

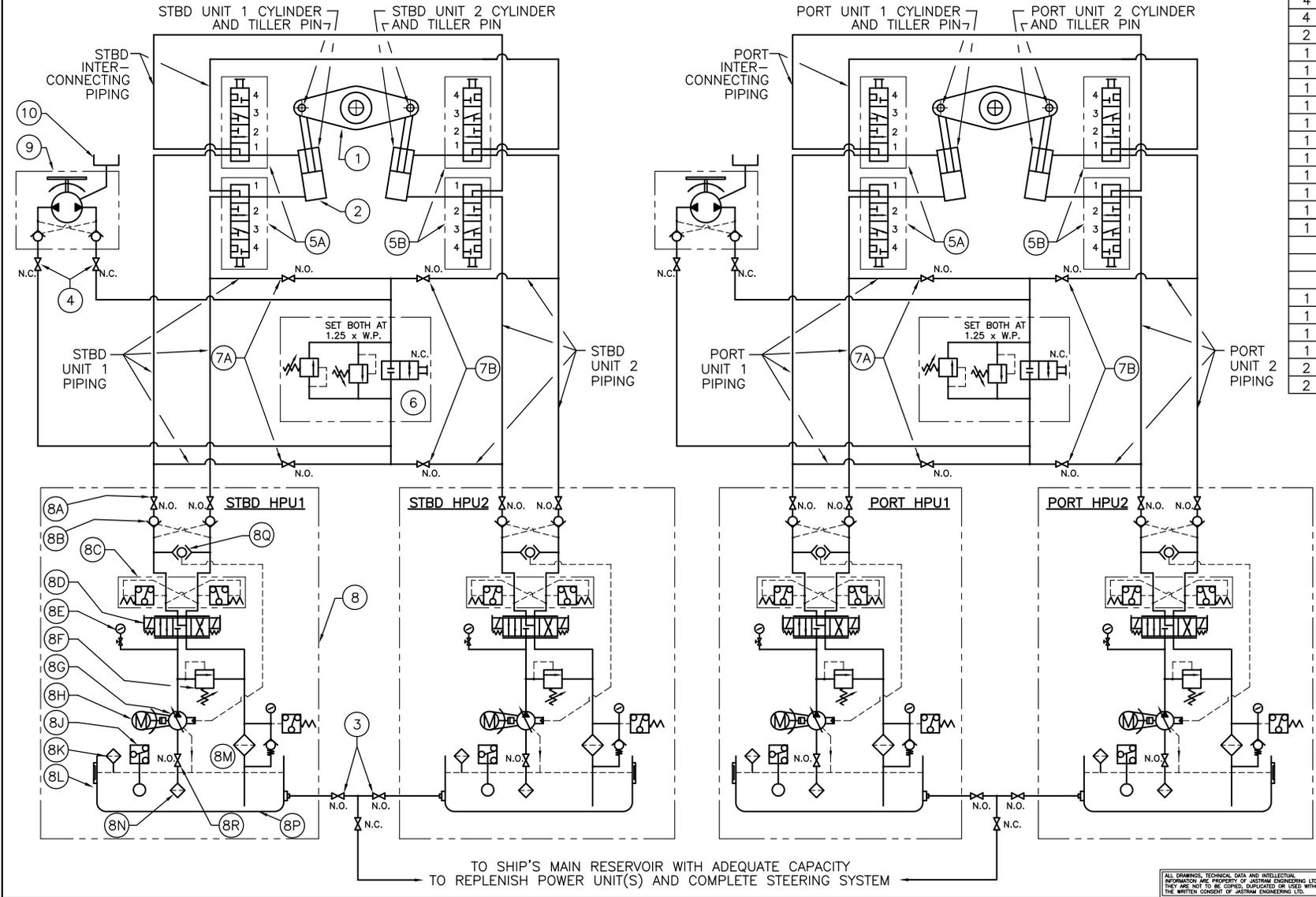
CONDITION	3-WAY VALVE POSITIONS		DARB ISOLATION VALVE POSITIONS	
	5A	5B	7A	7B
NORMAL	1	1	N.O.	N.O.
UNIT 1 PIPING FAILURE	3	1	CLOSED	N.O.
UNIT 2 PIPING FAILURE	1	3	N.O.	CLOSED
INTERCONNECTING PIPING FAILURE	2	2	N.O.	N.O.
UNIT 1 CYLINDER ISOLATION	*4	1	N.O.	N.O.
UNIT 2 CYLINDER ISOLATION	1	*4	N.O.	N.O.

*PRIOR TO SELECTING VALVE POSITION FOR CYLINDER, REMOVE CYLINDER'S TILLER PIN.

NOTES:
 1. ALL SOLENOID OPERATED VALVES ARE SHOWN IN THEIR DE-ENERGIZED STATE.
 2. N.O. - NORMALLY OPEN
 N.C. - NORMALLY CLOSED
 HPU - HYDRAULIC POWER UNIT
 W.P. - WORKING PRESSURE

3. SEE INDIVIDUAL COMPONENT O.A.D. DWG'S FOR LOCATION OF PRESSURE AND FLOW ADJUSTMENTS AS WELL AS ELECTRICAL CONNECTIONS.
 4. SHIPYARD IS RESPONSIBLE FOR PLACING IDENTIFICATION LABELS ON ALL UNIT 1 AND UNIT 2 3-WAY AND DARB ISOLATION VALVES ONCE INSTALLATION IS COMPLETE.

QTY.	ITEM	DESCRIPTION
2	1	TILLER
4	2	CYLINDER
6	3	RESERVOIR ISOLATION VALVE
4	4	HELM PUMP ISOLATION VALVE
4	5A	3-WAY ISOLATION VALVE - UNIT 1 PIPING
4	5B	3-WAY ISOLATION VALVE - UNIT 2 PIPING
2	6	DARB
4	7A	DARB ISOLATION VALVE - UNIT 1 PIPING
4	7B	DARB ISOLATION VALVE - UNIT 2 PIPING
4	8	HYDRAULIC POWER UNIT
2	8A	ISOLATION VALVE
1	8B	DUAL PILOT OPERATED CHECK
1	8C	HYDRAULIC LOCK SENSOR
1	8D	PROPORTIONAL 4-WAY DIRECTIONAL SOLENOID
1	8E	PRESSURE GAUGE AND ISOLATOR
1	8F	BACK UP RELIEF
1	8G	VARIABLE DISPLACEMENT PUMP
1	8H	ELECTRIC MOTOR
1	8J	LOW LEVEL SENSOR AND JUNCTION BOX
1	8K	AIR BREATHER AND FILLER
1	8L	SIGHT & TEMPERATURE GAUGE
1	8M	RETURN LINE FILTER w/ FILTER BYPASS
		DIFFERENTIAL PRESSURE GAUGE & FILTER CLOGGING SENSOR
1	8N	SUCTION LINE STRAINER
1	8P	RESERVOIR
1	8Q	SHUTTLE
1	8R	PUMP ISOLATION VALVE - LOCKABLE
2	9	HELM PUMP
2	10	HEADER TANK



FOR DISCUSSION
NOT FOR FINAL PRODUCTION

JQ131165
CCGS "EARL GREY"

REV.	DATE	DRAWING/DESIGN CHANGE No.	BY
Jastram			
<small>JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel.: (604) 988-1111 Fax: (604) 988-0334</small>			
DATE: 16-01-15	SCALE: N/A	DRAWN: C.Z.	APPR: N/A
TITLE: HYDRAULIC SCHEMATIC FOR TWIN S2-X-1-X REFIT			DRAWING NUMBER: D-611657

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TO SHIP'S MAIN RESERVOIR WITH ADEQUATE CAPACITY TO REPLENISH POWER UNIT(S) AND COMPLETE STEERING SYSTEM

1.4 TECHNICAL DESCRIPTION - STEERING GEAR

Drawing No.	Description
N.A.	Technical Specifications - Steering Gear
D-611657	Hydraulic Schematic

GENERAL

The steering system used in this vessel consists of two identical steering gears (port and starboard). Each steering gear can obtain a maximum of 16.0 T.m at +/- 35 degrees, at a working pressure of 1450 P.S.I.

The steering system consists of a main and auxiliary steering gear referred to as unit 1 and unit 2 respectively. The design is such that a failure in either the unit 1 or unit 2 steering gear will not render the other in-operable. A failure anywhere in the system can be isolated and steering quickly re-gained.

