HYDRA CONSULT INTERNATIONAL

INSPECTION REPORT

System Inspected:	FRAMO Cargo and Ballast pumping System

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To verify the condition of the FRAMO Cargo Pumping Plant, this report was requested by

JNE MARINE PARTNER

to carry out inspection of the plant, according to approved quotation number **PO no: R12041**

Inspection was carried out by:	**Santos, Henrique M. F.**
During the period of:	16TH JULY 2023

1. Report comments and recommendations

The FRAMO Cargo and ballast pumping system Inspection and report was thought to be an important tool for helping the vessels technical department and responsible SI, in programing any activities at the inspected system.
The inspection is according and follows the manufacturer FRAMO indications, instructions, information's, and recommendations made and at Service bulletins, Manuals, Service letters and FRAMO trainings. The Inspection Engineer have FRAMO pre-docking and annual inspections course/certificate.

The present Inspection, at the FRAMO pumping plant onboard the vessel was carried out during vessel stay at Chalkis Shipyard, in Greece.
The vessel was acquired by a short time ago and still have not done any operation. Condition of the FRAMO cargo and ballast pumping system during operations is unknown. This FRAMO system Inspection and the related tests done, are very important in this situation, because will help vessel SI and owner in taking the appropriated actions to solve any problem and improve the FRAMO system.

We recommended that some off equipment's mentioned bellow, in the report, at chapters, in red color column/dark grey, are repaired or replaced as soon as possible, because failure of those parts can cause system or equipment breakdown or stops. Other equipment's repairs, shown in yellow / light grey color at tables, can be done when more convenient time is, like during one of the IWS or dry-docking periods, but must be monitored carefully and regularly.
Bellow sees summarized recommendations from chapters:

Hydraulic Power Unit (HPU room) and auxiliary equipment / ref.chapter **2.1**

The HPU room and related equipment are in normal condition. The HPU area is well cleaned and maintained.

Oil cleanliness and damaged cables are the main issues here.

Due to **hydraulic oil contamination with particles**, the main filter is clogged and alarm for main filter dirty is on. The oil analyses made during last years do show that oil was contaminated. The history of oil contamination started in 01.09.2022 (with iso. 25/21/14) and never got better. Last oil analyses from 03/04/2023 still show ISO 21/17/10.

It's of major importance that oil is cleaned as soon as possible. This can be done by replacing all filters and keep system running with minimum 2 PPKS to get enough flow and at having 100bars system pressure. 24hours running should bring most particles, that are loose in the hydraulic system to filter. If this is not done soon, parts like system pressure control valve, relief valves, directional valves, sensors, calibrated orifices, and the pumps from PPKS will not working properly, or will become damage, causing failure and system instability. A kind of particles snowball effect will take place can ending up in complete system breakdown/ stop (one particle will create several and lead to much more, and so on).

After the system is cleaned, **new oil sample must be taken** and analyzed. If value still high system should be flushed a few more times and filters replaced again. It's important to have installed filters with good filtration ratio.

Other very important issue that must be solved ASAP it is related to **damaged transmission cables**. Main return valve has no cable and level transmitter sensor cable is broken at M12 connection plug. This valve is connected to the system safety alarms and if alarm show up, means a problem, and it gives shut down of entire FRAMO system. To be able to continue using the system, crew had to by-pass the alarm (made a jumper). This is very unsafe and if by any chance the valve closes, there will be no alarm and system return line and return side components will blow up/get damaged. Crew should remove the jumper and use the emergency override mode 1 (controlled valve return alarm by-pass) instead. We explained to crew how to do it. When new cable available, remove the jumper – if still there- and reset the system.

The oil level transmitter (LT1) cable is broken at M12 connection plug. It's still connected but hanging loose inside, sometimes giving Low Low-level alarm, and consequently shutting down the system. When alarm is showing on, we did instructed crew how to do the override at Emergency panel at override mode 1, inside the CCR cabinet. Cable must be replaced as soon as possible to avoid interference with operation.

