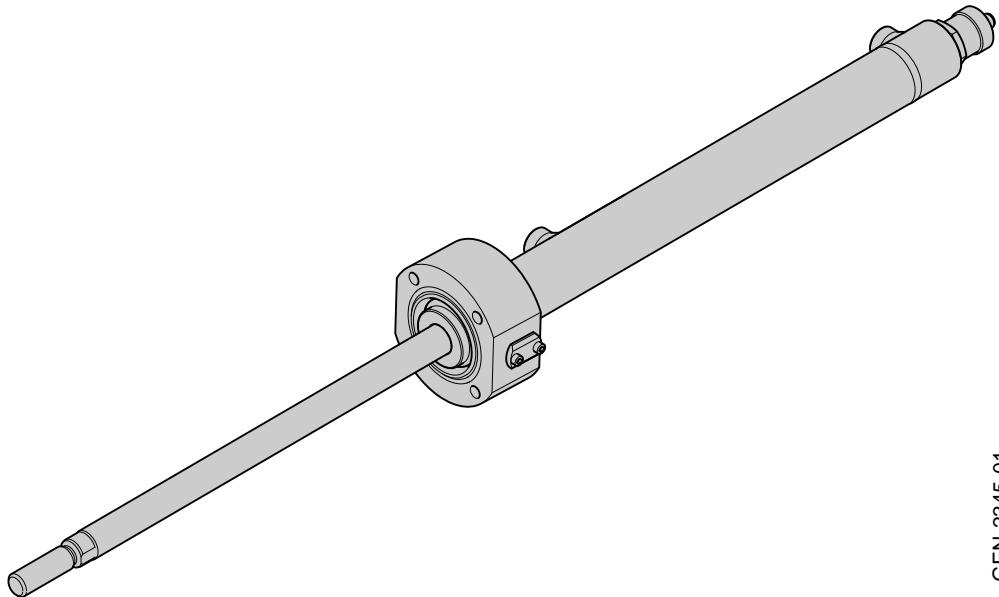
#### 4.4.2 Jet autocalibration

## Procedure

The complete procedure can be found in the **Workshop Manual**.

When the crew have performed qualified training by Marine Jet Power, a more extensive **Workshop Manual** covering also the qualified maintenance tasks, can be obtained from Marine Jet Power.

#### 4.3.5 Hydraulic Reversing Cylinder, Replace Seals



GEN-2345-01

Figure 44

#### Task Summary

The task is to replace the seals on the hydraulic reversing cylinder.

#### Task Interval

Do this task during:

- Preventive maintenance, every 2nd year or 4 000 running hours
- Corrective maintenance, while docked\*

## Prerequisites

### Conditions

The vessel is dry docked and supported properly.

Necessary scaffolding to access unit safely.

\*This task can also be done at dockside with help from divers.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Authorized Service Technician	Dry docked	60 minutes
Spare parts	Quantity	Generation	Part number
Seal kit for Cylinder	1	MK1	42013
Consumables	Quantity	Part number	
Cloth	-	-	
Molykote® D paste	-	-	
Special tools and test equipment	Quantity	Part number	
Hook spanner	1	-	
Seal Installer tool	1	-	
Reference document			
7.2 Torque			
Hydraulic System, Inspect Oil Level in Operation Manual			
Hydraulic System, Inspect Working Pressure in Operation Manual			
4.4.2 Jet autocalibration			

## Procedure

The complete procedure can be found in the **Workshop Manual**.

When the crew have performed qualified training by Marine Jet Power, a more extensive **Workshop Manual** covering also the qualified maintenance tasks, can be obtained from Marine Jet Power.

#### 4.3.6 Hydraulic Steering Cylinder, Replace Seals

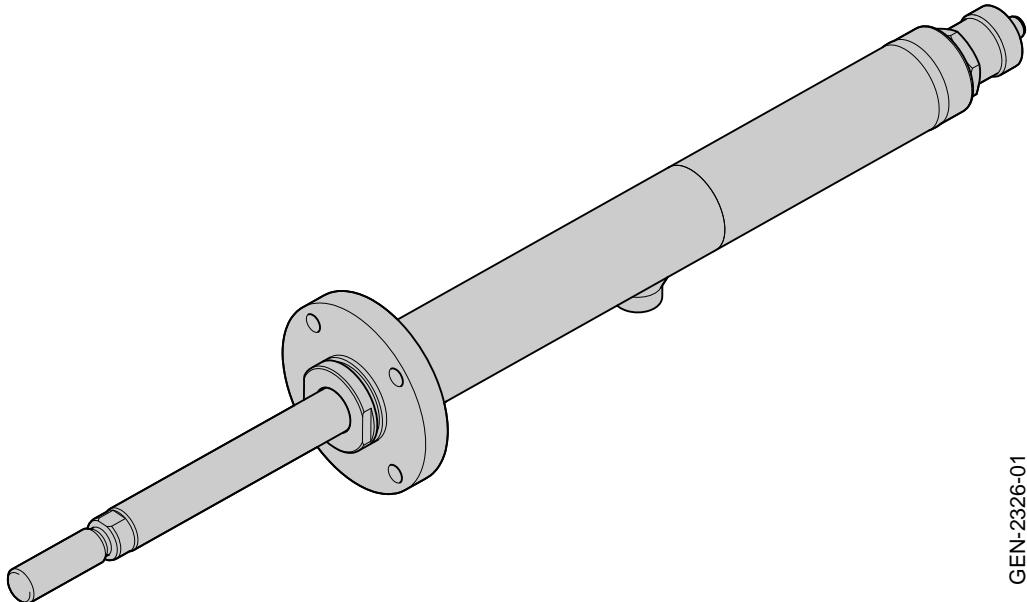


Figure 45

#### Task Summary

The task is to replace the seals on the hydraulic steering cylinder.

#### Task Interval

Do this task during:

- Preventive maintenance, every 2nd year or 4 000 running hours
- Corrective maintenance, while docked \*

## Prerequisites

### Conditions

The vessel is dry docked and supported properly.

Necessary scaffolding to access unit safely.

\* This task can also be done at dockside with help from divers.

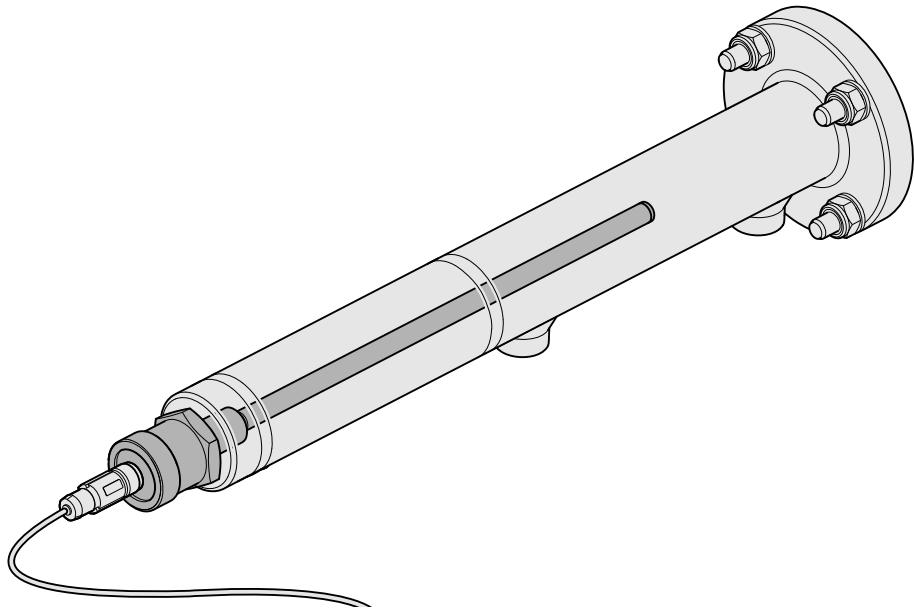
Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Authorized Service Technician	Dry docked	60 minutes
Spare parts	Quantity	Generation	Part number
Seal kit (for hydraulic steering cylinder Mark 1)	1	Mk1	42046
Seal kit (for hydraulic steering cylinder Mark 2)	1	Mk2	42046
Consumables	Quantity	Part number	
Cloth	-	-	
Molykote® D paste	-	-	
Special tools and test equipment	Quantity	Part number	
Face spanner	1	-	
Reference document			
7.2 Torque			
Hydraulic System, Inspect Oil Level in Operation Manual			
Hydraulic System, Inspect Working Pressure in Operation Manual			
4.4.2 Jet autocalibration			

## Procedure

The complete procedure can be found in the **Workshop Manual**.

When the crew have performed qualified training by Marine Jet Power, a more extensive **Workshop Manual** covering also the qualified maintenance tasks, can be obtained from Marine Jet Power.

#### 4.3.7 Hydraulic Steering Cylinder, Replace Feedback Sensor



GEN-2479-02

Figure 46

#### Task Summary

The task is to replace the feedback sensor on the hydraulic steering cylinder.

#### Task Interval

Do this task during:

- Corrective maintenance, while docked

## Prerequisites

### Conditions

Necessary scaffolding to access unit safely.

The feedback sensor cable is disconnected from the MBU.

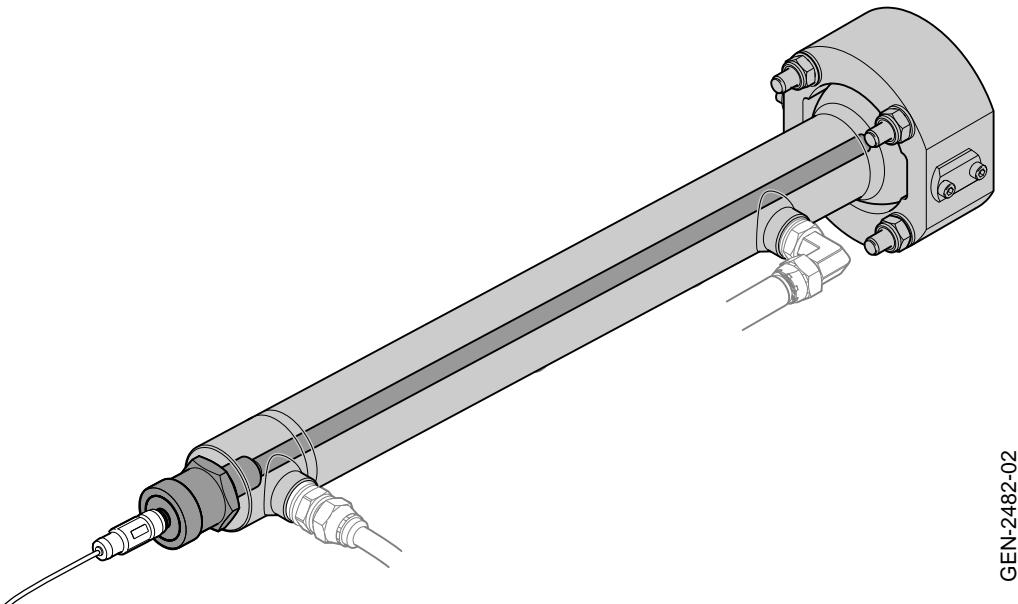
Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Authorized Service Technician	Dry docked or dockside	60 minutes
Spare parts	Quantity	Part number	
Feedback sensor (for hydraulic steering cylinder)	1	41912	
Consumables	Quantity	Part number	
Cloth	-	-	
Molykote® D paste	-	-	
Reference document			
7.2 Torque			

## Procedure

The complete procedure can be found in the **Workshop Manual**.

When the crew have performed qualified training by Marine Jet Power, a more extensive **Workshop Manual** covering also the qualified maintenance tasks, can be obtained from Marine Jet Power.

#### 4.3.8 Hydraulic Reversing Cylinder, Replace Feedback Sensor



GEN-2482-02

Figure 47

#### Task Summary

The task is to replace the feedback sensor on the hydraulic reversing cylinder.

#### Task Interval

Do this task during:

- Corrective maintenance, while docked

## Prerequisites

### Conditions

Necessary scaffolding to access unit safely.

The feedback sensor cables are disconnected from the MBU.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Authorized Service Technician	Dry docked	60 minutes
Spare parts	Quantity	Part number	
Feedback sensor (for hydraulic reversing cylinder)	1	41909	
Consumables	Quantity	Part number	
Cloth	-	-	
Molykote® D paste	-	-	
Reference document			
7.2 Torque			

## Procedure

The complete procedure can be found in the **Workshop Manual**.

When the crew have performed qualified training by Marine Jet Power, a more extensive **Workshop Manual** covering also the qualified maintenance tasks, can be obtained from Marine Jet Power.

### 4.3.9 Hydraulic and Lubrication System, Replace Breather Filter

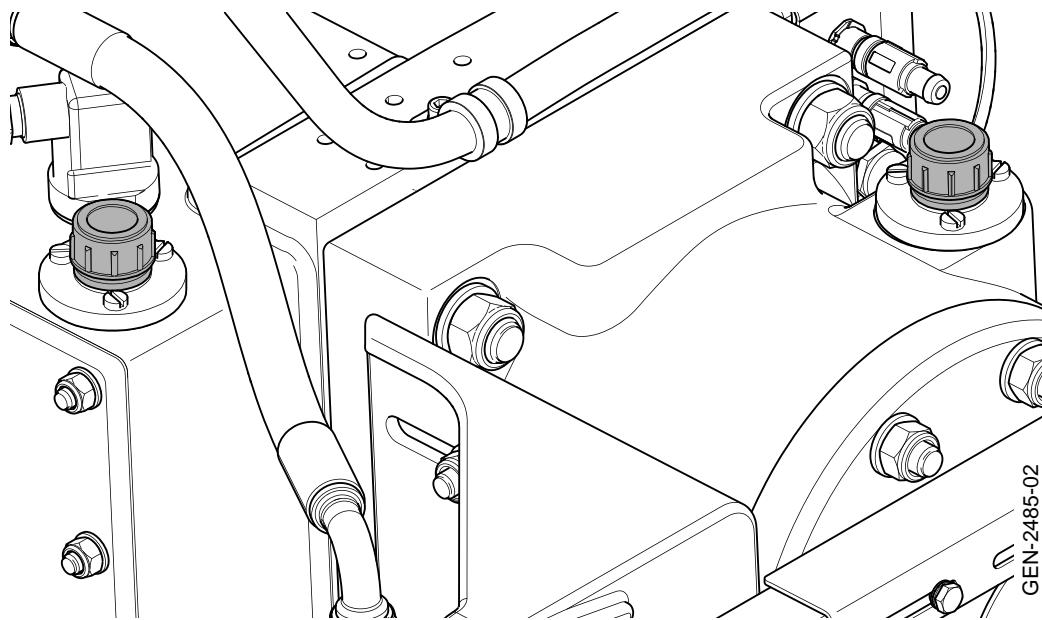


Figure 48

#### Task Summary

The task is to replace the breather filters on the hydraulic and lubrication system (hydraulic tank and shaft bearing assembly).

#### Task Interval

Do this task during:

- Preventive maintenance, annually
- Corrective maintenance

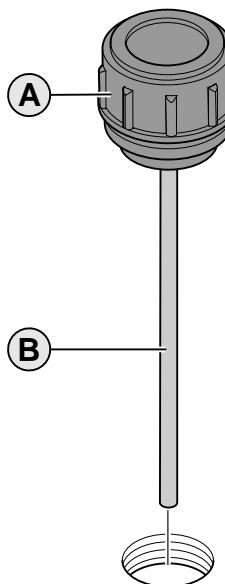
#### Prerequisites

##### Conditions

The jet propulsion system must be shut down.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Chief Engineer	Dockside	5 minutes
Spare parts	Quantity	Part number	
Breather filter	2	X350-1410-2	
Consumables	Quantity	Part number	
Cloth	1	-	
Protection plug	1	-	

## Procedure



GEN-2487-02

Figure 49

- 1 Clean the filter connection.
- 2 Turn the breather filter (A) to remove it. Use a protection plug to plug the filter connection if leaving the tank.
- 3 Remove the dipstick (B) from the filter.
- 4 Put the new breather filter on the dipstick (B) and install again.
- 5 Repeat procedure for the other filter.
- 6 Task completed.

### 4.3.10 Hydraulic System, Inspect Oil Quality

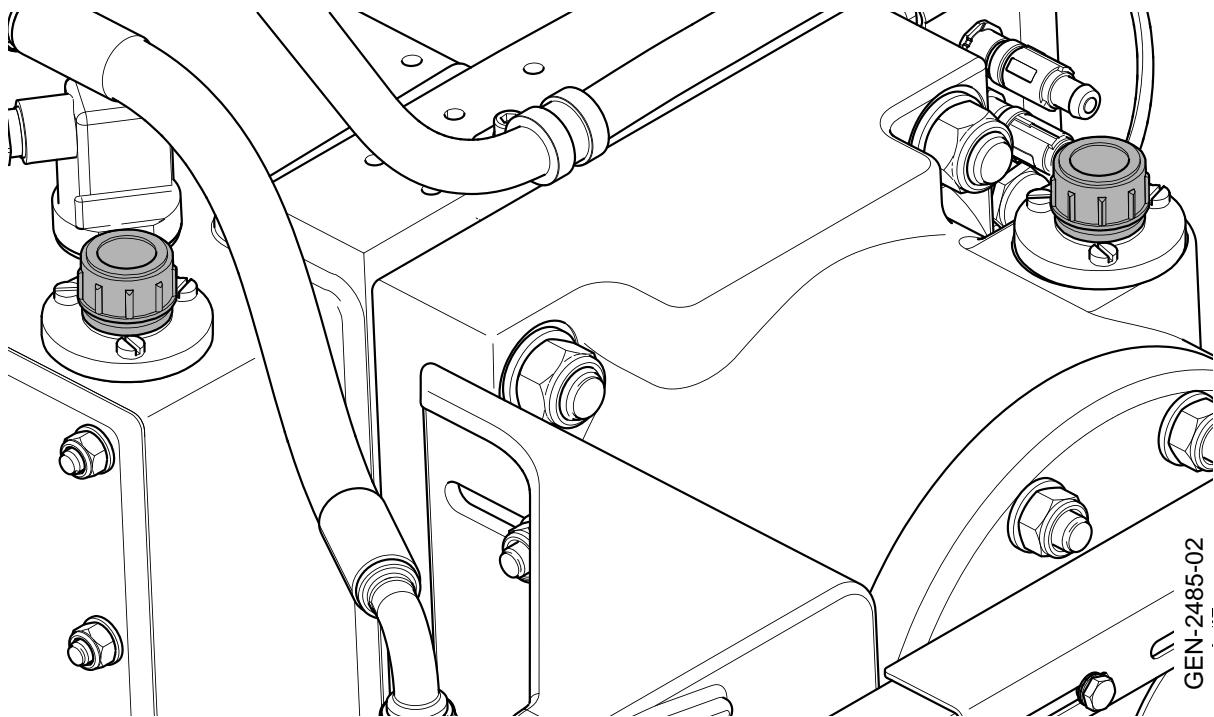


Figure 50

#### Task Summary

The task is to inspect the hydraulic oil quality on the hydraulic system (hydraulic tank and shaft bearing assembly).



**Warning!**  
Burn risk! The oil may be hot.

#### Task Interval

Do this task during:

- Preventive maintenance, annually

## Prerequisites

### Conditions

Vacuum pump for oil sampling available.

Number of personnel	Skill level	Maintenance facility level	Estimated time		
1	Crew	On equipment / at sea	5 minutes		
Consumables	Quantity	Part number			
Bottle for the oil sample	1(2)	-			
<b>Reference document</b>					
7.6.3 Oil Specifications 7.4 Oil Contamination Limits					

## Procedure

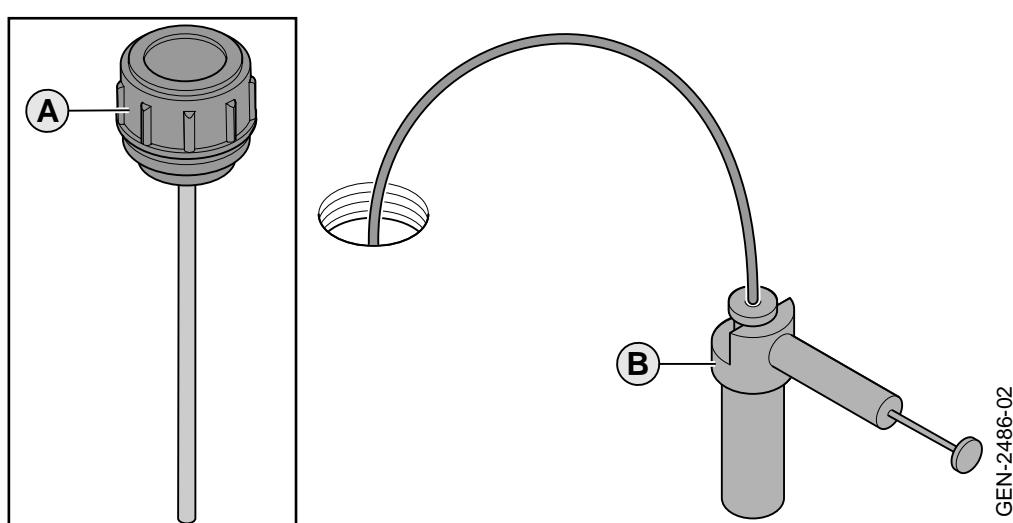


Figure 51

- 1 Remove the hydraulic air filter (A).
- 2 Insert the tube from vacuum pump (B) through the air filter mounting hole, down to the middle of the tank and take the oil sample.
- 3 Fill the bottle to 3/4.
- 4 Install the hydraulic air filter (A).
- 5 Label the bottles and send it for analysis.  
For acceptance criteria, see 7.4 Oil Contamination Limits.  
If the contamination is outside the acceptance criteria, the oil must be changed. See 4.3.12 Hydraulic Tank, Replace Oil and 4.3.14 Thrust Bearing, Replace Oil.
- 6 Task completed.

### 4.3.11 Hydraulic System, Add Oil

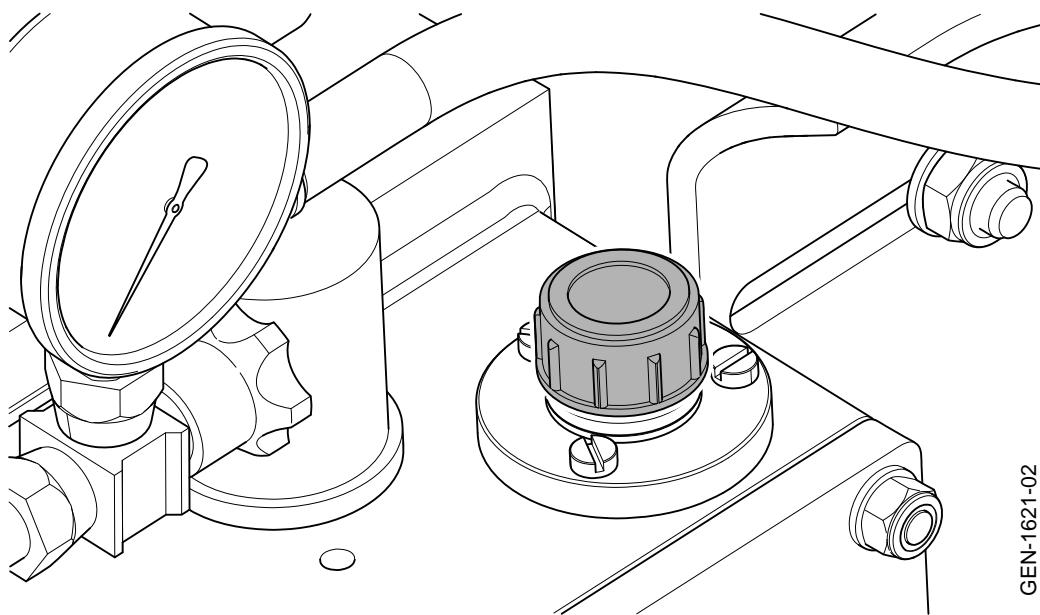


Figure 52

#### Task Summary

The task is to add oil to the hydraulic system (hydraulic tank).



**Warning!**  
Burn risk! Oil may be hot after operation.

#### Task Interval

Do this task during:

- Corrective maintenance, while docked

#### Prerequisites

##### Conditions

System completely shut off.

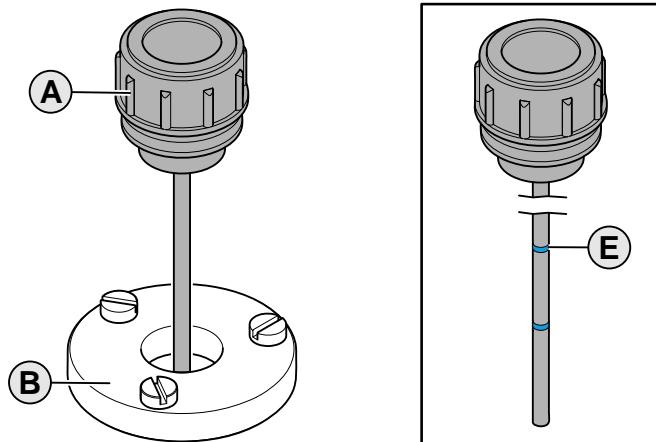
Oil container available.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Chief Engineer	On equipment / at sea	30 minutes

Consumables	Quantity	
Hydraulic oil	-	See 7.6.3 Oil Specifications for oil quality.
Cloth	1	-

Special tools and test equipment	Quantity	Part number
Filler unit	1	-
<b>Reference document</b>		
7.6.3 Oil Specifications		
7.4 Oil Contamination Limits		
Check the hydraulic pressure. See Hydraulic System, Inspect Working Pressure in Operation Manual.		

## Procedure



GEN-1681-01

Figure 53

- 1 Make sure you have the right oil. See 7.6.3 Oil Specifications.
- 2 Remove the filler breather filter (A) with the attached dipstick.
- 3 Fill with new oil through the air filter connection.

**Note!**

It is recommended to filter the oil before or upon filling. New oil may contain quite high particle counts.

- 4 Wipe the dipstick clean.
- 5 Install the filler breather filter until it is fully seated and remove it again.
- 6 View the oil level on the dipstick (E) to confirm that the oil level is within the safe operating range.
- 7 Repeat until the oil level is within the safe operating range.
- 8 Install the filler breather filter again.
- 9 Start the hydraulic system and make a function test to make sure that the system is working.
- 10 Check the hydraulic pressure. See Hydraulic System, Inspect Working Pressure in Operation Manual.
- 11 Task completed.

### 4.3.12 Hydraulic Tank, Replace Oil

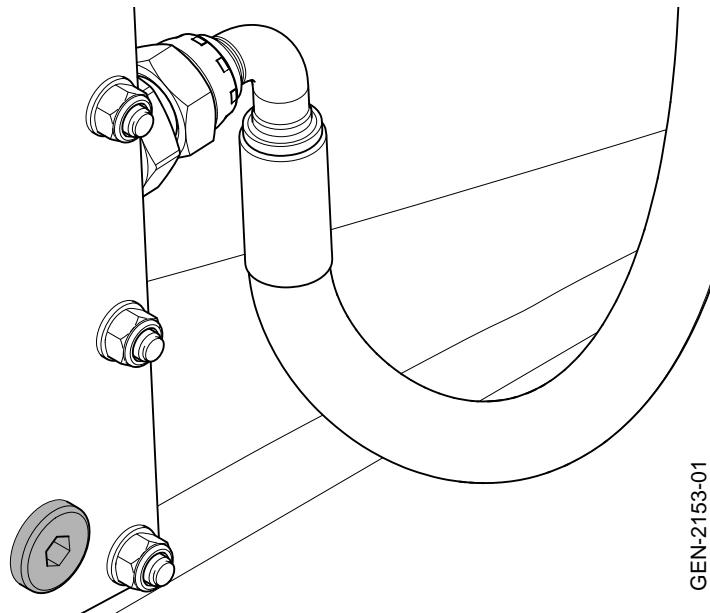


Figure 54

#### Task Summary

The task is to replace the hydraulic oil.



##### Warning!

The system must be completely shut off so that the hydraulic system is not pressurized. Use safety glasses.



##### Warning!

Burn risk! Oil may be hot.

#### Task Interval

Do this task during:

- Preventive maintenance, every 24 months
- Corrective maintenance, while docked

## Prerequisites

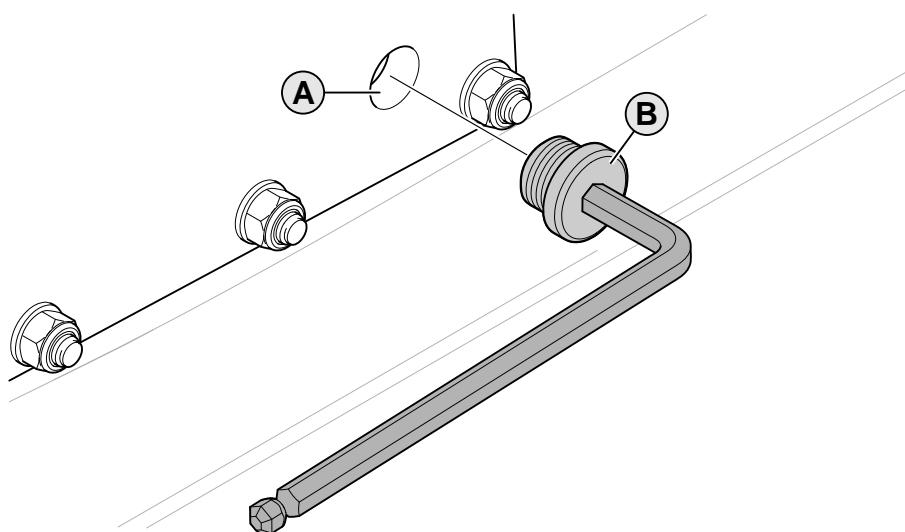
### Conditions

System completely shut off.