The steering system is protected from external forces on the rudder by a double acting relief and bypass valve (item 6 on the hydraulic schematic). The DARB valve is set to 1.25 times the working pressure. In this system, the DARB setting is 1815 psi.

The unit 1 steering gear's piping is independent of the unit 2 piping. These independent hydraulic lines are tied together at the 3-way shut off valves (items 5A and 5B) and at the DARB isolation valves (items 7A and 7B). The operation of these valves is described in the table on the hydraulic schematic. Through this piping and valve arrangement; if the unit 1 or unit 2 lines are isolated from one another, the DARB will still function to protect the steering gear.

The unit 1 and unit 2 steering gear are each provided with a hydraulic power unit. Each unit has its' own open reservoir, low level alarm sensor and hydraulic lock sensor.

MAIN STEERING GEAR (UNIT 1)

The unit 1 steering gear is power operated. Its hydraulic power unit (HPU - item 8) consists of a motor (item 8H), variable displacement pump (item 8G), power steering manifold mounted on top of an open reservoir (item 8P).

The power steering manifold incorporates a four way directional solenoid (item 8D) with manual over-ride plungers. These allow for local manual control of the steering gear power unit. The power steering manifold contains a dual pilot operated check (item 8B) at its outlet to lock the steering gear in position.

If the unit 1 piping or hydraulic power unit should fail, it can be isolated at its two 3-way shut-off valves and two DARB shut-off valves as described in the table for unit 1 piping failure.

If the unit 1 cylinder should require isolating from the tiller this can be accomplished by removing its cylinder to tiller pin and turning the cylinder's two 3-way shut-off valves as described in the table for unit 1 cylinder isolation. One cylinder only being in operation, the torque delivered to the rudder is reduced and the rudder speed is increased.

AUXILIARY STEERING GEAR (UNIT 2)

The unit 2 steering gear is power operated as well. Its hydraulic power unit, components and operation are identical to the unit 1 steering gear.

If the unit 2 piping or hydraulic power unit should fail, it can be isolated at its two 3-way shut-off valves and two DARB shut-off valves as described in the table for unit 2 piping failure.

If the unit 2 cylinder should require isolating from the tiller this can be accomplished by removing its cylinder to tiller pin and turning the cylinder's two 3-way shut-off valves as described in the table for unit 2 cylinder isolation. One cylinder only being in operation, the torque delivered to the rudder is reduced and the rudder speed is increased.

MANUAL STEERING GEAR

The steering gear is fitted with supplementary manual steering in the steering compartment. It is intended that this manual steering be used for emergency purposes only.

The circumstances requiring emergency steering might be a complete loss of the vessel's main and emergency switchboard AC power supplies.

The manual steering gear is operated from the helm pump (item 9) located in the steering compartment. The helm pump is provided with a header tank (item 10). Manual operation is accomplished by opening the helm pump isolation valves located below the helm pump. The helm pump is provided with a dual pilot operated check valve to lock the steering gear in position.

The hydraulic power unit isolation valves (items 8A) are to be closed shortly after the opening of the helm pump isolation valves in order to avoid fluid leakage from the helm reservoir to the main reservoir during manual operation of the steering gear.

CYLINDER INTERCONNECTING PIPING

The cylinder interconnecting lines allow the steering gear and DARB valve to be operational after a single failure in either the unit 1 or unit 2 piping. The interconnecting piping directs hydraulic fluid from the remaining operable power unit to both cylinders.

In the event that the cylinder interconnecting piping should fail, isolation of these lines can be achieved at the four 3-way shut-off valves as described in the table for interconnecting piping failure.

For Discussion

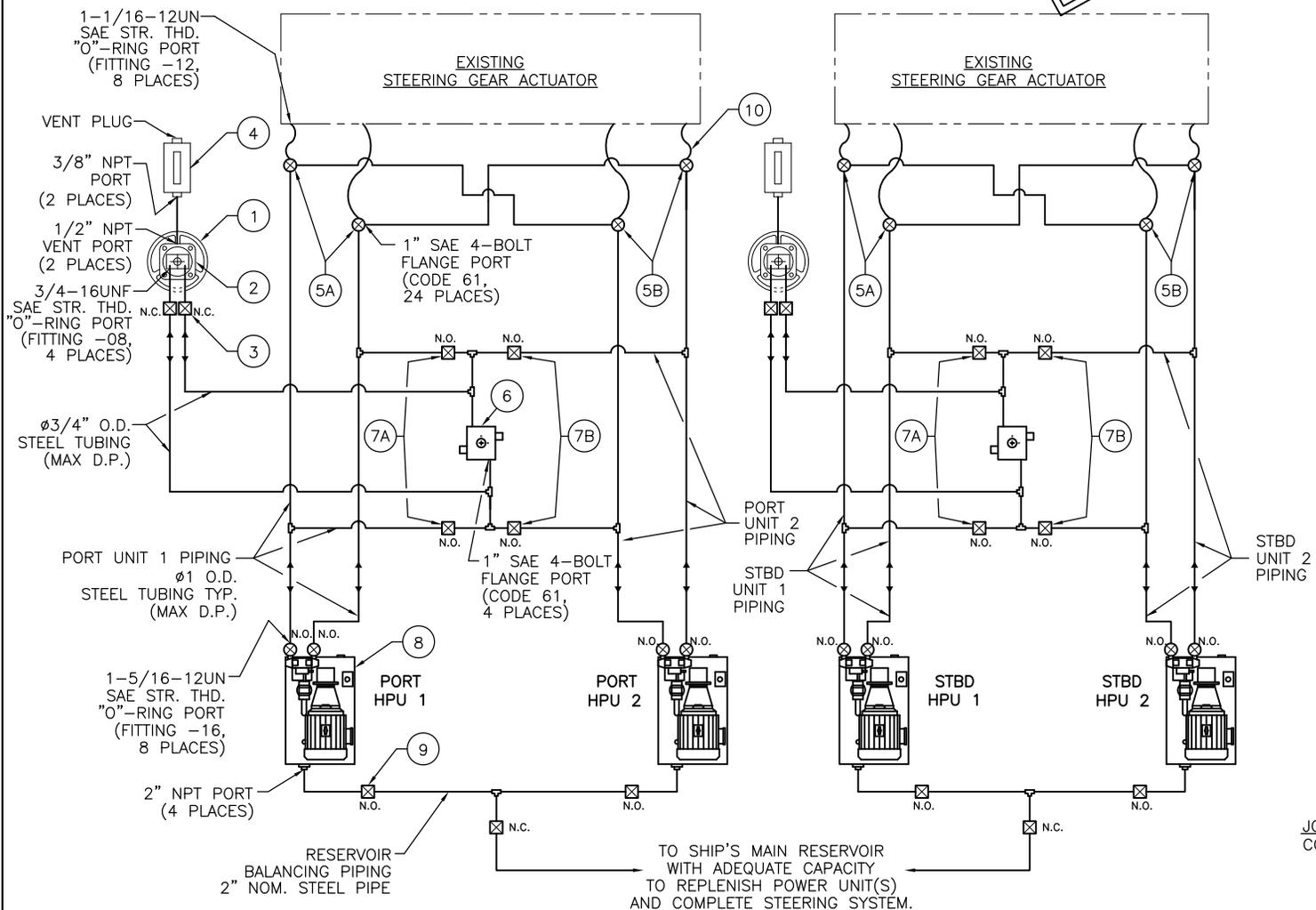
CONDITION	3-WAY VALVE POSITIONS		DARB SHUT-OFF VALVE POSITIONS	
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INTERCONNECTING PIPING FAILURE	2	2	N.O.	N.O.
UNIT 1 CYLINDER ISOLATION	*4	1	N.O.	N.O.
UNIT 2 CYLINDER ISOLATION	1	*4	N.O.	N.O.

STEERING GEAR TORQUE: 115,630 lb.ft (16.0 Tm) EACH AT ±35'
 DESIGN PRESSURE: 1815 PSI (12.5 MPa) - SET AT ITEM 6, DARB
 MAX. WORKING PRESSURE: 1450 PSI (10.0 MPa) - SET AT ITEMS 8, HPU
 SLOW SPEED FLOW RATE: 15.8 GPM (59.9 L/min) - SET THRU CONTROL SYSTEM
 FAST SPEED FLOW RATE: 31.6 GPM (120 L/min) - SET THRU CONTROL SYSTEM

FOR DISCUSSION
NOT FOR FINAL PRODUCTION

STEERING GEAR COMPARTMENT

*PRIOR TO SELECTING VALVE POSITION FOR CYLINDER, REMOVE CYLINDER'S TILLER PIN.