Besides the oil contamination problem and cables, during the inspection, we also observed the following:

- Keep monitoring the **magnetic chip detectors** every operation.
- **Hydraulic oil cooler** has no record of internal cleaning and anodes replacement. When possible clean, test and replace anodes if required.
- **Cummins diesel engines** with leakages. Cause of leakages can be due to gaskets, seals too dry or deformed. During next Cummins engine maintenance, repair the leakages.
- **Air filter** from the auxiliary tank is damaged and very dirty. Replace when possible.

It's recommended to **take some action on these** above items also, to improve system operationality and bring the condition of the system to normal.

Cargo (COP) and SLOP hydraulic driven offloading pumps / ref.chapters 2.3 and 2.3.1

The Cargo and SLOP pumps top plates and control valves are in normal conditions. Good preservation work, that should be an ongoing process,

Purging routines did show leakages at pumps cofferdams and our tests done during inspection showed that **cargo pump from tank. 1P, 3P and 4P S have cargo leak**. The one from COP **2P have an oil leak.** Is recommended having the pumps pressure tested and repair according to findings.

The performance test showed that 6 pumps are still operating within expected parameters, normal performance, but other **6 have differential pressure above limit,** what means that pumps performance is bellow expected and there is much clearance at wear rings. Its recommended to have the wear rings from 2P, 2S, 3S, 6p, 6S and SLOP SB replaced , when possible. Too much clearance at wear rings consequently makes stripping difficult and too much cargo stay inside the tank.

General comment:
Regular/yearly inspection of the FRAMO system is important to improve FRAMO system and keep it operating well. Having an annual inspection made and following the recommendations and do the repairs necessary, described at the inspection report, will help to maintain the system in good health, operating well and free of troubles.
HS SHIP REPAIRS/Hydra Consult have engineers to attend whenever required worldwide to help our customers to improve the quality and lifetime of vessels cargo pumping system.
Consult us for the Inspection programs we can offer.

2. Evaluation of the Inspected system (FRAMO cargo and ballast pumping system)

2.1. Hydraulic power unit(s) and auxiliary equipment

Hydraulic system type:	FRAMO A4V /CLOSED system
Hydraulic pump type:	04 x BOSCH REXROTH A4V SO 500DP / 30R-PPB25N00
Type of prime mover:	02 x ELETRIC MOTOR ABB M2CA 02 x CUMMINS KTA diesel engine
Location:	HPU room, Engine room

HPU (Hydraulic power unit)	Normal condition	Acceptable condition	Poor condition
Pump Shaft seal condition	X		
Hydraulic high-pressure hoses	X		
Hydraulic suction hoses/pipes	X		
Hydraulic drain hoses	X		
Flexible couplings	X		
Flexible dampers for electric motors	X		
Suction / return valves		Small leakages at suction valve	
Micro switches	X		
Transmitters and sensors	X		
Control / relief valves	X		
Piping / pipe clamps	X		
Shielding hydraulic flanges	NORMAL CONDITION		
Any leakages noted	FEW		
System pressure control valve	WORKING NORMALLY		
System pressure control valve filter	GREEN INDICATION- NORMAL CONDITION		
Electric motor(s) condition	NORMAL CONDITION, REPORTED WORKING WELL		
Electric motors bearings/ shaft seal replacement	No record		
Last tests (megger/insolation)	No report		
Diesel engine condition Engine type: CUMMINS KTA19	Reported working well, but need revision. With leakages		

Normal: Term is used when the equipment /parts is/are complete, clean and without broken or missing parts.
Acceptable: Term is used when the equipment /parts is/are complete, however some oxidation, materials wear is observed.
Poor: Term is used when equipment/parts are missing, damaged, leaking above limit

Comments:

The HPU room and related equipment are in normal condition and cleanliness from HPU area is good. Only subject to take in consideration is the small leakages at suction valves. This must be monitored and if increase, consider replacing the valves seals (can be seal kit for valves instead of expensive complete valve).

The diesel engines are showing some leakages. It's recommended to have some maintenance on it.

