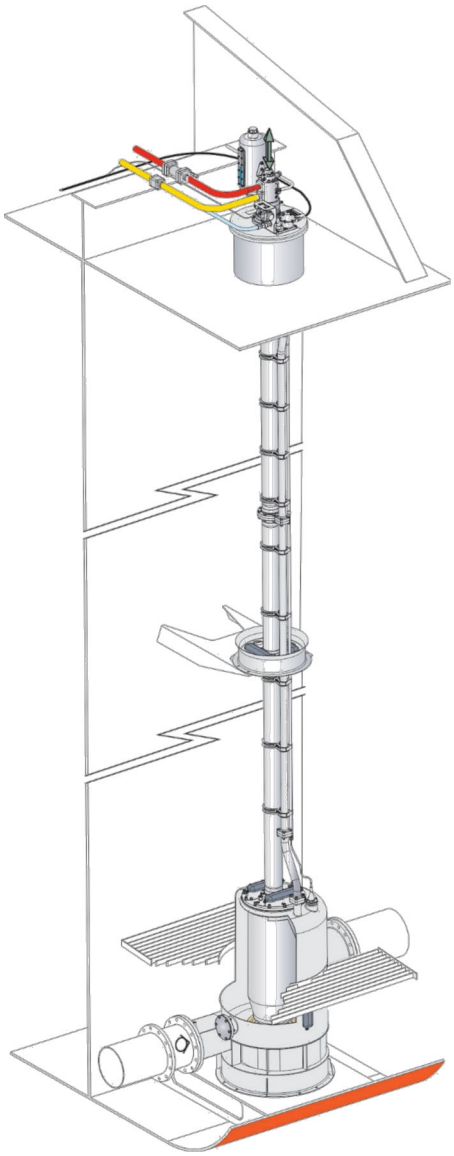
Framo

Submerged Ballast Pumps

No. 1000-0199-4
Rev.B 16Feb23

Operation manual



SB125
SB200
SB300
SB400
SB600

CONTENTS

Reference to associated instructions
1000-0109-4: Interchange of pump control valve
1375-0027-4: Service manual for Speed Torque Controller (STC)

1 GENERAL DESCRIPTION

The Framo hydraulically driven submerged ballast pump consists of five main parts:

- Pump casing/ air separator
- Pump head
- Pipe stack
- Top plate/Control valves
- Evacuation system

Figures in this procedure are made general for all types of submerged ballast pumps. For further information, see drawings for the actual ballast pump.

Pump casing / Air Separator

The pump casing is bolted to a foundation. Air entering the pump through the suction line will be separated in the air separator/ pump casing and removed by the evacuation system.

Pump head

The pump head includes the hydraulic motor, impeller and sealing arrangement. A cofferdam completely segregates the hydraulic oil from the ballast water. The cofferdam is filled with water/glycol.

Pipe stack

The pipe stack consists of a hydraulic section and an arrangement with pipe and cable for the evacuation system.
Supports on the pipe stack prevent horizontal movement and allow for vertical expansion.

Top plate/ Control valves

The pipe stack penetrates the top plate. A sealing arrangement between top plate and pipe stack allows the pipe stack to expand. The pump control valve STC(Speed Torque Controller) and evacuation control unit and header tank is located at the top plate.

