

行政院所屬各機關因公出國人員出國報告書

(出國類別：其他)

赴挪威參加 PORSGRON 公司 746/747 船 STEERING GEAR SYSTEM 舵機系統檢驗

服務機關：中國造船股份有限公司

出國人：姓名	單	位	職	稱
苗安然	高雄總廠	勤業廠	工	程師
倪瑞吉	高雄總廠	艙裝廠	工	程師

出國地點：挪威

出國時間：89年09月26日 89年10月02日

壹、前言：

746/747 系列船 STEERING GEAR SYSTEM 舵機系統是 742~745 系列船 STEERING GEAR SYSTEM 舵機系統的延續。由於本系列船的舵機系統是本公司第一次使用無汽缸(Non Cylinder),無活塞(Non Ram), (如附圖：一, 二); 三部電力液壓泵的歐洲舵機系統(如附圖：三)。Progrunn Steering Gear A/S 公司是船東(MAERSK SHIP LINE---- A.P.MOLLER GROUP)指定廠家。因設計缺失, 致 742~745 系列船問題頻生, 故障頻發, 測試不順, 交船延誤。

Progrunn Steering Gear A/S 公司位於挪威 Progrunn 鎮。距奧斯陸二個小時的車程。746/747 船訂於 89.09.28~89.09.30 作 FAT (Factory Acceptance Test), 職苗安然、倪瑞吉等二員奉派前往參加測試檢驗, 以確保其品質與功能正常, 並預防日後安裝於船上時之一些問題, 及早做改善或預防, 使上船後之安裝及測試交驗工作順利。

船東(MAERSK SHIP LINE-- A.P.MOLLER GROUP)也基於先前 742~745 系列船的種種問題, 以及日後增建的考量, 電力部份(Electric Power part)直接從丹麥(A.P. MOLLER GROUP)派了一位設計人員 Mr.Thomas N. Nielsen; 液壓部份(Hydraulic part)向 HYDROPOWER 公司借了 Mr.Borge Dam Larsen, 而 LR 也派 Mr.Oyvind Bolstad 驗船師參加檢驗, 使能對本次的測試檢驗工作順利成功, 並對以後欲增建的新船有所益助。

貳、概述：

746/747(742~745)系列船 STEERING GEAR SYSTEM 舵機系統異於傳統方式，舵部份(Rudder part)使用無汽缸(Non Cylinder)、無活塞(Non Ram)的液壓推力裝置(如附圖：一、二)，(傳統方式有汽缸(Cylinder)、活塞(Ram)如附圖：四，五)；液壓動力部份(Hydraulic part)使用三部電力液壓泵(Electric Power Pump)，三部自動舵控制器(Auto Pilot Controller)的舵機系統(如附圖：三)，(傳統方式只有二部電力液壓泵，二部自動舵控制器)(如附圖：四操作說明)。

雖然，歐洲原廠已有能力和經驗，使用無汽缸(Non Cylinder)、無活塞(Non Ram)的液壓推力裝置；一部或二部電力液壓泵(Electric Power Pump)的舵機系統。無汽缸(Non Cylinder)、無活塞(Non Ram)當然可減少液壓洩漏故障之發生，為了要增加航行安全，於是船東(A.P.MOLLER)指定廠家，使用PLC(Programmingable Logic Controller可程式控制器)控制的三部電力液壓泵(3 Electric Power Pumps)的舵機系統。由於要三部電力液壓泵交互控制，廠家為第一次設計和使用，系統複雜，所以經驗不足，設計缺失，致問題頻生，故障頻發，測試不順，交船延誤，中船和船東抱怨連連。因此746/747系列原廠做了部份修改，增加系統的穩定性和推力。

另外自動舵Auto Pilot部份採用了Sperry Marine提供的控制系統，和其他系列船一樣，沒有特別的不同，但由CSBC整合。(不再述)

參、裝備測試檢驗：

一、測試時分兩部份執行：

- (1)、ELECTRO CONTROLLER 部份：在 Prosgrunn 鎮 Prosgrunn Steering Gear A/S 公司測試。
- (2)、HYDRAULIC POWERPACK 部份：在奧斯陸市 Rexroth Mecman A/S 公司測試, 是 Prosgrunn Steering Gear A/S 公司的 OEM 廠商。

二、測試時依下列測試順序執行：

- (1)、ELECTRO CONTROLLER 部份：

A. Checked correct function of alarm , signal lamps , and autostart system on starters , ECR and WH panel.

a. Run:

CONTROLLER

- | | | | |
|---|------|------|--------|
| - gives light in run lamp starter , ECR , WH. | Stb. | Port | Centre |
| - gives light in steering control ready ECR , WH. | Stb. | Port | Centre |

b. Stop:

- | | | | |
|---|------|------|--------|
| - gives light in heating lamp starter , ECR , WH. | Stb. | Port | Centre |
|---|------|------|--------|

Note ! Selector switch to be on.

c. Standby switch on:

Stb.	Port	Centre
------	------	--------

- gives light in St.by lamp , WH. Next pump automatic In stand by when starting one of the pumps. Stopped pump goes in “stand by” according to priority.

Note ! stand by priority

- | | | | |
|---|------|------|--------|
| g. Servo power alarm | Stb. | Port | Centre |
| <ul style="list-style-type: none"> - input from steering control system, gives servo power alarm ECR, WH and autostart next pump (if in st.by). out the alarm light. | | | |
| h. Overload alarm: | Stb. | Port | Centre |
| <ul style="list-style-type: none"> Activated overload relay - gives alarm overload ECR, WH and autostart next pump, (if in st.by). | | | |
| i. Hydraulic lock: | Stb. | Port | Centre |
| <ul style="list-style-type: none"> - gives alarm ECR, WH. Autostart of next pump, (if in st.by). | | | |
| j. External alarm: | Stb. | Port | Centre |
| <ul style="list-style-type: none"> output is worling. | | | |
| k. Filter clogged: | Stb. | Port | Centre |
| <ul style="list-style-type: none"> - gives alarm "Filter clogged" ECR and WH delayed. | | | |

B. Automatic separation based on oil loss:

Note ! This sequence only allow max two pumps in operation simultaneously

1. Port pump set Stb. in stand by
2. Stb. pump set Port in stand by

3. Centre pump set Stb. in stand by

4. Centre pump substitutes any one of the two others.

l. All pump stopped: oilsep.

Activation of LV0, LV1, LV2, LV3, And LV4, gives alarm only, (SGR, ECR, WH).

m. Test according to flow chart oilsep.

Appendix 1

C. Manual separation test

n. Separation over vanes oilsep.

Test according to Appendix 2

o. Separation over stoppers oilsep.

Test according to Appendix 2

p. Test switch on oil Separation cabinet. oilsep.

Test according to Appendix 2

q. High oil temperature alarm checked. oilsep.

r. Checked function rudder oilsep.

locking device.

s. Rudder low speed alarm checked. oilsep.

t. Checked oil cooler control checked. oilsep.

u. Checked filter pump control oilsep.

v. Black out test oilsep.

pump/pumps running prior to

black out shall start up automatically when power is regained.