Oil container available.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Chief Engineer	Dockside	180 minutes + oil flushing
Spare parts	Quantity	Part number	
Oil filter	1	HS-25300-01	
Breather filter	1	X350-1410-2	
Consumables	Quantity		
Hydraulic oil	Oil volume ~ 12,3 l	See 7.6.3 Oil Specifications for oil quality.	
Cloth	1		
Special tools and test equipment	Quantity	Part number	
Filler unit	1	-	
Reference document			
7.6.3 Oil Specifications			
4.3.9 Hydraulic and Lubrication System, Replace Breather Filter			
7.4 Oil Contamination Limits			
4.3.20 Hydraulic System, Replace Oil Filter			

## Procedure



GEN-2154-01

Figure 55

- 1 Place an oil container under the drain hole (A) and remove the oil plug (B).
- 2 When all oil is drained, install the oil plug (B) to torque 30 Nm.

**Note!**

If draining the tank by this method is not possible, use the hydraulic pump to empty the hydraulic tank.

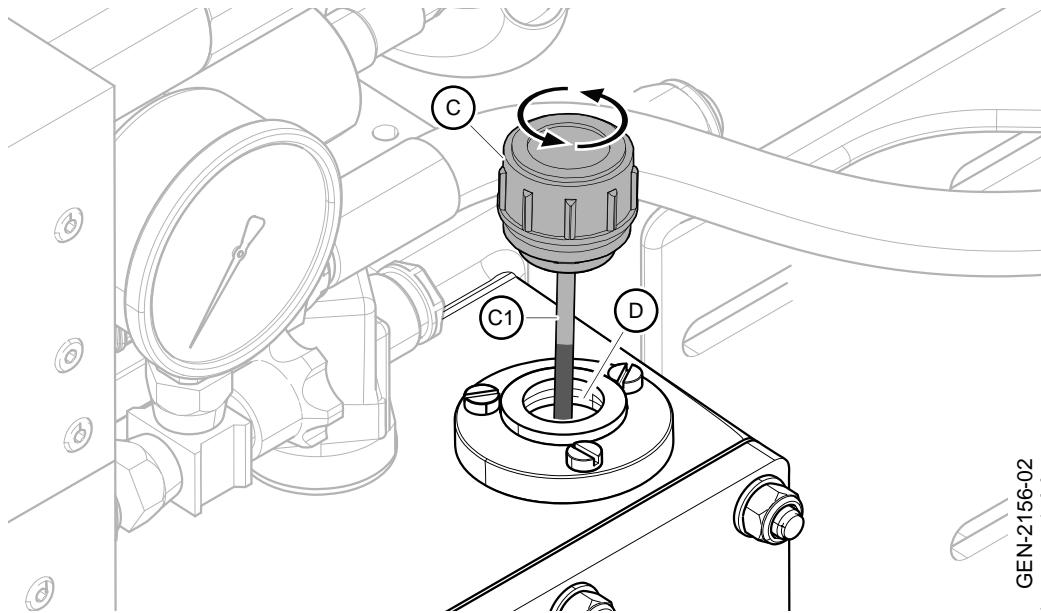


Figure 56

- 3 Make sure you have the right oil. See [7.6.3 Oil Specifications](#).
- 4 Remove the filler breather filter (A) with the attached dipstick.
- 5 Fill with new oil through the breather filter connection.

**Note!**

It is recommended to filter the oil before or upon filling. New oil may contain quite high particle counts.

- 6 Wipe the dipstick clean.
- 7 Install the filler breather filter until it is fully seated and remove it again.
- 8 View the oil level on the dipstick (E) to confirm that the oil level is within the safe operating range.
- 9 Repeat until the oil level is within the safe operating range.
- 10 Replace the breather filter, see [4.3.9 Hydraulic and Lubrication System, Replace Breather Filter](#)
- 11 Install and firmly tighten the new breather filter.
- 12 Replace the oil filter. See [4.3.20 Hydraulic System, Replace Oil Filter](#).
- 13 Start the hydraulic system and make a function test to make sure that the system is working.
- 14 Check the hydraulic pressure. See [Hydraulic System, Inspect Working Pressure in Operation Manual](#).
- 15 Task completed.

### 4.3.13 Thrust Bearing, Add Oil

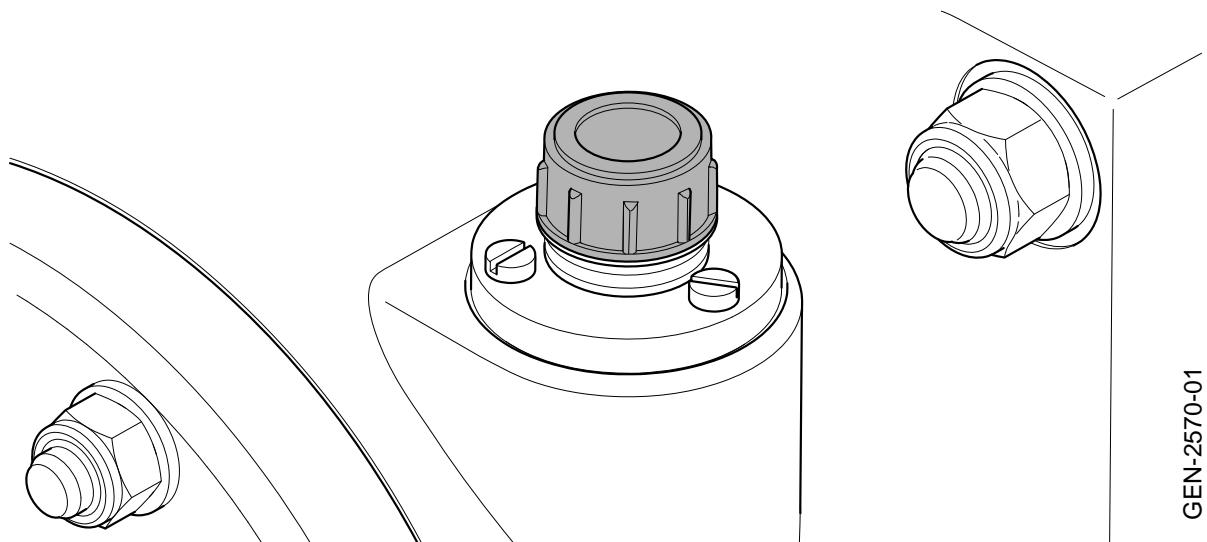


Figure 57

#### Task Summary

The task is to add lubrication oil to the thrust bearing.



#### Warning!

Burn risk! Oil may be hot after operation.

#### Task Interval

Do this task during:

- Corrective maintenance, while docked

#### Prerequisites

##### Conditions

System completely shut off.

Oil container available.

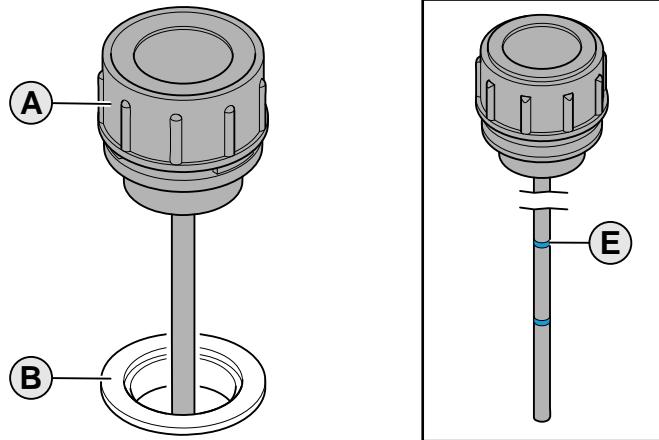
Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Chief engineer	Dockside	30 minutes

Consumables	Quantity	
Lubrication oil	-	See Lubrication oil for oil quality.
Cloth	1	-

Special tools and test equipment	Quantity	Part number
Filler unit	1	-

**Reference document**

*Lubrication oil in 7.6.3 Oil Specifications  
7.4 Oil Contamination Limits*

**Procedure**

GEN-2943-02

Figure 58

- 1 Make sure you have the right oil. See *Lubrication oil in 7.6.3 Oil Specifications*.
  - 2 Remove the breather filter (A) with the attached dipstick (E).
  - 3 Fill with new oil through the breather filter connection (B).
- Note!**  
It is recommended to filter the oil before or upon filling. New oil may contain quite high particle counts.
- 4 Wipe the dipstick (E) clean.
  - 5 Install the breather filter with the dipstick until it is fully seated.
  - 6 View the oil level on the dipstick (E) to confirm that the oil level is within the safe operating range.
  - 7 Repeat steps 2-6 until the oil level is within the safe operating range.
  - 8 Install and firmly tighten the breather filter (A) with the dipstick (E) again.
  - 9 Task completed.

#### 4.3.14 Thrust Bearing, Replace Oil

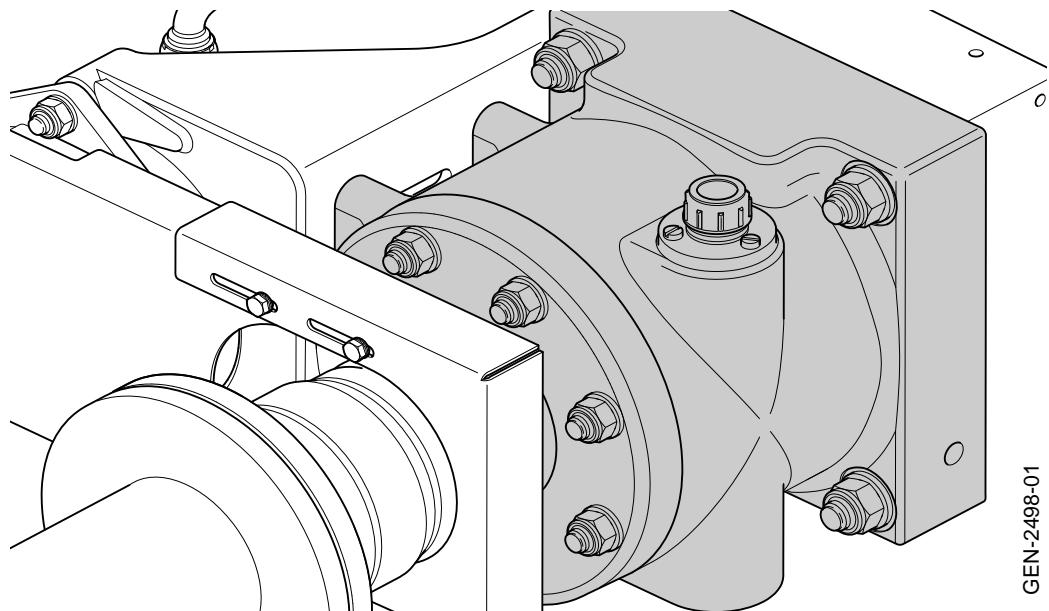


Figure 59

#### Task Summary

The task is to replace the lubrication oil.



##### Warning!

The system must be completely shut off so that the lubrication system is not pressurized. Use safety glasses.



##### Warning!

Burn risk! Oil may be hot.

#### Task Interval

Do this task during:

- Preventive maintenance, every 500 operating hours
- Corrective maintenance, while docked

## Prerequisites

### Conditions

System completely shut off.

Oil container available.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Chief Engineer	Dockside	60 minutes + oil flushing
<b>Spare parts</b>			
Breather filter		Quantity	Part number
Breather filter		1	X350-1410-2
<b>Consumables</b>			
Lubrication oil		Quantity	See <i>Lubrication oil</i> for oil quality.
Cloth		1	-
<b>Special tools and test equipment</b>			
Filler unit		Quantity	Part number
Filler unit		1	-
<b>Reference document</b>			
<i>Lubrication oil</i> in 7.6.3 Oil Specifications			
7.4 Oil Contamination Limits			
4.3.9 Hydraulic and Lubrication System, Replace Breather Filter			

## Procedure

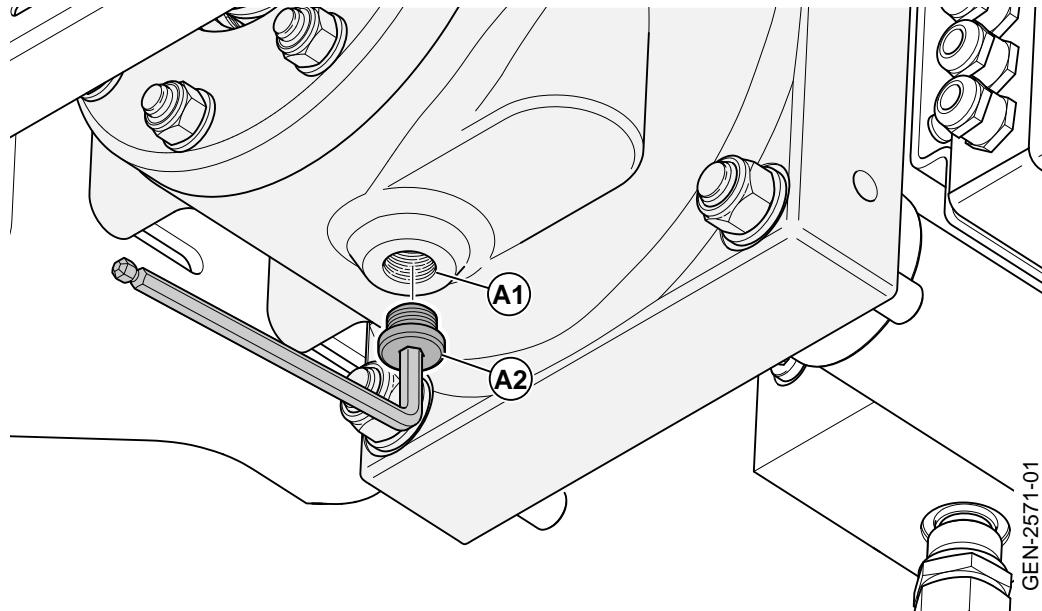
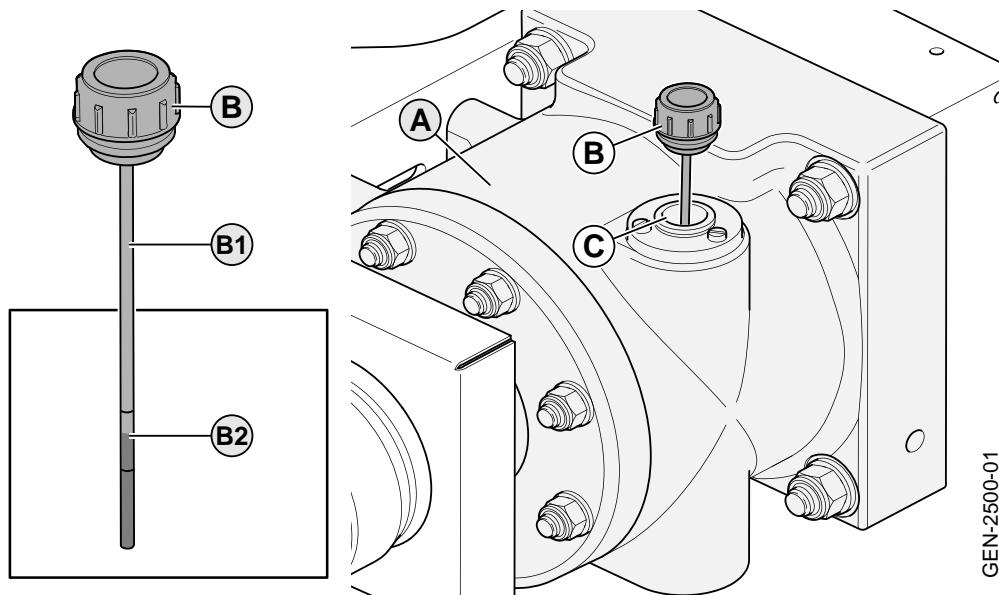


Figure 60

- 1 Place an oil container under the drain hole (A1) and remove the oil plug (A2).
- 2 If the drained oil is very dirty, do a flush of the thrust bearing from underneath through the drain hole.
- 3 When all oil is drained, install the oil plug (A2) to torque 30 Nm.



GEN-2500-01

Figure 61

- 4 Make sure you have the right oil. See [7.6.3 Oil Specifications](#).
- 5 Remove the breather filter (B) with the attached dipstick (B1).
- 6 Fill with new oil through the breather filter connection (C).

**Note!**

It is recommended to filter the oil before or upon filling. New oil may contain quite high particle counts.

- 7 Wipe the dipstick (B1) clean.
- 8 Install the breather filter with the dipstick until it is fully seated.
- 9 View the oil level on the dipstick (B1) to confirm that the oil level is within the safe operating range.
- 10 Repeat steps 4-8 until the oil level is within the safe operating range.
- 11 Inspect the breather filter:
  - 11.1 If breather filter is dirty or clogged, clean the breather filter.
  - 11.2 If breather filter is broken, replace the breather filter, see [4.3.9 Hydraulic and Lubrication System, Replace Breather Filter](#)
- 12 Install and firmly tighten the breather filter (B) with the dipstick (B1) again.
- 13 Task completed.

### 4.3.15 Hydraulic Tank, Inspect Oil Level Switch

#### Task Summary

The task is to inspect the oil level switch.

#### Task Interval

Do this task during:

- Preventive maintenance, annually

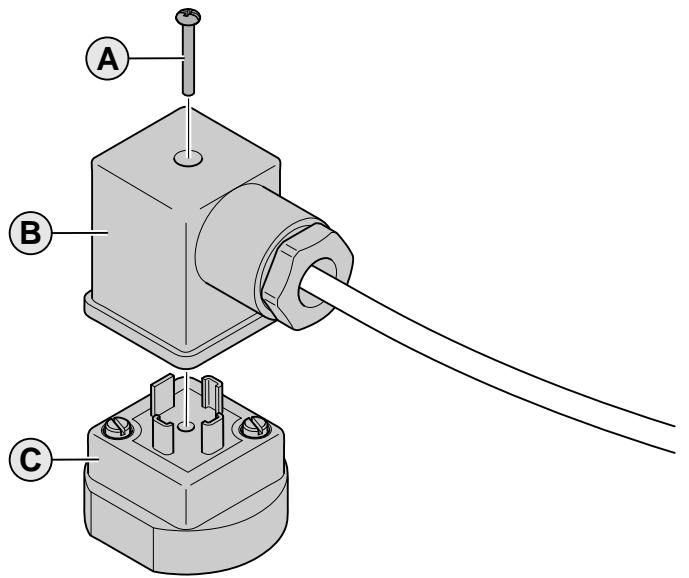
#### Prerequisites

##### Conditions

Control system power on.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Chief Engineer	Dockside	10 minutes

#### Procedure

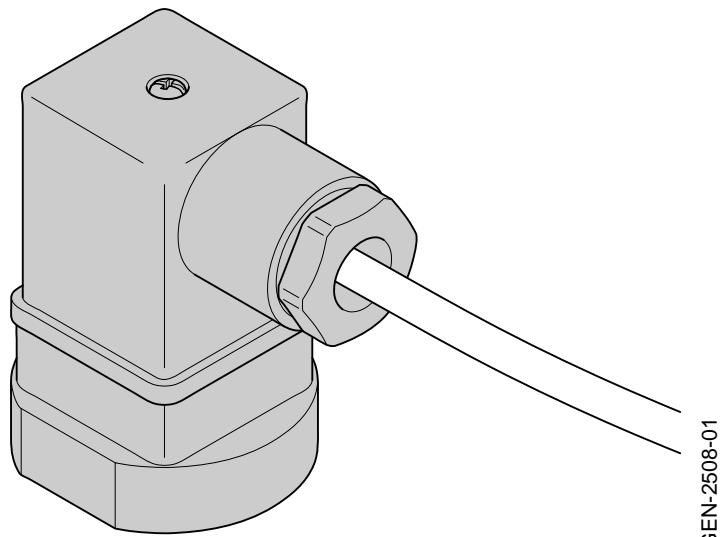


GEN-2509-01

Figure 62

- 1 Remove the screw (A) from the cable connector (B).
- 2 Disconnect the cable connector (B) from the contacts on the oil level switch (C). If an alarm is raised the alarm pathway is functional.
- 3 Install the cable connector.
- 4 Task completed.

#### 4.3.16 Hydraulic Tank, Replace Oil Level Switch



GEN-2508-01

Figure 63

#### Task Summary

The task is to replace the oil level switch.

#### Task Interval

Do this task during:

- Corrective maintenance

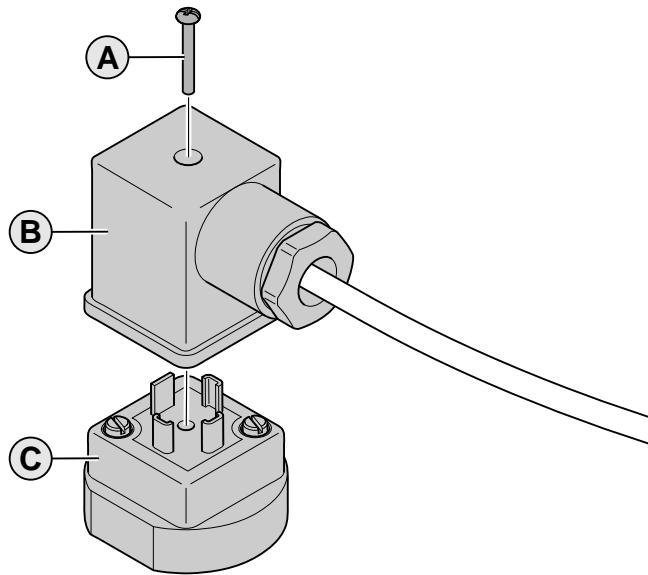
#### Prerequisites

##### Conditions

System completely shut off.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Chief Engineer	Dockside	20 minutes
Spare parts	Quantity	Part number	
Hydraulic oil level alarm switch	1	HS-25540-01	

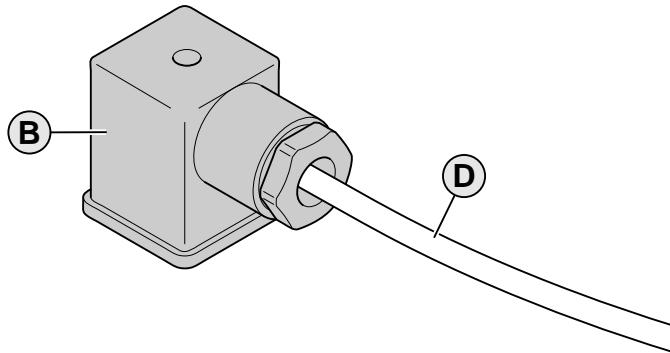
## Procedure



GEN-2509-01

Figure 64

- 1 Remove the screw (A) from the top of the cable connector (B).
- 2 Disconnect the cable connector (B) from the contact on the oil level switch (C).



GEN-2510-01

Figure 65

- 3 Remove the cable connector (B) from the alarm cable (D).
- 4 Install the new cable connector (B) on the alarm cable (D).

GEN-2511-01

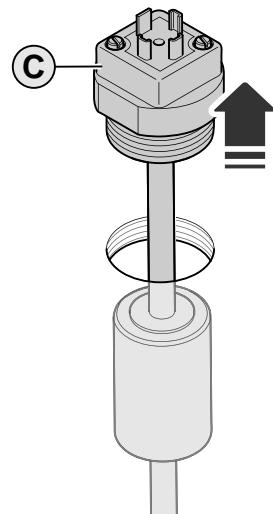


Figure 66

- 5 Unscrew the oil level switch (C) to remove it from the hydraulic tank.
- 6 Install the new oil level switch on the hydraulic tank.
- 7 Connect the cable connector (B) to the oil level switch (C).
- 8 Start the control system.
- 9 Check the new switch by disconnecting the cable connector (B) from the contact on the oil level switch (C). If an alarm is raised, the new switch is working.
- 10 Connect the cable connector (B) to the oil level switch (C).
- 11 Install the screw (A) to attach the cable connector (B) to the oil level switch (C).
- 12 Task completed.

### 4.3.17 Hydraulic System, Inspect Pressure Limit

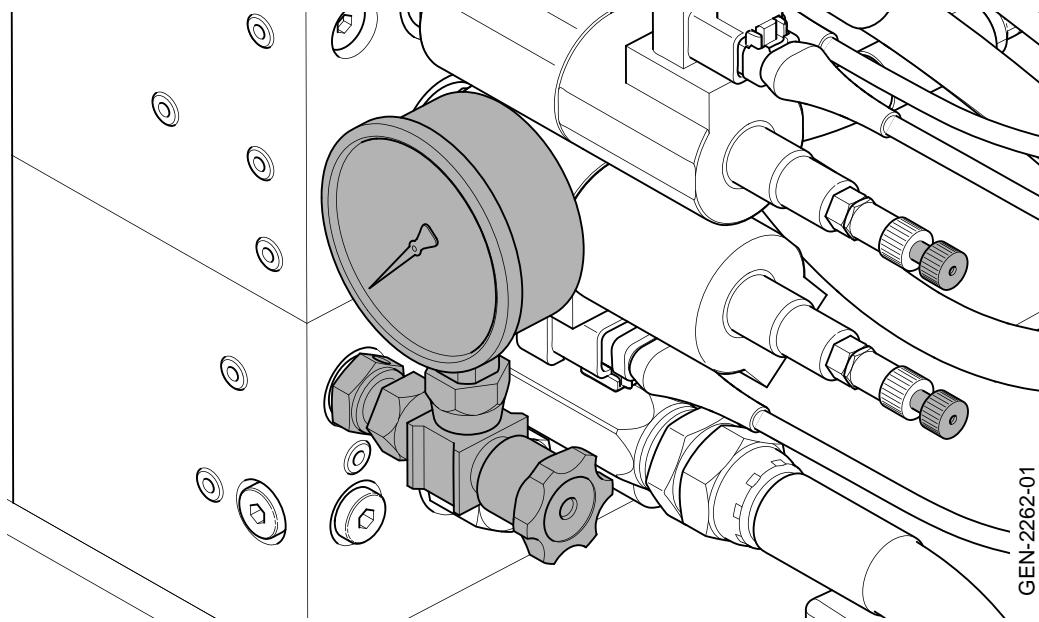


Figure 67

#### Task Summary

The task is to inspect the hydraulic pressure limit.

There is a pressure limit valve in the system that is activated at 180 bar if the normal pressure regulator fails.

#### Task Interval

Do this task during:

- Preventive maintenance, annually
- Corrective maintenance

#### Prerequisites

##### Conditions

Main engine running.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Authorized Service Technician	Dockside	20 minutes

#### Procedure

The complete procedure can be found in the **Workshop Manual**.

When the crew have performed qualified training by Marine Jet Power, a more extensive **Workshop Manual** covering also the qualified maintenance tasks, can be obtained from Marine Jet Power.

### 4.3.18 Hydraulic System, Adjust Pressure Limit

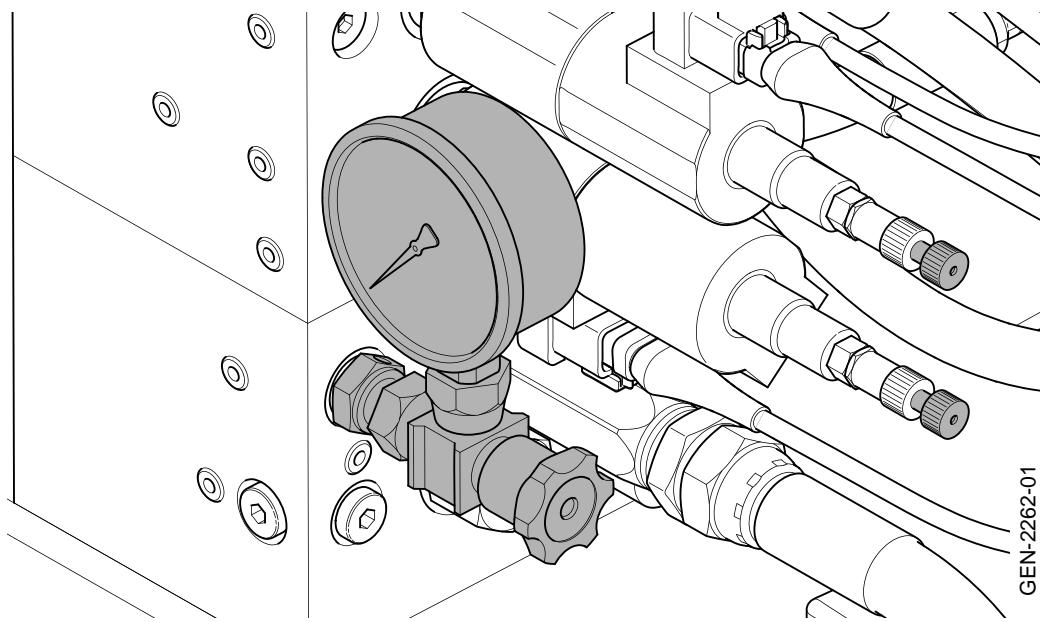


Figure 68

#### Task Summary

The task is to adjust the hydraulic pressure limit.

There is a pressure limit valve in the system that is activated at 180 bar if the normal pressure regulator fails.

#### Task Interval

Do this task during:

- Preventive maintenance, annually
- Corrective maintenance

#### Prerequisites

##### Conditions

Main engine running.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Authorized Service Technician	Dockside	20 minutes

#### Procedure

The complete procedure can be found in the **Workshop Manual**.

When the crew have performed qualified training by Marine Jet Power, a more extensive **Workshop Manual** covering also the qualified maintenance tasks, can be obtained from Marine Jet Power.