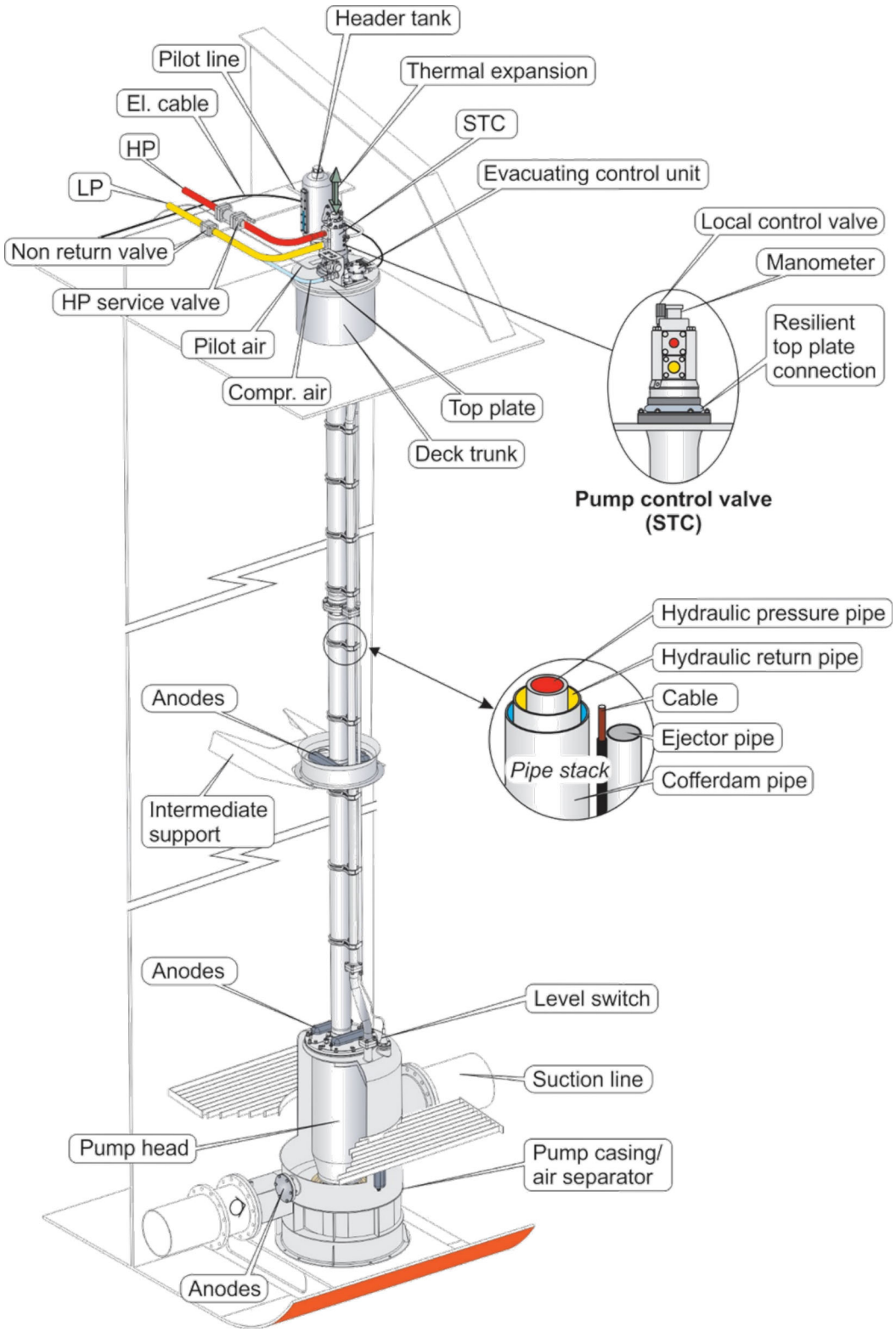
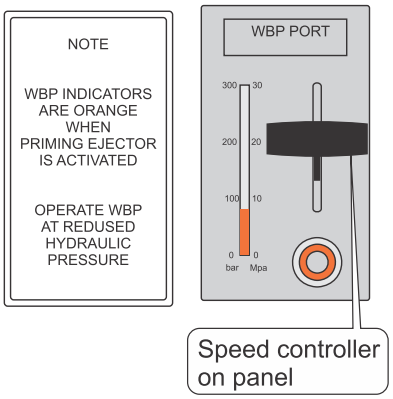

Header tank
Pilot line
Thermal expansion
El. cable
STC
HP
Evacuating control unit
LP
Local control valve
Non return valve
Manometer
HP service valve
Resilient top plate connection
Pilot air
Compr. air
Top plate
Deck trunk
Pump control valve (STC)
Hydraulic pressure pipe
Hydraulic return pipe
Anodes
Cable
Ejector pipe
Pipe stack
Cofferdam pipe
Intermediate support
Anodes
Level switch
Suction line
Pump head
Pump casing/ air separator
Anodes

Fig. 1

Evacuation system

Air in casing and suction piping are automatically evacuated by the ejector. Start and stop of ejector is controlled by the level switch (conductive type with intrinsically safe circuit (EExia)).

If there is air in the pump casing, the level switch will be dry and the ejector will start (indicated with steady light with orange colour in push button and graph bar on speed controller (control panel)). The pump speed must be reduced. When the water again reaches the level switch, the ejector will stop.



Note!
The evacuation system is activated only when pump control is switched "on".