(2)、HYDRAULIC POWERPACK 部份 : Appendix 3

A. Set values:

1. Safety valves, pos.80-81,to be set at 97.5 bar prior to the test.
2. Pump pressure, pos.40-42,to be set at 78 bar prior to pump functional test.
3. Pressure switch, pos.440-442,to be set at 10 bar falling pressure.
4. Pressure switch,pos.445-447,to be set at 30 bar falling pressure.

B. Test arrangement:

The power pack is to be tested with a hydraulic motor with throttle valves, simulating the steering machine.

C. Required certificates for electric motors and pumps to be delivered prior to test.

D. The test is carried out with 380V/50Hz, This affects flow and current.

E. Functional test:

a. Level switch:

All level switches to be checked during filling or draining of tank.

Pos.240:_____

Pos.241:_____

Pos.242:_____

Pos.540:_____

Pos.290:_____

b. Cooling circuits:

All cooling circuits lto be run for function and leakage control.

Pos.150: _____

Pos.151: _____

Pos.152: _____

c. Filtration circuits:

Fill up the separate leakage reservoir. Check visually that pos.530 is mounted correctly. Run the pump for function and leakage control.

d. Pump / valveblocks:

1. Pump pressure to be set at 78 bar. One pump / valvelock is tested at a time.
2. With the pump running. A raising signal starting at zero is given to spool A, pos.450. Maksimum flow at the testmotor I registrated. Function of the “spool movement switch”at pos.90 is checked. And signal level at trigger point noted.
3. With the pump running. A raising signal starting at zero is given to spool B, pos.450. Maksimum flow at the testmotor I registrated. Function of the “spool movement switch”at pos.90 is checked. And signal level at trigger point noted.
4. The procedure above is repeated for all three pumps / valveblock.

5. Pumps/valveblock,

pos. 40/130:

Flow A: _____ l/min

Pressure MA: _____ bar

Pos.90 Switch A: _____ mA

Flow B: _____ l/min

Pressure MB: _____ bar

	<u>Pos.90 Switch B: _____ mA</u>
pos. 41/131:	<u>Flow A: _____ l/min</u>
	<u>Pressure MA: _____ bar</u>
	<u>Pos.91 Switch A: _____ mA</u>
	<u>Flow B: _____ l/min</u>
	<u>Pressure MB: _____ bar</u>
	<u>Pos.91 Switch B: _____ mA</u>
pos. 42/132:	<u>Flow A: _____ l/min</u>
	<u>Pressure MA: _____ bar</u>
	<u>Pos.92 Switch A: _____ mA</u>
	<u>Flow B: _____ l/min</u>
	<u>Pressure MB: _____ bar</u>
	<u>Pos.92 Switch B: _____ mA</u>

e. Electric motors:

Current to main pump electric motors at maximum load.

<u>Pos.50: _____ Amp, _____ l/bar, _____ l/min</u>
<u>Pos.51: _____ Amp, _____ l/bar, _____ l/min</u>
<u>Pos.52: _____ Amp, _____ l/bar, _____ l/min</u>

F. Pressure test to be witnessed by Lloyds Register of Shipping. Test pressure 146 bar.

G. Oil quality control to be carried out prior to draining the tank. Documentation of this should follow this report.

H. HPU with valves tested: _____

Pressure test: _____

Adjusted set-values: _____

Calibrated equipment used: _____

肆、測試檢驗後，要求修改及澄清事項：

- 一、對於先前系列船(CSBC HULL No.742~745)和現在測試檢驗的 746/7 系列船，所有包括中船，船東及驗船師提出過之問題或缺點事項，必須於本 746/7 系列船完成測試，裝運前在廠方完成所有之修改。
- 二、廠方必須提供下列裝備，以利中船或船東於安裝或維護時使用：
 - (1)、三部ELECTRO CONTROLLER必須名牌標示 PORT, , CENTER, STARBOARD 以利區別和操作維護。
 - (2)、指示燈更換工具。
 - (3)、馬達/控制箱等有防水等級者須附裝Cable gland。
 - (4)、742~745之缺失在746/7修改後的完成圖和說明書，必須隨裝備交運至中船，以利安裝和測試。
- 三、所有的警報，其警示燈須同時亮，直到警報故障問題解決。
- 四、由於檢驗時 ELECTRO CONTROLLER 部份及 HYDRAULIC POWERPACK 部份為分別測試，依合約廠方必須派服務工程師到中船，負責執行裝備安裝後之 On board test，以及出海試航的 Acceptance test。

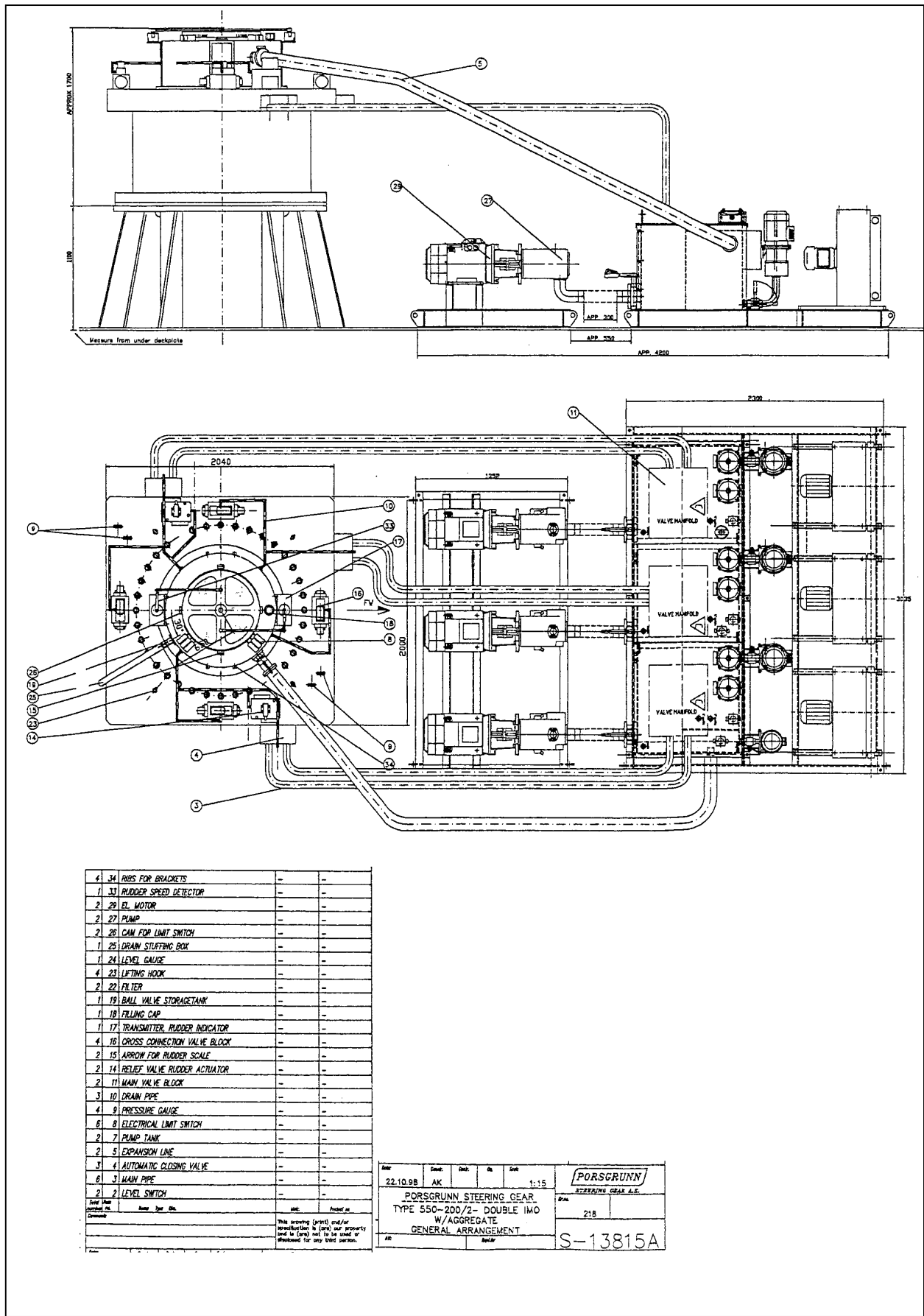
伍、心得:

- 1、了解 746/747 系列船 STEERING GEAR SYSTEM 舵機系統系列船在 ELECTRO CONTROLLER 部份充分利用 PLC(可程式控制器)，在控制功能上可任意修改之可塑性，先進於以往 Relay(電驛) 控制功能之固定性。
- 2、HYDRAULIC POWERPACK 部份使用無汽缸(Non Cylinder) 無活塞(Non Ram)的液壓推力裝置在減少液壓洩漏故障之發生，及液壓控制增加航行安全的考量設計。
- 3、整合舵機系統與自動舵控制系統，電羅經等航行安全和控制裝備及 Bridge 上之 Controller 和 Alarm Monitor，值班監視都全部統合在一起，而以資訊電腦自動化整合成一人管理(Integrated Bridge System) IBS 系統，提高航行安全與自動化，並節省人力。
- 4、進行測試以確認控制形式正確及功能正常。
- 5、進行測試中發現設計上之缺失及錯誤的改正，節省了真正安裝和調試時間，並使海試順利，降低裝備的損壞率，並節省造船成本。

陸、建議:

- 1、本系統的設計整合為公司第一次使用，錯誤及缺失難免較多，設計人員應多與原廠密切溝通，以減少後續船型的錯誤。
- 2、多培養先進裝備之優秀人才，以應付日後造船之趨勢和船東之需求。
- 3、本舵機系統的使用應是歐洲船東及船廠的趨勢，由於電裝工場除了新船的建造業務外，還負責修船業務，已經見過多次來修的歐洲船隻安裝本舵機系統，所以應多建立資料，吸收經驗，為修船業務做準備。

