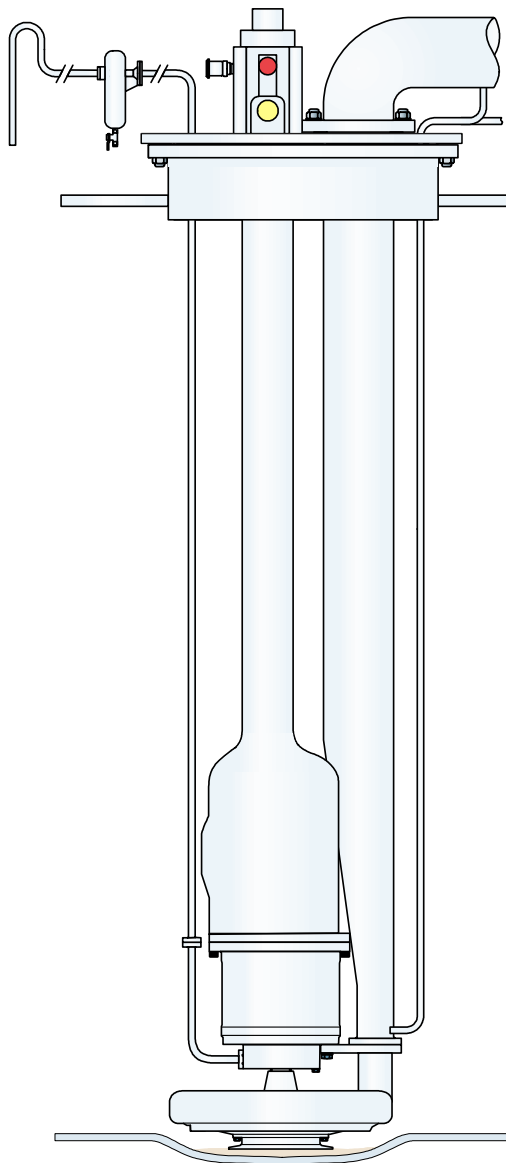


1000-0121-4

Date/Sign.: 08Jun98/AGAA



OPERATION MANUAL



FRAMO
Cargo Pumps
SD100
SD125
SD150
SD200
SD250
SD300
SD350



OPERATION MANUAL FRAMO CARGO PUMPS

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Ref. to associated instructions
1000-0102-4: Purging Routine for cargo pumps with liquid filled cofferdam
1000-0109-4: Interchange of hydraulic control valve
1375-0027-4: Service manual for Speed Torque Controller (STC)

1.0 GENERAL DESCRIPTION

The Framo cargo pump is a single stage centrifugal, hydraulically driven, submerged cargo pump in stainless steel.

The pump consists of three main parts:

- Top cover plate
- Pipe stack
- Pump unit.

1.1 Top cover plate

The cargo pump is supported by a deck trunk welded to the deck. All the connections are on the top cover plate, to which a hydraulic control valve is also mounted for remote and local operation of the cargo pump. This specially developed control valve regulates hydraulic pressure and oil flow to the motor according to the given discharge situation.

The pressure gauge indicates the oil pressure to the motor.

1.2 Pipestack

The pipestack connect the pump unit to the top cover plate.

1.3 Pump unit

The pump unit is mounted to the pipestack/casing with the compact hydraulic motor located inside the casing. The motor is surrounded by low pressure hydraulic oil. A short, independent shaft, supported by bearings lubricated by hydraulic oil, is connected to a single-stage, end-suction centrifugal pump. The hydraulic section is surrounded by a cofferdam that completely segregates the hydraulic oil from the cargo, with a manual seal-condition monitoring system.

This seal arrangement consists of a mechanical oil seal, single cofferdam lip seal and a double cargo lip seal. The cargo seal is exposed only to static head from the cargo.

Any leakagees in the cofferdam chamber will, by purging with compressed air or nitrogen, be blown through the cofferdam check pipe and collected in the exhaust trap.

A backstop unit is fitted to the shaft, enabling cargo to be loaded through the pump.

Wear rings are fitted between the impeller and the volute casing.