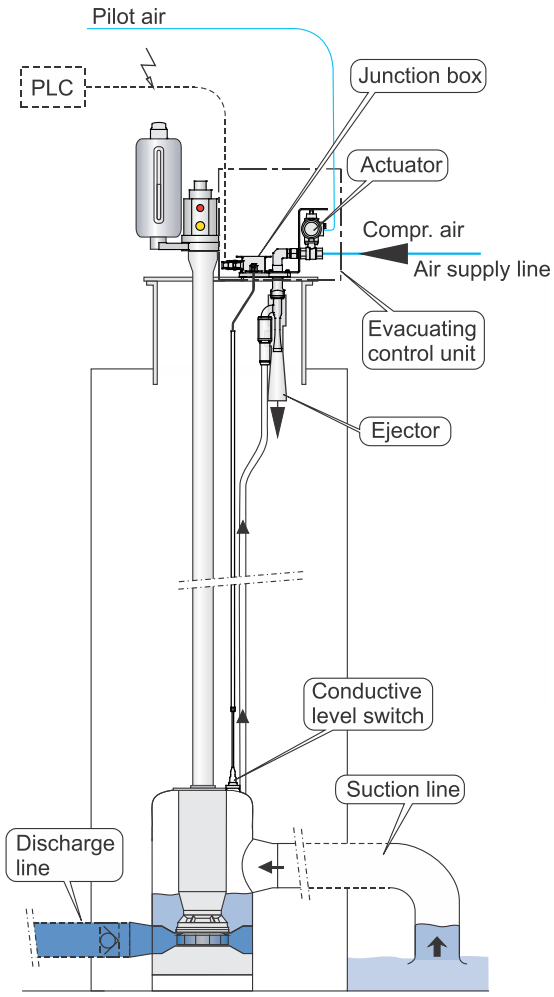


Fig. 2

The evacuating capacity for the air driven ejector is given in fig. 3.

With an air supply pressure of 7 bar to the ejector, the air consumption will be;

For SB125, SB200 and SB300: 1.1 Nm^3/min (18 Nl/sec)

For SB400 and SB600: 2.9 Nm^3/min (49 Nl/sec)

(Nm^3 = normal m^3)

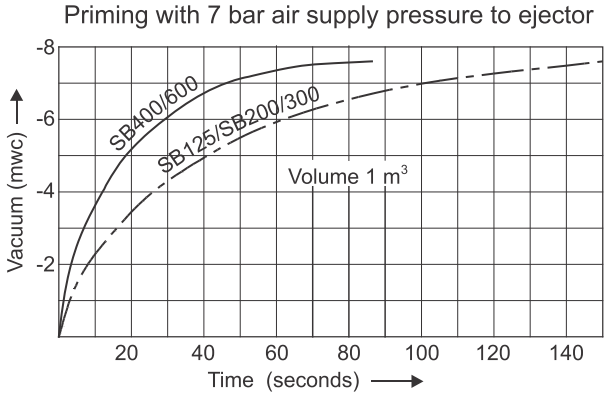


Fig. 3 Curve indicating vacuum in a 1 m^3 volume (suction line) versus priming time.

2 OPERATING INFORMATION

To get maximum lifetime of the pumps, operate the pumps within the operation range (ref. fig. 8).

When starting ballasting, the ballast water will normally gravitate through the ballast piping system.
Keep suction valve and discharge valve closed and open by-pass valve, to avoid gravitation through the ballast pump (ref. fig.4).

Note!
The ballast water must not gravitate through the pump, as this may damage the hydraulic motor.

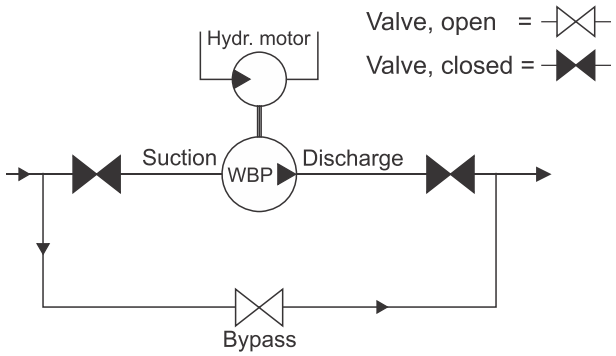


Fig. 4 Water gravitating through the ballast piping system.

2.1 Ballasting / deballasting

As the flow caused by gravitation decreases, the pump has to be started to increase the capacity.

- Check that the hydraulic system is started and enough hydraulic power is available.
- Check that pressurized air for evacuation system is available.

Note! *HP service valve (fig. 1) should always be open except when carrying out service work on the pump.*

Starting of pump

Open ballast pump suction valve.
Start the pump slowly, and let it run with hydraulic motor pressure 50 bar for approx. 1 minute.

CAUTION
Never dry run the pump.
Always open the suction valve before operating the ballast pump.

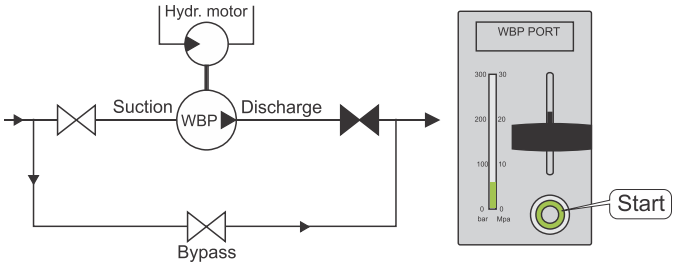


Fig. 5

Close bypass valve, open discharge valve and increase hydraulic motor pressure until required capacity is achieved.