QTY.	ITEM	DESCRIPTION
2	1	STEERING WHEEL (BY OTHERS)
2	2	HELM PUMP (BY OTHERS)
4	3	HELM PUMP SHUT-OFF VALVE - 1/2" NOM. (BY OTHERS)
2	4	HEADER TANK - 1 GAL.
4	5A	3-WAY SHUT-OFF VALVE - UNIT 1 PIPING
4	5B	3-WAY SHUT-OFF VALVE - UNIT 2 PIPING
2	6	DARB - 100 GPM
4	7A	DARB SHUT-OFF VALVE-UNIT 1 PIPING-1" NOM. (BY OTHERS)
4	7B	DARB SHUT-OFF VALVE-UNIT 2 PIPING-1" NOM. (BY OTHERS)
4	8	HYDRAULIC POWER UNIT - 20 HP
6	9	LOW PRESSURE SHUT-OFF VALVE (BY OTHERS)
8	10	FLEX HOSE - 1" NOM.

NOTES:

- N.O. - NORMALLY OPEN
N.C. - NORMALLY CLOSED
HPU - HYDRAULIC POWER UNIT
D.P. - DESIGN PRESSURE
W.P. - WORKING PRESSURE
DARB - DOUBLE ACTING RELIEF AND BYPASS
- ALL PIPES, FITTINGS AND HOSES TO BE SHIPYARD SUPPLIED UNLESS OTHERWISE INDICATED.
- SHIPYARD IS RESPONSIBLE FOR DETERMINING PIPE AND TUBING WALL THICKNESS AND HOSE CONSTRUCTION STANDARDS BASED ON MAXIMUM WORKING PRESSURES AS INDICATED. WHERE PRESSURES ARE NOT INDICATED, PIPES OR TUBES ARE SUBJECT TO LOCAL HYDROSTATIC PRESSURE ONLY. MAXIMUM PRESSURE OF HELM PUMP AUTOFILL LINE (IF SHOWN) IS 30 PSI.
- PIPING AND TUBING SIZES SHOWN ARE SUGGESTED MINIMUM DIAMETERS. SHIPYARD IS RESPONSIBLE FOR DETERMINING PIPE AND TUBING DIAMETERS BASED ON FLOW RATES AS INDICATED AS WELL AS LENGTH OF PIPING RUN EXPECTED.
- AVOID "GOOSENECKED" PIPING. SHIPYARD TO PROVIDE AIR BLEED FITTINGS ON PIPING AS REQ'D.
- ALL PIPES TO BE THOROUGHLY CLEANED PRIOR TO START-UP.
- FILL SYSTEM WITH ISO 32 HYDRAULIC FLUID.
- SEE INDIVIDUAL COMPONENT O.A.D. DWG'S FOR LOCATIONS OF PRESSURE AND FLOW ADJUSTMENTS AS WELL AS ELECTRICAL CONNECTIONS.
- SHIPYARD IS RESPONSIBLE FOR PLACING IDENTIFICATION LABELS ON ALL UNIT 1 AND UNIT 2 3-WAY AND DARB ISOLATION VALVES ONCE INSTALLATION IS COMPLETE.
- RESERVOIR FILLING (OR BALANCING) PIPING BETWEEN HPU 1&2 TO BE INSTALLED THROUGHOUT ITS LENGTH BELOW CONNECTING PORTS ON RESERVOIRS.

JQ131165
CCGS "EARL GREY"

REV.	DATE	DRAWING/DESIGN CHANGE No.	BY
Jastram			
<small>JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel.: (604) 986-1111 Fax: (604) 986-0334</small>			
DATE: 14-01-15	SCALE: N/A	DRAWN: C.Z.	APPR: N/A
TITLE: PIPING DIAGRAM FOR TWIN S2-160-1-35 REFIT			DRAWING NUMBER: D-601875

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1.2 TECHNICAL SPECIFICATIONS

Steering Gear Model

Jastram Refit

Rudder Stock Diameter	By Others
Torque (each rudder)	By Others
Relief Pressure	1815 psi
Max. Working Pressure	1450 psi
Steering Angle (max.)	+/- 37 deg.
Electronic Steering Angle Limit	+/- 35 deg.
Rudder Speed (slow/fast)	22 sec /11 sec thru +35 deg. to -35 deg.

Double Acting Relief and Bypass Valve

Jastram DARB - 100 GPM

Maximum Design Pressure	3000 psi.
Relief Pressure Setting	1815 psi.
Maximum Rated Flow	100 gpm
Dry Weight	50 lb / 22.6 kg
Directional Porting	1" SAE 4-Bolt Flange Port Code 61

Hydraulic Power Unit

Jastram Proportional HPU
(Qty 4)

Reservoir Capacity	60 US gal.
Maximum Ambient Temperature	104 ⁰ F (40 ⁰ C)
Oil Maximum Operating Temperature	150 ⁰ F (65 ⁰ C)
Motor	20 HP, 575/3/60
Full Load Speed	1765 rpm
Full Load Amperage	19.2 amp
Locked Rotor Current	140 amp
Service Factor	1.15
Pump	Variable Displacement Piston Pump 21.4 gpm at 1800 rpm
Directional Porting	1-5/16-12UN SAE Str. Thd. "O"-Ring Port, Fitting -16
Reservoir Porting	2" NPT Port

Power Steering Manifold

Jastram PSM 700

4-Way Directional Solenoid
Solenoid Voltage
Solenoid Holding Current
Back-up Relief Setting

Vickers
24 VDC
1.6 amp
1635 psi

For Discussion

RETURN LINE FILTER

1/2" NPT PORT (SPARE)

FOR DISCUSSION
NOT FOR FINAL PRODUCTION

CLEAN-OUT COVER

LOW LEVEL SENSORS CONNECTION
1/2" NPT CONDUIT PORT

47 (1194)

SERVICE FILTER GAUGE

JQ131165
CCGS "EARL GREY"

LIFTING EYE (4 PLACES)

PUMP ISOLATION VALVE - LOCKABLE

FILLER/BREATHER
SOLENOID MANUAL OVERRIDE PLINGERS

BACK-UP RELIEF ADJUSTMENT

MOTOR CONNECTION CONDUIT PORT

MAIN RESERVOIR CONNECTION
2" NPT PORT

ISOLATION VALVE AND CONNECTION TO MAIN PIPING
1-5/16-12UN SAE STR. THD. "O"-RING PORT (FITTING -16, 2 PLACES)

SELF CLOSING SIGHT & TEMP. GAUGE

WORKING PRESSURE GAUGE

RESERVOIR DRAIN
3/4" NPT PORT

A

4 (102)

39 (991)

VIEW A-A

ø9/16 (ø14) MOUNTING HOLE (4 PLACES)

NOTES:

- LIFT FROM RESERVOIR ONLY.
- RESERVOIR MAXIMUM CAPACITY: 60 U.S. GALLONS (304 LITRES).

