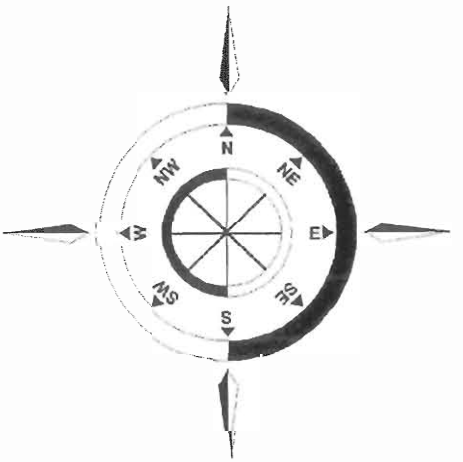
HamiltonJet

MARINE PROPULSION UNITS

CONTROLS

Installation & Servicing Manual



Control Type:	CT7 - CMU
Part Number:	89007
Revision 1	23/01/99
Amendment 3	11/08/00

AMENDMENT RECORD

Part No 89007
Control Type CT7 - CMU
Manual Installation & Servicing

Amdt	Incorporated By	Date
1.	CWF Hamilton & Co. Ltd	16/04/99
2.	K Braun	7-7-99
3.	K Braun	8-8-00
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		
17.		
18.		
19.		
20.		
21.		
22.		
23.		
24.		
25.		
26.		
27.		
28.		
29.		
30.		
31.		
32.		
33.		
34.		
35.		
36.		
37.		
38.		
39.		
40.		
41.		
42.		
43.		
44.		

Amdt	Incorporated By	Date
45.		
46.		
47.		
48.		
49.		
50.		
51.		
52.		
53.		
54.		
55.		
56.		
57.		
58.		
59.		
60.		
61.		
62.		
63.		
64.		
65.		
66.		
67.		
68.		
69.		
70.		
71.		
72.		
73.		
74.		
75.		
76.		
77.		
78.		
79.		
80.		
81.		
82.		
83.		
84.		
85.		
86.		
87.		
88.		

Warranty

The Company warrants each new Hamilton product to be free from defects in materials and workmanship under normal use and service, its obligations under this Warranty being limited to make good at its factory or at the factory of any subsidiary or branch of the Company the product or any part or parts thereof which shall be returned to it with transportation charges prepaid and which its examination shall disclose to its satisfaction to have been defective provided or such part or parts thereof shall be so returned to it not later than 24 months from the date of the original purchase from the Company or its authorised distributor, or 12 months from commissioning date, whichever occurs first. No allowance shall be granted for any repairs or alterations made by the purchaser or its agent without the written consent of the Company. This Warranty is expressly in lieu of all other warranties expressed or implied and of all other obligations or liabilities on its part, including any liability under the Sale of Goods Act, 1908, and no other person or agent or dealer is authorised to give any other condition or warranty to assume for the Company any other liability in connection with the sale of its products whether new or second hand. Any obligation on the part of the Company under this Warranty does not apply to any Hamilton product which may have been repaired or altered in any way outside the factory of the Company or to damages caused in the opinion of the Company by overloading, misuse, misapplication, improper storage, abnormal wear and tear due to exposure to the elements, negligence, accident, or whilst being operated in any other way other than in accordance with the operating and maintenance instructions of the Company nor does it apply to repairs made necessary by the use of parts or accessories not recommended by the Company. There is no liability on the part of the Company with respect to any items incorporated in any Hamilton product when such items have been manufactured by others and are warranted by their respective manufacturers in favour of the purchaser or when they are supplied by the Company on special order. The Company shall not be liable for any consequential loss or damage resulting directly or indirectly from any defect in the product the subject of this agreement. No liability on the part of the Company with respect to this Warranty shall extend to second - hand and reconditioned goods and the Warranty does not cover the cost of labour involved in the replacement of defective parts. No liability on the part of the Company with respect to this Warranty shall exist if the Hamilton product is not, in the opinion of the Company, installed as per the "Installation and Service Manual", "Designer's Manual" and/or "Owners Manual" supplied with each product. Warranty will not apply unless a negative earth bonding system has been installed in the vessel and a mainshaft critical speed check carried out to the Company's satisfaction.

C.W.F. HAMILTON & Co. Ltd.

This portion must be completed in every detail and returned immediately to:
C.W.F. HAMILTON & CO LTD, PO BOX 709, CHRISTCHURCH, NEW ZEALAND.

- -

Purchaser ....

Address ....

Hamilton Jet Model .... Serial number ....

Signed .... Date ....

Dealer ....

Delivery date .... Dealer's signature ....

GENERAL SAFETY NOTICE

The specific Safety Warnings and Cautions summarised below appear in appropriate Sections of this Manual. Each is referenced to the text by the Section on which it appears.

WARNINGS

A WARNING: Is an operation or maintenance procedure, practice condition or statement which, if not strictly observed, could result in injury or death to personnel.

This is a list of standard Warnings that will be found throughout this Manual. C.W.F. Hamilton & Co. Ltd advise that in the interests of safety, these Warnings be read and understood prior to commencement of any maintenance or overhaul activities on the Jet Units / Controls Systems described within this Manual.

WARNING:

SPARE "V" BELTS WILL CAUSE A POTENTIAL HAZARD TO BOTH PERSONNEL AND MACHINERY IF NOT PROPERLY SECURED.

ENSURE THAT THE SPARE "V" BELTS ARE FASTENED SECURELY TO THE JET UNIT AND DO NOT COME LOOSE AND FOUL OTHER EQUIPMENT DURING VESSEL OPERATION.

2.2. 6.4. 8.1.

WARNING:

ENSURE THAT THE VESSEL IS SECURELY MOORED DURING COMMISSIONING AS THE JET UNITS MAY PRODUCE LARGE THRUST FORCES.

DO NOT PROCEED IF ANY CONTROL SYSTEM FAULT ALARMS ARE STILL ACTIVATED.

3.39.

WARNING:

WHENEVER THE AUTOPILOT IS SWITCHED TO AN ACTIVE MODE, THE AUTOPILOT IMMEDIATELY OVERRIDES THE CMU CONTROL SYSTEM HELM INPUT. THIS CAN RESULT IN A SUDDEN CHANGE OF STEERING DIRECTION. THUS, WHENEVER ENGAGING OR DISENGAGING THE AUTOPILOT, ENSURE THE HELM CONTROLS ARE SET TO THE CENTRE POSITION.

4.14.

WARNING:

USE OF A WATERJET STEERED VESSEL IS DIFFERENT FROM A PROPELLER DRIVEN VESSEL BECAUSE THE WATERJET MAINSHAFT MUST ALWAYS BE ROTATING WHENEVER STEERING THRUST IS REQUIRED.

4.19.

WARNING:

1. POWER ASSISTED SLOWDOWN CAN PRODUCE A VERY RAPID DECELERATION.
2. NEW OPERATORS SHOULD USE THE POWER ASSISTED SLOWDOWN FEATURE VERY CAREFULLY.
3. DO NOT USE FULL HELM CONTROL UNTIL THE VESSEL HAS SLOWED.
4. SELECT ZERO SPEED AS SOON AS THE VESSEL HAS SLOWED.

4.20.

WARNING:

IF AT ANY TIME CONTROL OF THE VESSEL USING NORMAL CONTROL IS LOST, CONTROL SHOULD BE SWITCHED TO EMERGENCY CONTROL.

5.1.

WARNING:

PRIOR TO REPLACING ANY FUSES, ALL POWER TO THE ELECTRONIC CONTROL SYSTEMS MUST BE TURNED OFF.

5.7.

WARNING:

SPECIAL CARE MUST BE TAKEN WHEN REPLACING FUSES ON THE AUXILIARY INTERFACE CIRCUIT BOARDS TO ENSURE THE FUSE HOLDERS DO NOT TOUCH ADJACENT FUSE HOLDERS.

5.7.

CAUTIONS

***A CAUTION:** Is an operation or maintenance procedure, practice condition or statement which, if not strictly observed, could result in damage to, or destruction of, equipment or loss of mission effectiveness.*

This is a list of standard Cautions that will be found throughout this Manual. C.W.F. Hamilton & Co. Ltd advise that these Cautions should be read and understood prior to commencement of any maintenance on the Jet Units / Controls Systems described within this Manual.

CAUTION:

Arc Welding

Do not perform Electric Arc Welding unless the following requirements are met.

1. **Do not perform Electric Arc Welding closer than 1 metre from electronic modules or cables.**
2. **The Control System must be turned OFF and the power connector removed from all Jet Control Modules during Arc Welding.**
3. **Always use short earthing cables to earth Electric Arc Welding operations close to the weld area.**

3.1.

CAUTION:

Do not activate the Cylinders whilst purging air from the JHPU system, as this may introduce contamination into the valves of the JHPU and Reverse Cylinder Servo Valve.

3.9.

CAUTION:

The Steering and Reverse Feedback Senders will be damaged if their supply polarity is incorrect. Ensure that the supply polarity is correctly connected before applying power to the Senders.

3.12.

CAUTION:

Incorrect use of the CMU FIELD PROGRAMMER can lead to erratic or incorrect behaviour of the Control System. Follow the programming instructions carefully and verify that the Control System is running correctly as expected before operating the vessel. Never modify any parameters unless you understand their function and effect.

3.18.

CAUTION:

Factory Default settings should only be used as a last resort. After they have been reset, all the demand and feedback signals will need to be re-programmed.

3.30.

CAUTION:

Do not proceed if any Control System fault alarms are still activated.

3.39.

CAUTION:

Gear changing in Normal Mode can only occur when the Engine is running at IDLE speed.
In Emergency Mode the operator must ensure that the engine is at low idle before changing gear.

4.11.

CAUTION:

Never select a position of the Reverse Lever close to FULL ASTERN whilst the vessel is proceeding at high forward speed, as the resultant "braking effect" can be more severe than full braking of a motor car

4.20.

CAUTION:

The Hydraulics System should never be operated without hydraulic fluid in the System.

5.22.

CAUTION

ANTI FOULING PAINTS

Do not use copper- based anti-fouling paints. Use non metallic or any antifouling paint suitable for an aluminium hull. Where these are not available, tin based antifouling paints may be used. Leave all stainless steel parts polished and unpainted.

ANTI-SEIZE COMPOUNDS:

Do not use graphite based anti-seize compounds - these will cause corrosion.

6.1.

CAUTION:

Over tensioned V-Belts will cause reduced JHPU and Jet Unit Bearing life.

6.4.

CAUTION:

Tightening Torque's: Ensure all fasteners are tightened to torque's as described in Drawing 85018 or the relevant assembly drawings.

6.7.

CAUTION

Prevention of Corrosion

The Jet Unit has been designed to withstand the corrosive effects of operation in salt water through the use of materials that are resistant to salt water corrosion and by the placement of sacrificial zinc anodes in suitable locations. However, the Jet Unit is still vulnerable to the actions of the person who fits the Waterjet System into the hull and to the actions of the electrician.

One of the major causes of corrosion of metal parts in salt water, are stray currents coming from the vessel's electrical system. These currents can be very small, often defying detection, but acting over a long period can cause significant corrosion.

Vessels using Hamilton Jet Units at sea , must be bonded and wired as described in *Precautions Against Corrosion* Section of the Jet Unit Manual.

7.1.

CONTENTS LIST

LIST OF FIGURES

1. Design Basics

NOTE:

The Design Basics Section in the Jet Unit Manual contains additional information.

1.1. EQUIPMENT DESCRIPTION

The Control system described in this Manual is **Control Type 7 (CT7),** also called **"CMU"**. It is based around electronic modules called the Control and Monitoring Unit (CMU) and the Multi Station Unit (MSU).
Control of the vessel occurs at a Control Station, which is fitted with Control Levers, Helm Control, Control Switches, Push Buttons and Indicators. A vessel may have up to 4 Control Stations.

THE CONTROL AND MONITORING UNIT (CMU)

Each Jet Unit is controlled by a dedicated micro-controller called a CMU.
All CMU(s) are housed in the electrical cabinet called the Central Control Unit (CCU), which is mounted near the Bridge.
A single CMU takes signals from the "In-Control" Control Station to control the following:

- One hydraulically actuated Reverse Duct.
- One Engine Controller / Governor.
- One hydraulically operated Steering Deflector.

The CMU incorporates features such as:

- Integration of all control functions for each Jet Unit.
- Closed loop control of Reverse Duct and Steering Deflector positions.
- The ability to co-ordinate Throttle and Reverse Duct operation in a single Control Lever.
- Continuous error checking with associated alarms.
- The ability to be reconfigured by use of a Hand Held Programmer.

THE MULTI STATION UNIT (MSU)

The MSU is provided in vessels with more than one Control Station to co-ordinate the transfer of control between Control Stations. It is located in the electrical cabinet called the Central Control Unit (CCU), which is mounted near the Bridge.

The MSU takes signals from all Control Stations and all CMU's to control:

- Transfer of Control from one station to another.

The MSU also provides the following functions:

- Monitors Control Station Signals to ensure they are valid.
- Provides indication of Status and Alarms through lamps and a buzzer.

THE HYDRAULIC SYSTEM

Each Jet Unit is fitted with a hydraulic power unit, called the Jet Hydraulics Power Unit (JHPU) which is driven by the Jet Unit Mainshaft.

The Reverse Duct and Steering Deflector are hydraulically powered, under closed loop control from the Jet Unit's CMU hydraulics. Cylinder positions are fed back to the CMU by Position Sensors. The CMU controls each cylinder by controlling solenoid valves mounted on the JHPU. The JHPU is also fitted with a Pressure Solenoid Valve. This valve is used to dump oil flow when no cylinder movement is required. This reduces energy consumption and component wear.

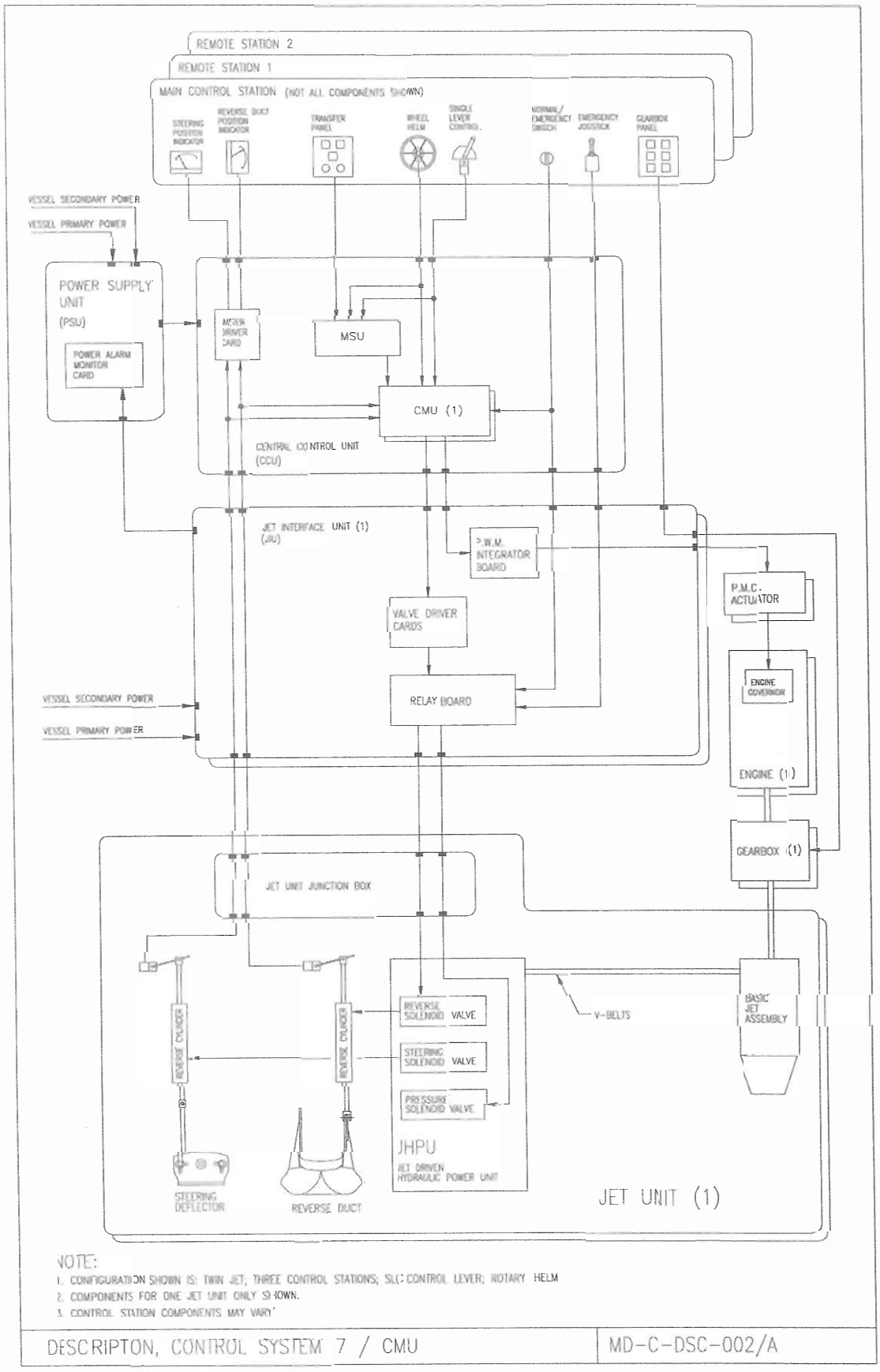


Figure 1-1 CMU System Block Diagram

THE POWER SUPPLY SYSTEM

The Control System utilises two wholly independent power supplies, the Primary Power Supply and the Secondary Power Supply.
The Control Stations receive their Power Supplies from an Electrical Cabinet called the Power Supply Unit (PSU), which is mounted near the Bridge.
The PSU provides the following functions:

- Accepts primary and secondary 24V DC power from the vessel.
- Automatically selects secondary power if primary becomes unusable.
- Regulates the incoming power before feeding it to the bridge mounted electronic equipment.
- Continually monitors power quality and activates alarms if the supply drops below set voltage limits.