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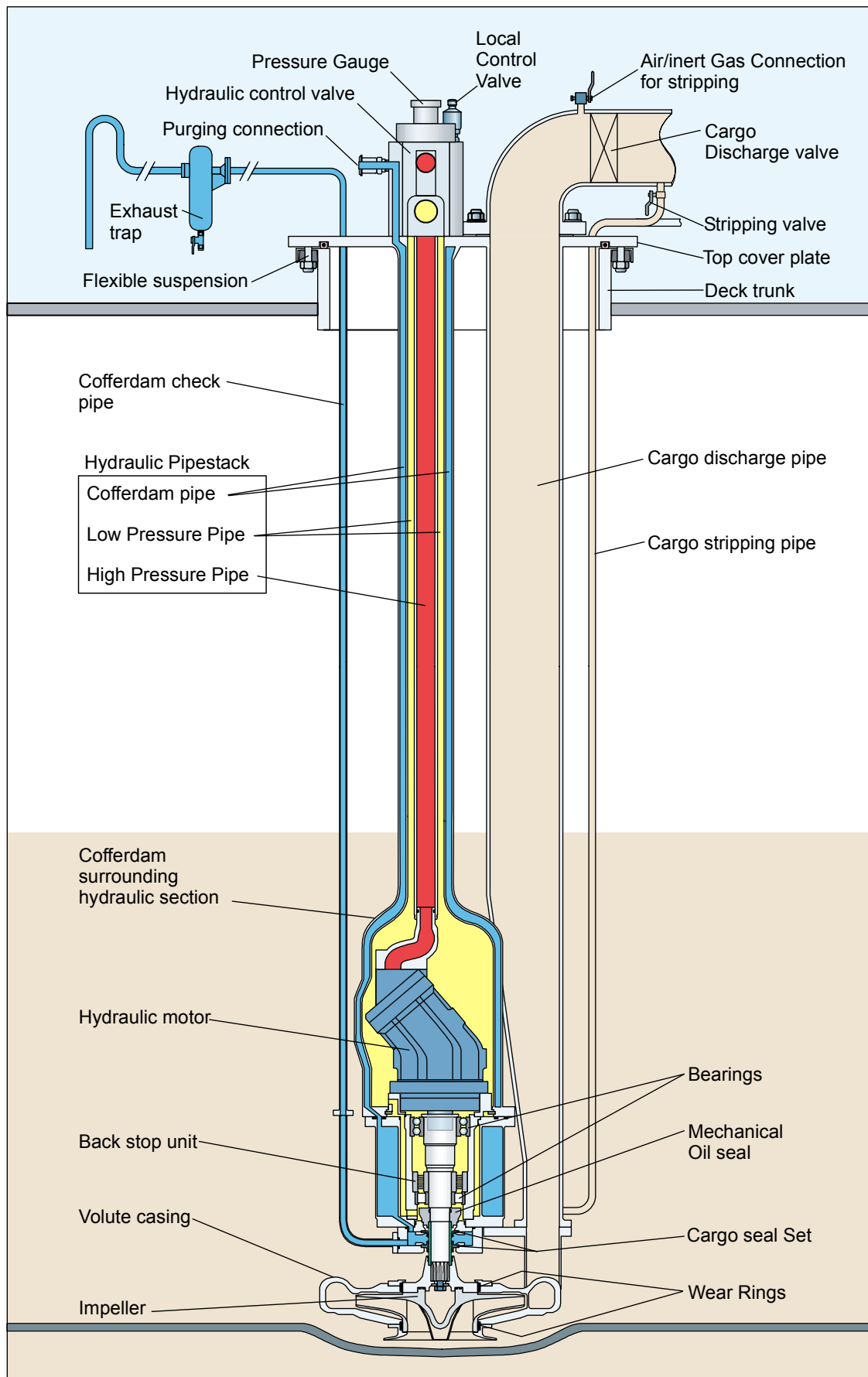


Fig. 1

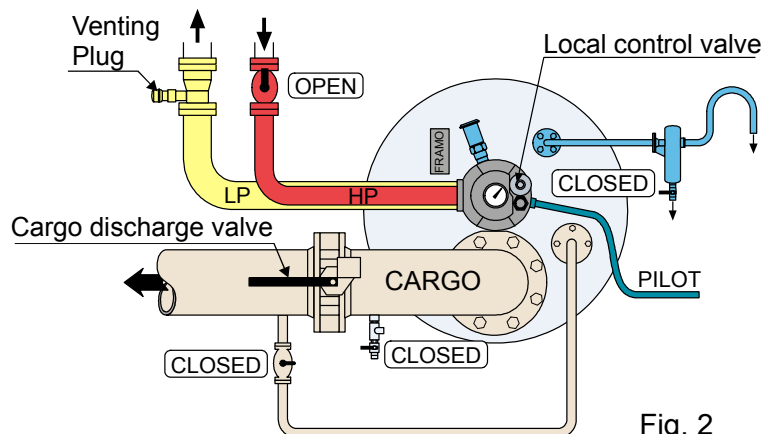


2.0 OPERATING INFORMATION

2.1 Discharging

Note that the ball valve at the hydraulic high pressure pipe should be closed only when carrying out service work on the pump.

Always purge the cofferdam before and after using the cargo pump.



Note!

The hydraulic system pressure should be maximum 15 bar above the highest consumer pressure in order to minimise energy consumption, noise level, wear and tear.

STARTING OF PUMP

a) Remote controlled:

- The local control valve at top cover plate must be in closed position.
- Close the cargo discharge valve.
- Increase the hydraulic system pressure to approximately 150 bar.
- Start the cargo pump from cargo control panel, and let it run with hydraulic pressure 40-50 bar for minimum 1 minute.
- Raise the hydraulic pressure until the cargo discharge pressure is above cargo manifold pressure.
- Open cargo discharge valve.
- Raise the hydraulic pressure until required discharge pressure or capacity is achieved.
- When the cargo tank is empty the hydraulic motor pressure will fall to 50-100 bar. Close cargo discharge valve and stop the pump from cargo control panel(handle in minimum position).

b) Local controlled:

- Open local control valve (by turning counter clockwise).
- Close remote control valve from cargo control panel (handle in maximum position).
- Close the cargo discharge valve.
- Increase the hydraulic system pressure to approximately 150 bar.
- Start the cargo pump by closing the local control valve and let it run with hydraulic pressure 40-50 bar for minimum 1 minute.
- Raise the hydraulic pressure until the cargo discharge pressure is above cargo manifold pressure.
- Open cargo discharge valve.
- Raise the hydraulic pressure until required discharge pressure or capacity is achieved.
- When the cargo tank is empty the hydraulic pressure will fall to 50-100 bar. Close cargo discharge valve and stop the pump by opening the local control valve.
- Open the remote control valve from cargo control panel (handle in minimum position).