### 4.3.19 Hydraulic System, Inspect Pressure Gauge, Replace Defect Pressure Gauge

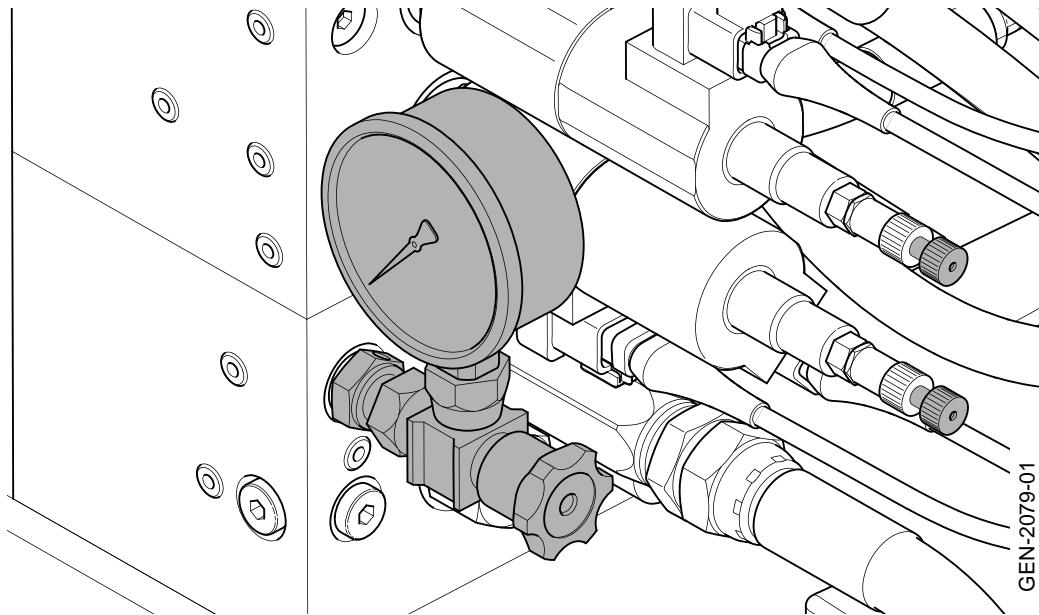


Figure 69

#### Task Summary

The task is to test the pressure gauge with a gauge test equipment.

If the pressure gauge is defect it should be replaced.

#### Task Interval

Do this task during:

- Preventive maintenance, every 5th year
- Corrective maintenance

#### Prerequisites

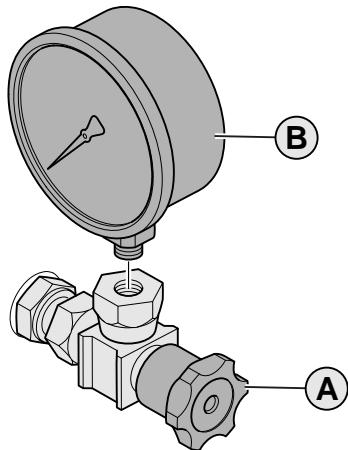
##### Conditions

Hydraulic system off.

Personnel number	Skill level	Maintenance facility level (choose one)	Estimated time
1	Chief Engineer	On equipment / at sea	30 minutes
Consumables	Quantity	Part number	
Wipes and cloths	-	-	
Protection plug	1	-	
Spare parts	Quantity	Part number	
Hydraulic pressure gauge	1	HS-22554-24	

Special tools and test equipment	Quantity	Part number
Gauge test equipment	1	-

## Procedure



GEN-2095-01

Figure 70



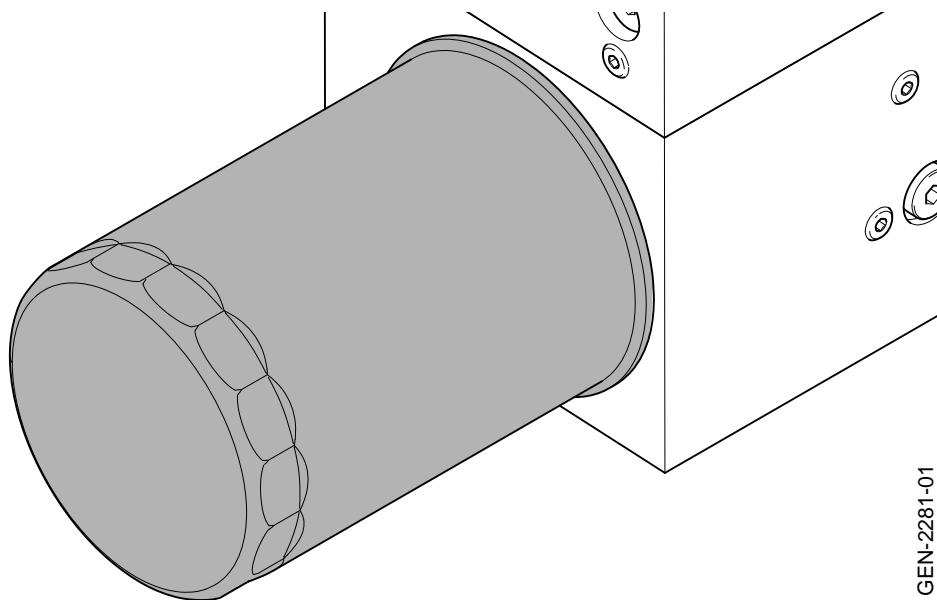
**Warning!**  
Pressurized system!

- 1 Remove the pressure gauge (B):
  - 1.1 Turn the needle valve (A) clockwise to close it.
  - 1.2 Use a wrench to remove the pressure gauge (B).
  - 1.3 Put a protection plug in the gauge connection.
- 2 Do a functional test of the pressure gauge:
  - 2.1 Connect the pressure gauge (B) to the gauge test equipment.
  - 2.2 Use the gauge test equipment.

**Note!**  
To use the gauge test equipment, refer to manufacturer's instructions.

  - 2.3 Remove the pressure gauge from the gauge test equipment.
  - 2.4 If the test shows that the pressure gauge (B) values are different more than 10%, then replace the pressure gauge.
- 3 Install the old or the new pressure gauge:
  - 3.1 Remove the protection plug from the gauge connection.
  - 3.2 Use a wrench to install the pressure gauge (B).
  - 3.3 Turn the valve (A) to open it.
- 4 Task completed.

### 4.3.20 Hydraulic System, Replace Oil Filter



GEN-2281-01

Figure 71

#### Task Summary

The task is to replace the oil filter.



##### Warning!

Pressurized system! The system must be completely shut off so that the hydraulic system is not pressurized. Use safety glasses.

#### Task Interval

Do this task during:

- Preventive maintenance, annually
- Corrective maintenance

#### Prerequisites

##### Conditions

The system is completely shut off.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Chief Engineer	Dockside	10 minutes
Spare parts	Quantity	Part number	
Oil filter cartridge	1	HS-25300-01	
Consumables	Quantity	Part number	
Cloth	1	-	
Bucket	1	-	

**Reference document**

Hydraulic System, Inspect Oil Level in Operation Manual.

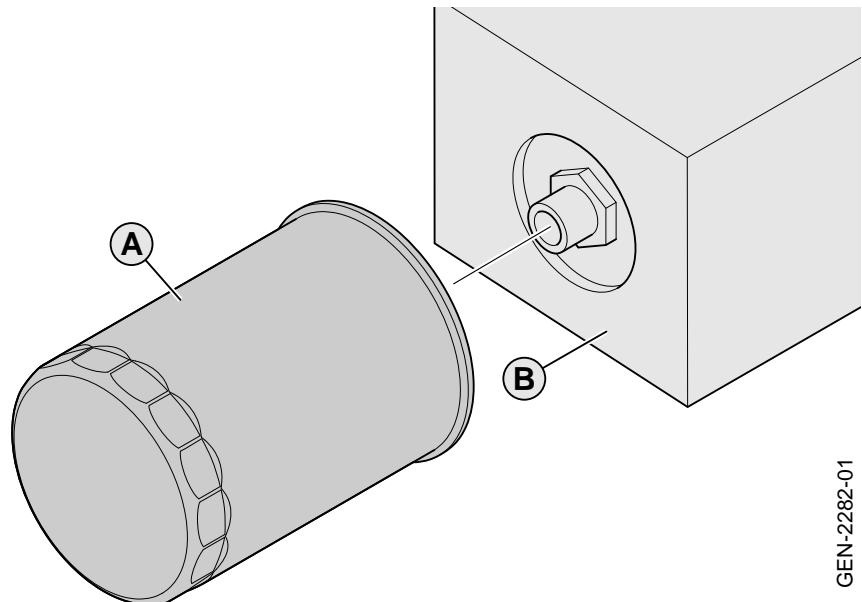
**Procedure**

Figure 72

- 1 Put a tray or an absorbing cloth under the oil filter (A) to collect any oil spill.
- 2 Turn the oil filter (A) counterclockwise to remove it from the valve block (B).
- 3 Install a new oil filter on the valve block (B). Tighten by hand.
- 4 Start the system.
- 5 Examine for leaks. Tighten connections.
- 6 Check the oil level. See *Hydraulic System, Inspect Oil Level* in Operation Manual.
- 7 Task completed.

### 4.3.21 Hydraulic System, Replace Directional Control Valves

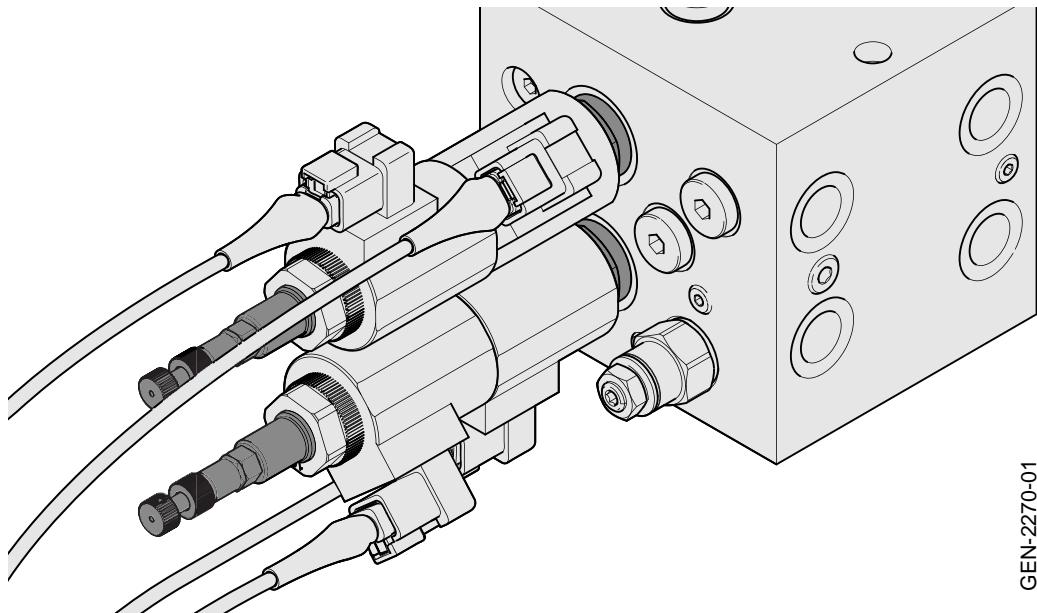


Figure 73

#### Task Summary

The task is to replace the directional control valves.

#### Task Interval

Do this task during:

- Corrective maintenance

#### Prerequisites

##### Conditions

The system is completely shut off.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Authorized Service Technician	Dockside	10 minutes
Spare parts	Quantity	Part number	
Bucket valve	1	HS-25410-07	
Nozzle valve	1	HS-25410-03	

#### Procedure

The complete procedure can be found in the **Workshop Manual**.

When the crew have performed qualified training by Marine Jet Power, a more extensive **Workshop Manual** covering also the qualified maintenance tasks, can be obtained from Marine Jet Power.

### 4.3.22 Hydraulic System, Replace Load Control Valves

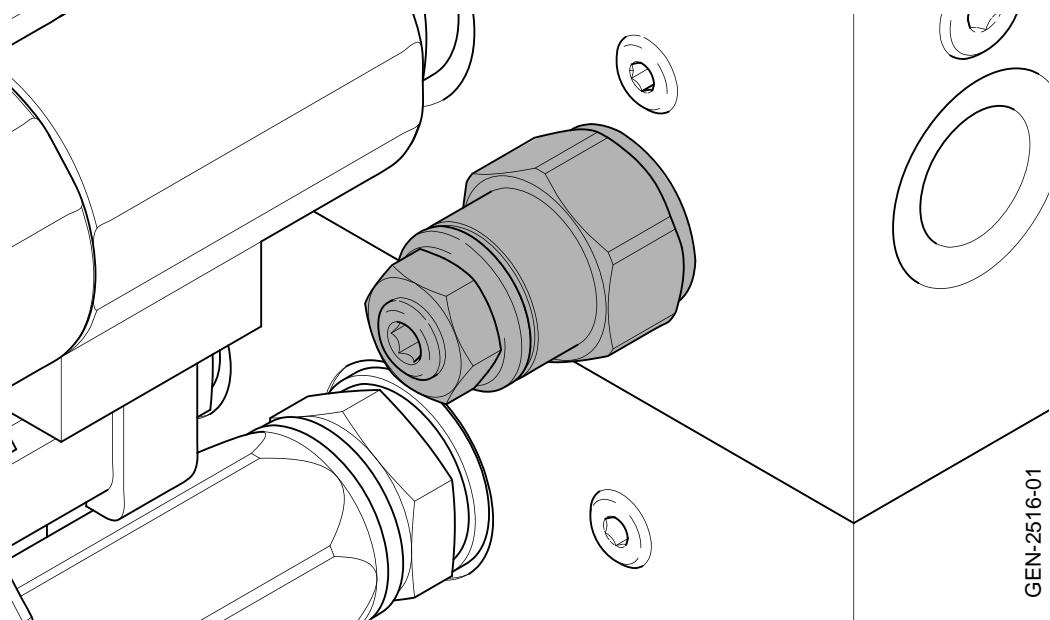


Figure 74

#### Task Summary

The task is to replace the load control valves.

#### Task Interval

Do this task during:

- Corrective maintenance

#### Prerequisites

##### Conditions

The system is completely shut off.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Authorized Service Technician	Dockside	10 minutes
Spare parts	Quantity	Part number	
Over Centre Valve	2	HS-25410-08	

#### Procedure

The complete procedure can be found in the **Workshop Manual**.

When the crew have performed qualified training by Marine Jet Power, a more extensive **Workshop Manual** covering also the qualified maintenance tasks, can be obtained from Marine Jet Power.

### 4.3.23 Hydraulic System, Replace Solenoid Coils

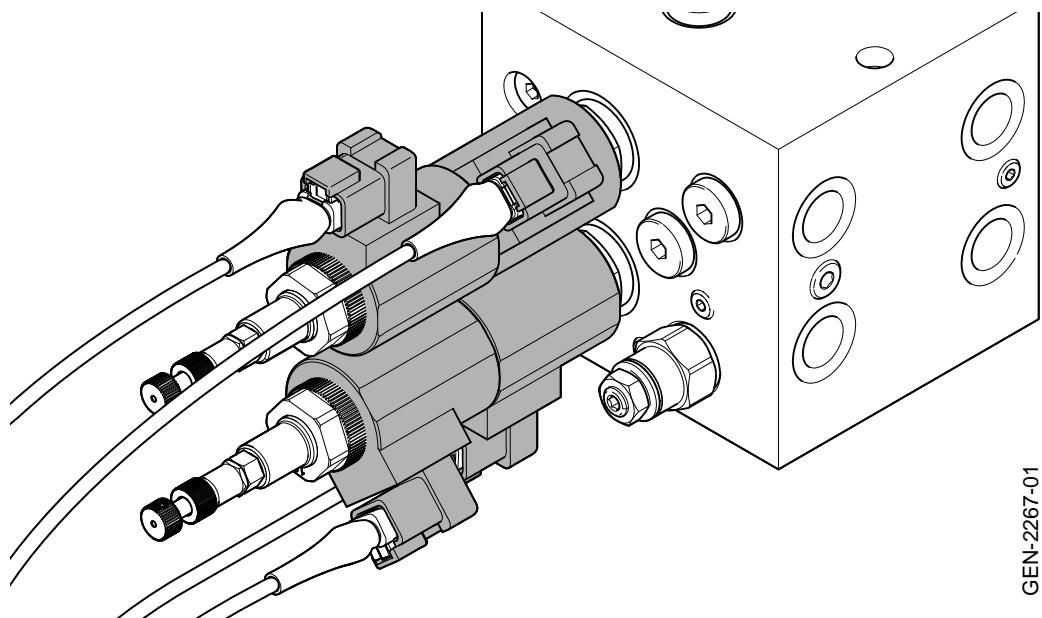


Figure 75

#### Task Summary

The task is to replace the solenoid coils.

#### Task Interval

Do this task during:

- Corrective maintenance

#### Prerequisites

##### Conditions

The system is completely shut off.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Authorized Service Technician	Dockside	10 minutes
Spare parts	Quantity	Part number	
Solenoid coil	4	HS-25410-05	

#### Procedure

The complete procedure can be found in the **Workshop Manual**.

When the crew have performed qualified training by Marine Jet Power, a more extensive **Workshop Manual** covering also the qualified maintenance tasks, can be obtained from Marine Jet Power.

## 4.3.24 Hydraulic Pump, Inspect

### Task Summary

The task is to do a general inspection of the hydraulic pump.

### Task Interval

Do this task during:

- Preventive maintenance, yearly.
- Corrective maintenance, while docked

### Prerequisites

#### Conditions

The system is completely shut off.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Chief Engineer	Dockside	40 minutes
Consumables	Quantity	Part number	
Cloth	-	-	

### Procedure

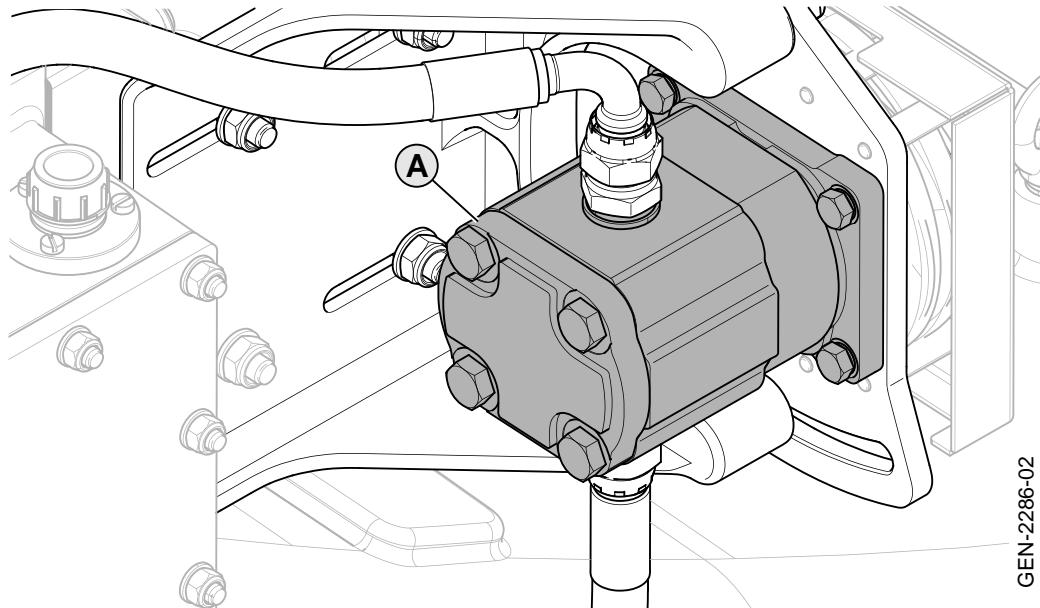


Figure 76

- 1 Inspect the pump and the connections for oil leaks. Repair any leakage immediately or replace the pump. See 4.3.25 Hydraulic System, Replace the Pump
- 2 Task completed.

### 4.3.25 Hydraulic System, Replace the Pump

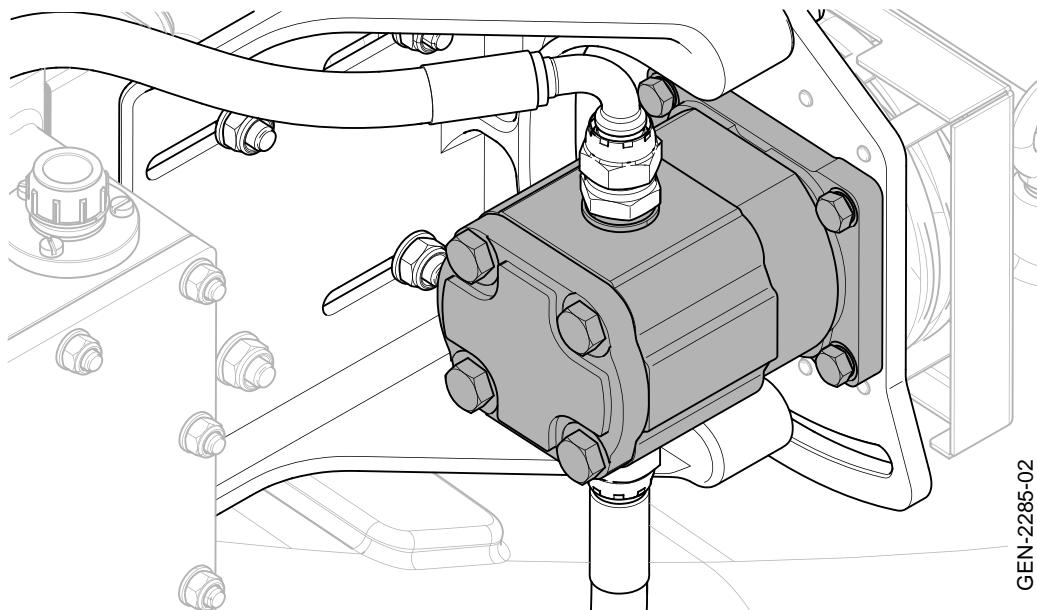


Figure 77

#### Task Summary

The task is to replace the hydraulic pump.



**Warning!**  
Pressurized system! Use safety glasses.



**Warning!**  
Hot hydraulic fluid! Burn risk.



**Warning!**  
Flammable! Hydraulic oil is flammable.

#### Task Interval

Do this task during:

- Corrective maintenance

## Prerequisites

### Conditions

The system is completely shut off.

Bucket available.

Personnel number	Skill level	Maintenance facility level (choose one)	Estimated time
1	Authorized Service Technician	Dock, workshop / dry dock	60 min

### Spare parts

	Quantity	Part number
Hydraulic Pump	1	HS-25220-06

### Consumables

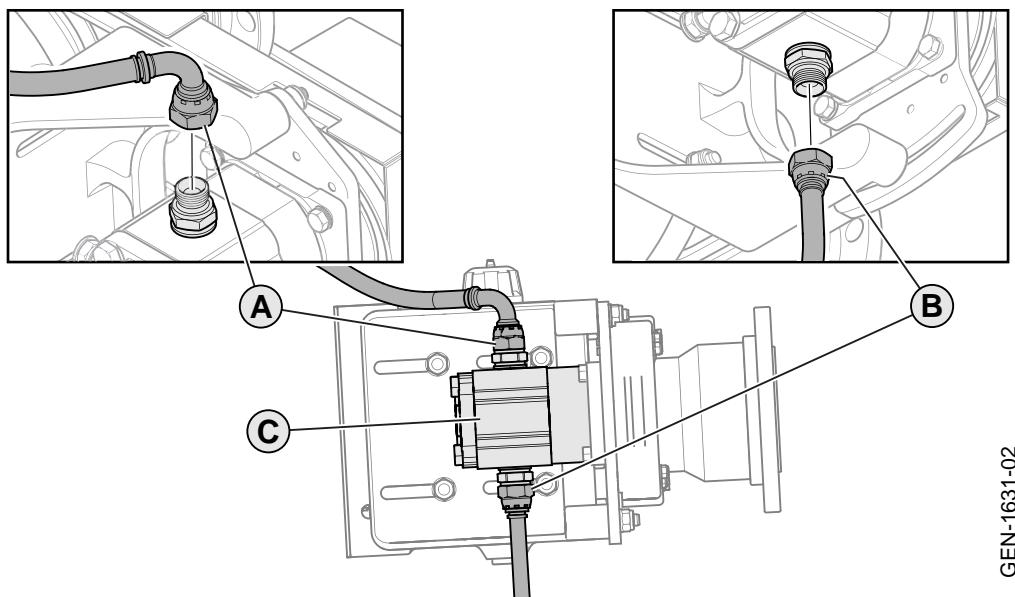
	Quantity	Part number
Wipes and cloths	-	-
Protection plugs for hoses and tubes	-	-

### Reference document

Hydraulic System, Inspect Oil Level in Operation Manual

4.3.18 *Hydraulic System, Adjust Pressure Limit*

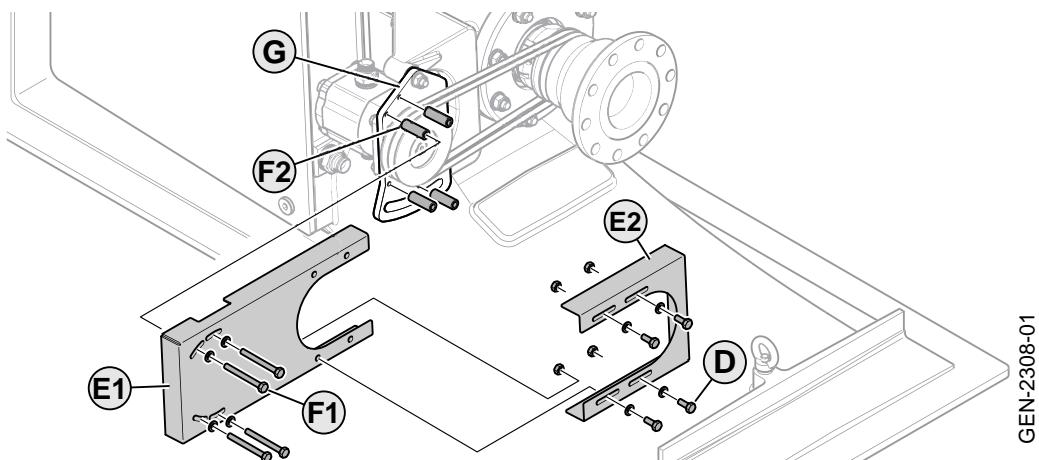
## Procedure



GEN-1631-02

Figure 78

- 1 Remove hydraulic hose connectors (A) and (B) from hydraulic pump (C). Drain excess oil in a bucket and install protection plugs on both hoses and fittings on pump.



GEN-2308-01

Figure 79

- 2 Remove the screws, nuts and washers (D) from the belt guard sections (E1) and (E2).
- 3 Remove the belt guard section (E2) from the belt guard section (E1).
- 4 Remove the screws, washers (F1), spacers (F2) and belt guard section (E1) from the pump plate (G).

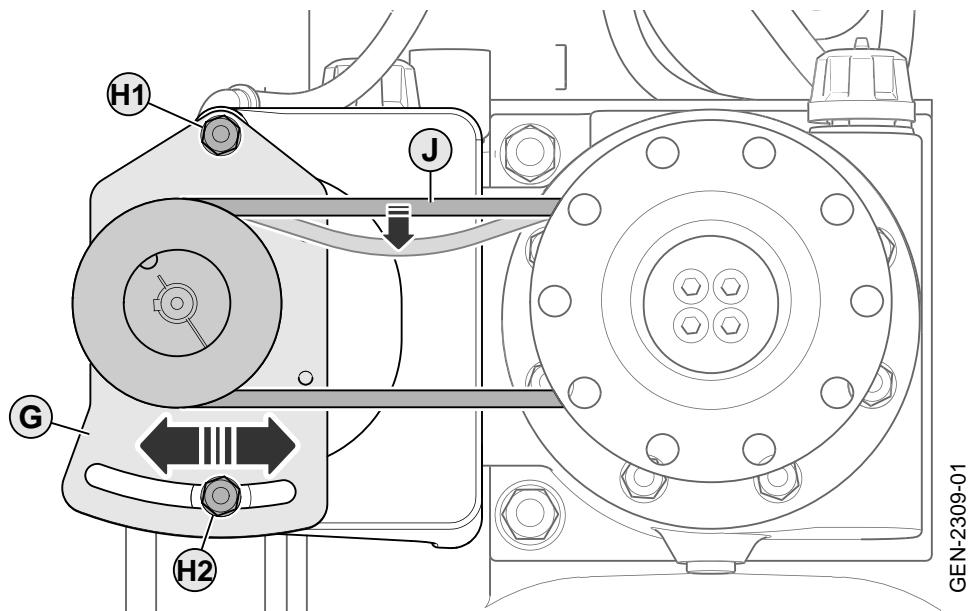


Figure 80

- 5 Loosen the nuts (H1) and (H2) on the pump plate (G).
- 6 Move the pump plate (G) and the pump to the right until the V-belts (J) are loose.
- 7 Remove the V-belts (J).

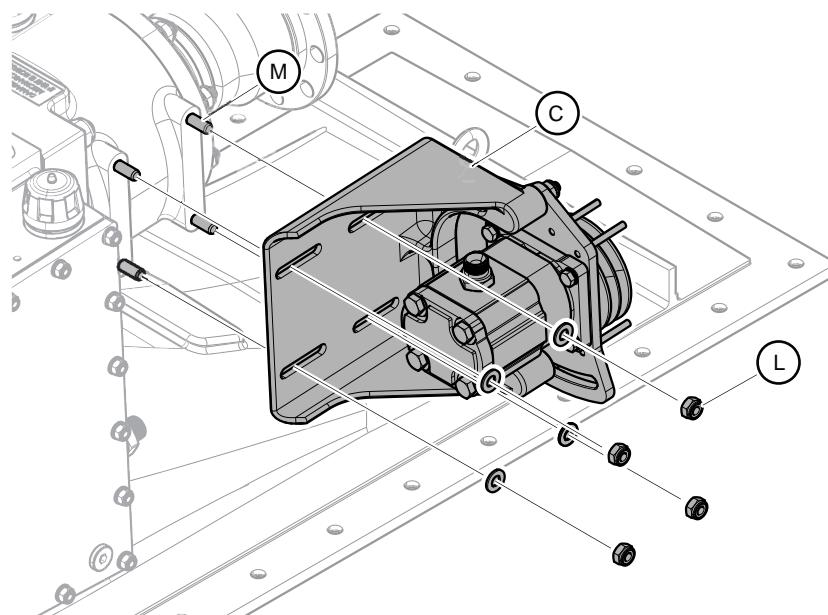


Figure 81

- 8 Remove the nuts and washers (L).
- 9 Remove the pump bracket and hydraulic pump (C) from the threaded pins (M)
- 10 Install the new pump bracket and hydraulic pump on the threaded pins (M).
- 11 Apply Loctite® 243 to the nuts (L).
- 12 Install the nuts and washers (L) again. Torque to 34 Nm.

