



**X** SERIES

# 350X

## ARESA

# INSTALLATION MANUAL

**mjp**  
MARINE JET POWER

A FORCE TO TRUST

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<b>1 Introduction .....</b>	<b>5</b>
<b>1.1 About This Manual .....</b>	<b>5</b>
1.1.1 General .....	5
1.1.2 Intended Use .....	5
1.1.3 How to Read This Manual .....	5
1.1.4 Skill Level .....	5
1.1.5 Facility Level.....	5
<b>2 Safety.....</b>	<b>6</b>
<b>2.1 Safety Instructions.....</b>	<b>6</b>
2.1.1 General .....	6
2.1.2 Local Regulations .....	6
2.1.3 Symbol Levels .....	6
2.1.4 Symbols .....	7
2.1.5 Personal Safety Equipment.....	8
2.1.6 Disposal .....	8
<b>3 Engineering Overview.....</b>	<b>9</b>
<b>3.1 Position of the Waterjet .....</b>	<b>9</b>
3.1.1 Procedures to Install the Waterjet .....	10
<b>3.2 The Turn Direction of the Drive Shaft.....</b>	<b>13</b>
<b>3.3 Work Space Around the Waterjet .....</b>	<b>14</b>
<b>3.4 Corrosion Protection .....</b>	<b>15</b>
3.4.1 Grounding .....	15
3.4.2 Anodes.....	15
<b>3.5 Installation Principles.....</b>	<b>16</b>
<b>3.6 Hull Modifications .....</b>	<b>17</b>
3.6.1 Wedge .....	17
3.6.2 Recess.....	18
3.6.3 Vee-hull, Alignment of Waterjet .....	19
3.6.4 Centre Jet Installation.....	19
<b>3.7 Lifting Points .....</b>	<b>20</b>
<b>3.8 Pipes and Hoses .....</b>	<b>21</b>
3.8.1 Pipe Couplings .....	22
<b>3.9 Drive Shaft .....</b>	<b>23</b>
3.9.1 Standard Shaft Arrangement.....	23
3.9.2 Cardan Shaft Arrangement .....	23
3.9.3 Constant Velocity Shaft Arrangement .....	23
<b>4 Control System Units .....</b>	<b>24</b>
<b>4.1 Display Panel.....</b>	<b>25</b>
<b>4.2 External Buzzer .....</b>	<b>25</b>
<b>4.3 Command Panel .....</b>	<b>26</b>
<b>4.4 VCS Panel (BUS) .....</b>	<b>27</b>
<b>4.5 Combinator Controller.....</b>	<b>28</b>
<b>4.6 Steer Wheel.....</b>	<b>29</b>
<b>4.7 Main Control Unit .....</b>	<b>30</b>
<b>4.8 Hydraulic Connection Box .....</b>	<b>31</b>
<b>5 Installation.....</b>	<b>32</b>
<b>5.1 Installation Overview .....</b>	<b>32</b>
<b>5.2 Installation Tasks .....</b>	<b>33</b>
5.2.1 Waterjet Unit, Unpack.....	33
5.2.2 Hydraulic Pump, Remove .....	35
5.2.3 Waterjet Unit, Install (Bolted).....	38
<b>5.3 Paint the Waterjet Unit .....</b>	<b>44</b>
5.3.1 Waterjet Unit, Paint .....	44
5.3.2 Waterjet Unit, Apply Anti-fouling Paint.....	47

<b>5.4 Hydraulic and Lubrication Installation .....</b>	<b>50</b>
5.4.1 Hydraulic Pump, Install .....	50
5.4.2 Lubrication System, Fill with Oil .....	53
5.4.3 Hydraulic System, Fill with Oil .....	55
5.4.4 Hydraulic Tank, Connect Oil Level and Temperature Alarm Switch .....	58
<b>5.5 Control System Installation .....</b>	<b>60</b>
5.5.1 Main Control Unit, Install .....	60
5.5.2 Command Panel, Install .....	61
5.5.3 VCS Panel, Install .....	63
5.5.4 Combinator Controller, Install .....	65
5.5.5 Steer Wheel, Install .....	67
5.5.6 Display Panel, Install .....	69
5.5.7 Control System, Install Cables .....	72
<b>5.6 Launch the Vessel.....</b>	<b>73</b>
<b>6 Appendix .....</b>	<b>74</b>
<b>6.1 Paint Program.....</b>	<b>74</b>
6.1.1 General .....	74
6.1.2 Touch Up Paint or Repaint .....	74
<b>6.2 Torque .....</b>	<b>75</b>
6.2.1 Screws and washers .....	75
6.2.2 Specifications for Screws with Nordlock Washer .....	76
6.2.3 Specifications for Screws with Plain Washer .....	77
6.2.4 Specifications for Lock Nuts .....	78
<b>6.3 Weld Specifications .....</b>	<b>79</b>
<b>6.4 Fluids and Lubricants .....</b>	<b>80</b>
6.4.1 Hazardous Substances .....	80
6.4.2 Assembly Adhesives, Sealants and Lubricants .....	80
6.4.3 Oil Specifications .....	81
6.4.4 Grease Specifications .....	82
<b>6.5 Material Specification .....</b>	<b>84</b>
6.5.1 Specific Recommendations .....	84
<b>6.6 Long Term Storage of Equipment .....</b>	<b>85</b>
6.6.1 Preservation of Equipment Before Installation .....	85
6.6.2 Suitable Products For Storage Protection .....	88
<b>6.7 Oil Contamination Limits .....</b>	<b>89</b>
6.7.1 Water Content per DIN ISO 3733 .....	90

# 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 the installation 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 planning and installing the mechanical, hydraulic, lubrication and electrical control system.

### 1.1.3 How to Read This Manual

This manual contains instructions regarding installation of the equipment. It also contains information on what to consider prior to installation.

Instructions regarding operation of the equipment are described in the **Operations Manual** and instructions for service of the waterjet system are described 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.

### 1.1.4 Skill Level

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

Skill level		Description
A	Crew	General technical knowledge about the Marine Jet Power system.
B	Technician	Good technical knowledge from similar systems. Preferably by Marine Jet Power.
D	Task specialist	Specific technical training in a specific field: mechanical, hydraulic, lubrication or control system. Could also be a welder, painter, electrician etc.
E	Shipyard engineer, mechanical	Special technical training in mechanical field.
F	Shipyard engineer, hydraulic / lubrication	Special technical training in hydraulic and lubrication field.
G	Shipyard engineer, control system	Special technical training in control system field.

### 1.1.5 Facility Level

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

- Dockside
- Dock, workshop / dry dock

## 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

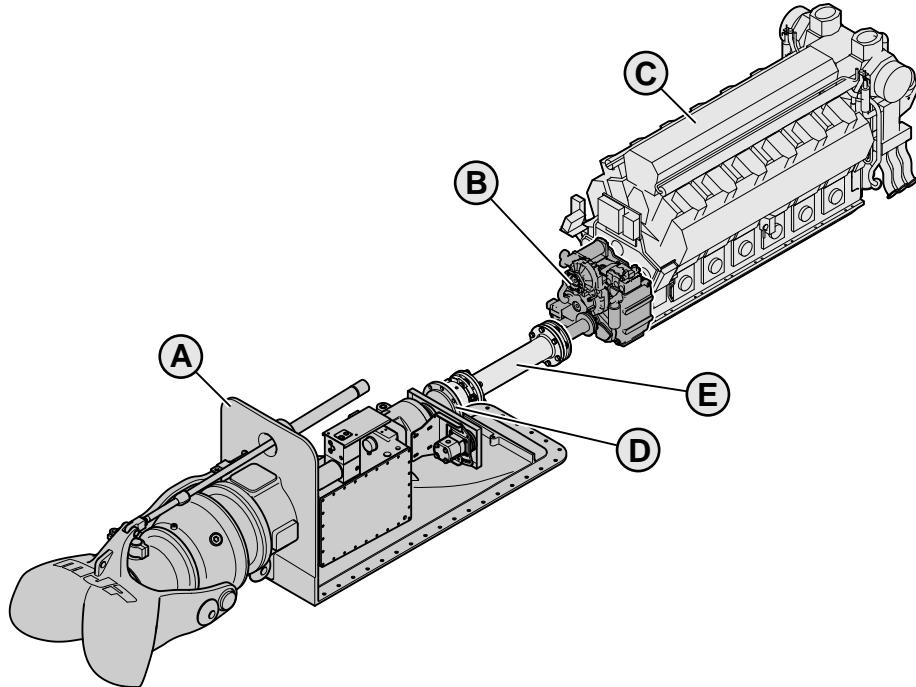
Discharge of hazardous substances must be done in accordance to local regulations.



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

### 3 Engineering Overview

#### 3.1 Position of the Waterjet



GEN-1635-01

Figure 1

Each waterjet (A) is connected to a gearbox (B) or an engine (C) by a drive shaft (D).

If possible, MJP recommends the standard shaft arrangement when you plan the position of the engine (C) and the gearbox (B). The standard shaft arrangement has an intermediate shaft (E) installed between the drive shaft (D) and the gearbox (B) or the engine (C). The length of the intermediate shaft is specified by:

- The length between the drive shaft (D) and engine (C), or
- The length between the drive shaft (D) and gearbox (B)

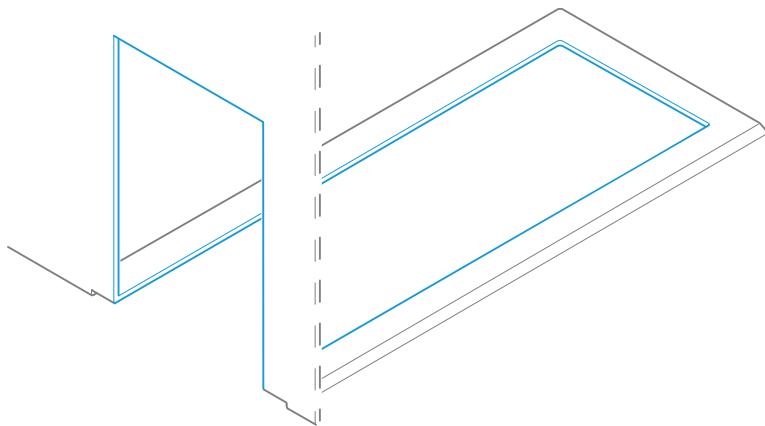
### 3.1.1 Procedures to Install the Waterjet

The waterjet will be bolted to the hull based on the material of the hull.

Hull material	Installation procedure
GRP	1. Bolted from the outside of the hull
Aluminium	1. Bolted from the outside of the hull

#### Cutout of the Hull

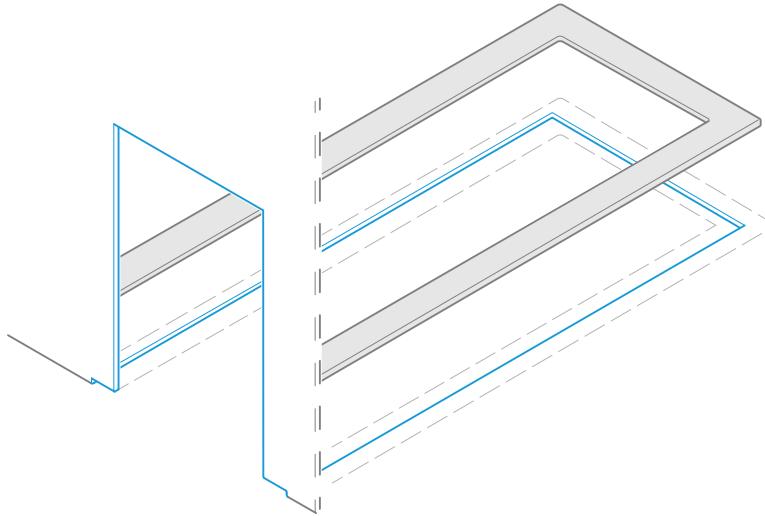
Cutout for bolting to the GRP hull.



GEN-3047-01

Figure 2

Cutout for bolting to the Aluminium hull.



GEN-2963-01

Figure 3

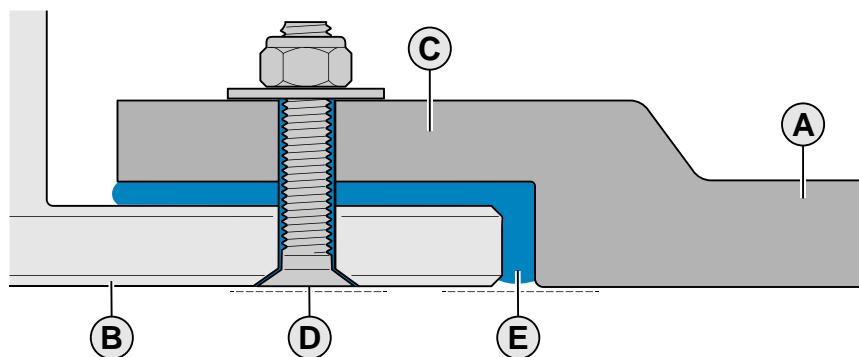
In a GRP hull a cutout hole is made after the lamination process is completed

A cutout hole is made in the bottom of the aluminium hull.

#### Note!

The interface drawing Hull installation gives information about placement and size of the cutout hole and also measurement of the recess.

## GRP Hull – Bolt Procedure



GEN-1616-01

Figure 4

Before the lamination process starts, an inverted recess is created on the female mold.

**Note!**

The interface drawing Hull installation gives information about placement of the recess.

After the lamination process is completed, a cutout hole is made in the recess (C).

**Note!**

The interface drawing Hull installation gives information about placement of the cutout hole.

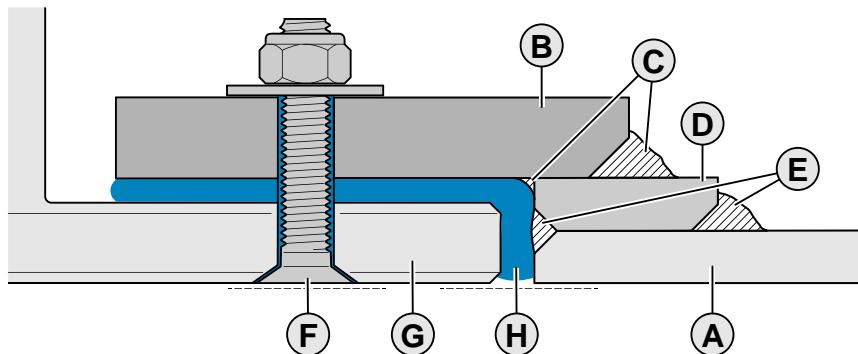
The waterjet unit is lifted into place through the cutout hole.

**Note!**

It is important that the waterjet unit is flush with the hull under the vessel and aligned with the drive shaft.

Holes are drilled in the recess (C) through the holes in the intake (B). The intake (B) is attached to the recess (C) with bolts (D). A marine sealant (E) prevents leakage.

## Aluminium – Bolt Procedure



GEN-1617-01

Figure 5

A cutout hole is made in the bottom of the aluminium hull (A).

**Note!**

The interface drawing Hull installation gives information about placement of the cutout hole.

A recess (B) is welded (C) to the aluminium hull (A) around the cutout hole.

If the hull is thinner than the intake + 2 mm, an extra strip (D) is welded (E) to the hull first. This is to achieve 2 mm of marine sealant and the waterjet unit flush with the hull .

The waterjet unit is lifted into place through the cutout hole.

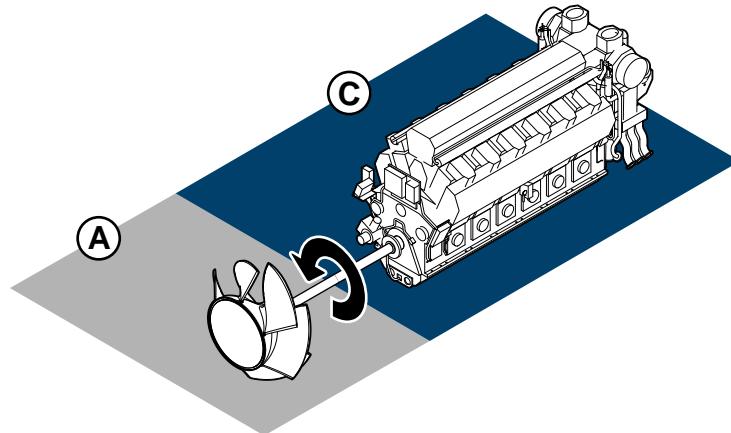
**Note!**

It is important that the waterjet unit is flush with the hull under the vessel and aligned with the drive shaft.

The waterjet unit is lifted into place through the cutout hole. Holes are drilled in the recess (B) through the holes in the intake (G). The intake (G) is attached to the recess (B) with bolts (F). A marine sealant (H) prevents leakage.

### 3.2 The Turn Direction of the Drive Shaft

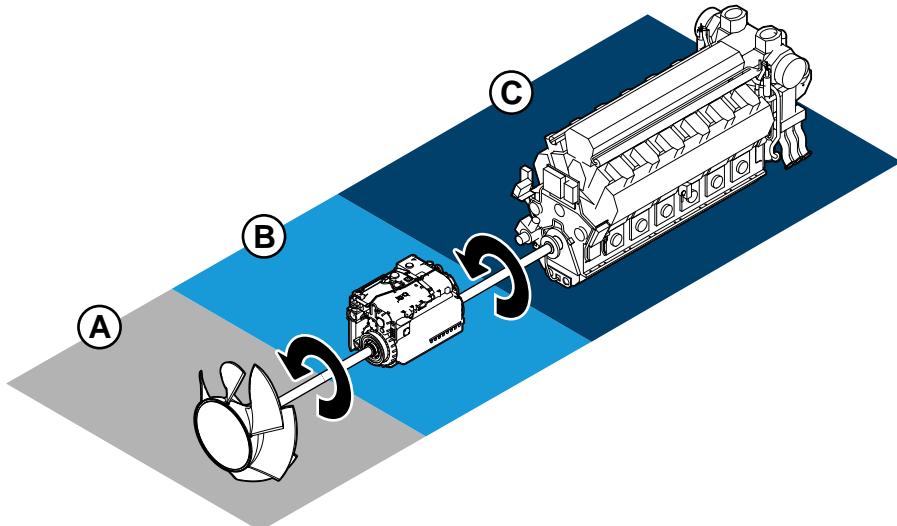
Always make sure the direction of rotation of the engine/gearbox output matches the impeller and waterjet designed direction of rotation. See figure below.