A

41-1/2 (1054)

29 (737)

45-1/4 (1149)

48-3/4 (1238)

54 (1372)

5 (127)

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TOLERANCES: (UNLESS SPECIFIED OTHERWISE)

X.X	+/- 0.1	FRACTION	+/- 1/64
X.XX	+/- 0.01	ANGULAR	+/- 0.5 DEG.
X.XXX	+/- 0.005	SURFACE FINISH	✓

ALL DIMENSIONS IN INCH(mm)

REV.	DATE	DRAWING/DESIGN CHANGE No.	BY
Jastram			
JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel.: (604) 988-1111 Fax: (604) 988-0334			
DATE: 19-01-15 (D/M/Y)	SCALE: N.T.S.	DRAWN: C.Z.	APPR. ENG. N/A PROD.
TITLE: HYDRAULIC POWER UNIT O.A.D. (20 HP)			DRAWING NUMBER: C-521436

**4.1 SCOPE OF SUPPLY - STEERING CONTROL &
RUDDER ANGLE INDICATION**

QTY.	DESCRIPTION
2	DIGITAL STEERING CONTROLLER, DSC 100-302
6	MODE CONTROL PROCESSOR, MCP 100-10
1	MODE CONTROL PANEL, CP 600
2	MODE CONTROL PANEL, CP 375
2	RUDDER FEEDBACK UNIT, RFU 2000-2410
1	ELECTRIC WHEEL, EW 200-31
1	JOG LEVER, JO 100-2
2	NFU/FFU DUAL LEVER CONTROLLER
8	RUDDER ANGLE INDICATOR, RAI 380
1	RUDDER ORDER INDICATOR, ROI 280
1	INDICATOR DIMMER KIT, Single
2	INDICATOR DIMMER KIT, Dual
2	3-FACE RUDDER ANGLE INDICATOR, RAI 3300
2	3-FACE RUDDER INDICATOR POWER SUPPLY
2	RUDDER FEEDBACK UNIT, RFU 300
1	AUTOPILOT CONTROL & DISPLAY UNIT SET
1	EMERGENCY STATION JUNCTION BOX

4.2 TECHNICAL DESCRIPTION - STEERING CONTROL

Drawing No.	Description
D-751927	Steering Control Cabling Diagram
N.A.	Technical Description - Rudder Angle Indication

NOTICE: This vessel's main steering gear is provided with both main and backup remote power steering control from the wheelhouse. The backup system can also be invoked on demand by turning off the main steering controller using the power switch provided on the side of the Digital Steering Controller (DSC). The backup steering control system is operated using the NFU Jog Lever in the wheelhouse.

GENERAL

This vessel is fitted with two independent rudders. The port and starboard rudders are entirely independent of one another. Each of the port and starboard rudders has its own complete steering system and has main & auxiliary steering gears.

Each main and auxiliary steering gear has its own Hydraulic Power Unit (HPU) consisting of an electric motor, hydraulic pump and Power Steering Manifold. Each Power Steering Manifold incorporates a 4-way directional solenoid valve. The system for the main steering gear will be referred to as Unit 1 and the system for the auxiliary steering gear will be referred to as Unit 2.

Each port and starboard steering system has its own remote steering control system. Full Follow-Up (FFU) synchronized (port and starboard) steering control, as well as Non Follow-Up (NFU) independent steering control are available at the port wing and starboard wing stations. The supplemental Non Follow-Up (NFU) backup power steering control and autopilot steering controls from the autopilot system are also available at the wheelhouse. In addition to the port & starboard power steering systems, the manual steering system can be operated from the Helm Pumps (existing) located in the steering compartment.

The power supplies for each port and starboard control system is derived from the associated steering power feeder circuit via the Motor Starter & Alarm (MSA) Units. Over-current protection devices for each control system are provided in their respective motor starters.

Rudder angle indication is available at the wheelhouse, port wing, starboard wing and aft steering stations, as well as at the Emergency Steering Station Junction Box for each rudder. Separate 3-face panoramic rudder angle indication systems are also provided at the wheelhouse for each rudder. The port and starboard rudder angle

indication systems are completely independent from each other as well as from the port and starboard steering control systems.

REMOTE STEERING CONTROL

Two separate and completely independent steering control systems are provided. Each of the port and starboard control system is capable of Full Follow-Up (FFU) and Non Follow-Up (NFU) independent steering controls. The FFU input devices are the Electric Wheel (EW 200) located at the wheelhouse and NFU/FFU Dual Lever Controller at each wing station. The NFU command input device is the Jog Lever (JO 100-2) located at the wheelhouse and NFU/FFU Dual Lever Controller located at the each wing station. These NFU/FFU Dual units provide independent control of the port and starboard rudders for added maneuverability.

The mode of steering control at the wheelhouse forward station is selected using the Steering Mode Control Panel (CP 600). This panel contains multi-pushbuttons with steering mode indicators and labeled as "STANDBY", "NFU JOG", "POWER HELM" and "AUTO" including "FAST RUDDER" indicator. FAST RUDDER indicator will light up when both Hydraulic Pumps are running simultaneously. The mode of steering control at each wing station is selected using the Mode Control Panel (CP 375). This panel also contains multi-pushbuttons with steering mode indicators and labeled as "NFU JOG", "FFU LEVER" and "AUTO" including "FAST RUDDER" indicator.

Two additional pushbuttons from each Control Panel are provided in order to control dimming of the illuminated steering mode indicators. Each Control Panel also contains a "FAULT" indicator and audio device in order to alert the operator to any fault within the main steering control systems.

In the wheelhouse STANDBY mode, the outputs of the steering control system to the directional solenoid valve are turned off. In this mode, both port and starboard remote power steering control systems wait to serve.

In the wheelhouse NFU JOG mode, the NFU steering will be active at the wheelhouse. NFU control is provided through the use of the Jog Lever (JO 100). The Jog Lever contains two sets of micro-switches to provide port and starboard directional commands for port and starboard rudders. The rudder will move to port or starboard as long as the Jog Lever is held off of its spring-centered position. Once released, the rudders will stop moving.

In the wheelhouse POWER HELM mode, the FFU steering will be active at the wheelhouse and Full Follow-Up control is provided through the use of the Electric Wheel (EW 200-31). The EW 200 contains separate potentiometers that provide rudder position commands to the port and starboard steering control systems. A Rudder Order Indicator (ROI 280) is provided to display the FFU rudder command of the Electric Wheel.

Note: Within each Digital Steering Controller's software configuration, the Bumpless Transfer function can be enabled. When Bumpless Transfer is turned on, the analog FFU input device will not become active (and the FFU input indicator on the Control Panel will flash) unless the device's rudder command position is within $\pm 3^\circ$ of the actual rudder angle position.

Since this vessel is fitted with two independent DSC's, the autopilot interfacing is accomplished through two identical but separate interfaces (one for the port steering control system and one for the starboard steering control system).

When the AUTO mode is selected either at the wheelhouse or at the wing station, an autopilot take-over handshake is initiated between the active DSC and the autopilot system. A dry contact in the active DSC (\pm REQ.) will close, providing an autopilot request signal to the autopilot system. When the autopilot system receives this request signal and is ready to assume control of the rudder, the autopilot system will close a dry contact (\pm ACK.) providing the active DSC with the autopilot acknowledge signal. Once the active DSC receives this autopilot acknowledge signal, the active DSC will look to the autopilot's command signals (\pm ANALOG) for rudder position commands.

Note: Upon restoration of power after a power-failure condition, the Digital Steering Control system will turn on in PREVIOUS mode.

Each wing station has steering mode Control Panel (CP 375) and NFU/FFU Dual Lever Controller. The steering mode Control Panel can be used to accept control from any station at any time.

In the wing station NFU JOG mode, independent NFU control of the port and starboard rudders is provided with NFU/FFU Dual Lever Controller. Each Dual Lever Controller contains independent two sets of micro-switches to provide port and starboard directional commands to the associate steering controller.

In the wing station FFU LEVER mode, the Dual Lever Controller provides independent FFU control of the port and starboard rudders. This unit contains completely independent two potentiometers that provide rudder position commands to each steering control system.

STEERING COMPARTMENT

The port and starboard steering control power supplies are routed through its associated Unit 1 or Unit 2 motor starters to the Emergency Station Junction Box through cables 16PA, 16PB, 16SA and 16SB.

Supplementary Non Follow-Up (NFU) control of the each steering gear is provided at the steering compartment emergency station. The emergency station contains the

rotary switches, which is provided for completely disconnecting the wheelhouse remote steering control system from their power supplies. This switch's positions are "LOCAL", "OFF" and "REMOTE".

In the emergency station switch's OFF position, the positive DC power supplies to the Unit 1 and Unit 2 4-way directional solenoids are disconnected. In the LOCAL position, the negative DC power supplies are routed to the NFU Jog Levers located on the front of the Emergency Station Junction Box (ESJB). Each Jog Lever contains a separate set of micro-switches for the emergency control system. In the REMOTE position, the DC power supply to the wheelhouse remote steering control system is connected. An additional set of switch contacts opens in the REMOTE position. These additional contacts are connected to the alarm and indication system to display the status of the emergency station switch.

Since the Unit 1 and Unit 2 Hydraulic Power Unit motors in the port or starboard system are not interlocked, two motors (Unit 1 and Unit 2) may be running simultaneously (such that the DSC-Digital Steering Controller rudder command signals would be routed to each running HPU) where the steering gear will be operated at the faster speed. The Unit 1 HPU & Unit 2 HPU also can be run independently (such that the DSC rudder command signals would be routed to just the HPU that is running) where the steering gear is then operated at a slow speed.