PARALLEL PUMPING

- Start hydraulic system and the first cargo pump as described in starting of pump.
 - Open the cargo discharge valve for the running cargo pump.
 - Start the next pump(s) following the same procedure. Ensure that enough hydraulic power is available.
 - Increase the hydraulic pressure (pump speed) until required discharge pressure or capacity is achieved. If discharge pressure or capacity does not rise, it is of no use to start more cargo pumps.
 - Pump capacity should be controlled by the pump hydraulic pressure, not by throttling the cargo discharge valve or any other valve in cargo piping system.
- This can be achieved easily by keeping all cargo pump controllers in max. position and regulate the main hydraulic system pressure until required discharge rate is achieved. If necessary each cargo pump must be balanced individually by decreasing/increasing cargo pump hydraulic pressure.
- Generally we recommend to run *as many pumps in parallel as practical, at a reduced hydraulic pressure, rather than just a few pumps at maximum hydraulic pressure.*
 - At the end of the discharge, the cargo pump may run dry or suck air through vortex, which will be indicated by vibration in pump and hunting in the hydraulic pressure. This can be avoided by reducing the cargo pump hydraulic pressure through this period.

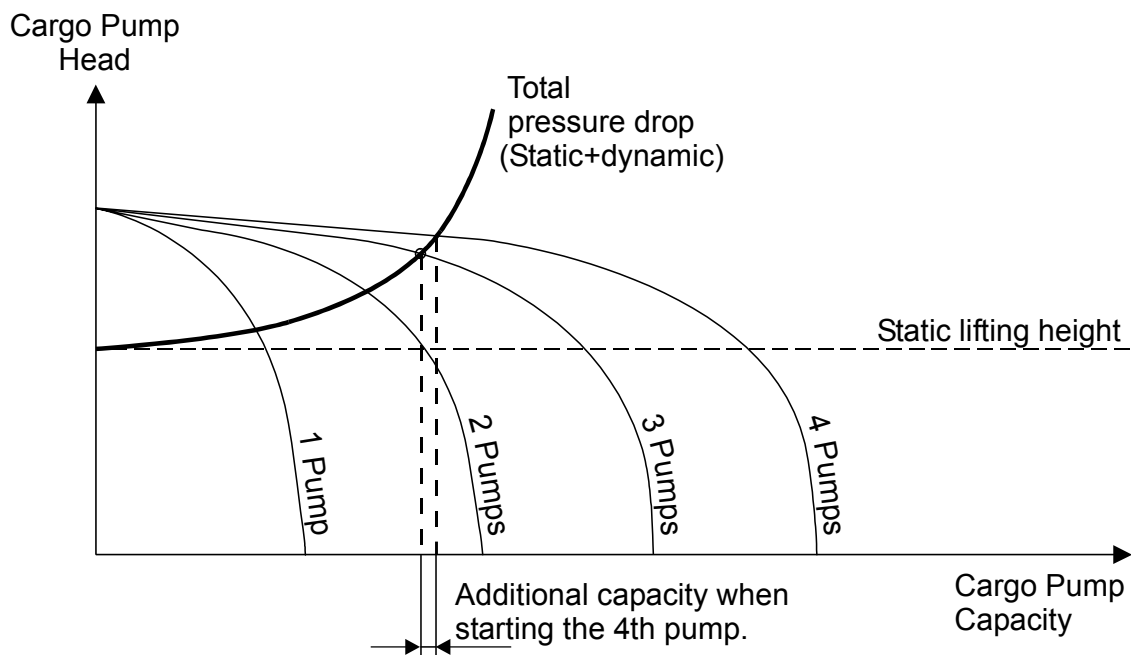
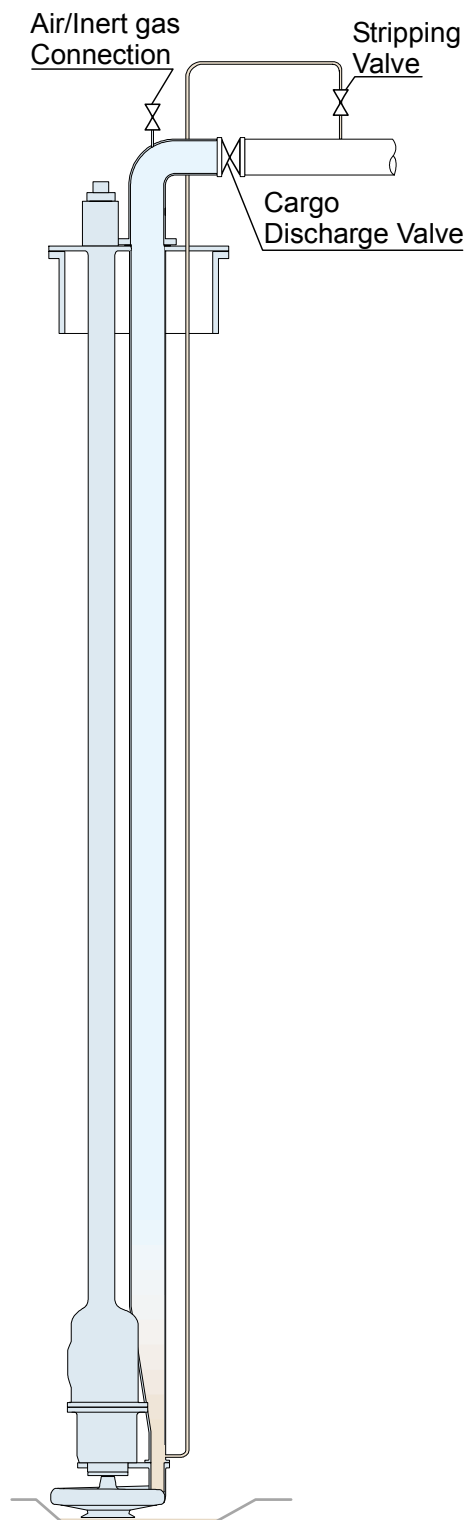