Each Jet Unit connects to the Vessels Primary and Secondary DC Supply via the Jet Interface Units (JIU).
A JIU provides the following power supply functions:

- Accepts primary and secondary 24V DC power from the vessel.
- Automatically selects secondary power if primary power becomes unusable.
- Ensures that Indicator and Emergency Control is maintained even when Control Station Primary and Secondary supply is lost as long as at least one Jet power supply still exists.
- Regulates the incoming power before feeding it to the rest of the electronic equipment in the JIU, and to the Jet mounted electronic equipment.
- Monitors local power quality and passes this information to the PSU at the Bridge.

GEARBOX CONTROL

NOTE:

Gearbox Control is optional.

The Control System can be used to control the Gearbox. This control is independent of the CMU, however the CMU monitors the Gearbox position and has the ability to prevent gear changes occurring if the Engine RPM is not at 'low idle'.

1.2. LOCATION AND PROTECTION OF CONTROL EQUIPMENT

It is advisable to decide on the locations of, and prepare mountings for the Control Equipment before their actual installation. This helps by:

- Making installation a fast and trouble free process.
- Reducing the chances of damage to equipment during installation.
- Allowing cabling routes and lengths to be determining early.

The following Sections give recommendations on this subject.

1.2.1. Operator Controls

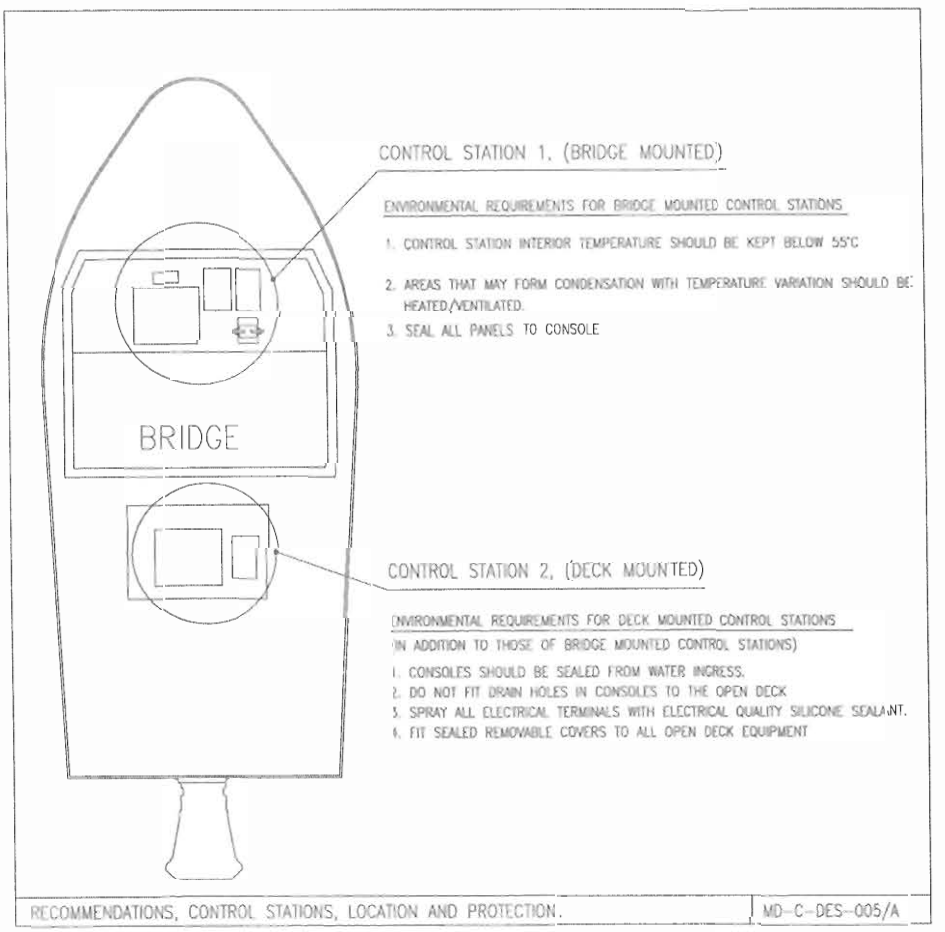


Figure 1-2 Control Station Locations

Location and Protection of Operator Controls
The diagram above shows the recommended locations of all Operator Control Equipment. This diagram shows a Single Jet Monohull installation, but cabinet locations are applicable to all installation types.

All Control Panels are designed for IP66 weather protection. But, for enhanced long life and trouble free operation, it is strongly recommended that a rigid protective housing be used to enclose exposed control panels.

The physical size of the Controls Panels can be determined from the drawings in the "Controls Stations" Section of the Drawings Package.

1.2.2. Electrical Cabinets

LOCATIONS OF ELECTRICAL CABINETS

Figure 1.3. "Typical CT7 / CMU Control Module Location" shows the recommended locations of all Electrical Cabinets. This diagram shows a Twin Jet Monohull installation, but cabinet locations are applicable to all installation types.

The physical size of the Electrical Cabinets can be determined from the drawings in the "Electronics" Section of the Drawings Package.

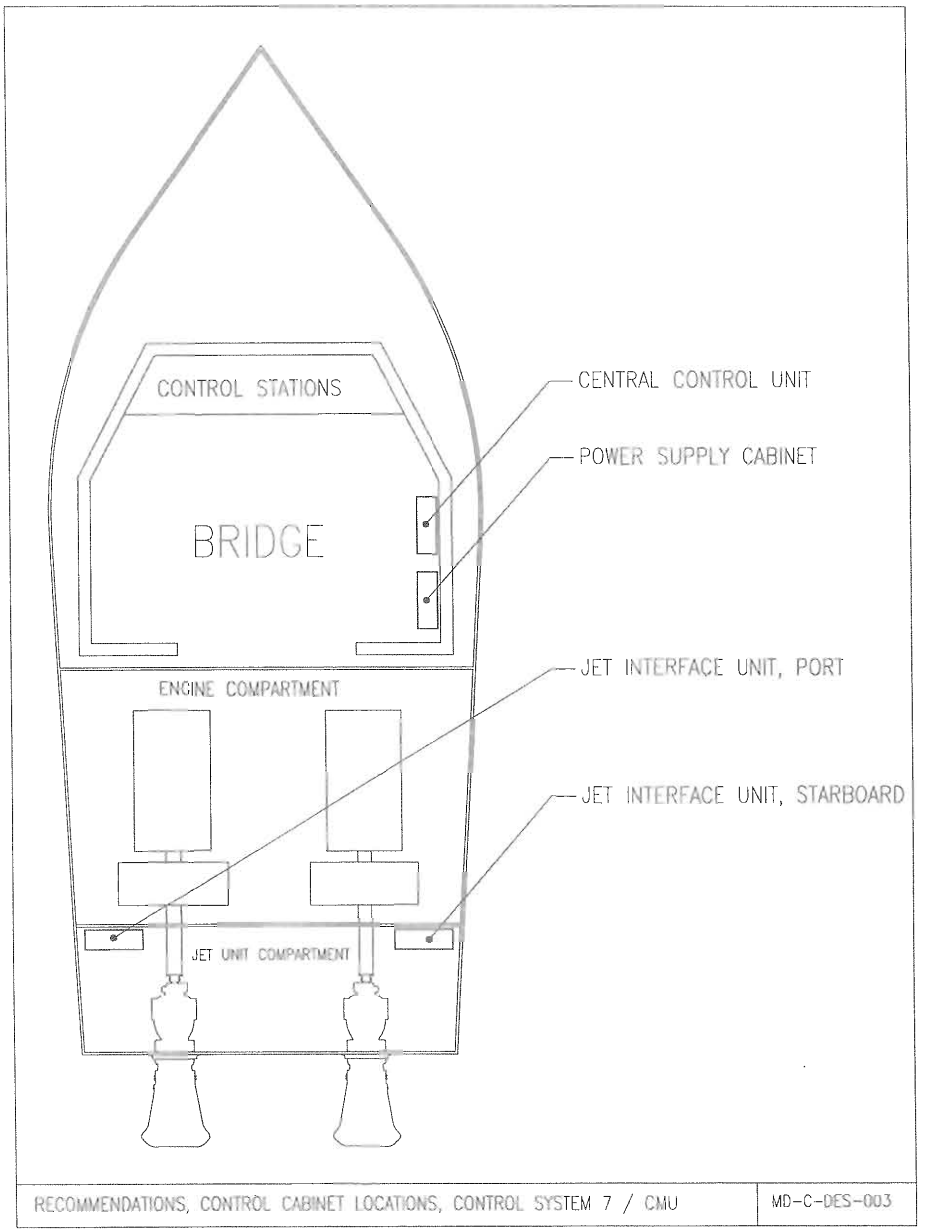


Figure 1-3 Typical CT7/CMU Control Module Location

CABINET ENVIRONMENT REQUIREMENTS

Temperature:
The Electrical Cabinets have an operating temperature range of 5 ºC to 65 ºC.

Fit thermostatically controlled heaters if the ambient temperature of the air outside the cabinets (during operation) is less than 0 ºC.

Condensation:
Condensation must be avoided inside the cabinets.

To avoid condensation:

- Ensure that the silica gel packs left inside the cabinet are in good condition. Replace if they have turned pink indicating they are full of moisture.
- Minimise the times the cabinet doors are opened.
- Ensure the door seals are in good condition.
- In cold climates install "Anti-Condensation Heaters" in all electrical cabinets. These heaters are connected so they automatically turn ON when the power to the control system is OFF.

Vibration:
The cabinets should not be exposed to high levels of vibration. If necessary, attach the cabinets to the Vessel using rubber anti vibration mounts.

1.2.3. Routing for Cables

The cable sizes and locations can be determined from the drawings in the "Wiring" Section of the Drawings Package.

Interconnections between all Control Equipment, the Jet Unit and other Equipment are made by electrical cables. It is very important to securely locate all cables and to protect them from moisture, oil, dirt and mechanical damage. The following guidelines should be followed.

1. **Location of Cables.**
   All cables should be located inside open top electrical trays or enclosed ducts. A good cable tray or duct will provide most of the required protection against oil, dirt and mechanical damage, as well as serving to locate the cables.

2. **Protection From Moisture, Oil, Dirt and High Temperatures.**
   Route cables in dry, oil and dirt free areas wherever possible. Use a fully sealed duct where the cables must pass through an area exposed to moisture, oil or dirt.

2. Installation

NOTE:

The Installation Section in the Jet Unit Manual contains additional information.

Locations of electrical equipment should have been considered before actual installation, as described **in Section 1.2. "LOCATION AND PROTECTION OF CONTROL EQUIPMENT"**. Refer to that Section before continuing with installation.

2.1. CONNECTING AND FILLING THE HYDRAULICS SYSTEM

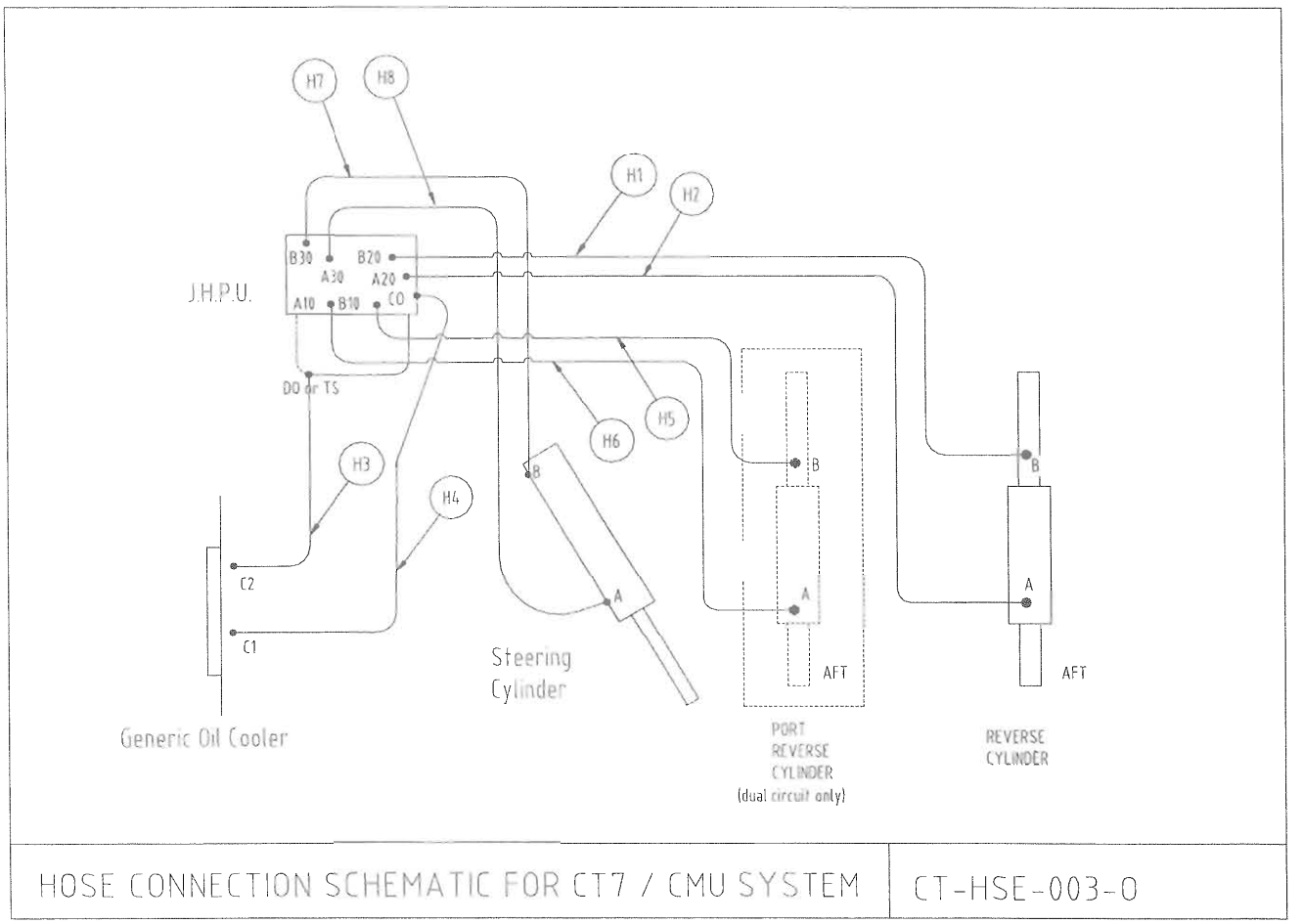


Figure 2-1 Hose Connection Schematic For CT7 / CMU System

2.1.1. JHPU Oil Cooler

Refer to drawings located in the "Other Hydraulics" Section of the drawings package, for mounting details.