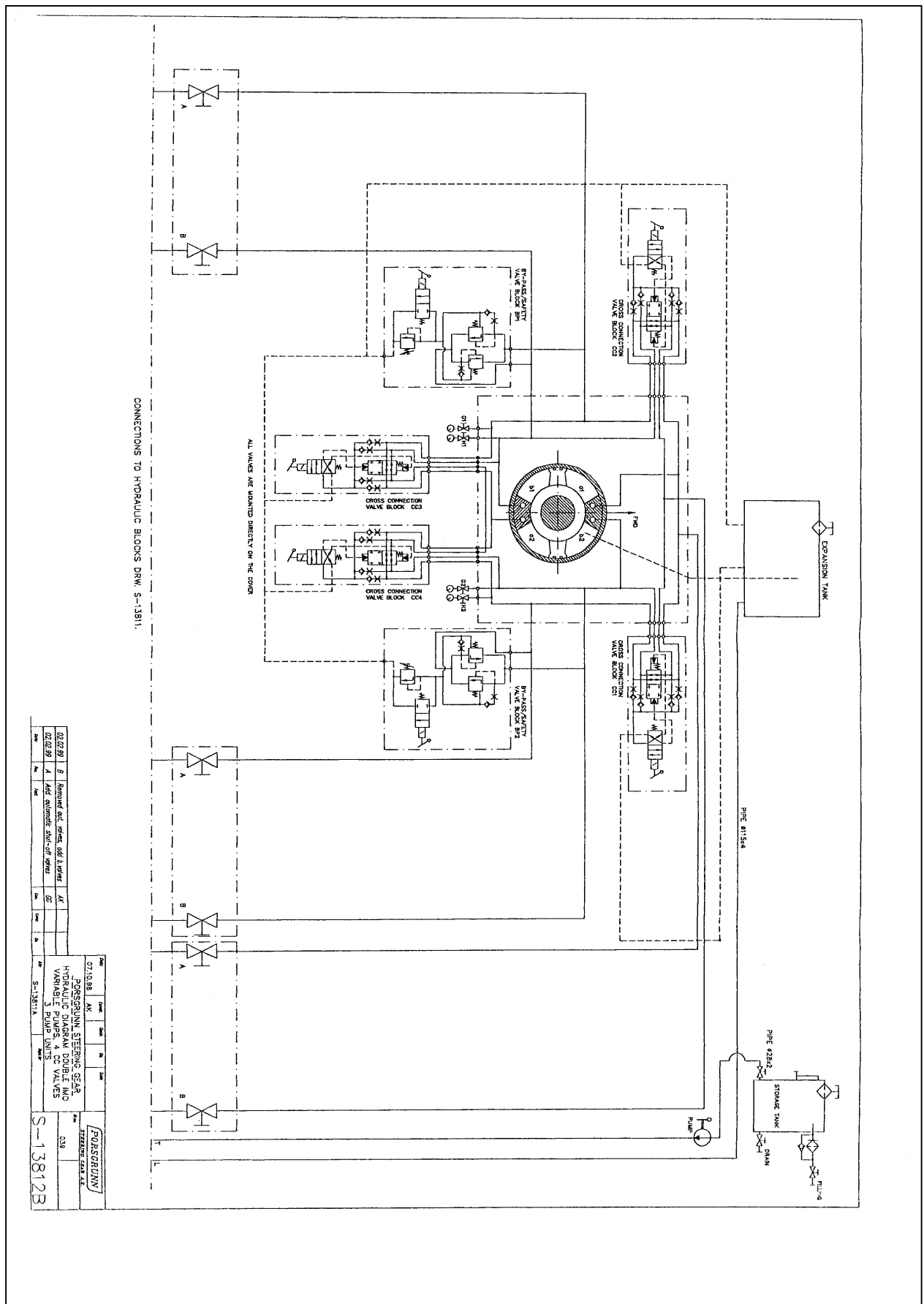
附圖：一、舵機系統圖



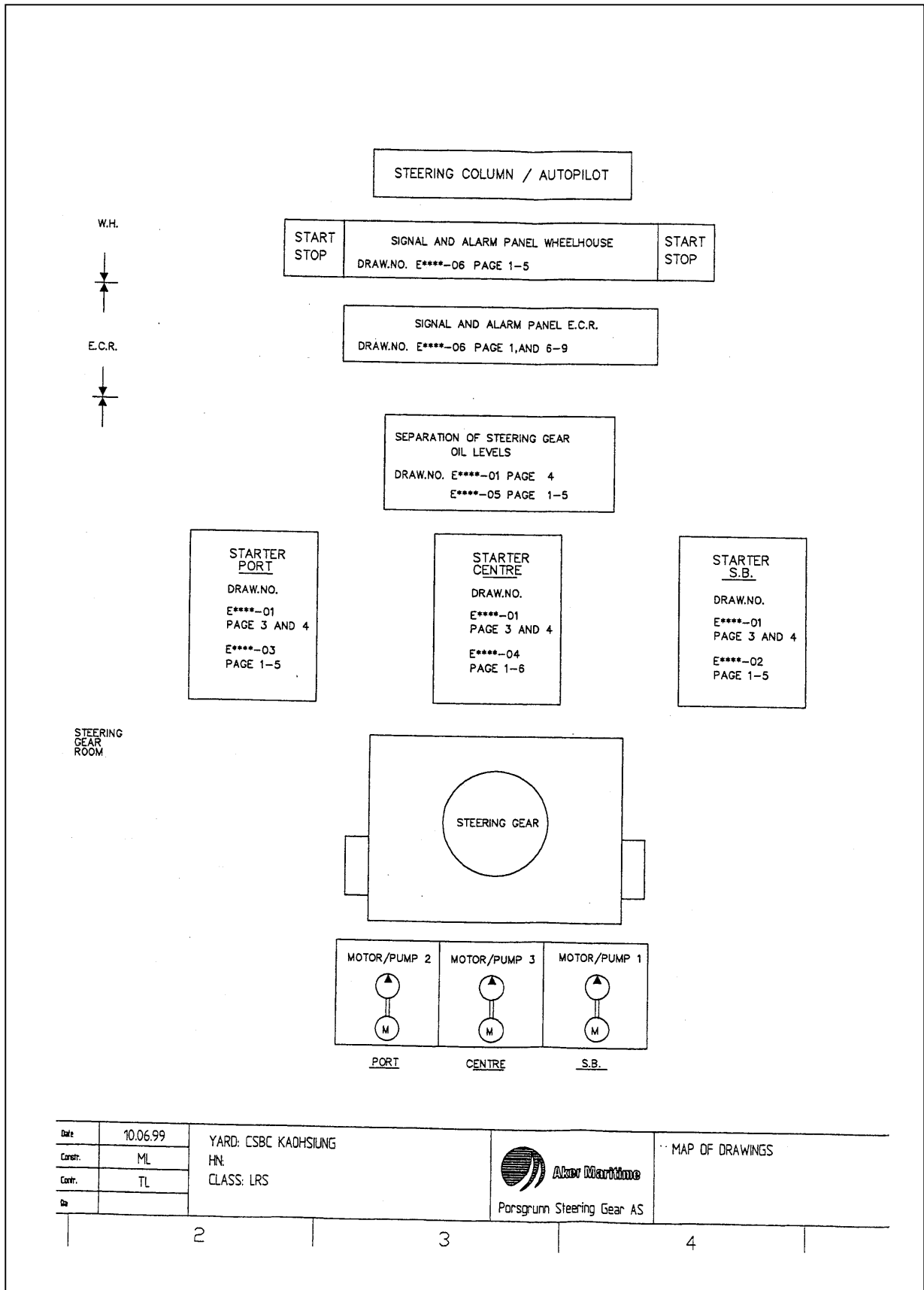
4	34	RIBS FOR BRACKETS	--	--
1	33	RUDDER SPEED DETECTOR	--	--
2	29	EL. MOTOR	--	--
2	27	PUMP	--	--
2	26	CAM FOR LIMIT SWITCH	--	--
1	25	DRAIN STUFFING BOX	--	--
1	24	LEVEL GAUGE	--	--
4	23	LIFTING HOOK	--	--
2	22	FILTER	--	--
1	19	BALL VALVE STORAGE TANK	--	--
1	18	FILLING CAP	--	--
1	17	TRANSMITTER, RUDDER INDICATOR	--	--
4	16	CROSS CONNECTION VALVE BLOCK	--	--
2	15	ARROW FOR RUDDER SCALE	--	--
2	14	RELIEF VALVE RUDDER ACTUATOR	--	--
2	11	MAIN VALVE BLOCK	--	--
3	10	DRAIN PIPE	--	--
4	9	PRESSURE GAUGE	--	--
6	8	ELECTRICAL LIMIT SWITCH	--	--
2	7	PUMP TANK	--	--
2	5	EXPANSION LINE	--	--
3	4	AUTOMATIC CLOSING VALVE	--	--
6	3	MAIN PIPE	--	--
2	2	LEVEL SWITCH	--	--

Date	22.10.98	Cont.	AK	Dist.	AK	Scale	1:15
PORSGRUNN STEERING GEAR TYPE 550-200/2- DOUBLE IMO W/AGGREGATE GENERAL ARRANGEMENT							
							PORSGRUNN STEERING GEAR A.S.
							218
							S-13815A