GEN-0888-03

Figure 6

Waterjet with inverted impeller without gearbox



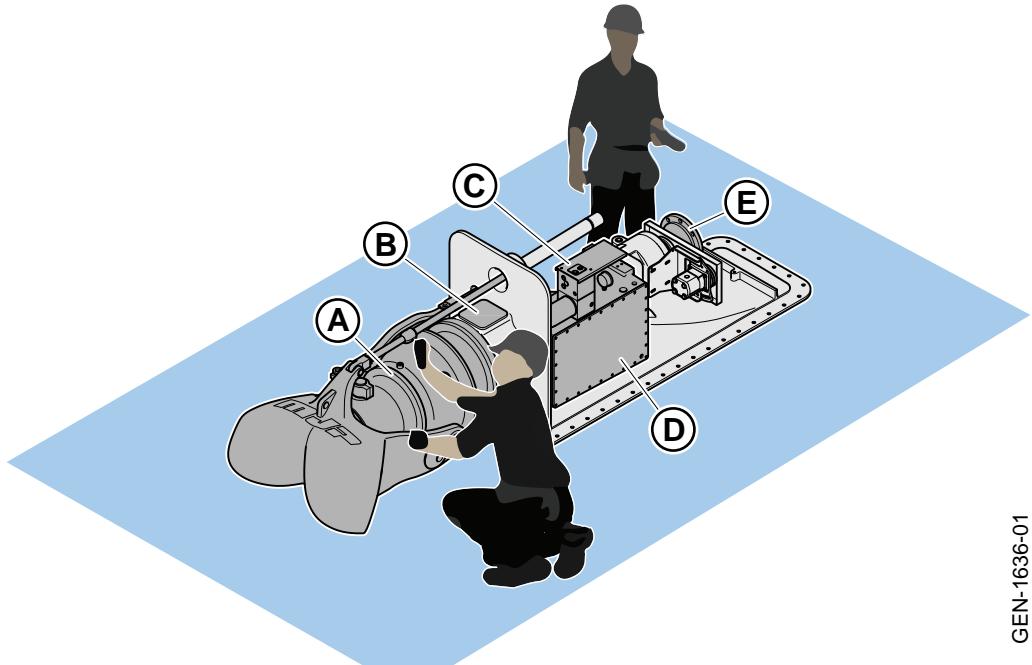
GEN-0887-03

Figure 7

Waterjet with inverted impeller

A	Impeller
B	Gearbox
C	Engine

### 3.3 Work Space Around the Waterjet



GEN-1636-01

Figure 8

Pos	Area	Description
A	Steering and pump unit	Make sure that there is sufficient space to access moving parts and corrosion protection for inspection and service.
B	Inspection hatch	Make sure that there is sufficient space to access the inspection hatch for inspection of drive shaft and impeller.
C	Valve block	Make sure that there is sufficient space to operate the valve block buttons in emergency situations. Also make sure that there is sufficient space to access it for inspection and service.
D	Hydraulic tank	Make sure that there is sufficient space to access the filters and oil level sensor for inspection and service.
E	Shaft arrangement	Make sure that there is sufficient space to access the different components of the shaft arrangement for inspection and service.

## 3.4 Corrosion Protection

Paint is the main corrosion protection for metallic parts in water. Always make sure that the paint of the waterjet surfaces are in good conditions at all times. For more information, see *6.1 Paint Program*.

### 3.4.1 Grounding

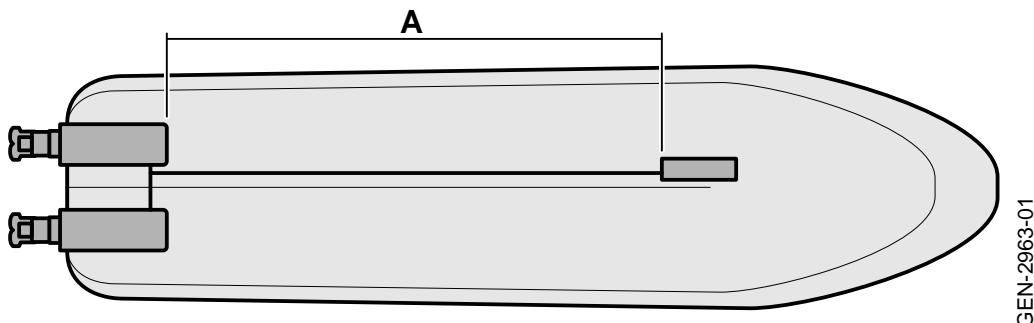


Figure 9

It is recommended to have a long distance (A) between the ground plate and the jet.

Hull material	Grounding
Aluminium	Waterjet grounded to hull.
GRP	Waterjet grounded to ground plate.

### 3.4.2 Anodes

Anodes are highly active metals that are used to prevent a less active material surface from corroding. Anodes are created from a metal alloy with a more negative electrochemical potential than the other metal it will be used to protect. The anode will be consumed in place of the metal it is protecting, which is why it is referred to as a "sacrificial" anode.

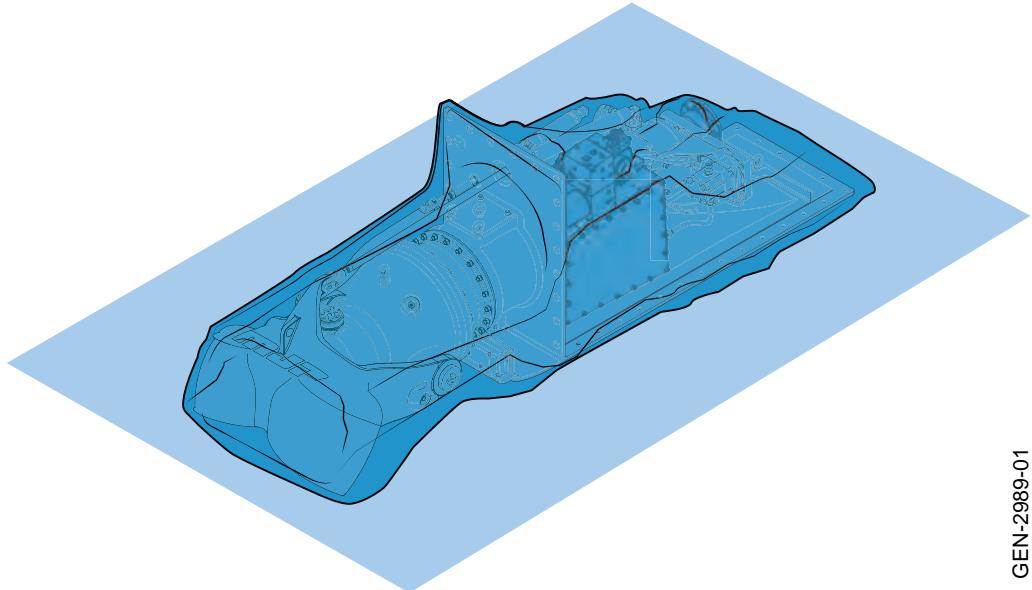
Waterjet anodes are only dimensioned to protect waterjet. The hull needs separate protection.

#### Material

Operating water	Anode material
Salt water	Zinc
Fresh water	Aluminium or magnesium

### 3.5 Installation Principles

Make sure that the waterjet always has an sufficient protection against damages that may occur during installation procedures. The waterjet must be protected when grinding and welding is performed on the hull of the boat, even during procedures that do not directly affect the waterjet. Fire proof tarpaulin or equivalent can be used for protection of the waterjet.



GEN-2989-01

Figure 10

## 3.6 Hull Modifications

Make sure that the transom plate is 90 degrees before installation of the waterjet. If the transom is tilted in any direction, make one of the changes below:

### 3.6.1 Wedge

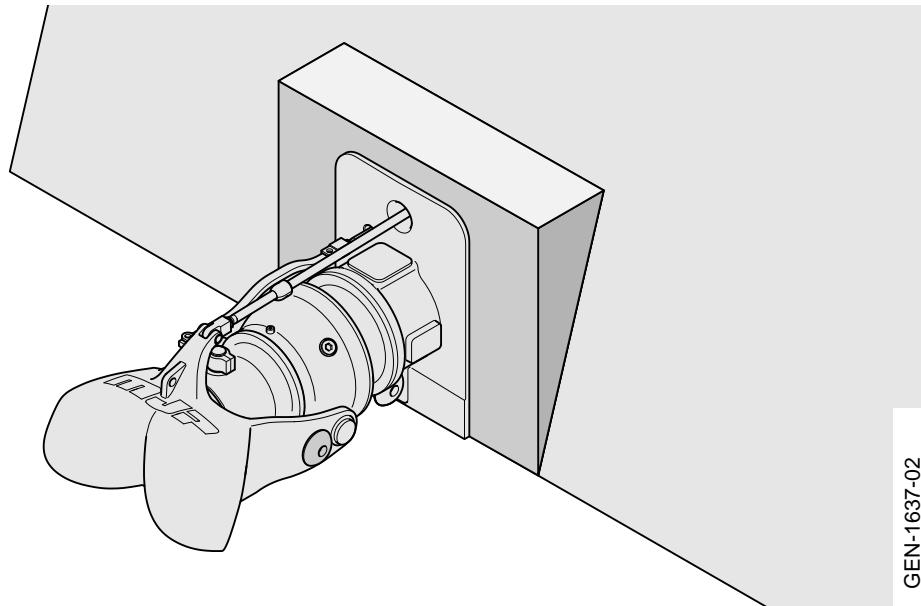


Figure 11

If the transom angle to bottom is less than 90 degrees, a wedge must be built.

Make sure to have enough space around the Jet (A & B) so it is possible to weld or screw it from the inside of the hull.

### 3.6.2 Recess

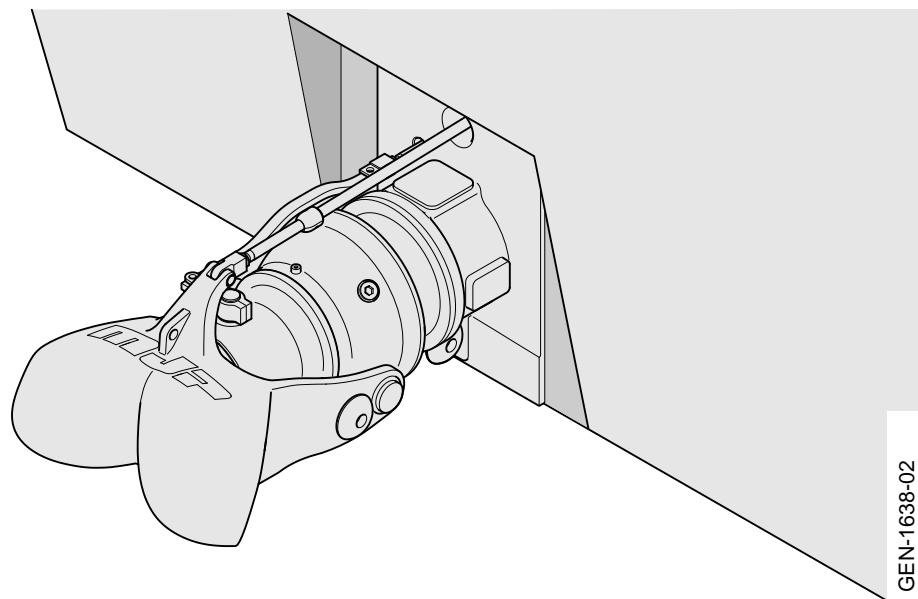


Figure 12

If the transom angle to bottom is more than 90 degrees, a recess must be built.

Make sure to have enough space around the Jet (A & B) so it is possible to weld or screw it from the outside of the hull.

Also make sure that the inspection hatch is still accessible for inspection.

### 3.6.3 Vee-hull, Alignment of Waterjet

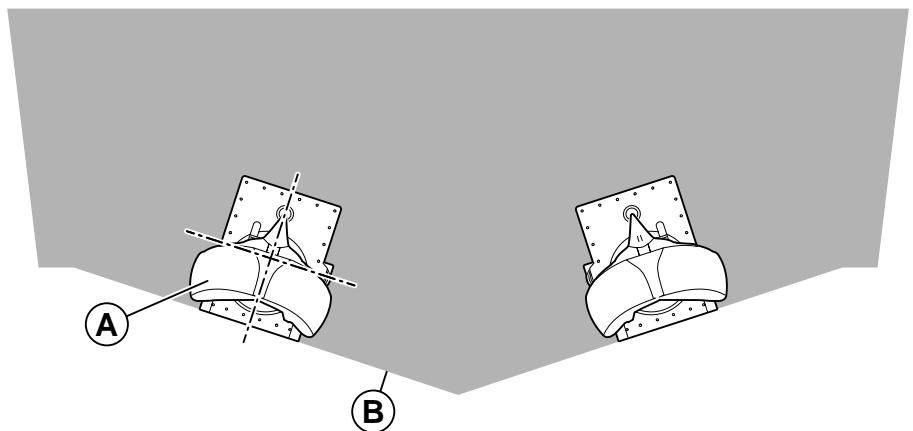


Figure 13

The waterjet (A) must be aligned with the bottom of the hull (B) when mounted.

### 3.6.4 Centre Jet Installation

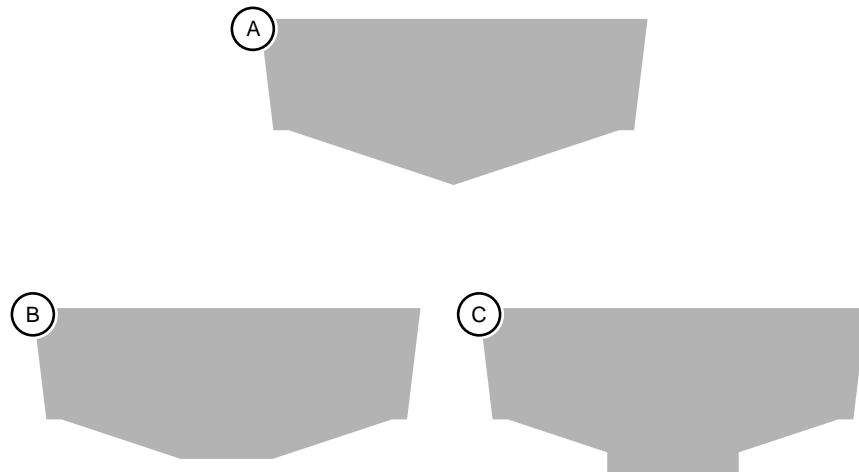


Figure 14

A vee hull (A) must be prepared before installation of the waterjet unit. The hull around the waterjet unit must be flat so that it can be in level. There are two ways to prepare the vee hull (A):

- **Flattened hull (B)**  
The flat surface of the hull is connected into the apex of the vee hull with a triangular shape.
- **Nacelle hull (C)**  
A nacelle is an alternative to the flattened hull.

### 3.7 Lifting Points

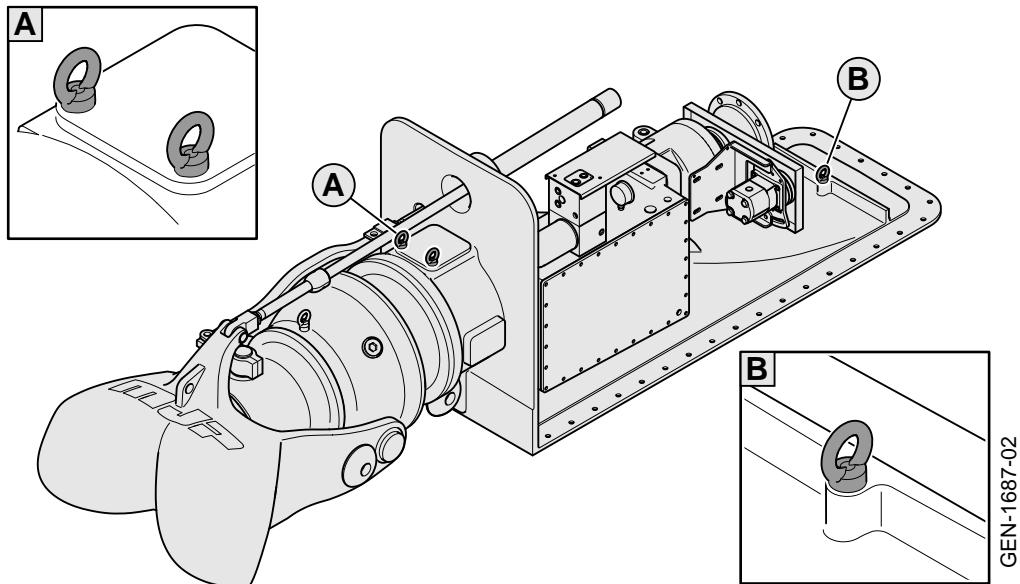


Figure 15

MJP recommend to use the lifting eyes (A) and (B) when lifting the waterjet unit. Attach applicable lifting equipment to the lifting eyes.



#### Warning!

Hanging loads can be a danger. Make sure to carefully lift and hoist the waterjet unit in a safe manner. This will help to prevent injury to personnel and/or damage to equipment.

## 3.8 Pipes and Hoses

The hydraulic system controls the hydraulic cylinders for the steering and reversing unit. Marine Jet Power deliver the waterjet unit with hydraulic hoses. All other pipes, hoses and couplings shall be supplied by the shipyard.

All pipes, hoses and couplings that are supplied by the shipyard must be of marine quality and approved for use at an operational pressure of 140 bar and design pressure of 180 bar. The relief valve shall have a pressure limit of 180 bar and design pressure of 180 bar. Marine Jet Power recommends the shipyard to use pipes in general. Flexible connections such as hoses, bellows and swivels need to be used for resiliently mounted components and for components that move. For recommended pipe sizes please consult the specific documentation for the project at hand. If the application requires longer pipe lengths than recommended, contact Marine Jet Power for guidance. To reduce the risk for leakage and to increase the life of the hoses it is important to install the hoses as recommended:

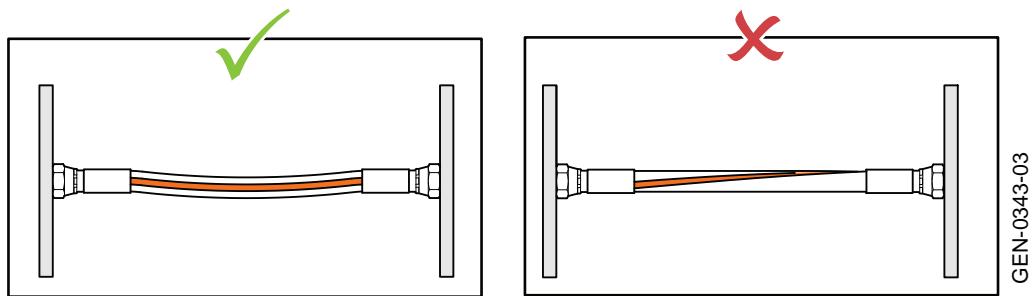


Figure 16

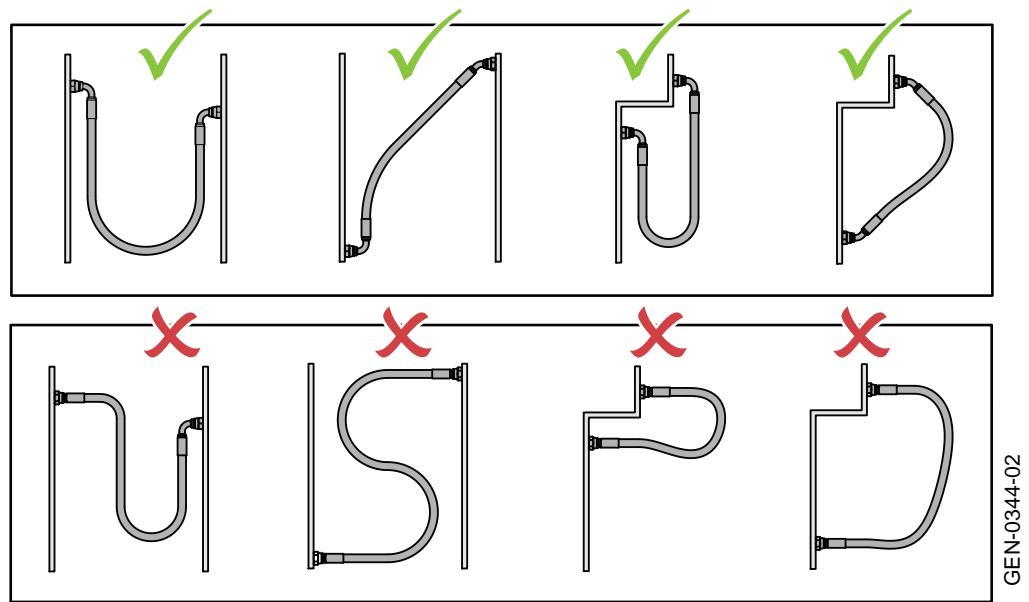
**Note!**

Hoses can shrink up to 4% when they are pressurized. Make sure that there is slack to accommodate the shrinkage.

