出國報告（出國類別：洽公）

參加兩艘四萬噸級成品油輪貨油泵驅動液壓動力單元出廠前性能測試

服務機關：台灣中油股份又限公司儲運處
姓名職稱：組長　林頂光
派赴國家：挪威
出國期間：104 年 9 月 24 日至 104 年 10 月 2 日
報告日期：104 年 11 月

摘要

為配合 A10101 計畫兩艘新建 4 萬噸級成品油輪(建造船號為 1053 及 1054)建造期程，並確認主要裝備的性能能滿足規範要求，於出廠前進行出廠性能測試(FACTORY ACCEPTANCE TEST, FAT)。

此次測試項目為兩艘成品油輪貨油系統的高壓液壓油動力單元(Hydraulic Power Unit, HPU)於裝備供應商(Frank Mohn AS 公司)位於挪威卑爾根的製造工廠進行。

此次出國主要任務為參加製造工廠裝備出廠前測試，包括液壓泵及相關附屬裝置運轉及性能測試及外觀完整性檢查等，以確認裝備性能可達到設計目標。同時拜訪位於荷蘭鹿特丹 FRAMO 公司維修、訓練及備品供應中心及卑爾根管件製造工廠。了解整個貨油系統的組成系統船上安裝應注意事項及原廠在營運期間對使用者提供的支援及執行方法等。經兩天運轉測試，初步測試結果確認兩套液壓動力單元系統性能符合本案兩艘成品油輪需求，後續尚有各單獨貨油泵出廠前性能測試及最終船上安裝、調校及船上運轉測試等。以確保未來營運期間系統正常運轉。

目錄

兩艘四萬噸級成品油輪
貨油泵驅動液壓動力單元出廠前性能測試

一、目的

為淘汰本公司兩艘船齡已超過 25 年的四萬噸級成品油輪「安運」、「康運」，滿足 104 年以後國內油品充分供應之需求，於 102 年 6 月 23 日與台船公司簽約辦理 A10101 計畫新建兩艘 4 萬噸級成品油輪(建造船號為 1053 及 1054)，預定於 105 年 12 月交船。

為配合兩艘新船建造期程，並確認主要裝備的性能可符合滿足本船所需，故於出廠前進行出廠性能測試(FACTORY ACCEPTANCE TEST, FAT)，本項測試主要目的在製造工廠，裝備在控制環境下進行全負荷測試，以確認實際性能可達到原設計目的。以確保未來在船上安裝後能夠滿足實際作業需求。

此次測試裝備為兩套貨油系統的高壓液壓油動力單元(Hydraulic Power pack Unit, HPU) 。每船一套，各由 3 部液壓油供應泵，四部液壓油泵(兩部馬達驅動兩部柴油引擎驅動)。於裝備供應商(Frank Mohn AS 公司)位於挪威卑爾根的製造工廠進行。

主要內容，包括測試前系統沖洗(Flushing)，液壓泵及相關附屬裝置運轉及性能測試及外觀完整性檢查等。經兩天運轉測試，初步測試結果包括液壓油流量、系統壓力、所需功率及相關安全裝置包括溫度、壓力、液位等計測及警報裝置功能等均正常及且無明顯震動、噪音等異常狀況。測試完成後，廠商即依計畫裝船送往台灣國際造船高雄廠，由台船公司安裝於船上。

二、參加廠試過程

(一)出國行程

1. 9 月 24 日　搭乘荷航 KL 808 班機於 9 月 25 日 0625 抵達荷蘭阿姆斯特丹。
2. 9 月 25 日晨 由 Framo 公司亞洲區代表陪同參訪 FRAMO 位於鹿特丹維修中心。
3. 9 月 25 日晚 搭乘 KL 1151 班機飛往挪威奧斯陸
4. 9 月 26 日　周末
5. 9 月 27 日　由奧斯陸飛往卑爾根
6. 9 月 28、29 日 於 Fraom Fusa 工廠進行兩套 HPU 出廠前測試
7. 9 月 30 日 參訪 Framo Holsnoy 管路工廠
8. 10 月 1 日 2040 搭乘 KL 807 班機 10 月 2 日抵達台北

(二)參加廠試人員

1．廠商(Frank Mohn AS 公司)代表:

專案經理 : Mr.Bengt Holme

專案工程師 : Mr.Magnus Hlmefjord

測試工程師: Mr.Stain Krydsby

2. 船東：中油儲運處造船組組長 林頂光

3. 中油委託技術服務廠商：
財團法人聯合船舶設計發展中心艤裝組 程心華 工程師

(三)廠試標的：

1. 名稱：液壓動力單元

2. 數量：2 套

3. 廠牌：FRAMO

4. 型號：CCC 500-4

5. 單元組成及額定容量：

船號	1053 (鴻運)		1054 (盛運)	
	序 號	規 格	序 號	規 格
馬達(1)	3G1F1521264667	470 kW	3G1F1521264669	470 kW
液壓泵(1)	34431475	856 l/min x 279 Bar	34431479	856 l/min x 279 Bar
馬達 (2)	3G1F1521264668	470 kW	3G1F1521264670	470kW
液壓泵(2)	34431476	856 l/min x 279 Bar	34431480	856 l/min x 279 Bar
引擎(1)	37265806	485kW	37265809	485kW
液壓泵(3)	34431477	865 l/min x 279 Bar	34431481	865 l/min x 279 Bar
引擎(1)	37265808	485kW	37265810	485kW

液壓泵(4)	34431478	865 l/min x 279 Bar	34431482	865 l/min x 279 Bar
輔助單元	41822544		41822544	

(四)廠試過程

1. 出發前資料收集

本項測試於8月25日接獲原廠通知配合船廠交期，本系統計劃於9月下旬進行出廠前測試(Factory Acceptance Test)，請船東派員參加。為了解測試過程及測試方法請FRAMO 公司先提供測試計劃。以預作準備。於出發前陸續收到廠商提供相關資料並進行澄清。包括液壓系統佈置圖及主要裝備規格、測試程序(包括系統啟動程序，系統啟用前沖洗程序及控制及警報系統設定點)、測試報告內容格式、相關測試儀器之校正證書及馬達、柴油引擎廠試報告等資料。

依據廠商提供資料進行進一步確認澄清，於出發前完成。

2. 廠試前溝通會議

104年10月28日上午0830抵達Framo 位於Fusa 工廠，由該廠 Managing Director Mr. Sigbjorn Drengenes 主持起始會議，品保主管 Qualiity Manager 介紹訪客安全注意事項後，由專案工程師 ：Mr.Magnus Hlmefjord 介紹測試流程及測試內容。經雙方確認後至測試工場進行測試。

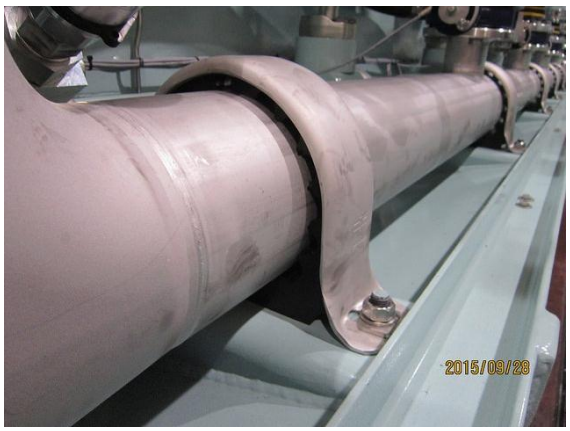
3. 廠試經過

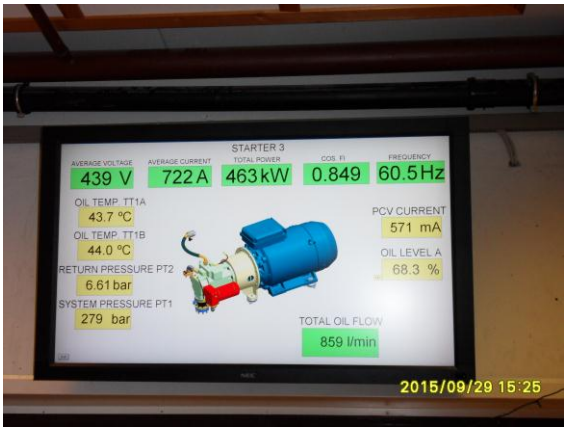
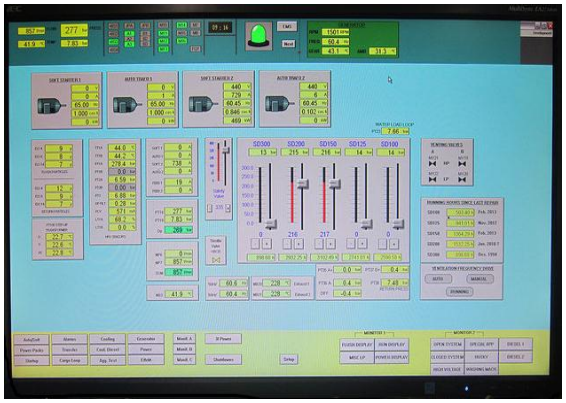
抵達測試工場後，先由測試工程師 Mr.Stain Krydsby介紹現場佈置，相關測試裝備及測試機組等並進形外觀檢查並核對各主要裝備序號後開始進行運轉測試。依據測式程序，首日進行第一套HPU運轉測試及相關保護裝置功能測試。由一號馬達驅動液壓泵開始至第2部柴油引擎驅動液壓泵輪流運轉，每部機全負荷運轉30分鐘，測試流量及壓力及負荷狀況，同時記錄相關數據並觀察裝備運轉情形是否有異常噪音、振動洩漏等狀況。運轉完成後並進行警報等安全裝置測試。之後就測試過程及記錄等進行討論確認。完成第一日測試。

第二日依照第一日程序進行第二套機組測試。

4.結束會議

就兩日測試結果核對是否與原設計性能標準相符，確認最終測試報告內容請由參與人員簽署確認，完成此次測試。

	
測試前起始會議	測試現場佈置介紹
	
測試裝備(負載泵)	液壓動力單元
	
液壓泵減震接頭	管路減震、降噪墊圈

	
運轉資料顯示屏	運轉控制顯示台
	
貨油系統操作控制台(船上)	柴油引擎控制台
	
警報模擬測試	警報顯示測試

	
運轉測試	現場討論
	
訓練中心貨泵操作訓練機	訓練中心訓練機收艙操作

三 、心得及建議

1. 本次赴 FRAMO 參加出廠前測試，為第一次參加此類裝備測試。測試主要目的為透過在測試環境下，確認裝備性能符合船上作業需要，以彌補在船上測試時，可能因實際環境限制而無法精準量測項目。為達到此目的，除在測試時確認結果外，在測試前即需先了解相關測試所需相關資訊，如依據標準，測試程序方法，測試要求結果等都應在出發前要求廠商提供，事前充分準備可節省測試時間並使測試更有效率。

2. 此次出國除參加兩套液壓動力單元性能測試外，也利用時間拜訪位於荷蘭的維修、訓練及配件供應中心，對於 FRAMO 公司後續技術支援從操作到維護保養及配件供應有大概了解。此型式貨油系統，操作上透過程式控制較傳統貨油系統相對簡單安全性也提高，但要完全發揮它的特性，操作者的用心與否也是關鍵。對於配件供應，FRAMO 公司標榜主要零件，包括提供的液壓管線，都有一個編號如果船東能夠提供正確的資訊，該公司宣稱要