Leakages at Cummins

AUXILIAR UNIT (hydraulic service tank, main filter, and hydraulic oil cooler)	Normal Condition	Acceptable condition	Poor condition
Hydraulic oil level in the service tank	X – 60%		
Hydraulic oil service tank condition	X		
Draining of water in the service tank	X		
Hydraulic service tank *air* filter			DAMAGED AND CLOGGED
Hydraulic oil cooler Type: SPERRE DPK408-1800		To be inspected	
Hydraulic oil cooler inlet valve (1 piece)	X		
Hydraulic oil cooler outlet valves (1 piece)	X		
Hydraulic oil cooler - last inspection record: no records		X	
Main Hydraulic oil filter		Dirty filter alarm is on	
Main Hydraulic oil filter valves	X		
Filter element replaced on:	2022		
Last oil sampling results water content (PPM)		SEE COMMENTS	
Last oil sampling results oil cleanliness (ISO4406 code 18/16/12)		SEE COMMENTS	

Hydraulic oil sample valve / location	At main return after cooler		
Jockey pumps/ Feed pumps Type: Leistritz	X		
Jockey pumps electric motors: ABB M2AA-090-L2	X		

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Comments:

The last hydraulic oil analyses sampling results report we had access indicate that oil is with quantity of particles above recommended.

Due to oil contamination is very important to make a new oil sample. Result will indicate what are the actions to be taken in future.

Air filter from auxiliar unit

Auxiliary unit

Hydraulic Oil TRANSFER UNIT and related tanks	Normal Condition	Acceptable condition	Poor condition
Hydraulic oil transfer unit Type: KRAL CKC 15.BAA.000480	X		
Filter element Type: PALL UltiPor lll	X		
Hydraulic hoses	X		

Transfer pump electric motor Type: ABB M2VA 80	X		
Hydraulic oil level in the storage tank	X		
Draining of water in the storage tank	0 - NORMAL		
Air vent pipe's location	Inside engine room		

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Comments:
Normal condition. No actions required for now.

2.1.1. Running hours and Magnetic chips detector inspection

Power Pack no.	Results for FRAMO systems doc.				Running Hours	Hydraulic pump serial no.	Remarks
	Zero	Low	Medium	High			
1		X			-	-	ELECTROMAGNETIC CHIP DETECTOR TYPE
2		X			-	-	ELECTROMAGNETIC CHIP DETECTOR TYPE
3		X			-	-	ELECTROMAGNETIC CHIP DETECTOR TYPE
4		X			-	-	ELECTROMAGNETIC CHIP DETECTOR TYPE
FEED pump´s							

Low: (normal)Term is used when *the* quantity of particles collected is not relevant.
Medium (acceptable) Term is used when the quantity of particles collected are within limits, however some materials wear is observed
High (poor): Term is used when equipment/parts/ particles are above recommended limit. Contact manufacturer or maintenance company for details and actions

Comments:
Magnetic chip detectors to be inspected every 3 month and record of inspection to be part of vessel Programed maintenance plan.

2.1.2. Relief valves control of adjustments

Valve	Before	After	Comments
Back up valve (main relief valve/ P1 +25bars)	--	--	
System pressure relief valve (at min.flow / P1 +20bars)	--	--	
Main return pressure control valve / feed pressure (Open system = 3 or 2 bars) (Close system = 6bars)	6 bars	*6 bars*	*No adjustment required here*
TO BE ADJUSTED WHEN IS POSSIBLE. PREFERABLE AFTER DRY-DOCKING PERIODS			
Equipment(s) used in test/control: Digital manometer KELLER type LEO2-Ei / 300bar/81191.1 / S.N.036256			

2.1.3. HPU power-packs control of adjustment and thermal check

Power Pack. no	Minimum displacement (min. mech. Pressure) A4V SO = 35 bars +/-5		Minimum pressure (hydraulic min. pressure) A4V SO = 55bars		Minimum to maximum flow speed adjustment A4VSO= 0,5- 1 sec	
	Before	After	Before	After	Before	After
1		35		55		0,7sec
2		35		55		0.7 sec
3		35		55		0,7 sec

TO BE ADJUSTED WHEN IS POSSIBLE. PREFERABLE AFTER DRY-DOCKING PERIODS

A4V pumps Thermal imaging check.