**Note!**

Do not twist the hose when installing. Hoses have a marking along its length. This marking indicates that the hose is straight.

- The hose shall have the appropriate length. A hose which is too short will be stretched by the movement of the component, whereas a long hose might rub against something causing wear.



GEN-0344-02

Figure 17

- Minimize the number of bends in the hydraulic hose, a single u-bend is preferred. Use large radius pipe bends and minimize total number of bends.

Avoid introducing additional tension in the pipe when they are mounted. The pipes need to be fastened using clamps which are made for clamping pipes.

Recommended distance between clamps:

Pipe diameter	Clamp distance
<13 mm	1 m
16 — 30 mm	1,5 m
>31 mm	2 m

### 3.8.1 Pipe Couplings

There are two main types of pipe couplings:

- Welded couplings
- Tube fittings

The weld free coupling have mechanical deformation clamps and seals against the pipe. Either type of coupling can be used. The choice is made depending on the shipyard's preferences.

Always follow the coupling suppliers instruction to achieve a pressure tight connection.

## 3.9 Drive Shaft

The waterjet is connected with the gearbox or engine by one of three different types of shaft arrangements. These shaft arrangements have standard, cardan or constant velocity intermediate shafts. The intermediate shaft has two flexible points which can transmit torque, even when they are not aligned. This gives a more safe operation and longer lifetime to the shaft arrangement.

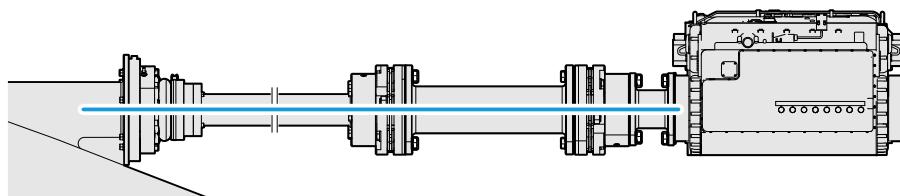
**Note!**

MJP recommends the standard shaft arrangement, if possible.

**Note!**

For maximum allowed force on Waterjet shaft flange see MJP provided drawings.

### 3.9.1 Standard Shaft Arrangement

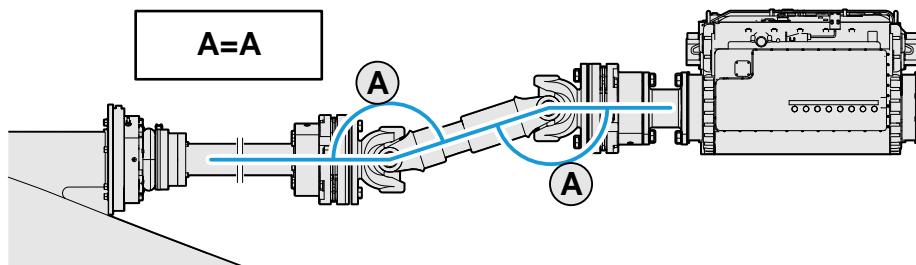


GEN-0890-03

Figure 18

### 3.9.2 Cardan Shaft Arrangement

The engine and waterjet must be vertically in line. But they can be on a different height.

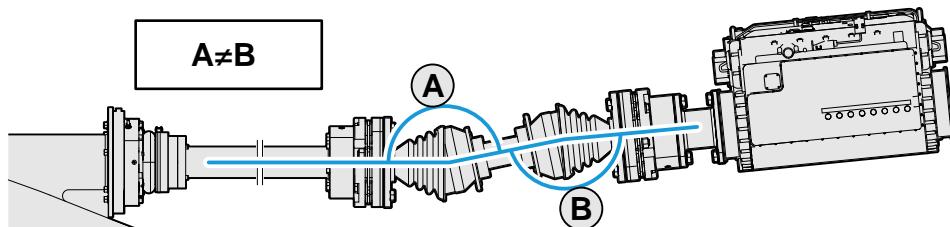


GEN-0891-03

Figure 19

### 3.9.3 Constant Velocity Shaft Arrangement

If the engine and waterjet can not be vertically in line and they are on a different height, use this type of shaft arrangement.



GEN-0892-03

Figure 20

## 4 Control System Units

The table below shows the normal installation places of a Marine Jet Power 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.

Unit	Name	Normally installed at	Comment
Display panel	DISP	Bridge	Touch display for alarm display and system.
External buzzer	–	Bridge	Sound for alarm, silenced with alarm button.
Command panel	CP	Bridge	Select command mode and clutch control.
VCS controller	VCS	Bridge	Control of bucket position and RPM.
Combinator controller	–	Bridge	Control of bucket position and RPM.
Steer wheel	–	Bridge	Control of nozzle position.
Main control unit	MCU	Engine room	Port and starboard.

## 4.1 Display Panel



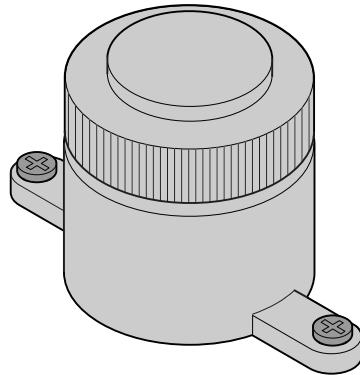
GEN-2986-01

Figure 21

Depending on system configuration the touch screen display may have different functions.

- Calibration and setup of control system.
- Indication of bucket and nozzle position and waterjet status.
- Control of functions (where specified).
- Display and acknowledgement of alarms.
- Control of brightness of display.

## 4.2 External Buzzer

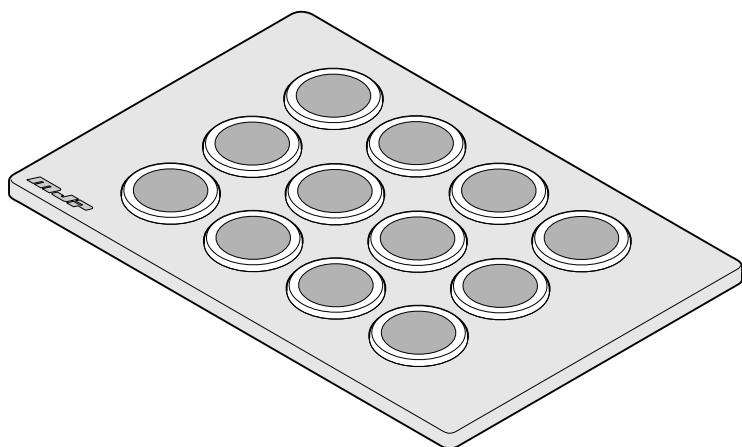


GEN-0478-02

Figure 22

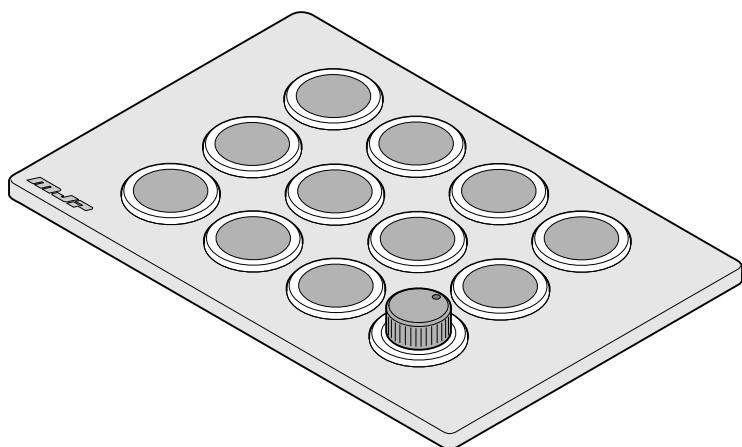
The external buzzer will sound if there is an alarm, it can be silenced with the alarm button.

## 4.3 Command Panel



GEN-2814-01

Figure 23



GEN-2814-02

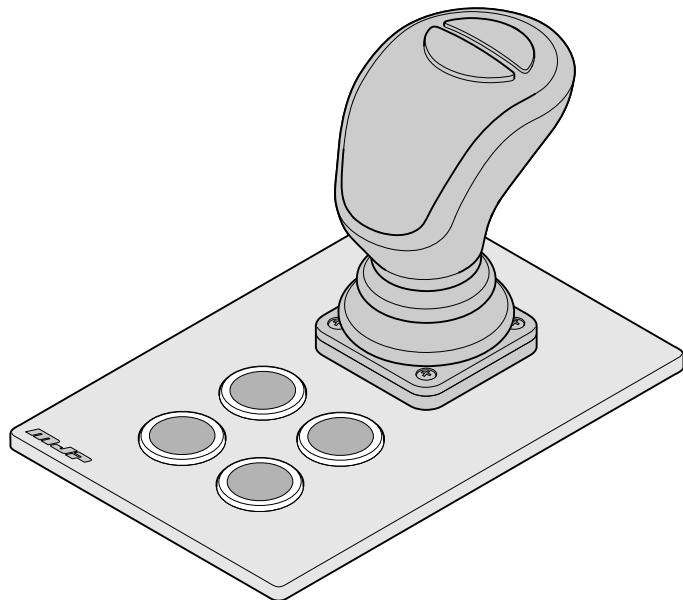
Figure 24

The command panel is the main control panel for operational modes. It provides physical buttons at a station to switch between command modes as well as providing clutch control. Command panel buttons also illuminate to provide status indication. Acknowledgments of system alarms and silencing of alarm buzzer is handled on this panel. Dimmer function for lamps is handled via command panel and there is also a diagnostic lamp test function.

The command panel is connected to both main control units.

It is possible to have knobs on the panel that control Dimmer, RPM Balance or Idle adjust.

## 4.4 VCS Panel (BUS)

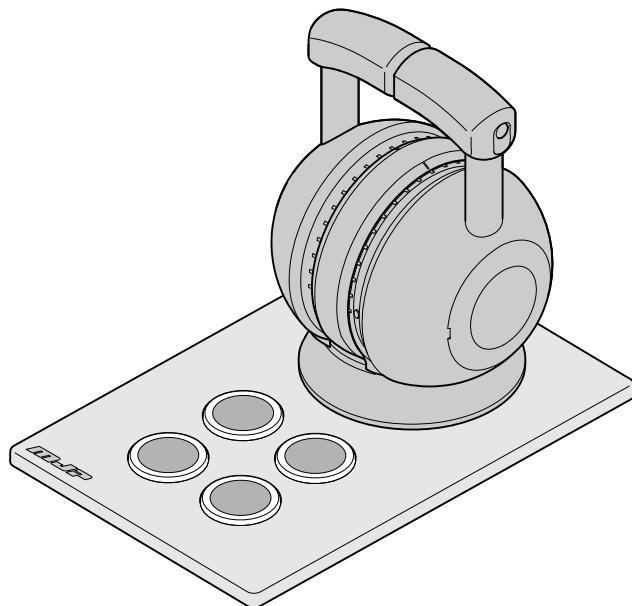


GEN-1893-02

Figure 25

The vector control system (VCS) makes it possible to manoeuvre the vessel with a joystick. The computer translates steering commands, optimise waterjet positioning and RPM to make the boat move as requested.

## 4.5 Combinator Controller



GEN-1917-01

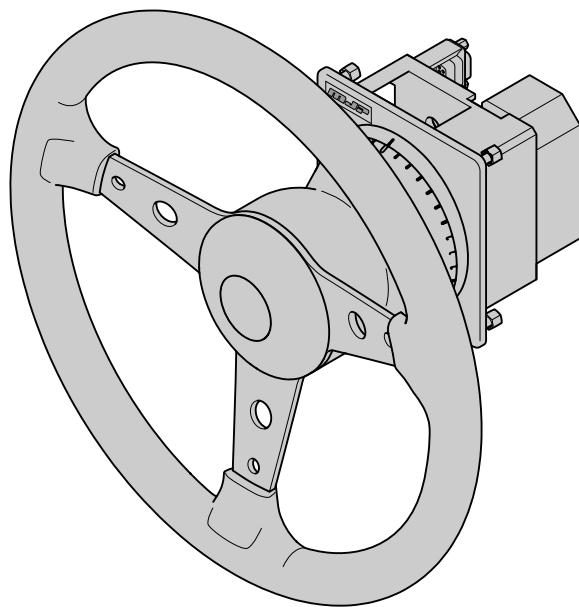
Figure 26

The combinator has two levers for control of the jet bucket and engine RPM. Especially on fast vessels it is appreciated to control RPM with combinator levers and to steer with a steer controller.

**Note!**

The paragraph above describes a typical setup. The settings are adjustable and not tied to controller, but to manoeuvring mode. The controller could work for bucket only, with a separate lever/knob as RPM control.

## 4.6 Steer Wheel



GEN-1333-01

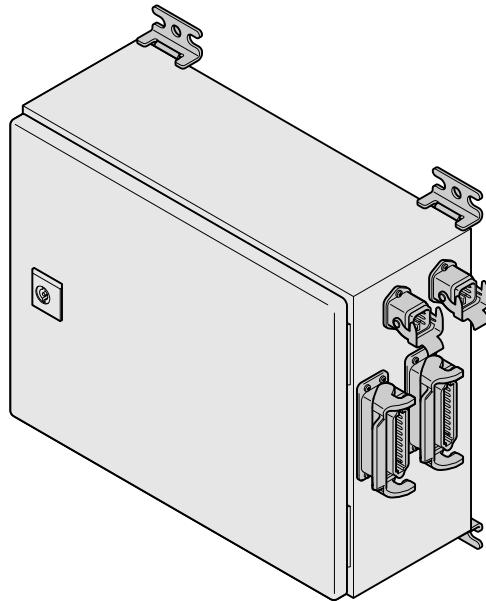
Figure 27

The steer wheel controls nozzle position directing the flow of water leaving the waterjet. In a multiple waterjet system, the steer wheel controls all waterjets and nozzles move in parallel.

**Note!**

The steer will have no effect if the waterjet is not producing thrust, even if the vessel is moving through water.

## 4.7 Main Control Unit



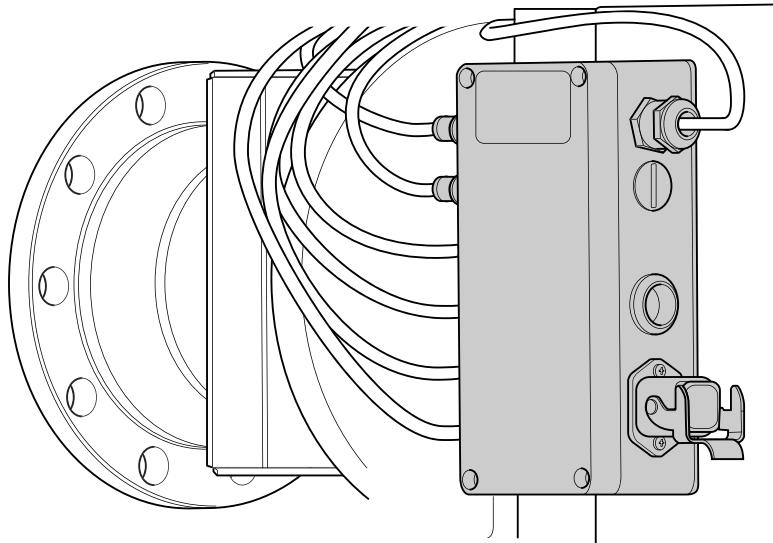
GEN-1646-01

Figure 28

The MCU is the main controller, responsible for taking command requests from operator and safely operating waterjet, engine, clutch and other options.

In systems without a backup system the MCU connects directly to waterjet, clutch and engine interface.

## 4.8 Hydraulic Connection Box



GEN-2917-01

Figure 29

The hydraulic connection box provides a connection point between the waterjet and control system. There is one hydraulic connection box pre fitted to each waterjet unit.

## 5 Installation

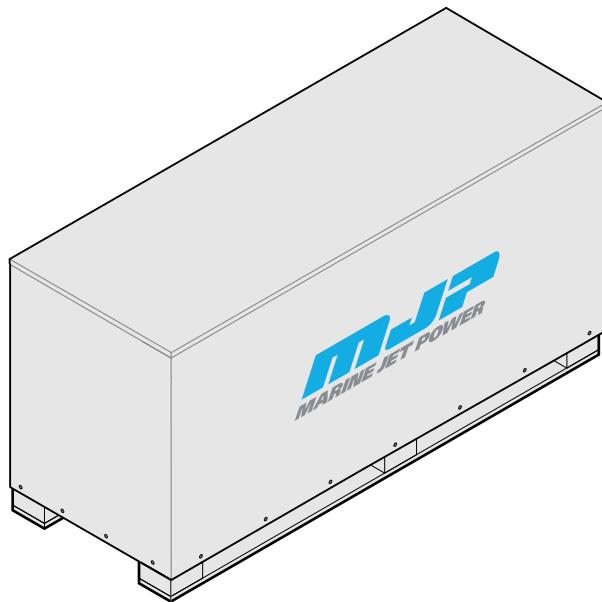
### 5.1 Installation Overview

This section contains information about installation procedure and installation flow.

- 1 Unpack the Waterjet unit, see [5.2.1 Waterjet Unit, Unpack](#).
- 2 Remove the Hydraulic pump with bracket, see [5.2.2 Hydraulic Pump, Remove](#).
- 3 Install the Waterjet unit, see [5.2.3 Waterjet Unit, Install \(Bolted\)](#).
- 4 Paint the waterjet unit:
  - 4.1 If the waterjet needs to be touch-up painted or repainted, see [5.3.1 Waterjet Unit, Paint](#)
  - 4.2 The waterjet should be painted with a primer and an anti-fouling paint, see [5.3.2 Waterjet Unit, Apply Anti-fouling Paint](#)
- 5 Install hydraulic and lubrication system:
  - 5.1 Install the Hydraulic pump with bracket, see [5.4.1 Hydraulic Pump, Install](#).
  - 5.2 Fill the Lubrication system with oil, see [5.4.2 Lubrication System, Fill with Oil](#).
  - 5.3 Fill the Hydraulic system with oil, see [5.4.3 Hydraulic System, Fill with Oil](#).
  - 5.4 Connect the oil level alarm sensor, see [5.4.4 Hydraulic Tank, Connect Oil Level and Temperature Alarm Switch](#).
- 6 Launch the vessel.
- 7 When the vessel has been launched, the hull structure will bend because of the pressure from the water. MJP recommends that the drive shaft is aligned again when the vessel is in the water. Inspect and adjust shaft alignment.
- 8 Installation by the yard is now completed.  
Make sure to fill in the Yard installation report and then Contact Marine Jet Power for commissioning of the vessel.
- 9 Installation completed.