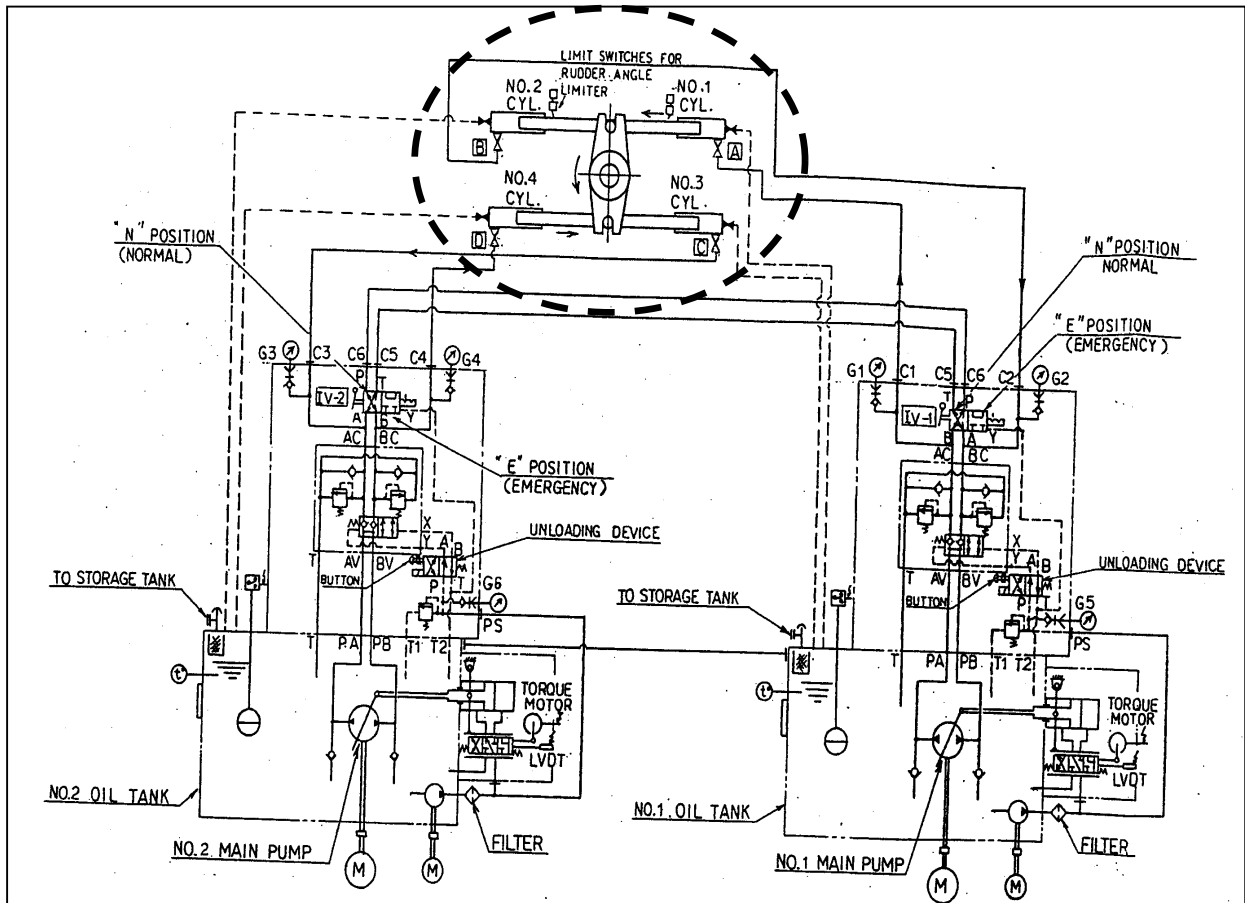
附圖：二、舵機系統液壓回路方塊圖



附圖：三、舵機系統控制回路方塊圖



附圖：四 傳統方式舵機系統有汽缸(Cylinder) 活塞(Ram)



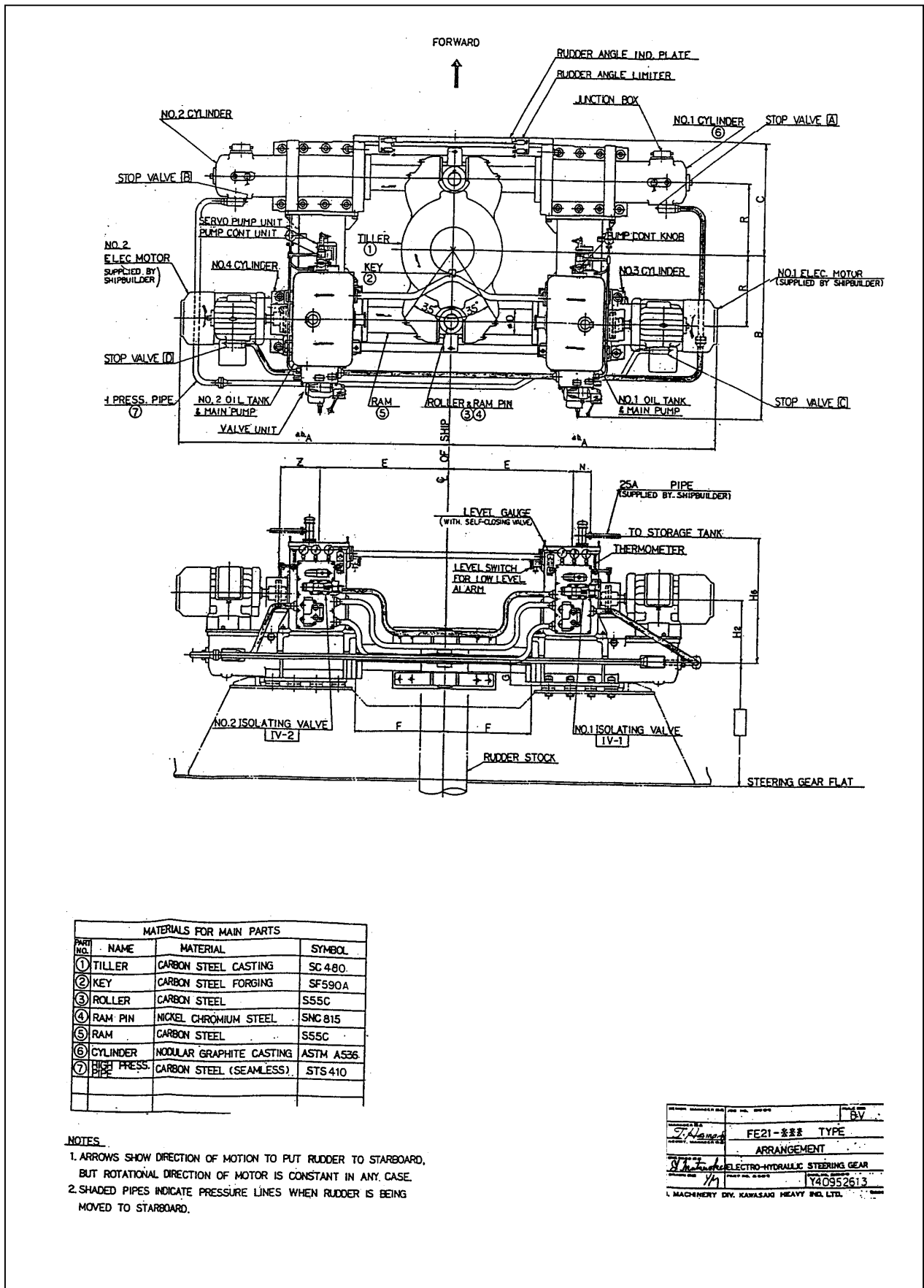
OPERATING INSTRUCTIONS					
CONDITION	WORK. PUMP	WORK. CYL.	POSITION OF ISOLATING VALVE		STOP VALVE
			IV-1	IV-2	
NORMAL	No.1	ALL	N	N	OPEN
	No.2		N	N	
TWO PUMPS USE	No.1&2	ALL	N	N	
EMERGENCY (ONE PUMP USE)	No.1	No.1&2	E	N	
	No.2	No.3&4	N	E	

• ARROWS INDICATE DIRECTION OF STARBOARD.
 • ◀▶ SHOWS THE NORMALLY CLOSED VALVE.

MATERIAL 材料	SENIOR MANAGER 部長	JOB NO. 圖號	RULE 規格
WEIGHT 重量	MANAGER 部長 <i>H.S.</i>	FE21-*** TYPE	BV
SCALE 尺度	ASSIST. MANAGER 部長 <i>H. Nakamura</i>		
3 RD ANGLE PROJECTION 3角法	CHECKED 檢核 <i>P. Sato</i>	HYDRAULIC CIRCUIT DIAGRAM	
DATE 作成日	DRAWN 圖師 <i>H. Nakamura</i>	ELECTRO-HYDRAULIC STEERING GEAR	
NOV. 26, 1986	PART NO. 部品號	DWG. NO. 圖號 Y 40950745	

HYD. MACHINERY DIV. KAWASAKI HEAVY IND. LTD.