Local control of the each steering gears are provided in the steering compartment by means of manual override plungers on the associated 4-way directional solenoids.

Note: During local manual emergency operation of Hydraulic Power Unit (manual override), Hydraulic Lock Alarm may be triggered.

The control voltage for each directional solenoid is routed through its respective RFU 2000 to take advantage of the rudder angle limit switches contained in each unit. These limit switches serve to stop the hydraulic cylinder travel before any mechanical stops are reached. The switches are cam operated and are directly coupled to the rudder stock through a mechanical linkage. Each RFU's limit switch circuit is completely independent of the rudder feedback circuits also contained in this unit.

4.3 TECHNICAL DESCRIPTION - RUDDER ANGLE INDICATION

Drawing No.	Description
D-751927	Steering Control Cabling Diagram
N.A.	Technical Description - Steering Control

GENERAL

This vessel's rudder angle indicating system gives rudder position reference in the wheelhouse, port wing, starboard wing and aft station as well as on the Emergency Station Junction Box in the steering compartment for each of the port and starboard rudders. Each RAI system consists of four Rudder Angle Indicators with a RAI 380 on the Emergency Station Junction Box and the Rudder Feedback Unit (RFU 2000). These items are shown in the Steering Control Cabling Diagram.

All the circuitry necessary to drive the RAI is contained within each RFU 2000. Each RFU 2000 is mechanically linked to the ship's rudders and converts the position of the rudders into an electronic signal. This signal is called the rudder angle indicator signal. Each RFU also contains limit switches, which serve to stop the steering gear before its mechanical stops are reached. The circuit for these switches is independent of each RFU 2000's rudder angle indication circuitry.

The power supply for each RAI system is shown to be independent from each other as well as from the port and starboard steering control power supplies. The feeder circuit and short-circuit protection is to be provided by the shipyard as indicated.

Additional rudder angle indicator systems are supplied at the wheelhouse forward station to provide a 3-face panoramic view of the rudder angle. These items are also shown in the Steering Control Cabling Diagram as the RAI 3300's. Each RAI 3300 system is completely independent of the RAI 380 system and the steering control system. Each RAI 3300 system uses its own power supply and feedback potentiometer inside its respective Rudder Feedback Unit (RFU 300). Each RFU 300 is also mechanically linked to the ship's associate rudders.

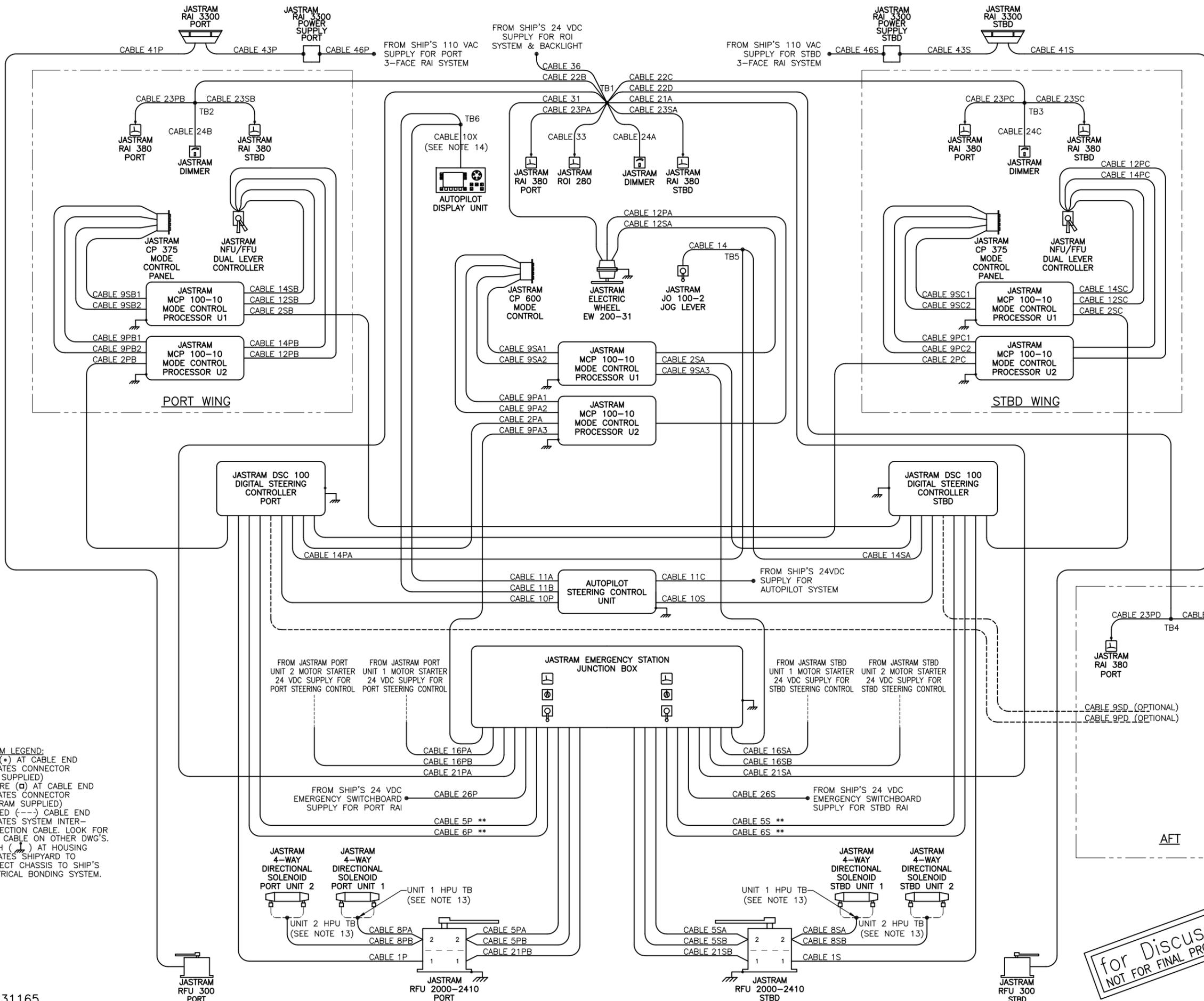


DIAGRAM LEGEND:
 - DOT (•) AT CABLE END INDICATES CONNECTOR (NOT SUPPLIED)
 - SQUARE (◻) AT CABLE END INDICATES CONNECTOR (JASTRAM SUPPLIED)
 - DASHED (---) CABLE END INDICATES SYSTEM INTER-CONNECTION CABLE. LOOK FOR SAME CABLE ON OTHER DWG'S.
 - EARTH (⏏) AT HOUSING INDICATES SHIPYARD TO CONNECT CHASSIS TO SHIP'S ELECTRICAL BONDING SYSTEM.

CABLE No.	AWG	No. CONDUCTORS	SHIELDED	CABLE No.	AWG	No. CONDUCTORS	SHIELDED
14	18	6	NO	1P	18	4(2PAIR)	YES
14PA	18	3	NO	1S	18	4(2PAIR)	YES
14PB	18	3	NO	* 2PA	18	4(2PAIR)	YES
14PC	18	3	NO	* 2PB	18	4(2PAIR)	YES
14SA	18	3	NO	* 2PC	18	4(2PAIR)	YES
14SB	18	3	NO	* 2SA	18	4(2PAIR)	YES
14SC	18	3	NO	* 2SB	18	4(2PAIR)	YES
*** 16PA	14	5	YES	* 2SC	18	4(2PAIR)	YES
*** 16PB	14	5	YES	** 5P	14	3	YES
*** 16SA	14	5	YES	** 5A	16	3	YES
*** 16SB	14	5	YES	** 5PB	16	3	YES
21PA	16	4	YES	** 5S	14	3	YES
21PB	16	4	YES	** 5SA	16	3	YES
21SA	16	4	YES	** 5SB	16	3	YES
21SB	16	4	YES	** 6P	14	4	YES
22B	16	9	YES	** 6S	14	4	YES
22C	16	9	YES	*** 8PA	16	3	YES
22D	16	9	YES	*** 8PB	16	3	YES
23PA	18	6	YES	*** 8SA	16	3	YES
23PB	18	5	YES	*** 8SB	16	3	YES
23PC	18	5	YES	9PA1	18	7	YES
23PD	18	4	YES	9PA2	20	10	YES
23SA	18	6	YES	9PA3	18	5	YES
23SB	18	5	YES	9PB1	18	6	YES
23SC	18	5	YES	9PB2	20	9	YES
23SD	18	4	YES	9PC1	18	6	YES
24A	18	3	YES	9PC2	20	9	YES
24B	18	6	YES	9PD	18	4 (OPT.)	YES
24C	18	6	YES	9SA1	18	7	YES
24D	18	6	YES	9SA2	20	10	YES
26P	16	2	YES	9SA3	18	5	YES
26S	16	2	YES	9SB1	18	6	YES
31	18	4	YES	9SB2	20	9	YES
33	18	5	YES	9SC1	18	6	YES
36	16	2	YES	9SC2	20	9	YES
41P	16	3	YES	9SD	18	4 (OPT.)	YES
41S	16	3	YES	10P	18	6	YES
43P	16	2	YES	10S	18	6	YES
43S	16	2	YES	11A	16	2	YES
46P	16	2	YES	* 11B	18	4(2PAIR)	YES
46S	16	2	YES	11C	16	2	YES
				12PA	18	3	YES
				12PB	18	3	YES
				12PC	18	3	YES
				12SA	18	3	YES
				12SB	18	3	YES
				12SC	18	3	YES