## 5.2 Installation Tasks

### 5.2.1 Waterjet Unit, Unpack



GEN-1671-02

Figure 30

#### Task Summary

The task is to unpack the waterjet unit.

#### Prerequisites

##### Conditions

Weight of waterjet: 595 kg

Access to nylon sling.

Access to lifting crane.

**Personnel number**

**Skill level (choose one)**

**Maintenance facility level (choose one)**

1	Task specialist	Dock, workshop / dry dock
---	-----------------	---------------------------

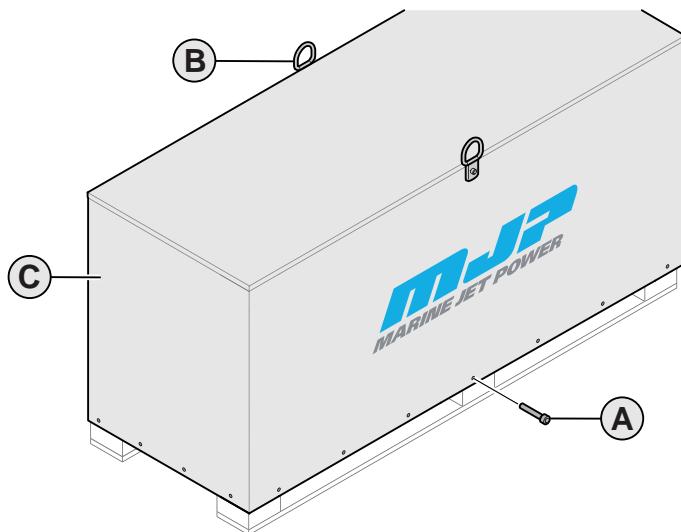
**Consumables**

**Quantity**

**Part number**

Rubber sheet or cushion	1	-
-------------------------	---	---

## Procedure



GEN-1668-02

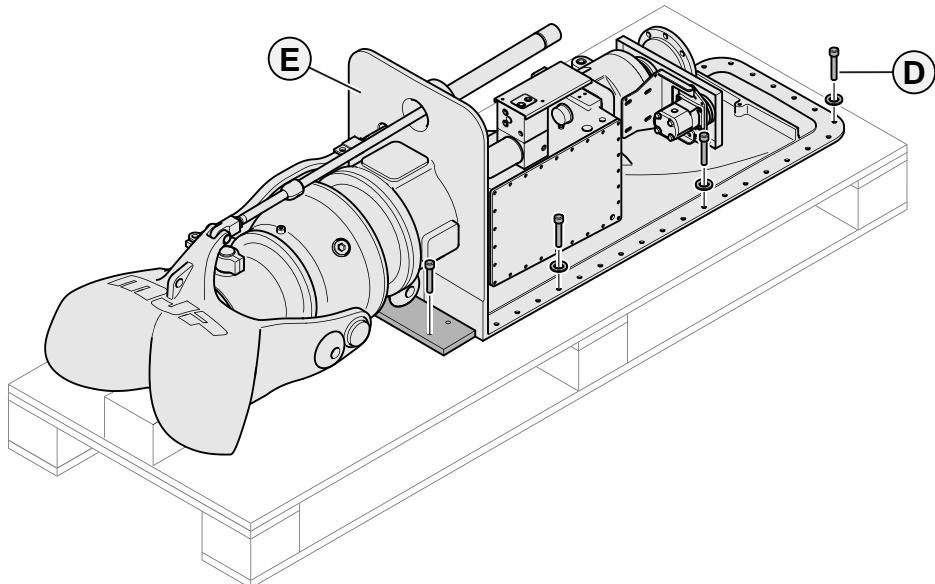
Figure 31

- 1 Remove the screws (A).
- 2 Attach lifting eyes (B) to the middle of the transportation box.
- 3 Attach the lifting equipment to the lifting eyes (B).
- 4 Lift the transportation box (C) vertically.



### Warning!

Make sure to carefully lift the transportation box. This will help prevent damage to the equipment.

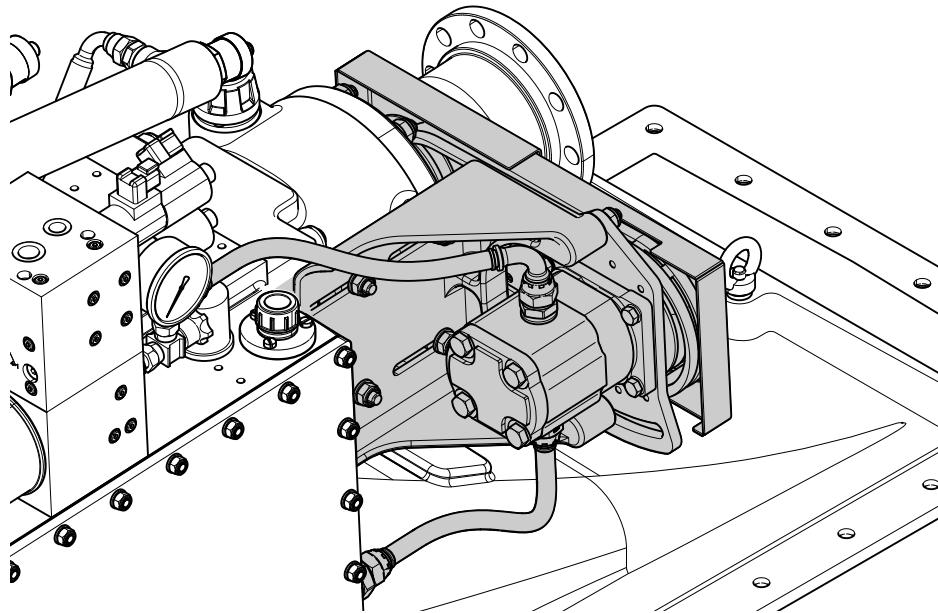


GEN-1670-02

Figure 32

- 5 Remove the screws (D) and the boards from the waterjet unit (E).
- 6 Task completed.

## 5.2.2 Hydraulic Pump, Remove



GEN-1640-02

Figure 33

### Task Summary

The task is to remove the hydraulic pump with bracket to be able to install the waterjet to the hull.

**Personnel number**

**Skill level (choose one)**

**Maintenance facility level (choose one)**

1	Task specialist	Dock, workshop / dry dock
---	-----------------	---------------------------

## Procedure

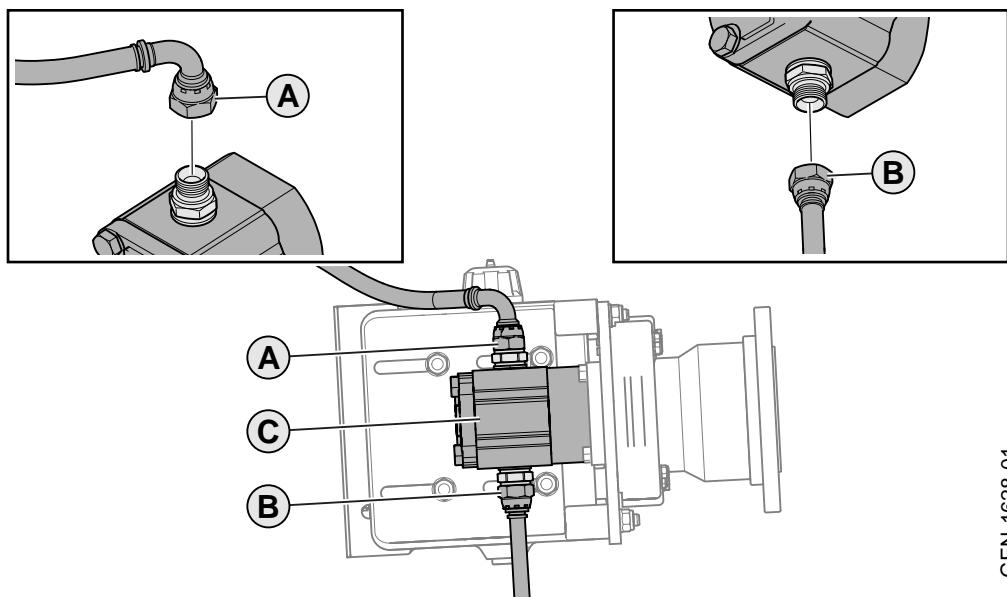


Figure 34

- 1 Remove the hydraulic hose connectors (A) and (B) from the hydraulic pump (C).

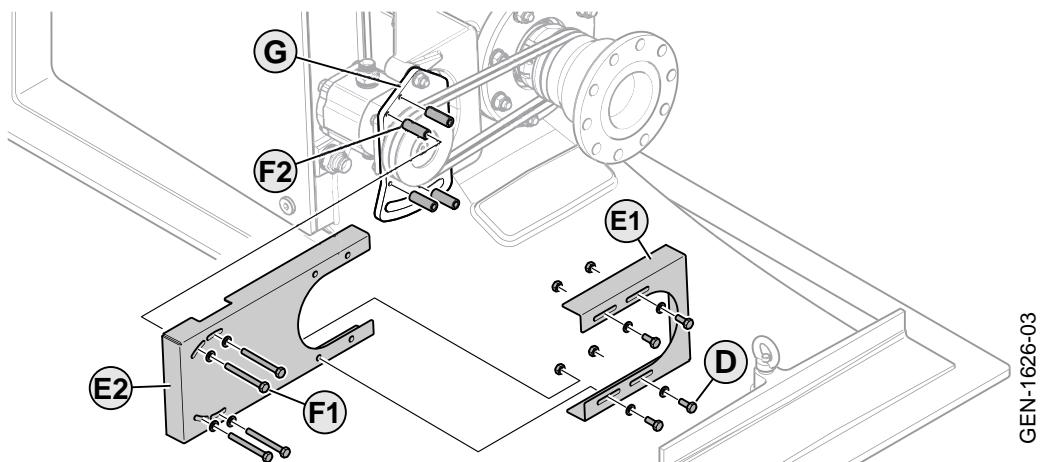


Figure 35

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

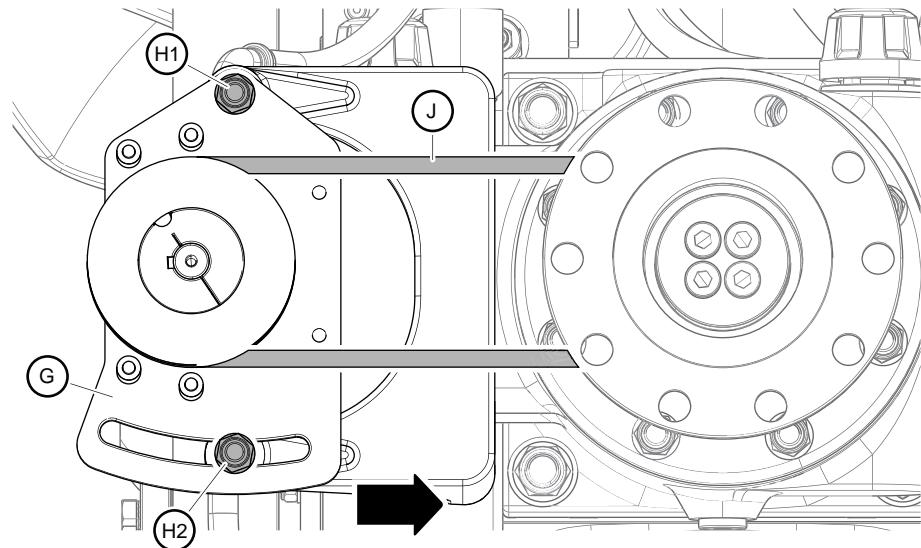
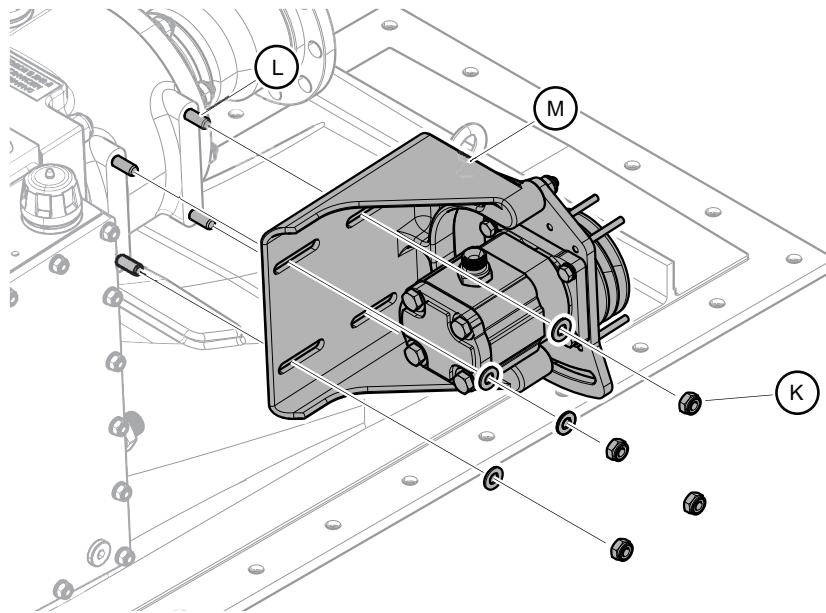


Figure 36

- 7 Loosen the nuts (H1) and (H2).
- 8 Move the pump plate (G) and pump to the right until the wedge belts (J) are loosened.
- 9 Remove the wedge belts (J).



GEN-1627-02

Figure 37

- 10 Remove the nuts and washers (K) from the threaded pins (L)
- 11 Remove the pump bracket and hydraulic pump (M).
- 12 Task completed.

### 5.2.3 Waterjet Unit, Install (Bolted)

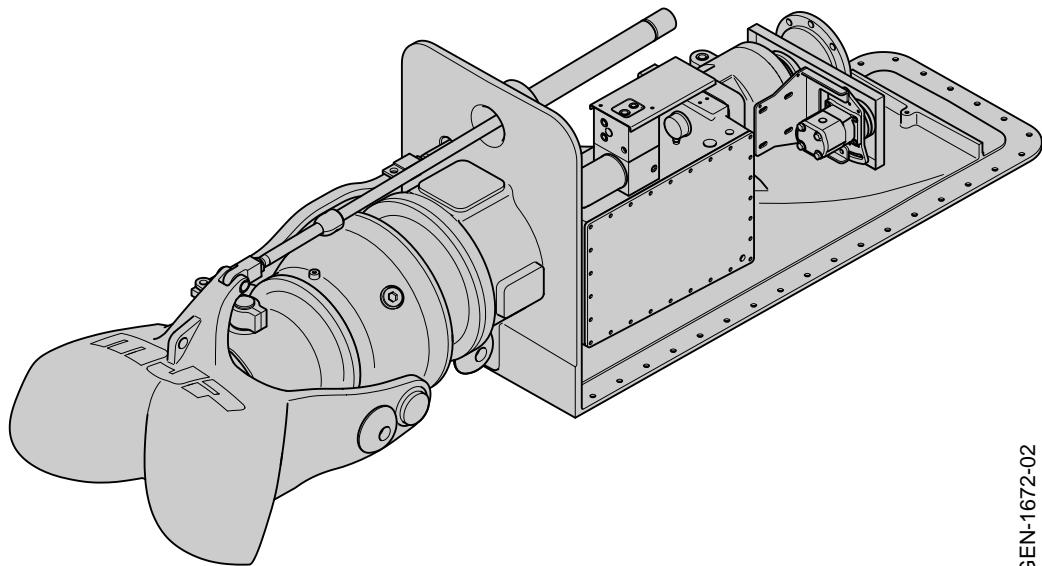


Figure 38

#### Task Summary

The task is to install the waterjet unit to the hull with screws.



##### Warning!

Hanging loads may be a danger. Make sure lifting and hoisting procedure is done in a safe manner and according to Marine Jet Powers lifting point recommendation.



##### Caution!

Protect the hydraulic hoses and feedback cables from damage when hanging the waterjet unit. Let end caps on hydraulic hoses, hydraulic cylinders and lubrication oil pipes stay in place to keep dirt out.



##### Caution!

Take the alignment of waterjet and installation intake details into account before installation.

##### Note!

When using marine sealant, the sealant must harden for 24 hours.

## Prerequisites

### Conditions

Weight of waterjet: 595 kg

Access to nylon sling.

Access to lifting crane or cradle.

Personnel number	Skill level	Maintenance facility level
1	Task specialist	Dock, workshop / dry dock
Consumables	Quantity	Part number
Rubber sheet or cushion	1	-

**Reference document**

Drawing Hull installation in Drawing package.

## Procedure

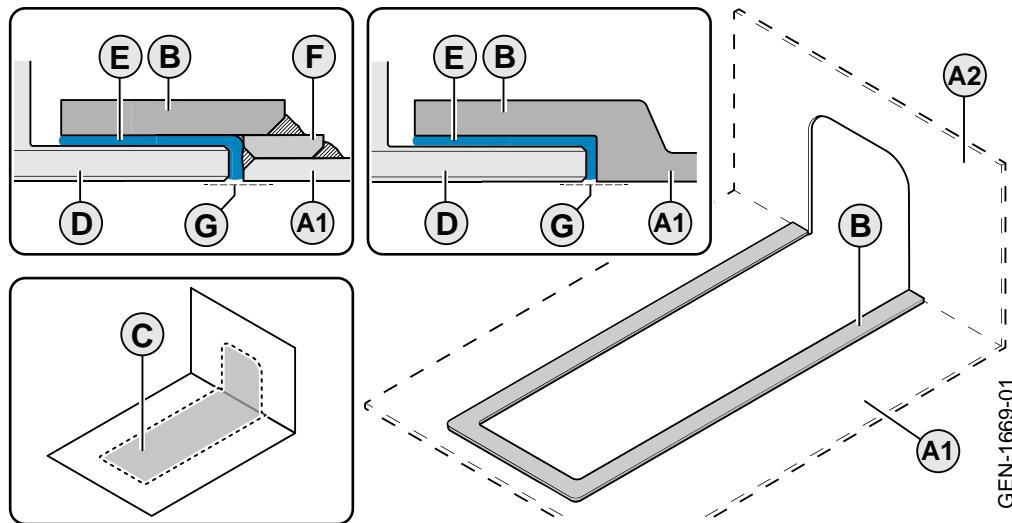


Figure 39

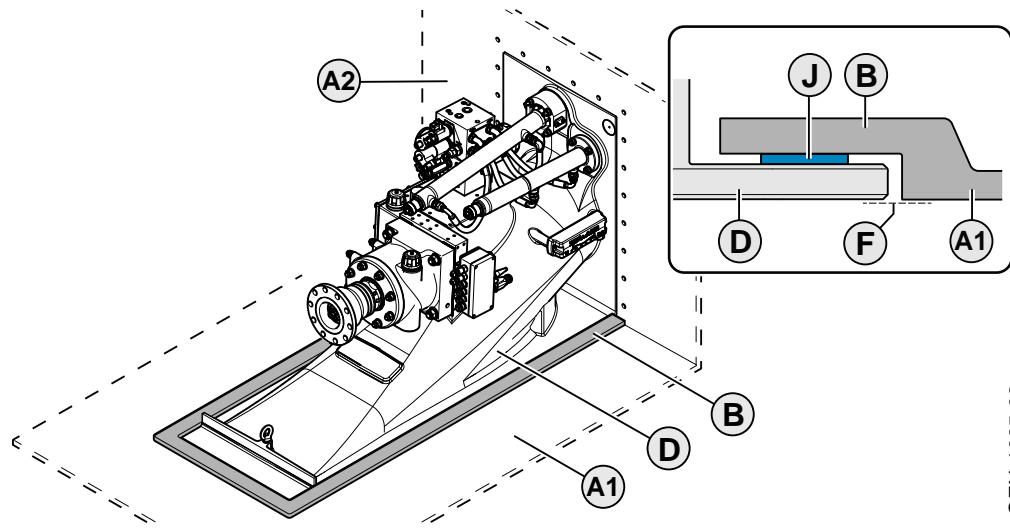
A recess (B) must be made by the shipyard so that the waterjet unit (D) can be installed to the hull (A1). For GRP hull an inverted recess is created on the female mold. After the lamination process is completed, a cutout hole (C) is made in the recess.