附圖五、傳統方式舵機系統有四個汽缸、活塞



MATERIALS FOR MAIN PARTS			
PART NO.	NAME	MATERIAL	SYMBOL
①	TILLER	CARBON STEEL CASTING	SC 480.
②	KEY	CARBON STEEL FORGING	SF590A
③	ROLLER	CARBON STEEL	S55C
④	RAM PIN	NICKEL CHROMIUM STEEL	SNC 815
⑤	RAM	CARBON STEEL	S55C
⑥	CYLINDER	NOBULAR GRAPHITE CASTING	ASTM A536
⑦	PIPE PRESS.	CARBON STEEL (SEAMLESS)	STS 410

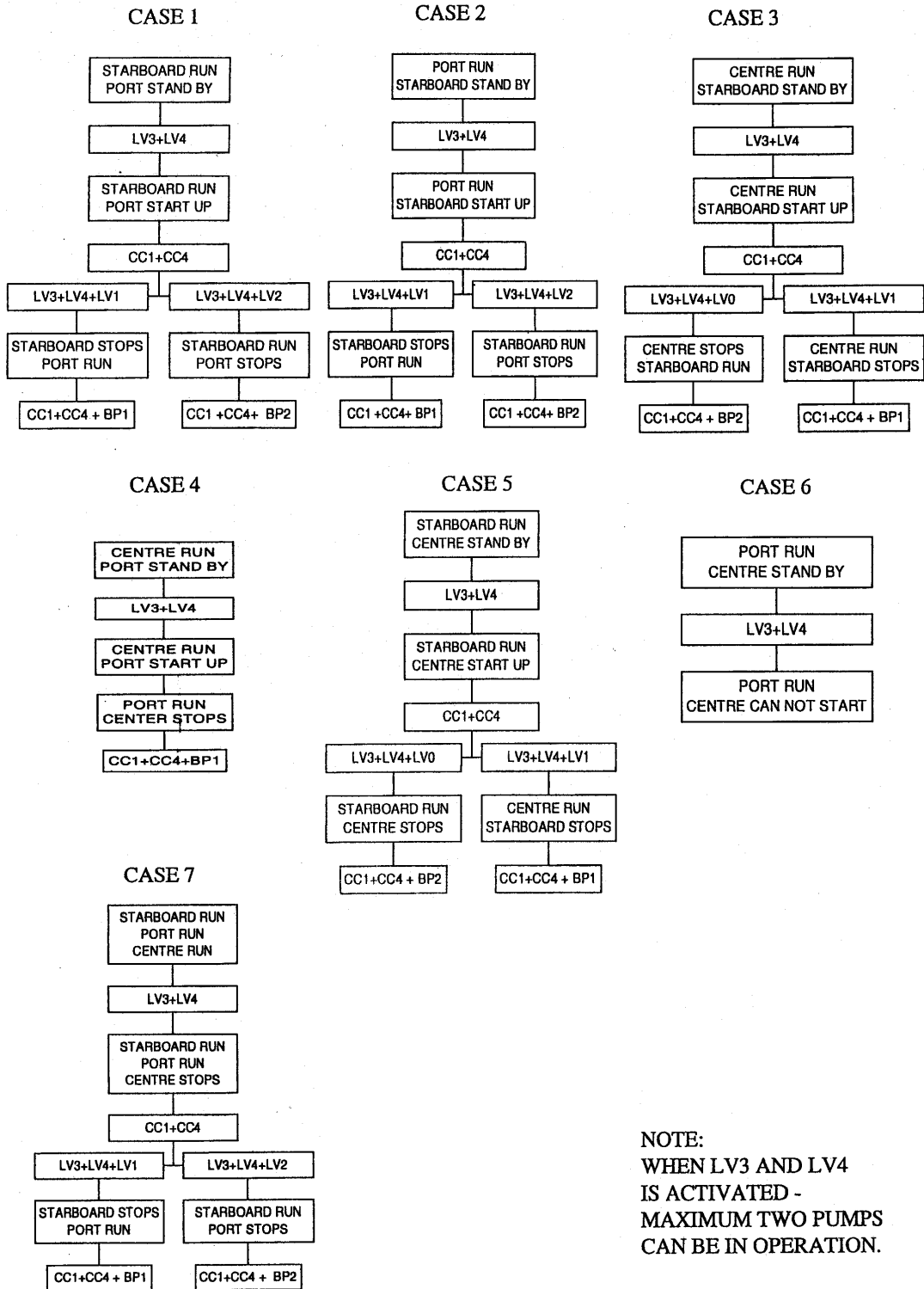
NOTES.

- ARROWS SHOW DIRECTION OF MOTION TO PUT RUDDER TO STARBOARD, BUT ROTATIONAL DIRECTION OF MOTOR IS CONSTANT IN ANY CASE.
- SHADED PIPES INDICATE PRESSURE LINES WHEN RUDDER IS BEING MOVED TO STARBOARD.

FE21-型	TYPE	BY
ARRANGEMENT		
ELECTRO-HYDRAULIC STEERING GEAR		
140952613		
MACHINERY DIV. KAWASAKI HEAVY IND. LTD.		

Appendix 1 、 測試流程圖

FLOW CHART FOR OIL-SEPARATION SYSTEM S-1414/S-1415



NOTE:
WHEN LV3 AND LV4
IS ACTIVATED -
MAXIMUM TWO PUMPS
CAN BE IN OPERATION.

Appendix 2、測試流程圖

CSBC: N746/747

MANUAL SEPARATION TEST

S-1414 / S1415

SEPARATION 1- VANES

PUMP RUNNING	CROSS CONNECTION VALVE ACTIVATED	BY PASS VALVE ACTIVATED
STARBOARD	CC1,CC4	BP2
PORT	CC1,CC4	BP1
CENTER	CC1,CC4	BP1
STB/PORT	CC1,CC4	
STB/CENTER	CC1,CC4	
PORT/CENTER	CC1,CC4	BP1 CENTRE STOPS
STB/PORT/CENTER	CC1,CC4	CENTRE STOPS