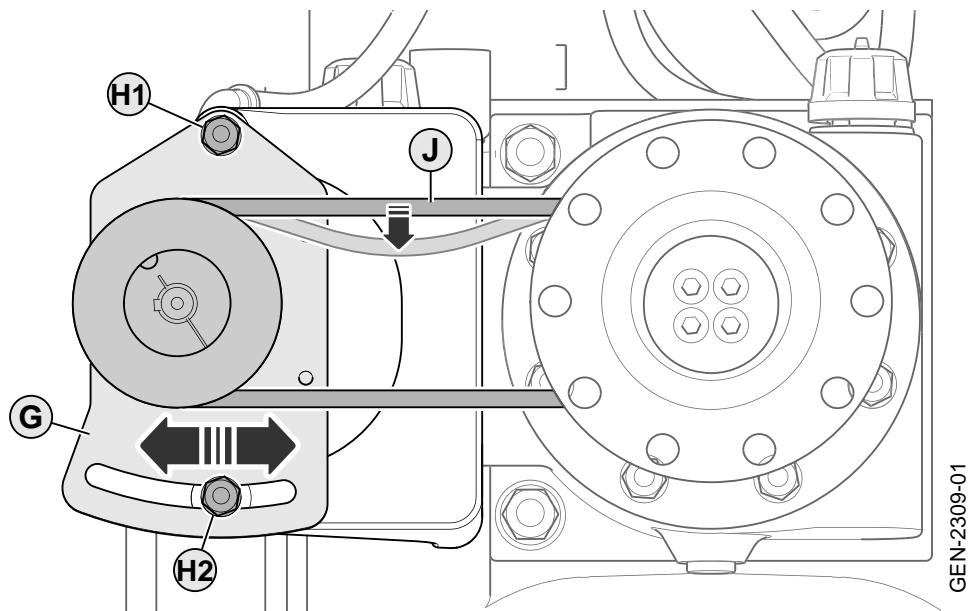


Figure 82

- 13 Loosen the nuts (H1) and (H2) from the pump plate (G).
- 14 Install the V-belts (J).
- 15 Move the pump plate (G) and the pump to the left until the V-belts are tightened.
- 16 Push down on the V-belts to measure the deflection and adjust the pump plate (G) and pump until the deflection of the V-belts is 4–8 mm.
- 17 Tighten the nut (H2).
- 18 Make sure that the deflection is correct. If not, loosen the nut (H2) and repeat step 16
- 19 Tighten the nuts (H1) and (H2) to 31–34 Nm.

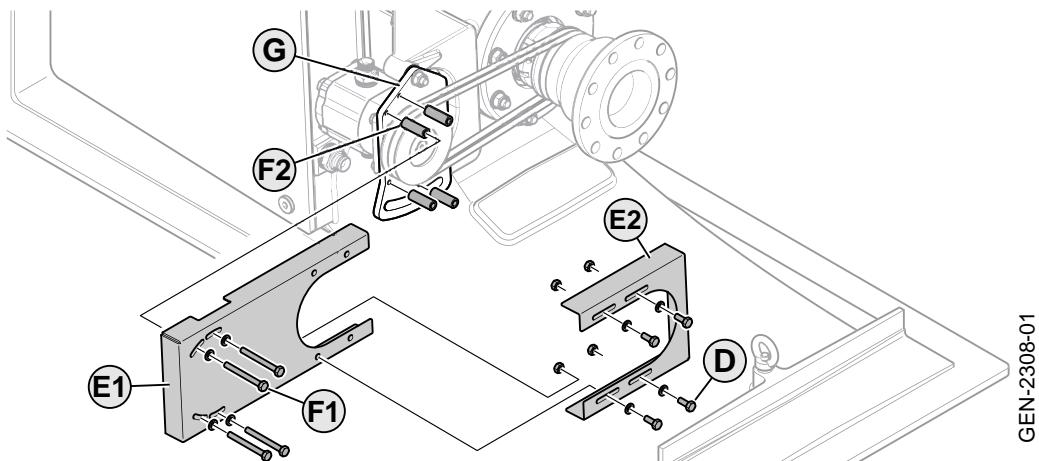


Figure 83

- 20 Install the screws, washers (F1) and spacers (F2) on the threaded pins of the pump plate (G) to attach the belt guard section (E1).
- 21 Align the belt guard section (E2) to the belt guard section (E1).
- 22 Install the screws, nuts and washers (D) to the belt guard sections (E1) and (E2).

GEN-1631-02

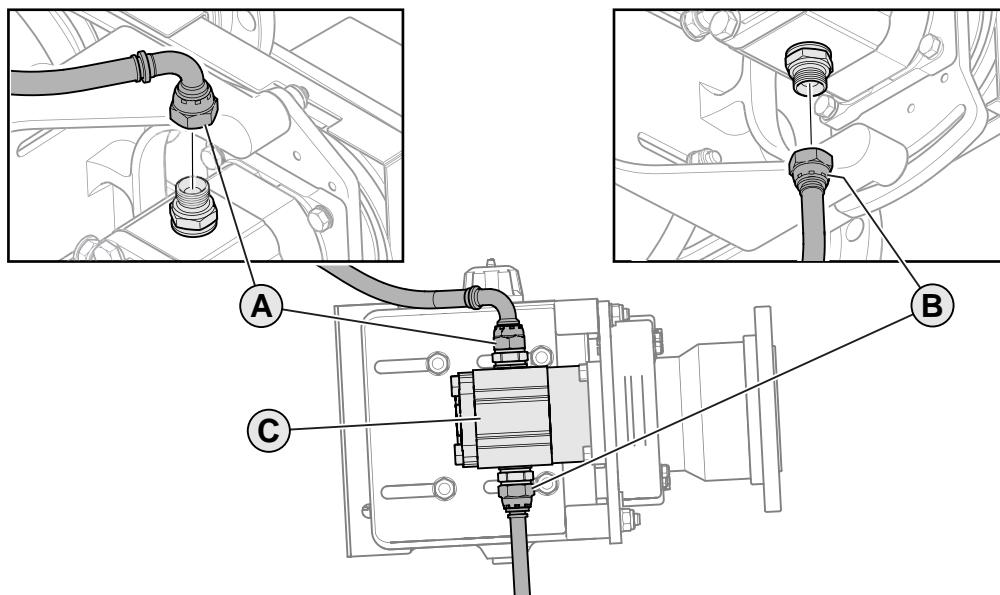


Figure 84

- 23 Apply Molykote 111 compound to the hose connectors (A) and (B).
- 24 Remove plugs on both hoses and fittings. Install hydraulic hose (B) to pump.
- 25 The hydraulic pump must be filled with hydraulic oil through fitting (A), fill it up completely.
- 26 Install hydraulic hose (A) to pump.
- 27 Torque the hose connectors to 21 Nm.
- 28 Inspect the oil level. See *Hydraulic System, Inspect Oil Level* in Operation Manual.
- 29 Start the system and adjust working and standby pressure. See and *4.3.18 Hydraulic System, Adjust Pressure Limit*.
- 30 Task completed.

### 4.3.26 V-Belts, Inspect and Adjust

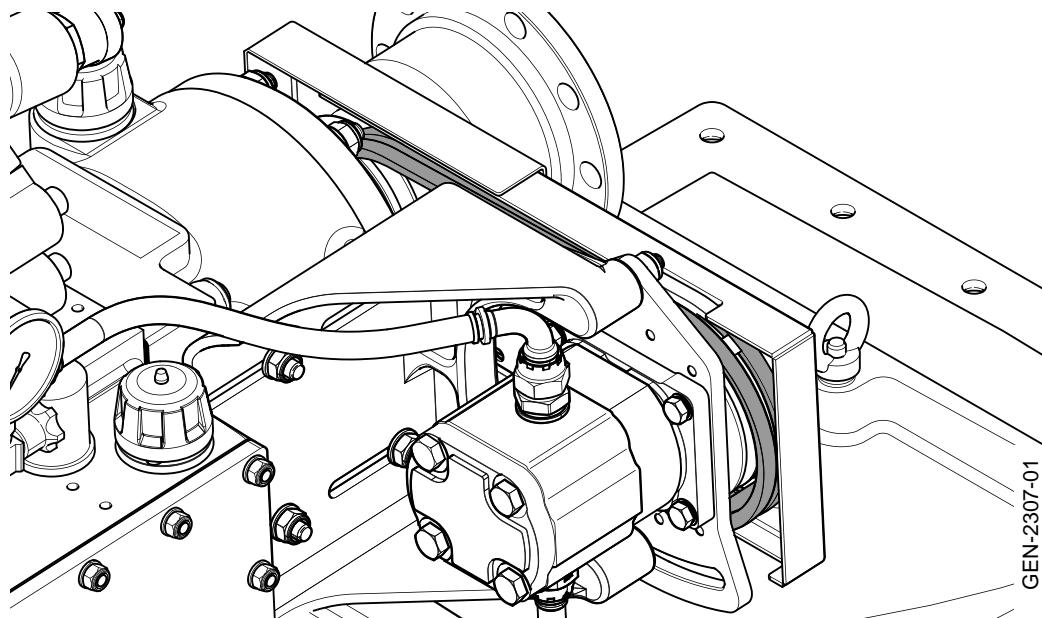


Figure 85

#### Task Summary

The task is to inspect and if needed, to adjust the V-belts.

#### Task Interval

Do this task during:

- Preventive maintenance, annually
- Corrective maintenance

#### Prerequisites

##### Conditions

The system is completely shut off.

Personnel number	Skill level (choose one)	Maintenance facility level (choose one)	Estimated time
1	Chief Engineer	Dock, workshop / dry dock	60 min

## Procedure

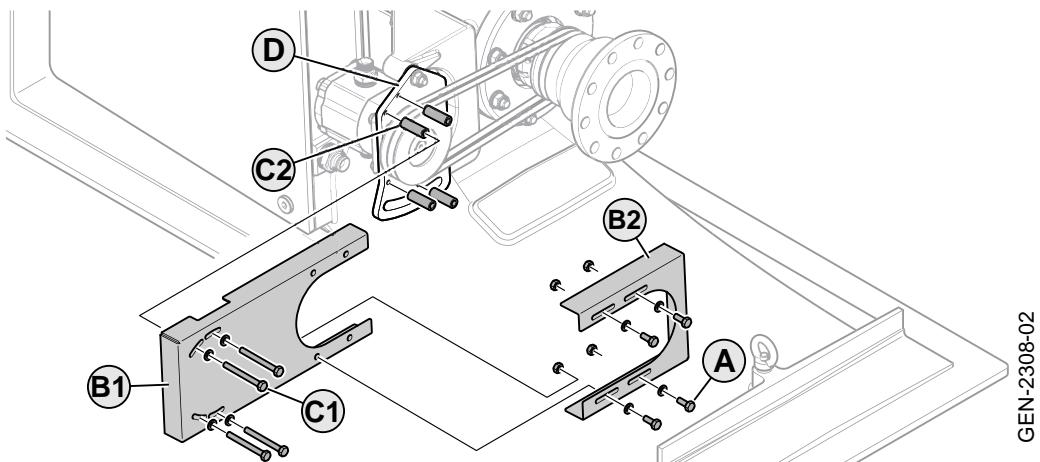


Figure 86

- 1 Remove the screws, nuts and washers (A) from the belt guard sections (B1) and (B2).
- 2 Remove the belt guard section (B2) from the belt guard section (B1).
- 3 Remove the nuts, washers (C1), spacers (C2) and belt guard section (B1) from the pump plate (D).

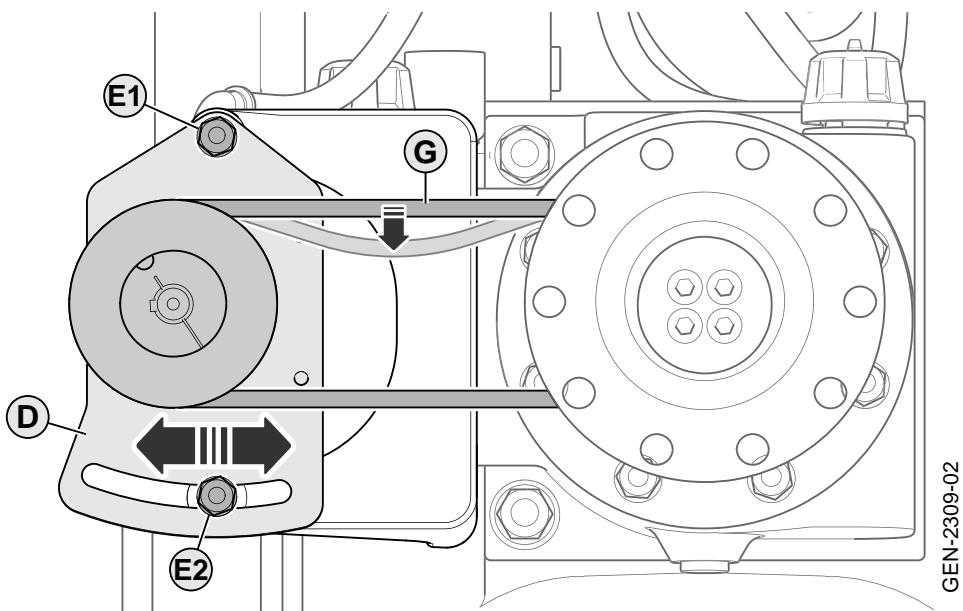
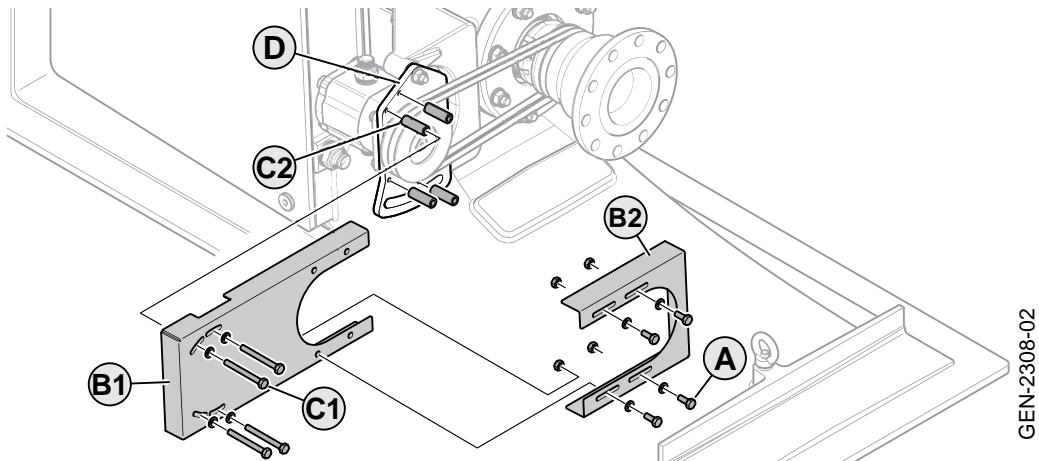


Figure 87

- 4 Push down on the V-belts (G) to measure the deflection.
- 5 If the measured deflection on the V-belts is not within 4-8 mm, loosen the nuts (E1) and (E2) on the pump plate (D).
- 6 Push down on the V-belts (G) to measure the deflection and adjust the pump plate (D) and the pump until the deflection of the V-belts is 4-8 mm.
- 7 Tighten the nut (E2).
- 8 Make sure that the deflection is correct. If not, loosen the nut (E2) and repeat steps 6 to 8.
- 9 Tighten the nuts (E1) and (E2) to torque 31-34 Nm.



GEN-2308-02

Figure 88

- 10 Install the nuts, washers (C1) and the spacers (C2) to attach the belt guard section (B1) to the pump plate (D).
- 11 Align the belt guard section (B2) to the belt guard section (B1).
- 12 Install the screws, nuts and washers (A) to the belt guard sections (B1) and (B2).
- 13 Task completed.

### 4.3.27 V-Belts, Replace

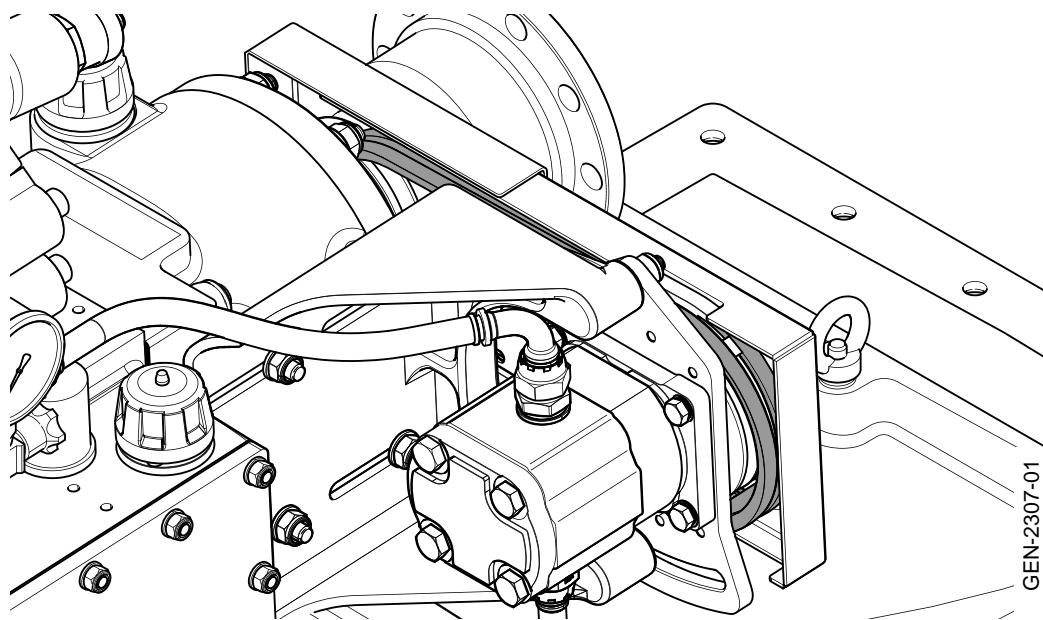


Figure 89

#### Task Summary

The task is to replace the V-belts.

#### Task Interval

Do this task during:

- Preventive maintenance, every 5th year. Also replace of spare belts, that is put around the shaft and fastened to the belt guard.
- Corrective maintenance. Change of belts to spare belts.

#### Prerequisites

##### Conditions

Intermediate shaft removed to allow replace belts to be installed around drive shaft when changing all belts every 5th year.

System completely shut down for changing to spare belts.

Personnel number	Skill level	Maintenance facility level (choose one)	Estimated time
1	Change of V-belts to spare belts: Chief Engineer	Dock, workshop / dry dock	60 min
1	V-belts, replace: Authorized Service Technician	Dock, workshop / dry dock	60 min
Spare parts	Quantity		Part number
V-Belts	4, including 2 spare belts		9611-625-00T

## Procedure

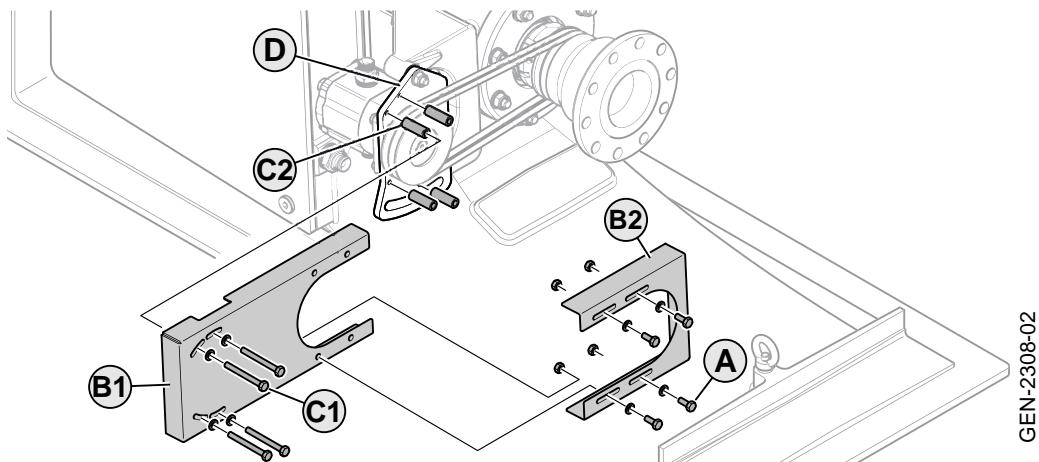


Figure 90

### 1 Remove the V-belts.

- 1.1 Remove the screws, nuts and washers (A) from the belt guard sections (B1) and (B2).
- 1.2 Remove the belt guard section (B2) from the belt guard section (B1).
- 1.3 Remove the bolts, washers (C1), spacers (C2) and belt guard section (B1) from the pump plate (D).

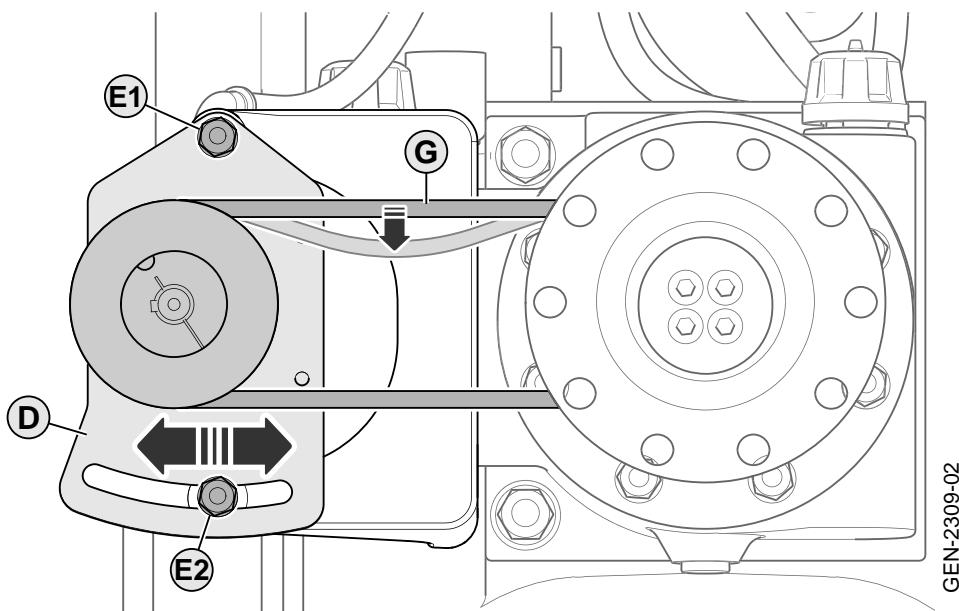


Figure 91

- 1.4 Loosen the nuts (E1) and (E2) on the pump plate (D).
- 1.5 Move the pump plate (D) and the pump to the right until the V-belts (G) are loose.
- 1.6 Remove the V-belts (G) including the spare belts if they are unused.

### 2 Install the new V-belts.

- 2.1 Move the pump plate (D) and the pump to the left until the V-belts (G) are tightened.
- 2.2 Tighten the nut (E1).
- 2.3 Push down on the V-belts (G) to measure the deflection and adjust the pump plate (D) and pump until the deflection of the V-belts is 4–8 mm.

- 2.4 Tighten the nut (E2).
- 2.5 Make sure that the deflection is correct. If not, loosen the nut (E2) and repeat step 2.3 to 18.
- 2.6 Tighten the nuts (E1) and (E2) to 31–34 Nm.

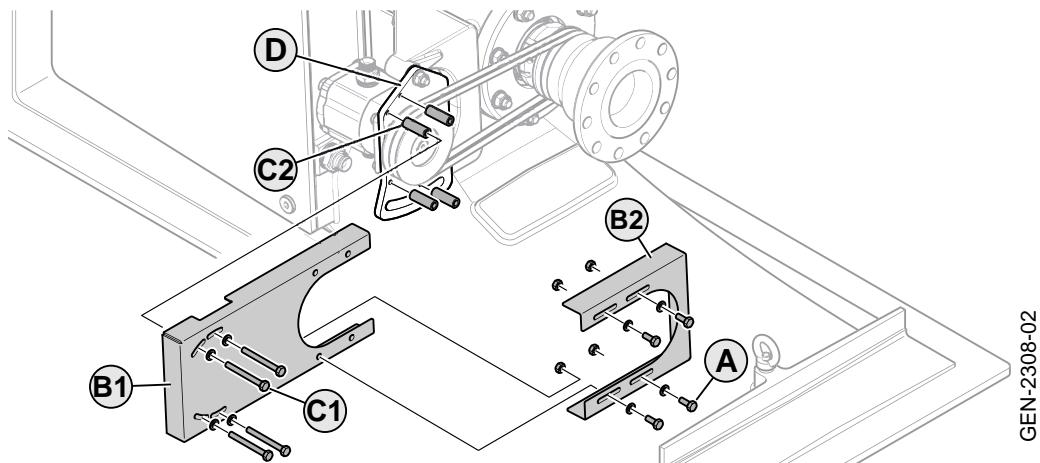


Figure 92

- 2.7 Install the bolts, washers (C1) and the spacers (C2) to attach the belt guard section (B1) to the pump plate (D).
- 2.8 Align the belt guard section (B2) to the belt guard section (B1).
- 2.9 Install the screws, nuts and washers (A) to the belt guard sections (B1) and (B2).
- 2.10 Fasten spare belts.
- 2.11 Task completed.

## 4.4 Control System



### Warning!

When working with electrical components inside Control System Units, make sure that you follow routines regarding ESD. Semiconductors and circuit boards can be damaged by electrostatic discharge (ESD). When handling, care must be taken so that the devices are not damaged. Use an ESD bracelet or similar ESD rated protection. Otherwise always discharge yourself and your tools by touching a grounded bare metal surface before touching an ESD-sensitive electronic component. Damage due to inappropriate handling is not covered by the warranty.

### 4.4.1 Control System Components, inspect for wear and damages

#### Task Summary

The task is to inspect for damaged control system components and to clean components from dirt and grime.



### Warning!

Never use regular water for cleaning electrical components or cabinets.

#### Task Interval

Do this task during:

- Yearly inspection

#### Prerequisites

##### Conditions

The control system is completely shut off.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Chief Engineer	Dockside	4 hours
Consumables	Quantity	Part number	
Wipes and cloths	-		
Distilled water	-		
Contact cleaner spray for electrical contacts	-		

## Procedure

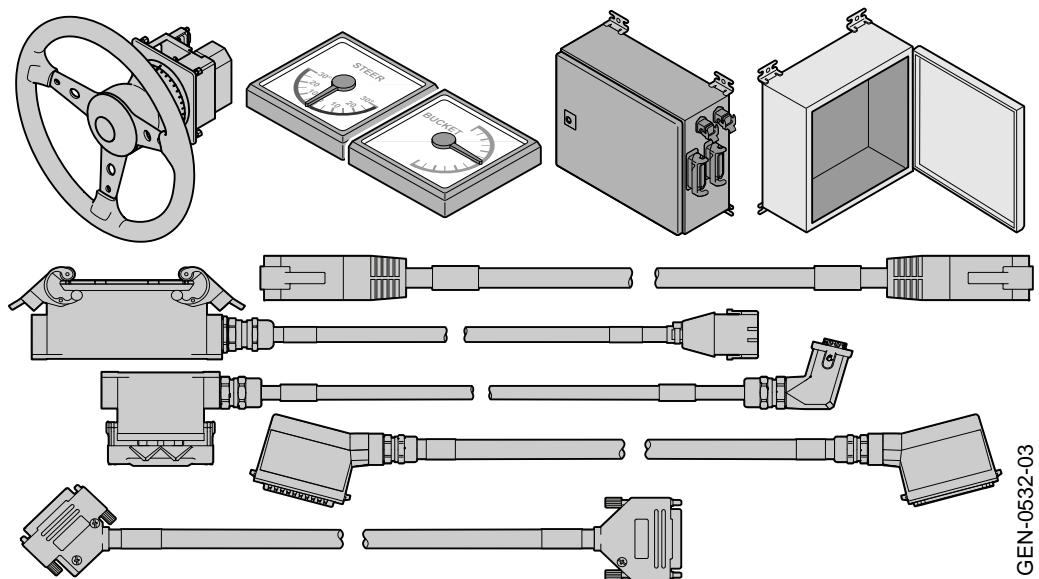


Figure 93

- 1 In the Engine room:
  - 1.1 Inspect the outside of the control cabinets.
    - A. Visually inspect all cabinets, look for signs of corrosion and damage. Most often noted around the top surface.  
If corrosion is seen, this should be photographed and then cleaned and repainted.
  - 1.2 Inspect the inside of the control cabinets.
    - B. Ensure cabinets are clean and fresh internally, no sign of dust or water ingress.  
Clean cabinet if dirty and search for the source. If intrusion of dirt or water occurs, check all seals and repair broken seals or replace cabinet.
    - C. Check for signs of modification, check that all items are secure on the DIN rail.  
Fasten all loose objects.
  - 1.3 Check all connectors for tightness and integrity.
    - D. Ensure all connectors and glands are tight, secure and not damaged.  
Fasten all loose connectors and secure loose cables.
    - E. Check for signs of wear or fatigue on the cable around the connector.  
Replace damaged cables, see *4.4.7 Control System, Inspect and Replace Cables*
    - F. Ensure there are no excessive bending or pressure on the cable and connector.  
Re-route cables if they have excessive bending.
    - G. Check that no connections are cross threaded. Where cables pass through glands the outer sheath should be clamped such that the strain is taken by the gland.
- 2 In the Jet room:
  - 2.1 Inspect the outside of the control cabinets and connection boxes.
    - H. Visually inspect all cabinets, look for signs of corrosion and damage. Most often noted around the top surface.  
If corrosion is seen, this should be photographed and then cleaned and repainted.
  - 2.2 Inspect the inside of the control cabinets.
    - I. Ensure cabinets are clean and fresh internally, no sign of dust or water ingress.  
Clean cabinet if dirty and search for the source. If intrusion of dirt or water occurs, check all seals and repair broken seals or replace cabinet.