For Aluminium hull that is thinner than the intake (D) + 2 mm, an extra strip (F) must be made. This is to achieve 2 mm of marine sealant and the waterjet unit flush with the hull.

It is important that the waterjet unit (D) is flush (G) against the hull (A1), under the vessel.

Between the recess (B) and waterjet (D), there must be a layer of approximately 2 mm marine sealant (E).

- 1 Make a cutout hole (C) in the bottom of the hull (A1) and the transom (A2). Refer to the *Hull installation* drawing.  
If the hull (A1) is made of aluminium, proceed to step 2.  
If the hull (A1) is made of GRP, proceed to step 5.
- 2 If the hull (A1) is thinner than the intake (D) + 2 mm, an extra strip (F) is spot welded and welded to the hull first.
- 3 Spot weld the recess (B) to the hull (A1). Refer to the Hull installation drawing.
- 4 Weld the recess (B) to the hull (A1).



GEN-1625-02

Figure 40

- 5 Use applicable lifting equipment to lift the waterjet unit (D) into the cut out hole (C) in the hull (A1) and the transom (A2).

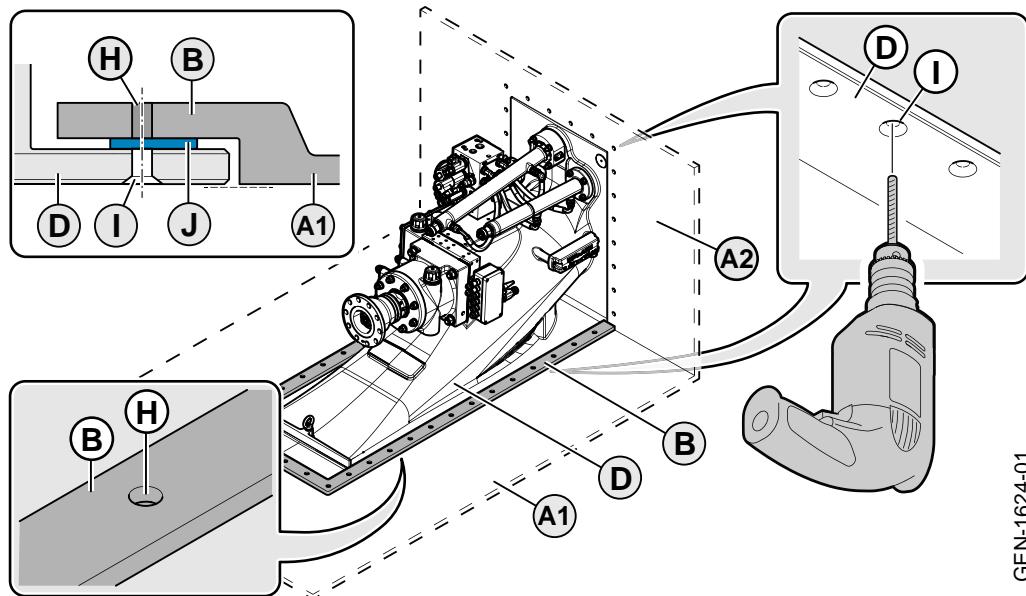
**Warning!**

Hanging loads can be a danger. Make sure lifting and hoisting procedure is done in a safe manner and according to Marine Jet Powers lifting point recommendation. This will help prevent injury to personnel and/or damage to equipment.. For more information about how to lift the waterjet unit, see.

- 6 Put the washers (J) or equivalent between the waterjet unit (D) and the recess (B) to simulate a sealant thickness of 2 mm.
- 7 Make sure that the waterjet unit (D) is flush (F) with the hull (A1) and sit tight against the transom (A2). If it is not a perfect fit, it is more important that the waterjet unit is flush (F) with the hull under the vessel.
- 8 If there is gaps between the transom (A2) and the waterjet (D), try first to align the transom to the waterjet. If there is still gaps between transom and the waterjet, fill all gaps with a Polyurethane marine sealant (Sikaflex 291 or equivalent)

**Note!**

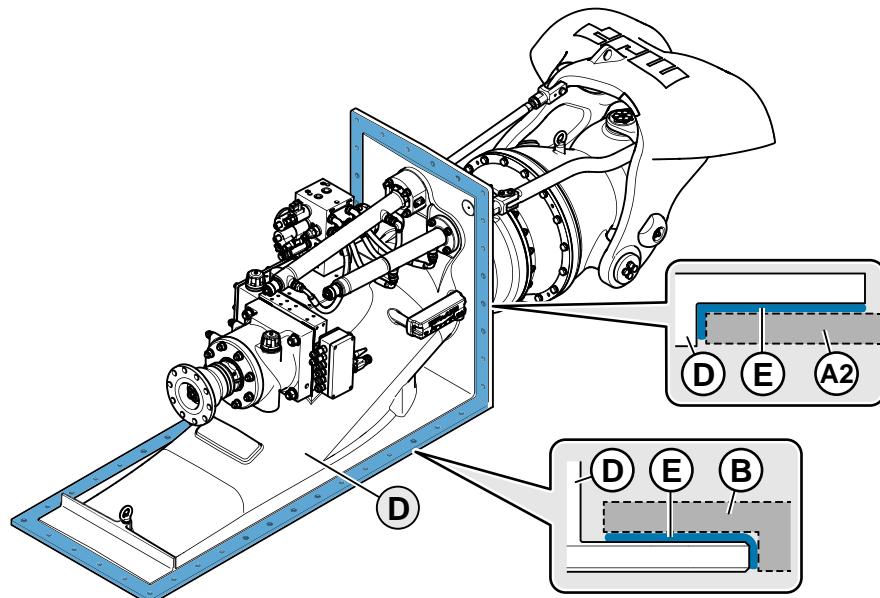
Let the sealant filler cure. Refer to the manufacturer's instruction.



GEN-1624-01

Figure 41

- 9 Drill holes (H) in the recess (B) and the transom (A2), using the predrill holes (I) in the waterjet unit (D).
- 10 Lower the waterjet unit (D) from the hull (A1) and the transom (A2).
- 11 Remove the washers (J) or equivalent from between the waterjet unit (D) and the hull (A1).



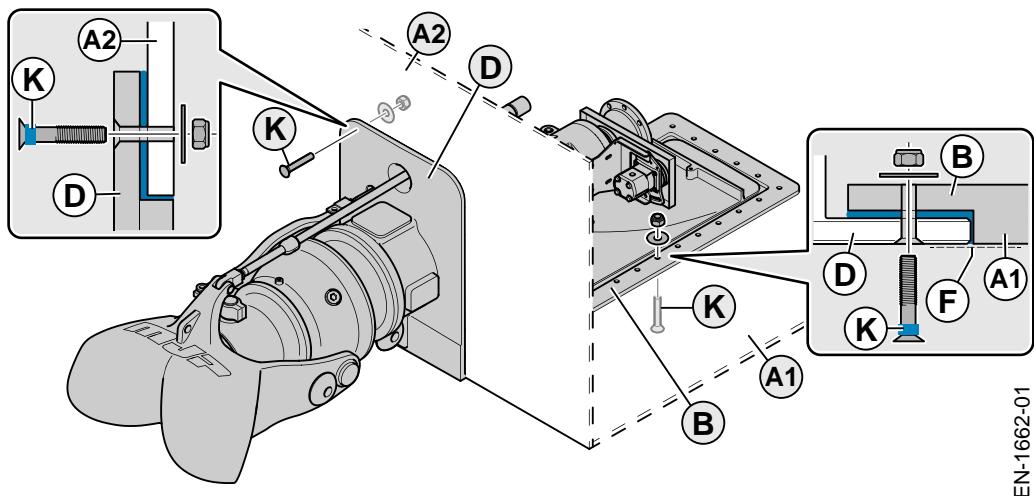
GEN-3026-01

Figure 42

- 12 Apply marine sealant (E) between the waterjet unit (D), the recess (B) and transom (A2). Put the marine sealant around the holes, not in them.

**Caution!**

The marine sealant will begin to dry, make sure the waterjet is installed to the recess and transom as soon as possible.



GEN-1662-01

Figure 43

- 13 Lift the waterjet unit (D) into the cut out hole (C).
- 14 Apply marine sealant on the screws (K).

**Note!**

Do not put the marine sealant in the holes.

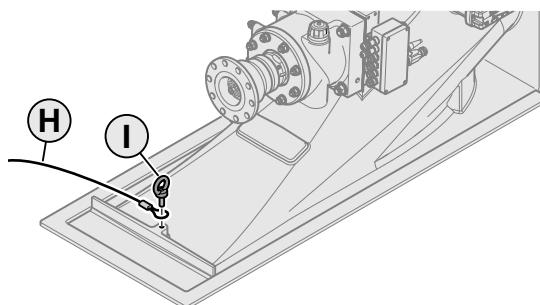
- 15 Install the screws. Tighten only until jet is in correct position.
- 16 Make sure that the waterjet unit (D) is flush (F) with the hull (A1) and is tight with the transom (A2) all around the waterjet unit (D).



**Caution!**

Let the sealant cure for 24 hours.

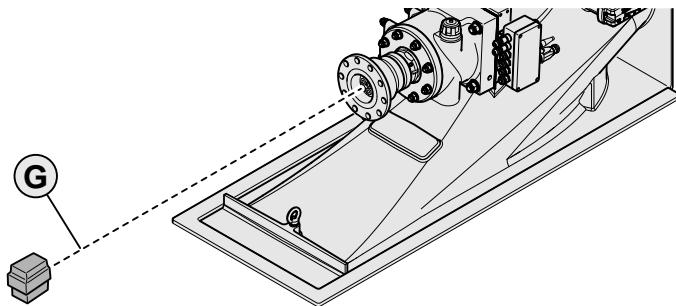
- 17 Tighten the screws (K) to the recommended torque.



GEN-3028-02

Figure 44

- 18 Install an earth cable (H) to the Waterjet. Use the lifting eye (I) or another point with direct contact to the waterjet.



GEN-3028-01

Figure 45

- 19 Check the visualized drive shaft centre line (G).

**Note!**

If the visualized drive shaft centre line (G) is off centered, adjust the visualized drive shaft centre line (G) by adjusting the gearbox and the motor.

- 20 Task completed.

## 5.3 Paint the Waterjet Unit

### 5.3.1 Waterjet Unit, Paint

#### Task Summary

The task is to paint the waterjet unit if it is necessary to touch up paint or repaint.

**Caution!**

Do not use metallic based paint. The paint can cause galvanic corrosion and damage the equipment.

#### Prerequisites

**Conditions**

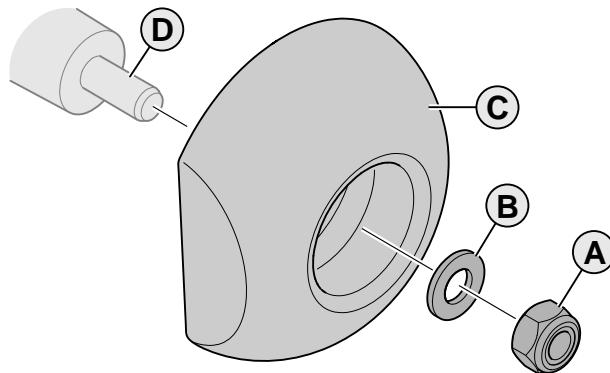
None

Personnel number	Skill level	Maintenance facility level
1	Task specialist	Dock, workshop / dry dock
Consumables	Quantity	Part number
Epoxy-based paint compatible with epoxy primer and anti-fouling paint	-	-
Emulsion cleaner	-	-

**Reference document**

6.1 *Paint Program*

## Procedure

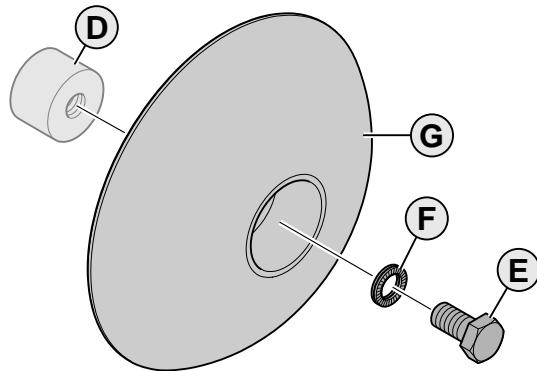


GEN-2243-01

Figure 46

### 1 Remove the anodes:

- 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.



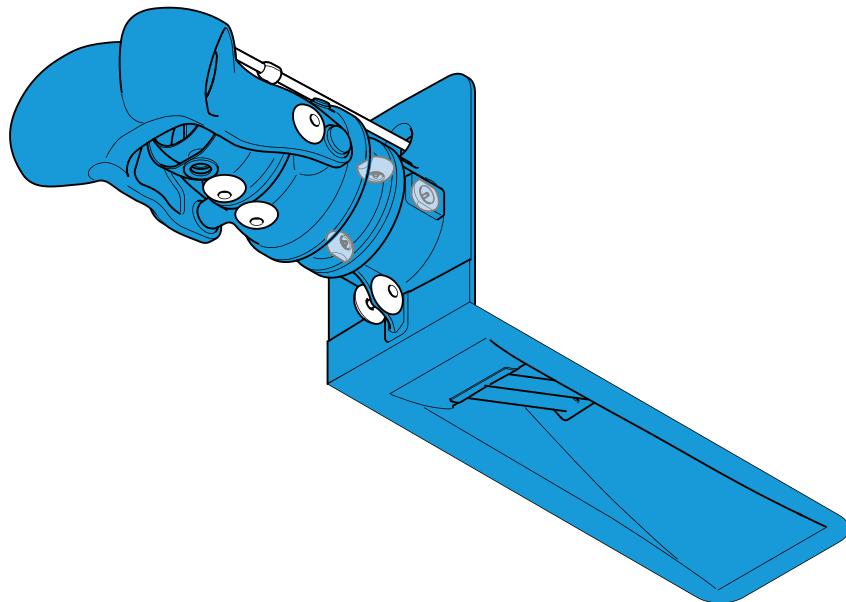
GEN-0382-02

Figure 47

### 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 anode mount (D) carefully and remove all oxide, paint or dirt.



GEN-2567-02

Figure 48

- 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.
- 8 Make sure to mask the cylinder rod and the cylinder openings, 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 (C), anode mount (D) surface or threads. The paint can decrease the corrosion protection from the anodes (C). This can cause damage to the equipment.



**Caution!**

Make sure that the cylinder rod is not painted or stained. This can cause damage to the equipment.



**Caution!**

Do not paint the interior of the pump unit. This can cause damage to the equipment.

- 10 Task completed.

## 5.3.2 Waterjet Unit, Apply Anti-fouling Paint

### Task Summary

The waterjet unit is normally supplied painted with epoxy primer and intermediate coating. For vessels that will be stationary in water, the Jet should be protected from growth of subaquatic organisms by applying an 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 anti-fouling paint. Metallic based paint can damage the equipment.

### Prerequisites

#### Conditions

None

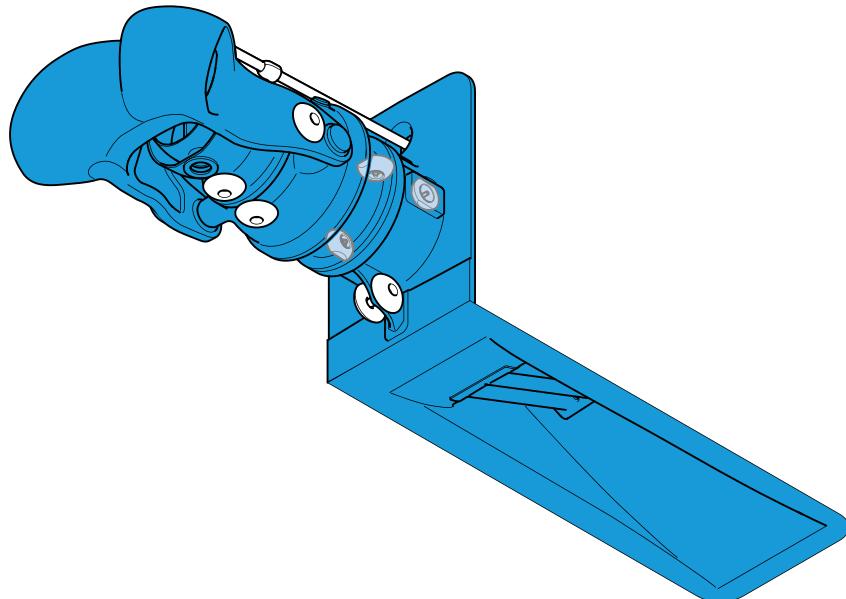
Personnel number	Skill level	Maintenance facility level
1	Task specialist	Dock, workshop / dry dock
Consumables	Quantity	Part number
Anti-fouling paint Primer compatible with MJP paint program	-	-
Anti-fouling paint compatible with MJP paint program	-	-
Emulsion cleaner	-	-

#### Reference document

6.1 Paint Program

## Procedure

- 1 Remove oil and grease with an emulsion cleaner.
- 2 Clean the entire area with high pressure fresh water in order to remove salts and other impurities.
- 3 Let the surface dry.