* SEE NOTE 2
 ** SEE NOTE 5
 *** SEE NOTE 12

- NOTES:**
- CABLES TO BE SUPPLIED BY SHIPYARD.
 - CABLES 2PA, 2PB, 2PC, 2SA, 2SB, 2SC AND 11B MUST BE RS-485 SHIELDED, TWISTED-PAIR COMMUNICATION CABLE WITH A CONTROLLED IMPEDANCE OF 120 OHMS, BELDEN 3082A, LAPP 2170340 OR EQUIV.
 - SHIPYARD TO CONFIRM FINAL CABLING LAYOUT AND COMPONENT LOCATIONS, AS WELL AS CABLE CONSTRUCTION STANDARDS.
 - FOR MORE INFORMATION ON THE WIRING OF INDIVIDUAL CABLES, SEE OWNER'S MANUAL.
 - CABLE CONDUCTORS SIZE SHOWN ON CABLES 5P, 5S, 6P & 6S ARE SUGGESTED MINIMUM DIAMETERS BASED ON A MAXIMUM CABLE LENGTH OF 200 ft. (61 m). FOR EACH ADDITIONAL 100 ft. (30 m) OF CABLE LENGTH, THE DIAMETER OF THESE CONDUCTORS SHOULD BE INCREASED BY 2 AWG.
 - JASTRAM JOG LEVER IS SUPPLIED WITH 5 ft. OF PRE-WIRED CABLE.
 - TERMINAL BLOCKS (TB#) TO BE SUPPLIED BY SHIPYARD.
 - TERMINAL BLOCKS SHOULD BE HOUSED IN FIRE-RESISTANT AND SPLASHPROOF ENCLOSURES.
 - SHIPYARD TO SUPPLY SHORT-CIRCUIT PROTECTION AND DISCONNECT SWITCH ON ALL RAI POWER SUPPLIES.
 - REFER TO AUTOPILOT MANUAL FOR INFORMATION REGARDING CONNECTION OF CABLES 10P & 10S TO AUTOPILOT CONNECTION UNIT.
 - CABLING TO BE SEPARATED ON A PORT AND STBD BASIS THROUGHOUT THE LENGTH OF THE VESSEL AS SHOWN.
 - CABLES 8PA, 8PB, 8SA, 8SB, 16PA, 16PB, 16SA & 16SB ARE ALSO SHOWN ON THE MOTOR STARTER & ALARM CABLING DIAGRAM.
 - HYDRAULIC POWER UNIT TERMINAL BLOCKS ARE SUPPLIED BY JASTRAM AND ARE INCLUDED ON EACH HYDRAULIC RESERVOIR/MANIFOLD ASSEMBLY.
 - CABLE 10X IS PROVIDED WITH AUTOPILOT DISPLAY UNIT.

JQ131165
 CCGS
 "EARL GREY"

for Discussion
 NOT FOR FINAL PRODUCTION

REV.	DATE	DRAWING/DESIGN CHANGE No.	BY
0/0/0	15-01-15	N/A	P.K.

JASTRAM ENGINEERING LTD.
 135 Riverside Drive
 North Vancouver, B.C.
 Canada V7H 1T6
 Tel.: (604) 988-1111
 Fax: (604) 986-0334

DATE: 15-01-15 SCALE: N/A DRAWN: P.K. APPR. _____
 TITLE: STEERING CONTROL CABLING DIAGRAM DRAWING NUMBER: D-751927

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7.1 SCOPE OF SUPPLY - MOTOR STARTER AND ALARM

<u>QTY.</u>	<u>DESCRIPTION</u>
4	MOTOR STARTER & ALARM UNIT, MSA 301, 20HP 575/3/60
4	ALARM PANEL (WH), AP 600
4	ALARM PANEL (ECR), AP 600
2	HYDRAULIC LOCK ALARM PROCESSOR BOX

for Discussion

7.2 TECHNICAL SPECIFICATIONS – MAIN MOTOR STARTER & ALARMS

Motor Starter and Alarm System Jastram Quad (Port Stbd, Unit 1 Unit 2)
MSA

Motor Starter and Alarm Unit	4 of MSA 301
Wheelhouse Alarm Panel	4 of AP 600
ECR Alarm Panel	4 of AP 600
Hydraulic Lock Alarm Processor Box	2 of HLAP

Ship's Power Supply Voltages

Main AC Supply	575 VAC, 3 phase, 60 Hz
Emergency DC Supply	24 VDC

Hydraulic Power Unit Motor

Baldor CEM2334T-5, 3P, Insul. Class F

Horsepower	20 Hp
Full Load Speed	1765 rpm
Service Factor	1.15
Rated Motor Voltage	575 VAC, 3 phase, 60 Hz
Operable Voltage Range	±10% of rated voltage
Rated Full Load Amps	19 Amps @ 575 VAC
Rated Locked Rotor Amps	138 Amps @ 575 VAC

MSA Unit

Operable Ambient Temp. Range	0° C (32° F) to +55° C (131° F)
Transformer (T1)	600-120 VAC, 200 VA, 50/60 Hz
Motor Contactor	Jastram, JB-822048
Overload Alarm Relay	Jastram, JB-822074
Overload Alarm Relay Trip Point	Rated Full Load Amperage
Phase Fail Alarm Trip Point	Imbalance between any 2 lines greater than 10% of ship's supply voltage (line to line)
Main 3 Phase Supply Fuses	3 Amps
Control Fuse (F4)	8 Amps
Steering Control Power Supply Output	24 VDC (4 Amp maximum)
Auxiliary DC Supply Current Draw	30 mA normal operation 2.5 Amps (max.) emergency operation

7.3 TECHNICAL DESCRIPTION - MOTOR STARTER AND ALARMS

Drawing No.	Description
D-751928	Motor Starter & Alarm Cabling Diagram

NOTICE: During local emergency operation of Hydraulic Power Unit (manual override), Hydraulic Lock Alarm may be triggered.

GENERAL

This vessel is fitted with two independent rudders. Each of the port and starboard rudders has its own complete steering system and consists of a main and auxiliary steering gear. Both main and auxiliary steering gears are power operated. Each steering gear consists of an electric motor, hydraulic pump and power steering manifold. Each of the electric motor is operated by its own Motor Starter & Alarm (MSA) system. The two MSA systems for each rudder will be referred to as the Unit 1 & Unit 2 systems.

The cables and components for the MSA systems are laid out so that the systems can be separated on a port and starboard basis.

The Unit 1 and Unit 2 motor starters' contactors are not electrically interlocked so that both of the Hydraulic Power Units can be operated simultaneously.

Eight Alarm Panels will be used for the alarm system processed within the MSA Units. Each remote Alarm Panel (AP 600) includes "START" and "STOP" pushbuttons for remote control of the motors.

MOTOR STARTERS (STEERING COMPARTMENT)

Each of the Hydraulic Power Unit motors has its own motor starter. Each motor starter is sized for a 20 Hp, 575/3/60 motor. Each motor starter is housed in a splash-proof and corrosion-resistant NEMA 4 enclosure with all cable access through the removable gland panel on the bottom of the box. The mounting arrangements for the enclosures are external.