Fig. 3 Performance curve for cargo pumps running in parallel

This example indicates that the benefit by starting the 4th pump is very low. Therefore it is not recommended to start this pump.



2.2 Stripping

- Reduce the cargo pump hydraulic pressure to approx. 100* bar, at the end of discharging, or when the pump starts to lose suction, indicated by vibrations and hydraulic pressure pulsation.
- Empty the cargo tank at reduced hydraulic pressure (100 bar). Throttling of cargo valve may improve the stripping result.
- When the cargo tank is empty, close the cargo valve and stop the pump.
- Purge cargo deck line. Close manifold valve and relieve deck line pressure to minimise back-pressure during stripping of cargo pump.
- Start the pump locally and increase pressure to approximately 80 - 100 bar.
- Open stripping valve.
- Connect the air/inert-gas supply to the cargo pipe and adjust air/inert gas pressure to 1 bar + static height, normally 2-4 bar.
- Strip until the pipestack is empty. Recognised by frequent speed variations of pump. The stripping time can be reduced by closing air/inert gas supply during high speed periods.
- Close stripping valve and stop the cargo pump.
- Repeat the stripping sequence if necessary (ref. fig.5).
- Stop stripping, and stop the cargo pump.
- Purge the pump's cofferdam.

*Note: * Pump speed (hydraulic pressure) depends on discharge head, specific gravity and viscosity of the cargo and differs from ship to ship. Ideal speed must therefore be based upon experience onboard.*

Fig. 4



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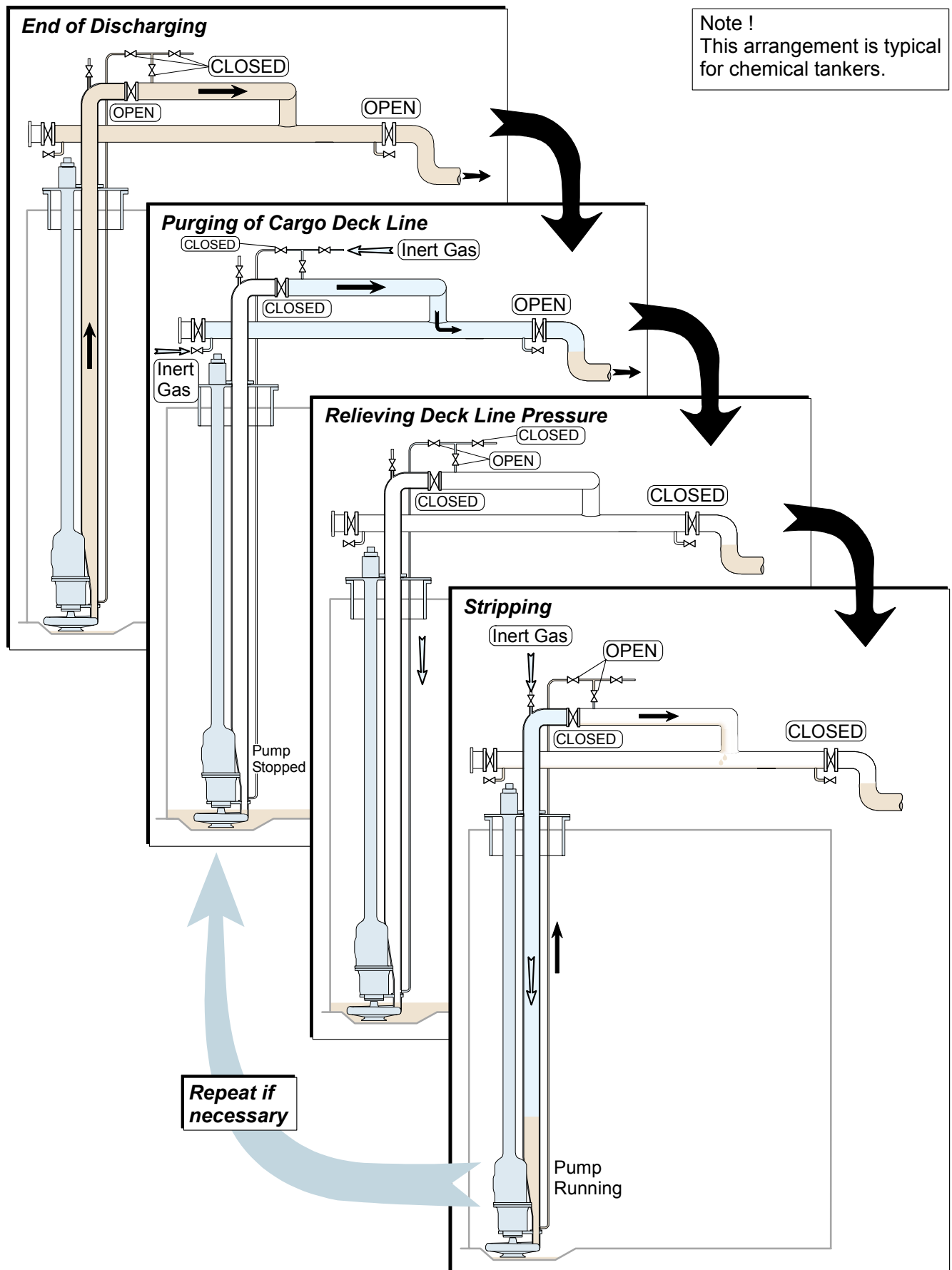
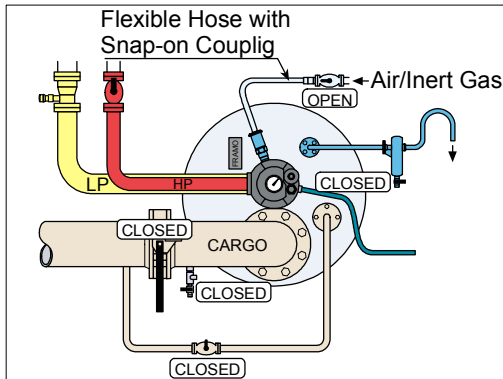