SEPARATION 2-STOPPERS

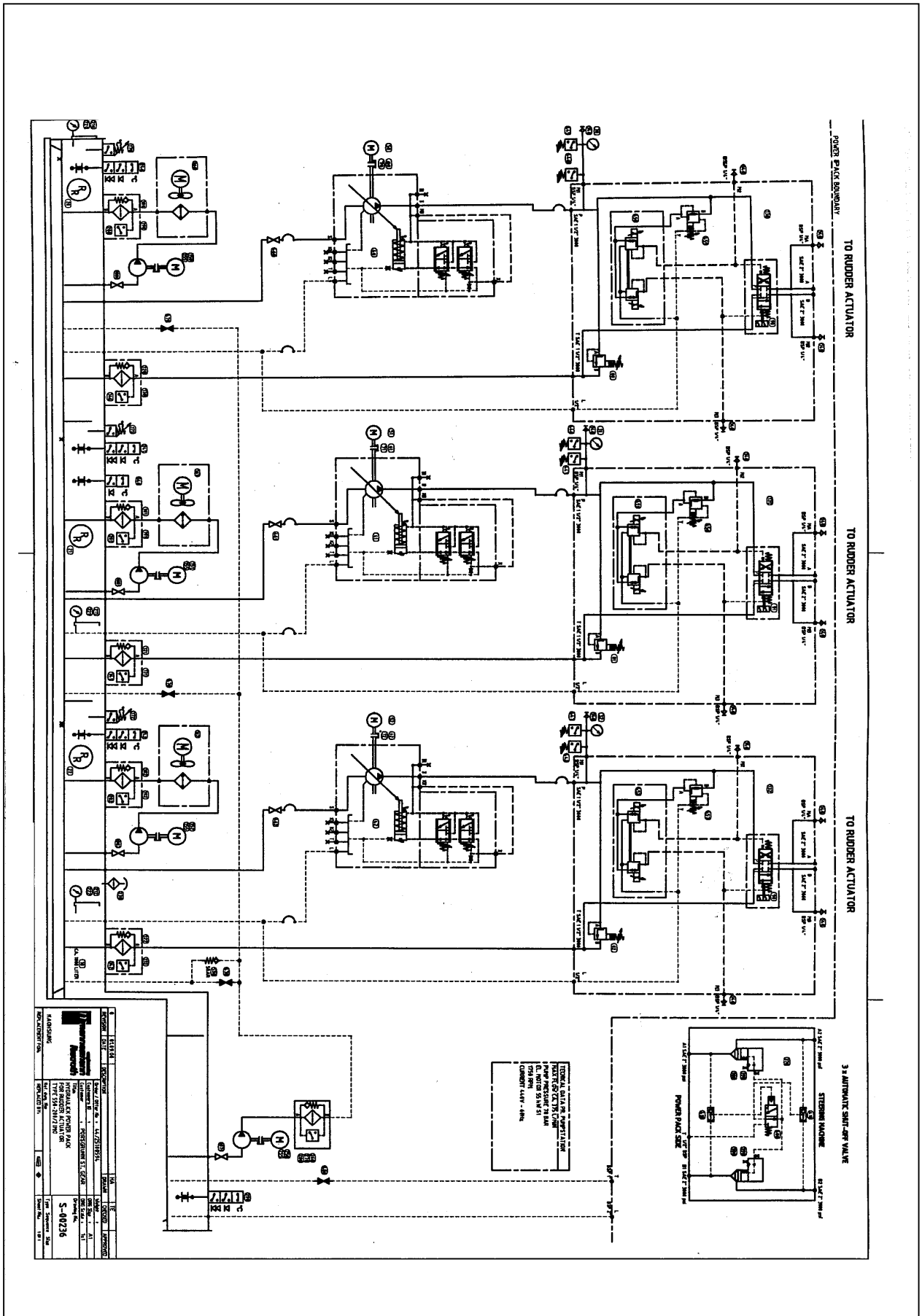
PUMP RUNNING	CROSS CONNECTION VALVE ACTIVATED	BY PASS VALVE ACTIVATED
STARBOARD	CC2,CC3	BP2
PORT	CC2,CC3	BP1
CENTER	CC2,CC3	BP2
STB/PORT	CC2,CC3	
STB/CENTER	CC2,CC3	BP2 CENTRE STOPS
PORT/CENTER	CC2,CC3	
STB/PORT/CENTER	CC2,CC3	CENTRE STOPS

TEST SWITCH ON OIL SEPARATION CABINET

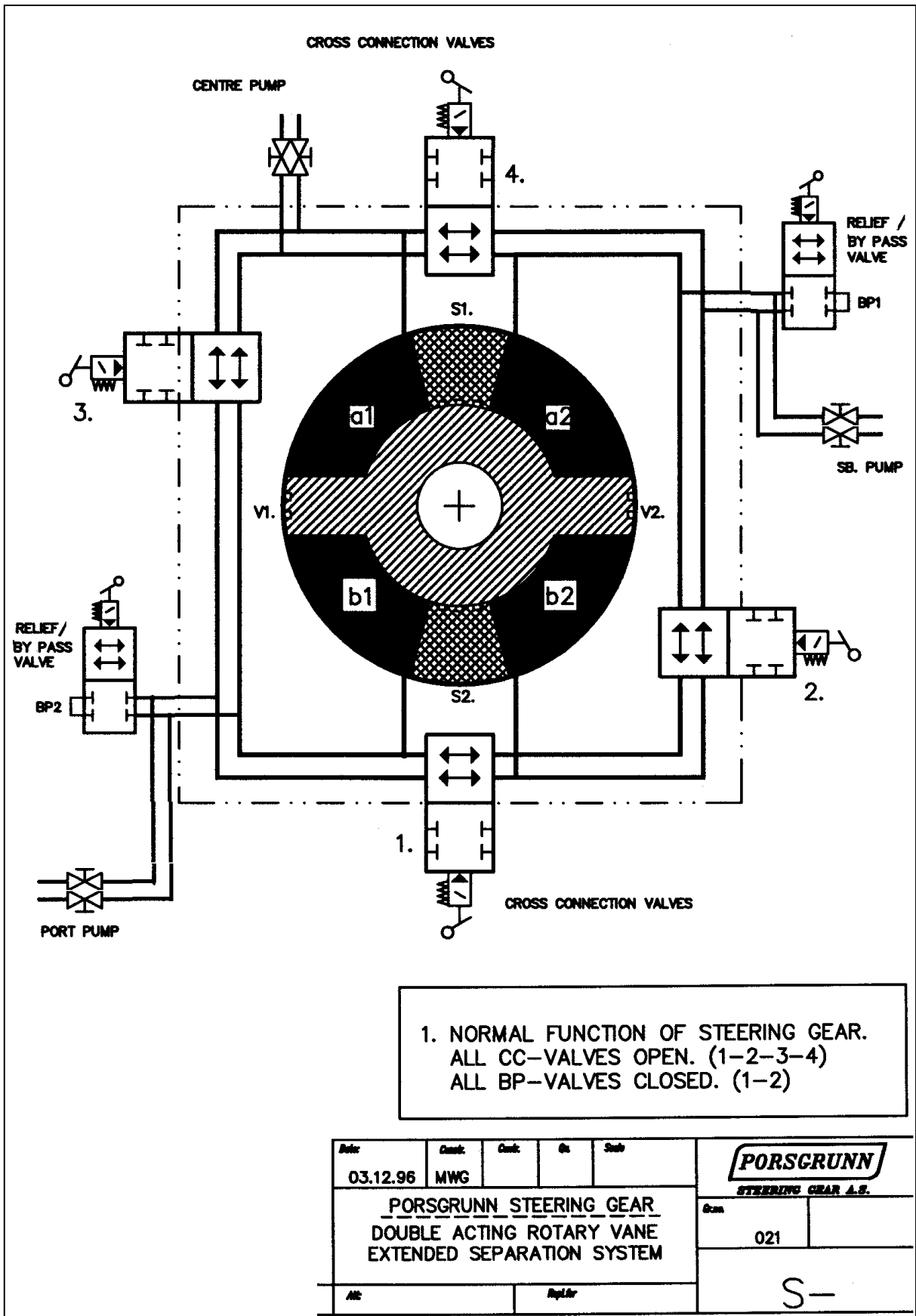
SWITCH POS.	CROSS CONNECTION VALVE ACTIVATED	BY PASS VALVE ACTIVATED
3 SEP. VANES PORT	CC1,CC4	BP1
4 SEP. VANES STB.	CC1,CC4	BP2
5 SEP. VANES CENTRE	CC1,CC4	BP1
6 SEP.- STOPPERS PORT	CC2,CC3	BP1
7 SEP. STOPPERS STB.	CC2,CC3	BP2
8 SEP. STOPPERS CENTER	CC2,CC3	BP2