The oil cooler is mounted on the Intake of the Jet Unit.

Hose [H4] carries hot oil from the JHPU connection [C0] to connection [C1] on the Oil Cooler. Hose [H3] returns cool oil from Connector [C2] on the Oil Cooler to the JHPU Tank.

1. Check that the Oil Cooler is still sealed from factory. If in doubt, remove the Oil Cooler Assembly and clean with compressed air and flush if necessary. Replace the assembly.
2. Connect Hose [H4] from the JHPU connection [C0] to connection [C1] on the Oil Cooler.
3. Connect Hose [H3] from the JHPU Oil Tank to connection [C2] on the Oil Cooler.
4. Disconnect both hoses [H3] and [H4] from the JHPU.
5. Using a funnel, fill the Oil Cooler by pouring oil into either [H3] and [H4] hose end until the Oil Cooler and hoses are full of oil.
6. Reconnect hoses [H3] and [H4] back to the JHPU. **Ensure that the hoses are correctly connected as shown on Figure 2.1. "Hose Connection Schematic For CT7 / CMU System".** Also refer to drawings located in the "Other Hydraulics" section of the drawings package.

2.1.2. Filling the JHPU

Refer to drawings located in the "Hydraulic Power Units" Section of the drawings package, for details of the JHPU.

Remove the Filler Cap from the JHPU Oil Tank and fill to the "Full" mark on the Dipstick. Replace the Filler Cap and tighten firmly.

The oil used in the JHPU System should meet the requirements of ISO 4406 with an ISO Code of 18/14.

Use hydraulic oil as described on **Drawing 85018. "Recommendations for Lubricants & Oils".**

2.1.3. Spare "V" Belts

WARNING:

SPARE "V" BELTS WILL CAUSE A POTENTIAL HAZARD TO BOTH PERSONNEL AND MACHINERY IF NOT PROPERLY SECURED.

ENSURE THAT THE SPARE "V" BELTS ARE FASTENED SECURELY TO THE JET UNIT AND DO NOT COME LOOSE AND FOUL OTHER EQUIPMENT DURING VESSEL OPERATION.

The Coupling will have a set of spare "V" Belts attached to it, with a Note explaining what to do with the spare belts.

Ensure that the Mainshaft passes through the "V" Belts. This allows the spare "V" Belts to be used without disconnecting the Driveshaft from the Coupling.

2.2. MOUNTING CONTROL STATION COMPONENTS

Refer to drawings located in the "Control Stations" Section of the drawings package, for mounting details.

Control Station components such as Control Levers and Control Panels cannot be permanently attached until commissioning is completed. However, they should be temporarily attached, as described below.

1. Use the component mounting holes as a template to drill holes in the mounting surface.
2. Temporarily fit the control component to check that it mounts correctly.
3. Temporarily attach the control component, as it will have to be removed during commissioning for access to electrical terminals.

2.3. MOUNTING ELECTRICAL CABINETS

Refer to drawings located in the "Electronics" Section of the drawings package, for mounting details.

During mounting, connect all Electrical Cabinets to the Earth Bonding System. **(Refer to Section 3."Precautions Against Corrosion").** To carry out this operation, connect one of the mounting points of the cabinet to the Earth Bonding System. Clean the mounting point so that a good electrical connection is made.

2.4. INTERCONNECTIONS

Interconnections between operator controls, electrical cabinets and the Jet Unit are made using electrical cables. Making interconnections is a three stage process:

- Installing cables.
- Preparing electrical connections, (no connections made yet).
- Making connections incrementally as part of the Commissioning process in **Section 3.1.1. "Commissioning the Electrical System".**

2.4.1. Installing Cables

Refer to the Wiring Diagrams located in the "Wiring" section of the drawings package, for wiring details.

Note that trays or ducting for cables should have been arranged before the actual installation of cables. **Refer to Section 1.2.3. "Routing for Cables" for details.**

- Install cables in trays or ducts. Refer to wiring drawing for details of cable runs.
- Use the following guidelines to ensure reliability of cabling:

a) Ensure cables are not exposed to dirt, oil, water, high temperature, or vibrations.
b) Do not install heavy cables on top of lighter cables.
c) Apply cable ties every 400 mm minimum to avoid vibration of cable sheaths and conductors.
d) Keep cables parallel, and do not cross over unless necessary.
e) Avoid sharp edged cable ties or unprotected metal ties on lighter cable sheaths.

2.4.2. Preparing Electrical Connections

This can only be done after the controls equipment and cables have been installed.

1. Fit protective crimp terminals to all wire ends. These are called "Bootlace Ferrules". Use colour coded ferrules if possible.
2. Label each wire end with the mating screw terminal number.
3. Ensure all cable glands in cabinets are properly fitted and tightened. Plug unused glands with short cable off-cuts.

3. Commissioning

NOTE:

The Commissioning Section in the Jet Unit Manual contains additional information. Section 5. "Faultfinding" in the Controls Manual contains additional information.

CAUTION:

Arc Welding:

Do not perform Electric Arc Welding unless the following requirements are met:

1. **Do not perform Electric Arc Welding closer than 1 metre from electronic modules or cables.**
2. **The Control System must be turned OFF and the power connector removed from all Jet Control Modules during Arc Welding.**
3. **Always use short earthing cables to earth Electrical Arc Welding operations close to the weld area.**

3.1. BEFORE LAUNCH

3.1.1. Commissioning the Electrical System

Commissioning of the Controls Systems involves the following stages:

Stage 1: Connecting cables between the **P**ower **S**upply **U**nit (PSU), all **J**et **I**nterface **U**nits (JIU's) and the Vessel 24V DC power supplies (Primary and Secondary), and then performing checks after power is turned on.

Stage 2: Connecting cables between all **C**entral **C**ontrol **U**nits (CCU's), the Control Stations and all other components. On completion, performing checks after power is turned on.

Stage 3: Connecting cables between the JIU's and the Jet Units, Gearbox Controllers and Throttle Controllers, and then performing checks after power is turned on.

Stage 4: Checking the operation of Secondary and Emergency Power Supply Systems.

STAGE 1: CONNECTIONS BETWEEN THE PSU, JIU(S) AND 24V DC

Refer to Wiring Diagrams located in the "Wiring" section of the drawings package, for wiring details.

NOTE:

The vessel's primary and secondary 24V DC power supply connections should be wired through an Isolation Switch which should be turned OFF.

Carry out the following actions:

1. Connect all cables between the PSU and all Jet Interface Units (JIU's) by following the system wiring diagram. Do not connect power to the system yet.
2. On the Power Alarm Monitor PCB, **(refer to Figure 3-1 "Power Alarm Monitor PCB" and Figure 3-2 "Table of Input Channels")** which is inside the PSU cabinet, check that all relevant input channels are connected using the Channel Select switches:
   - PSU Primary supply.
   - PSU Secondary supply.

   And for each Jet Interface Unit:
   - JIU Primary supply.
   - JIU Secondary supply.
3. Connect the vessel's primary and secondary 24V DC power supplies to the PSU and to all JIU's, by following the System Wiring Diagrams.
4. Check that the polarity of the power connections to the PSU and to all JIU's are correct.
5. Turn the primary and secondary power to the PSU and JIU's to "ON" using the Isolation Switch. This should cause the PSU to start to operate and power to be supplied to the JIU's.
6. Check the Power Alarm Monitor PCB to see if any relevant input channel LED's are not "ON". **(Refer to Figure 3-1 "Power Alarm Monitor PCB").**
7. Check for blown fuses in Auxiliary Interface PCBs in the PSU and all JIU's. Replace as necessary. **(Refer to Figure 3-3 "The Auxiliary Interface PCB in the PSU" and Figure 3-4 "The Auxiliary Interface PCB in the JIU").**
8. Check that the PSU and all JIU's are electrically isolated from the Vessel. This is carried out by using the "Chassis Leakage Test" on the Auxiliary Interface PCBs in the PSU and all JIU's. **(Refer to Figure 3-3 "The Auxiliary Interface PCB in the PSU" and Figure 3-4 "The Auxiliary Interface PCB in the JIU").**

"The Power Alarm Monitor PCB".

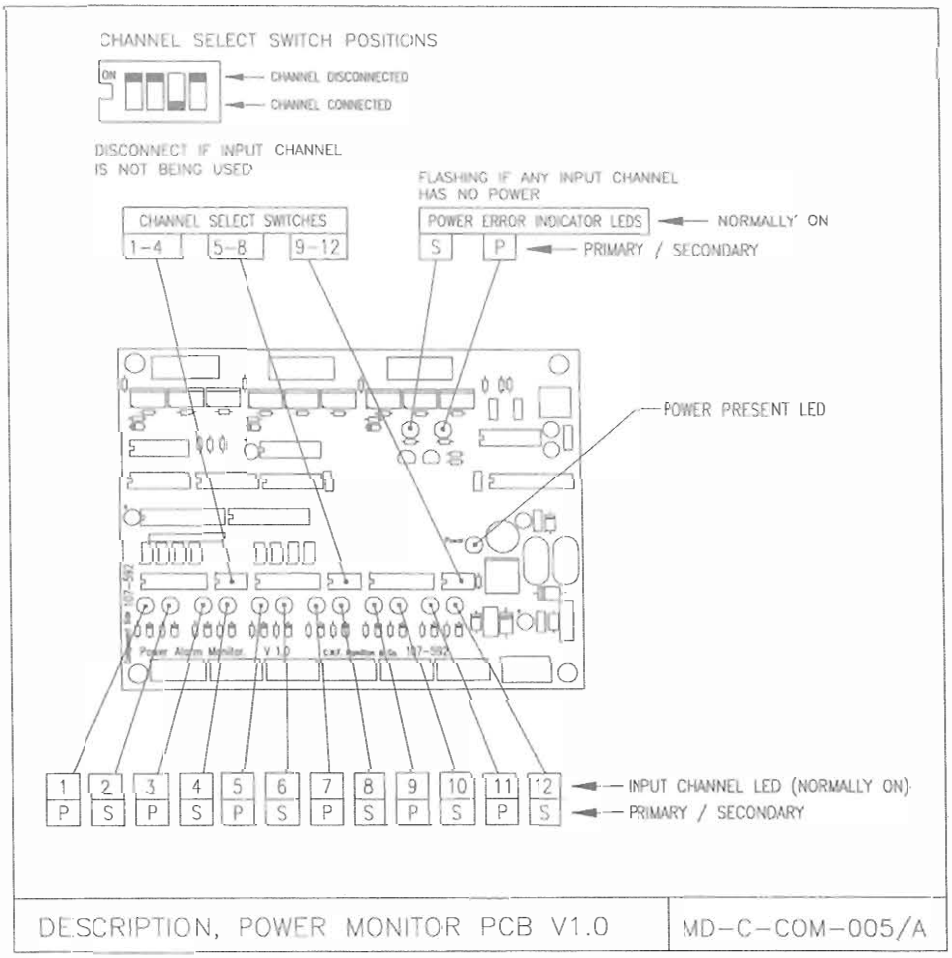


Figure 3-1 Power Alarm Monitor PCB

NOTE:

1. **The board monitors the Input Channels as groups of Primary and Secondary channels, as shown on the diagram.**

2. **Unused channels must be disconnected as shown, otherwise the board will generate an error condition.**

3. **The following table shows how the input channels are allocated to various Jet Unit installation types.**

Figure 3-2 Table of Input Channels

	INPUT CHANNEL											
Jet Installation Type	1	2	3	4	5	6	7	8	9	10	11	12
1 Jet Unit	PSU 12V primary	PSU 12V secondary	J1 JIU 24V primary	J1 JIU 24V secondary	disconnect	disconnect	disconnect	disconnect	disconnect	disconnect	disconnect	disconnect
2 Jet Units	PSU 12V primary	PSU 12V secondary	J1 JIU 24V primary	J1 JIU 24V secondary	J2 JIU 24V primary	J2 JIU 24V secondary	disconnect	disconnect	disconnect	disconnect	disconnect	disconnect
3 Jet Units	PSU 12V primary	PSU 12V secondary	J1 JIU 24V primary	J1 JIU 24V secondary	J2 JIU 24V primary	J2 JIU 24V secondary	J3 JIU 24V primary	J3 JIU 24V secondary	disconnect	disconnect	disconnect	disconnect
4 Jet Units	PSU 12V primary	PSU 12V secondary	J1 JIU 24V primary	J1 JIU 24V secondary	J2 JIU 24V primary	J2 JIU 24V secondary	J3 JIU 24V primary	J3 JIU 24V secondary	J4 JIU 24V primary	J4 JIU 24V secondary	disconnect	disconnect

FUSES AND CONNECTORS

ITEM	FUSE No	VALUE	CONNECTOR	DESCRIPTION
1	F1, F16	5A	J1	PRIMARY SUPPLY, 24V & 0V FUSED
2	F2, F15	5A	J2	SECONDARY SUPPLY, 24V & 0V FUSED
3	F4	2A	J8	PORT METER DRIVER BOARD
4	F5	2A	J11	STARBOARD METER DRIVER BOARD
5	F9	2A	J13	STARBOARD CMU BOARD
6	F11	2A	J14	PORT CMU BOARD
7	F13	2A	J15	MSU BOARD
8	F7	3A	J4	SMOOTHING CAPACITOR

FORCE SECONDARY SUPPLY

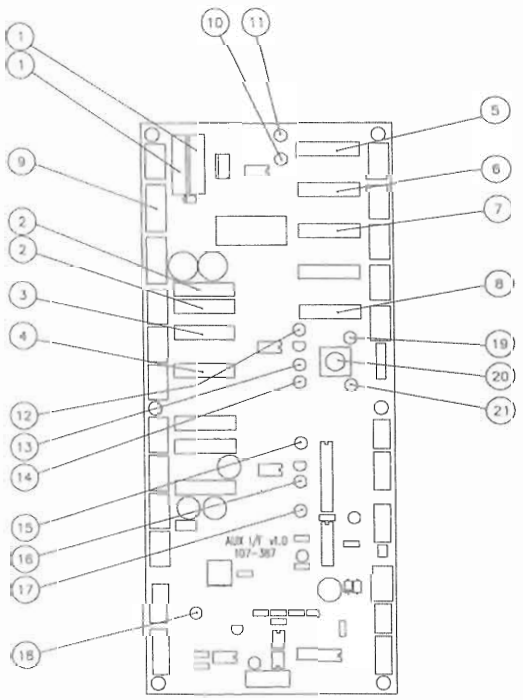
ITEM	NAME	DESCRIPTION
9	J3	REMOVE THIS PLUG TO FORCE SYSTEM TO USE SECONDARY POWER SUPPLY

POWER SUPPLY LED's

ITEM	NAME	DESCRIPTION
10	D2	PRIMARY SUPPLY OK & IN JSE
11	D3	PRIMIMARY SUPPLY OVER VOLTAGE
12	D6	SECONDARY SUPPLY OK
13	D5	SECONDARY SUPPLY OVER VOLTAGE
14	D4	SEC SUPPLY UNDER VOLTAGE
15	D18	EMERGENCY SUPPLY OVER VOLTAGE
16	D19	EMERGENCY SUPPLY OK
17	D17	EMERGENCY SUPPLY UNDER VOLTAGE
18	D14	EMERGENCY SWITCHMODE OPERATIONAL