Fig. 5

2.3 Purging of cofferdam

Purging of submerged cargo pumps with «dry» cofferdam. For submerged cargo pumps on oil production and storage vessels, refer to instruction 1000-102-4 for cargo pumps with liquid filled cofferdam.



WHY PURGE THE COFFERDAM?

- Leakage detection
- Condition monitoring of the shaft seal system
- Avoid that leakages are blocking the cofferdam

HOW TO PURGE THE COFFERDAM

CAUTION:

Venting gas and liquid may be dangerous.

Use safety gear to avoid contact with drain from exhaust trap and venting line.

Preparation:

- Place a suitable container underneath the exhaust trap to collect the leakage.
- Check that drain valve and bottom of exhaust trap is not clogged by residue after last purging operation. Stick up with a pin if necessary. Close drain valve.
- Check that relief valve on hydraulic control valve is open. For technical details, refer to service manual for the valve.
- Connect air or inert gas supply to the snap-on coupling on the purging connection. (Maximum supply pressure is 7 bar.)
- Drain the supply line for condensed water.

Purging:

- Open valve on air/inert gas supply line
- Check that air/inert gas is coming out of the exhaust trap vent line. (Cofferdam is open)
- The relief valve is set to an opening pressure of 3 - 3.5 bar, so a small leakage here is normal.
- Purge cofferdam in several sequences if required
- Drain exhaust trap between each sequence
- Disconnect air/inert gas supply
- Close exhaust trap drain valve
- Measure the amount of leakage, -evaluate and log the purging result.

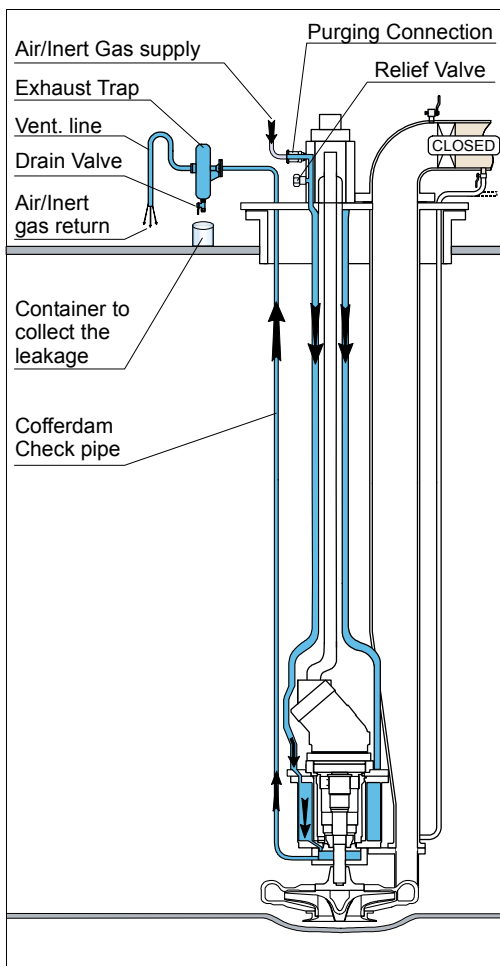


Fig. 6



EVALUATION OF THE PURGING RESULT

Cargo leakage

Cargo in the cofferdam can come from shaft seals, flange face seals in pipestack/pumphead or damage (cracks) on the pipestack/pumphead. A small leakage rate over the shaft seals up to about 0.5 l/day during pump operation is normal, and replacement of seals should not be necessary with this leakage rate. For short periods of time, higher leakage peaks can occur. The leakage rate is also depending on the type of cargo. Some cargoes like naphtha, condensate etc. penetrate the shaft seals more easily than lub. oils, vegetable oils and other viscous cargoes.