manu.separation test.qa

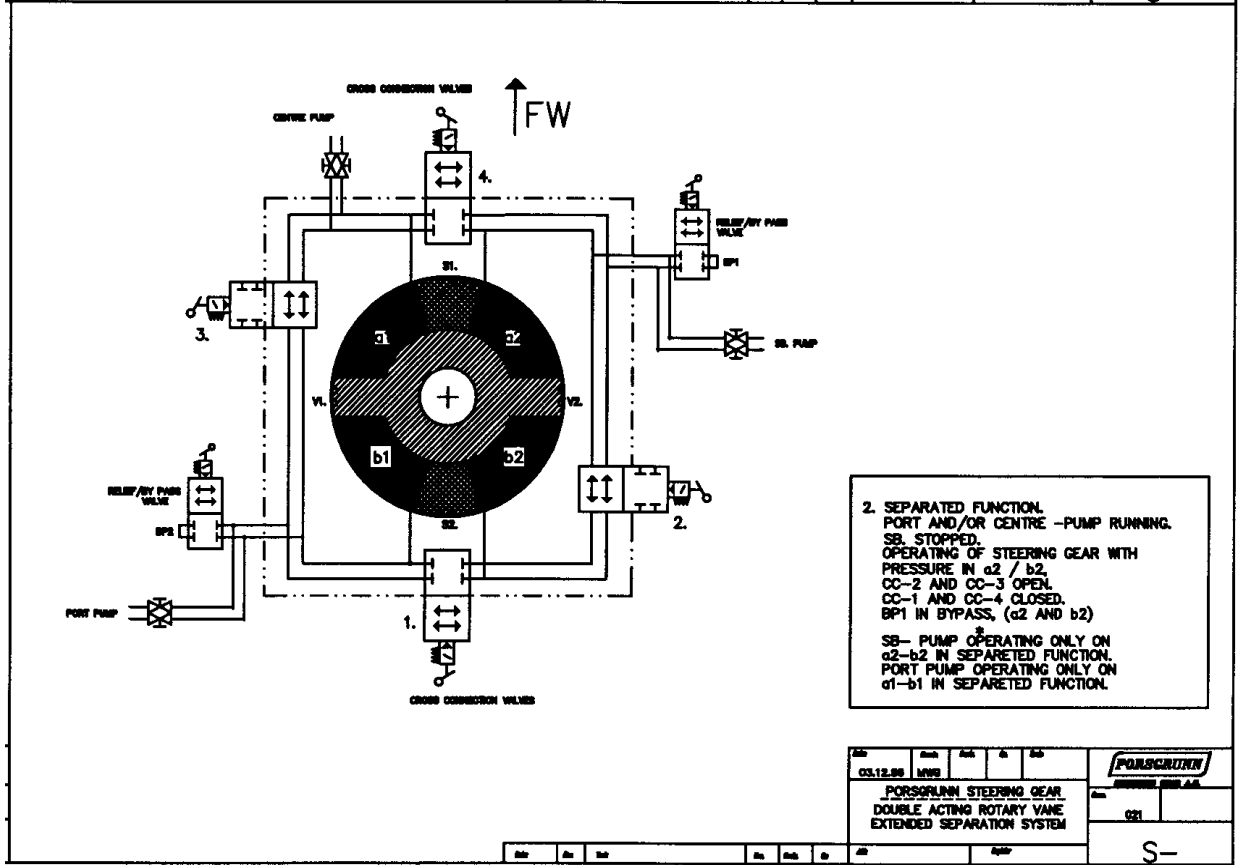
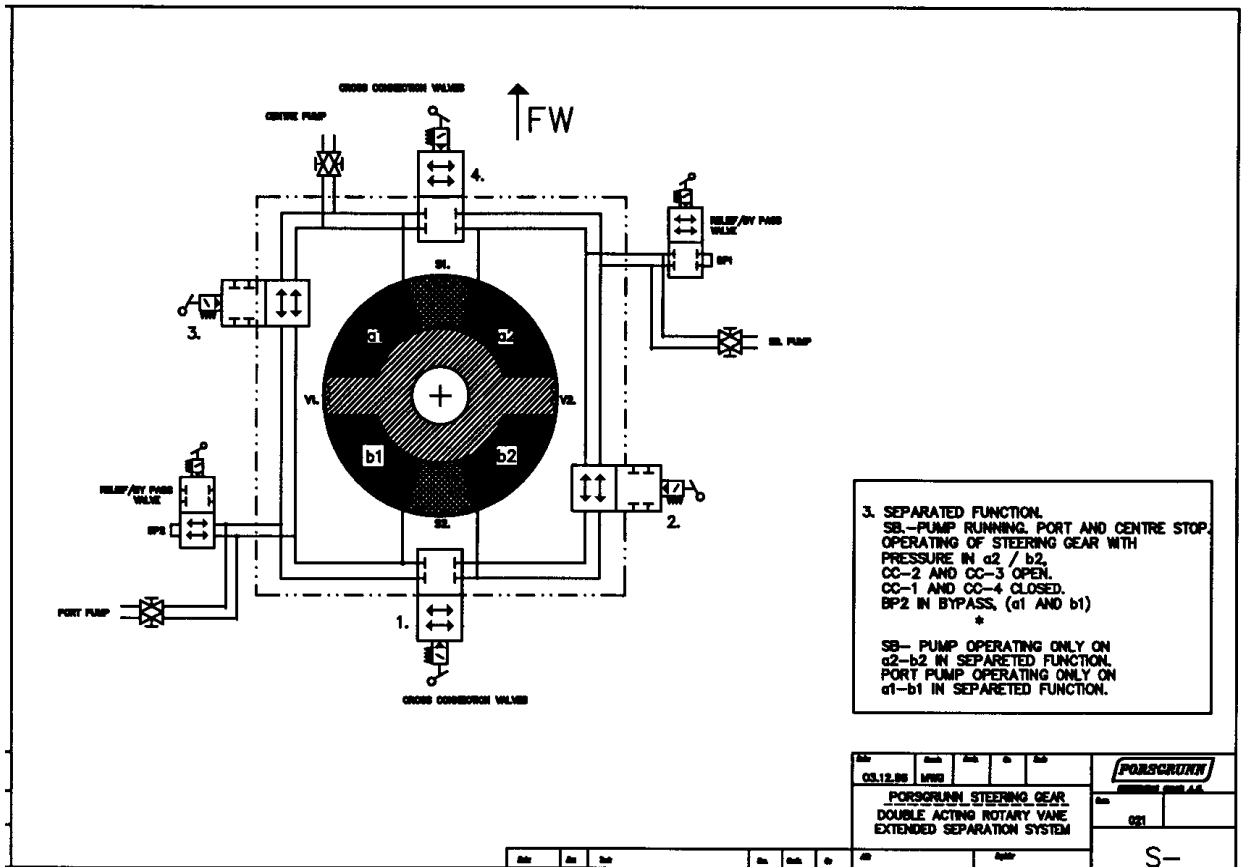
Appendix 3、液壓系統流程圖



Appendix 4、液壓控制流程圖(一)



Appendix 5、液壓控制流程圖(二)



Appendix 6、液壓控制流程圖(三)