Note!
Avoid running pumps against closed discharge valve for a longer period.

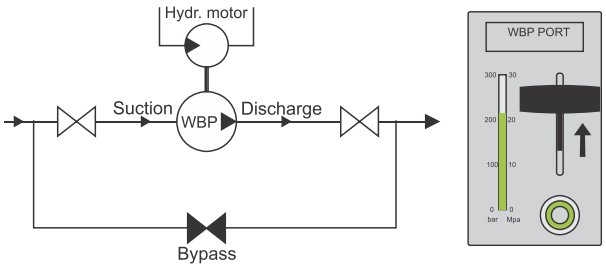


Fig. 6

Pumping

The ballast pump is designed to operate with discharge head between 20 and 30 mlc (design head).

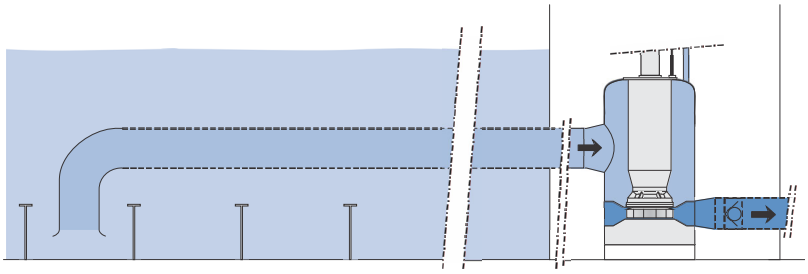


Fig. 7

When running pump at low discharge head and high motor pressure, the capacity will be higher than normal. This may lead to heavy vibrations and damage to the pump.
There are two ways to bring the pump back to the operation range:

a) Reduce speed / hydraulic motor pressure.

b) Throttle the discharge valve.

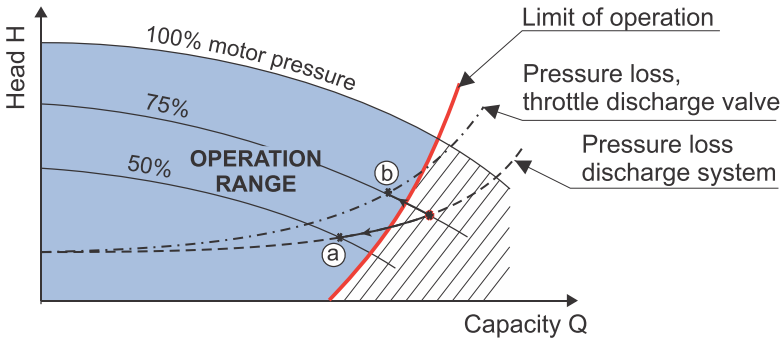


Fig. 8

Note! *Performance diagram for the actual pump gives the operation range*

End of deballasting

With low water level in the ballast tank, the pump capacity must be reduced to avoid loss of suction. A gradually increasing amount of air will enter the pump suction line via the vortex forming at the suction bell mouth. Air will accumulate in the pump casing (air separator) and the evacuation system will eventually be activated – priming light in control panel switched on.(steady orange light).
The pump capacity must be reduced to match the water inflow to the suction bell mouth area (the inflow is depending of the tank layout, opening in stiffeners etc.). This is most critical when emptying a ballast tank furthest away from the pump.