GEN-2567-02

Figure 49

- 4 Make sure to mask the cylinder rod and the cylinder openings, in the impeller house, to protect it from paint.
- 5 Remove the anodes, if they are still mounted and mask the anode mount surface and threads.
- 6 Roughen the area that is going to be painted with a sandpaper or sweep blasting.
- 7 Remove dust from all areas.
- 8 Paint the waterjet surfaces and the inside of the intake, first with the anti-fouling primer and then with the anti-fouling paint.



**Caution!**

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



**Caution!**

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



**Caution!**

Do not paint the interior of the pump unit. This can cause damage to the equipment.

GEN-0382-02

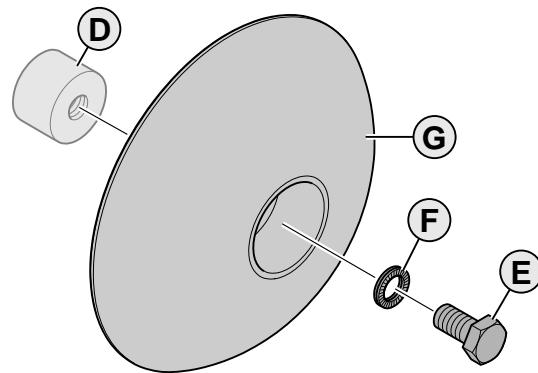


Figure 50

GEN-1684-01

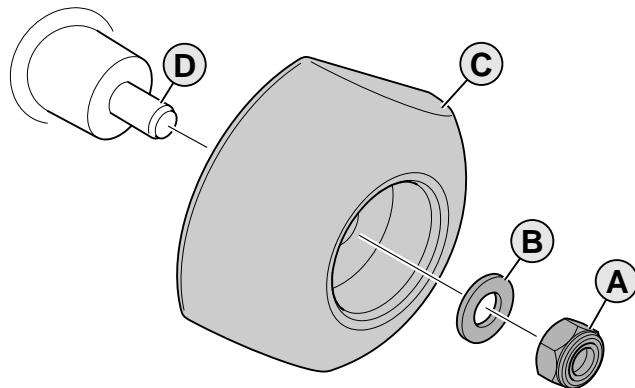
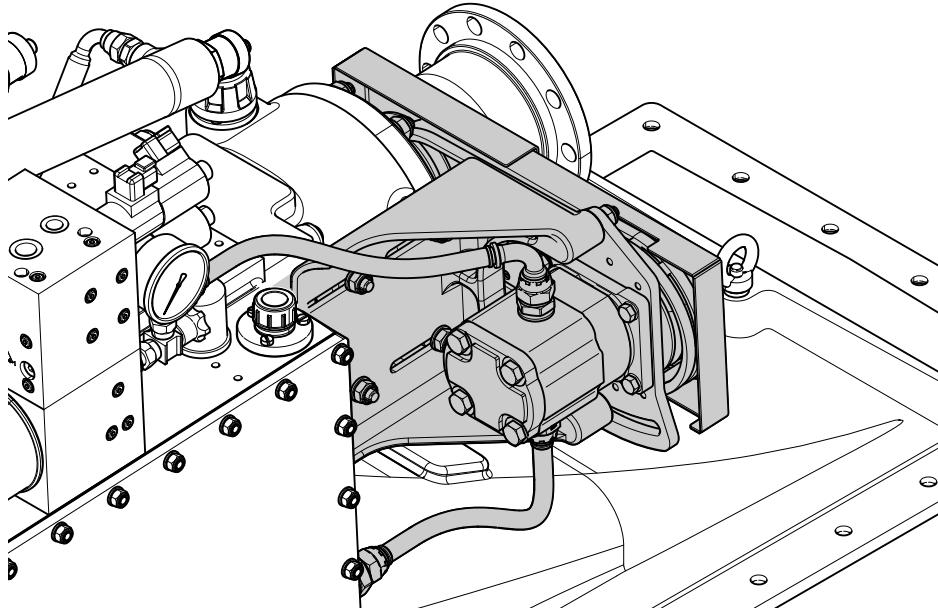


Figure 51

- 9 Install the nuts (A), lock washers (B) and anodes (C) again.
- 10 Install the screws (E), lock washers (F) and anodes (G) again.
- 11 Put Loctite® 243 on the threads. Torque to 31-34 Nm.
- 12 Task completed.

## 5.4 Hydraulic and Lubrication Installation

### 5.4.1 Hydraulic Pump, Install



GEN-1640-02

Figure 52

#### Task Summary

The task is to install the hydraulic pump.

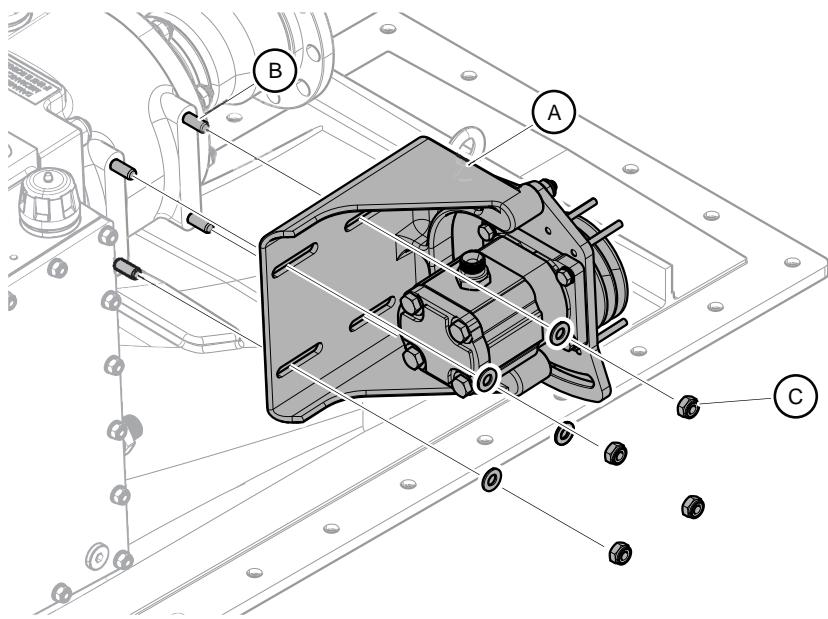
#### Prerequisites

##### Conditions

None

Personnel number	Skill level (choose one)	Maintenance facility level (choose one)
1	Task specialist	Dock, workshop / dry dock
Consumables	Quantity	Part number
Loctite 243 Loctite 2701	- -	- -

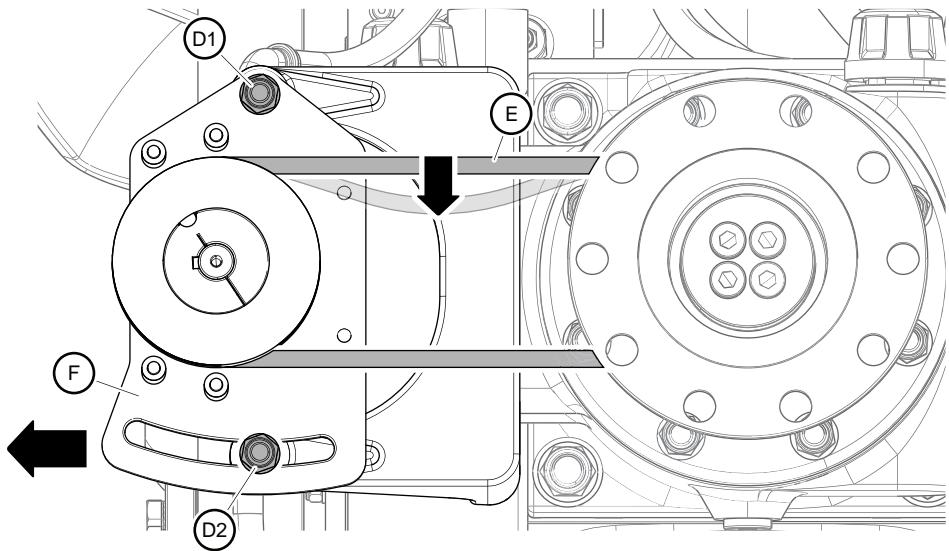
## Procedure



GEN-1529-01

Figure 53

- 1 Put the pump bracket and hydraulic pump (A) on the threaded pins (B).
- 2 Install the nuts and washers (C).
  - 2.1 Put Loctite® 243 on the nuts.
  - 2.2 Tighten the nuts to torque 34 Nm.



GEN-1675-01

Figure 54

- 3 Loosen the nuts (D1) and (D2) on the pump plate (F).
- 4 Install the wedge belts (E).
- 5 Move the pump plate (F) and pump to the left until the wedge belts (E) are tightened.
- 6 Tighten the nut (D1).
- 7 Push down on the wedge belts (E) to measure the deflection and adjust the pump plate (F) and pump until the deflection of the wedge belts (E) is 4-8 mm.

- 8 Tighten the nut (D2).
- 9 Make sure that the deflection is correct. If not, loosen the nut (D2) and repeat step 7 to 9.
- 10 Put Loctite® 2701 on the nuts (D1) and (D2) and tighten to torque 31-34 Nm.

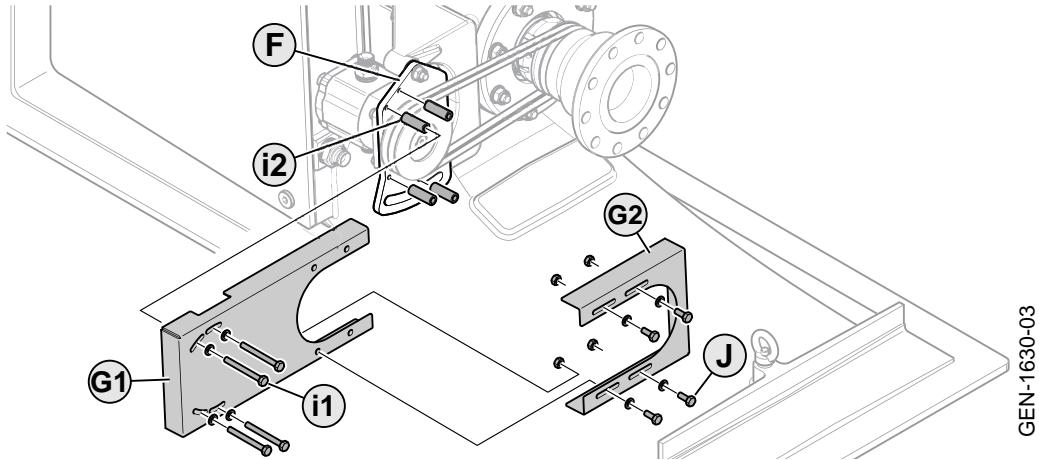


Figure 55

- 11 Install the screws, washers (i1) and spacers (i2) on the threaded pins of the pump plate (F) to attach the belt guard section (G1).
- 12 Align the belt guard section (G2) to the belt guard section (G1).
- 13 Install the screws, nuts and washers (J) to the belt guard sections (G1) and (G2).

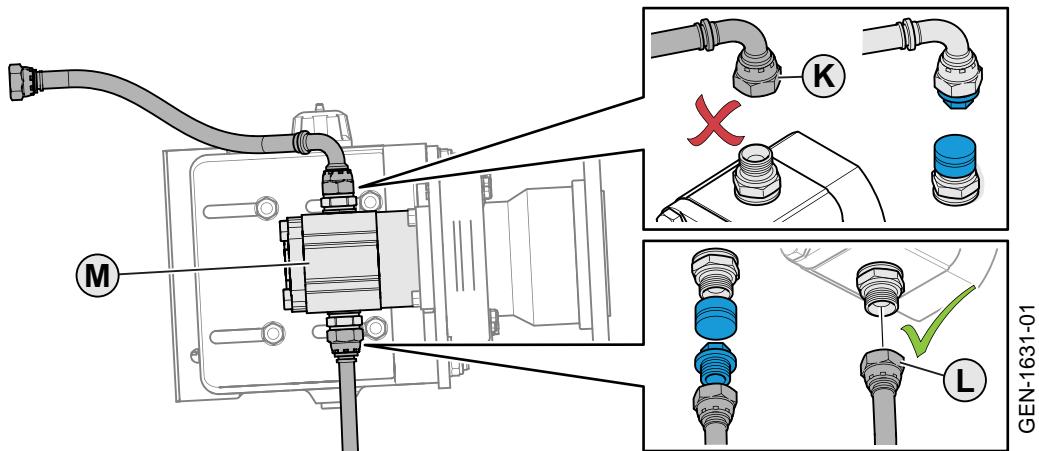


Figure 56

- 14 Leave the hose connector (K) until the oil is filled. Protect the connectors with plugs.
- 15 Install the hydraulic hose connector (L) to the hydraulic pump (M).
  - 15.1 Put Loctite® 542 on the hose connector.
  - 15.2 Tighten the hose connector to torque 21 Nm.
- 16 Task completed.



**Warning!**

Do not run the pump without oil.

## 5.4.2 Lubrication System, Fill with Oil

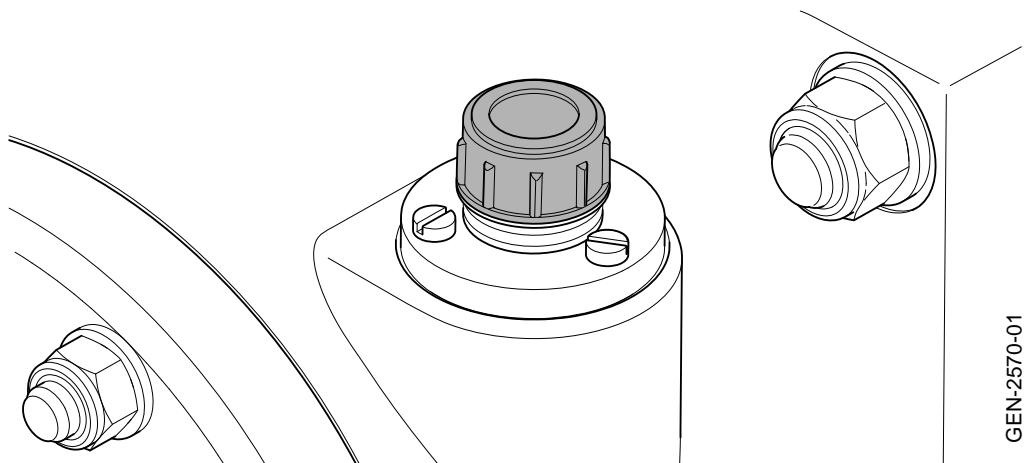


Figure 57

### Task Summary

The task is to add oil to the lubrication system.

### Task Interval

Do this task during:

- First fill of tank

### Prerequisites

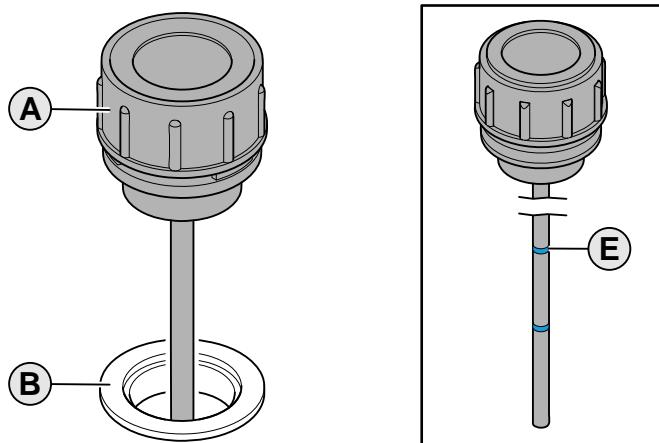
#### Conditions

System completely shut off.

Oil container available.

Number of personnel	Skill level	Maintenance facility level
1	Shipyard engineer, hydraulic/lubrication	Dock, workshop / dry dock
Consumables	Quantity	Part number
Lubrication oil	~ 0,8 l tank volume	-
Cloth	1	-
Special tools and test equipment	Quantity	Part number
Filler unit	1	-

## Procedure



GEN-2943-02

Figure 58

- 1 Remove the air filter (A) with the attached dipstick (E).
- 2 Fill with new oil through the air filter connection (B).

**Note!**

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

- 3 Wipe the dipstick (E) clean.
- 4 Install the air filter with the dipstick until it is fully seated.
- 5 View the oil level on the dipstick (E) to confirm that the oil level is within the safe operating range.
- 6 Repeat steps 1-5 until the oil level is within the safe operating range.
- 7 Install and firmly tighten the air filter (A) with the dipstick (E) again.
- 8 Task completed.

### 5.4.3 Hydraulic System, Fill with Oil

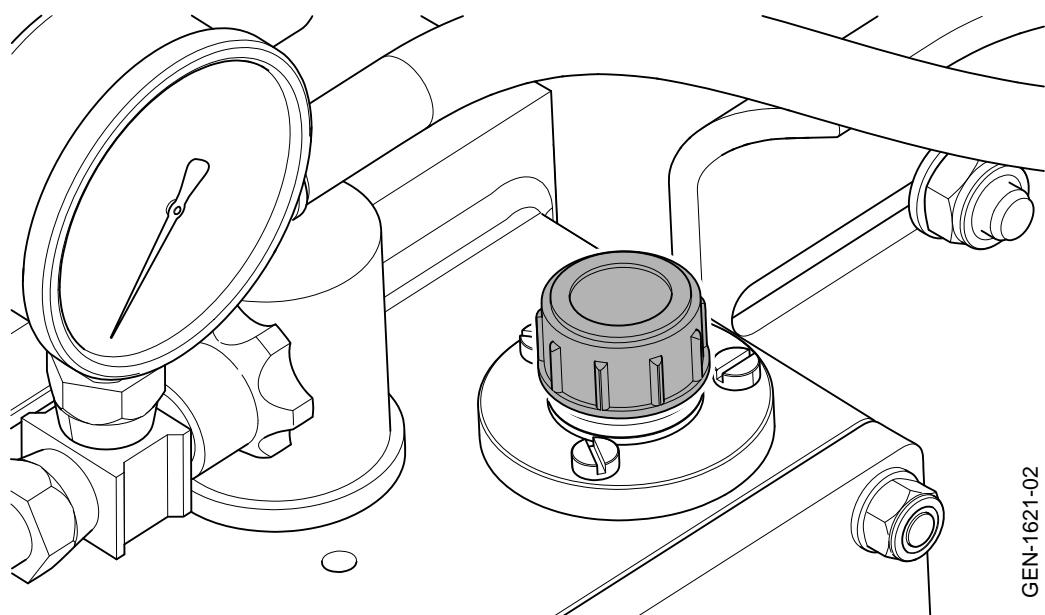


Figure 59

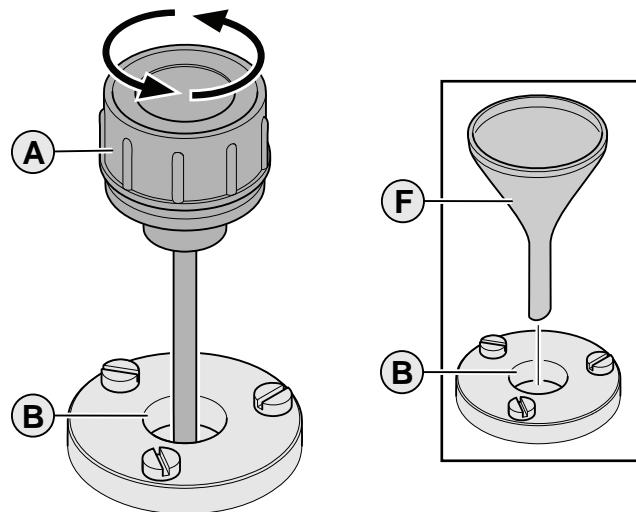
#### Task Summary

The task is to fill hydraulic system with oil. The hydraulic tank, piping and hoses is not filled with oil when sent from Marine Jet Power.