J. Check for signs of modification, check that all items are secure on the DIN rail.  
Fasten all loose objects.

2.3 Inspect cables.

K. Inspect the cabling around the Jet space, take special note of connectors, as well as areas where cables bends.

Replace damaged cables, see *4.4.7 Control System, Inspect and Replace Cables*

L. Ensure cables are above the bilge level and is not secured to a object or location where vibration occurs.

Re-route cables if they have excessive bending, if they are below the bilge level or is secured to a object or location where vibration occurs.

2.4 Inspect feedback connections.

M. Ensure all connectors are tight, secure and not damaged.

Fasten all loose connectors and secure loose cables.

N. Check for signs of wear or fatigue on the cable around the connector.

Replace damaged feedback sensors or cables, see *4.3.7 Hydraulic Steering Cylinder, Replace Feedback Sensor* and *4.3.8 Hydraulic Reversing Cylinder, Replace Feedback Sensor*

O. Ensure there are no excessive bending or pressure on the cable and connector.

Re-route cables if they have excessive bending.

3 On the Bridge:

3.1 Inspect Controls.

P. Visually inspect all items on the bridge for corrosion or damage. Most often noted on open bridges. If corrosion is seen, this should be photographed

Remove corrosion if visible and replace damaged Controls.

Q. Ensure all buttons are readable. If sealing covers are fitted ensure they are intact.

Replace lenses on buttons if they are damaged or unreadable. See *4.4.11 Indoor Panels, Lenses and LEDs, Replace*

If sealing covers are damaged, change the covers if personnel is adequately trained and certified or send item to MJP for repair.

R. Move all control heads through the full range of motion, note any play and / or friction which may indicate the control is not fully functional.

Replace damaged Controls.

3.2 Inspect cables.

S. Inspect all cables, ensuring connectors are correctly fastened, there is no excessive bending or pressure on connectors. Take particular note of any pivot points, for example where cables travel to a seat arm rest. Ensure that cables are not stressed in any arm rest position.

Fasten all loose connectors, secure loose cables and re-route cables if they have excessive bending.

4 Task completed.

## 4.4.2 Jet autocalibration



GEN-2986-01

Figure 94

### Task Summary

The task is to auto calibrate the Jet.

**Note!**

Adequately trained and certified personnel are required for this task.

### Task Interval

Do this task during:

- First start-up
- Corrective maintenance

### Prerequisites

**Conditions**

Main engine running

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Authorized Service Technician or Chief Engineer with remote support	Dockside	15 minutes

**Reference document**

3 Remote Support Setup

### Procedure

The complete procedure can be found in the **Workshop Manual**.

### 4.4.3 Control Levers, Calibrate



GEN-2988-01

Figure 95

### Task Summary

The task is to calibrate the controls in the system.

### Task Interval

Do this task during:

- Corrective maintenance

### Prerequisites

#### Conditions

None

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Authorized Service Technician or Chief Engineer with remote support	Dock, workshop / Dry dock	15 minutes

#### Reference document

3 Remote Support Setup

### Procedure

The complete procedure can be found in the **Workshop Manual**.

When the crew have performed qualified training by Marine Jet Power, a more extensive **Workshop Manual** covering also the qualified maintenance tasks, can be obtained from Marine Jet Power.

#### 4.4.4 Display Panel, Service Menu

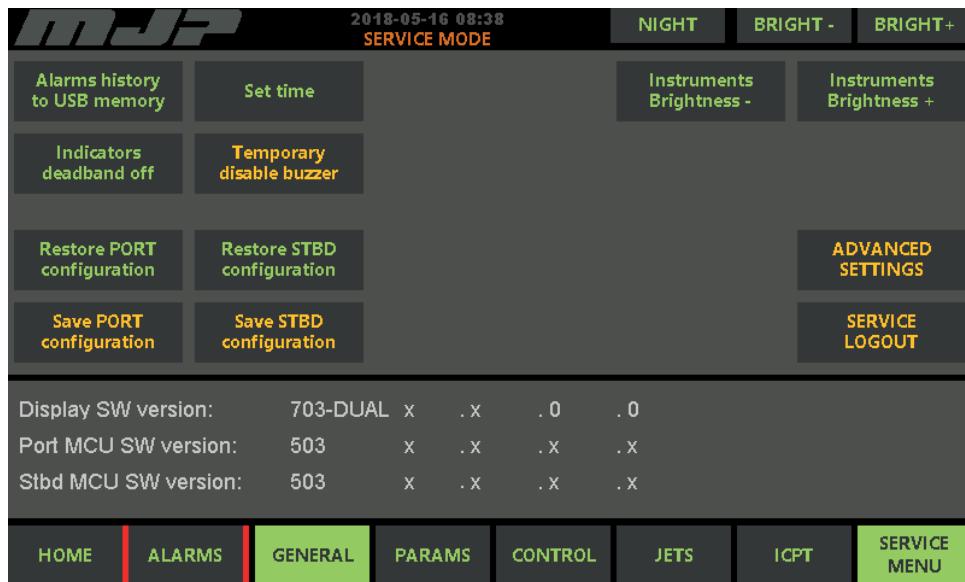


Figure 96

#### Task Summary

The task is to enter the control systems Service Menu.

Some changes can be done without Service Login, such as instrument brightness.

The service menu Service Login gives access to changes of the system parameters.



##### Warning!

Changes to the system parameters may adversely affect the control system or make it unsafe to operate.

#### Task Interval

Do this task during:

- Corrective maintenance

#### Prerequisites

##### Conditions

The system power is on.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Authorized Service Technician or Chief Engineer with remote support	Dockside	10-60 minutes

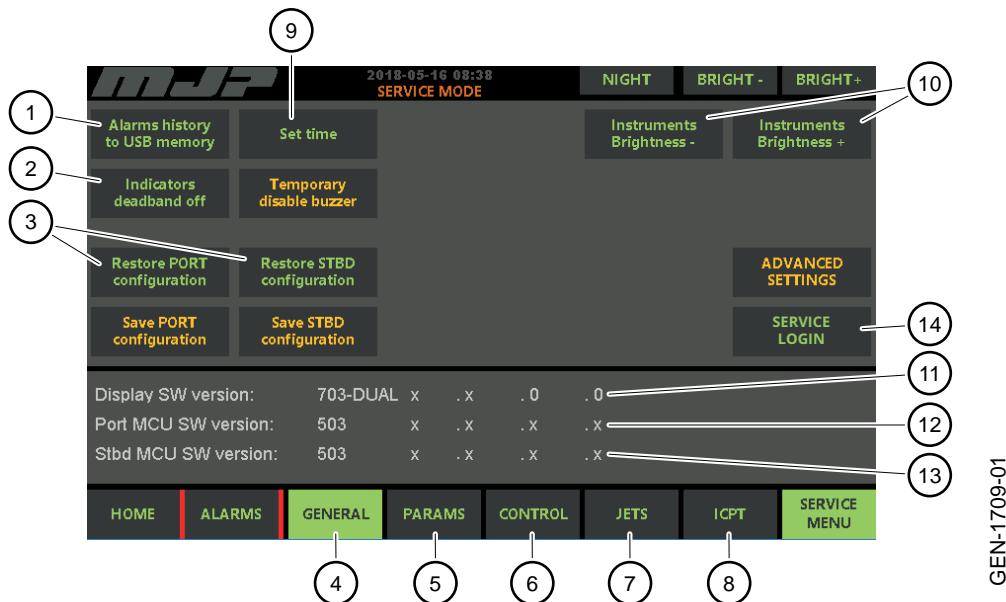
##### Reference document

3 Remote Support Setup

## Service Menu, General

Entering the service menu opens the Service Menu > General page. The items 4-8 are added to the tool bar at the bottom of the screen. These buttons are used to navigate between different service pages. At any time, tap HOME button to return to the home screen.

### User Mode



GEN-1709-01

Figure 97

The display defaults to ‘user mode’ which prevents changing to the system parameters which may adversely affect the control system or make it unsafe to operate. The following options are available in ‘user mode’.

Pos	Part	Description
1	Alarm history to USB memory	Tap this button to download the alarm history to an attached USB memory stick.
2	Feedback indicators deadband off	Tap this button if an exact position of bucket and feedback is required. In this case, the indicators in the display may not appear centred when the port controls are in neutral.
3	Restore PORT Configuration	Allows the operator to restore the display configuration to the values stored in the control system PLC.
4	GENERAL	Tap to open the general information and setup page.
5	PARAMS	Tap to open the system parameter page.
6	CONTROL	Tap to open the control head information and setup page.
7	JETS	Tap to open the waterjet information and setup page.
8	ICPT	Tap to open the interceptor information and setup page.
9	Set Time	Tap to set the time and date in the display.
10	Instrument brightness	Adjusts the backlight brightness of control heads and instruments connected to the Jetmaster 3 control system.
11	Display SW version	The current software version running in the display unit software version, has five fields: <ul style="list-style-type: none"><li>• HW version supported</li></ul>

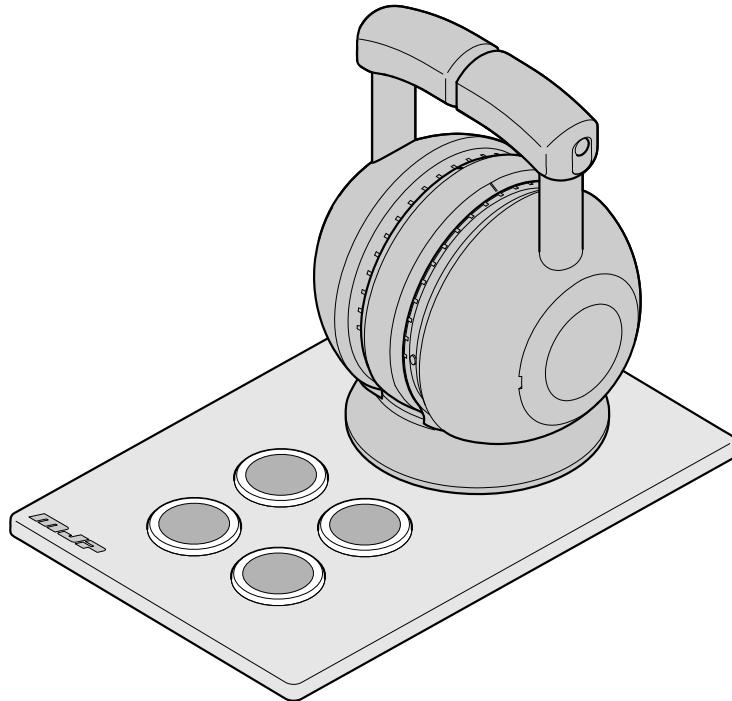
Pos	Part	Description
		<ul style="list-style-type: none"> <li>• SW major version</li> <li>• SW minor version</li> <li>• SW project specific major version</li> <li>• SW project specific minor version.</li> </ul>
12	Port MCU SW version	<p>The current SW version running in the port MCU software version, has five fields:</p> <ul style="list-style-type: none"> <li>• HW version supported</li> <li>• SW major version</li> <li>• SW minor version</li> <li>• SW project specific major version</li> <li>• SW project specific minor version</li> </ul>
13	Stbd MCU SW version	<p>The current SW version running in the starboard MCU software version, has five fields:</p> <ul style="list-style-type: none"> <li>• HW version supported</li> <li>• SW major version</li> <li>• SW minor version</li> <li>• SW project specific major version</li> <li>• SW project specific minor version.</li> </ul>
14	Service login / logout	Tap to login / logout of service mode.

## Display Panel, Service Login

The complete procedure can be found in the **Workshop Manual**.

When the crew have performed qualified training by Marine Jet Power, a more extensive **Workshop Manual** covering also the qualified maintenance tasks, can be obtained from Marine Jet Power.

#### 4.4.5 Combinator Controller, Replace



GEN-1917-01

Figure 98

#### Task Summary

The task is to replace the combinator controller.

#### Task Interval

Do this task during:

- Corrective maintenance

#### Prerequisites

##### Conditions

The control system is completely shut off.

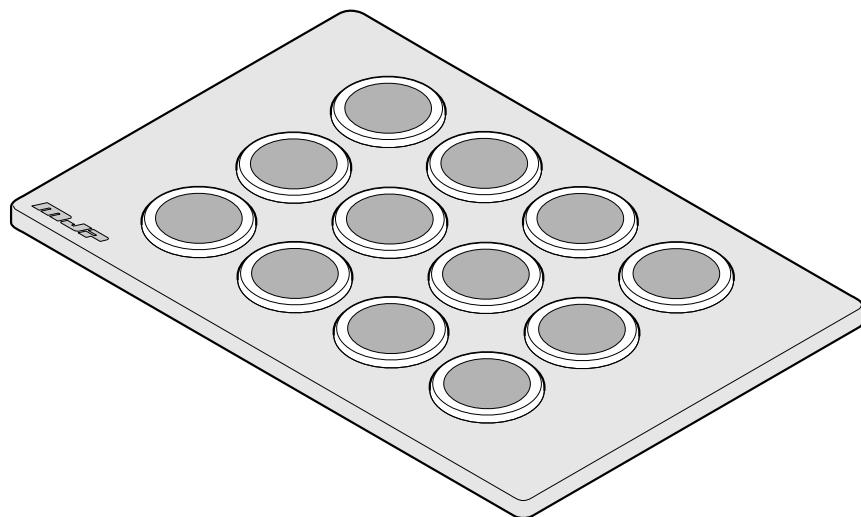
Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Authorized Service Technician	Dockside	20 minutes
Spare parts	Quantity	Part number	
Combinator controller	1	Contact MJP	

#### Procedure

The complete procedure can be found in the **Workshop Manual**.

When the crew have performed qualified training by Marine Jet Power, a more extensive **Workshop Manual** covering also the qualified maintenance tasks, can be obtained from Marine Jet Power.

## 4.4.6 Command Panel BUS, Replace



GEN-2814-01

Figure 99

### Task Summary

The task is to replace the command panel.

### Task Interval

Do this task during:

- Corrective maintenance

### Prerequisites

#### Conditions

The system is completely shut off.

All levers in neutral position.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Authorized Service Technician	Dockside	20 minutes
Spare parts		Quantity	Part number
Command panel	1		Contact MJP

### Procedure

The complete procedure can be found in the **Workshop Manual**.

When the crew have performed qualified training by Marine Jet Power, a more extensive **Workshop Manual** covering also the qualified maintenance tasks, can be obtained from Marine Jet Power.

## 4.4.7 Control System, Inspect and Replace Cables

### Task Summary

The task is to inspect and replace damaged control system cables.

### Task Interval

Do this task during:

- Corrective maintenance

### Prerequisites

#### Conditions

The control system is completely shut off.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Chief Engineer	Dockside	45 minutes
Spare parts	Quantity	Part number	
Control system cables	—	See separate drawing	

### Procedure

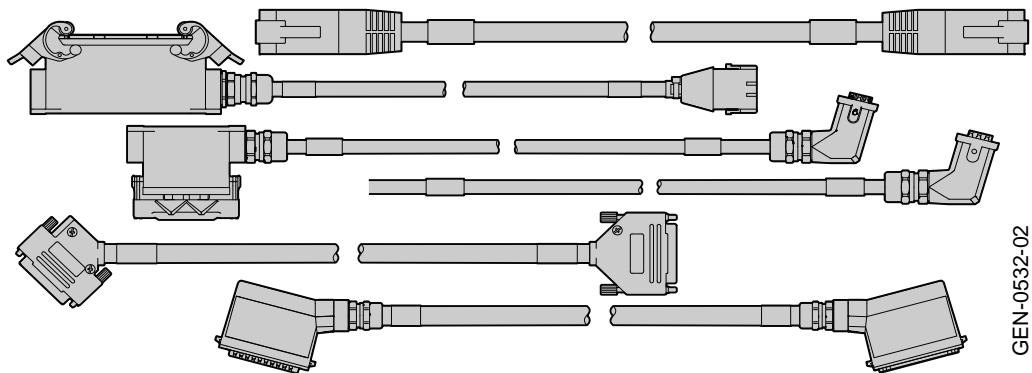


Figure 100

- 1 Identify which cable to inspect for damage. See Control System.
- 2 Examine that the cable is working correctly.
- 3 If there are damages, change cable.
- 4 Power on and start the system.
- 5 Verify that the system works correctly.

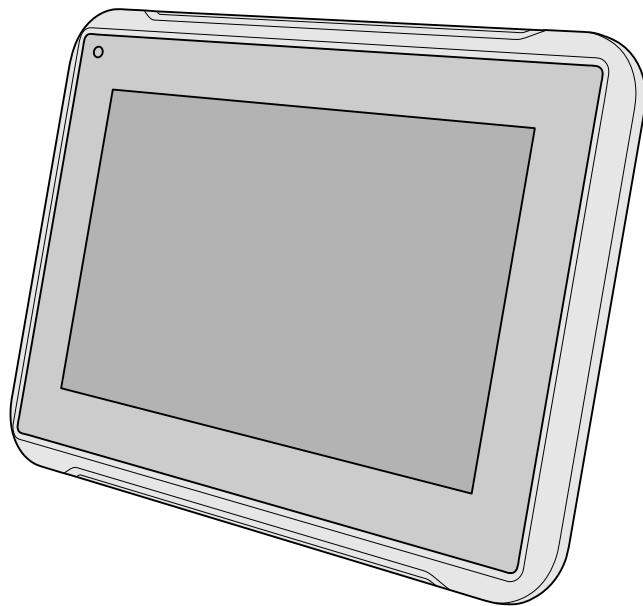


#### Caution!

If the system does not work correctly, make sure that all the cables are adequately installed. Cables that appear to be correctly installed may need to be adjusted to achieve a correct installation.

- 6 Task completed.

#### 4.4.8 Display Panel, Replace



GEN-1654-01

Figure 101

#### Task Summary

The task is to replace the display panel.

#### Task Interval

Do this task during:

- Corrective maintenance

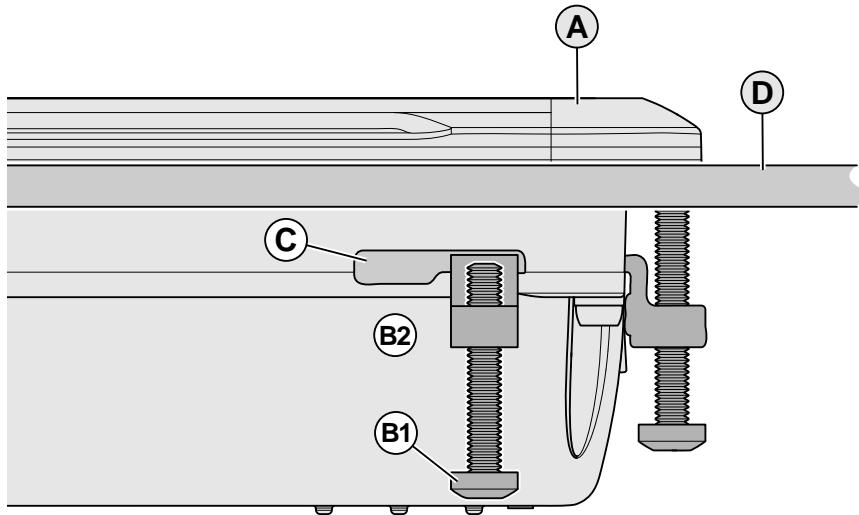
#### Prerequisites

##### Conditions

The control system is completely shut off.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Chief Engineer	Dockside	20 minutes
Spare parts	Quantity	Part number	
Display Panel	1	C-50005	

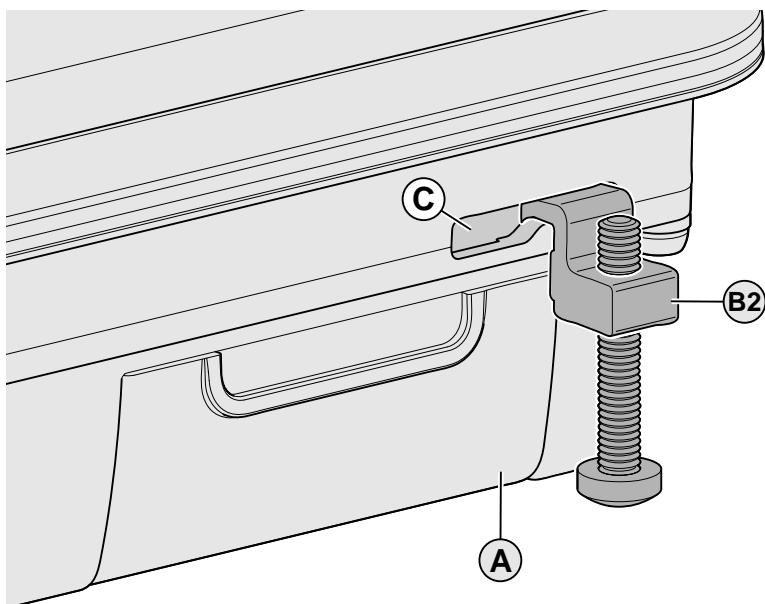
## Procedure



GEN-1690-01

Figure 102

- 1 Remove the display panel (A):
  - 1.1 Examine each cable connected to the display panel (A) to make sure all labels are correct.
  - 1.2 Disconnect each cable connected to the display panel.
  - 1.3 Examine each cable to make sure that there is no damage on the cables. If the cables are damaged, contact MJP.
  - 1.4 Loosen the screws (B1) on the installation fasteners (B2) installed in the insertion slots (C) on the display panel (A).



GEN-1691-01

Figure 103

- 1.5 Remove the installation fasteners (B2) from the insertion slots (C).

GEN-1692-01

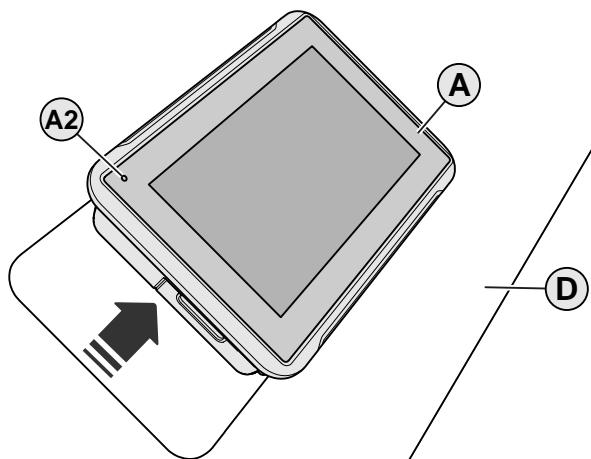


Figure 104

- 1.6 Remove the display panel (A) from the control panel (D).
- 2 Install the new display panel:
  - 2.1 Insert the new display panel into the cut out hole on the control panel (D).

**Note!**

The display must be oriented with the round LED (A2) in the top left corner.

- 2.2 Insert the installation fasteners (B2) in the insertion slots (C).
- 2.3 Tighten the fastener screws (B1).

**Caution!**

Do not tighten the fastener screws with too much force. This can cause damage to the plastic case of the display panel.

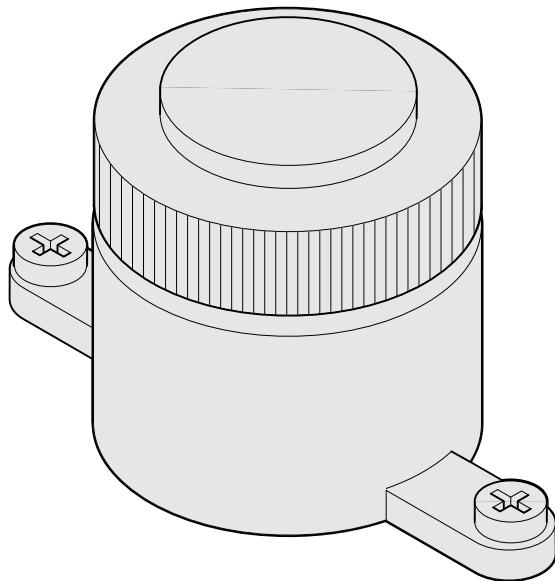
- 2.4 Connect the cables to the new display panel.

**Caution!**

Make sure to use LAN A (LAN B is for service.)

- 3 Start the system:
  - 3.1 Make sure that the display panel starts correctly.
  - 3.2 Do a check of all menus, modes, functions and alarms of the display panel.
- 4 Task completed.

#### 4.4.9 External Alarm Buzzer, Replace



GEN-0485-01

Figure 105

#### Task Summary

The task is to replace the external alarm buzzer.

#### Task Interval

Do this task during:

- Corrective maintenance

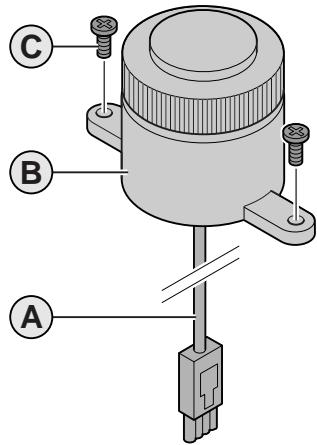
#### Prerequisites

##### Conditions

The control system is completely shut off.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Chief Engineer	Dockside	20 minutes
Spare parts	Quantity	Part number	
External alarm buzzer	1	Contact MJP	

## Procedure



GEN-0478-01

Figure 106

- 1 Remove the external alarm buzzer:
  - 1.1 Examine the cable (A) and the display cable to make sure that all labels are correct.
  - 1.2 Disconnect the cable (A) from the display cable.
  - 1.3 Remove the screws (C) from the alarm buzzer.
  - 1.4 Remove the alarm buzzer (B) from the control panel.
- 2 Install the new alarm buzzer:
  - 2.1 Install the screws (C) to attach the new alarm buzzer to the control panel.
  - 2.2 Connect the cable (A) to the display cable.

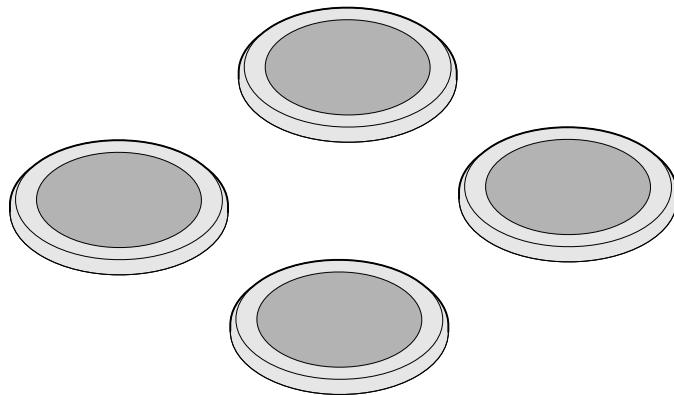


**Caution!**

Before you connect the cable, examine the cable to make sure there is no damage on the cable and that all labels are correct.

- 2.3 Start the system.
  - 2.4 Make sure that the alarm buzzer operates correctly by trigger an alarm.
- 3 Task completed.

#### 4.4.10 Indoor Panels, Lenses and LEDs, Inspect



GEN-0497-03

Figure 107

#### Task Summary

The task is to inspect lenses and LEDs on indoor panels.

#### Task Interval

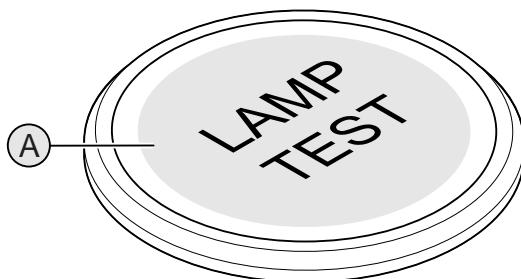
Do this task during:

- Corrective maintenance

#### Prerequisites

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Crew	On equipment / at sea	20 minutes

#### Procedure

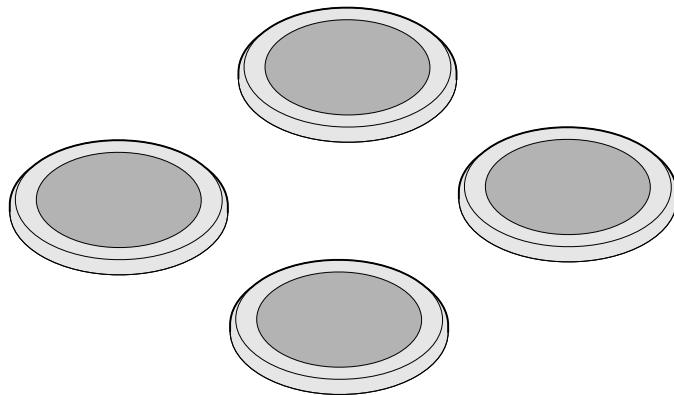


GEN-0500-03

Figure 108

- 1 Check that all lenses are not broken and fully readable.
- 2 Press the LAMP TEST button (A) to see if there is any broken LEDs.
- 3 Replace broken LEDs. See 4.4.11 Indoor Panels, Lenses and LEDs, Replace.
- 4 Replace broken or unreadable lenses. See 4.4.11 Indoor Panels, Lenses and LEDs, Replace
- 5 Task completed.