CHASSIS LEAKAGE TEST

ITEM	NAME	DESCRIPTION
19	D10	LED, OFF IF LEAKAGE TO 0V
20	SW1	BUTTON, PRESS TO TEST
21	D9	LED, OFF IF LEAKAGE TO +V



DESCRIPTION, AUX. I/F BOARD V1.0 107-387, POWER SUPPLY UNIT | MD-C-COM-004/a

Figure 3-3 The Auxiliary Interface PCB in the PSU

FUSES AND CONNECTORS

ITEM	FUSE No	VALUE	CONNECTOR	DESCRIPTION
1	F1, F16	5A	J1	PRIMARY SUPPLY, 24V & 0V FUSED
2	F2, F15	5A	J2	SECONDARY SUPPLY, 24V & 0V FUSED
3	F9	3A	J13	GEARBOX SOLENOIDS
4	F11	3A	J14	EMERGENCY SUPPLY TO PSU
5	F13	3A	J15	STEERING VALVE DRIVER BOARD
6	F21	3A	J25	NORMAL/EMERGENCY CHANGEOVER RELAYS
7	F7	3A	J4	REVERSE VALVE DRIVER BOARD

FORCE SECONDARY SUPPLY

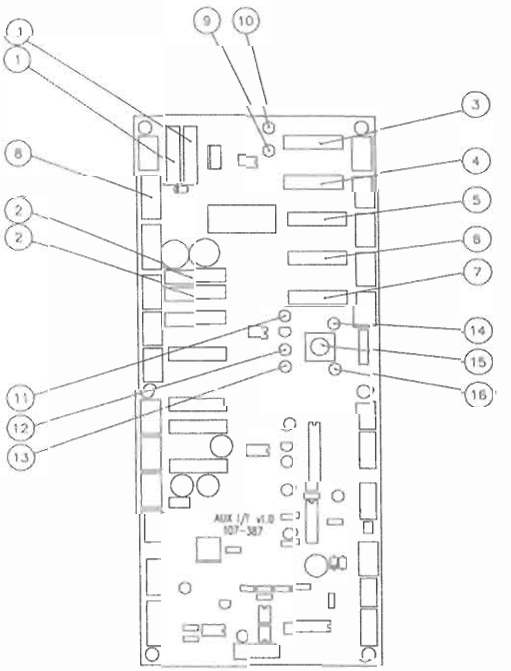
ITEM	NAME	DESCRIPTION
8	J3	REMOVE THIS PLUG TO FORCE JET INTERFACE UNIT TO USE SECONDARY POWER SUPPLY

POWER SUPPLY LED's

ITEM	NAME	DESCRIPTION
9	D2	PRIMARY SUPPLY OK & IN USE
10	D3	PRIMARY SUPPLY OVER VOLTAGE
11	D6	SECONDARY SUPPLY OK
12	D5	SECONDARY SUPPLY OVER VOLTAGE
13	D4	SEC SUPPLY UNDER VOLTAGE

CHASSIS LEAKAGE TEST

ITEM	NAME	DESCRIPTION
14	D10	LED, OFF IF LEAKAGE TO 0V
15	SW1	BUTTON, PRESS TO TEST
16	D9	LED, OFF IF LEAKAGE TO +V



DESCRIPTION, AUX. I/F BOARD V1.0 107-387, JET INTERFACE UNIT | MD-C-COM-006/a

Figure 3-4 The Auxiliary Interface PCB in the JIU

STAGE 2: CONNECTIONS BETWEEN CONTROL STATIONS, CCU(S), PSU AND JIU(S)

Refer to Wiring Diagrams located in the "Wiring" section of the drawings package, for wiring details.

Carry out the following actions:

1. Switch off power to the PSU and JIU's using the Isolation Switch.
2. Connect all cables between the Control Station(s), the CCU(s) and the JIU(s) by following the System Wiring Diagram.
3. Turn ON the primary and secondary power to the PSU and JIU using the Isolation Switch.
4. There will be a spurious power alarm. Cancel this alarm using the ALARM CANCEL & TEST button on a Control Panel.
5. Confirm that when using the ALARM CANCEL & TEST button, that both the power alarm lamps stay solidly ON and no further alarm is activated.
6. If a power alarm lamp is still flashing, look at the Power Alarm Monitor PCB to see which supply has failed. **(Refer to Figure 3-1 "Power Alarm Monitor PCB" and Figure 3-2 "Table of Input Channels").**
7. Check for blown fuses in Auxiliary Interface PCBs in the PSU and all JIU's. Replace as necessary. **(Refer to Figure 3-3 "The Auxiliary Interface PCB in the PSU "and Figure 3-4 "The Auxiliary Interface PCB in the JIU").**
8. Check that the PSU and all JIU's are electrically isolated from the Vessel. This is done by using the "Chassis Leakage Test" on the Auxiliary Interface PCBs in the PSU and all JIU's. **(Refer to Figure 3-3 "The Auxiliary Interface PCB in the PSU" and Figure 3-4 "The Auxiliary Interface PCB in the JIU").**

STAGE 3: CONNECTIONS BETWEEN JIU(S), JET UNITS, GEARBOXES AND THROTTLES

Refer to the Wiring Diagrams located in the "Wiring" section of the drawings package, for wiring details.

Checks are carried out here to confirm that power wiring to the Jet Unit, Gearbox and Engine Throttle is correct.

Carry out the following actions:

1. Switch off power to the PSU and JIU's using the isolation switch.
2. Connect all cables between all Jet Units and Gearbox Limit Switches to all the JIU(s) by following the System Wiring Diagrams. **All cables should now be connected.**
3. Turn the primary and secondary power to the PSU and JIU(s) ON, using the Isolation Switch.
4. There will be a spurious power alarm. Cancel this alarm with the ALARM CANCEL & TEST button.
5. Confirm that both the power alarm lamps stay solidly ON when using the ALARM CANCEL & TEST button and that no further alarms are activated.
6. If a power alarm lamp is still flashing, look at the Power Alarm Monitor PCB to see which supply has failed. **Refer to Figure 3-1 "Power Alarm Monitor PCB" and Figure 3-2 "Table of Input Channels").**
7. Check for blown fuses in Auxiliary Interface PCBs in the PSU and all JIU's. Replace as necessary. **(Refer to Figure 3-3 "The Auxiliary Interface PCB in the PSU" and Figure 3-4 "The Auxiliary Interface PCB in the JIU").**
8. Check that the PSU and all JIU's are electrically isolated from the Vessel. This is done by using the "Chassis Leakage Test" on the Auxiliary Interface PCBs in the PSU and all JIU's. **(Refer to Figure 3-3 "The Auxiliary Interface PCB in the PSU" and Figure 3-4 "The Auxiliary Interface PCB in the JIU").**

NOTE:

After completing this Section, the CMU Control System should be operating, but it will not be useable as it has not yet been set up. Therefore you may notice the CONTROL STATUS, CONTROL ALARM and TRANSFER PANEL STATUS Indicator Lamps are flashing on the Control Stations. This is normal.

STAGE 4: CHECKING OPERATION OF SECONDARY SUPPLIES

Refer to the Wiring Diagrams located in the "Wiring" Section of the drawings package, for wiring details.

Secondary 24V DC Supply to PSU.
The PSU has an automatic system that detects loss of primary 24V DC power and switches over to the secondary 24V DC power.

To check this operation, carry out the following actions:
1. Disconnect the 24V Primary Power to all equipment using the Isolation Switch.
2. This will cause a Power Alarm to operate. Cancel this with the ALARM CANCEL & TEST button on a Control Panel.
3. Power should have been automatically transferred to the secondary supply. This is confirmed by checking for the following LED lights.

Figure 3-5 Table of LED Display and State for Primary and Secondary Power

LOCATION	LED	STATE
Auxiliary Interface PCB in the PSU	D2: Primary supply OK & in use	OFF
Auxiliary Interface PCB in the PSU	D6: Secondary supply OK	ON
Power Alarm PCB in the PSU	All connected Primary indicator LED's	OFF
Power Alarm PCB in the PSU	All connected Secondary indicator LED's	ON
Auxiliary Interface PCB in each JIU	D2: Primary supply OK & in use	OFF
Auxiliary Interface PCB in each JIU	D6: Secondary supply OK	ON

Emergency Supply
The PSU also has an Emergency Supply that takes power from a JIU if the Primary and Secondary power supplies to the PSU fail.
1. Turn off power at the Isolation Switch.
2. Remove connectors J1 and J2 from the Auxiliary Interface PCB in the PSU. This disconnects Primary and Secondary power to the Auxiliary Interface PCB in the PSU. These connectors are identified by labels "J1" and "J2" on the PCB.
3. Turn on power at the Isolation Switch.
4. Power should have been automatically transferred to the Emergency supply. This is confirmed by checking for the following LED lights.

Figure 3-6 Table of LED Display and State for Emergency Power

LOCATION	LED	STATE
Auxiliary Interface PCB in the PSU	D2: Primary supply OK & in use	OFF
Auxiliary Interface PCB in the PSU	D6: Secondary supply OK	OFF
Auxiliary Interface PCB in the PSU	D19: Emergency supply OK	ON
Auxiliary Interface PCB in the PSU	D14: Emergency Switch Mode operational	ON
Power Alarm PCB in the PSU	D5: Primary indicator LED	OFF
Power Alarm PCB in the PSU	D3: Secondary indicator LED	OFF

5. Check for a voltage of 12V on connection J11-1 relative to J11-2 on the Auxiliary Interface PCB in the PSU.
6. Turn off power at the Isolation Switch.
7. Replace "J1" and "J2" on the Auxiliary Interface PCB in the PSU.

3.1.2. Checking the Emergency Changeover System

Refer to the Drawings located in the "Electronics" Section of the drawings package, for details.

There is a separate Emergency Changeover System for each Jet Unit. Each Emergency Changeover System should be checked as follows.

1. Set all NORMAL / EMERGENCY switches to NORMAL.
2. Check that the changeover relays in the JIU cabinet are operating when the Jet Unit control system is changed from NORMAL to EMERGENCY mode. To carry out these checks:
   a) Arrange for an assistant to be positioned close to the Jet Interface Unit cabinet. The assistant will confirm that the Emergency relays activate by observing their indicator LED's change state.

   b) Perform the following checks when switching each NORMAL / EMERGENCY control to the EMERGENCY position and then back to the NORMAL position.
      I. Check with the assistant that all relays changed state.
      II. Check that the EMERGENCY OVERRIDE lamp turns ON, then OFF, on all Master Control Panels.

3.1.3. Checking the Gearbox Systems (Where Applicable)

Check for correct operation of the Gearbox System using the following procedure:
1. Switch to EMERGENCY Control Mode.
2. Press the NEUTRAL push button(s) on the Main Gearbox Control Panel.
3. Check that the lamp(s) of the NEUTRAL push button(s) become lit, and that the other back lights (DRIVE and BACKFLUSH) are not lit.
4. Perform the same steps as 1 to 3 above, on the DRIVE and BACKFLUSH push buttons, returning to NEUTRAL after each test.

3.1.4. Commissioning the Hydraulic Systems

The hydraulic systems can be fully commissioned before launch by using a special motor that drives the JHPU independently of the Mainshaft. This motor is called the "JHPU Field Driver". It can be supplied by C.W.F. Hamilton if required. It is used to purge air from the system and check the correct operation of all the valves prior to launching the vessel.

ATTACHMENT OF THE JHPU FIELD DRIVER

Refer to the Drawings located in the "Hydraulic Power Units" section of the drawings package, for details.

The JHPU Field Driver Unit is not essential for commissioning of the Jet or the CMU System but, if available, does offer the following advantages:-
   a) The system may be run and any air purged from the hydraulics without the need to run the main engines.
   b) The CMU System may, with the exception of the zero thrust and engine related settings, be Set Up prior to launch and prior to the commissioning of the engine.

If a JHPU Field Driver Unit is not being used for commissioning of the Jet or the CMU System, then continue with Section 3.2. *"AFTER LAUNCH"*.

1. Wire up the A/C Pump Motor, delta connection for 220 Va/c 3 phase, or star connection for 440 Va/c 3 phase as marked on motor name plate.
2. Check the motor rotation as marked on the motor name plate. Hold the hydraulic motor by its torque arm.
3. Remove the Belt Guard from the JHPU.
4. Loosen Nuts holding JHPU to the Jet Unit and slide the JHPU towards the Mainshaft.
5. Remove the V-Belts from the JHPU Pulley.
6. Attach the JHPU Field Driver. To carry out this operation:
   a) Screw 2 M8 Bolts with Washers into the front face of the JHPU Pulley.
   b) Push the JHPU Field Driver Motor over the Bolt Heads, rotate and tighten up the M8 Bolts.
   c) Rest the Torque Reaction Arm of the Motor on top of the Jet Unit Coupling.

7. Connect the Motor Hoses to the JHPU Field Driver Pump Unit via the quick release Hose Couplings.
8. Ensure that both hoses are properly connected, especially the Reservoir line into the Filter. Failure to do so will block the Reservoir line and put full pressure onto the Motor Shaft Seal. This will blow out the Motor Shaft Seal.
9. Fill JHPU Field Driver Pump Unit to the top of the Sight Gauge with the same oil as the JHPU System. **The capacity is approximately 15 litres.**

PURGING AIR FROM THE JHPU SYSTEM

Refer to the Drawings located in the "Hydraulic Power Units" section of the drawings package, for details.

1. Ensure oil level in JHPU is fully topped up.
2. Turn the Bypass Valve Handle on the JHPU Field Driver Pump Unit, parallel to the Reservoir. This gives 650 to 750 RPM.

NOTE:

The Valve Handle at 90° to the Reservoir gives 350 to 450 RPM and is used to check the Relief Valve setting ONLY.

3. Install a 0 to 2300 PSI Pressure Gauge in the Port labelled "PO" on the top of the JHPU. This Port is normally plugged. The Pressure Gauge reads the system operating pressure. When not working, this pressure goes to the "Standby" value. This can range from 150 to 250 psi, depending on oil temperature.

4. Run the JHPU at 700 RPM for 15 minutes. This serves to:
   - Remove any foreign matter from the oil by the action of the filters.
   - Allow any air in the oil cooler and JHPU to be removed.
   - Allow any air suspended in the oil to be removed.
5. Check that the "PO" pressure is in the "Standby" range, as described in paragraph 3 above.

CAUTION:

Do not activate the cylinders whilst purging air from the JHPU system as this may introduce contamination into the valves of the JHPU and Reverse Cylinder Servo Valve.

6. Check the oil level in the JHPU periodically during purging and top up the oil level to prevent air from entering the pump.

7. After this initial purging, purge air from the Reverse and Steering Cylinders by stroking them fully for 5 cycles. To carry out this operation:
   - Set Control Mode to BACKUP.
   - Move the BACKUP Jogstick in the appropriate direction to stroke the cylinders.
   - Refill the JHPU.

8. Continue running for at least 15 minutes to remove any new air and dirt that may have entered the system.

CHECKING OPERATION OF THE PRESSURE VALVE ON JHPU

Refer to the Drawings located in the "Hydraulic Power Units" section of the drawings package, for details.

1. To operate the JHPU Field Driver on the slower speed, turn the Valve Handle at 90° to the Reservoir gives 350 to 450 RPM and is used to check the Pressure Relief Valve setting ONLY.
2. Set control mode to EMERGENCY.
3. Operate the Emergency Control Jogstick in the reverse direction until the Reverse Cylinders come up against their travel limits.
4. "PO" pressure should rise to 1500 psi and drop back to the "Standby" pressure when the Jogstick is centred.

NOTE:

Pressures may vary by 50 psi when the oil is below 40° C or above 60° C.

SETTING EMERGENCY MODE CYLINDER SPEEDS

Refer to the Drawings located in the "Electronics" Section of the drawings package, for details.

Cylinder speeds in Emergency Mode are adjusted by varying the drive signal to the Solenoid Valves. These signals are produced by the Emergency Relay Control Module which is located in the Jet Interface Unit.

To Adjust:

1. Locate the potentiometers on the Emergency Relay Control Module. **Refer to Figure 3-7 "Emergency Relay Module".** Obtain a suitable screwdriver for the potentiometer slot.
2. Arrange for an assistant to operate the EMERGENCY JOGSTICK to exercise each hydraulic cylinder.
3. Observe the speed of movement of the hydraulic cylinder, and adjust the potentiometer to give a suitable speed.