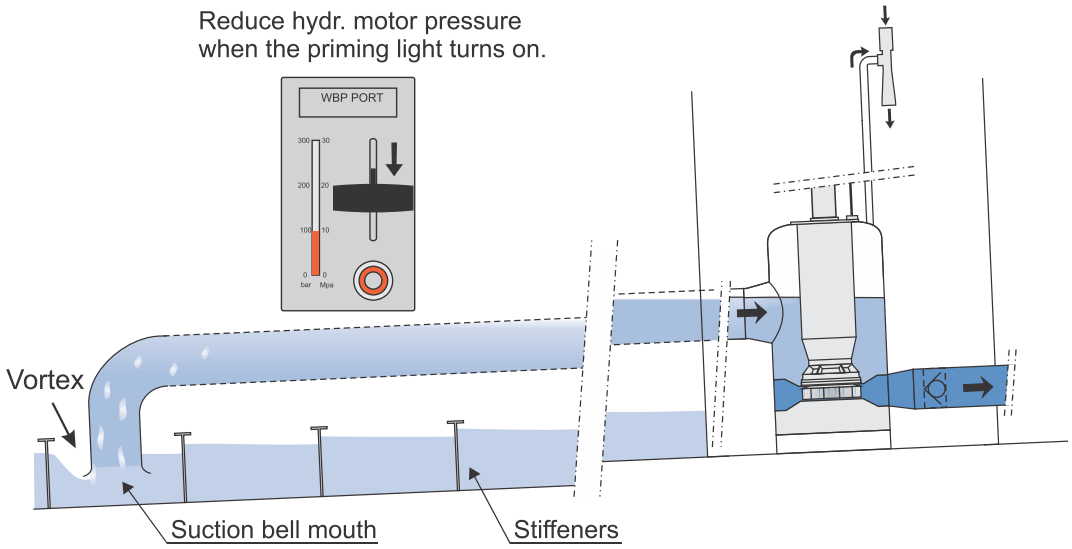


Fig. 9 End of deballasting (ship in aft trim condition)

Stopping the pump

When the ballast tank is empty, the pump will lose suction. The evacuation system will be operating continuously (indicated by steady orange light on button and on bar graph).

Close the discharge valve. Adjust speed control lever to minimum and push the button to stop the pump. Button flashes with green colour for 15 sec. before turning off.

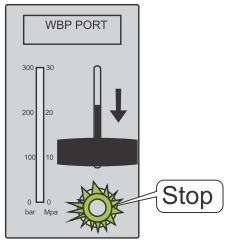


Fig. 11

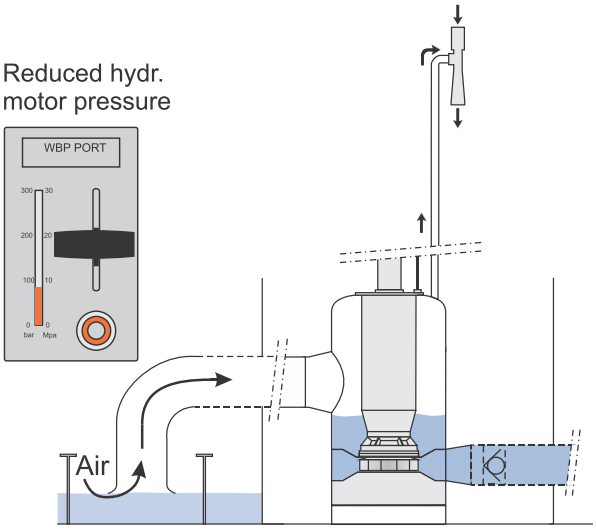


Fig. 10

Close the suction valve.

Note! *Do not run the pump unnecessary when the pump loses suction.*

Operation of pump from local control valve

The ballast pump can be operated from the local control valve at the STC valve.

Open local control valve by turning counter-clockwise.

Set the speed control lever to maximum position.

Start the pump by closing the local control valve (turning clockwise). Run the pump as described for remote controlled operation.

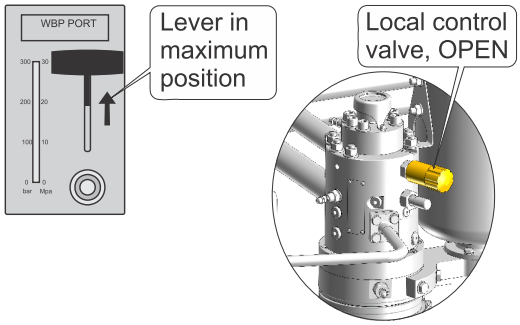


Fig. 12

2.2 Cofferdam control

The pump hydraulic section is surrounded by the liquid filled cofferdam that completely segregates the hydraulic oil from the ballast. Static overpressure in the cofferdam gives clean cofferdam liquid to the seal faces and lubrication of these. Condition monitoring of the shaft seal arrangement is carried out by surveillance of the liquid level in the header tank.