If the leakage rate is up to about 2 litres/day, the pump must be purged a couple of times daily, and inspected as soon as possible to find the reason for the leakage.

Intensify the purging if the leakage rate is increasing above acceptable level. If this is not keeping the leakage under control, do not operate the pump, use the portable pump to discharge the cargo.

The development of a cargo leakage can be followed if purging is done according to specified intervals. Thereby maintenance work can be planned, and unexpected shut down due to leakage can be avoided.

Hydraulic oil leakage

Hydraulic oil in the cofferdam can come from shaft seals, flange face seals in pipestack/pumphead or damage (cracks) on the pipestack/pumphead.

A small leakage rate into the cofferdam up to about 10 ml/h (0.25 l/day) from the mechanical oil seal or lip seal during pump operation is normal. For short periods of time, higher leakage peaks can occur.

If the leakage rate is increasing above acceptable level, the pump must be purged a couple of times daily, and inspected as soon as possible to find the reason for the leakage. Intensify the purging if the leakage rate is increasing above acceptable level. If this is not keeping the leakage under control, close the hydraulic service valve. Do not operate the pump, use the portable pump to discharge the cargo.

PRECAUTIONS TO BE TAKEN WHEN HANDLING SPECIAL TYPES OF CARGO

The main rule is to have the cofferdam clean, dry and vented to atmosphere through the exhaust trap vent line, in order to detect leakages easily. However, when handling certain groups of cargoes it may be an advantage to fill the cofferdam with liquid to improve the seal life-time and to avoid solidifying cargo blocking the cofferdam. Recommended type of liquid in the cofferdam for some groups of cargoes is given below.

This is a general advice, as the ship's staff has to learn by experience which type of liquid gives the best result for the great number of different types of cargoes.

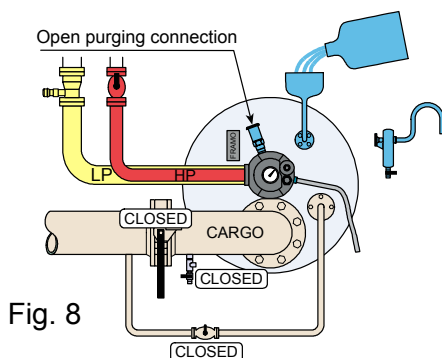


Fig. 8

To fill liquid in the cofferdam, disconnect the exhaust trap piping from the pump top plate. Using a suitable adapter, fill the liquid through the cofferdam check pipe. Open the purging connection to ventilate the cofferdam during filling. (Connect a open female coupling or similar).

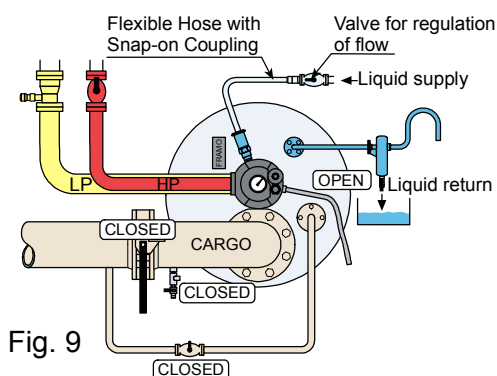


Fig. 9

A circulation of liquid through the cofferdam can be arranged in the following way:

- Connect liquid supply to the purging connection. The supply line must also be equipped with a valve to regulate the liquid flow.
- Open drain valve on the exhaust trap, and collect the return liquid here.

Acid cargoes

After discharging and purging is finished, it may be an advantage to circulate fresh water through the cofferdam to remove all residue after a leakage.

Polymerising cargoes. (TDI, MDI)

Fill cofferdam with 5-10 litres of DOP to avoid blocking of cofferdam.

Crystallizing cargoes (molasses, etc.)

Fill cofferdam with 5-10 litres of fresh water. The cofferdam may also be filled completely and arranged with a small water circulation.

Phenol, caustic etc.

A circulation of hot water through the cofferdam can avoid clogging.

(But remember some of these types of cargoes are very dangerous, poisonous).

Heated oil products (fuel oil, crude oil)

Fill cofferdam with approx. 5-10 litre of diesel oil/white spirit to keep any leakage into cofferdam in liquid form. This is especially important after stripping and during tank cleaning.

Note!

When filling or circulating liquid in the cofferdam, it is important that the hydraulic oil return pressure always is higher than the pressure will be in the liquid filled cofferdam. This is especially important on hydraulic systems with non-pressurised return line.



2.4 Cleaning of pump/tank washing

For Viscous / Solidifying cargoes.

During tank washing the pump should be run at approximately the same flow rate as cleaning water / liquid supply.

Halfway the tank washing time stop the pump and let the cleaning water level in tank raise to 5-10 cm.