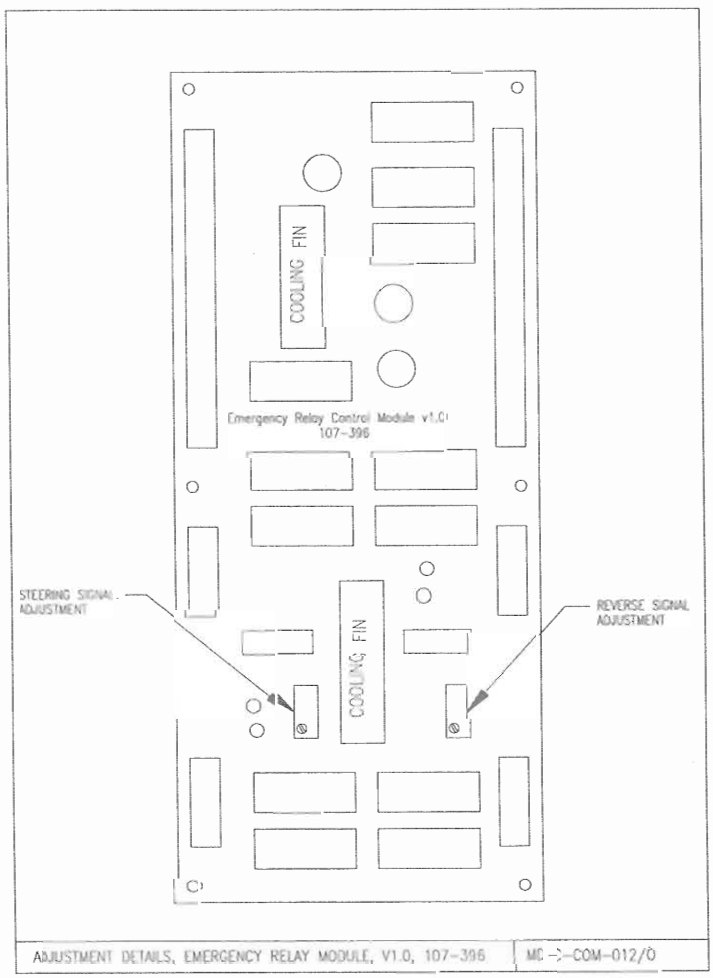


Figure 3-7 Emergency Relay Module

3.1.5. Checking Input Sensor Voltages

The Control System accepts information from Sensors as voltages. It is important to check that the output polarities of these Sensors are correct. This can be done by checking voltages produced by these Sensors at certain key physical positions, as described below:

Figure 3-8 Table of Input Sensor Voltages

SENSOR	SENSOR POSITION	VOLTAGE (V)	NOTES
Helm Wheel or Joystick Input	Port Maximum	< 2.5	-
	Mid Helm	2.5	tolerance +/- 0.1V
	Starboard Maximum	> 2.5	-
Autopilot Helm Input (bipolar) Voltage Sense depends on Bit 4 of Analogue Input Data inversion (60)	Port Maximum	- 10V-	Default
	Mid Helm	0.0	tolerance +/- 0.1V
	Starboard Maximum	+ 10 V	
Single Lever Control (SLC) or Reverse Lever Input	Reverse Maximum	< 1.5	-
	Neutral point Detent	2.5	tolerance +/- 0.1V
	Ahead Maximum	> 3.5	-
Throttle Lever Control Input (Where applicable)	Maximum throttle	> 3.5	-
	Centre point (approx.)	2.5	
	Minimum throttle	< 1.5	-
Steering Deflector Feedback Sender	Port Maximum	> 3.0	-
	Mid Helm	-	-
	Starboard Maximum	< 1.5	-
Reverse Duct Feedback Sender	Reverse Maximum	< 1.5	-
	Zero Speed Position	-	-
	Ahead Maximum	> 3.0	-

The Emergency Controls may be used to move the Steering Deflector and Reverse Duct, which will in turn move the Steering and Reverse Duct Senders. The JHPU must be running.

NOTE:

***If* the Steering and Reverse Feedback Senders on the Jet Unit have the wrong output polarity, this can be corrected by rotating the Sensor Body by 180°.**

CAUTION:

The Steering and Reverse Feedback Senders will be damaged if their supply polarity is incorrect. Ensure that the supply polarity is correctly connected before applying power to the Senders.

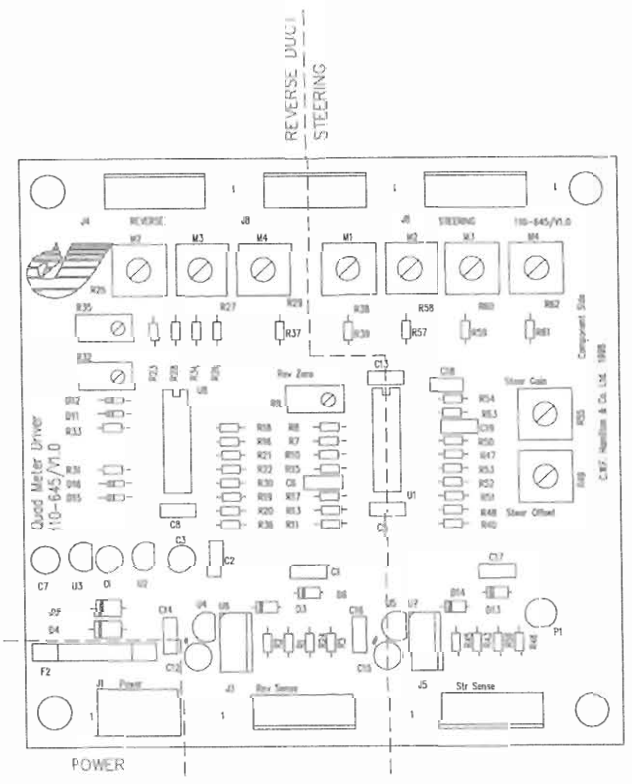
3.1.6. Adjusting Steering and Reverse Indicators

NOTE:

There are two possible versions of Meter Driver PCB fitted to the CT7 / CMU Controls System. Identify which board is fitted by comparing with *Figure 3-9 "Meter Driver PCB (New Version)"* and *Figure 3-11 "Meter Driver PCB (Old Version)"*. Use the Set-Up Procedure related to the relevant Figure.

THE METER DRIVER PCB (New Version)

The indicator electronics must be adjusted to match the Indicators with the movement of the corresponding item (Steering Deflector of Reverse Duct). These adjustments are carried out on the Meter Driver Board which is located in the Central Control Unit cabinet. The adjustments are carried out on potentiometers as shown in the following diagram.



J1	Power in
J3	Reverse Duct Sensor
J4	Output To Reverse Duct Meters
J5	Steering Sensor
J6	Output To Steering Meters
J8	Output To Reverse Duct & Steering Meters
R55	Steering Meter Gain Adjust
R49	Steering Meter Minimum Adjust
R35	Reverse Duct Meter Up Adjust
R32	Reverse Duct Meter Down Adjust
R9	Reverse Duct Meter Neutral Adjust
R25	Reverse Duct Meter Attenuation
R27	Reverse Duct Meter Attenuation
R28	Reverse Duct Meter Attenuation
R38	Steering Meter Attenuation
R58	Steering Meter Attenuation
R60	Steering Meter Attenuation
R62	Steering Meter Attenuation

ADJUSTMENT DETAILS, METER DRIVER CARD 110-645/V1.0	MD-C-COM-013/A

Figure 3-9 The Meter Driver PCB (New Version)

ADJUSTMENT POSITIONS (New Version)

Adjustment comprises moving the Steering Deflector and Reverse Duct to each of their key positions, and making adjustments to the Meter Driver PCB so that the corresponding Indicator Needle is in the correct position. The key positions of the Steering Deflector and Reverse Duct, and the corresponding needle positions are given in the following table.

Figure 3-10 Table of Steering and Reverse Indicator Positions (New Version)

ITEM	Key Position	How to Detect Item position	Position of Indicator Needle
Steering Deflector.	Port Maximum.	Indicator on Jet Unit shows Port Maximum.	Limit Mark on Port side.
	Centre Helm.	Indicator on Jet Unit shows Centre Helm.	Centre point of Indicator.
	Starboard Maximum.	Indicator on Jet Unit shows Starboard Maximum.	Limit mark on Starboard side.
Reverse Duct.	Ahead Maximum.	Cylinder is at fully retracted position.	Limit Mark on Ahead side.
	Zero Speed.	When Jet Unit is operational. This occurs after engine start. Move Reverse Duct until thrust from Jet Unit is zero.	Centre point of Indicator.
	Astern Maximum.	Cylinder is at fully extended position.	Limit mark on Astern side.

REVERSE DUCT METER SET UP PROCEDURE (New Version):

1. Move potentiometers **R25, R27 & R29** to their mid-point position.
2. Move Reversing Duct to full neutral position using the Emergency Controls.
3. Adjust **R9** to move the Master Station Reverse Duct meter to show neutral.
4. If the system has more than one control station, adjust the offset screw of the Reverse Duct meter at each of the other stations to ensure that each meter shows neutral.
5. Move the Reverse Duct to the fully down position.
6. Adjust **R32** to move the Master Station Reverse Duct meter to show full down position.
7. Move the Reverse Duct to the fully up position.
8. Adjust **R35** to move the Master Station Reverse Duct meter to show full up position.
9. Repeat Steps 6 to 9 above until the meter is displaying both the fully down and fully up positions satisfactorily.
10. Move the Reverse Duct to the fully up position.
11. If the system has more than one control station, adjust potentiometers **R25** (for Remote Station 1), **R27** (for Remote Station 2) and **R29** (for Remote Station 3) to set the Remote Station Reverse Duct Meters to show the fully up position.

STEERING DEFLECTOR METER SET UP PROCEDURE (New Version):

1. Move potentiometers **R38, R58, R60** and **R62** to their mid point positions.
2. Move the Steering Deflector fully to Starboard using the Emergency Controls.
3. Adjust **R49** to move the Master Station Steering Deflector Meter to indicate full Starboard.
4. If the system has more than one control station, adjust the offset screw of the Steering Deflector Meter at each other station to ensure that each Meter indicates the full Starboard position.
5. Move the Steering Deflector to the straight ahead position.
6. Adjust **R55** to move the Master Station Steering Deflector Meter to indicate the straight ahead position.

7. Move the Steering Deflector to the full Port position.
8. Adjust **R62** to move the Master Station Steering Deflector Meter to indicate the full Port position.
9. Repeat Steps 6 to 9 above until the meter is displaying both ahead and full Port position satisfactorily.
10. Move Steering Deflector to the full Port position.
    If the system has more than one control station, adjust potentiometers **R38, R58** & **R60** to set the remote station Steering Deflector meters to indicate the full Port position.

THE METER DRIVER PCB (Old Version)

The indicator electronics must be adjusted to match the Indicators with the movement of the corresponding item (Steering Deflector of Reverse Duct). These adjustments are carried out on the Meter Driver Board which is located in the CCU cabinet. The adjustments are carried out on potentiometers as shown in the following diagram.

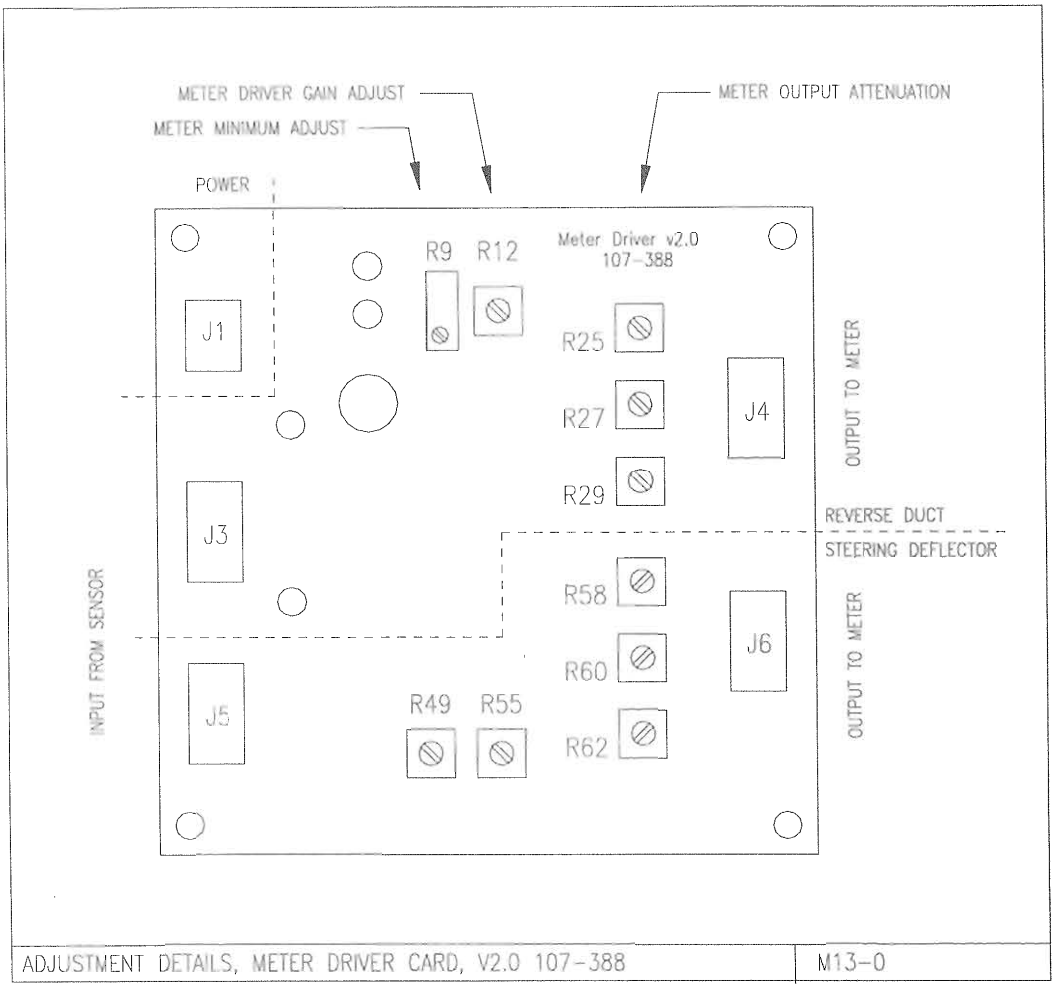


Figure 3-11 Meter Driver PCB (Old Version)

ADJUSTMENT POSITIONS (Old Version)

Adjustment comprises moving the Steering Deflector and Reverse Duct to each of their key positions, and making adjustments to the Meter Driver PCB so that the corresponding Indicator Needle is in the correct position. The key positions of the Steering Deflector, Reverse Duct and the corresponding needle positions are given in **Figure 3-12 "Table of Reverse Duct and Steering Deflector Adjustment Positions".**

Figure 3-12 Table of Reverse and Steering Indicator Positions (Old Version)

ITEM	Key Position	How to Detect Item position	Position of Indicator Needle
Steering Deflector	Port Maximum	Indicator on Jet Unit shows Port Maximum	Limit Mark on Port side
	Centre Helm	Indicator on Jet Unit shows Centre Helm	Centre point of Indicator
	Starboard Maximum	Indicator on Jet Unit shows Starboard Maximum	Limit mark on Starboard side
Reverse Duct	Ahead Maximum	Cylinder is at fully retracted position	Limit Mark on Ahead side
	Zero Speed	When Jet Unit is operational. This occurs after engine start. Move Reverse Duct until thrust from Jet Unit is zero.	Centre point of Indicator
	Astern Maximum	Cylinder is at fully extended position	Limit mark on Astern side

REVERSE DUCT METER SETUP PROCEDURE (Old Version):

1. Move potentiometers **R12**, **R25**, **R27** & **R29** to their mid-point position.
2. Move Reverse Duct to full reverse position using Emergency Controls.
3. Adjust **R9** to move master station Reverse Duct meter to show full reverse.
4. If the system has more than one control station, adjust the offset screw of the Reverse Duct meter at each other station to ensure that each meter shows full reverse.
5. Move Reverse Duct to neutral position.
6. Adjust **R12** to move master station Reverse Duct meter to show neutral.
7. Move Reverse Duct to full ahead position.
8. Adjust **R29** to move master station Reverse Duct meter to show full ahead.
9. Repeat Steps 6 to 9 until the meter is displaying both neutral and full ahead position satisfactorily.
10. Move the Reverse Duct to full ahead position.
11. IF the system has more than one control station, adjust potentiometers **R25** and **R27** to set the Remote Station Reverse Duct meters to show full ahead.