所需要的料件 24 小時內可以自工廠出貨，因此船上不需要準備大量備品，可節省配件庫存成本。但船上對相關資訊提供變得相對重要，對於此部分的資料管理，未來主辦工程師也需要費心注意。

3. 本計畫兩艘成品油輪的貨油系統採用液壓潛式(SUBMERGE)系統，主要考量整體的可靠性較長軸型深井泵(DEEP WELL)為高。但如何維持液壓油的純淨為使用這系統的首要注意的課題，FRAMO 亦宣稱避免因市場上一般管件工程輕忽的管路品質對液壓系統的影響，對船上所用和本系統有關的管系及屬件完全由該公司自行生產供應，少部分必需配合現場空間現場施作項目也由該公司提供必要組件並由船廠依照 FRAMO 的施工標準施工。為此特別要求利用最後一天至該公司管件工廠參觀，以了解該工廠對於確保管件內部的清潔及防震、減噪的作法及未來船廠建造階段對管件的從完成品保存到加工組裝及船上安裝應注意的事項等，在未來監造階段可隨時要求船廠確實注意遵照辦理以降低本公司風險。

四、附件

(一)、系統沖洗程序及結果

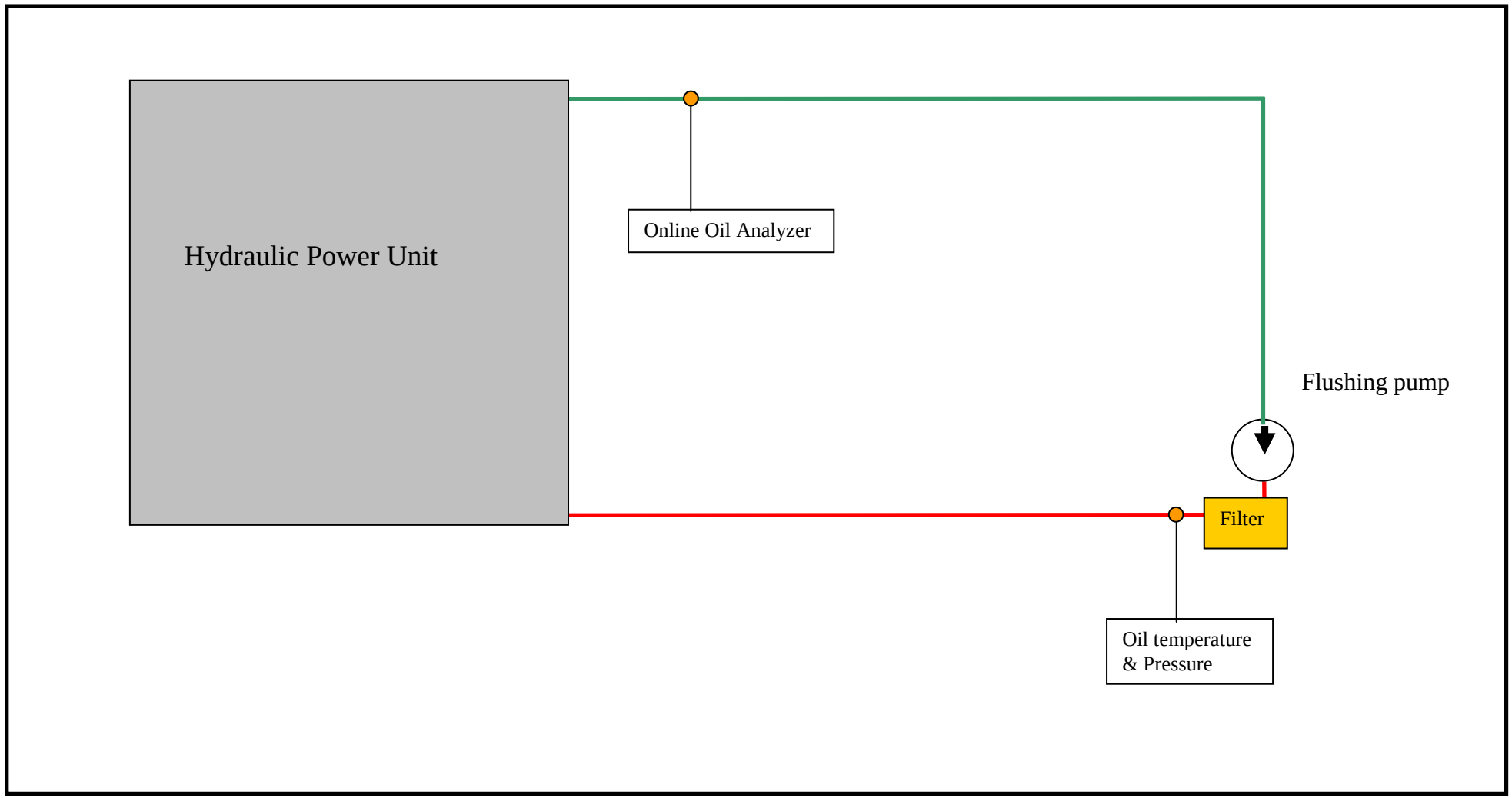
(二)、液壓單元測試程序

(三)、測試報告

附件1

No: 0161-0296-4
Date/sign: 13.06.00/AL
Rev: C
Rev. date: 13.11.2012

SCHEMATIC FLUSHING DIAGRAM



Framo

Mounting Instruction

No. 1401-0044-4
Rev.J Dec-2014

Hydraulic oils - Oil filling
Pressure testing - Flushing

FRAMO

CONTENTS

1 GENERAL

High pressure hydraulic pumps, motors and control valves have narrow tolerances and require clean hydraulic oil to obtain good performance and long lifetime.

Contaminated oil will not provide satisfying lubrication and is a leading contributor to reduced efficiency, excessive down time and increased maintenance costs.

There are three types of possible contamination in hydraulic systems:

- *Solid particles* Increased wear, reduced oil- and component life time, sticking valves, unexpected system shut downs.
- *Water* Reduced lubrication, generation of metal particles to the system, corrosion, reduced life time for oil and components.
- *Air* Unstable hydraulic system, risk for pressure shocks and damage to system components.

The contamination may enter the system:

- During production and assembling of the system.
- During hydraulic oil filling. (New oil from supplier, refined and blended under “clean” conditions is not clean).
- With the atmospheric air through air venting of the hydraulic tanks.
- By wear and tear generated within the system.
- During service.

To prevent contamination, it is important to maintain a high standard of cleanliness at all times.

- Keep pipes and components clean and protected during the whole production- and assembling period.
- When oil is filled into the system from the storage tank the Framo hydraulic oil transfer unit must always be used.
- Oil filling must be done without mixing air into the oil during oil filling. It is very time-consuming to get rid of air when it is mixed into the hydraulic oil.
- Hydraulic tanks must be vented indoor, not to open deck. Air filters should be used.
- Wear and tear to be prevented by checking the hydraulic oil quality and cleanliness regularly, and by replacing filter elements when necessary.
- Keep all parts clean during service and assembling. Refill with clean oil, vent and flush carefully after assembling.

Flushing is the last and final cleaning procedure in order to remove particles that have entered the system during installation, and to bring the cleanliness of the system oil up to an acceptable level.

2 SELECTION OF HYDRAULIC OIL

Hydraulic oil is a very important part of the Framo hydraulic system and must meet the specification 1400-0068-4, unless a different specification is received in writing from Frank Mohn AS.

3 REQUIREMENTS

Cleanliness level

The required cleanliness level is based upon ISO Solid Contaminant Code ISO 4406. The code was revised during 1999 and is now referring to 3 sizes of particles, 4 - 6 - and 14 micron(c). (Previous code referred to 5 - and 15 micron).

A typical result according to the revised code will be 18/16/12.
Framo will only use the two last digits referring to 6- and 14 micron(c).

The highest level of particles accepted in Framo systems is code 16/12.
Recommended cleanliness level during circulation and flushing is code 15/11 or better.

When reporting a particle count, inform if the counting is reported according to previous ISO 4406 or revised ISO 4406 (1999).

Code	Number of particles in 1 ml	Particle size acc. to previous code	Particle size acc. to 1999 revision
16	320 –640	5 micron	6 micron (c)
12	20 – 40	15 micron	14 micron (c)
15	160 – 320	5 micron	6 micron (c)
11	10 -20	15 micron	14 micron (c)

Water content

The water content must be below 300 PPM (0.03 %).

Leakage and pressure testing of piping system

The hydraulic system must be pressure tested to ensure that it is correctly mounted and not leaking.

It is recommended to carry out a leakage test of the piping system with clean nitrogen gas at low pressure (typically 1 - 1.5 bar) before oil filling in order to locate possible leakages in the system without causing oil spill.

For final pressure testing with hydraulic oil, Framo requires the following minimum test pressures:

Pressure lines: According to the classification society requirement, but at least system pressure + 70 bar.

Return lines: To be pressure tested according to classification society requirements. However, Framo requires minimum 9 bar.
Maximum pressure for the hydraulic oil transfer unit is 14 bar.

4 REQUIRED TIME FOR OIL FILLING, PRESSURE TESTING AND FLUSHING

Required time for oil filling, pressure testing and flushing depends on system size and types of pumps. For general planning of these processes, please refer to the following guidelines:

- Oil filling: Capacity for oil transfer, which shall be used for filling, is 29 / 36 l/min (50 or 60 Hz).

- Pressure testing: Main process is preparations. Pressure testing itself takes less than 1/2 hour, assuming no leakages. ***Note!*** *FPSO requires 1 hrs. stand time.*

- Flushing:
  - Internal circulation: Minimum 1.5 hours
  - Main line + branch line flushing: Minimum 0.5 hour for each branch line, at correct temperature.

  Total time depends on pipes sizes / available flow from main power packs (no. of lines to be flushed simultaneously). See system flushing diagram for required flows for different pumps.

- Flushing of pilot lines can be done without any disconnection of pilot lines from remote control manifold. Required time: 10-15 min pr pilot line, 4-6 pilot lines in parallel.

- Oil filling of COP: Several / all LP pipes stacks may be filled simultaneously, while HP pipe stacks must be filled individually. See table below for typical filling times.

		SD100 L=14m	SD125/150 L=14m	SD200 L=18m	SD300 L32m	SD350 L=32m
LP pipe stack	Closed loop	40 min	40 min	90 min	4-5 hours	6 hours
	Open loop	70 min	70 min	160 min	NA	NA
HP pipe stack		1 min	1 min	1-2 min	2-3 min	4-5 min

Approximate filling times are based on running system at approx. 100 bar. Filling time may be reduced by running at higher system pressure (only closed loop).

All given times are for oil filling and flushing processes only. In addition comes all preparations like connection and disconnection of flushing and pressure test equipment, and necessary heating of system (before efficient flushing starts).