Hydraulic oil temperature during readings: 46º TO 48ºC
Equipment used : FLIR Thermal Camera CATS62/vers.3.0.44 – serial 20413585

PPK.2

PPK.3

COMMENTS:
PPks have temperatures within the expected values and difference between inlet, outlet and drain are normal.
Feed pump has a normal temperature. No actions required.

It's important to keep monitoring the pumps debris/chip detectors and if any pump start showing high particles content at magnetic, consider repairing it.
Pressure manifold and cooler temperatures are normal, considering the hydraulic oil temperature and room temperature.

2.2. Control panels, remote-control valves and related equipment

Equipment / Location	Normal Condition	Acceptable condition	Poor condition
Main control panel / CCR	X		
System pressure pot-meter	X		
System pressure indicator/ pressure gauge	X		
Pumps pot-meters and pressure indicators	X		
Remote control panels: 2 x at HPU room, 1 x CO_2 room	X		
Remote Proportional control valves Type: FRAMO / MOOG VALVES	X		
RCV manifolds filters (pilot line filter): 2 x	X		
PLC Battery installed (Yes / No X)			

PLC general condition	Normal		
Emergency override panels; key and tools available	YES, INSIDE PANEL		
Wiring and connections		SEVERAL JUMPERS NOTICED	

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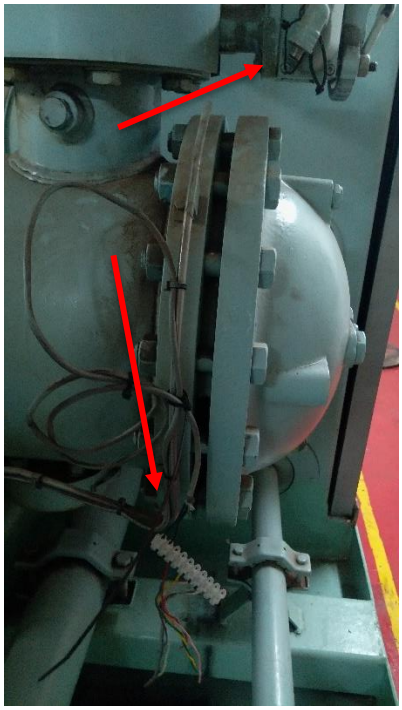

2.2.1. Alarms tests

Reference to instrument list no.: 0216-1254-1

Alarm Description	Alarm	Shut down	Remarks
Hydraulic oil level high	YES	N/A	
Hydraulic oil level low	YES	N/A	
Hydraulic oil level low low	YES	YES	INSTRUMENT/ CABLE SHOWING DEFECT
Main return line closed	NO	NO	NO CABLE, NO ALARM, JUMPERS INSTALLED
Main suction line closed	YES	YES	
Local suction lines closed	4 x	YES	SHUT DOWN THE CORRESPONDENT PPK

Feed / Protection pressure	YES		
Clogged main return filter. (Main filter dirty)	YES		ALARM IS ON
Hydraulic oil temperature (oil temperature high)	YES	N/A	AT 63 º gives alarm
Excessive wear (Wear indication)	YES	N/A	
Emergency stop power pack room	N/A	YES	Located at HPU room entrance
Emergency stop on deck (Emergency stop cargo pumps)	N/A	YES	*ONLY STOP CARGO PUMPS*
Emergency stop C.C.R.	N/A	YES	
System pressure low	YES	N/A	
Cooling system failure	YES	N/A	
HPU oil leakage	N/A	N/A	
HPU Shielding	N/A	N/A	
Power failure	YES		
Inert gas low pressure	N/A		JUMPER INSTALLED
Other alarms: • Diesel engine alarms	YES	YES *	* Only the emergency alarms for DIESEL
Comments: *ITS RECOMMENDED TO HAVE THE ALARMS TEST ONCE A YEAR, EXCEPT FOR EMERGENCY STOPS AND INERT GAS LOW PRESSURE ALARMS THAT MUST BE CHECKED BEFORE ANY DISCHARGE OPERATION.*			