#### Prerequisites

Personnel number	Skill level (choose one)	Maintenance facility level (choose one)
1	Task specialist	Dock, workshop / dry dock
Consumables	Quantity	Part number
Hydraulic oil according to specification	~ 12,3 l tank volume plus pump and hoses	-
Cloth	1	-
Loctite® 542	-	-
Special tools and test equipment	Quantity	Part number
Filler unit complete with 10 micron filter	1	-
Reference document		
6.4 Fluids and Lubricants		

## Procedure



GEN-2914-01

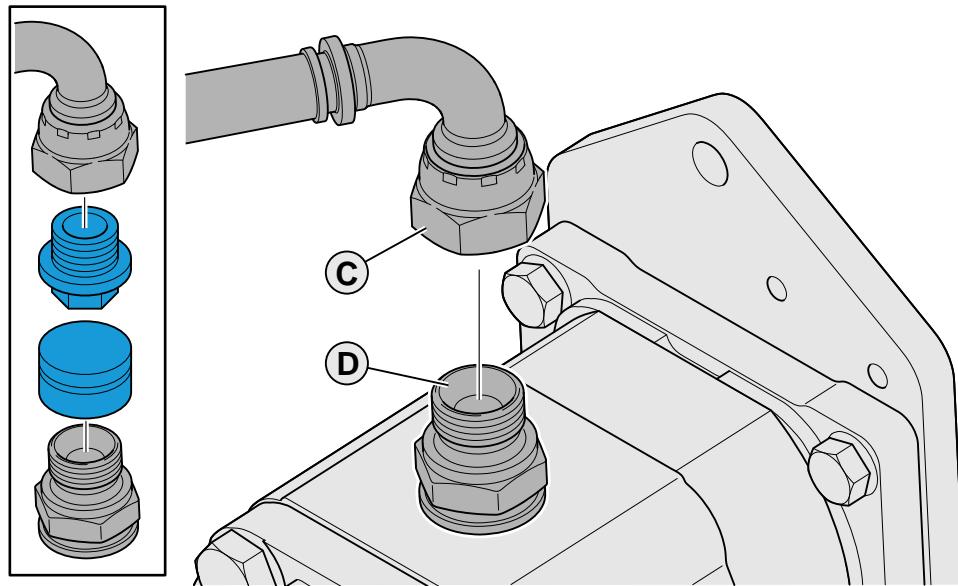
Figure 60

- 1 Make sure you have right oil. See *6.4 Fluids and Lubricants*.
- 2 Turn air filter (A) to loosen it.
- 3 Lift air filter (A).
- 4 Use a clean funnel (F) to fill oil through air filter connection (B).

**Note!**

MJP recommends that you put oil through a 10 micron filter.

- 5 Put air filter (A) in air filter connection (B) again.
- 6 Firmly tighten air filter (A).



GEN-1623-01

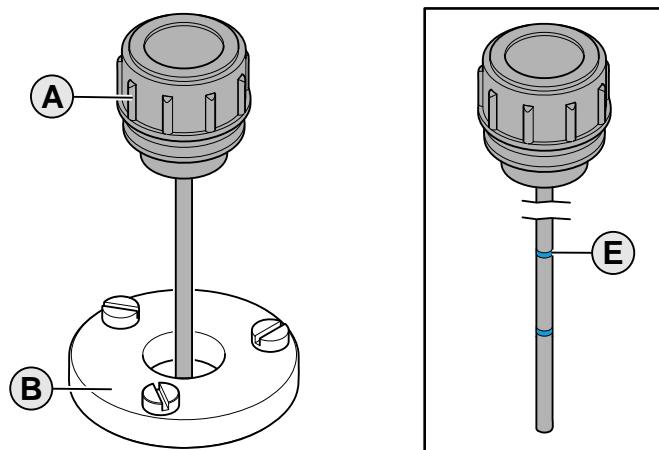
Figure 61

- 7 Remove plug from case drain port (D) on hydraulic pump.
- 8 Fill pump with oil through case drain port (D).

9 Remove plug from case drain tube (C) and connect case drain tube to case drain port (D).

9.1 Put Loctite® 542 on hose connector.

9.2 Tighten hose connector to torque 21 Nm.



GEN-1681-01

Figure 62

10 Check oil level

10.1 Turn air filter (A) to loosen it.

10.2 Lift air filter (A).

10.3 Make sure that oil level is at top mark (E) on oil level stick under air filter (A). If necessary, fill oil through oil filter connection (B) to top mark (E) on oil level stick.

10.4 Put air filter (A) in air filter connection (B) again.

10.5 Firmly tighten air filter (A).

11 Task completed.



**Warning!**

Do not start hydraulic system before it has been commissioned by Marine Jet Power personnel.

### 5.4.4 Hydraulic Tank, Connect Oil Level and Temperature Alarm Switch

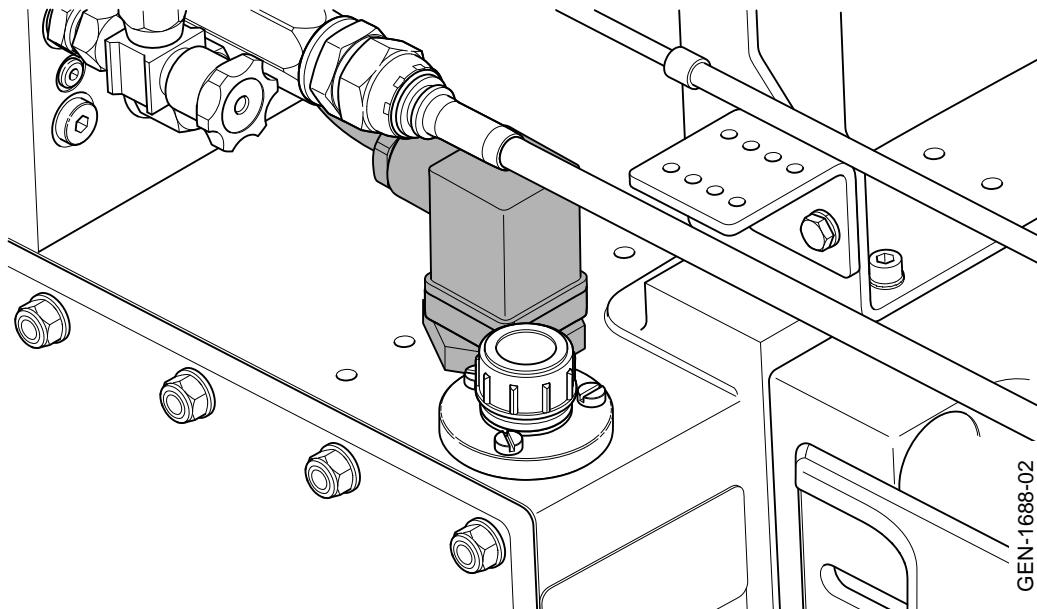


Figure 63

#### Task Summary

The task is to connect the alarm cable to the oil level and temperature alarm switch on the hydraulic tank and ship alarm system.

#### Prerequisites

##### Conditions

None

Personnel number

Skill level (choose one)

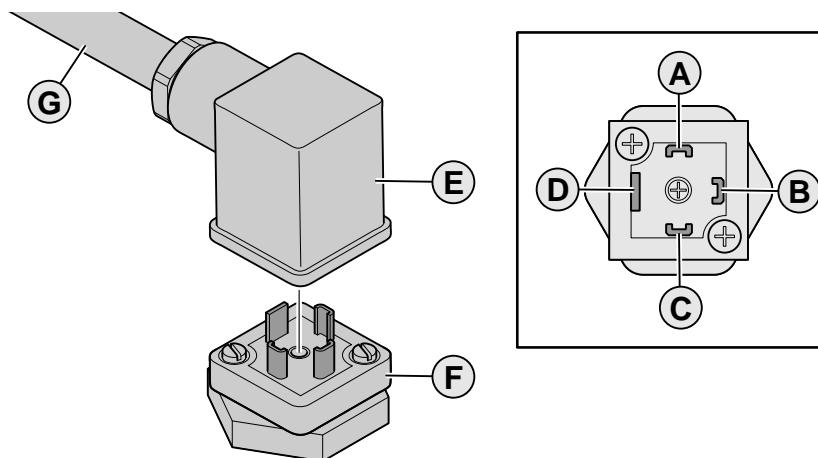
Maintenance facility level  
(choose one)

1

Task specialist

Dock, workshop / dry dock

## Procedure



GEN-1689-02

Figure 64

**Note!**

The cable connector (E) is supplied by MJP. The alarm cable (G) is supplied by the yard. Refer to table below and for the correct wiring information.

Pos	Function	Description
A	Oil temperature alarm	The connection between (A) and (C) is closed when the oil temperature is normal. The switch (F) opens when the oil temperature is higher than +70°C and resets when the oil temperature is +50°C
B	Oil level alarm	The connection between (B) and (C) is closed when the oil level is normal. The switch (F) opens when the oil level is too low.
C	Power	Gives power to the oil level and temperature alarm switch.
D	Ground	-

- 1 Connect the cable connector (E) to the contact on the oil level and temperature alarm switch (F).
- 2 Connect the alarm cable (G) to the ship alarm system.
- 3 Task completed.

## 5.5 Control System Installation

### 5.5.1 Main Control Unit, Install

#### Task Summary

The task is to install the Main control unit.

Number of personnel	Skill level	Maintenance facility level
1	Shipyard engineer, control system	Dock, workshop / dry dock

#### Procedure

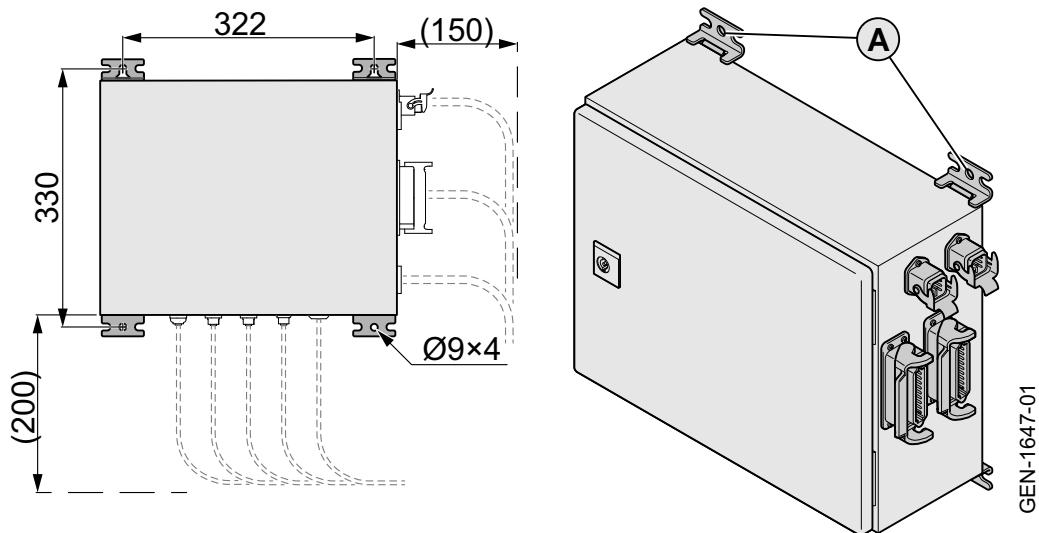


Figure 65

- 1 Unpack the control unit.
- 2 Put the control unit in position. Refer to the ship drawing.

**Note!**

Avoid proximity to heat and moisture sources. Make sure that the engineering section has been considered.

**Note!**

The Main control unit is ideally placed close to the engine and jet, high up on a bulkhead in the engine room.

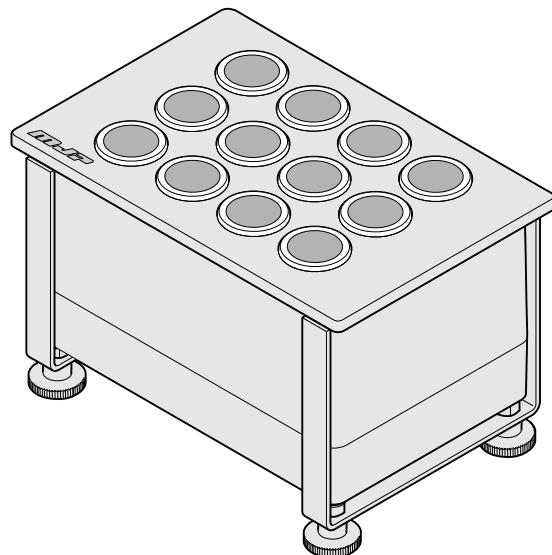
- 3 Install the control unit by using the holes (A) on the top and bottom of the unit.

**Note!**

Make sure to mount the cabinet on a sturdy wall. Use vibration damping material behind the mounting brackets, for example thick rubber.

- 4 Task completed.

### 5.5.2 Command Panel, Install



GEN-2817-01

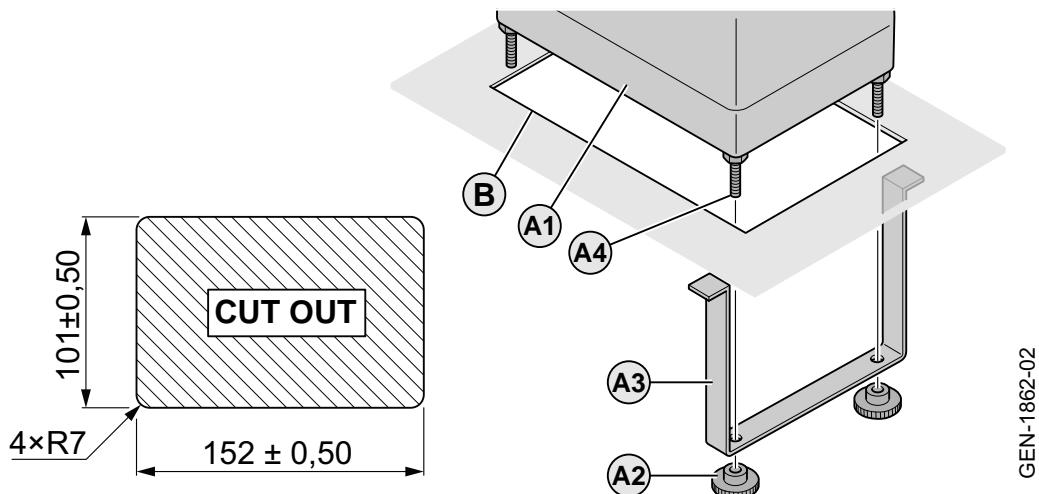
Figure 66

#### Task Summary

The task is to install the command panel.

Number of personnel	Skill level	Maintenance facility level
1	Shipyard engineer, control system	Dock, workshop / dry dock

## Procedure



GEN-1862-02

Figure 67

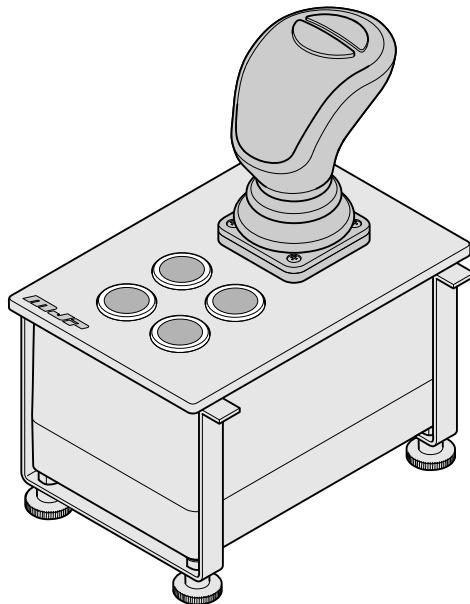
- 1 Unpack the command panel (A1).
- 2 Remove the nuts (A2) and the bracket (A3) from the threaded pins (A4) under the command panel (A1).
- 3 If not prefabricated, make a cutout in the bridge panel (B).
- 4 Put the command panel (A1) in the cutout in the bridge panel (B).

**Note!**

Make sure that the engineering section has been considered.

- 5 Put the nuts (A2) and the bracket (A3) on the threaded pins (A4) under the command panel (A1).
- 6 Tighten the nuts (A2) to fasten the bracket (A3) and command panel (A1) to the bridge panel (B).
- 7 Task completed.

### 5.5.3 VCS Panel, Install



GEN-1864-02

Figure 68

#### Task Summary

The task is to install the vector control system (VCS) panel.

Number of personnel	Skill level	Maintenance facility level
1	Shipyard engineer, control system	Dock, workshop / dry dock

## Procedure

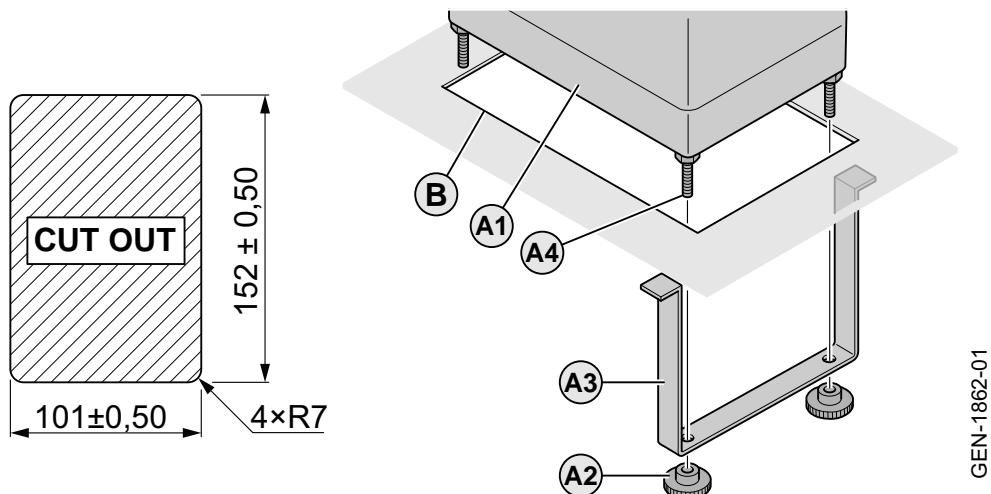


Figure 69

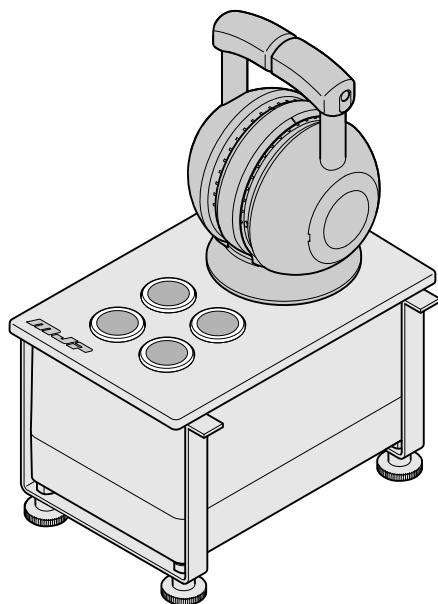
- 1 Unpack the VCS panel (A1).
- 2 Remove the nuts (A2) and the bracket (A3) from the threaded pins (A4) under the VCS panel.
- 3 If not prefabricated, make a cut-out in the bridge panel (B).
- 4 Put the VCS panel (A1) in the cut-out in the bridge panel (B).