5 YARD PREPARATION FOR OIL FILLING PRESSURE TESTING AND FLUSHING

5.1 Standard sequence for oil filling, pressure testing and flushing.

All processes related to oil filling, pressure testing and flushing must be started after attendance of Framo commissioning engineer. Standard process is as follows:

- Inspection of cleanliness level on pipes selected by Framo commissioning engineer.
- Leakage testing with nitrogen (Yard responsibility).
- Initial oil filling of high pressure pipes.
- Pressure testing of high pressure pipes.
- Initial oil filling of low pressure pipes.
- Pressure testing of low pressure pipes.

5.2 Leakage testing:

Preparation for leakage testing to be done according to fig. 1.
Before testing is started, every pipe connection and fitting is to be checked and bolts re-tightened (ensure correct torque) to assure that there are no loose connections. It is recommended to adjust and keep the nitrogen gas pressure at low pressure (typically 1 - 1.5 bar) while every connection on the piping system is examined by means of a soap-water mixture in order to locate possible leakage.

Equipment for leakage testing (Yard supply):

- Nitrogen gas bottles with separate relief valves (for safety).

5.3 Preparation for oil filling and pressure testing

All Framo components are pressure tested and flushed prior to shipment and need no flushing, provided the blank flanges are tight and kept on until final installation.

Before oil filling and pressure testing can be started, pipes to cargo pumps, ballast pumps and other consumers, must be disconnected and blinded off with a blind flange. High pressure blind flange to have integrated bleed plug for air venting during filling, see fig. 1.
Disconnected pipes and equipment must be blinded off!

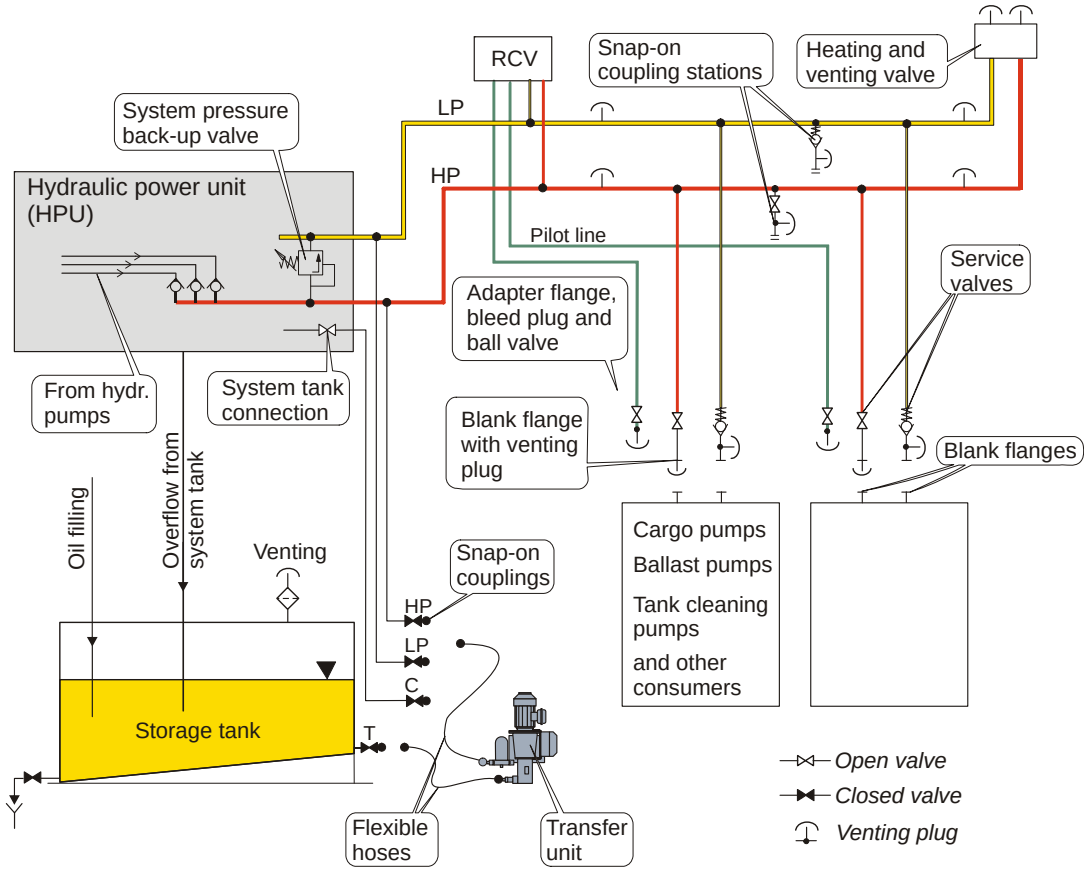


Fig. 1: Arrangement for oil filling and pressure testing

Note! *Hydraulic pipes must be pressure tested with hydraulic oil – water or other fluid must never be used for pressure testing.*

For pressure testing of the pressure lines, a dedicated and clean pressure testing pump must be used. *The hydraulic power unit must not be used for pressure testing!* For pressure testing of the return lines, the hydraulic oil transfer unit can be used if test pressure < 14 bar.

Pressure testing equipment (Yard supply):

- Pressure testing pump (HP).
- HP blind flanges with venting plugs (Valve to be open if test pressure > 380 bar).
- LP blind flanges.
- Adaptor flange, venting plugs and ball valves on pilot line.
- Blinding for disconnected pipes and equipment.
- Necessary equipment for collecting and removing of hydraulic oil in case of leakage.
- Warning signs.
- Communication equipment.

Systems with pilot operated heating and venting valve:

Pilot line for heating valve must be prepared for pressure testing and flushing, see fig. 2. Connect a flexible hose with ball valve between pilot valve for heating valve and bleed point for main return filter.

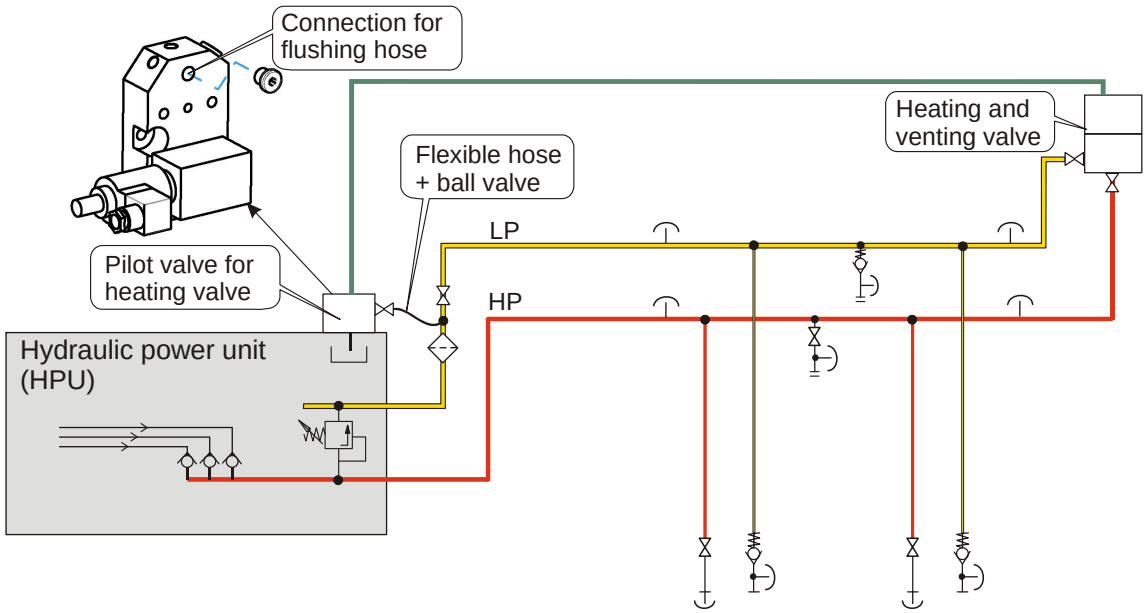


Fig. 2: Arrangement for pilot line to heating and venting valve (closed loop systems)

5.4 Pressure testing – safety

The hydraulic piping system is under very high pressure during testing.
Every possible action must be taken by the Yard in order to avoid damage both to people and material.

Note! *Before pressure testing is started every person not participating in the pressure testing itself should be evacuated from exposed areas.*

All access to the ship to be marked with signs, for example as shown to the right:

WARNING!

ONGOING PRESSURE TESTING
OF
HYDRAULIC PIPING

To have an overview of the hydraulic system there should be one person in charge for the pressure testing. One person should be looking after the system in the power pack room, one in the pump room and others on strategic places along the piping system. They must have communication equipment enabling them to inform the person in charge if a leakage occurs.

Note! *If hydraulic oil is leaking from the piping system during testing, the test pressure must be set to zero. Leaking oil must be collected immediately and exposed area cleaned.*

The hydraulic oil must be drained out before any repairs are made on the piping system.

Hydraulic oil is slightly toxic, but will not cause bodily harm during normal use according to Oil Company's information. However, be aware of that:

- Long lasting contact with the skin may cause skin irritation. Cover the skin or use protecting cream when working with hydraulic oil.
- Oil into the eyes is normally not dangerous, but painful. Rinse the eye with fresh water for at least 15 minutes.
- High concentrations of oil mist can irritate the respiratory organs.
- Follow oil supplier instruction regarding health and environment.

5.5 Preparation for flushing:

Flushing equipment (Yard supply):

- Orifices. (Low noise orifices can be purchased from Framo).
- Flexible hoses with flanges for connection of HP to LP and pilot to LP connection.
- Ball valve for pilot line.

The flushing procedure is based upon use of the Framo hydraulic power unit, and orifices must therefore be installed in the pressure lines to ensure that the hydraulic pump pressure always is kept above 50 bar - max.70 bar.

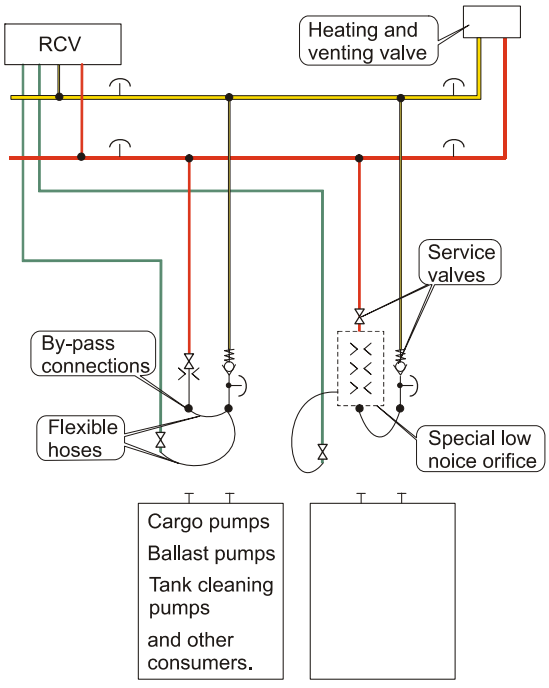


Fig. 3: Arrangement for flushing

Required flushing flow for different return pipe dimensions are given in tables. The calculated flow and orifice dimensions are based upon oil viscosity 46 cSt, density 870 kg/m^3, a Reynolds number of approx. 4000, orifice discharge coefficient 0,65 and 50 bar pressure drop over the orifice. For other viscosities and pipe dimensions, flow and orifice dimensions may be calculated from the following formulas:

Required oil flow : $Q = 8{,}7 \times d \times \nu/46$ [l/min]

d = Inside pipe diameter [mm]

Orifice diameter : $D = \sqrt{Q \times 0{,}3}$ [mm]

ν = Oil viscosity [cSt]

HP and LP side to be interconnected by a flexible hose. We recommend using HP flexible hoses to avoid collapsing due to bending. Minimum dimensions:

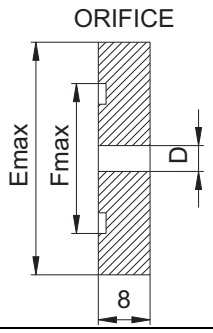
Return	Flushing flow	Typical pumps
1 1/4"	Up to approx. 500 l/min	SD100/125/150/200
1 1/2"	Approx. 500-800 l/min	SD250/300/350

Flow / orifice vs. pipe dimensions. Based on ISO VG 46, at minimum 40 ºC.