The power supply for each Unit 1 motor starter is fed from the ship's main service switchboard. Short-circuit protection and local disconnect switch are provided by the shipyard as indicated in the cabling diagram.

The power supply for each Unit 2 motor starter is fed from the ship's emergency switchboard. Short-circuit protection and local disconnect switch are provided by the shipyard as indicated in the cabling diagram.

Each motor starter is fitted with an adjustable automatic-restart timer.

Each motor starter is capable of being started and stopped at the door of the enclosure without any interconnection to the remote panels being made. Each motor starter identifies on its control panel door the Hydraulic Power Unit (HPU) it serves.

REMOTE STARTER PANELS (WHEELHOUSE & ENGINE CONTROL ROOM)

The remote Alarm Panels (AP 600) contain MOTOR START and MOTOR STOP pushbuttons for each motor starter. The start / stop pushbuttons are capable of controlling the motors when the LOCAL / REMOTE switch on the motor starter is in the REMOTE position.

ALARM SYSTEM

Each motor starter contains circuitry to process the alarms. Each alarm system is supplied by both a normal DC (rectified) and auxiliary DC (emergency) power supply. Each system is configured to switch automatically between these two supplies in the event of a power failure. The auxiliary power supplies are fed from the ship's emergency DC switchboard to the motor starters

Each unit outputs to multiple Alarm Panels (AP 600) located in the wheelhouse and engine control room. The Alarm Panels are fitted with independent dimmer controls.

The alarms are acknowledged and tested using the "SILENCE" and "TEST" pushbuttons on each of the wheelhouse remote Alarm Panels (AP 600).

The alarm system features self-monitoring circuitry that indicates when the conductors to any monitored point are caused to open. The alarms are set to lock-in with a flashing indicator until manually acknowledged (silenced). After silencing, the indicator turns from flashing to steady if the alarm still exists, or turns off if the alarm condition has been rectified.

The following indication and alarm points are monitored by the alarm system and output to the remote indicator panels:

Condition

Indication

Motor Starter AC Supply Voltage
Motor Starter Contactor

AC Supply Indicator
Motor Start Indicator
Motor Stop Indicator

Motor Starter AC Voltage Sensor

Power Fail Indicator and Alarm

Motor Starter AC Phase Monitor
Motor Overload Sensor
Hydraulic Power Unit Oil Level Sensor
Hydraulic Power Unit Hydraulic Lock Sensor
Hydraulic Power Unit Filter Differential
Pressure Sensor

Phase Fail Indicator and Alarm
Overload Indicator and Alarm
Low Oil Indicator and Alarm
Hydraulic Lock Indicator and Alarm
Service Filter Indicator and Alarm

Alarm Normal Power Supply
Alarm Auxiliary Power Supply

Normal DC Indicator
Aux. DC Fail Indicator and Alarm

CENTRAL MONITORING SYSTEM (CMS) INTERFACE (OPTIONAL)

Each main motor starter has the Central Monitoring System (CMS) Interface as an option. This interface provides the alarm monitoring signals from the motor starter to the ship's monitoring system(s). Interface is provided for four of the alarm and indication points listed above. The alarm points and indicators are: Overload Alarm, Phase Fail Alarm, Control DC Fail Alarm, Low Oil Alarm.

All alarm and indication interfaces are provided through dry contacts. All alarm contacts are normally-closed when the alarm system is in normal condition. When the alarm condition is triggered, the alarm contact will alternate open and closed, and will continue to alternate until the "SILENCE" button on the AP 600 Alarm Panel is pressed. After the "SILENCE" button is pressed, the alarm interface contact will change to a steady open state if the alarm condition still exists. If the alarm condition has been rectified, the alarm interface contact will turn to a steady closed state.

All CMS contacts are provided with a single common connection. Each interface contact is rated for a maximum of 5 amps at 24 VDC.

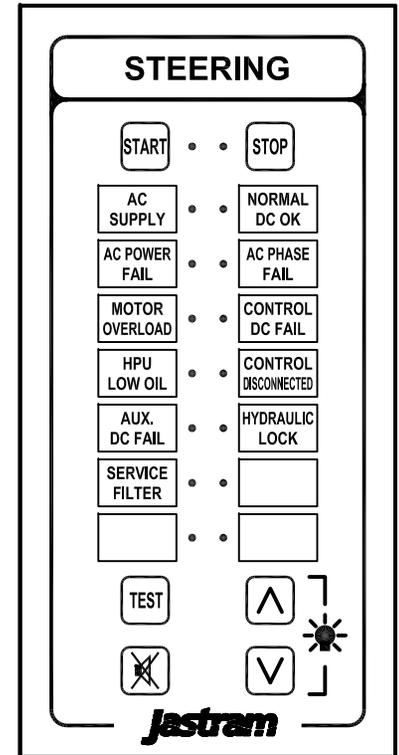
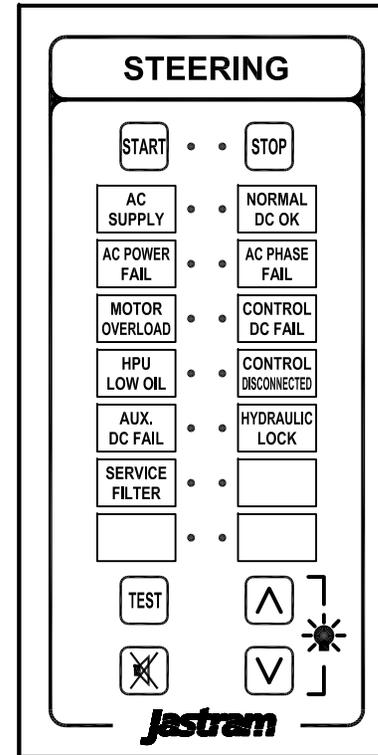
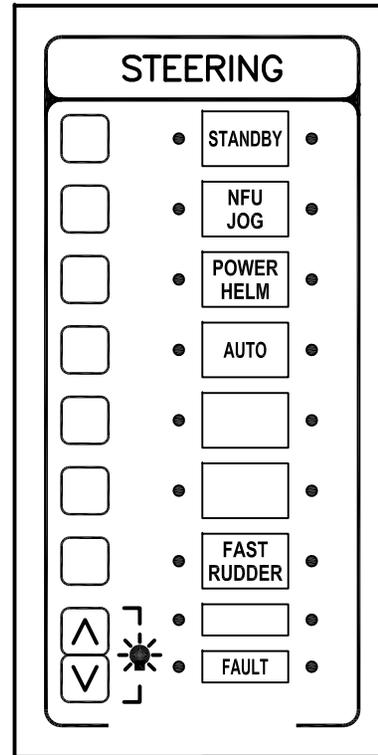
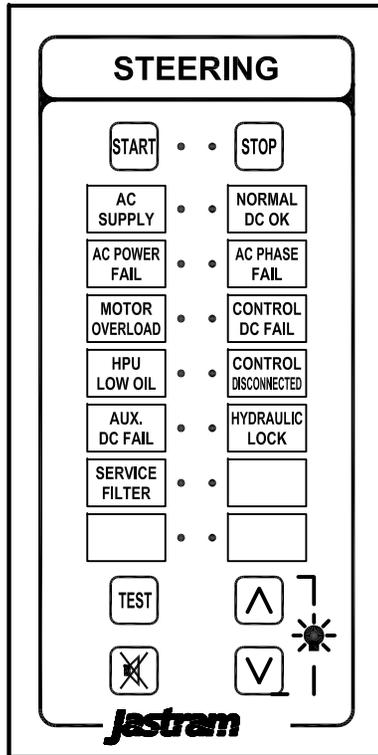
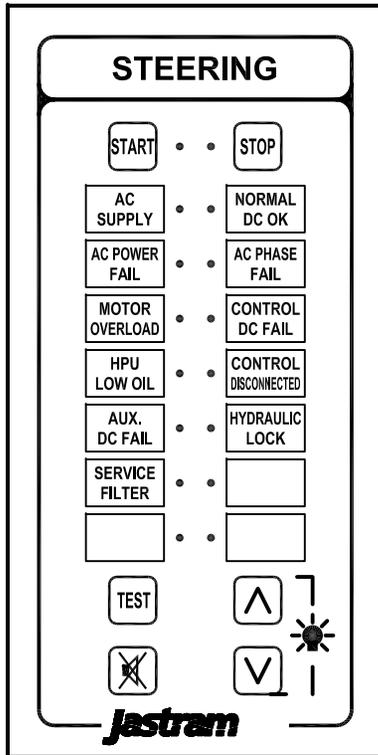
ALARM PANEL
PORT UNIT 2
(AP 600)