Operate pump at full speed for 3-5 minutes in order to get a good cleaning of wear rings, seal rings and pumps parts.

For cleaning of stripping pipe, open the stripping valve and run the pump at full speed for 2-3 min.

After this flushing, open the cargo discharge valve and run the pump at full speed until tank is empty.

After this flushing, the cargo valve is opened and the pump runs at full speed until tank is empty. In this manner a good cleaning of pump and piping is achieved. Cleaning water left in pump's cargo pipe is to be stripped as described under Chapter 2.2.

For Corrosive cargoes.

Tanks to be cleaned should be flushed with a large amount of cleaning water at the shortest possible time to neutralise the remaining cargo and to expose the pump to "highly corrosive cargo concentrations" for the shortest period as possible.

After tank flushing the same cleaning procedure as for viscous / solidifying cargoes should be followed.

CAUTION:

Cleaning water must never remain in the tank - this may result in severe corrosion of tank and pump.

Note!

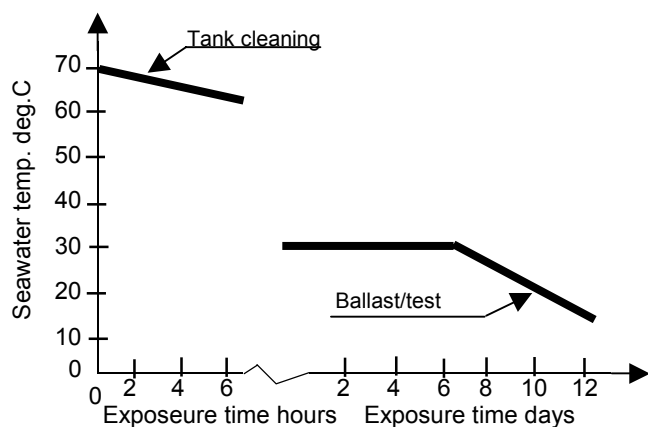
If steam is used to clean the pump, the steaming out period must not exceed 10 minutes, to avoid damage of seals or hydraulic motor. Always purge the cofferdam before tank washing with steam.

Note!

If using sea water or brackish water for tank cleaning, see chapter 2.5.

2.5 Precautions if using cargo pumps in sea water

Recommended maximum time/temperatures



Seawater for ballast and testing.

- When possible, take fresh seawater in open sea and avoid contaminated harbour water.
- Empty the tanks as soon as possible when the ballast is no longer required or when the testing is finished.
- Flush the pump with fresh water.

Seawater tank cleaning. (Continuous circulation)

- Keep the temperature below 60°C. Temperature up to 70°C can be accepted for a limited time.
- Keep the cleaning water circulating.
- Avoid pH values below 7. Avoid chlorinated water. Check carefully if the ship has been carrying acids.
- Flush with fresh water after seawater cleaning.



2.6 Loading through pump

The pump is equipped with a back stop unit enabling the pump to be used as a drop line (see fig. 11).

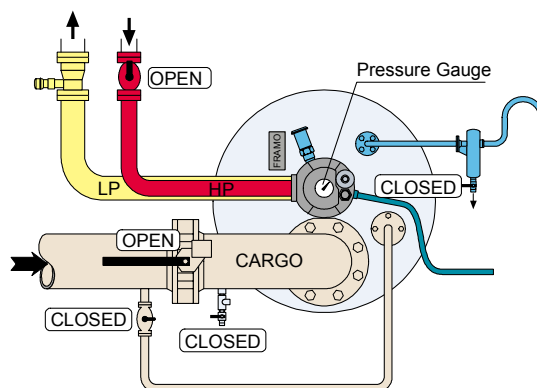


Fig. 10

Procedure for loading through the cargo pump

- * Take cargo sample upstream of manifold valve.

Open manifold valve partly, to fill cargo line on deck.

- * Take sample upstream of cargo pump discharge valve.

Open cargo pump discharge valve (ref. fig.10). Keep manifold valve in throttle position until the 1-foot sample is taken.

Open manifold valve slowly until required pressure/capacity is reached.

Note: *Maximum acceptable loading pressure is 8 bar at the pump top cover plate.*

If a separate drop line is installed, start loading through the pump only until the 1-foot sample is taken, and the cargo tank level is above the drop line outlet.

Then open valve to drop line and continue loading through both the pump and the drop line.