#### 4.4.11 Indoor Panels, Lenses and LEDs, Replace



GEN-0497-03

Figure 109

#### Task Summary

The task is to replace broken LEDs on indoor panels.

The same procedure to replace broken or worn lenses on indoor panels.

#### Task Interval

Do this task during:

- Corrective maintenance

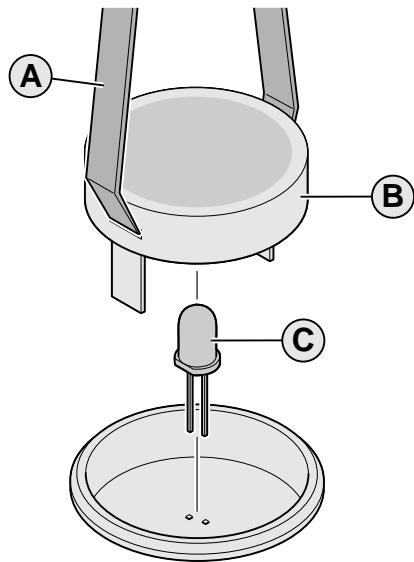
#### Prerequisites

##### Conditions

None

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Crew	On equipment / at sea	20 minutes
Spare parts		Quantity	Part number
LED yellow		1	J10-2J12-1064
LED red		1	J10-2J12-1062
Lenses		-	Contact MJP
Special tools and test equipment		Quantity	Part number
LED Tool kit (for backup unit and command panel)		1	Contact MJP

## Procedure



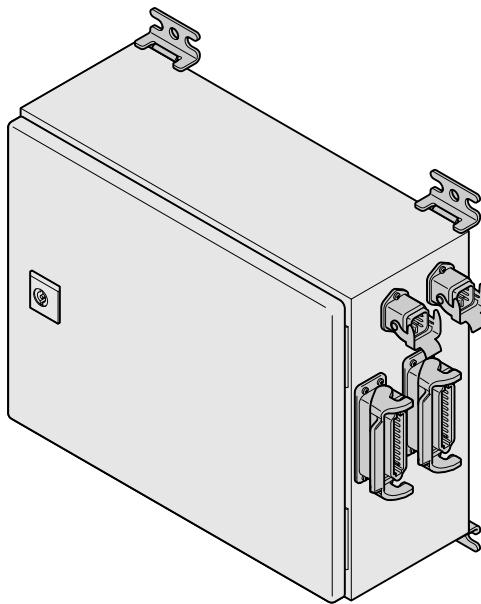
GEN-0687-01

Figure 110

For changing lenses (B), skip step 2 and 3.

- 1 Use the lens remover tool (A) to gently remove the cap / lens (B).
- 2 Use the LED remover to remove the broken LED (C).
- 3 Install a new LED.
- 4 Press the cap / lens (B) gently back into place.
- 5 Task completed.

#### 4.4.12 Main Control Unit, Replace



GEN-1646-01

Figure 111

#### Task Summary

The task is to replace Main control unit.

#### Task Interval

Do this task during:

- Corrective maintenance

#### Prerequisites

##### Conditions

The control system is completely shut off.

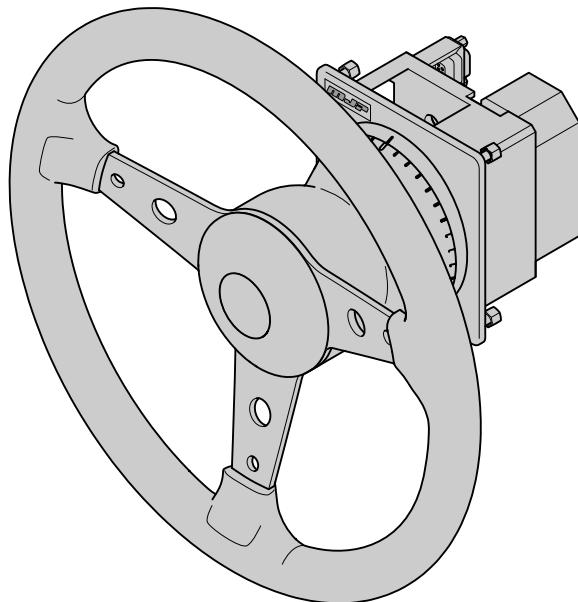
Number of personnel	Skill level	Maintenance facility level	Estimated time
1	MJP Commissioning Engineer	Dockside	90 minutes
Spare parts		Quantity	Part number
Main control unit		1	Contact MJP

#### Procedure

The complete procedure can be found in the **Workshop Manual**.

When the crew have performed qualified training by Marine Jet Power, a more extensive **Workshop Manual** covering also the qualified maintenance tasks, can be obtained from Marine Jet Power.

#### 4.4.13 Steer Wheel, Replace Steer Controller



GEN-1333-01

Figure 112

#### Task Summary

The task is to replace the steer controller under the steer wheel.

#### Task Interval

Do this task during:

- Corrective maintenance

#### Prerequisites

##### Conditions

The control system is completely shut off.

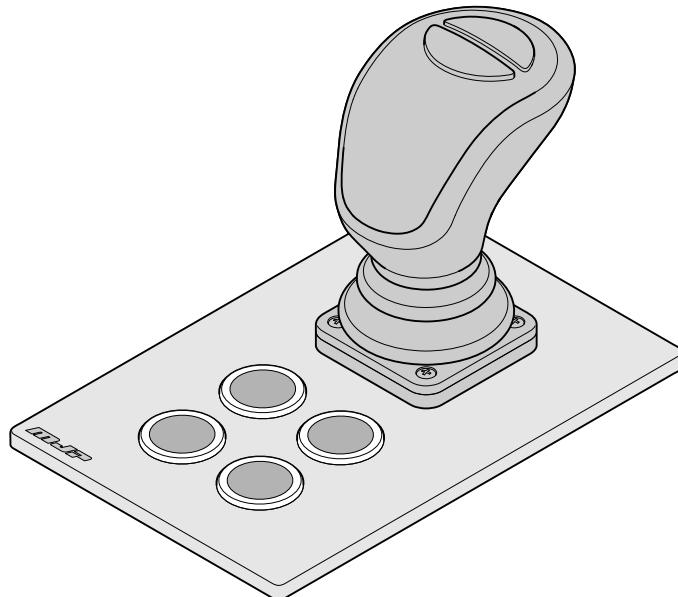
Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Authorized Service Technician or Chief Engineer with remote support	Dockside	20 minutes
Spare parts	Quantity	Part number	
Steer controller	1	Contact MJP	
Reference document			
3 Remote Support Setup			

#### Procedure

The complete procedure can be found in the **Workshop Manual**.

When the crew have performed qualified training by Marine Jet Power, a more extensive **Workshop Manual** covering also the qualified maintenance tasks, can be obtained from Marine Jet Power.

#### 4.4.14 VCS Panel (BUS), Replace



GEN1893-02

Figure 113

#### Task Summary

The task is to replace the VCS panel.

#### Task Interval

Do this task during:

- Corrective maintenance

#### Prerequisites

##### Conditions

The control system is completely shut off.

Number of personnel	Skill level	Maintenance facility level	Estimated time		
1	Authorized Service Technician or Chief Engineer with remote support	Dockside	20 minutes		
Spare parts	Quantity	Part number			
VCS panel MJP BUS	1	Contact MJP			
<b>Reference document</b>					
<i>3 Remote Support Setup</i>					

#### Procedure

The complete procedure can be found in the **Workshop Manual**.

When the crew have performed qualified training by Marine Jet Power, a more extensive **Workshop Manual** covering also the qualified maintenance tasks, can be obtained from Marine Jet Power.

## 4.4.15 Control System Components and Waterjet operation test

### Task Summary

The task is to confirm that all control system components and Waterjets works trouble-free in operation..

### Task Interval

Do this task during (after): • Yearly inspection



#### Caution!

Before you test the functionality of the Waterjet when the gearbox is clutched in, be aware of the vessel's surroundings.

## Prerequisites

### Conditions

The vessel is in the water, fully functional after yearly inspection.

Hydraulic pressure is required.

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Authorized Service Technician	Dockside	4 hours

## Procedure

The complete procedure can be found in the **Workshop Manual**.

When the crew have performed qualified training by Marine Jet Power, a more extensive **Workshop Manual** covering also the qualified maintenance tasks, can be obtained from Marine Jet Power.

## 5 Spare Part List

### 5.1 Control System

See document *System Equipment and Cable list*.

## 5.2 Hydraulics

### 5.2.1 Hydraulic Pump

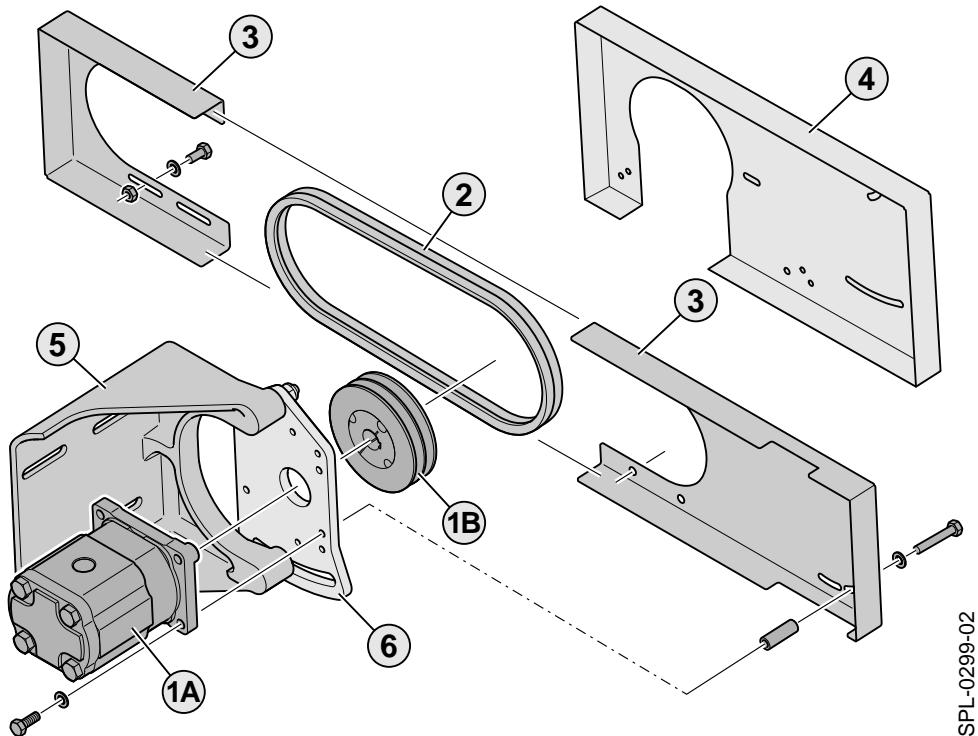


Figure 114

Pos	Description	Quantity	Part number
1A	Hydraulic pump	1	HS-25220-06
1B	Belt wheel	1	Included with pump
2	Belt	2	9611-625-00T
3	Belt guard	1	Contact MJP
4	Alternative Belt guard	1	X310-1410-5
5	Pump bracket	1	X310-1410-4
6	Pump plate	1	X310-1400

## 5.2.2 Hydraulic Valve Block

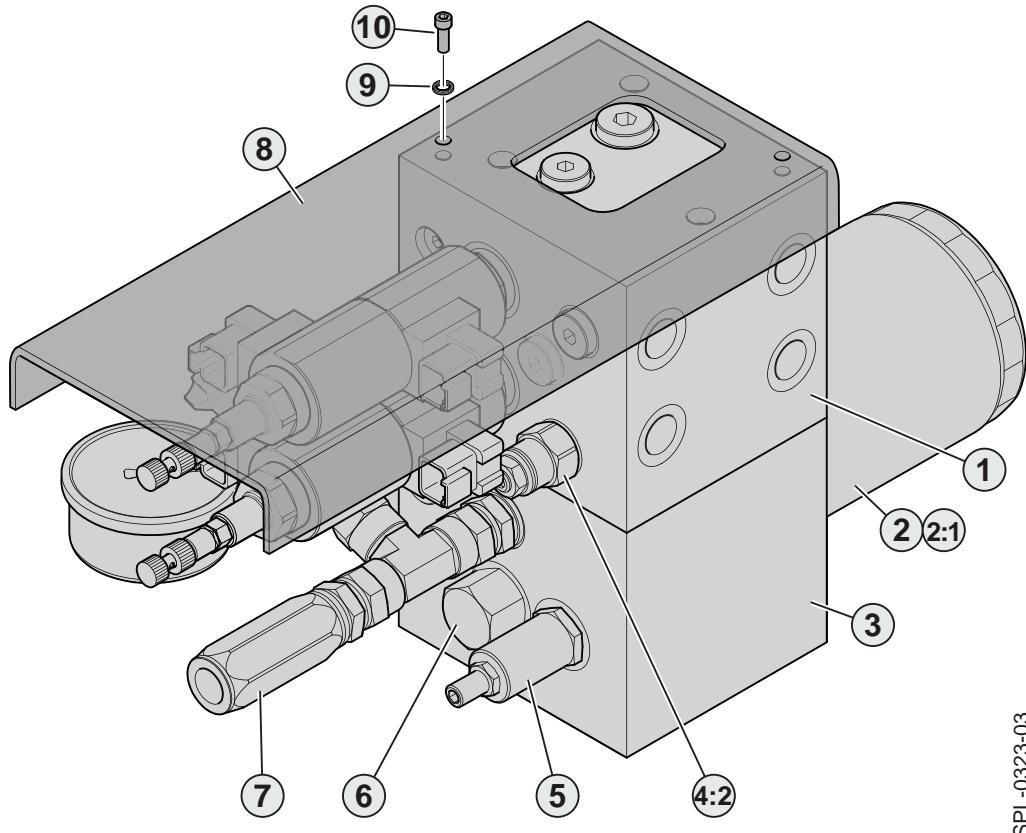


Figure 115

Pos	Description	Quantity	Part number
1	Valve Block	1	HS-25410-06
2	Oil filter	1	HS-25300-01
2:1	Oil filter adapter	1	HS-22330-08
3	Valve block	1	HS-25400-14
4:2	Load control valve 175 bar	1	HS-25410-08
5	Relief valve 170 bar	1	HS-22554-65
6	Compensator	1	HS-22135-32
7	Check valve	1	HS-25440-02
8	Valve block cover plate	1	X310-1405-2
9	Lock washer	2	22004
10	Screw	2	21007

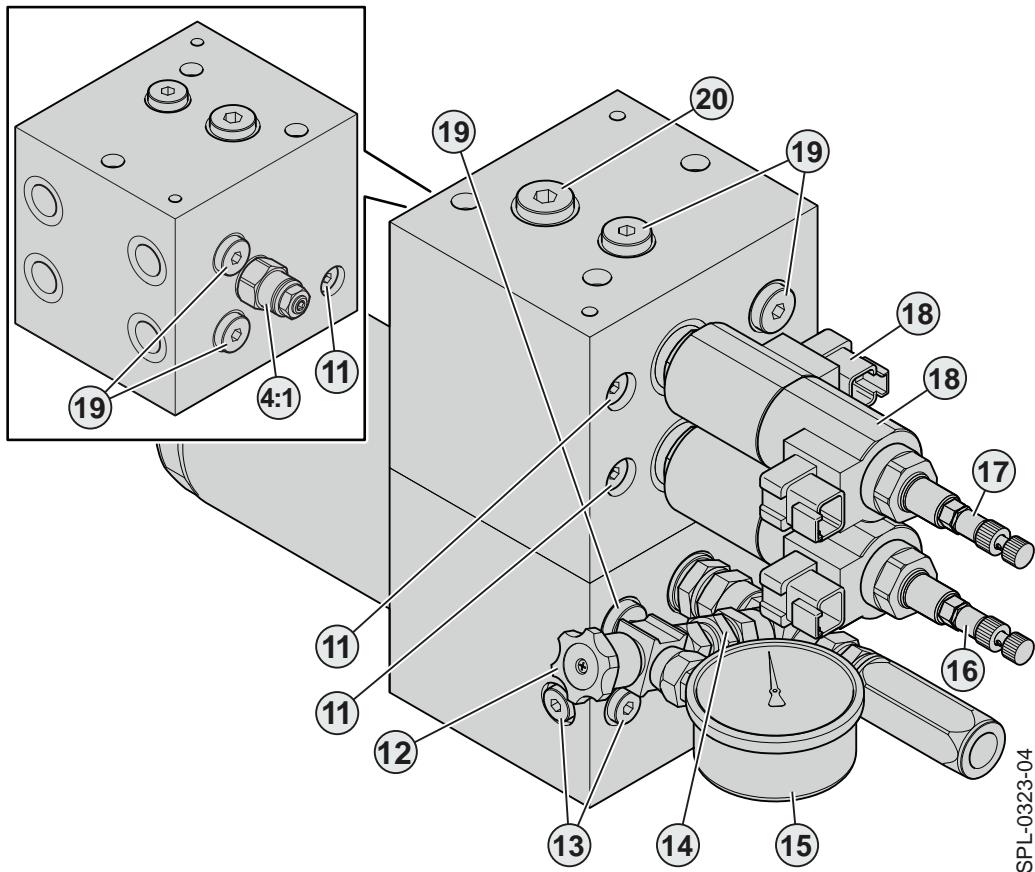
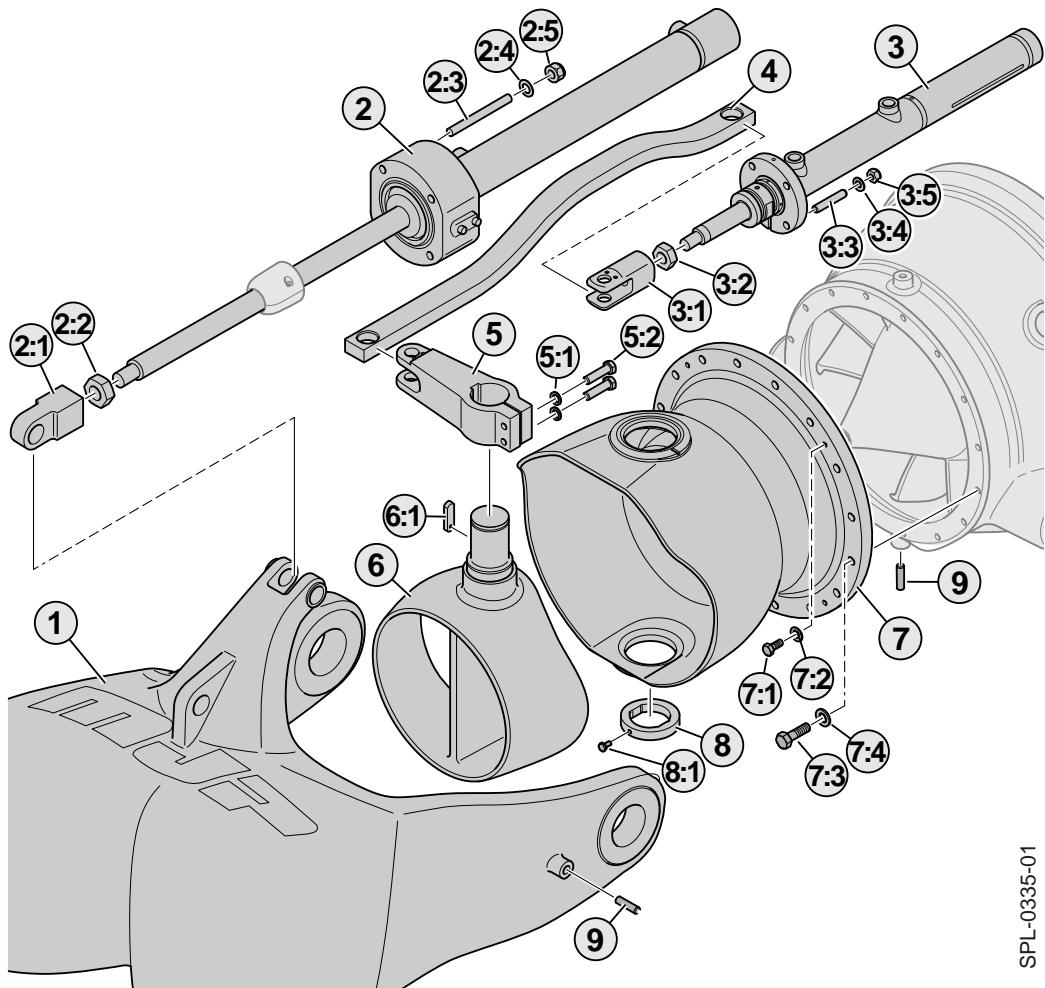


Figure 116

Pos	Description	Quantity	Part number
4:1	Load control valve 175 bar	1	HS-25410-08
11	Shuttle valve	3	HS-22483-27
12	Shut off valve for pressure gauge	1	HS-22483-11
13	Oil plug 1/8"	2	33086
14	Adapter for pressure gauge	1	HS-22330-07
15	Pressure gauge 0-250 bar	1	HS-22554-24
16	Proportional directional valve	1	HS-25410-07
17	Proportional directional valve	1	HS-25410-03
18	Coil 24V DC	4	HS-25410-05
19	Oil plug 1/4"	6	33048
20	Oil plug 3/8"	1	33001

## 5.3 Mechanics

### 5.3.1 Steering Unit



SPL-0335-01

Figure 117

Pos	Description	Quantity	Part number
1	Reversing bucket	1	X350-1203-1
2	Hydraulic reversing cylinder	1	41987
2:1	Reversing cylinder rod end	1	X350-1460-6
2:2	Reversing cylinder rod end nut	1	23172
2:3	Stud M12	4	23169
2:4	Washer M12	4	22018
2:5	Lock nut M12	4	9145-181-00G
3	Hydraulic steering cylinder, Mark 2	1	42043
3:1	Steering cylinder rod end	1	X350-1470-2
3:2	Steering cylinder rod end nut	1	23084
3:3	Stud M10	4	8731-055-SSU
3:4	Washer M10	4	22020

3:5	Lock nut M10	4	9145-180-00L
4	Push rod	1	X350-1201-8
5	Tiller arm	1	X350-1201-4
5:1	Lock washer M12	2	22001
5:2	Screw M12×45	2	21147
6	Steering nozzle	1	X350-1201-1
6:1	Key	1	X350-1201-18
7	Nozzle	1	X350-1201-2
7:1	Screw M8×16	4	21004
7:2	Lock washer M8	4	22000
7:3	Screw M10×35	16	21215
7:4	Lock washer M10	16	22010
8	Spacer	1	X350-1201-17
8:1	Screw M16×12	1	21008
9	Anode stud M10	6	8731-038-SSS

### 5.3.2 Steering Unit, Pin shafts

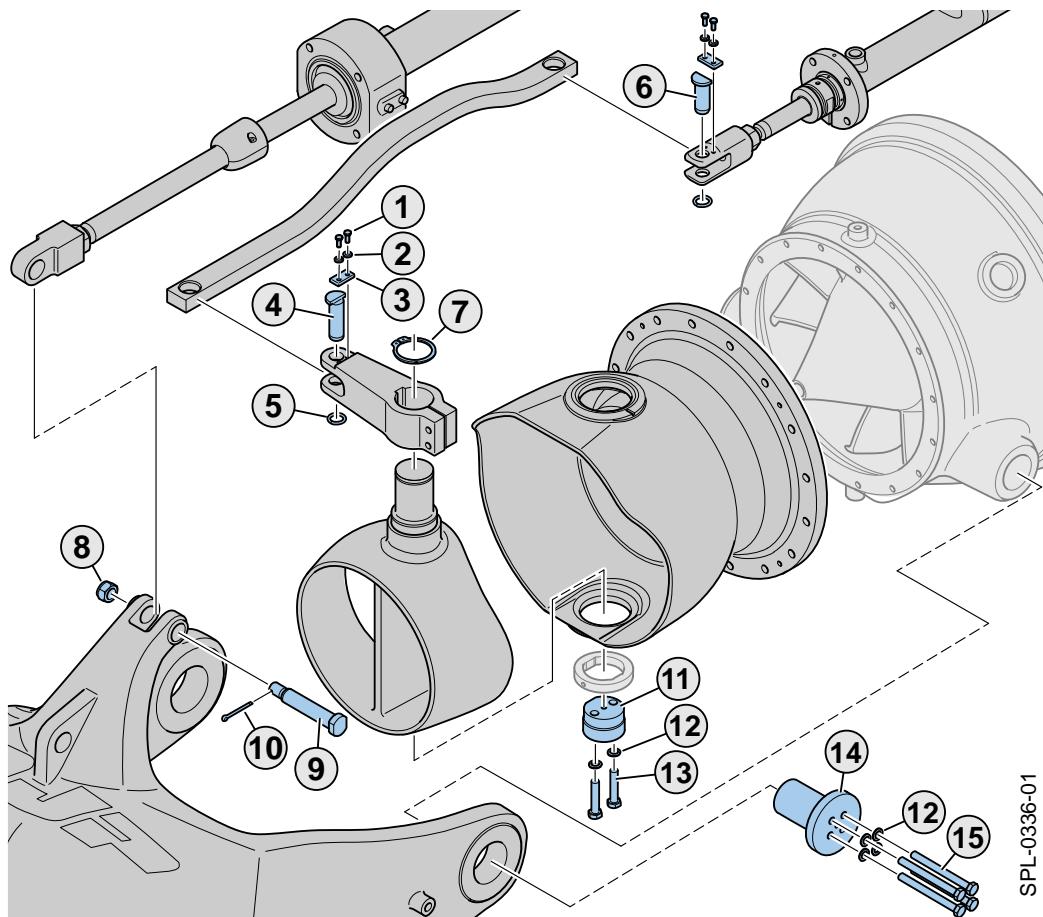


Figure 118

Pos	Description	Quantity	Part number
1 - 15	Complete Pin shaft set		X350-1205-SP
1	Screw M5	4	21218
2	Lock washer M5	4	22024
3	Locking plate	2	X350-2101-23
4	Pin shaft	1	X350-2101-22
5	Retaining ring 19	2	22040
6	Pin shaft	1	X350-2101-24
7	Retaining ring 50	1	22039
8	Lock nut M16	1	23012
9	Pin shaft	1	X350-1203-2
10	Split cotter pin 4x40	1	9231-483-00H
11	Pin shaft	1	X312-1201-3
12	Lock washer M10	10	22010
13	Screw	2	21115

Pos	Description	Quantity	Part number
14	Pivot pin	2	2081-042-00S
15	Screw M10×110	8	9142-362-00W

### 5.3.3 Steering Unit, Bushings

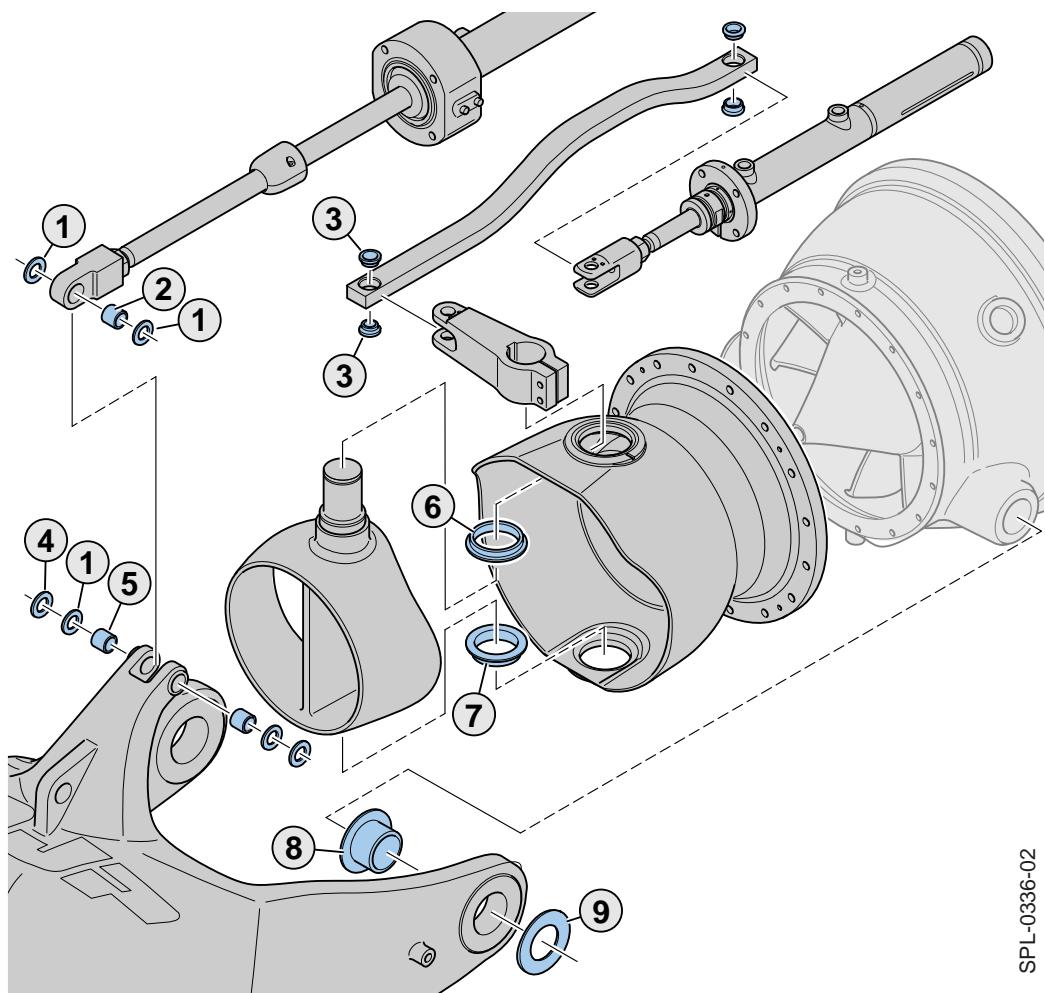
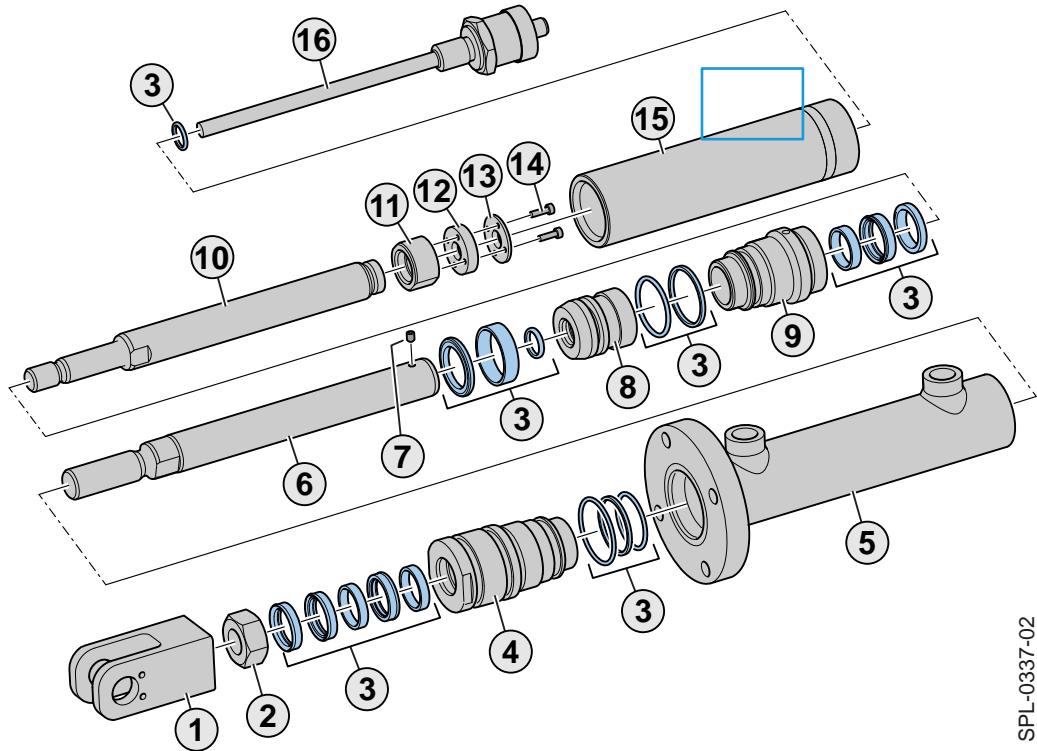