ALARM PANEL
PORT UNIT 1
(AP 600)

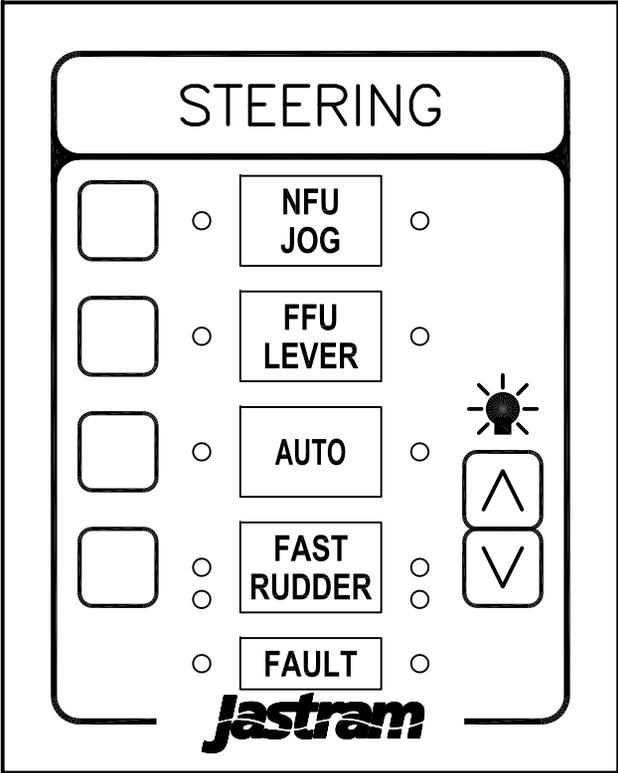
CONTROL PANEL
(CP 600)

ALARM PANEL
STBD UNIT 2
(AP 600)

ALARM PANEL
STBD UNIT 1
(AP 600)

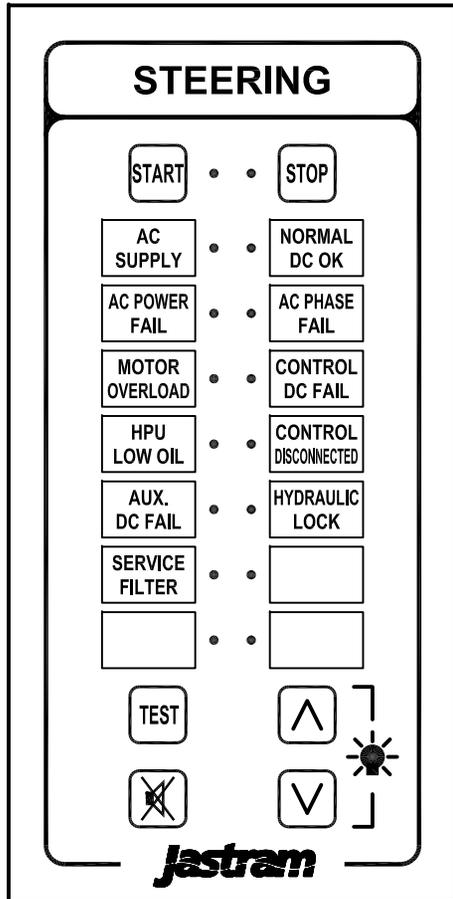


WHEELHOUSE
STEERING STAND PANEL LAYOUT

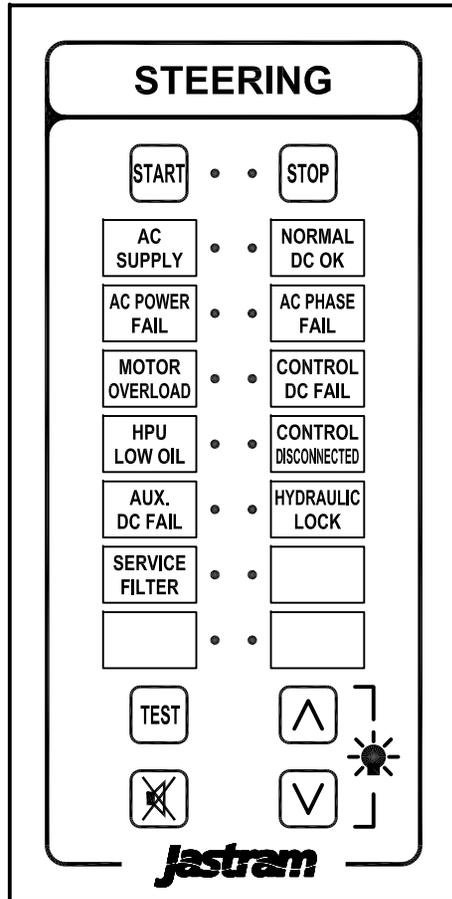


WING STATION
MODE CONTROL PANEL LAYOUT

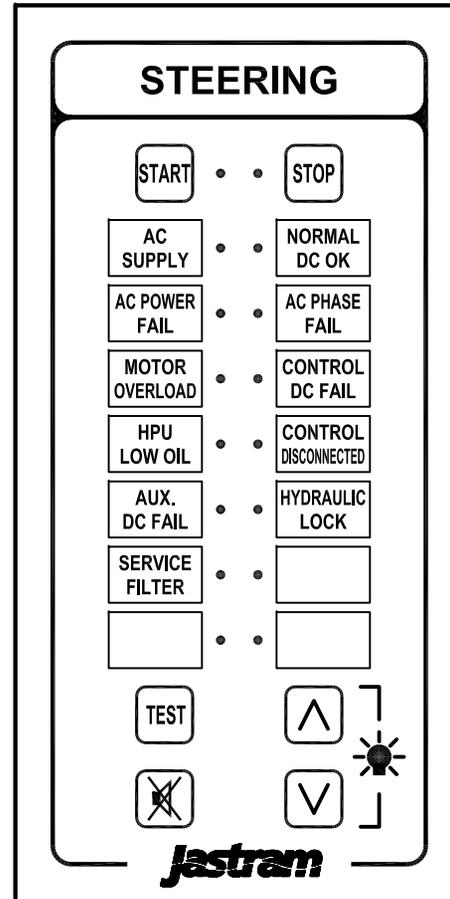
ALARM PANEL
PORT UNIT 2
(AP 600)



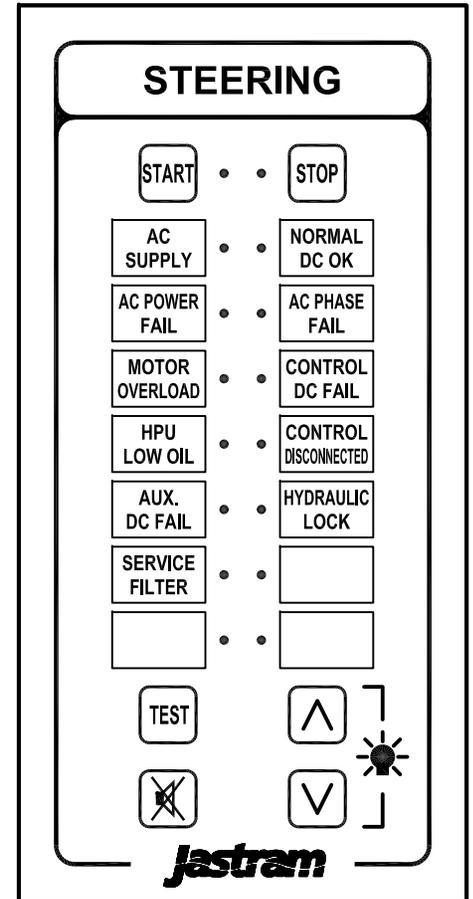
ALARM PANEL
PORT UNIT 1
(AP 600)



ALARM PANEL
STBD UNIT 2
(AP 600)



ALARM PANEL
STBD UNIT 1
(AP 600)



ENGINE CONTROL ROOM PANEL LAYOUT