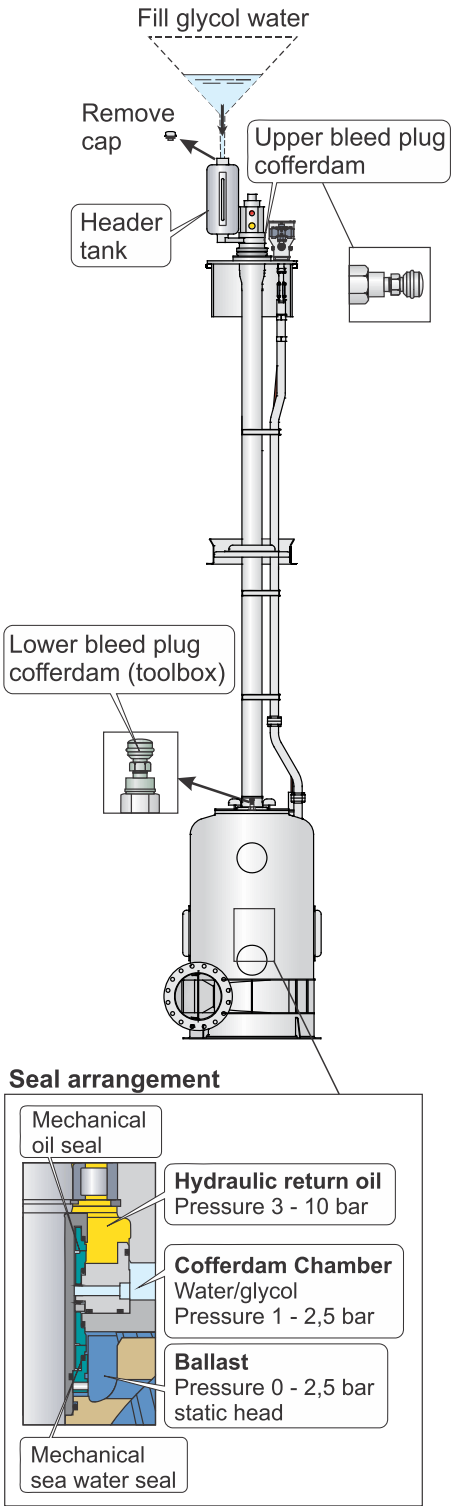


Fig. 13

Clean and correct type of cofferdam liquid is important in order to get a long lifetime of the shaft seal arrangement.

Cofferdam liquid:

- Demineralized water: 40 - 50 %
- Glycol * 60 - 50 %

  Freezing point -40°C - -35°C

*Propylene glycol, C3H8O2
(monopropylene glycol, 1.2 propanediol, propanediol)

Use only pure glycol without additives.

Note!

Think safety and health. Read the Material Safety Data Sheet before using the different glycol.

Note!
Never use other anti-freeze solutions. Some of the additives in anti-freeze forms deposits on seal parts and thereby causing seals to fail.

Glycol is added to prevent freezing. If no danger of temperature below 0°C the cofferdam can be filled with demineralized water without glycol.

Filling sequence:

Remove the cap on header tank and fill the cofferdam volume through the header tank.

- Hydraulic oil filling of pump must be done before filling of cofferdam.

  Note!
  Before starting oil filling of pump, fill 2-3 litres of cofferdam liquid into header tank.

- After filling is completed, and the jockey/feed pump is in continuous operation, fill up the cofferdam until liquid level stabilises at normal level on the sight glass (halfway between low and high level mark).

- Air in cofferdam must be released during filling. When filling pump head, vent through the lower bleed plug (fig. 13).
  Ventilate pipe stack through the upper bleed plug.

The cofferdam volume depends on pump type and pump length. The following formulas give approx. volume (in litres) required to fill cofferdam to normal mark in header tank:

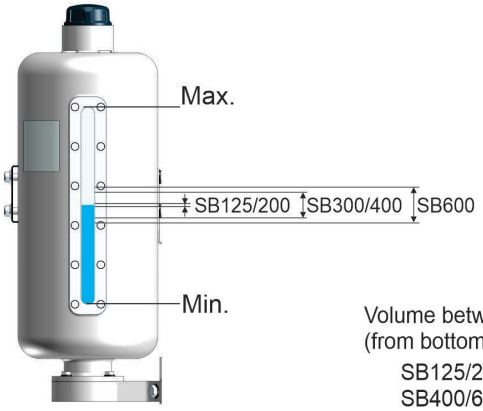
	Volumes (litres)			
Pump type	Pump head	Pipe stack	Header tank	Total
SB125	3	L x 0,5	5	8 + (L x 0,5)
SB200	2,5	L x 0,5	5	7,5 + (L x 0,5)
SB300	13	L x 0,8	5	18 + (L x 0,8)
SB400	95	L x 3,5	7	102 + (L x 3,5)
SB600	125	L x 3,5	7	132 + (L x 3,5)

L = Pump length in metres. (See Framo Specification)

Monitoring of cofferdam level

We recommend regular control of the cofferdam level.

The liquid level in the header tank varies with the temperature of the ballast water, hydraulic oil and ambient temperature. Figure 14 indicates normal level variations for the different pump types with a temperature change of ±10°C on the cofferdam liquid for the different pump types.



Normal level variations depends on pump type and pump length. Figure indicates normal level variations with ±10 °C temperature variation on cofferdam liquid.

Volume between min. and max. level (from bottom to top of sight glass):
SB125/200/300: 5.2 litres
SB400/600: 9.1 litres

Fig. 14

Because of level changes due to temperature variations, the level should always be monitored at the same temperature, i.e. at normal operating temperature.