Standard pipe dimensions (ODxt) Stainless steel pipes			Other pipe dimensions Max ID	Flow (l/min)	Orifice ØD (mm)
DIN	*JIS*	*ANSI*			
35.0x2.0	34.0x2.8	33.4x2.77	31	270	9.1
44.5x2.0	48.6x2.8	48.3x2.77	45	390	10.9
54.0x2.0	60.5x2.8	60.3x2.77	55	470	12.0
76.1x2.0	76.3x3.0	73.0x3.05	72	625	13.8
84.0x2.0	89.1x3.0	88.9x3.05	83	715	14.8
106.0x3.0	114.3x3.0	114.3x3.05	109	940	16.9
131.0x3.0	139.8x3.4	141.3x3.40	135	1170	18.9
156.0x3.0	165.2x3.4	168.3x3.40	162	1400	20.6
206.0x3.0	216.3x4.0	219.1x3.76	212	1840	23.7
257.0x3.5	267.4x4.0	273.0x4.19	265	2300	26.5

Pump type	Valve ØA	ØE_max	ØF_max	ORIFICE ØD
SD100	31	72	54	10.9
SD125/150	31	72	54	10.9
SB200/300	31	72	54	10.9
SD200	38	80	64	12.0
SB400	38	80	64	12.0
SB600-T	38	80	64	12.0
SD250/300	45	80	64	13.8
SB600	45	80	64	13.8
SD350	56	97	78	14.8

Fig. 4



F_max is maximum outer diameter to be used for the O-ring groove. Inner diameter for the O-ring must not come into the valve opening ØA.

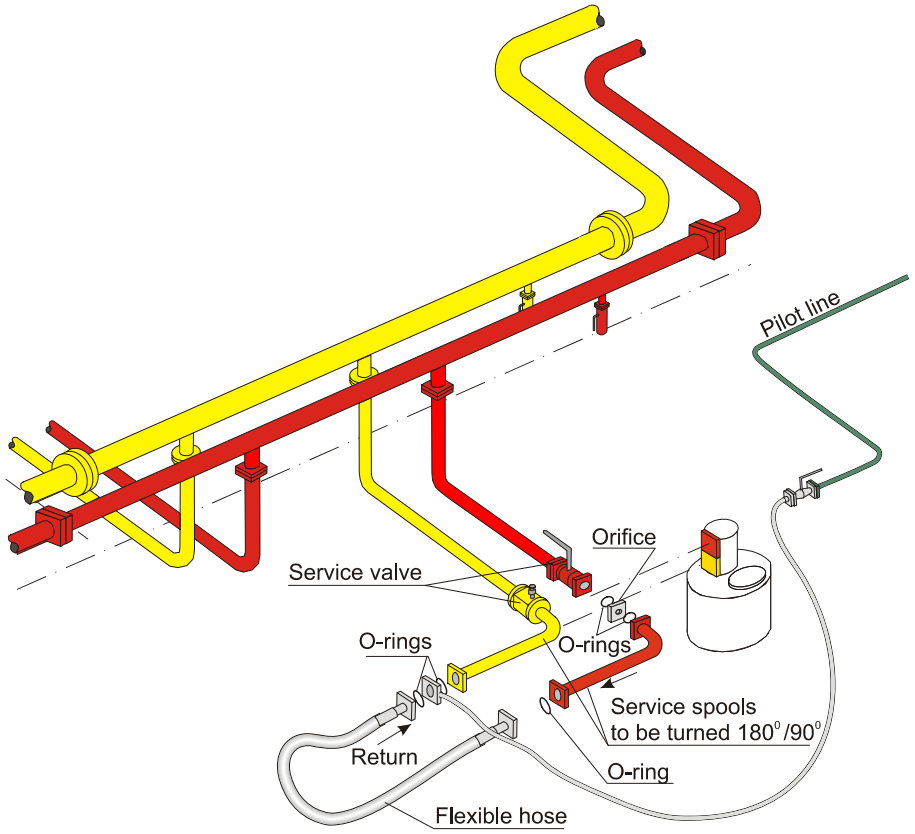


Fig. 5: Typical arrangement for flushing of branch lines + pilot lines

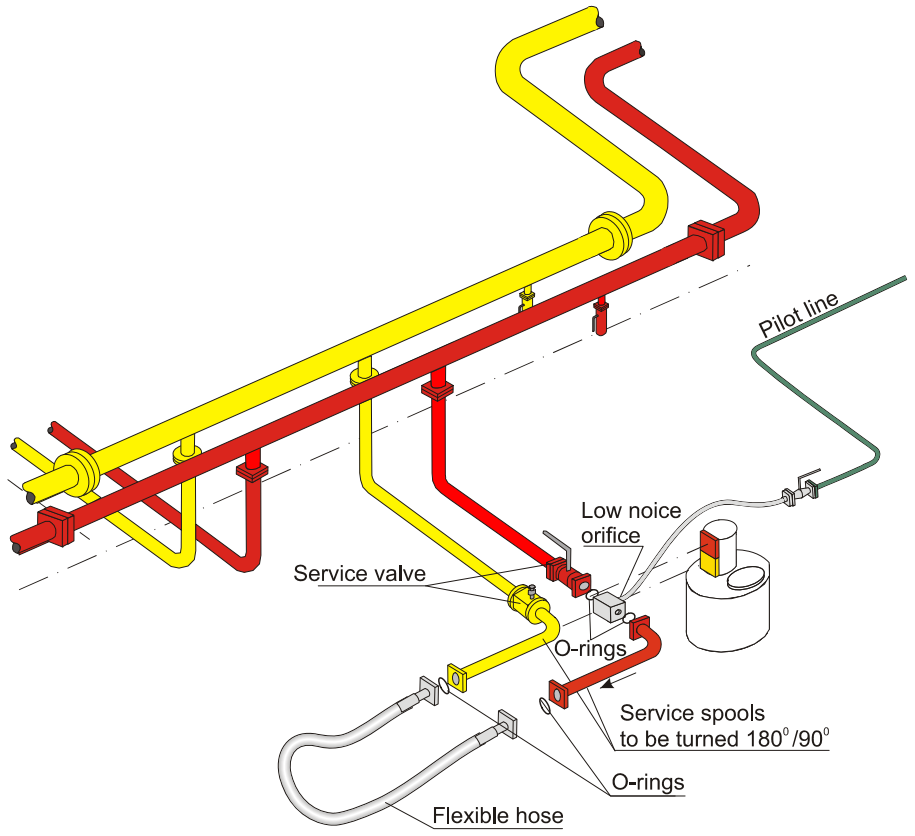


Fig. 6: Typical arrangement for flushing of branch lines + pilot lines with low noise orifice

For flushing of special components the flushing procedure is in general based upon bypassing component and installing HP orifice.
For thruster motor and control valve system, refer to Framo Mounting Instruction No. 1401-0011-4.

6 DISMANTLING OF FLUSHING EQUIPMENT

- Keep pipes and components clean and protected during dismantling of flushing equipment.
- Service spools should be assembled immediately after dismantling of flushing equipment.
- The Framo commissioning engineer is responsible for checking that service spools are installed correctly after flushing. If final assembly is not possible (cargo pump not installed), service spools and valves must be satisfactorily blinded off.

PAMAS Partikelmess- und Analysesysteme

PMA-Particle Measuring and Analysing Software

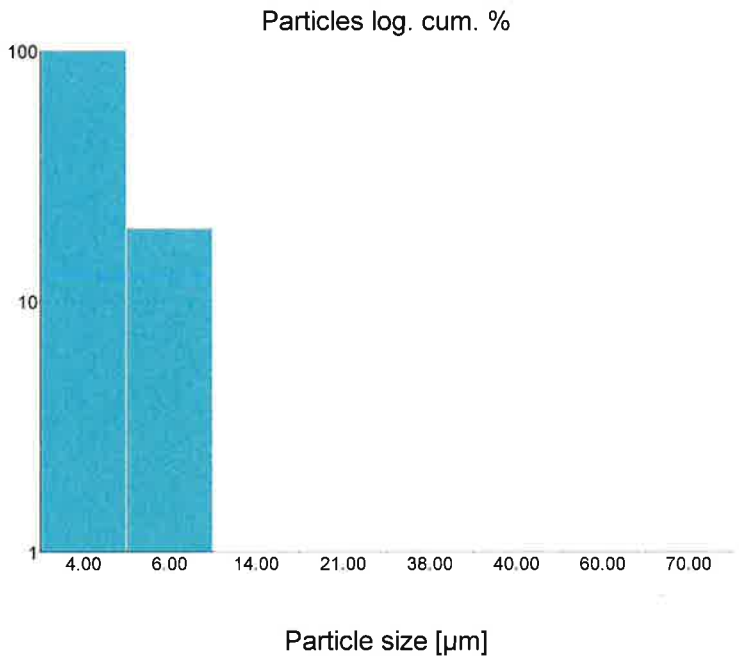
PAMAS PMA Program v2.4.2.2 u 29.09.2015

Measurement file	: C:\PAMAS\PMA v2.4.2.2u\16569-15.mes
Sample ID	: 16569-15
Customer	: Frank Mohn Fusa
Sampling location	: CSBC Corp. Taiwan # 1
Sampling date	: 24.09.2015
measured at	: 29.09.2015 08:25:07
User	: A.K.Holsen
Counter	: ID: SYS-3216 v5.3 S#: R28-EP0000010629
Sensor	: L-5050-1681
Comment	: :Water: PPM 33 O/no 617600 Oljetype : Shell Tellus S3 M-46 Stian Krydsby
Print	: Average values of measurement(s) 1, 2, 3, 4, 5