Note: * *For sampling procedures, ref. charterer's requirements.*

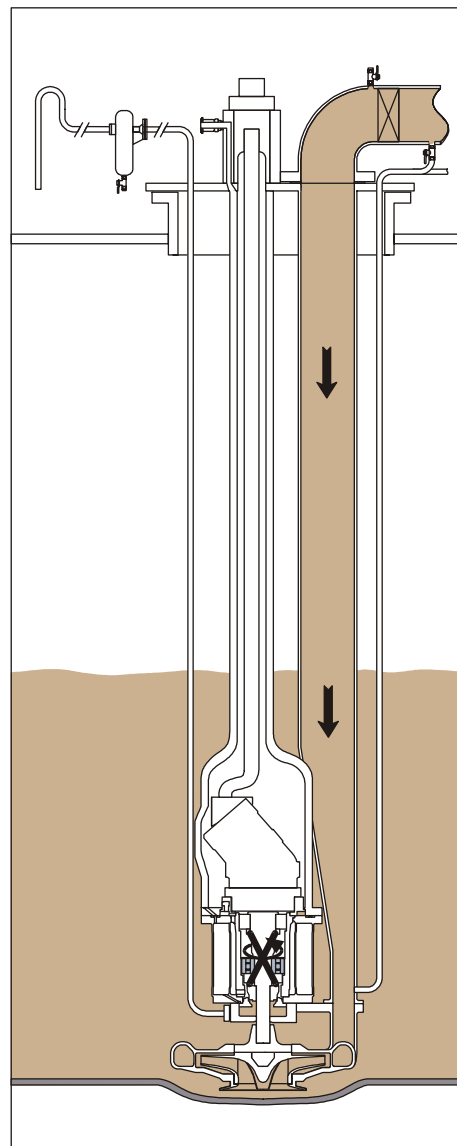


Fig.11



3.0 MAINTENANCE INFORMATION

Prior to entering a cargo 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 cargo tank before the tank is confirmed gas free. Before doing service on pump, always close and lock the hydraulic pressure inlet valve and purge the cofferdam. Purge cofferdam according to Framo Purging Routine (ref. chapt.2.3).

Caution: Venting gas and liquid may be dangerous.

To prevent skidding and minimize the risk of fire it is important to remove oil spill during maintenance and servicing work. The operator should be confident that all flange connections are in satisfactory condition so as to prevent hydraulic oil and cargo spills.

4.0 TROUBLE SHOOTING

Warning: To prevent damage from dangerous cargoes, take necessary precautions, wear safety gear and avoid contact with spray/gases.

Symptom:	Possible reason:	Remedy: *)
The cargo pump will not start. The hydraulic control valve is checked according to the service manual for the valve and found in good order.	Pump impeller stuck.	Empty the tank by means of a portable pump. After tank cleaning and gas freeing dismantle the impeller for inspection.
The pump is vibrating heavily during discharge, and it is <i>not</i> due to variations caused by the hydraulic control valve.	Rotating parts out of balance. (Impurities stuck in the impeller). Worn out hydr. motor. Loose support ring at pumphead.	Empty the tank and check impeller. Change/repair hydr. motor. Contact FM Services. Tighten up all bolts for support ring.
The capacity is too low.	A rag (cloth) in the impeller. Worn out wear-rings. Faulty hydraulic control valve. Leaking pilot line	Dismantle the pump impeller for inspection. Dismantle the pump, check, eventually renew the wear rings. a) Test run pump with another hydraulic control valve with same max. Flow setting, see Interchange of hydraulic control valve. b) See trouble shooting in service manual for hydraulic control valve.

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



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Symptom:	Possible reason:	Remedy: *)
Cargo-stripping insufficient.	Wrong air/nitrogen pressure	Check stripping procedure
Noise, heat generation when loading through pump. Vacuum in LP-pipe detected by opening venting plug on the non-return valve. (Ref. fig. 2).	Damaged / worn out backstop unit.	Change backstop unit. Contact FM Services.
No air/inert gas is coming out of the exhaust trap/venting pipe when purging.	Blocked cofferdam system Blocked check pipe Blocked pipestack/pumphead.	Check the exhaust trap and piping for blockage. Open if possible. If the blockage is not possible to open, do not operate the pump. Use the portable pump to discharge the cargo. When the tank is empty/gasfree, disconnect the cofferdam check pipe from the pump head. By purging, the blockage will be detected either in the pipestack/pumphead or in the check pipe. Blocked check pipe: - Use steam or solvent from top plate, or stick up the pipe using a steel chord or similar. Pressurize the pipe from top plate to blow out the blockage. Blocked pipestack/pumphead: - Remove and clean lower seal house. - Stick up the hole leading into the pump-head cofferdam with a pin. - Use steam, solvent etc. to open up the blockage. - Continue dismantling until blockage is found. <i>Note! Pressure test pump after assembly.</i>

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



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Symptom:	Possible reason:	Remedy: *)
Cargo leakage in cofferdam	Worn out cargo seals Cracks/wear on ceramic sleeve Leaking pipestack/pumphead seals Cracks in pipes Combined purging /stripping valve leaking * * Combined valve only on earlier pump models.	How to find the leakage? Pressure test the cofferdam. Soap wash to localize the leakage. Never start any dismantling before you know if/where you have a leakage. Change cargo seal set. Change ceramic sleeve Control seal elements. Change damaged seals. Check condition of seal grooves (pitting, scratches etc.) and repair if necessary Contact FM Services A/S Control seal elements. Change damaged seals. Check condition of seal grooves (pitting, scratches etc.) and repair if necessary.
Hydraulic oil in cofferdam	Worn out shaft seal Leaking pipestack/pumphead seals	Pressure test the hydraulic return line, and check for leakage's at the shaft seal or at other seals. Change mechanical oil seal or lip seal. Control seal elements. Change damaged seals. Check condition of seal grooves (pitting, scratches etc.) and repair if necessary.

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

Note!

Evaluate if changed parts as sleeves, mechanical seals etc. are possible to recondition.

Keep these parts in stock until next visit by a FRAMO representative, and ask for an evaluation.