The header tank level (H) to be measured in mm above bottom of sight glass.

By using the enclosed log form (page 13), it is possible to establish a trend towards increasing or decreasing level. The filled in example below indicates how to use the log form.

Leakage rate (to be calculated) = $\frac{(H_2 - H_1)x31}{h}$ [ml/h]

LOG FORM FOR LIQUID FILLED COFFERDAM ON FRAMO SUBMERGED BALLAST PUMPS

VESSEL NAME: _____ TYPE OF LIQUID USED IN COFFERDAM: _____

Header tank level(H) to be measured in mm above low level mark on sight glass. 1 mm on sight glass is equivalent to 31 ml volume.

Pump location (P or S)	Date	Header tank level (H) (mm)	Ballast water temperature (°C)	Hydraulic oil temperature (°C)	Ambient temperature (°C)	Hours of operation since last control (h)	Leakage rate (ml/h)*	Comments / Remarks (Action taken)	Signature / Date
S	05.03.09	105	5	45	5	10			
S	07.03.09	106	5	44	6	12	2,6		
S	12.03.09	103	3	45	4	15	- 6,2		

EVALUATION OF CHANGES IN LIQUID LEVEL IN HEADER TANK

When pump is not running, the leakage rate from the mechanical seals is very low (up to 0,1 ml/h). Therefore increasing or decreasing level due to leakages from mechanical seals should not be expected when pump is not in operation.

Changes in liquid level	Possible reason
Sudden decrease	Can indicate that it is air in the cofferdam system, which most likely occurs in the first period after initial water/glycol filling or complete refill after service.
Decreasing level	Different temperature compared to the previous measurement (temperature of the ballast water, hydraulic oil and ambient temperature), ref. fig.14. When pump is running the normal leakage rate can be up to 20 ml/h from the mechanical sea water seal. This will give a decreasing level in header tank of up to approx. 0,65 mm/h, i.e 65 mm per 100 running hours. For a shorter periode of time, higher leakage peaks can occur. Abnormal decreasing level over a period of time indicate a worn out mechanical sea water seal, see chapter 4, “Trouble shooting”.
Increasing level	Different temperature compared to the previous measurement (temperature of the ballast water, hydraulic oil and ambient temperature), ref. fig.14. Normal leakage rate can be up to 5 ml/h from the mechanical oil seal. This will give a increasing level in header tank of up to approx. 0,16 mm/h, i.e. 16 mm per 100 running hours. For a shorter periode of time, higher leakage peaks can occur. A continous leakage rate > 20 ml/h or a sudden increasing level in header tank indicate a worn out mechanical oil seal, and overhauling may be necessary (ref. chapter 4, Trouble shooting).

IN CASE OF ANY DOUBT, please contact Framo Services AS for assistance.

If the level drop under min. level, refill the header tank.
Log the volume.

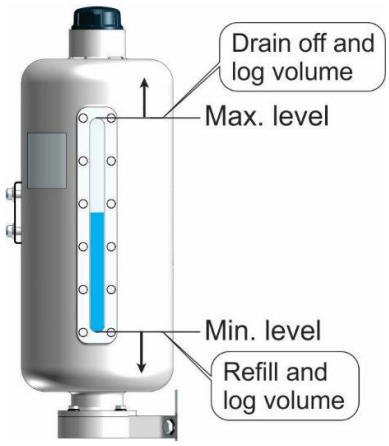


Fig. 15

If level exceed max. level, the header tank must be drained. Volume must be logged.
Empty the header tank by draining through the cofferdam bleed plug, see fig. 16. Refill the header tank.

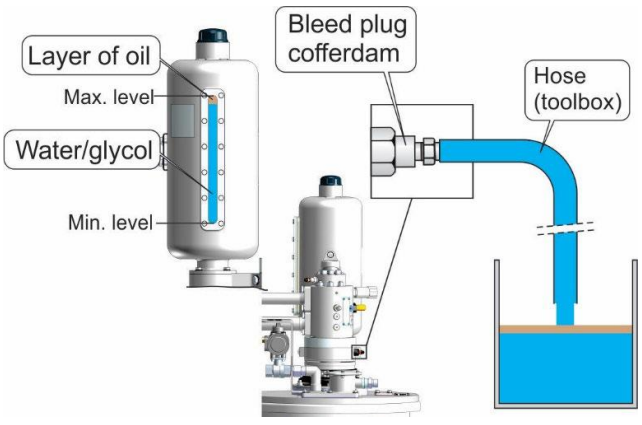


Fig. 16

3 MAINTENANCE INFORMATION

Prior to entering a ballast tank for doing service it is essential to become familiar with the ship's safety rules and requirements regarding cargo-handling equipment. Do not enter a ballast tank before the tank is confirmed gas free.