**Note!**

Make sure that the engineering section has been considered.

- 5 Put the nuts (A2) and the bracket (A3) on the threaded pins (A4) under the VCS panel (A1).
- 6 Tighten the nuts (A2) to fasten the bracket (A3) and VCS panel (A1) to the bridge panel (B).
- 7 Task completed.

### 5.5.4 Combinator Controller, Install



GEN-1861-02

Figure 70

#### Task Summary

The task is to install the combinator controller.

Number of personnel	Skill level	Maintenance facility level
1	Shipyard engineer, control system	Dock, workshop / dry dock

## Procedure

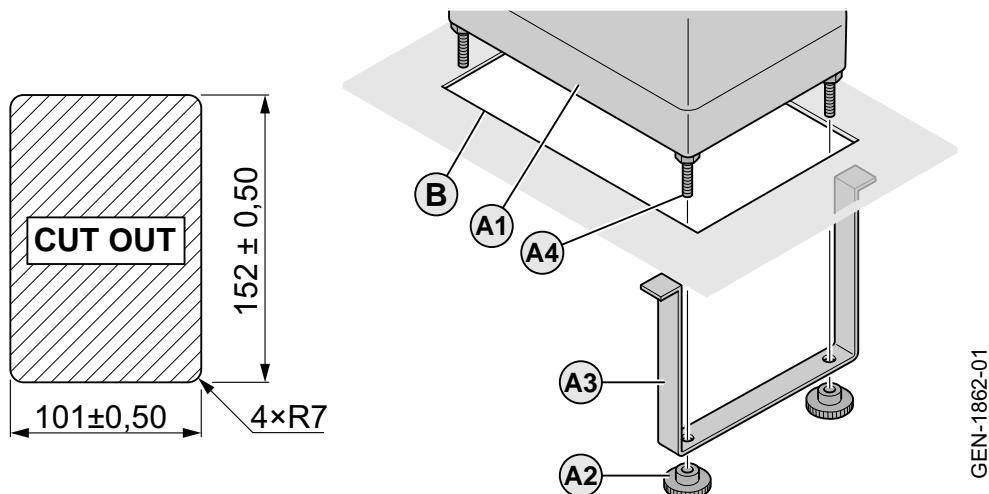


Figure 71

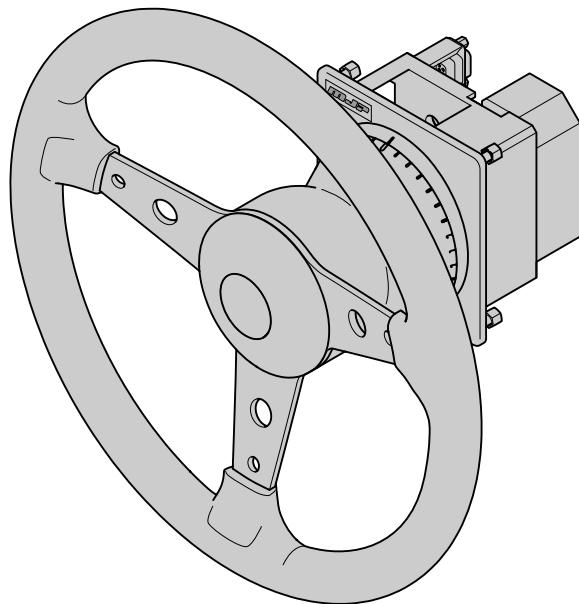
- 1 Unpack the combinator controller (A1).
- 2 Remove the nuts (A2) and the bracket (A3) from the threaded pins (A4) under the combinator controller (A1).
- 3 If not prefabricated, make a cut-out in the bridge panel (B).
- 4 Put the combinator controller (A1) in the cut-out in the bridge panel (B).

**Note!**

Make sure that the engineering section has been considered.

- 5 Put the nuts (A2) and the bracket (A3) on the threaded pins (A4) under the combinator controller (A1).
- 6 Tighten the nuts (A2) to fasten the bracket (A3) and combinator controller (A1) to the bridge panel (B).
- 7 Task completed.

### 5.5.5 Steer Wheel, Install



GEN-1333-01

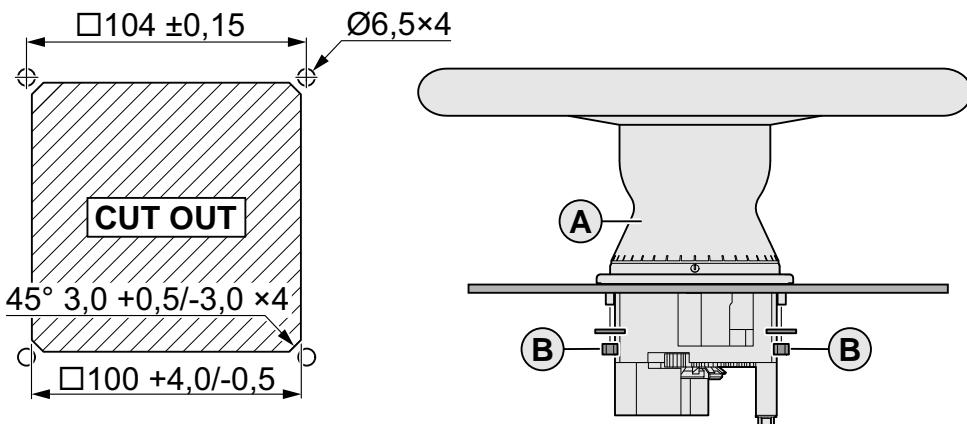
Figure 72

#### Task Summary

The task is to install the steer wheel.

Number of personnel	Skill level	Maintenance facility level
1	Shipyard engineer, control system	Dock, workshop / dry dock

## Procedure



GEN-1060-02

Figure 73

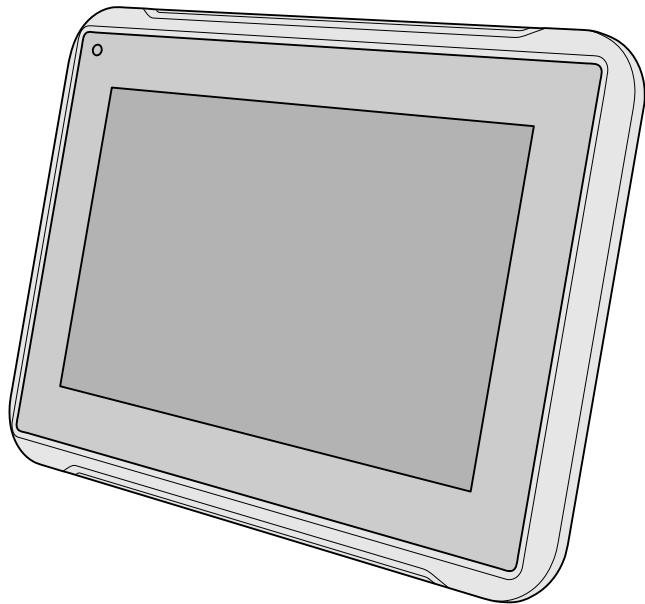
- 1 Unpack the steer wheel (A).
- 2 Remove the nuts and spacers (B) under the steer wheel.
- 3 If not prefabricated, make a cutout in the panel.
- 4 Put the steer wheel into the cutout in the panel. Refer to the ship drawing.

**Note!**

Make sure that the engineering section has been considered.

- 5 Install all the nuts and the spacers (B) to attach the steer wheel (A) to the panel.
- 6 Task completed.

## 5.5.6 Display Panel, Install



GEN-1654-01

Figure 74

### Task Summary

The task is to install the Display panel.

Number of personnel	Skill level	Maintenance facility level
1	Shipyard engineer, control system	Dock, workshop / dry dock

## Procedure

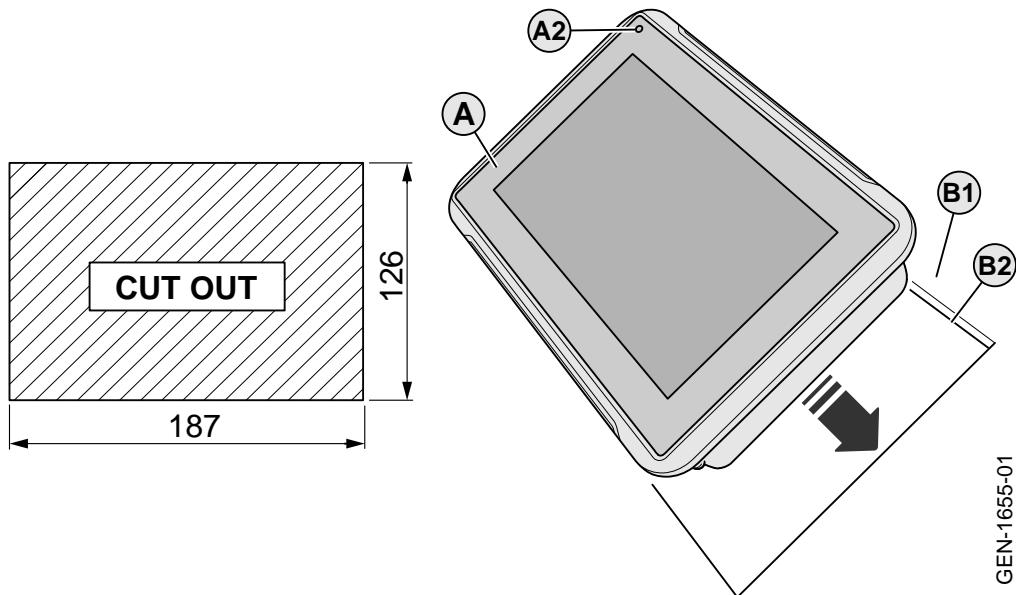


Figure 75



### Caution!

Make sure to obey the guidelines in the Engineering Overview chapter. This will help to prevent damage to the equipment.



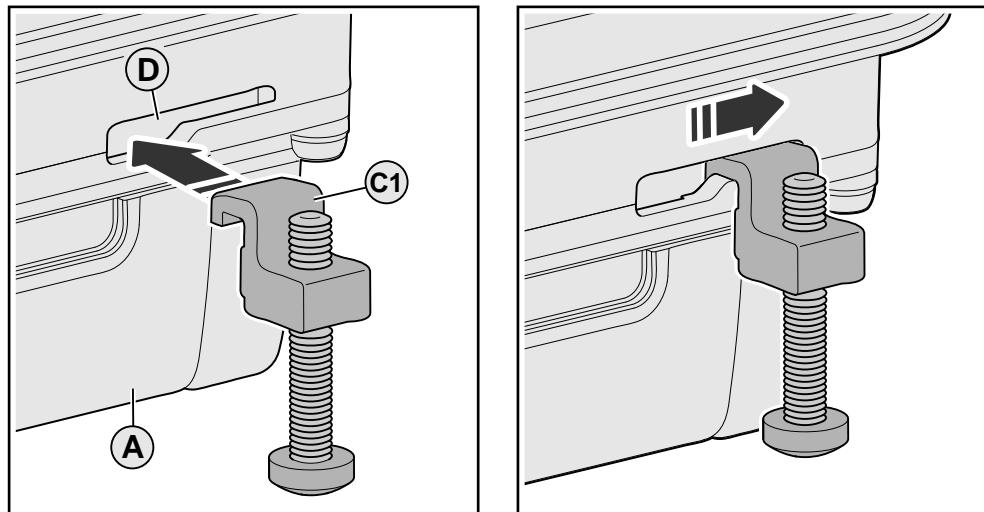
### Caution!

Make sure that there is sufficient clearance for the cable connections at the sides of the display panel.

- 1 Unpack the display panel (A).
- 2 If not prefabricated, make a cutout (B2) in the panel (B1).
- 3 Install the display panel (A):
  - 3.1 Put the display panel (A) into the cutout hole (B2) on the control panel (B1).

### Note!

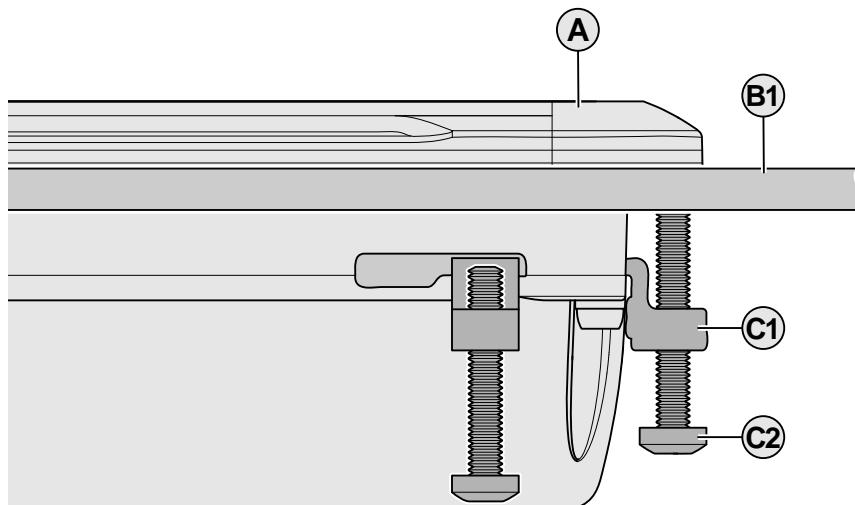
The display must be oriented with the round LED (A2) in the top left corner.



GEN-1658-02

Figure 76

- 3.2 Install the supplied installation fasteners (C1) in the insertion slots (D).



GEN-1659-01

Figure 77

- 3.3 Tighten the fastener screws (C2).



**Caution!**

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

- 3.4 Connect the cables to the display panel.



**Caution!**

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

- 4 Task completed.

## 5.5.7 Control System, Install Cables

### Task Summary

The task is to install the cables for the control system.

Number of personnel	Skill level	Maintenance facility level
1	Shipyard engineer, control system	Dock, workshop / dry dock

#### Reference document

Control System Chapter 5, System Layout.

### Procedure

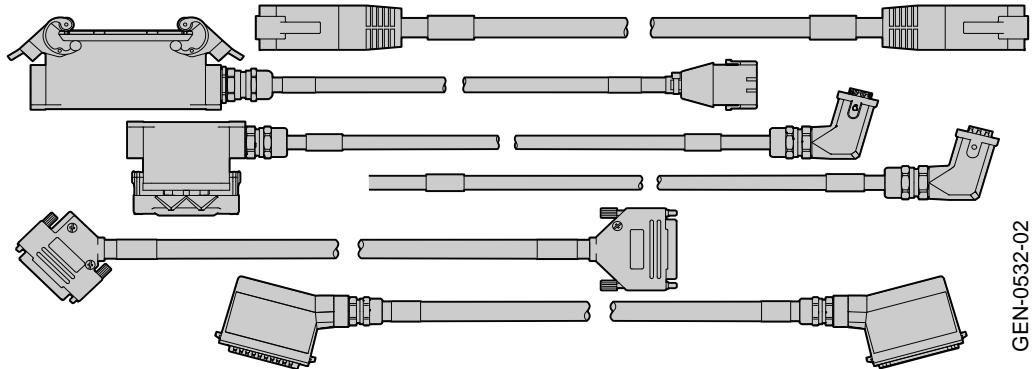


Figure 78

- 1 Install control system cables. Refer to the cabling System layout drawings.



#### Caution!

Do not install cable glands on manoeuvre and backup unit top side.



#### Caution!

Consider minimum cable radius. See the table below:

Cable diameter (mm)	Min. bend radius (mm)	Cable diameter (mm)	Min. bend radius (mm)
16	102	41	210
21	114	53	241
27	146	63	267
35	184		

- 2 Task completed.

## 5.6 Launch the Vessel

- 1 Launch the vessel.
- 2 When the vessel has been launched, the hull structure will bend because of the pressure from the water. MJP recommends that the drive shaft is aligned again when the vessel is in the water. Inspect and adjust shaft alignment.
- 3 Installation by the yard is now completed.  
Make sure to fill in the Yard Installation Report and then Contact Marine Jet Power for the commissioning.
- 4 Installation completed.

# 6 Appendix

## 6.1 Paint Program



**Caution!**

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

### 6.1.1 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

### 6.1.2 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.

## 6.2 Torque

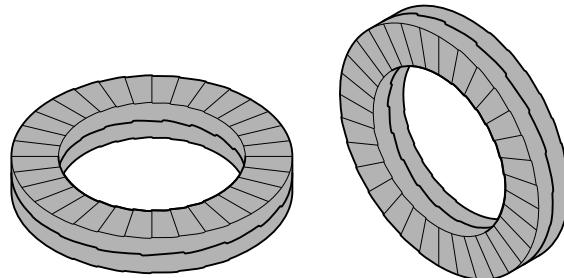
**Caution!**

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.

### 6.2.1 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 79

## 6.2.2 Specifications for Screws with Nordlock Washer



GEN-3043-01

Figure 80

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

### 6.2.3 Specifications for Screws with Plain Washer

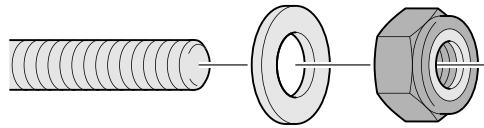


GEN-3044-01

Figure 81

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

## 6.2.4 Specifications for Lock Nuts



GEN-3045-01

Figure 82

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

## 6.3 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.		

## 6.4 Fluids and Lubricants

### 6.4.1 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.

### 6.4.2 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.

## 6.4.3 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.
-------------	---

## 6.4.4 Grease Specifications

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



GEN-3156-01

Figure 83

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

## 6.5 Material Specification

### 6.5.1 Specific Recommendations

It is recommended to assemble the jet unit with the product as described:

Product name	Source of supply	Essential Characteristics
Sikaflex 291	Sika	Low viscosity, paste, various color, flash point 79 °C.

Specifications for the recommended products.

## 6.6 Long Term Storage of Equipment

### 6.6.1 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

## 6.6.2 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.

## 6.7 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	

**6.7.1 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 Hydraulic Steering Cylinder, Replace Seals and Hydraulic Reversing Cylinder, Replace Seals in Service Manual.
Inspect cylinders and hoses	See Hydraulic Cylinders and Hoses, Inspect in the Service Manual
Replace the air filter	See Hydraulic and Lubrication System, Replace Air Filter in the Service Manual.

**Mechanics**

Inspect the pump unit	See Hydraulic Pump, Inspect in the Service Manual.
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