2.3. Cargo (COP) and SLOP offloading pumps – Hydraulic driven

Hydraulic cargo pumps type: 02 x FRAMO **SD150 - 6**
10 x FRAMO **SD200 - 6**
02 x FRAMO **SD100 -6**

Cargo pumps condition

	STC valve			manometer (PG)			Local control valve (LCV)			Cofferdam Purging lines, valves			Cargo Stripping lines and valves			Cargo lines and valves			Hydraulic branch lines and valves		
Tank no.	**Normal**	**Acceptable**	**Poor**	**Normal**	**Acceptable**	**Poor**	**Normal**	**Acceptable**	**Poor**	**Normal**	**Acceptable**	**Poor**	**Normal**	**Acceptable**	**Poor**	**Normal**	**Acceptable**	**Poor**	**Normal**	**Acceptable**	**Poor**
1P	X			X			X			X			X			X			X		
1S	X			X			X			X			X			X			X		
2P	X			X			X			X			X			X			X		

2S	X			X			X			X			X			X			X		
3P	X			X			X			X			X			X			X		
3S	X			X			X			X			X			X			X		
4P	X			X			X			X			X			X			X		
4S	X			X			X			X			X			X			X		
5P	X			X			X			X			X			X			X		
5S	X			X			X			X			X			X			X		
6P	X			X			X			X			X			X			X		
6S	X			X			X			X			X			X			X		
SLOP pumps condition:																					
SLOP P	X			X			X			X			X			X			X		
SLOP S	X			X			X			X			X			X			X		

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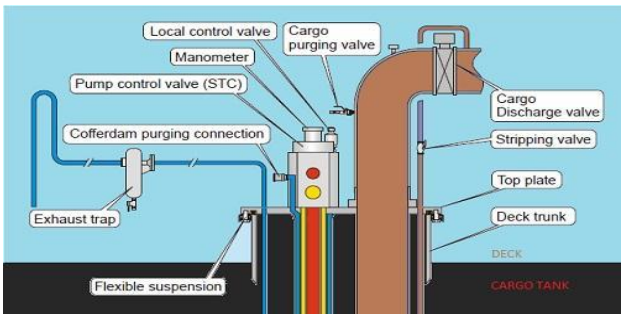
Comments:
In general, the cargo pumps top plates arrangement and related equipment are in normal condition.



Top plate arrangement

2.3.1. Cargo pumps performance test and purging

- All cargo pumps with suitable cargo in the tanks need to be run against closed valve.
- The expected cargo pressure (head), see performance diagram for the pump and calculate.
- *Cargo with viscosity >1 will result in higher hydraulic pressure*.
- To get a proper value, it is necessary to use a calibrated manometer to read the cargo and hydraulic pressure.
- Pumps cofferdam purging to be done according to manufacturer instructions

Performance test

Equipment(s) used in test/control: Digital manometer KELLER type LEO2-Ei / 300bar/81191.1 / S.N.036256

Recorded data (collected data during test)								**Tests data and results** (after calculations and corrections)				
Max. System pressure: 250 bars				**System pressure during test:** 200bars				**DP (bars)** *data Calc. for water*		**Head (mlc)** *data Calc. for water*		**CONCLUSION**
Return pressure: 6 bars				**Observations:**								
Tank No.	***Pump type***	***SpG*** *(kg/dm³)*	***Viscosity*** *(cSt)*	*Ullage (meters)*	***Head to measure point*** *hm (meters)*	***Hydraulic pressure recorded during test*** *Pp(bars)*	***Cargo pressure recorded during test*** *CPr (bars)*	***Expected***	***Recorded***	***Expected***	***Recorded***	
1P	SD150	1	1	11,200	1	165	12,3	118	155	138	138	
1SB	SD150	1	1	13,020	1	162	12,8	118	152	138	144	
2P	SD200	1	1	12,500	1	185	12,6	142	175	143	142	dpw above limit