Figure 119

Pos	Description	Quantity	Part number
1 - 9	Complete Bushing set		X350-1208-SP
1	Insulating washer	4	X350-1203-4
2	Rod end bearing	1	X350-1460-6-2
3	Insulating bushing	4	X310-1203-3
4	Washer M20	2	22023
5	Insulating bushing	2	X350-1203-3
6	Bushing upper	1	X350-1101-4
7	Bushing lower	1	X350-1101-3
8	Pivot pin	2	2081-043-00N
9	Insulating washer	2	2081-044-00J

### 5.3.4 Steering Cylinder Mark 2

Visible indication between Mark 1 and Mark 2 is next to position 15

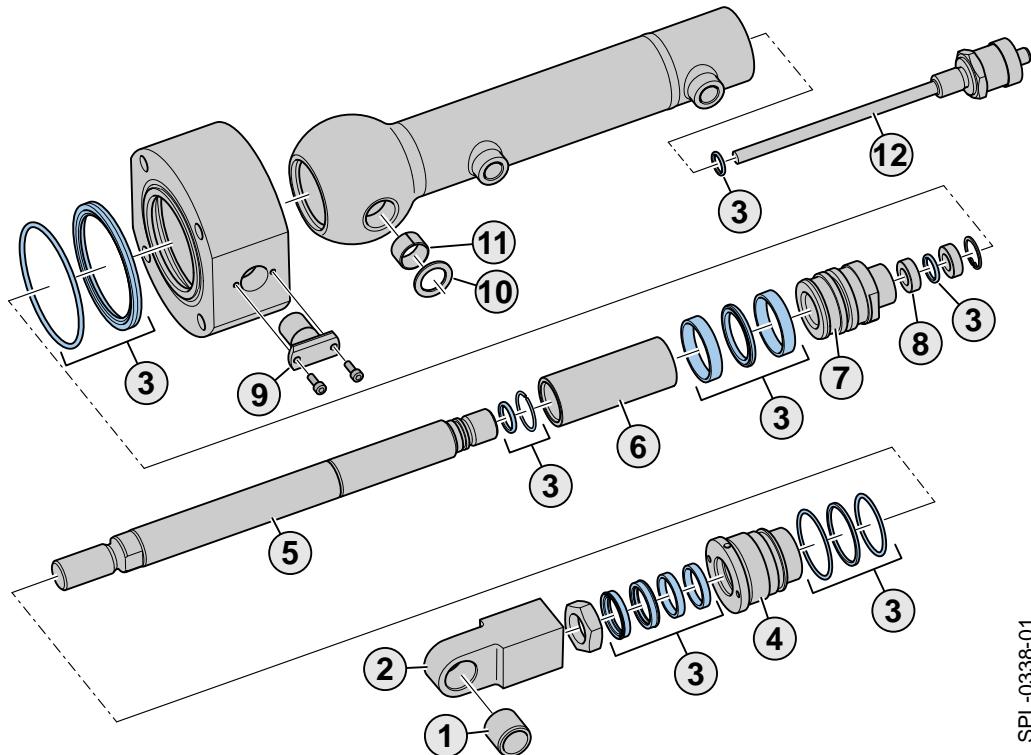


SPL-0337-02

Figure 120

Pos	Description	Quantity	Part number
1	Piston rod end	1	X350-1470-2
2	Nut M20	1	23084
3	Complete Seal kit, steering cylinder	1	42046
4	Cylinder front end	1	45159
5	Cylinder Tube	1	—
6	Piston rod, outer	1	45336
7	Locking screw M5	1	—
8	Piston	1	45215
9	Cylinder back end	1	45106
10	Piston rod, inner	1	45335
11	Holder	1	—
12	Magnet	1	—
13	Indicator	1	—
14	Screw M4x12	4	—
15	Protection tube	1	—
16	Linear sensor	1	41912

### 5.3.5 Reversing Cylinder



SPL-0338-01

Figure 121

Pos	Description	Quantity	Part number
1	Bushing cylindrical (included in Complete Bushing set)	1	45062
2	Piston rod end	1	45287
3	Seal kit reversing cylinder	1	42013
4	Cylinder front end	1	45163
5	Piston rod	1	45253
6	Piston spacer	1	45357
7	Piston	1	45217
8	Piston spacer	1	45355
9	Pivot shaft	2	45403
10	Bushing axial	2	45061
11	Bushing radial	2	45066
12	Linear sensor	1	41909

### 5.3.6 Hoses

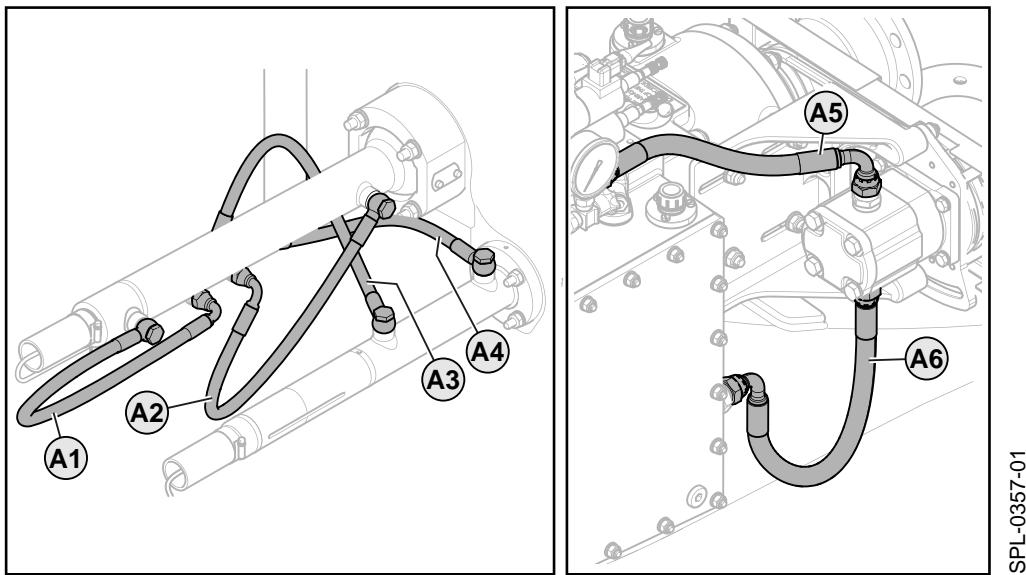
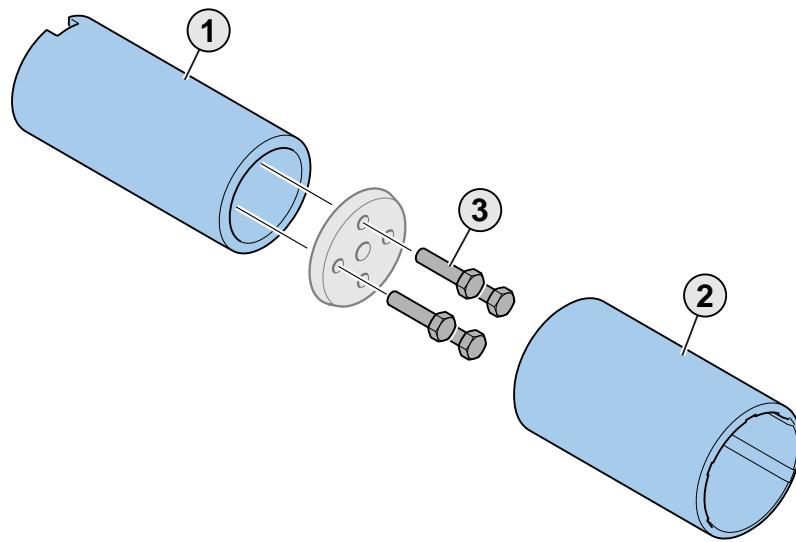


Figure 122

Pos	Description	Quantity	Part number
A1-A6	Complete Spare Hoses Kit	1	X350-1420-E-SP
A1	3/8" Hydraulic hose	1	2604011-003
A2	3/8" Hydraulic hose	1	2604011-003
A3	3/8" Hydraulic hose	1	2604011-002
A4	3/8" Hydraulic hose	1	2604011-001
A5	1/2" Hydraulic hose	1	2604003-005
A6	3/4" Hydraulic hose	1	2604002-005

### 5.3.7 Water Lubricated Bearing

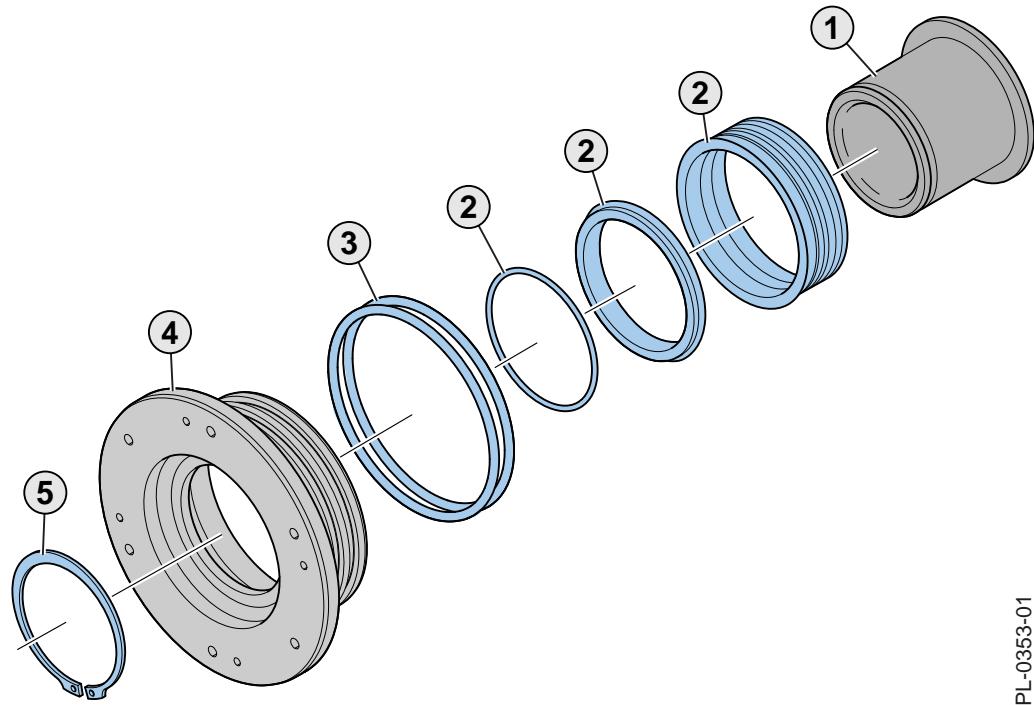


SPL-0361-01

Figure 123

Pos	Description	Quantity	Part number
1-3	Complete Water lubricated bearing Kit	1	X350-1101-2-SP
1	Bearing sleeve	1	X350-1110-2
2	Water lubricated bearing	1	X350-1101-2
3	Screws	4	21215

### 5.3.8 Mechanical Seal

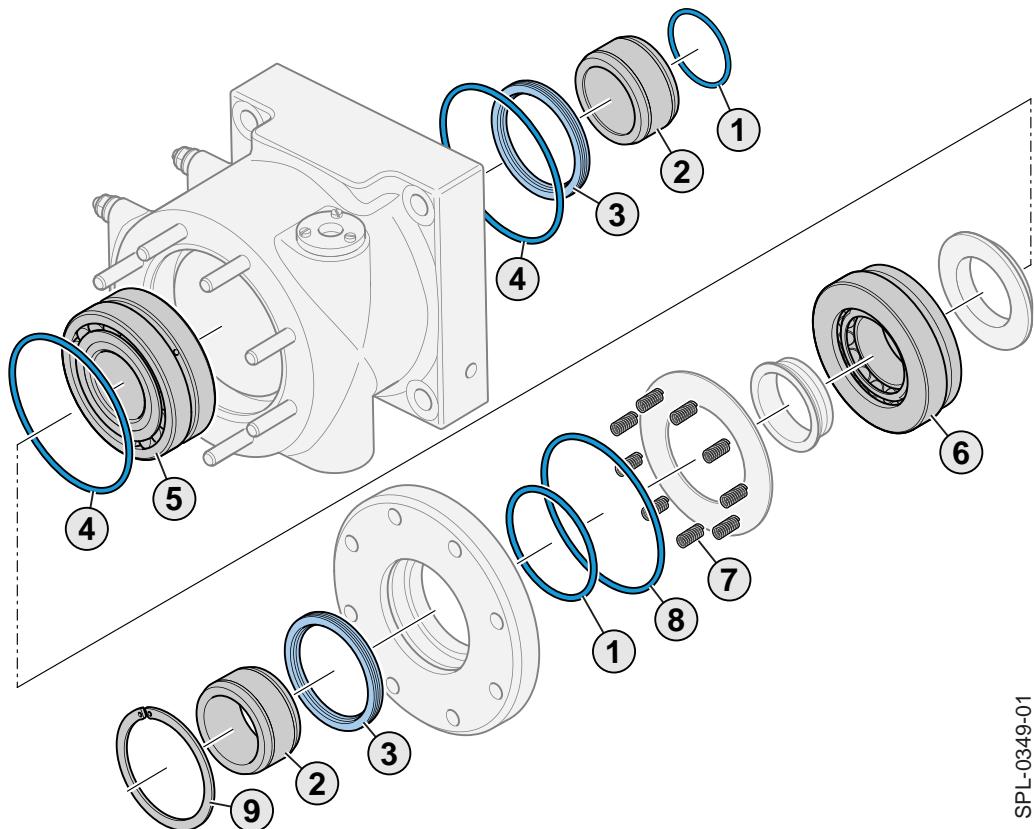


SPL-0353-01

Figure 124

Pos	Description	Quantity	Part number
1-5	Complete Mechanical seal Kit	1	X350-1110-SP
1	Seal carrier	1	8703-012-00S
2	Mechanical seal	1	9470-090-0BC
3	O-ring	2	X310-1110-04
4	Static Seal carrier	1	9212-329-SSQ
5	External Circlip	1	32065

### 5.3.9 Bearing and Seals



SPL-0349-01

Figure 125

Pos	Description	Quantity	Part number
1-9	Complete Bearing and seals Kit	1	X350-1111-SP
1	O-ring	2	9329-036-00S
2	Seal sleeve	2	2031-016-00U
3	Shaft seal	2	9411-473-00L
4	O-ring	2	33079
5	Roller bearing	1	9512-215-009
6	Thrust bearing	1	9516-206-00B
7	Compression spring	8	9609-353-00U
8	O-ring	1	9327-010-00G
9	Internal circlip	1	9211-677-00A

### 5.3.10 Anodes

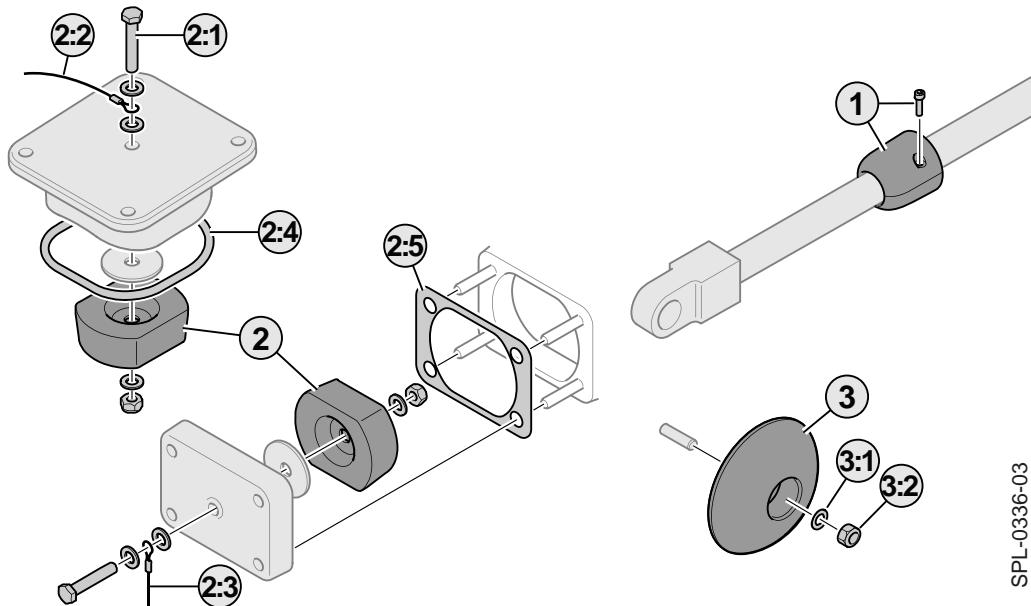


Figure 126

Pos	Description	Quantity	Part number
1-3:2	Anode spare kit 350X, Complete (1 - 3:2) (Zink, Magnesium, Aluminium)	1	X350-1350-01 (Zn) X350-1350-02 (Mg) X350-1350-03 (Al)
1	Anode, shaft	1	KG-2701010-01 (Zn) KG-2701010-02 (Mg) KG-2701010-03 (Al)
2	Anode, side cut	3	9612-402-00X (Zn) 81954 (Mg) 81953 (Al)
2:1	Screw M10x20	3	21115
2:2	Earth cable 220 mm	1	8729-086-22P
2:3	Earth cable 400 mm	2	8729-086-40M
2:4	O-ring	1	32102
2:5	Gasket, anode pocket	2	X310-1301-12
3	Anode, round	6	KG-310 (Zn) KG-75-MG (Mg) KG-80-AL (Al)
3:1	Anode washer M10	14	22020
3:2	Anode lock nut M10	9	23037

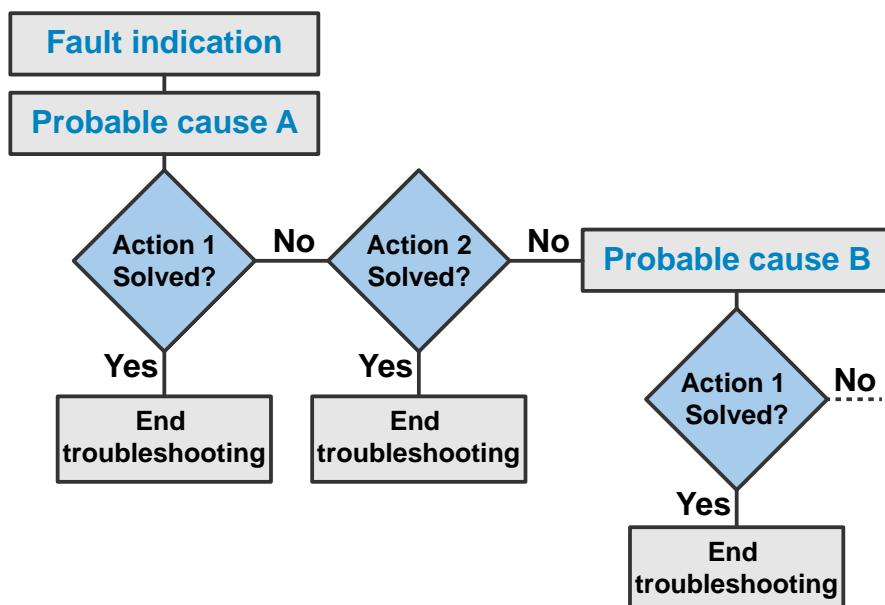
# 6 Fault Indication

## 6.1 Troubleshooting

Troubleshooting must be performed under controlled circumstances by authorised personnel. See the Service Manual for required skill level for each task.

### 6.1.1 How to Read

The action procedure is described in the flow chart.



GEN-0225-02

Figure 127

### 6.1.2 Troubleshooting Procedure

#### Vibration from Waterjet/Shafline

Probable cause	Action
A. Waterjet operated at very high RPM in low speed resulting in pump cavitation.	Lower RPM.
B. Debris in intake or pump.	See 4.2.2 <i>Intake and pump, Inspect.</i>
C. Bearing damage.	Make sure the shaft is rotating freely.
D. Shafting wear/damage.	Check the condition of intermediate shaft U-joint or CV-joint.
E. Impeller damage or housing contact.	See 4.2.3 <i>Pump Unit, Inspect Impeller Blade Tip Clearance</i>

## Low Hydraulic Oil Level

Probable cause	Action
A. Leaking cylinders, connections, pipes or hoses.	<p>1. See 4.3.1 <i>Hydraulic Cylinders and Hoses, Inspect</i></p> <p>2. Repair any leakage and fill up with oil. See 4.3.11 <i>Hydraulic System, Add Oil</i></p>

## Low Hydraulic Pressure

Probable cause	Action
A. Valve or pressure regulator malfunction.	<p>1. See Hydraulic System, Inspect Working Pressure in Operation Manual and.</p> <p>2. 4.3.17 <i>Hydraulic System, Inspect Pressure Limit</i> and 4.3.18 <i>Hydraulic System, Adjust Pressure Limit</i>.</p> <p>3. Still not solved - Contact MJP.</p>

## High Temperature, Hydraulic Oil

Probable cause	Action
A. Low oil volume in the system.	See Hydraulic System, Inspect Oil Level in Operation Manual.
B. Malfunction in the load sensing system.	<p>1. See Hydraulic System, Inspect Working Pressure in Operation Manual.</p> <p>2. Monitor the pressure gauge during operation. Monitor that the working pressure drops when no manoeuvring is done. See Hydraulic Tank, Inspect Standby Pressure.</p> <p>3. If the cylinder reach the mechanical end position, the pressure will not drop. Calibrate the steering and reversing function on related jet. Contact authorized MJP support.</p>
C. Steering and / or reversing is behaving "nervously".	<p>1. During operation, monitor hydraulic control valves (manual handles) to make sure that the valves are not operating when no course corrections are made. If levers are moving / shaking, the gain parameter needs to be adjusted.</p> <p>2. Contact authorized MJP support for the correct parameter tuning.</p>
D. The relief valve is limiting the pressure instead of the load sensing system.	<p>1. See</p> <p>2. See 4.3.17 <i>Hydraulic System, Inspect Pressure Limit</i> and 4.3.18 <i>Hydraulic System, Adjust Pressure Limit</i></p>
E. Oil viscosity is too high.	<p>1. See 4.3.10 <i>Hydraulic System, Inspect Oil Quality</i></p> <p>2. Consider using oil with lower viscosity.</p>
F. Abnormal oil leakage in the hydraulic pump.	1. See 4.3.24 <i>Hydraulic Pump, Inspect</i> .

## 6.2 Alarms

### 6.2.1 Display Panel, Acknowledge Alarms



GEN-2986-01

Figure 128

#### Task Summary

The task is to correct alarms on display panel.

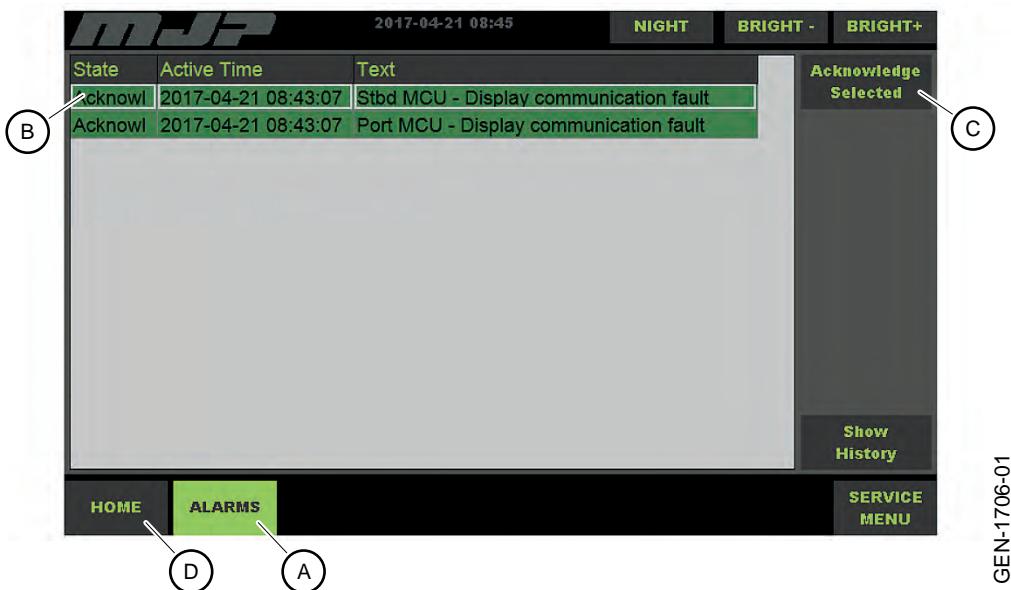
#### Prerequisites

##### Conditions

None

Number of personnel	Skill level	Maintenance facility level	Estimated time
1	Crew	On equipment / at sea	-

## Procedure



GEN-1706-01

Figure 129

When a system alarm is raised, buzzer and display panels will sound. If a command panel is specified, alarm indicator will be blinking.

- 1 Tap ALARMS button (A) to change to alarm list.
- 2 Select active alarm (B) and tap ACKNOWLEDGE SELECTED button (C) to let system know that you have seen alarm.

**Note!**

If you tap ACKNOWLEDGE SELECTED button (C) without any alarm selected, buzzer will be silenced. All alarms in list will still be unacknowledged. If a new alarm is raised, alarm buzzer will start sounding again.

- 3 Identify alarm in software alarms list and follow "Operator Action" instruction details.

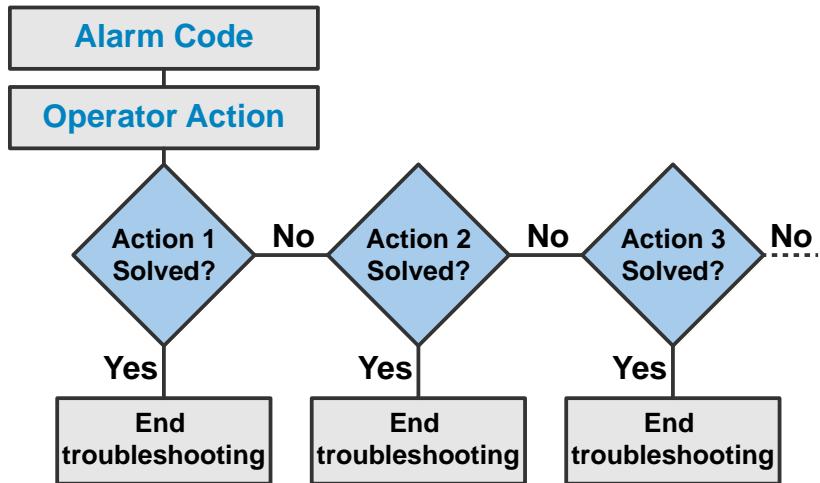
**Note!**

If an alarm is still active in system, ALARMS button (A) will indicate this by a steady red light.

- 4 Tap HOME button (D) to change screen to home screen.
- 5 Task completed.

## 6.2.2 Alarm List

The action procedure is described in flow chart.



GEN-0550-02

Figure 130

## Severity Level

1	Critical alarm, stop the vessel and resolve.*
2	Minor alarm, resolve as soon as possible.*
3	Warning, smaller issue.*

\* If not resolved it can escalate to other Warnings, Minor or Critical Alarms.