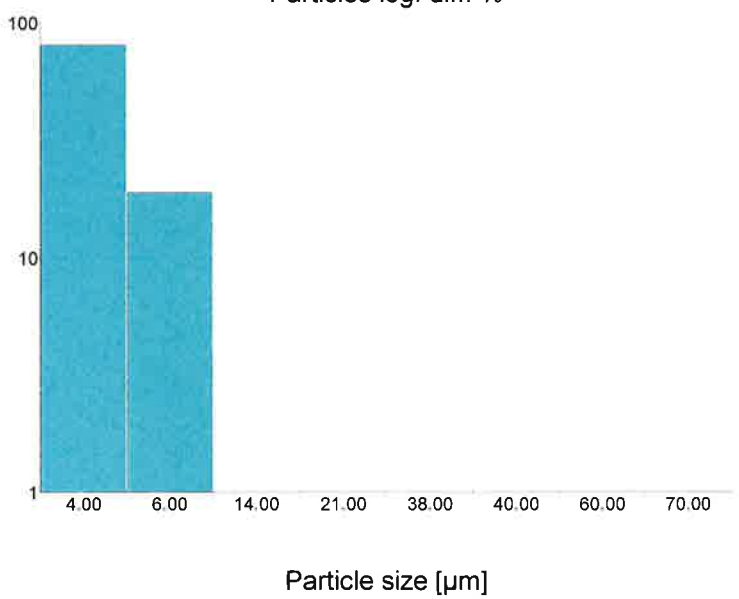
Measured volume	: 10.0 ml
Analysed Volume	: 1 ml
Dilution Factor	: -

ISO 4406	: 19/16/11
SAE AS 4059E	: 9A (9,8,5,6,5,5)

Diameters	cumulative
> 4.00 µm (c)	3140
> 6.00 µm (c)	613
> 14.00 µm (c)	17
> 21.00 µm (c)	4
> 38.00 µm (c)	0
> 40.00 µm (c)	0
> 60.00 µm (c)	0
> 70.00 µm (c)	0



Diameters	differential
4.00 - 6.00 µm (c)	2527
6.00 - 14.00 µm (c)	596
14.00 - 21.00 µm (c)	13
21.00 - 38.00 µm (c)	4
38.00 - 40.00 µm (c)	0
40.00 - 60.00 µm (c)	0
60.00 - 70.00 µm (c)	0
> 70.00 µm (c)	0



PMA-Particle Measuring and Analysing Software

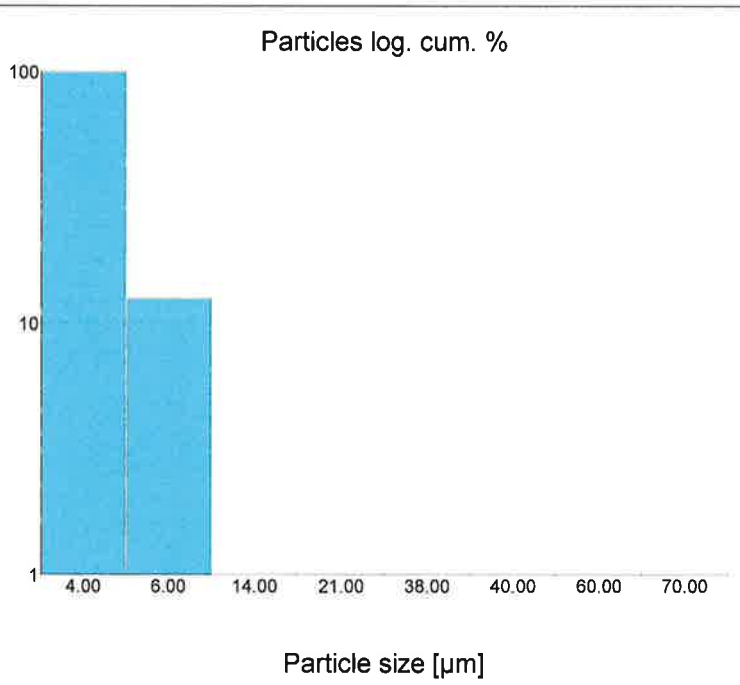
PAMAS PMA Program v2.4.2.2 u 02.10.2015

Measurement file	: C:\PAMAS\PMA v2.4.2.2u\16594-15.mes
Sample ID	: 16594-15
Customer	: Frank Mohn Fusa
Sampling location	: CSBC Corp. Taiwan # 2
Sampling date	: 28.09.2015
measured at	: 02.10.2015 09:15:14
User	: A.K.Holsen
Counter	: ID: SYS-3216 v5.3 S#: R28-EP0000010629
Sensor	: L-5050-1681
Comment	: :Water: PPM 25 O/no 617601 Oljetype : Shell Tellus S3 M-46 Stian Krydsby
Print	: Average values of measurement(s) 1, 2, 3, 4, 5

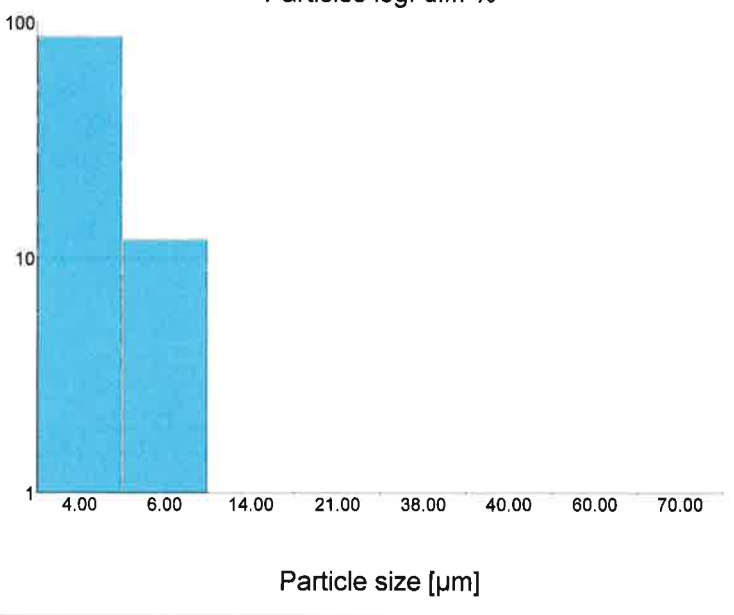
Measured volume	: 10.0 ml
Analysed Volume	: 1 ml
Dilution Factor	: -

ISO 4406	: 16/13/9
SAE AS 4059E	: 6A (6,5,3,3,0,000)

Diameters	cumulative
> 4.00 µm (c)	475
> 6.00 µm (c)	60
> 14.00 µm (c)	3
> 21.00 µm (c)	1
> 38.00 µm (c)	0
> 40.00 µm (c)	0
> 60.00 µm (c)	0
> 70.00 µm (c)	0



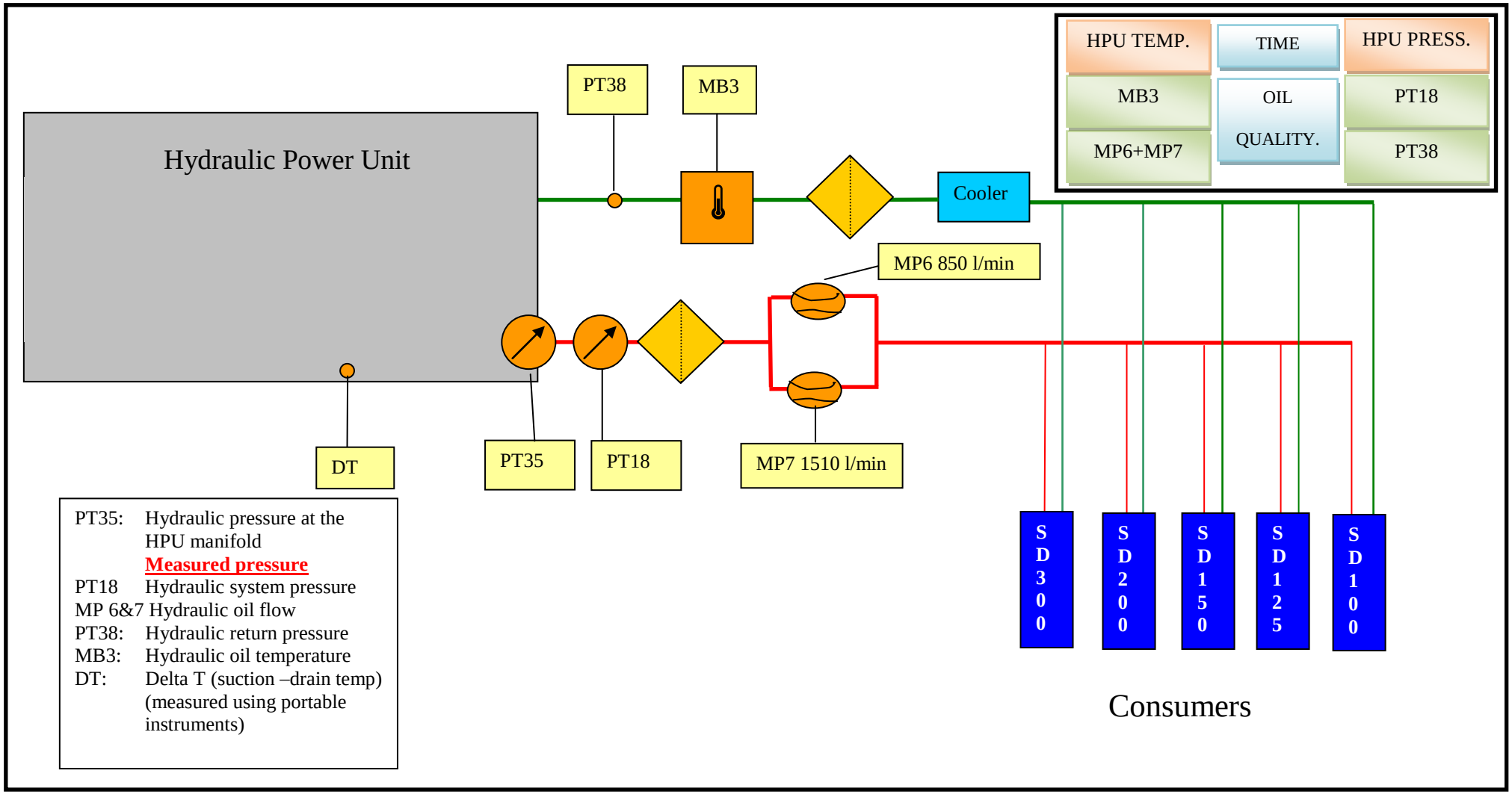
Diameters	differential
4.00 - 6.00 µm (c)	416
6.00 - 14.00 µm (c)	57
14.00 - 21.00 µm (c)	2
21.00 - 38.00 µm (c)	1
38.00 - 40.00 µm (c)	0
40.00 - 60.00 µm (c)	0
60.00 - 70.00 µm (c)	0
> 70.00 µm (c)	0



附件**2**

No: 0161-0295-4
Date/Sign: 29.06.00/AL
Rev.: C
Rev. date: 13.11.2012

SCHEMATIC OF TEST ASSEMBLY



1. SCOPE

The purpose of the in house test is to verify the correct functioning of the equipment listed below. However, this is not a full-scale test, due to the capacity of the test loop.

- The Hydraulic Power Unit (HPU).
- Electric Control System.

The HPU will be connected to our test loop as shown in drawing 0161-0295 and 0161-0296.
The power pack will be run at full load and minimum load operating conditions.

2. OIL FILLING AND FLUSHING

Visual inspect the hydraulic tank and inspect components and lines for possible damages.

Fill the hydraulic system with oil by using the oil transfer unit.

- Open venting and start the hydraulic transfer pump.
- Vent all piping, filter box and oil cooler until it is completely filled with oil.
- Fill up hydraulic tank to normal oil level.