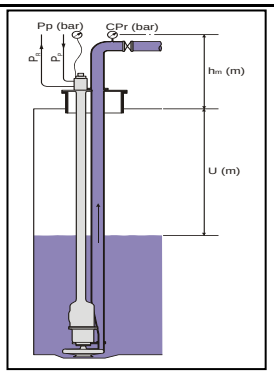
2SB	SD200	1	1	12,025	1	185	13,0	142	175	143	146	dpw above limit
3P	SD200	1	EMPTY									
3SB	SD200	1	1	13,340	1	185	12,5	142	175	143	142	dpw above limit
4P	SD200	1	1	11,993	1	178	11,9	142	168	143	134	
4SB	SD200	1	1	16,500	1	168	16,5	142	158	143	186	
5P	SD200	1	EMPTY									
5SB	SD200	1	1	6,575	1	168	11,5	142	158	143	125	
6P	SD200	1	1	11,770	1	190	12,2	142	180	143	144	dpw above limit
6SB	SD200	1	1	9,370	1	190	12,2	142	180	143	135	dpw above limit

Performance test show that pumps from tanks 2P, 2SB, 3SB, 6P and 6SB have DPW above limit (170bars) and need to have wear rings replaced, impeller, impeller hub inspected.

$$H = \frac{C\,Pr \cdot 10}{SpG \cdot 0{,}981} + U + hm \text{ (mlc)}$$

$$CPe = \frac{(Hp - U - hm) \cdot SpG \cdot 0{,}981}{10} \text{ (bar)}$$

dpw = (Pp / SpG) – Pr(bar)



H	Pump discharge head	(mlc)
CPr	Cargo pressure, recorded	(bar)
SpG	Specific gravity	(kg/dm³)
U	Ullage	(m)
hm	head to measuring point	(m)
Hp	Head from performance diagram	(mlc)
Cpe	Cargo pressure, expected	(bar)
dpw	Hydraulic diff. pressure (calc. for water)	(bar)
Pp	Hydraulic pressure (recorded)	(bar)
Pr	Hydraulic return pressure (recorded)	(bar)

Purging routine form / evaluation:

Cargo pumps with excessive cargo leaks:	**1P, 3P, 4P**
Cargo pumps with excessive hydraulic oil leaks:	**2P**
Cargo pumps with blocked cofferdam:	Non
Purging routines form filled in correctly:	Yes **X** No

Comments:

Purging routines did show leakages at pumps cofferdams and our tests done during inspection showed that **cargo pump from tank. 1P, 3P and 4P S have cargo leak**. The one from COP **2P have an oil leak.** Is recommended having the pumps pressure tested and repair according to findings.

Cargo leak: Prior to any dismantling of the cargo pump, cofferdam must be pressure tested to identify the location of the leak. A small leakage rate of up to about 0.5 l/day (and higher with light cargoes) during pump operation is normal. Acceptable leakage rate

depends on the type of cargo. For critical cargoes, when the leakage rate is more than 2 litres/day or higher, the pump must be pressure tested/repaired at first opportunity

Hydraulic oil Leak: After the pump head have been lowered from the pipe stack, the pump head and pipe stack must be pressure tested separately to identify the leak. Hydraulic oil leakage: 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 pressure tested/repaired at first opportunity.

Blocked Cofferdam: This is a serious situation as the cargo pump's cofferdam can not be monitored. The cargo pump must be repaired at first oportunity. In general is not recommended operating the cargo pump with blocked cofferdam. For advice, depending of type of cargo etc., contact your Service Station.