## Display Alarms

Alarm Code Port	Alarm Code Stbd	Alarm Description	Severity Level	Operator Action
Port Control System Fail to safe	Stbd Control System Fail to safe	The system has entered fail to safe mode.	1	1 Return all controls to neutral position, refer to alarm list for faults which need to be fixed. 2 Do a check of calibration by contacting authorized MJP support 3 Do a check of connected cable and connectors. 4 Return to harbour.
Port Controls not calibrated	Stbd Controls not calibrated	A control head has been detected which is not calibrated.	2	1 Do a check of calibration by contacting authorized MJP support 2 Return to harbour.
Port Steering	Stbd Steering	A mismatch has occurred between	3	1 Do a check of calibration by contacting authorized MJP support

## Display Alarms (cont'd.)

Alarm Code Port	Alarm Code Stbd	Alarm Description	Severity Level	Operator Action
pots out of sync	pots out of sync	steering control head sensors.		2 Do a check of connected cable and connectors. 3 Return to harbour.
Port Steering pots out of span	Stbd Steering pots out of span	A steering control head sensor has a fault.	1	1 Do a check of calibration by contacting authorized MJP support 2 Do a check of connected cable and connectors. 3 Return to harbour.
Port Thrust lever out of span	Stbd Thrust lever out of span	A thrust controller sensor has a fault.	1	1 Do a check of calibration by contacting authorized MJP support 2 Do a check of connected cable and connectors. 3 Return to harbour.
Port VCS out of span	Stbd VCS out of span	A VCS control sensor has a fault.	2	1 The VCS function must not be used. 2 Do a check of calibration by contacting authorized MJP support 3 Do a check of connected cable and connectors.
Port engine lost while clutched	Stbd engine lost while clutched	Engine Running signal for specified engine has been lost whilst clutched in.	2	1 Make sure that engine is running. 2 Do a check of connected cable and connectors. 3 Return to harbour.
Port RPM knob A out of span	Stbd RPM knob A out of span	A separate RPM dial has a fault.	2	1 Do a check of calibration by contacting authorized MJP support 2 Do a check of connected cable and connectors.
Port RPM knob B out of span	Stbd RPM knob B out of span	A separate RPM dial has a fault.	2	1 Do a check of calibration by contacting authorized MJP support 2 Do a check of connected cable and connectors.
Port Station out of sync	Stbd Station out of sync	Active station has been forced back to Main station because active station differed between MCU's.	2	-
Port MCU - Stbd MCU communication fault	Stbd MCU - Port MCU communication fault	A communication fault has occurred between MCU's.	1	1 Examine cross link cable. Note: Separate mode only is available on main controls. 2 Return to harbour.

## Display Alarms (cont'd.)

Alarm Code Port	Alarm Code Stbd	Alarm Description	Severity Level	Operator Action
Port MCU - Display communication fault	Stbd MCU - Display communication fault	A communication fault has occurred between display and MCU.	2	Do a check of Ethernet connections.
Port BCU - Port MCU communication fault	Stbd BCU - Stbd MCU communication fault	A communication fault has occurred between display and MCU.	1	Do a check of Ethernet connections.
Port Backup fault	Stbd Backup fault	The MCU does not receive Backup OK signal.	2	<ol style="list-style-type: none"> <li>1 Do a check of power supply to Backup unit.</li> <li>2 Do a check of connected cable and connectors.</li> <li>3 Return to harbour.</li> </ol>
Port clutch feedback fault	Stbd clutch feedback fault	Confirm that clutch is operational.	1	<ol style="list-style-type: none"> <li>1 Do a check of connected cable and connectors.</li> <li>2 Return to harbour.</li> </ol>
Port hydraulic oil level	Stbd hydraulic oil level	Hydraulic oil is outside expected level.	1	<ol style="list-style-type: none"> <li>1 Make sure oil level in level glass on tank is OK:</li> <li>2 Do a check of connected cables and connectors.</li> </ol>
Port hydraulic oil temperature	Stbd hydraulic oil temperature	Hydraulic oil is above expected temperature.	1	<ol style="list-style-type: none"> <li>1 Check oil temperature on tank. If it is OK:</li> <li>2 Do a check of connected cables and connectors.</li> </ol>
Port hydraulic oil pressure	Stbd hydraulic oil pressure	Hydraulic oil is below expected pressure.	1	<ol style="list-style-type: none"> <li>1 Make sure oil pressure on tank is OK:</li> <li>2 Do a check of connected cables and connectors.</li> </ol>
Port analogue sensor fault	Stbd analogue sensor fault	A fault has occurred with analogue sensors on tank.	2	<ol style="list-style-type: none"> <li>1 Do a check of calibration by contacting authorized MJP support</li> <li>2 Do a check of connected cable and connectors.</li> </ol>
Port waterjet bucket not at setpoint	Stbd waterjet bucket not at setpoint	The reversing bucket is not in its expected position.	2	<ol style="list-style-type: none"> <li>1 Do a check of calibration by contacting authorized MJP support</li> <li>2 Do a check of connected cable and connectors.</li> <li>3 Return to harbour.</li> </ol>

## Display Alarms (cont'd.)

Alarm Code Port	Alarm Code Stbd	Alarm Description	Severity Level	Operator Action	
Port waterjet bucket out of span	Stbd waterjet bucket out of span	The reversing bucket feedback sensor is not operational.	1	1	Do a check of calibration by contacting authorized MJP support
				2	Do a check of connected cable and connectors.
				3	Return to harbour.
Port waterjet nozzle not at setpoint	Stbd waterjet nozzle not at setpoint	The steering nozzle is not in its expected position.	2	1	Do a check of calibration by contacting authorized MJP support
				2	Do a check of connected cable and connectors.
				3	Return to harbour.
Port waterjet nozzle out of span	Stbd waterjet nozzle out of span	The steering nozzle feedback sensor is not operational.	1	1	Do a check of calibration by contacting authorized MJP support
				2	Do a check of connected cable and connectors.
				3	Return to harbour.
Port Configuration file fault	Stbd Configuration file fault	Unable to load configuration.	1	1	Contact authorized MJP support.
				2	Return to harbour.
Port feedback fault	Stbd feedback fault	A feedback sensor of nozzle or bucket is not operational.	1	1	Do a check of connected cable and connectors.
				2	Return to harbour.
Display - Port MCU communication fault	Display - Stbd MCU communication fault	The display has lost its connection to MCU.	2	1	Do a check of connected cable and connectors.
				2	Return to harbour.

## Ship Monitoring System Alarms

Location	Alarms	Alarm Description	Severity Level	Operator Action
All MCU and Backup Units	Primary Power Fault	A fault has occurred with primary supply to unit.	2	<p>1 Make sure that power supply is present. If multiple units are affected it is most likely an external problem.</p> <p>2 If a single unit is affected, make sure that both positive and negative fuses are OK and that power supply unit has a green light.</p>
All MCU and Backup Units	Secondary Power Fault	A fault has occurred with secondary supply to unit.	2	<p>1 Make sure that power supply is present. If multiple units are affected it is most likely an external problem.</p> <p>2 If a single unit is affected, make sure that both positive and negative fuses are OK and that power supply unit has a green light.</p>
All MCU and Backup Units	System OK	Confirm primary or secondary power is present at unit.	1	Make sure that PLC is set to run load and 'RUN' status light on PLC is green.

# 7 Appendix

## 7.1 Paint Program



**Caution!**

Copper and other metallic based anti-fouling paint must NOT be used. This is due to the risk of galvanic corrosion.

### 7.1.1 General

The waterjets shall be painted with Anti Fouling Paint at the same interval as the hull.

The waterjet unit is painted with epoxy-based paint at delivery, and it is important to make sure that the epoxy - based paint is intact prior to applying the Anti Fouling paint during installation and service.

- 1 The first and second coats are painted by Marine Jet Power and are epoxy-based.
- 2 The third and fourth coats are painted by the shipyard personnel when the vessel is outfitted. Marine Jet Power recommends that the third layer of primer is added for sufficient adhesion of the anti-fouling paint.

Layer	Paint type	Color/Shade	Thickness	Painted by
First	Epoxy-based paint	Grey/Black	150 µm	Marine Jet Power personnel (before delivery)
Second	Epoxy-based paint	Grey/Black	150 µm	Marine Jet Power personnel (before delivery)

Third	Anti-fouling paint primer			Shipyard personnel
Fourth	Anti-fouling paint			Shipyard personnel

### 7.1.2 Touch Up Paint or Repaint

For best results, remove all of the old coatings. If that is not possible, remove all of the loose paint.

## 7.2 Torque

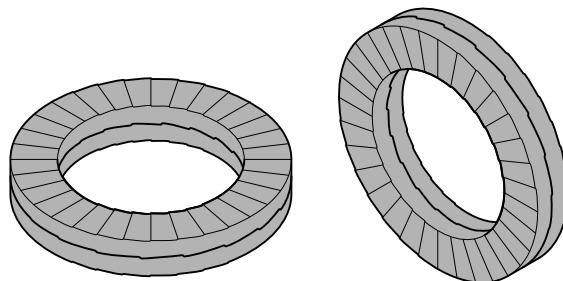
**Caution!**

All bolted connections are critical in an MJP waterjet. It is important to have lock washers correctly mounted and they have to be in good condition.

### 7.2.1 Screws and washers

The material used in screws is A4-80 or A4-100. The anti-seizing lubrication Molybdendisulphide ( $\text{MoS}_2$ ) must be used for all bolts from Marine Jet Power.

Most screw joints are secured with nordlock washers. These washers may be re-tightened 5 times before they need to be replaced.



GEN-0903-01

Figure 131

## 7.2.2 Specifications for Screws with Nordlock Washer

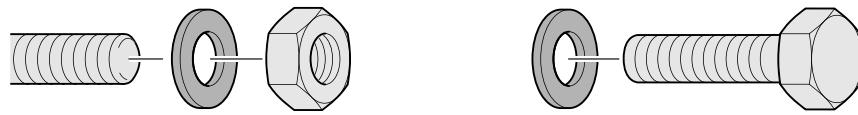


GEN-3043-01

Figure 132

Dimension	Normal A4-80, M <sub>v</sub> (Nm)	Impeller screws A4/100, M <sub>v</sub> (Nm)
M4	2.4	3.7
M5	4.8	7.3
M6	8.3	12.5
M8	20	30
M10	38	59
M12	67	102
M14	107	161
M16	164	251
M18	229	347
M20	321	489
M22	445	654
M24	553	842
M27	805	1235
M30	1093	1682
M33	1474	2289
M36	1902	2931
M39	2452	3776

### 7.2.3 Specifications for Screws with Plain Washer

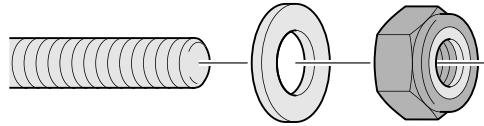


GEN-3044-01

Figure 133

Dimension	Normal A4-70, Mv(Nm)	Normal A4-80, Mv(Nm)
M4	2.1	2.7
M5	4,1	5,4
M6	7,0	9,3
M8	17	22
M10	33	44
M12	57	76
M14	91	121
M16	140	187
M18	195	261
M20	273	364
M24	472	629
M27	682	909
M30	930	1240
M36	1620	2160

## 7.2.4 Specifications for Lock Nuts



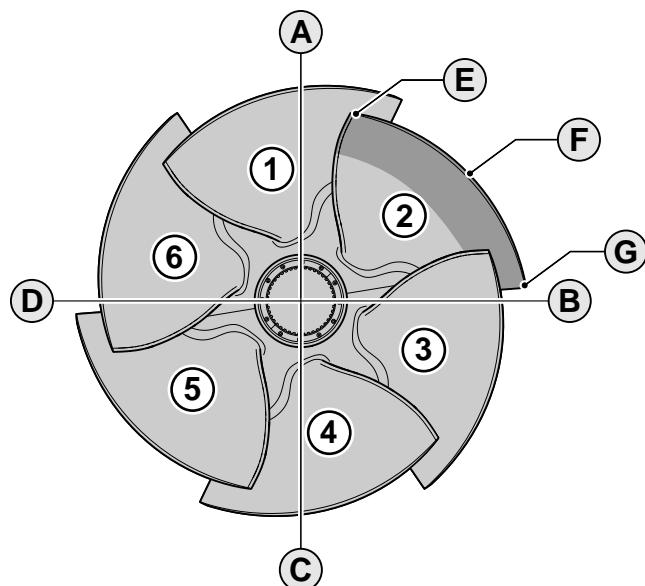
GEN-3045-01

Figure 134

Dimension	Normal A4-70, M <sub>v</sub> (Nm)
M5	4 - 4.6
M6	7 - 8
M8	17 - 19
M10	31 - 34
M12	60 - 65
M16	110 - 120
M20	203 - 224

## 7.3 Impeller Clearance Protocol

Date	MJP project	Waterjet ID	Written by



GEN-1296-01

<b>Blade 1 (mm)</b>	<b>Leading edge (E)</b>	<b>Middle (F)</b>	<b>Trailing edge (G)</b>
TOP (A):			
RIGHT (B):			
BOTTOM (C):			
LEFT (D):			
<b>Blade 2 (mm)</b>	<b>Leading edge (E)</b>	<b>Middle (F)</b>	<b>Trailing edge (G)</b>
TOP (A):			
RIGHT (B):			
BOTTOM (C):			
LEFT (D):			
<b>Blade 3 (mm)</b>	<b>Leading edge (E)</b>	<b>Middle (F)</b>	<b>Trailing edge (G)</b>
TOP (A):			
RIGHT (B):			
BOTTOM (C):			
LEFT (D):			
<b>Blade 4 (mm)</b>	<b>Leading edge (E)</b>	<b>Middle (F)</b>	<b>Trailing edge (G)</b>
TOP (A):			
RIGHT (B):			
BOTTOM (C):			
LEFT (D):			
<b>Blade 5 (mm)</b>	<b>Leading edge (E)</b>	<b>Middle (F)</b>	<b>Trailing edge (G)</b>
TOP (A):			
RIGHT (B):			
BOTTOM (C):			
LEFT (D):			
<b>Blade 6 (mm)</b>	<b>Leading edge (E)</b>	<b>Middle (F)</b>	<b>Trailing edge (G)</b>
TOP (A):			
RIGHT (B):			
BOTTOM (C):			
LEFT (D):			

## 7.4 Oil Contamination Limits

Cleanliness levels are defined by three numbers separated by slashes (/). These numbers correspond to 4, 6 and 14 micron, in that order. Each number refers to an ISO range code, which is determined by the number of particles for that size (4, 6 & 14μm) and larger, present in 1 ml of fluid. The oil contamination limits are valid for both hydraulic and lubrication systems. Refer to the "Particles / ml" column in the chart below to see the actual particle ranges.

Cleanliness requirements for both hydraulic and lubricating oil for Marine Jet Power are according to ISO 4406 with the number of particles as 22/18/13.

Particles / ml	4μm	6μm	14μm	ISO code
2,500,000 to 1,300,000				28
1,300,000 to 640,000				27
640,000 to 320,000				26
320,000 to 160,000				25
160,000 to 80,000				24
80,000 to 40,000				23
40,000 to 20,000	22			22
20,000 to 10,000				21
10,000 to 5,000				20
5,000 to 2,500				19
2,500 to 1,300		18		18
1,300 to 640				17
640 to 320				16
320 to 160				15
160 to 80				14
80 to 40			13	13
40 to 20				12
20 to 10				11
10 to 5				10
5 to 2.5				9
2.5 to 1.3				8
1.3 to 0.64				7
0.64 to 0.32				6
0.32 to 0.16				5
0.16 to 0.08				4
0.08 to 0.04				3
0.04 to 0.02				2
0.02 to 0.01				1
0.01 to 0.00				0

**Example of ISO code generation**

Larger than 4 µm = 22340 pieces	
Larger than 6 µm = 1950 pieces	Generates ISO Code = 22/18/13
Larger than 14 µm = 43 pieces	

**7.4.1 Water Content per DIN ISO 3733**

In a new fluid, the water content must be out of the quantitative detectable range. Unless otherwise specified in individual fluid standards, the water content for continuous operation must not exceed 0.1%. The lower, the better. Water is a harmful contaminant, reducing the life of the hydraulic fluid and the mechanical components. Water in a system may result in corrosion, cavitation and altered fluid viscosity. Depending on the fluid, water may also react with the fluid to create harmful chemical by-products or destroy important additives. Left unchecked, water contamination may result in microbial growth. At this stage, system components may already have been damaged.

**Caution!**

If the water content value is above 0.1%, locate the water infusion source and repair it before a oil change is completed. This will help to prevent damage to the equipment.

**Hydraulic**

Replace the hydraulic cylinder seals	See 4.3.6 <i>Hydraulic Steering Cylinder, Replace Seals</i> and 4.3.5 <i>Hydraulic Reversing Cylinder, Replace Seals</i>
Inspect cylinders and hoses	See 4.3.1 <i>Hydraulic Cylinders and Hoses, Inspect</i>
Replace the air filter	See 4.3.9 <i>Hydraulic and Lubrication System, Replace Breather Filter</i> <i>Hydraulic Tank, Replace Air Filter</i>

**Mechanics**

Inspect the pump unit	See 4.3.24 <i>Hydraulic Pump, Inspect</i>
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## 7.5 Weld Specifications

Make sure to contact MJP before any welding of the Waterjet is performed, to sort out why it is necessary.



### Warning!

Welding can destroy electronic components. Before performing welding on the vessel, make sure that all earth cables and control system cables are removed from the control system cabinets. Damage due to inappropriate handling is not covered by the warranty.

## Welding procedure

Welds	To be full penetration and conform to Classification Society rules for Aluminium vessels (Welding in Hull construction). The responsibility for WPS and WPQR to be developed lies with the customer or the contracted company which performs the welding. Classification Society to be informed of WPS. Material ID of MJP goods are stamped in castings, if not available contact Marine Jet Power.		
Welder qualifications	Properly qualified welder with Classification Society welder qualification or equivalent.		
Inspection	Inspection to be done by a qualified welding inspector.		
Site	The site must be: a) Dry and free from steel grinding dust or other contaminants that could affect the finished weld condition. b) Sheltered from draughts to prevent disturbance to shielding gas.		
Welding process	M.I.G or T.I.G		
Welding filler wire	Material of Jet component:	Filler material:	Hull material:
	42100 (4000-series)	5183 / 5356	5000-series
	44100/44200(4000-series)	5183 / 5356	5000-series
	42100 (4000-series)	4043	6000-series
	44100/44200 (4000-series)	4043	6000-series
	5083 (5000-series)	5183	5052, 5083, 5086, 6061
Shield gas	Pure Argon or an Argon / Helium mix. Preferred option is Argon / Helium mix.		
Weld position	Flat down-hand is preferred. If not possible, the use of a backing strip will be necessary. Weld down-hand from one side only, then grind off the backing strip.		

## 7.6 Fluids and Lubricants

### 7.6.1 Hazardous Substances

Marine Jet Power have used fluids and lubricants that are free from asbestos, polychlorinated biphenyls, ozone depleting substances and organotin compounds. The fluids and lubricants may however contain hazardous ingredients that will cause personal injury and affect the environment. Read the material safety data sheets to find information of the products and contact the manufacturer for more information.

### 7.6.2 Assembly Adhesives, Sealants and Lubricants

#### Specifications for the adhesives, sealants and lubricants used by MJP

Product	Source	Essential Characteristics	Use
Anti-seize paste for assembly and long-term lubrication of metallic components	Molykote® DX paste or equivalent	High viscosity, paste, off-white, excellent corrosion prevention, thermally stable up to 125 °C.	For assembly and running in of metallic components. Used for bolts.
Silicone compound	Molykote® 111 Compound or equivalent	High viscosity, grease, translucent white, flash point 101 °C.	O-ring, valve and seal lubrication.
Ethyl cyanoacrylate adhesive	Loctite® 495 or equivalent	Low viscosity, colourless, instant adhesive.	Offers fast bonding on a wide range of materials.
Medium strength thread locking adhesive	Loctite® 243 or equivalent	General purpose thread locker that provides a medium strength bond	Thread locker
Silicone grease	Greasil® 4000 or equivalent	Water repellent, non-melting silicone grease lubricant, nontoxic, environmental user friendly.	O-ring, valve and seal lubrication.
Polyurethane marine sealant	Sikaflex® 291 or equivalent	Noncorrosive, odourless, good grip, several colours, can be painted.	Flexible, vibration-resistant, waterproof seals.
2 component epoxy resin	Chockfast® Orange or equivalent	Low viscosity, heat resistant up to 90 °C, very low shrinkage, resistant to corrosion, oils, fuels and many chemicals.	Alignment of equipment or surfaces 12-100 mm.

## 7.6.3 Oil Specifications

### Hydraulic oil

Oil quality	ISO VG 32 should be used. ISO VG 22 works for colder climates. Oil with good corrosion protective properties must be used.
Minimum oil temperature in tank before start	+5° C
Recommended tank temperature during operation	+40 to +60° C
Alarm temperature	+70° C For continuous use over 70° C during operation, contact MJP.

### Lubrication oil

#### The oil specification for the bearing unit

Oil quality	Gear and bearing oil (Synthetic), ISO VG 68 HC.
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## 7.6.4 Grease Specifications

**DIN 51825 - K 1 G -20**



GEN-3156-01

Figure 135

Lubricants - Lubricating greases K - Classification and requirements

- (A) Type of grease lubricant and lubricating material
- (B) Consistency index
- (C) Upper operating temperature
- (D) Lower service temperature

### Type of Grease Lubricant and Lubricating Material

Code letter	Explanation
K	K grease lubricants are high-viscosity lubricants made of mineral oil and/or synthetic oil plus a thickening agent. The addition of active ingredients and/or solid lubricants is permitted.
KP	K grease lubricants with active ingredients for reducing friction and wear in the mixed friction zone and/or for increasing load capacity are identified with the additional code letter P (KP grease lubricants). They are used, for example, to lubricate anti friction bearings whose dynamic equivalent load P exceeds one tenth of the dynamic load capacity C (see the information published by the manufacturer of the anti friction bearings).
KF	K grease lubricants with solid lubricating additives are identified with the additional code letter F.
KPF	K grease lubricants containing active ingredients and solid lubricating additives are identified by the two additional code letters P and F.

### Consistency Index

NLGI-class	Worked penetration according to DIN ISO 2137
000	44,5 mm to 47,5 mm
00	40,0 mm to 43,0 mm
0	35,5 mm to 38,5 mm
1	31,0 mm to 34,0 mm
2	26,5 mm to 29,5 mm
3	22,0 mm to 25,0 mm
4	17,5 mm to 20,5 mm

## Consistency Index (cont'd.)

NLGI-class	Worked penetration according to DIN ISO 2137
5	13,0 mm to 16,0 mm
6	8,5 mm to 11,5 mm

## Upper Operating Temperature

Code letter	Upper operating temp.	Reaction to water
C	+ 60 °C	0-40 or 1-40
D	+ 60 °C	2-40 or 3-40
E	+ 80 °C	0-40 or 1-40
F	+ 80 °C	2-40 or 3-40
G	+ 100 °C	0-90 or 1-90
H	+ 100 °C	2-90 or 3-90
K	+ 120 °C	0-90 or 1-90
M	+ 120 °C	2-90 or 3-90
N	+ 140 °C	by agreement
P	+ 160 °C	by agreement
R	+ 180 °C	by agreement
S	+ 200 °C	by agreement
T	+ 220 °C	by agreement
U	over + 220 °C	by agreement

## Lower Service Temperature

Code number	Lower service temp.
-10	-10 °C
-20	-20 °C
-30	-30 °C
-40	-40 °C
-50	-50 °C
-60	-60 °C

## 7.7 Long Term Storage of Equipment

### 7.7.1 Preservation of Equipment Before Installation

Store the Marine Jet Power equipment indoors and in conditions recommended. Always keep the components in their original package as long as possible. Intermediate shafting, electronic, hydraulic and other non stainless parts are stored in a dry place. It is also important to rotate the impeller to minimize the risk of bearing damage during docking periods.

Store the Marine Jet Power equipment as described in the specifications:

#### Specifications for the assembled components.

Component	Shelf life	Min./max temperature	Humidity	Special conditions
Pump unit	4 years	-20/+50 °C	N/a	The impeller has to be rotated every three months to avoid damage on the bearing. After three months of storage, it is important to paint with a new primer. The seals limits the storage life.
Hub unit	4 years	-20/+50 °C	Steady	The impeller has to be rotated every three months to avoid damage on the bearing. Store ONLY fully sealed in plastic, away from dirt and dust.
Steering unit	4 years	-20/+50 °C	N/a	After three month storage paint needs a new primer.
Hydraulic tank unit	2 years	-20/+50 °C	Steady	The seals limits the storage life.

#### Specifications for the components made of plastic and polymer.

Component	Shelf life	Min./max temperature	Humidity	Special conditions
Hydraulic hoses	4 years	-5/+20 °C	Below 75%	Store sealed and in a dark place, preferably with a black plastic wrapping.
O-rings	2 years	-5/+20 °C	Below 75%	Store sealed and in a dark place, preferably with a black plastic wrapping.

## Specifications for the components made of plastic and polymer. (cont'd.)

Component	Shelf life	Min./max temperature	Humidity	Special conditions
Mechanical seal	4 years	-5/+20 °C	Below 75%	Store in a dark place, preferably in its original box.
Shaft seal, face type	4 years	-5/+20 °C	Below 75%	Store in a dark place, preferably in its original box.
Shaft seal element, radial seal type	4 years	-5/+20 °C	Below 75%	Store in a dark place and sealed. Preferably in a black plastic bag.
Shaft seal bearing, Thordon	10 years	-20/+40 °C	Steady	Store in a plastic wrapping on end to minimize deformation.

## Specifications for the stainless components.

Component	Shelf life	Min./max temperature	Humidity	Special conditions
Machined parts	UNLIMITED	-20/+50 °C	Steady	Store in a dry and clean place. Keep away from corrosive materials.
Bolts	UNLIMITED	-20/+50 °C	Steady	Store in a dry and clean place. Keep away from corrosive materials.

## Specifications for the components made of bronze and PTFE.

Component	Shelf life	Min./max temperature	Humidity	Special conditions
Bushings	UNLIMITED	-20/+50 °C	Steady	N/a
Bearings (not stainless components)	10 years	+5/+20 °C	Below 75%	Store in a dry place. Keep in the original box and wrapping.
Shaft coupling	UNLIMITED	-20/+50 °C	Below 75%	Store in a protective packaging.
Hydraulic filters	4 years	-20/+50 °C	Steady	N/a

## Specifications for the electronic components.

Component	Shelf life	Min./max temperature	Humidity	Special conditions
Hydraulic cylinders	4 years	+5/+20 °C	Below 75%	Seals limits the storage life.
Seal kit for hydraulic cylinders	4 years	+5/+20 °C	Below 75%	Store in a dark place, sealed and preferably in a black plastic.
Feedback sensors	10 years	+5/+20 °C	Below 75%	Store in a protective ESD safe package.
Control system, complete system and components	10 years	+5/+20 °C	Below 75%	Store in a protective ESD safe package.
Cables	10 years	+5/+20 °C	Below 75%	N/a

## 7.7.2 Suitable Products For Storage Protection

Two types of products can be used depending on the time of the storage.

Storage time	Product	Fulfils the requirement of
While waiting for installation	TECTYL 502-C	MIL-C-16173D, Grade 2
Military mobilization storage or similar	TECTYL 511-M	MIL-C-16173D, Grade 5

**Note!**

It takes longer to remove the protective layer of the TECTYL 511-M.

## 7.8 Equipment Disposal

Dispose the components in accordance to Marine Jet Powers recommendations:

### Specifications for disposal of the components.

Item	Expected life	Disposal	Logistic
Water jet unit, cast and machined parts	Life of vessel	Recycle	Send back to MJP
Bolts, nuts and washers	Life of vessel or changed when unit is serviced	Recycle	Transport to metal recycling central
Bushings	Approximately 4 years or 4 000 operating hours depending on operating water conditions	Recycle	Transport to metal recycling central
Bearings	Approximately 8 000 hours ("L10") possible life of vessel depending on oil condition	Recycle	Transport to metal recycling central
O-rings	Changed at service of jet unit	Burn	Transport to recycling central
Water jet unit and mechanical seal	5years or 8 000 operating hours	Recycle	Transport to recycling central
Water jet unit, mechanical seal and seal element	N/A	Recycle	Transport to recycling central
Water jet unit, mechanical seal and metal parts	N/A	Recycle	Transport to recycling central
Drive shaft and drive shaft couplings with bolts, washers and nuts	Life of vessel	Recycle	Transport to metal recycling central
Shaft system with couplings and seals	Life of vessel	Recycle	Transport to metal recycling central
Hydraulic and lubrication oils	Change every second year or based on oil test sample	Recycle	Transport to recycling central
Hydraulic filters	Change yearly or when the indicator is red	Recycle	Transport to recycling central
Hydraulic tank unit	Life of vessel	Scrap. Remove metal parts and recycle	Transport to scrapping facility
Hydraulic hoses	Change every 5th year	Scrap. Remove metal parts and recycle	Transport to scrapping facility
Hydraulic cylinders	Life of vessel, depending on operating conditions, oil and water quality	Recycle	Send back to MJP

## Specifications for disposal of the components. (cont'd.)

Item	Expected life	Disposal	Logistic
Hydraulic cylinder seal kits	Change every second year or 2 000 operating hours	Landfill	Transport to recycling central
Feedback sensors and built-in hydraulic cylinders	When malfunctioning	Electronic disposal	Transport to recycling central
Control system, complete system and or components of the system (for example control heads, panels, indicators and PLC components).	When malfunctioning or obsolete	Electronic disposal. Separate metal parts and recycle	Send back to MJP
Cables	Life of vessel	Electronic disposal. Separate metal parts and recycle	Transport to recycling central

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