Before doing service on pump, always close and lock the HP service valve.

Close the ballast valves (suction line and discharge line). Ensure that the valves are in closed position until the work/service is finished (info sign to be placed on the control panel/computer).

Before starting to dismantle impeller, wear rings etc., make sure that pipe stack/ pump head is secured properly in order not to drop down when work is in progress.

Note! *To prevent contamination and hazardous situations it is important to avoid oil spill during maintenance and repair work. Drain in accordance with procedures ("Instruction for maintenance and repair" for actual pump).*

The operator should be confident that all flange connections are in satisfactory condition so as to prevent hydraulic oil and cargo spills.

After any work has been carried out in the ballast tank, always check that the tank is free for foreign objects.

4 TROUBLE SHOOTING

Symptom:	**Possible reason:**	**Remedy: *)**
Ballast pump operational problem (First it is necessary to verify if the problem is in the pump control system or in the pump head itself).	General	Ref. system service manual - Trouble shooting section
The pump will not start	a) Ballast pump remote control system failure b) Pump control valve failure c) Pump impeller stuck. c1)Foreign objects stuck in pump or other mechanical problem	a) Ref. instruction for Remote control system b) Ref. Instruction for Pump control valve – STC c1)Pump head to be inspected.
Pump is vibrating heavily	a) Control system problem b) Rotating parts out of balance.	a) Ref. instr. for Pump control system. b) Impurities stuck in impeller or other mechanical problem.
Too low pumping capacity	a) Control system problem b) Worn wear rings. Impurities stuck in impeller, or other mechanical problem	a) Ref. instr. for Pump control system and instr. for Pump control valve. (If required interchange pump control valve as described in instr. 1000-0109-4) b) Pump head to be inspected

**) Ref. instruction for maintenance and repair for actual pump.*

Symptom:	Possible reason:	Remedy: *)
Decreasing level in header tank. (See also chapt. 2.2)	General ***Note!*** *Always pressure test pump prior to and after dismantling. This is required to locate possible leakage and to confirm no leakage upon completion of repair.* a) Worn mechanical sea water seal b) Leaking seal element in flange connection c) Crack in piping	Log level in header tank for a periode of time. Evaluate the changes (see chapt. 2.2). Pressure test pump cofferdam system at approx. 3 bar. Check for leakage – if required spray with soapy water to locate the leakage. ***Note!*** *For inspection of pump head / shaft seal it is required to lift pump out of pump casing prior to pressure test, see instruction for maintenance and repair.* a) Replace mechanical seawater seal. (replaced seal to be reconditioned if feasible) b) Check for loose bolts and for pitting corrosion in seal faces – in case of corrosion repair is required. Assemble using new seal element. c) Contact a Framo Service Station
Increasing level in header tank. (See also chapt. 2.2) Hydraulic oil in cofferdam.	General a) Leaking mechanical oil seal b) Leaking seal element in flange connection(s). c) Crack in piping	Log level in header tank for a periode of time. Evaluate the changes (see chapt. 2.2). Pressurize pump return side at approx 4 bar and check for and locate the leakage. ***Note!*** *For inspection of shaft seal area it is required to lift pump out of pump casing prior to pressure test, see instruction for maintenance and repair.* a) Replace mechanical oil seal (replaced seal to be reconditioned if feasible) b) Check sealing surface for possible damage – repair if damaged. Assemble using new seal element. c) Contact Framo Service Station
The ejector do not start	Signal from ballast tank level switch not detected.	Stop the pump and check level switch and related wiring to control panel.
The ejector do not stop	Signal from ballast tank level switch not detected.	Stop the pump and check level switch and related wiring to control panel.

*) Ref. instruction for maintenance and repair for actual pump.

Note!
Evaluate if changed parts as sleeves, mechanical seals etc. are possible to recondition.
Send these parts to Framo Service Station and ask for an evaluation

LOG FORM FOR LIQUID FILLED COFFERDAM ON FRAMO SUBMERGED BALLAST PUMPS

VESSEL NAME: _____ TYPE OF LIQUID USED IN COFFERDAM: _____

Header tank level(H) to be measured in mm above low level mark on sight glass. 1 mm on sight glass is equivalent to 31 ml volume.

Pump location (P or S)	Date	Header tank level (H) (mm)	Ballast water temperature (°C)	Hydraulic oil temperature (°C)	Ambient temperature (°C)	Hours of operation since last control (h)	Leakage rate (ml/h)*	Comments / Remarks (Action taken)	Signature / Date

*Leakage rate (to be calculated) = $\frac{(H_2 - H_1)x31}{h}$ [ml/h] Also ref. chapter 2.2, “Monitoring of cofferdam level”