STEERING DEFLECTOR METER SETUP PROCEDURE (Old Version):

1. Move potentiometers **R55**, **R58**, **R60** and **R62** to their mid point positions.
2. Move the Steering Deflector fully to Starboard using Emergency Controls.
3. Adjust **R49** to move the Master Station Steering Deflector meter to show full Starboard.
4. If the system has more than one control station, adjust the offset screw of the Steering Deflector meter at each other station to ensure that each meter shows full Starboard.
5. Move the Steering Deflector to straight ahead position.
6. Adjust **R55** to move master station Steering Deflector meter to show straight ahead.
7. Move Steering Deflector to the full Port position.

8. Adjust **R62** to move the master station Steering Deflector meter to show full Port.
9. Repeat steps 6 - 9 until the meter is displaying both Ahead and full Port positions satisfactorily.
10. Move Steering Deflector to the full Port position.
11. If the system has more than one control station, adjust potentiometers **R58** and **R60** to set the Remote Station Steering Deflector meters to show full Port.

3.1.7. Completing Mountings and Electrical Connections

After the Control System Electric's have been checked, the electrical connections and control panels can be finally attached.

FINAL ATTACHMENT OF THE CONTROL PANELS TO THE VESSEL

1. Ensure that all fasteners used are made of stainless steel.
2. Ensure that all fasteners use sealing washers to prevent entry of water around the fastener.
3. All Controls Panels are sealed by adhesive foam gaskets which are supplied. Use the following guidelines when fitting Control Panels:
   a) Ensure the underside of the Control Panel is free of dirt and grease. Clean the underside of the panel with solvent if dirty.
   b) Apply the adhesive side of the gasket to the underside of the Control Panel.
   c) Apply a thin smear of silicone grease to the non adhesive side of the gasket before securing the Control Panel to the mounting. This will minimise tearing of the gasket on removal.
   d) Replacement gaskets are available from Hamilton Jet.

FINAL ATTACHMENT OF ELECTRICAL CONNECTIONS

1. Ensure all electrical connectors are firmly connected.
2. Ensure all cables are firmly attached to a fixed object near the connectors. This will prevent any mechanical loads from loosening the connector.
3. Spray all connectors with electrical grade silicone moisture repellent.

3.1.8. Setting Option Switches on the CMU *and* MSU Circuit Boards

On the CMU Circuit Board and MSU Circuit Board (if fitted) there are two switches that allow for different configurations. They are situated near the centre of the circuit boards and are labelled SW1 (a four way switch) and SW2 (a 10 way rotary switch). The following tables explains how they should be set.

CMU, SW1
On Multi Jet Systems each CMU must have the SW1 switch set the same.

Figure 3-13 Table of CMU Circuit Board "Switch 1" Settings

Switch No	On	Off	Comment
1	Idle speed reset enabled.	Idle speed reset disabled.	Must be on for safe vessel operation.
2	MSU network enabled.	MSU network disabled.	Must be on for Multi station systems.
3	Helm mid point start-up detection enabled.	Helm mid point start-up detection disabled.	Must be on for safe vessel operation.
4	Hydraulic position error detection enabled.	Hydraulic position error detection disabled.	Must be on for safe vessel operation.

CMU, SW2

The SW2 switch sets the address of the CMU. The Port side CMU address should be set to 1 and increment the address by 1 for each additional CMU after that, so that the Starboard outer CMU has the highest address.
This address is used on Multi-Station systems, but even on single station systems the address must be set to a non-zero number.

Figure 3-14 Table of CMU Circuit Board "Switch 2" Settings

SW2 Position	Number of Stations
0	0 (Invalid)
1	1 (Port CMU Address)
2	2 (Port +1 CMU Address)
3	3 (Port + 2 CMU Address)
4	4 (Port + 3 CMU Address)
5...9	undefined

MSU, SW1

The MSU Circuit board uses the position of the first 3 switches on SW1 to determine the number of CMU's on the MSU network. The fourth switch disables helm matching on vessels with up to 3 Control Stations. On vessels with four Control Stations SW1-4 disables **ALL** control matching.

Figure 3-15A Table of MSU Circuit Board "Switch 1" Settings

Vessels with 1 to 3 Control Stations

SW1 - 1	SW1 - 2	SW1 - 3	SW1 - 4	Number of CMU's / Matching
Off	Off	Off	X	No CMU's (testing only)
On	Off	Off	X	1 CMU
Off	On	Off	X	2 CMU's
On	On	Off	X	3 CMU's
Off	Off	On	X	4 CMU's
X	X	X	Off	Helm matching enabled
X	X	X	On	Helm matching disabled

Figure 3-15B Table of MSU Circuit Board "Switch 1" Settings

Vessels with 4 Control Stations

SW1 - 1	SW1 - 2	SW1 - 3	SW1 - 4	Number of CMU's / Matching
Off	Off	Off	X	No CMU's (testing only)
On	Off	Off	X	1 CMU
Off	On	Off	X	2 CMU's
On	On	Off	X	3 CMU's
Off	Off	On	X	4 CMU's
X	X	X	Off	Control matching enabled
X	X	X	On	Control matching disabled

MSU, SW2

The MSU Circuit Board uses the position of the rotary switch SW2 to determine the number of Control Stations connected to the MSU network

Figure 3-16 Table of MSU Circuit Board "Switch 2" Settings

SW2 Position	Number of Stations
0	0 (Invalid)
1	1 (Master station only - Invalid)
2	2 (Master + 1 Remote station)
3	3 (Master + 2 Remote stations)
4...9	undefined

3.1.9. Parameter Programming

Before each CMU can be used, all the relevant control parameters must be programmed into it. Some of these parameters can only be programmed at the factory, others can be modified by the customer. These parameters include:

- Mid and end points of the Helm and Control Levers.
- The corresponding mid and end points of the Steering Deflector and Reverse Duct positions.
- Engine speed demand maximums and idle speed limit. (Where applicable).

Parameter programming is accomplished using the hand-held CMU FIELD PROGRAMMER which is plugged into the CMU board.

NOTE:

Each CMU is programmed independently of any other CMU. It is the responsibility of the person configuring the CMU's to ensure that different CMU's are programmed correctly. (i.e. Two CMU's linked to one SLC must be programmed with the same SLC mid point position.

USING THE CMU FIELD PROGRAMMER

CAUTION:

Incorrect use of the CMU FIELD PROGRAMMER can lead to erratic or incorrect behaviour of the Control System. Follow the programming instructions carefully and verify that the Control System is running correctly as expected before operating the vessel. Never modify any parameters unless you understand their function and effect.

NOTE:

Before attempting any programming, check that the indicator lines on the single Rotary Switch (marked "Value") and on the two Rotary Switches (marked "Parameter Number") are correctly aligned with their respective 0..9 numbers on the face of the Field Programmer. This is achieved by rotating the Rotary Switches from one end-stop to the other and verifying that the indicator lines on the Rotary Switches align with their respective 0.to.9 numbers.

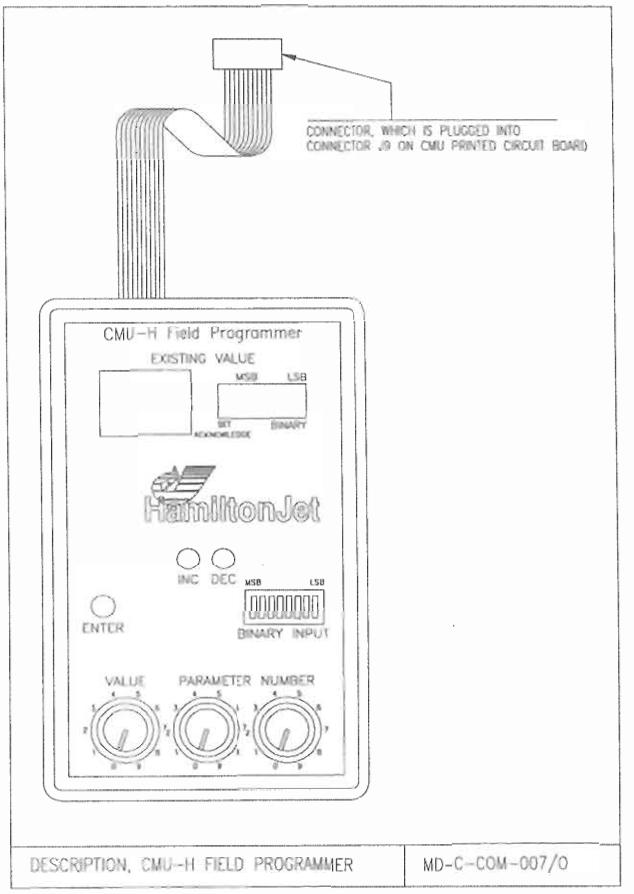


Figure 3-17 The CMU Field Programmer

Description

The CMU FIELD PROGRAMMER is a small hand held electronic device that allows a technician to easily change existing values of parameters in the CMU. The CMU FIELD PROGRAMMER can also be used to provide a log of the previous 10 Alarm codes.

Programming is basically a process of:

1. Plugging the CMU FIELD PROGRAMMER into the CMU.
2. "Entering" new parameters.
3. Unplugging the CMU FIELD PROGRAMMER from the CMU board Connector J9.

CMU Field Programmer: Controls and Indicators

1. EXISTING VALUE Display

This display serves two purposes.

a) Displays the EXISTING VALUE in the CMU value of the selected parameter.

b) Displays for 0.5 second the new PARAMETER NUMBER whenever it is changed. After 0.5 seconds, the display reverts back to display the EXISTING VALUE.

c) Analogue voltage levels are stored as a binary number displayed in the Binary display. 8 bit parameters are displayed in full. 12 bit parameters only have their 8 most significant bits displayed.

d) The display is only active if the parameter has a value that can be meaningfully displayed.

2. The SET ACKNOWLEDGE Light

This light confirms that the CMU has just accepted a new value for a parameter. It should turn on for 0.5 second immediately after the ENTER, INC. or DEC push buttons have been pressed. The SET ACKNOWLEDGE Light will not turn on if either:

a) The PARAMETER NUMBER was invalid / unused.

b) The PARAMETER NUMBER was not modifiable (A factory only parameter).

3. **The INC. and DEC Push-Buttons**
   The INC. and DEC Push-Buttons allow the parameter value of the selected parameter to be increased or decreased. This is another way of adjusting the parameter values. These push buttons also automatically "enter" the new parameter value, the ENTER push button does not have to be pressed after changing the parameters. It is not possible to increment or decrement parameters beyond their pre-set limits. If the limit has been reached, the confirmation beep will not sound and the EXISTING VALUE will remain as previously set.

4. **The ENTER Push-Button**
   When the ENTER Push-Button is pressed, the VALUE of the selected parameter will be saved by the CMU, overwriting the EXISTING VALUE. The EXISTING VALUE will then change to reflect this. The programmer will 'beep' when a parameter is programmed.
   If a parameter is out of range, the programmer will not accept the parameter and no confirmation beep will be heard and the EXISTING VALUE will not change.

5. **BINARY INPUT Switches**
   The Binary Input Switches are an alternative method of selecting the required parameter value. These are used for bit field setting.

6. **VALUE Switch (1 off)**
   The Value Switch is a rotary switch used to select the required parameter value. This can range from 0 to 9 using this switch.

7. **PARAMETER NUMBER Switches (2 off)**
   These are rotary switches used to select the required parameter number. The left switch is for 10's and the right switch for 1's. For example, to select parameter 25 rotate the left switch to '2' and the right switch to '5'. There can be a up to 100 parameters (not all parameters may be valid).

CMU Field Programmer Programming Procedure

1. **Connect the CMU FIELD PROGRAMMER** cable to Header J9 of the appropriate CMU board.
   - Ensure that the CMU FIELD PROGRAMMER cable is connected to the correct connector.
   - Ensure that the connector is properly oriented and beware of static damage to the electronics.
   - Although the programmer can be connected to the CMU at any time, the programming mode will only be invoked at "Power-Up / Reset" or when the CMU is running in "MID-IDLE" mode (i.e. When both the Helm and Reverse Lever or SLC are at mid position).
   - When in programming mode the CMU will "lock" the hydraulic control signals at zero and keep the engine control signal at minimum idle demand. Any alarms are also cleared.
   - The CMU Field Programmer becomes active immediately after it is sensed by the CMU.

2. **Change any parameters as required by:**
   a) Selecting the PARAMETER NUMBER of the parameter that needs changing. THEN EITHER:
   b) Select the new value for that parameter number using the VALUE switch or the BINARY INPUT switches and press the ENTER Push-Button.
   OR
   c) Select the new value for that parameter number using the INC. or DEC Push Buttons.
   OR
   d) If a position is being programmed, e.g. Reverse Duct "Up" position, move the Reverse Duct to the appropriate position and then press the ENTER Push Button.
   - The order in which parameters are entered is not important.
   - When modifying analogue position parameters, always allow one second to elapse between moving the device (Steering Deflector or Reverse Duct, etc.) and pressing 'ENTER'.

3. **Unplug the CMU FIELD PROGRAMMER** from the CMU. This causes the CMU to "Re-Boot". The CMU will return to its normal running mode Initial State after about one second.

Interrogating the Alarm Code Log

1. **Description**
   The CMU has the ability to record the Alarm Code of up to 10 Alarm occurrences. When the Alarm Log is full (10 codes have been recorded) the earliest recorded Alarm Codes are overwritten.
   In this way the latest 10 Alarm Codes are always held by the CMU.
   A new Alarm Code is only recorded when it is different from the previously recorded Alarm Code.

2. **Reading The Alarm Code Log**
   The Alarm Code Log can be interrogated using the Field Programmer. Parameters #90 to #99 are used for Alarm Code Logging. The CMU Logs the first Alarm Code in Parameter #90. The second Alarm Code is placed in parameter #90 and the older Alarm Code is moved to parameter #91 and so on until 10 Alarm Codes are recorded. After 10 Alarm Codes are recorded, the oldest Alarm Code is discarded each time a new Alarm Code is logged.
   Each Alarm Code has an associated 'Age' displayed on the Binary Display. The 'Age' of an Alarm Code corresponds to the number of times the Control System has been reset since the Alarm Log was last cleared.
   The Alarm Code is given by dialling the parameter wanted (#90 to #99) and reading the Alarm Code from the EXISTING VALUE display and the Age from the Binary Display.
   If less than 10 Alarms have been logged, the empty parameters are blank.

3. **Clearing the Alarm Code Log**
   The Alarm Code Log may be cleared by pressing 'Enter' on the CMU Field Programmer when the Parameter is set to #90.

NOTE:

A 5 volt power supply is supplied to the CMU Field Programmer through Fuse F11 on the CMU Board. If the programmer appears to be completely inactive then turn off the control system power and check this fuse.