The flushing at the test plant will be carried out as follows:

- Start the flushing pump.
- Flush the system until the required cleanliness of the hydraulic oil is obtained.
- The oil temperature during flushing must be between 50 and 60°C.
- Vent the system until all air is out.

After the oil flushing is completed an oil sample must be analyzed to verify that the required cleanliness is obtained. The cleanliness of the hydraulic oil after flushing must be according to code 16/12 - ISO 4406.
A completed particle count report must be filed.

3. ELECTRIC CONTROL SYSTEM

The alarms on the control panel are to be tested according to the instrument list for the actual order. For practical reasons, the alarms may be tested at different stages during the test.

4. START UP, ADJUSTMENT AND TESTING

Before start up of HPU with diesel engine driven powerpacks, fill up lubrication oil and prescribed coolant water to normal level and connect the diesel engine to its cooling loop.

1. Start the feed pumps one at the time (in low speed for two-speed pumps) and check direction of rotation.
2. Close the main return valve after the filter for one minute to remove air from the by-pass line and to check the functionality of the by-pass valve.
3. Open the main return valve and start two feed pumps (one in high speed for two-speed pump).
4. Adjust the low-pressure relief valve until 6 bar is measured on the main hydraulic pumps' suction connection. Inspect for leakage and observe abnormal noise and vibration.
5. Vent the hydraulic pressure and return lines.
6. Check the oil level in hydraulic tank and refill if necessary.
7. Stop the first feed pump and repeat the procedures for the last feed pump.
8. Close the back up valve, and after it is completely close open it 3-4 turns. Check that the 3-way valve on the back up valve’s drain is open (remove handle and check flow direction on the valve ball). Set the control valve for the consumer to maximum and set the potmeter for the system pressure control valve to minimum.

   WARNING. The hydraulic pump must not be operated below 50 bar !

9. Assuming oil filling and venting is completed, two (one in high speed for two-speed pumps) feed pumps are running and the main hydraulic pumps' suction pressure is 6 bar. Start the electric motor on one powerpack and check direction of rotation. Increase the system pressure to min. 100 bar, max 150 bar, using the system pressure control valve. Adjust consumers until the pump swivel angle is approximately 5-10°. Run the powerpack until the system is warmed up and free of air. (Approximately 1 hour)
10. Adjust the hydraulic system and set the pressure according to 1400-0267
11. During running inspect for leakage and observe abnormal noise and vibration.
12. Check the temperature, maximum drain temperature 80°C with suction temperature 55°C.
13. When the procedure in 1400-0267 is completed, stop all the main hydraulic power packs and leave one feed pump running (at low speed for two-speed pump).
14. The following data is to be measured and reported according to test form 0074-0069 for each tested power pack. The power pack must run at steady state conditions and the oil temperature must be between 40-50°C.
    Any deviation from design data is to be reported. The hydraulic power capacity must be within the system power balance.

附件3

TEST REPORT
HYDRAULIC POWER UNIT
ELECTRIC MOTOR DRIVEN

FRAMO

No.: 0074-0069
Rev/Date.:
Page 1

FM Order No.	617600		
Customer/ ShipYard	**CSBC Corp. Taiwan**	**Hull No.**	1053
Test engineer(s)	J.Bayer/S.Krydsby/T.Bøthun	**Test date**	28.09.2015

Measuring object

Unit	**Maker**	**Type**
Electric motor	ABB	M3BP 355 MLA 4
Hydraulic Pump	Rexroth	A4VSO520 DP30R

Capacity

		Rated	**Recorded data**	
Power pack No.			**PP1**	**PP2**
Serial No. *Electric motor*			3G1F1521264667	3G1F1521264668
Serial No. *Hydraulic pump*			34431475	34431476
Input Power	[kW]		477	465
Shaft Power	[kW]	470	458	446
Frequency	[Hz]	60	60,43	60,4
Efficency :	[%]	96,0		
Power factor : Cos. φ		0,86	0,843	0,849
Average Voltage	[V]	440	439	439
Average Current +2%	[A]	745	729	723
Thermistor	[Ω]		225	193
Heater	[Ω]		181	181
Heater	[Ω]		184	181
Speed	[rpm]	1788		
System pressure, Pso	[bar]	279 +/- 2	277	277
System pressure relief valve setting	[bar]	299	(at Qmin)	
Back-up valve setting	[bar]	304	(at Qmin)	
Pilot pressure relief valve settings	[bar]	NA		
PCV driver card input	[VDC]	8,4	7,49	
Pressure control valve current min	[mA]	0	35	
Pressure control valve current max	[mA]	600	566	
Hydraulic oil flow	[l/min]	856 +/- 2	856	855
Suction pressure	[bar]	6 +/ 1	6,36	6,38
Oil temperature - Tank	[°C]	40-50	42,4	41,6
Oil temperature - Suction	[°C]	40-50	43,3	42,5
Oil temperature - Drain	[°C]	max 80	60,0	60,5
Insulation test @ 500 VDC	[MΩ]	>100MΩ	>550MΩ	>550MΩ
Total oil flow	[l/min]	3442		
Ambient temperature	[°C]	ca.23	20,8	20,8

☑ Alarms are checked according to alarm check list no. 1400-0384

☑ Chip detectors are tested and cleaned.

Remarks

Test engineer

Stian Krydsby
29.09.2015

Framo Fusa AS FRAMO QUALITY CONTROL

Witnessed by Framo

S. Krydsby

Witnessed by

9/29/15'

9/29/15'

FRAMO	TEST REPORT HYDRAULIC POWER UNIT Auxiliary Unit	No.: 0074-0069 Rev/Date.: Page 2

FM Order No.	617600		
Customer/ ShipYard	**CSBC Corp. Taiwan**	**Hull No.**	1053
Test engineer(s)	J.Bayer/S.Krydsby/T.Bøthun	**Test date**	28.09.2015

Measuring object(s)

Unit	Maker	Type
Feed pump	ABB	M3AA 132 SMB 2 HO
Jocky pump		
Hydraulic pump	Leistritz	L3MS45/90-IFOKO-W

Capacity

Electric motor		**Rating data**	**Recorded data**		
Jocky pump no			**1**	**2**	**3**
Rated power	[kW]	12,5	12,5	12,5	12,5
Serial No. *Electric motor*			3G1P152403118	3G1P152403119	3G1P152403120
Serial No. *Hydraulic pump*			26442-15	26443-15	26444-15
Frequency	[Hz]	60	60	60	60
Effiency	[%]	91,8	na	na	na
Power factor : Cos. φ		0,94	na	na	na
			Measured Data		
Speed	[rpm]	3486	3550	3550	3550
Heater	[Ω]		478	468	482
Voltage	[V]	440 D	440	440	440
Current	[A]	19,4	9	9	9
Oil temperature - Tank	[°C]	max.60	45	45	45

Measuring object(s)

Unit	Maker	Type
Oil cooler	Framo	DPK 406-1800-VS7

Capacity

Oil cooler		**Rating data**		**Additional info**
Serial No.		41822544		
Year		2015		
Areal	[m2]	29,1		

Remarks

Test engineer	Witnessed by Framo	Witnessed by	Witnessed by
Stian Krydsby 29.09.2015			

TEST REPORT
HYDRAULIC POWER UNIT
DIESEL ENGINE

FRAMO

No.:	**0074-0069**		
Rev/Date.:			
Page	3		

FM Order No.	617600		
Customer/ ShipYard	**CSBC Corp. Taiwan**	**Hull No.**	1053
Test engineer(s)	J.Bayer/S.Krydsby/T.Bøthun	**Test date**	28.09.2015

Measuring object(s)

Unit	**Maker**	**Type**
Diesel Engine	Cummins	KTA19-D(M1)
Hydraulic pump	Rexroth	A4VSO500 DP30R

Capacity		**Full speed - Full load test**				
		Rating data	**Recorded data**			
Power pack No.			**3**	**4**		
Serial No. *Diesel Engine*			37265806	37265808		
Serial No. *Hydraulic pump*			34431477	34431478		
Rated power	[kW]		485	485		
			Measured test data			
Oil temperature - Tank	[°C]	40 - 50	42,6	42,9		
Oil temperature - Suction	[°C]	40 - 50	43,5	43,8		
Oil temperature - Drain	[°C]	max. 80	57	57		
System pressure at HPU	[bar]	279 +/- 2	277	278		
Hydraulic oil flow at MP6	[l/min]	865 +/- 2	866	865		
Suction pressure at HPU	[bar]	6 +/ 1	6,36	6,38		
Exhaust-temp	[°C]	max.500	458	454		
Speed	[rpm]	1800	1800	1800		
Internal Inlet cool. water temp.	[°C]		81	82		
Internal Outlet cool. water temp.	[°C]		73	74		
External Inlet cool. water temp.	[°C]		32	33,2		
External Outlet cool. water temp.	[°C]		48,7	49,3		
External cool. water flow	[m/h]		14,1	14,1		
External cooling water dP press.	[bar]		2,9	2,9		
Engine Lubrication Oil press.	[bar]		4,9	4,8		
Engine Lubrication Oil temp.	[°C]		85	87		
Ambient temperature	[°C]		20,7	19,8		

REMARKS

Test engineer

Stian Krydsby
29.09.2015

Framo Fusa AS FRAMO QUALITY CONTROL

Witnessed by Framo

9/29/15

Witnessed by

9/29/15

Framo

B.

TEST REPORT
HYDRAULIC POWER UNIT
DIESEL ENGINE

FRAMO

No.: 0074-0069
Rev/Date.:
Page 4

FM Order No.	617600		
Customer/ ShipYard	**CSBC Corp. Taiwan**	**Hull No.**	1053
Test engineer(s)	J.Bayer/S.Krydsby/T.Bøthun	**Test date**	28.09.2015

Measuring object(s)

Unit	**Maker**	**Type**
Starting system: Air [x]	TDI Turbstart TWO	45MA-301R-066-5-5F
Electric [ ]		

Control system

Full speed - Full load

Diesel engine		**Rating data**	**Measured test data**		
Power Pack No.			**3**	**4**	
Number of teeths at flywheel	[no.]		142	142	
Starter unit / serial no.			1503-0837	1503-0836	
EFC - unit serial no.			19751393	19571604	
Speed	[rpm]	1800 : + 5 / -10	1800	1800	
EFC supply voltage	[VDC]	24.0 : +/- 15 %	23,57	23,72	
Actuator voltage	[VDC]	8 - 16.0 Vdc	10,5	10,32	
Speed sensor signal level at EFC	[VAC]	20 +/- 2 Vac	19,34	19,2	
Speed sensor signal level at PLC	[VAC]	14 +/ -2 Vac	13,42	13,29	
			Low speed - No load		
		Rating data			
Power Pack No.			**3**	**4**	
Speed	[rpm]	1500 : + 50 / -50	1520	1516	
Actuator voltage	[VDC]	7 - 9.0 Vdc	8,5	8,18	
Speed sensor signal level at EFC	[VAC]	16 +/- 2 Vac	16	16	
Speed sensor signal level at PLC	[VAC]	12 +/ -2 Vac	12,07	12,31	

Measuring object(s)