2.4. Ballast Pumps (WBP) – Hydraulic driven

Hydraulic ballast pump type: 02 x FRAMO SB300-4 /Submerged

Ballast pumps condition

Tank no.	STC valve			Manometer and cover (PG)			Local control valve (LCV)			Header tanks/ Cofferdam drain			Priming system/ Ejector			Hydraulic branch lines and valves			Air lines, air lines valves and filters		
	Normal	Acceptable	Poor	Normal	Acceptable	Poor	Normal	Acceptable	Poor	Normal	Acceptable	Poor	Normal	Acceptable	Poor	Normal	Acceptable	Poor	Normal	Acceptable	Poor
S	X				x		X			x			X			X			X		
P	X				x		X			x			X			X			X		

Last inspection of pump protection anodes:	No records
Protection anodes replaced on:	Need to be replaced

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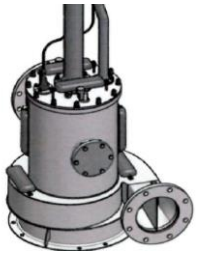
Poor: Term is used when equipment/parts are missing, damaged, leaking above limit

Comments:

Normal performance and working reported, however was noticed that most of anodes are worn out and should be replaced.

During vessel stay at yard the ballast pump SB side was repaired. Performance its normal.

Top plate with header tank and priming system



Pump head and casing

2.4.1 Ballast pumps capacity and performance test

Comments: *normal performance reported*
No actions required for now.

2.5. Other pumps and hydraulic driven equipment's

Equipment and location	Manometers and protection cover (PG)			Control and relief valves			Control panels			Hydraulic lines, hoses and valves			Cargo lines, hoses and valves		
	Normal	Acceptable	Poor	Normal	Acceptable	Poor	Normal	Acceptable	Poor	Normal	Acceptable	Poor	Normal	Acceptable	Poor
PORTABLE pump **Type:** FRAMO TK150 **Location:** FWD store	X			X			N/A			X			X		

Winches hydraulics	N/A			X			X			X					
TCP PUMP **Type:** MA150/200	X			X			X			X			X		

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Comments: Normal performance and operation reported on all equipment. No actions required for now.

2.6. Piping

Piping:	**Normal Condition**	**Acceptable condition**	**Poor condition**
Main high-pressure pipe Material: Mild steel	X		
Main low-pressure pipe Material: Stainless Steel on deck /mild steel in cover area	X		
Branch lines (high pressure) Material: Mild Steel	X		
Branch lines (low pressure) Material: Stainless Steel	X		
Pilot lines Material: Duplex Stainless steel	X		
Flexible pipe clamps	X		
Bulkhead adaptors	X		
Axial compensators (Anchor)	X		
By-pass / air-venting / heating valve assembly	X		
Snap-on stations	X		
Cargo lines Material: Mild steel	X		
Preservation	X		

Normal: Term is used when the equipment /parts is/are complete, clean and without broken or missing parts.
Acceptable: Term is used when the equipment /parts is/are complete, however some oxidation, materials wear is observed.
Poor: Term is used when equipment/parts are missing, damaged, leaking above limit/corroded.

2.7. Bow Thruster

NO FRAMO BOW THRUSTER INSTALLED IN THE VESSEL

2.8. Cargo Heaters

All cargo tanks heaters are in normal condition and no actions required for now.

3. Spare parts and tools

Spare parts and tool verification during inspection	
Location	ENGINE ROOM STORE
Storage	NORMAL
Framo toolbox:	Available and complete
Torque wrench for STC & Impeller:	Available and complete
Pump pressure testing kit:	Available and complete
Manometer set:	Available and complete
Inventory available:	NOT FOUND
Availability of wear and tear spare parts	RECOMMENDED HAVING ONE SET OF SPARES FOR EACH TYPE OF PUMPS
Availability of spare filter elements	TO BE IMPROVED

Comments:
It is recommended to have at least one complete set of parts for each type of pump. The same is recommended regarding filters. Special tools, testing kit and manometer set are important to have available onboard, because without some of these tools it's very difficult to make a proper maintenance of the FRAMO system and pumps. We recommend having the tools purchased and available.

3.1. Spare parts and tools necessary for installation and repairs

NOTE: If not listed below, any other spare required is available onboard			
Reference chapter no.	**Part description**	**Quantity**	**Manufacturer part ID.**

NOTE: SEPARATE LIST WITH SPARE PARTS RECOMMENDATION WILL BE SENT IN SEPARATE.

5. Attached documents:

- PURGING ROUTINES
- OIL SAMPLE ANALYSES REPORTS