CMU PARAMETER NUMBERS AND MEANINGS

User Changeable Parameters:

Figure 3-18 Table of CMU Parameters and Meanings

Parameter Number	Parameter Name	Description and Values
00	PCB_status	Status code written into EEPROM after programming. This must be set to '83'
01	idle_speed_maximum	Sets maximum idle speed limit (0..9)
02	max_fwd_speed	Sets maximum forward speed (0..9)
03	max_rev_speed	Sets maximum reverse speed (0..9)
04	master_helm_port	Master station helm positions
05	master_helm_mid	Value = analog voltage at position
06	master_helm_stbd	
07	remote1_helm_port	Remote station 1 helm positions
08	remote1_helm_mid	Value = analog voltage at position
09	remote1_helm_stbd	
10	remote2_helm_port	Remote station 2 helm positions
11	remote2_helm_mid	Value = analog voltage at position
12	remote2_helm_stbd	(Used for extra Joystick input if fitted)
13	remote3_helm_port	Remote station 3 helm positions
14	remote3_helm_mid	Value = analog voltage at position
15	remote3_helm_stbd	
19	Valve Dither	Sets the Hydraulic Valve Dither. 00= no dither, Maximum = 9 (relating to 3.5% dither)
20	Valve Driver Setup	Initiates the set-up routine for the setting of the deadband of the Hydraulic Valve Drivers.1 = turn on set-up routine O = turn off set-up routine
21	steering_fb_port	Steering Deflector positions
22	steering_fb_mid	Value = feedback analogue voltage at position
23	steering_fb_stbd	
24	bucket_fb_min	Reverse Duct positions
25	bucket_fb_down	Value = feedback analogue voltage at position
26	bucket_fb_neut	
27	bucket_fb_up	
28	bucket_fb_max	
29	warmup_rpm	Maximum RPM during warm-up (5 to 99)%.
30	unused	-
31	master_lever_min	Master station lever positions
32	master_lever_rev	Value = feedback analogue voltage at position
33	master_lever_mid	(also Port Master SLC for 2 lever CMU)
34	master_lever_fwd	(also Master Reverse Levers for Separate Lever set-up)
35	master_lever_max	(also Master Throttle Levers for Separate Lever set-up)
36	remote1_lever_min	Remote station 1 lever positions
37	remote1_lever_rev	Value = feedback analogue voltage at position
38	remote1_lever_mid	(also Port Remote SLC for 2 lever CMU)
39	remote1_lever_fwd	
40	remote1_lever_max	
41	remote2_lever_min	Remote station 2 lever positions
42	remote2_lever_rev	Value = feedback analogue voltage at position
43	remote2_lever_mid	(also Starboard Remote SLC for 2 lever CMU)
44	remote2_lever_fwd	
45	remote2_lever_max	

Parameter Number	Parameter Name	Description and Values
46	remote3_lever_min	Remote station 3 lever positions Value = feedback analogue voltage at position (also Starboard Master SLC for 2 lever CMU)
47	remote3_lever_rev	
48	remote3_lever_mid	
49	remote3_lever_fwd	
50	remote3_lever_max	

Factory Changeable only Parameters

Parameter Number	Parameter Name	Description and Values
51	Kp_steering	Steering Deflector servo-loop coefficients (0..15)
52	Ki_steering	
53	Kd_steering	
54	Kp_bucket	Reverse Duct servo-loop coefficients (0..15)
55	Ki_bucket	
56	Kd_bucket	
57-59	unused	-
60	Analog_Inv	Analogue channel data inversion (binary data bit-field)
61	Max_steering_error	Maximum position error for valve control (0..20)
62	Max_bucket_error	Maximum position error for valve control (0..20)
63	Steering_alarm_zone	Steering servo alarm error limit in % (5..20)
64	Bucket_alarm_zone	Rev. duct servo alarm error limit in % (5..20)
65	Steering_alarm_time	Steering servo alarm time-out (5..10)
66	Bucket_alarm_time	Rev. duct servo alarm time-out (5..10)
67	Apilot_alarm_time	Autopilot servo alarm time-out (10..20)
68-69	unused	
70	Centre_SLC_ratio	Ratio used to calculate centre Jet SLC position in % (0..9)
71-78	unused	
90-99	Alarm Code Log	
90	Alarm Code log Clear	'Enter' this parameter to clear the Alarm Code Log
99	Default Parameter Set	Enter '7', '0', '9' to reset Factory Default Parameters

PARAMETER DESCRIPTIONS

NOTE:

Not all parameters may be applicable to a specific Control System.

The control parameters listed above are described below in functional groups with the corresponding parameter numbers indicated in brackets.

The CMU software checks parameters to verify that they are within a valid range. If they are not within a valid range then the CMU will not allow them to be programmed. Any parameters indicated as having a range 0..9 must be restricted to these values.

1. **PCB / CMU Status Code (0)**

This programmed value must be set to 83. It is set by default to 83 and there is no reason to change it.

NOTE:

Changing this parameter to anything except 83 will cause the Controls to become inoperable.

2. **Maximum Idle Speed (1)**

This sets the highest speed possible when using the idle speed increment switch on the Control Panel. The minimum idle speed is pre-set by the engine manufacturer. The maximum possible idle is fixed in the CMU software to 50% of maximum RPM. The parameter value (0..9) entered determines the operating maximum idle speed within the above limits, e.g. entering 2 makes the idle speed limit about 18% of maximum RPM and entering 7 makes it about 40% of maximum RPM.

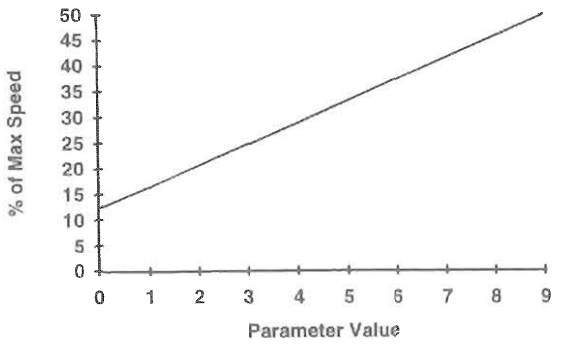


Figure 3-19 Graph of Idle Speed Parameters

3. **Maximum Forward Speed (2)**

This allows the throttle position when the Reverse Duct is in the "Full Ahead" position to be derated from the maximum possible engine speed. Entering a 0 makes the maximum forward speed about 60% of the maximum possible while entering 9 sets it to the maximum possible.

With vessels using separate Throttle and Reverse Levers, this parameter should be set to the same value as parameter 3, Maximum Reverse Speed.

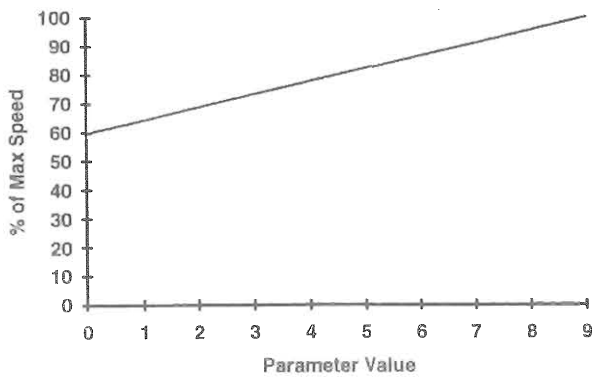


Figure 3-20 Graph of Maximum Forward Speed Parameters

4. **Maximum Reverse Speed (3)**

This allows the throttle position to be de-rated from the maximum possible engine speed, when the Reverse Duct is in the "Full Reverse" position.
A 0 (zero) value makes the maximum reverse speed about 60% of the maximum possible while entering 9 sets the maximum reverse speed to the maximum possible.

With vessels using separate Throttle and Reverse Levers, this parameter should be set to the same value as parameter 2, Maximum Forward Speed.

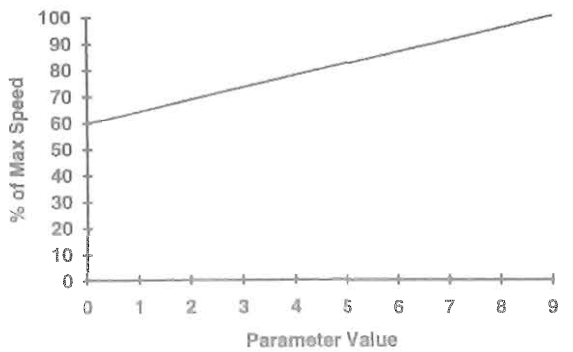


Figure 3-21 Graph of Maximum Reverse Speed Parameters

5. **Master Control Station Helm Wheel / Joystick Positions (4, 5, & 6)**
   These allow the physical movement of the Wheel or Joystick to be programmed into the CMU. The mid-point and both the port and starboard end points must be entered so that the correct position of the Steering Deflector can be calculated for a given steering input. **Refer to Figure 3.32 "CMU Steering Parameters".**

6. **Remote Control Station Helm Wheel / Joystick Positions (7, 8, 9), (10, 11, 12) and (13, 14, 15)**
   These allow the physical movement of the Wheel or Joystick to be programmed into the CMU. The mid-point and both the port and starboard end points must be entered so that the correct position of the Steering Deflector can be calculated for a given steering input. They correspond to the Master Helm positions, as shown in **Figure 3.32 "CMU Steering Parameters"..**

7. **Valve Dither (19)**
   Dither is a feature that can be enabled to prevent the Valves from sticking. Dither keeps the Valves oscillating at a low amplitude. Set to '00' there is no dither. This is the factory default and is recommended. The maximum dither is set at 3.5% of the maximum drive signal which relates to a parameter of '9'. Each increase / decrease of the Dither parameter relates to an increase / decrease of 0.4% of the maximum drive signal.

8. **Valve Drive Set-Up (20)**
   To set-up the Valve Driver circuit boards located in the Jet Interface Units, it is necessary to initiate the set-up routine using this parameter. Start the set-up routine by programming '1' into this parameter. Stop the routine by programming a '0'. Disconnecting the Programmer will also stop the routine.
   When the routine has started, the CMU will attempt to drive the Hydraulic Steering and Reverse Duct at the minimum drive levels in both port, starboard and up / down directions.

9. **Steering Deflector Positions (21, 22, & 23)**

   These allow the physical positions of the Steering Deflector to be programmed into the CMU. The mid point and both the port and starboard end points must be entered so that the correct position of the Steering Deflector can be calculated for a given steering input. Refer to the following **"Figure 3.22 CMU Steering Parameters"**.

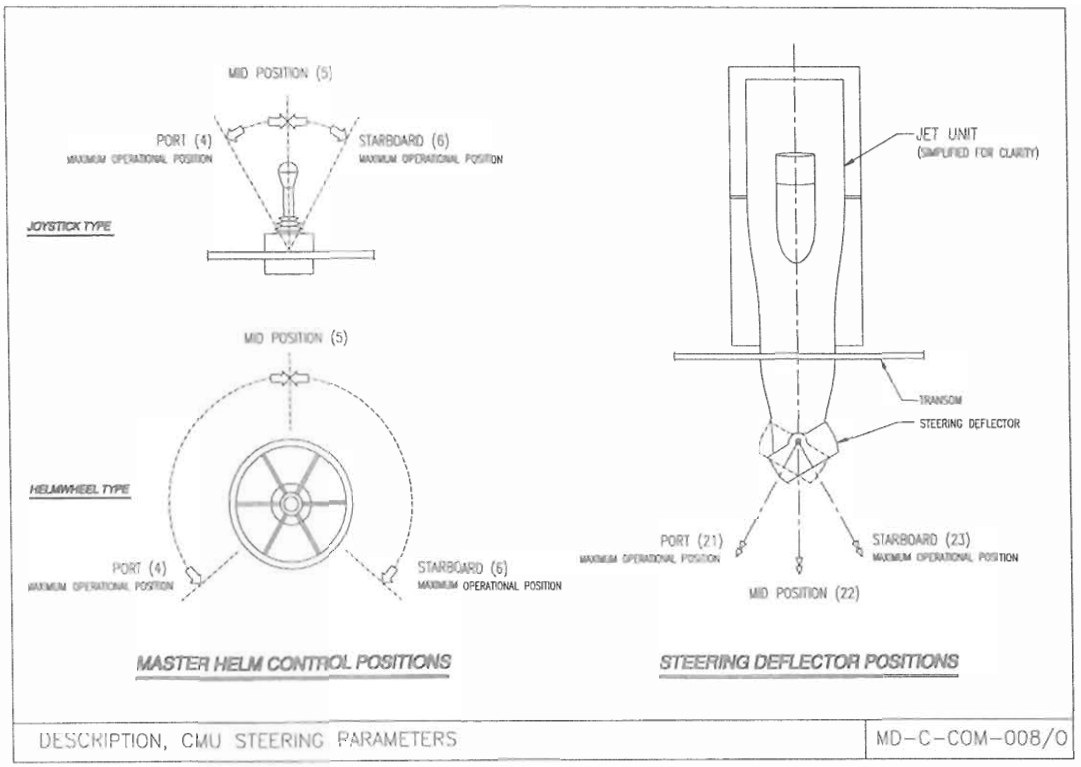


Figure 3-22 CMU Steering Parameters.

10. Reverse Duct Positions (24 - 28)

These allow the physical positions of the Reverse Duct to be programmed into the CMU. The Up, Down, and Zero Speed positions must be entered along with the Minimum and Maximum positions as shown on the following **"Figure 3-23 CMU Reverse Duct Parameters.**

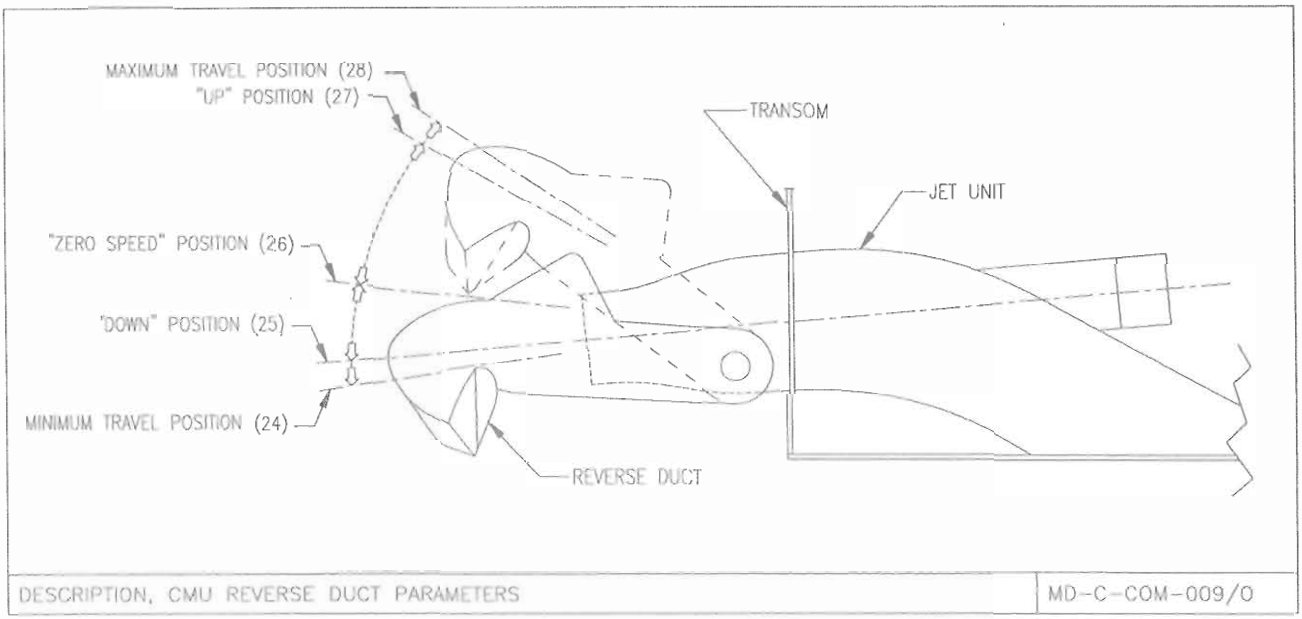


Figure 3-23 CMU Reverse Duct Parameters

11.Engine Warm Up Maximum RPM (29)

This setting allows the maximum engine RPM during warm-up, to be set. The value is a percentage of the maximum RPM and may be set between 5% and 99%.

Small changes may be made using the 'INC' and 'DEC' keys on the Field Programmer. Alternatively the required value may be set on the 'Binary Input' switches and then press 'ENTER'.

12.Master Control Station, Single Lever Control (SLC) Positions (31 to 35)

These allow the physical positions of the Master SLC to be programmed into the CMU. The positions are the "Zero Speed" and "Idle-Zone" Detents and also the Forward and Reverse Lever movement limits. The **"Figure 3.24 CMU Single Lever Controller Parameters"** below shows how the SLC positions relate to engine speed demand and Reverse Duct positions.