Unit	Maker	Part No.
Electric Fuel control (EFC)	Cummins	3098693

Diesel EFC card adjustment

Full speed - Full load

Diesel engine : Cummins		**Rating data**	**Measured test data**		
Power Pack No.			**3**	**4**	
Gain	[0-100%]	20 - 60 %	25	25	
Droop	[0-100%]	0 %	0	0	
Damping [Jumper between A-B]		NO	NO	NO	

DIESEL TEMPERATURE SENSOR TEST Test method reference doc.no 0222-7235-3

Power Pack No.		**3**		**4**		
MEASURED TEST DATA		Alarm	Shutdown	Alarm	Shutdown	
Setting	[°C]	96	99	96	99	
Calibrator value	[°C]	96,2	99,2	97	100	
Measured value	[mA]	14,24	14,58	14,26	14,59	
Displ. Contr Panel	[°C]	96	99	96	99	
PLC Software counts		960	990	960	990	
Ambient temp	[°C]	22		22		

REMARKS

Test engineer	Witnessed by Framo	Witnessed by	Witnessed by
Stian Krydsby			
29.09.2015		9/29/15	9/29/15

Framo Fusa AS FRAMO QUALITY CONTROL

TEST REPORT
HYDRAULIC POWER UNIT
ELECTRIC MOTOR DRIVEN

No.: 0074-0069
Rev/Date.:
Page 1

FM Order No.	617601		
Customer/ ShipYard	**CSBC Corp. Taiwan**	**Hull No.**	1054
Test engineer(s)	J.Bayer/S.Krydsby/T.Bøthun	**Test date**	29.09.2015

Measuring object

Unit	**Maker**	**Type**
Electric motor	ABB	M3BP 355 MLA 4
Hydraulic Pump	Rexroth	A4VSO520 DP30R

Capacity

		Rated	**Recorded data**	
Power pack No.			**PP1**	**PP2**
Serial No. *Electric motor*			3G1F1521264669	3G1F1521264670
Serial No. *Hydraulic pump*			34431479	34431480
Input Power	[kW]		465	462
Shaft Power	[kW]	470	446	444
Frequency	[Hz]	60	60,48	60,5
Efficency :	[%]	96,0		
Power factor : Cos. φ		0,86	0,842	0,853
Average Voltage	[V]	440	439	439
Average Current +2%	[A]	745	730	718
Thermistor	[Ω]		196,6	198,7
Heater	[Ω]		181,4	181,7
Heater	[Ω]		181,3	185,9
Speed	[rpm]	1788		
System pressure, Pso	[bar]	279 +/- 2	279	279
System pressure relief valve setting	[bar]	299	(at Qmin)	
Back-up valve setting	[bar]	304	(at Qmin)	
Pilot pressure relief valve settings	[bar]	NA		
PCV driver card input	[VDC]	8,4	7,51	
Pressure control valve current min	[mA]	0	33	
Pressure control valve current max	[mA]	600	571	
Hydraulic oil flow	[l/min]	856 +/- 2	857	858
Suction pressure	[bar]	6 +/ 1	6,59	6,63
Oil temperature - Tank	[°C]	40-50	42,7	42,4
Oil temperature - Suction	[°C]	40-50	43,0	42,8
Oil temperature - Drain	[°C]	max 80	59,0	60,0
Insulation test @ 500 VDC	[MΩ]	>100MΩ	>550MΩ	>550MΩ
Total oil flow	[l/min]		3446	
Ambient temperature	[°C]	ca.23	23,9	24

☑ Alarms are checked according to alarm check list no. 1400-0384

☑ Chip detectors are tested and cleaned.

Remarks

Test engineer

Stian Krydsby
29.09.2015

Framo Fusa AS FRAMO QUALITY CONTROL

Witnessed by Framo

Witnessed by

9/29/15

TEST REPORT
HYDRAULIC POWER UNIT
Auxiliary Unit

FRAMO

No.: 0074-0069
Rev/Date.:
Page 2

FM Order No.	617601		
Customer/ ShipYard	**CSBC Corp. Taiwan**	**Hull No.**	1054
Test engineer(s)	J.Bayer/S.Krydsby/T.Bøthun	**Test date**	29.09.2015

Measuring object(s)

Unit	**Maker**	**Type**
Feed pump	ABB	M3AA 132 SMB 2 HO
Jocky pump		
Hydraulic pump	Leistritz	L3MS45/90-IFOKO-W

Capacity

Electric motor		**Rating data**	**Recorded data**		
Jocky pump no			**1**	**2**	**3**
Rated power	[kW]	12,5	12,5	12,5	12,5
Serial No. *Electric motor*			3G1P152403121	3G1P152403122	3G1P152403123
Serial No. *Hydraulic pump*			26445-15	26452-15	26457-15
Frequency	[Hz]	60	60	60	60
Effiency	[%]	91,8	na	na	na
Power factor : Cos. φ		0,94	na	na	na
			Measured Data		
Speed	[rpm]	3486	3550	3550	3550
Heater	[Ω]		466	481	479
Voltage	[V]	440 D	440	440	440
Current	[A]	19,4	9,1	9,5	9,1
Oil temperature - Tank	[°C]	max.60	45,8	45,9	46

Measuring object(s)

Unit	**Maker**	**Type**
Oil cooler	Framo	DPK 406-1800-VS7

Capacity

Oil cooler		**Rating data**		**Additional info**
Serial No.		41822530		
Year		2015		
Areal	[m2]	29,1		

Remarks

Test engineer: Stian Krydsby 29.09.2015

Witnessed by Framo

Framo Fusa AS FRAMO QUALITY CONTROL

Witnessed by 9/29/15

Witnessed by 9/29/15

TEST REPORT
HYDRAULIC POWER UNIT
DIESEL ENGINE

FRAMO

No.:			**0074-0069**
Rev/Date.:			
Page			3

FM Order No.	617601		
Customer/ ShipYard	**CSBC Corp. Taiwan**	**Hull No.**	1054
Test engineer(s)	J.Bayer/S.Krydsby/T.Bøthun	**Test date**	29.09.2015

Measuring object(s)

Unit	**Maker**	**Type**
Diesel Engine	Cummins	KTA19-D(M1)
Hydraulic pump	Rexroth	A4VSO500 DP30R

Capacity

Full speed - Full load test

		Rating data	**Recorded data**			
Power pack No.			**3**	**4**		
Serial No. *Diesel Engine*			37265809	37265810		
Serial No. *Hydraulic pump*			34431481	34431482		
Rated power	[kW]		485	485		
			Measured test data			
Oil temperature - Tank	[°C]	40 - 50	42,8	43		
Oil temperature - Suction	[°C]	40 - 50	43,1	43,3		
Oil temperature - Drain	[°C]	max. 80	61	59		
System pressure at HPU	[bar]	279 +/- 2	279	279		
Hydraulic oil flow at MP6	[l/min]	865 +/- 2	866	865		
Suction pressure at HPU	[bar]	6 +/ 1	6,60	6,61		
Exhaust-temp	[°C]	max.500	448	449		
Speed	[rpm]	1800	1800	1800		
Internal Inlet cool. water temp.	[°C]		82,3	82,3		
Internal Outlet cool. water temp.	[°C]		75,6	74,1		
External Inlet cool. water temp.	[°C]		32,8	34,8		
External Outlet cool. water temp.	[°C]		49,7	51		
External cool. water flow	[m/h]		14,1	14,1		
External cooling water dP press.	[bar]		2,9	2,9		
Engine Lubrication Oil press.	[bar]		4,5	4,8		
Engine Lubrication Oil temp.	[°C]		91,6	92,1		
Ambient temperature	[°C]		23,8	23,8		

REMARKS

Test engineer

Stian Krydsby
29.09.2015

Framo Fusa AS FRAMO QUALITY CONTROL

Witnessed ~~by Framo~~

9/29/15'

Witnessed by

9/9/15'

TEST REPORT
HYDRAULIC POWER UNIT
DIESEL ENGINE

FRAMO

No.: 0074-0069
Rev/Date.:

FM Order No.	617601		
Customer/ ShipYard	**CSBC Corp. Taiwan**	**Hull No.**	1054
Test engineer(s)	J.Bayer/S.Krydsby/T.Bøthun	**Test date**	29.09.2015

Measuring object(s)

Unit	**Maker**	**Type**
Starting system: Air [x]	TDI Turbstart TWO	45MA-301R-066-5-5F
Electric [ ]		

Control system

Full speed - Full load

Diesel engine		**Rating data**	**Measured test data**		
Power Pack No.			**3**	**4**	
Number of teeths at flywheel	[no.]		142	142	
Starter unit / serial no.			1506-0334	1506-0337	
EFC - unit serial no.			19784432	19733070	
Speed	[rpm]	1800 : + 5 / -10	1800	1800	
EFC supply voltage	[VDC]	24.0 : +/- 15 %	23,67	23,68	
Actuator voltage	[VDC]	8 - 16.0 Vdc	10,79	10,68	
Speed sensor signal level at EFC	[VAC]	20 +/- 2 Vac	19,79	20,08	
Speed sensor signal level at PLC	[VAC]	14 +/ -2 Vac	15,26	14,06	
		Low speed - No load			
		Rating data			
Power Pack No.			**3**	**4**	
Speed	[rpm]	1500 : + 50 / -50	1516	1514	
Actuator voltage	[VDC]	7 - 9.0 Vdc	8,51	8,78	
Speed sensor signal level at EFC	[VAC]	16 +/- 2 Vac	16,37	16,63	
Speed sensor signal level at PLC	[VAC]	12 +/ -2 Vac	13,53	12,52	

Measuring object(s)

Unit	Maker	Part No.
Electric Fuel control (EFC)	Cummins	3098693

Diesel EFC card adjustment

Full speed - Full load

Diesel engine : Cummins		**Rating data**	**Measured test data**		
Power Pack No.			**3**	**4**	
Gain	[0-100%]	20 - 60 %	25	25	
Droop	[0-100%]	0 %	0	0	
Damping [Jumper between A-B]		NO	NO	NO	

DIESEL TEMPERATURE SENSOR TEST Test method reference doc.no 0222-7235-3

Power Pack No.		**3**		**4**		
MEASURED TEST DATA		Alarm	Shutdown	Alarm	Shutdown	
Setting	[°C]	96	99	96	99	
Calibrator value	[°C]					
Measured value	[mA]					
Displ. Contr Panel	[°C]	96	99	96	99	
PLC Software counts		960	990	960	990	
Ambient temp	[°C]					

REMARKS

Test engineer Witnessed ~~by Framo~~ Witnessed by Framo Witnessed by

Stian Krydsby
29.09.2015

Framo Fusa AS FRAMO QUALITY CONTROL

9/29/15

9/29/15

SHIP NAME	:
OWNER	:
SHIPYARD/ HULL NO	:
CLASSIFICATION SOCIETY	:
FRAMO ORDER NO.	:

Date/signature: _____
OWNER REPRESENTATIVE

Date/signature: _____
CLASS REPRESENTATIVE

Date/signature: _____
YARD REPRESENTATIVE

Date/signature: _____
FRAMO COMISSIONING ENGINEER

Notes:

HYDRAULIC SYSTEM					**T 1: Inhouse test**	**T 2: Commissioning test**	
Instr. no.	**Application**	**Setpoint / Timedelay**	**Function**	**Remark**	**T 1**	**T 2**	**Comment**
PT1	System pressure low	40 bar / 5 sec.	Alarm FM panel Common alarm	Alarm inhibited if no power packs are running	**OK**		
PT2	Feed pressure low	2.0 bar / 3 sec.	Alarm FM panel Common alarm Common trip Shutdown power packs Shutdown feed pumps	Only when feed pumps running in high capacity mode (Time delay 5sec. when start in high capacity mode.)	**OK**		
	Protection pressure low	2.0 bar / 30 sec.	Alarm FM panel Common alarm	Powerpacks not running	**OK**		
		4.0 bar / 20 sec.	Alarm FM panel Common alarm	Powerpacks running	**OK**		
TT1(A)	Oil temperature high	60 º C / 2 sec.	Alarm FM panel Common alarm		**OK**		#1 Alternative No.1 (ref. dedicated instrument list)
	Unload power packs at high temperature. Re-load power packs at normal temperature	> 65 º C < 60 º C	Power packs running are unloaded one by one each minute until all except one is unloaded. Power packs running are re-loaded one by one in 1 sec. intervals	Indicated by flashing run lamps and by re-trig of high oil temperature lamp. * Function not active when run in Thruster Mode	**OK**		
TT1(B)	Open/close cooling water valve	50 º C - 30 º C		Also see “cooling system failure” alarm below. (Instr.no XV1)	**OK**		#1 Alternative No.2 (ref. dedicated instrument list)
	Open cooling water valve when transmitter failure.	Output < 2 mA	Open cooling water valve.		**OK**		
	Oil temperature sensor failure	TT1A - TT1B Δ t : [5] º C delay 60 sec.	Alarm FM panel Common alarm		**OK**		

HYDRAULIC SYSTEM					**T 1: Inhouse test**	**T 2: Commissioning test**	
Instr. no.	**Application**	**Setpoint / Timedelay**	**Function**	**Comment**	**T 1**	**T 2**	**Comment**
PT3	Main filter dirty	PT3 - PT2 (Δp) > 2.5 bar / 5 min.	Alarm FM panel Common alarm	Alarm inhibited when hydr. oil temperature is below 30 degr.C	**OK**		**Alternative No.2*** (ref. dedicated instrument list)
LSH1-2	HPU oil leakage	2 sec	Alarm FM panel Common alarm		**OK**		
ZS1-n	Local suction line closed	Open contact	Alarm FM panel Stop corresponding p.pack Common alarm	One instrument for each power pack -n pcs power packs installed	**OK**		
ZS11-12	Main return line closed	Open contact	Alarm FM panel Shutdown power packs Shutdown feedpumps Common alarm Common trip	Restart feed pump in low capacity mode	**OK**		
LT1	Oil level low	[redacted]% (ref. dedicated instrument list)	Alarm FM panel Common alarm	Powerpack not running : time delay 20 sec. Powerpack running:, time delay 5 sec.	**OK**		
	Oil level high	[redacted] % (ref. dedicated instrument list)	Alarm FM panel Common alarm	Powerpack not running: time delay 20 sec. Powerpack running, :time delay 5 sec.	**OK**		
	Oil level low low	[redacted] % (ref. dedicated instrument list) 2 sec.	Alarm FM panel Shutdown power packs Shutdown feed pumps Common alarm Common trip		**OK**		

HYDRAULIC SYSTEM					**T 1: Inhouse test**	**T 2: Commissioning test**	
Instr. no.	**Application**	**Setpoint / Timedelay**	**Function**	**Comment**	**T 1**	**T 2**	**Comment**
XS1-n	Wear indication	Closed contact 0.5 sec.	Alarm FM panel Common alarm	One instrument for each power pack -n pcs power packs installed.	OK		
XV1	Cooling system failure	Internal / 60 sec.	Alarm FM panel Common alarm	Alarm to be init. when mismatch between command and feedback signal to cooling valve or temperature transmitter loop failure at temp sensor TT1B.			#2
HSx-y,	Emergency stop, hydraulic system	Open contact	Alarm FM panel Shutdown power packs Shutdown feed pumps Common alarm Common trip				#3
HS1-n	EM'CY STOP Cargo pumps	Open contact	Alarm FM panel Shutdown cargo pumps Common alarm	n pcs buttons installed			#3
Sz	Emergency stop, hydraulic system	Open contact	Alarm FM panel Shutdown power packs Shutdown feed pumps Common alarm Common trip	(-Sz located on hydraulic system control panel)	OK		
	PLC failure	Internal	Alarm FM panel Common alarm	Alarm if plc mal function	OK		
	Power failure	External / internal, 2 sec	Alarm FM panel Common alarm	Alarm if failure to AC input or internal DC power supply.	OK		

HYDRAULIC SYSTEM – optional alarms.					**T 1: Inhouse test**	**T 2: Commissioning test**	
	Communication failure	Internal	Alarm FM panel Common alarm	Alarm if serial link failure to diesel engine control system. Remote control lamp is flashing for actual powerpack.			**#4**
	Communication failure	Internal/ external	Alarm FM panel Common alarm	Alarm if serial link failure to integrated control system.			**#4**
	Inert gas pressure low	Open contact / 0.5 sec.	Alarm FM panel Trip cargo pumps	Input signal from external system.			**#4**
	Cargo discharge pressure high	Open contact / 0.5 sec.	Alarm FM panel Stop cargo pumps	Input signal from external system.			**#4**
TEx-y	High bearing temp. Booster pump	T > 80 °C 1 sec.	Alarm FM panel Common alarm				**#4**
XVx	Cooling system failure (bypass valve)	Internal / 60 sec.	Alarm FM panel Common alarm	Alarm to be init. when mismatch between command and feedback signal to cooling valve or temperature transmitter loop failure.			**#5**

DIESEL ENGINE CONTROL SYSTEM					**T 1: Inhouse test**	**T 2: Commissioning test**	
Instr. no.	**Application**	**Setpoint / Timedelay**	**Function**	**Comment**	**T 1**	**T 2**	**Comment**
TTxx-yy	Cooling water temp.high	96 °C, 3 sec.	Alarm diesel panel Common alarm to FM panel Common alarm to Ship syst.	One instrument for each power pack -n pcs power packs installed			**#6**
	Cooling water temp.high high	100 °C, 3 sec.	Alarm diesel panel Shutdown diesel engine Common trip Common alarm to Ship syst.	One instrument for each power pack -n pcs power packs installed			**#6**
PTxx-yy	Lube oil pressure low	1.8 bar, 4 sec.	Alarm diesel panel Common alarm to FM panel Common alarm to Ship syst.	One instrument for each power pack -n pcs power packs installed	**OK**		
	Lube oil pressure low low	1.3 bar, 1 sec.	Alarm diesel panel Shutdown diesel engine Common trip Common alarm to Ship syst.	One instrument for each power pack -n pcs power packs installed	**OK**		
TSxx-yy	Lube oil temp high	120 °C, delay3 sec.	Alarm diesel panel Common alarm to FM panel Common alarm to Ship syst.	One instrument for each power pack -n pcs power packs installed			**#6**
LSxx-yy	Cooling water level low	Open contact, 3 sec.	Alarm diesel panel Common alarm to FM panel Common alarm to Ship syst.	One instrument for each power pack -n pcs power packs installed	**OK**		
STxx-yy	Overspeed	1860 RPM, 1.0 sec.	Alarm diesel panel Shutdown diesel engine Common trip Common alarm to Ship syst.	One instrument for each power pack -n pcs power packs installed	**OK**		

NOTE ! (Only for new systems, systems which is first in serie delivered from FMFU after June 2014, see dedicated system drawings)

DIESEL ENGINE CONTROL SYSTEM					**T 1: Inhouse test**	**T 2: Commissioning test**	
Instr. no.	**Application**	**Setpoint / Timedelay**	**Function**	**Comment**	**T 1**	**T 2**	**Comment**
PSLLn+1	Lube.Oil pressure Low low secondary stop	1.1 bar / 1 sec.	Alarm diesel panel Shutdown diesel engine Common trip/ alarm to Ship syst.	One instrument for each power pack -n pcs power packs installed			
TTHHn+1	Cooling water temp High high secondary stop	105 °C / 1 sec.	Alarm diesel panel Shutdown diesel engine Common trip/alarm to Ship syst.	One instrument for each power pack -n pcs power packs installed			
STn1 Nominell speed 1800 rpm	Engine overspeed	1890 rpm 4473 Hz / 1 sec.	Alarm diesel panel Shutdown diesel engine Common trip/alarm to Ship syst.	One instrument for each power pack -n pcs power packs installed			

Optional alarms : (All systems)

	Battery Charger fault (option)	Open contact, 60 sec.	Alarm diesel panel Common alarm to FM panel Common alarm to Ship syst.	Signal from battery charger. One charger for each power pack -n pcs power packs installed			
XVy	Cooling system failure Diesel engine cooling water valve. (install if sea water cooling)	Internal / 60 sec.	Alarm FM panel Common alarm	Alarm to be init. when mismatch between command and feedback signal to cooling valve.			**#7**

#1. Switch tested by manufacturer, cable installation on HPU and control panel circuit tested during inhouse test.
#2. Valve deliverd as separate item, tested by manufacturer. Control panel circuit tested during inhouse test.
#3. Switches delivered as separate items, tested by manufacturer. Control panel circuit tested during inhouse test.
#4. Control panel circuits tested during inhouse test.
#5. Valve delivered as separate item, tested by manufacturer. Control panel circuit tested during inhouse test.
#6. Sensor calibrated by manufacturer. Cable installation on HPU, Diesel Control panel- and main control panel circuits tested during inhouse test.
#7. Valve delivered as separate item, tested by manufacturer. Control panel circuit tested during inhouse test.

THRUSTER SYSTEM					**T 1: Inhouse test**	**T 2: Commissioning test**	
Instr. no.	**Application**	**Setpoint / Timedelay**	**Function**	**Comment**	**T1**	**T2**	**Result**
Sx	EM Stop Thruster	Open contact	Alarm thruster panels Common alarm thr. panels Shutdown thruster	One pcs em. stop button located at each thruster panel.	**OK**		
ST1	Speed fault	Joy stick command >38%, and speed feedback < 2% time delay: 10 sec.	Alarm thruster wheel house panel Common alarm thr. panels Shutdown thruster	When thruster is engaged only			**#8**
PT1	System pressure low	120 bar 20 sec.	Alarm thruster wheel house panel Common alarm thr. panels	Alarm if pressure command P > 150 bar and actual system press < 120 bar Alarm inhibited if thruster off			**#8**
	Reduced capacity	Internal	Alarm thruster wheel house panel Common alarm thr. panels	Alarm if insufficient number of powerpacks running.	**OK**		
	Power failure	Internal	Alarm thruster wheel house panel Common alarm thr. panels	Alarm if failure to powersupply needed for thruster operation	**OK**		
	Common alarm	Internal	Common alarm thr. panels	Any alarm in hydraulic system Alarm inhibited if thruster off.	**OK**		
	Gravity tank level low (option)	Open contact / 3 sec.	Alarm on thruster wheel house panel				**#8**

#8. Thruster panel- and control panel circuits tested during inhouse test.