For Separate Lever Systems:
Parameter 31, sets the Throttle Lever minimum.
Parameter 35, sets the Throttle Lever maximum.
Parameters 32, 33 and 34, set the Reverse Lever 'Reverse', 'Mid Idle' and 'Forward' positions.

For Triple Jet Installations: using just 2 SLC's.
Parameter 31 to 35 are used for Port Master SLC positions.

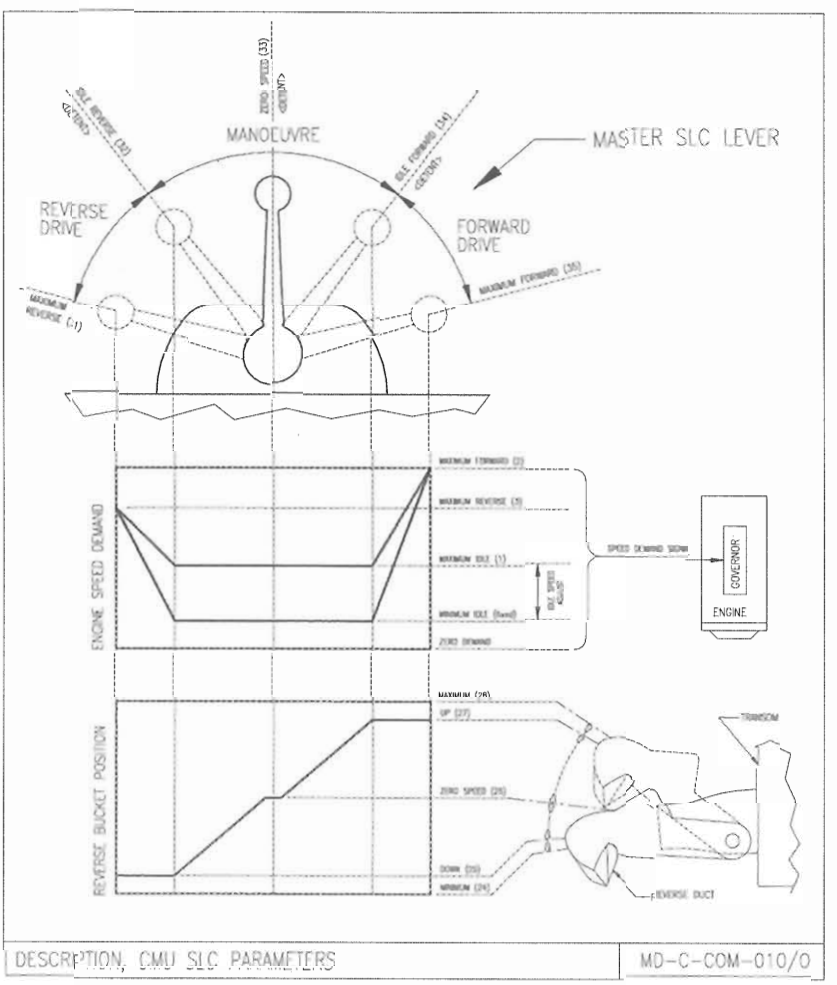


Figure 3-24 CMU Single Lever Controller Parameters

13. Remote Control Station, Single Lever Control (SLC) Positions (36 - 40)

These allow the physical positions of the remote SLC to be programmed into the CMU. The positions are usually the neutral and idle -zone indents plus the forward and reverse lever movement limits. If the remote SLC is simply a potentiometer without indents, then suitable positions have to be chosen. The previous diagram shows how the SLC positions relate to engine speed demand and Reverse Duct position.

For Triple Jet - 2 SLC installations, these inputs are used for Port Remote SLC.

14. Remote Control Station 2, Single Lever Control (SLC) Positions (41 - 45)

These allow the physical positions of the remote 2 SLC to be programmed into the CMU. The positions are usually the neutral and idle -zone indents plus the forward and reverse lever movement limits. If the remote 2 SLC is simply a potentiometer without indents, then suitable positions have to be chosen. The previous diagram shows how the SLC positions relate to engine speed demand and Reverse Duct position.

For Triple Jet - 2 SLC installations, these inputs are used for Starboard Remote SLC.

15. Remote Control Station 3, Single Lever Control (SLC) Positions (46 - 50)

These allow the physical positions of the remote 3 SLC to be programmed into the CMU. The positions are usually the neutral and idle -zone indents plus the forward and reverse lever movement limits. If the remote 3 SLC is simply a potentiometer without indents, then suitable positions have to be chosen. The previous diagram shows how the SLC positions relate to engine speed demand and Reverse Duct position.

For Triple Jet - 2 SLC installations, these inputs are used for Starboard Master SLC.

16. Hydraulic Steering Deflector, Servo Algorithm Coefficients (51, 52, 53 Factory Only)

These are the coefficients (Kp, Ki, and Kd) for the Steering Deflector positioning algorithm. The hydraulic positioning uses the classical PID algorithm;

Drive signal = Kp x error + Ki x *errors + Kd x (error - last_error)
Where error = target_position - actual_position.

They can only be modified at the factory using a special programmer. ***Do not modify the values (0..15) without careful modelling and analysis of the positioning behaviour.***

17. Hydraulic Reverse Duct Servo, Algorithm Coefficients (54, 55, 56 - Factory Only)

These are the coefficients (Kp, Ki, and Kd) for the Reverse Duct positioning algorithm. The hydraulic positioning uses the classical PID algorithm;

Drive signal = Kp x error + Ki x *errors + Kd x (error - last_error).
Where error = target_position - actual_position.

They can only be modified at the factory using a special programmer. ***Do not modify the values (0..15) without careful modelling and analysis of the positioning behaviour.***

18. Analogue Input Data Inversion Selection Bits (60 - Factory only)

These allow the processor to invert the ADC data result of some analogue input channels. The 8 bits correspond to the following channels;

Bit 0 (lsb) Master Helm.
1 Remote 1 Helm.
2 Remote 2 Helm.
3 Remote 3 Helm.
4 Autopilot.
5 unused.
6 Steering Deflector position feedback.
7 (msb) Reverse Duct position feedback.

SET a bit to 1 (LED ON) to INVERT the corresponding analogue data.
These bits MUST be defined before attempting to program any position parameters.
Bit 6 should be set (by default).

19. Hydraulic Position Error Maximum Limits (61 and 62)

These are used for programming the maximum positioning error that will allow the hydraulic pressure valve to turn off. Parameter 61 is the Steering limit (0...20) and parameter 62 is the Reverse Duct limit (0...20).

NOTE:

These values are used directly as binary values in the program and are NOT scaled to the total hydraulic travel.

20. Steering and Reverse Bucket Servo Alarm Error Limits (63 and 64 - Factory Only)

These parameters specify the Servo operation position error limits. The values entered for steering (63) and the Reverse Duct (64) are in percent of total mechanical travel, e.g. 6%. The valid range is 5 to 20 for both. Always confirm that the corresponding valve operation limits above, are 'inside' these alarm limits by running the system again.

21. Steering and Reverse Duct Servo Alarm Time-outs (65, 66, and 67 - Factory Only)

These parameters specify the time-outs for the Servo operation error detection. The values entered are in seconds and the valid ranges are 5 to 10 for the Steering (65) and Reverse Duct (66), but a special case for the Autopilot (67) has the range 10 to 20 seconds.

22. Centre Jet SLC Position Ratio (70 - Factory Only)

This parameter (0..9) is used as a percent (0 to 90%) ratio to calculate the Centre Jet SLC position using the port and starboard outer SLC positions. The calculated position of the Centre Jet will always be between the most forward and most astern SLC.

Description

On 3 Jet Systems, the Centre Jet does not have a related SLC, therefore the Centre Jet Processor will calculate its SLC input as being between the port and starboard SLC's. It will be forward of the most astern SLC by the "Centre Jet SLC position ratio in the range 0 to 90% (in steps of 10%).

The overall effect is that the centre Jet Unit is "slaved" to the most astern Jet Unit but also modified by whatever the other Jet Unit is doing. The actual position ratio cannot be determined exactly until the vessel manoeuvring forces are measured in the water.

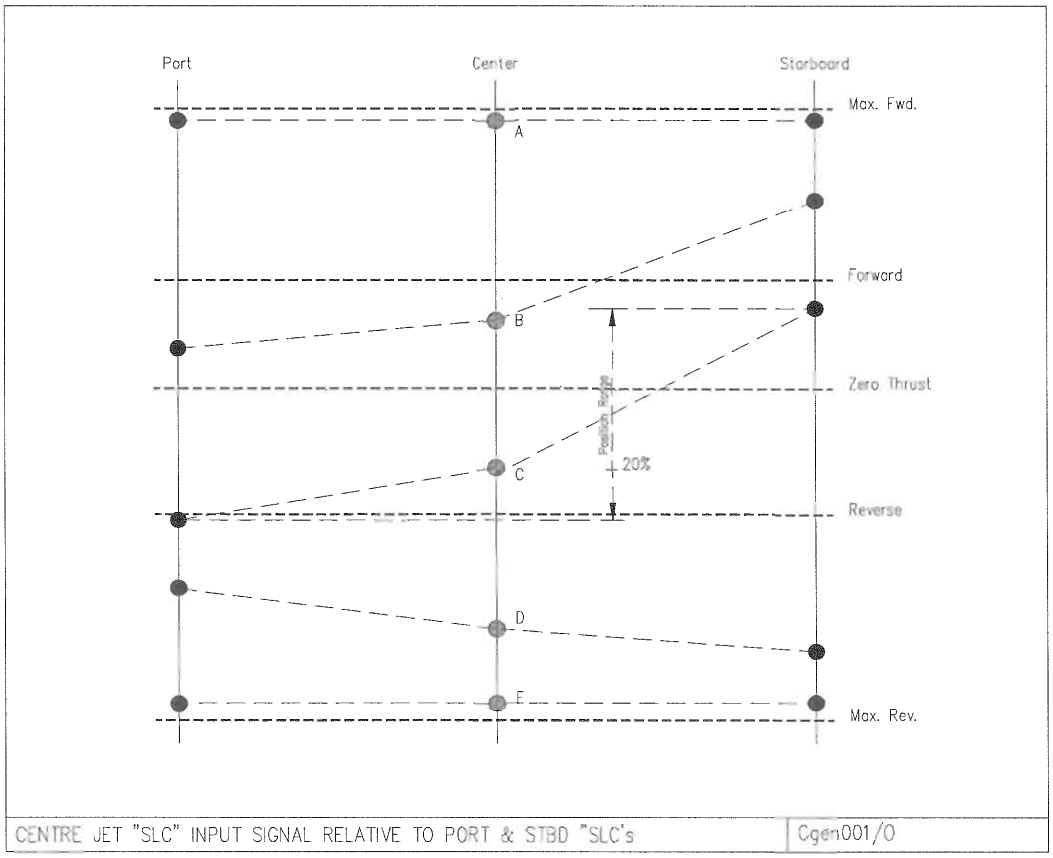


Figure 3-25 Centre Jet SLC Position Ratio

23. Alarm Code Log (90-99)

These parameters display the values of Alarm Codes that have occurred most recent in parameter #90, next oldest in #91, then in #92 etc. When all parameters are full, the oldest one is erased so that only the latest 10 Alarm Codes are retained. An Alarm Code that is the same as the immediately previous one is not retained in the log. The 'age' of each Alarm Code is given in the Binary display. The 'age' signifies the number of 'resets' the CMU has been through since the last Alarm Log Clear.

24. Alarm Code Log Clear (90)

The Alarm Code Log can be cleared by pressing the 'enter' key when parameter #90 is set.

25. Reset Factory Default Parameters (99)

By 'entering' '7', then '0', then '9' in that order in parameter #99 all parameters are reset to their factory defaults.

CAUTION:

Factory Default settings should only be used as a last resort. After they have been reset, all the demand and feedback signals will need to be re-programmed.

ADJUSTING THE SLC SYSTEM

The Reverse system can be partially set-up before launch. Refer to the examples in Sub Section Control Programming Examples.

This involves setting values for the following parameters:

1. Master Station Reverse Lever positions (31-35).
2. Remote Station 1 Reverse Lever positions (36-40) (if fitted).
3. Remote Station 2 Reverse Lever positions (41-45) (if fitted).
4. Remote Station 3 Reverse Lever positions (46-50) (if fitted).
5. Reverse Duct positions (24-28).
6. Centre Jet SLC Position Ratio (70) (Triple Jet Units only).

NOTE:

The Reverse Duct Positions (24-28) and Centre Jet SLC Position Ratio (70) (Triple Jet Units only) are only set up approximately before launch. Further adjustment will be necessary when the Vessel is launched and the Jet Unit is operating. Refer to Sub Section "SLC Systems".

The values for these are read from either the actual Reverse Lever, or the Reverse Duct position. To program these values in:

1. Set Control Mode to NORMAL.
2. Plug in CMU Field Programmer.
3. Move SLC or Reverse Duct to the desired position for each parameter. Note that the Reverse Duct may be moved by setting the Control Mode to EMERGENCY and using the Reverse Duct Jogstick. Hydraulic power must be available.

NOTE:

To prevent mechanical overloads in the Reverse system, set the "Minimum" and "Maximum" positions at the actual mechanical travel limits. Then set the "Up" and "Down" positions inside these as required. This will prevent the mechanical limits being reached in normal operation.

4. ENTER and store all parameters as described in Sub Section "Using the CMU Field Programmer"
5. Unplug the CMU Field Programmer.

The CMU will restart with the new SLC parameters. An error condition will be created if the new positions are not correct relative to each other, e.g. A Reverse Duct Neutral position has been mistakenly programmed above the Up position.

Checking the CMU Reverse Duct Position Alarm

To check the CMU Reverse Duct Position Alarm, a condition must be simulated where the CMU (via the hydraulics) cannot command the Reverse Duct to move to a given commanded position (as input from the SLC).
Use the following procedure to carry out this operation:

1. Set the Control Mode to NORMAL.
2. Set the SLC Lever to ZERO SPEED.
3. Stop the JHPU running by switching off the JHPU Field Driver. Select 'DRIVE' gear.
4. Move the SLC Lever a small distance either way from ZERO SPEED and hold it there. The CONTROL ALARM lamps should start flashing and the audible alarms should illuminate.
5. Press the ALARM CANCEL (& TEST) button on either Control Station. The audible alarms should both extinguish, but the CONTROL ALARM lamps should both continue to flash.

6. To correct the alarm condition, return the SLC Lever to the ZERO SPEED position and select NEUTRAL gear. The CONTROL ALARM lamp should stop flashing.

ADJUSTING THE STEERING SYSTEM

The Steering Control system can be completely set-up prior to launching the vessel. Refer to the examples in Sub Section "Programming Examples". The programming of Helm and Steering positions is done in the same way as the SLC and Reverse Duct.

This involves setting values for the following parameters:
1. Master Station Helm wheel (or joystick) positions (4-6).
2. Remote Station 1 Helm wheel positions (7-9) (if fitted).
3. Remote Station 2 Helm wheel positions (10-12) (if fitted).
4. Remote Station 3 Helm wheel positions (13-15) (if fitted).
5. Steering Deflector positions (21-23).

The values for these are read from either the actual Helm Wheel, or the Steering Deflector position. To program these values in:

1. Set Control Mode to NORMAL.
2. Plug in CMU Field Programmer.
3. Move the Helm Wheel or Steering Deflector to the desired position for each parameter. Note that the Steering Deflector may be moved by setting the Control Mode to EMERGENCY and using the Steering Jogstick. Hydraulic power must be available.

NOTE:

To prevent mechanical overloads in the Steering System, the port and starboard steering positions must be set a little "inside" the actual mechanical travel limits.

4. ENTER and store all parameters as described in ***Sub Section "Using the CMU Field Programmer".***
5. Unplug the CMU Field Programmer.

The CMU will restart with the new Steering parameters. **Note that an error condition will be created if the new positions are not correct relative to each other.**

CHECKING CMU STEERING POSITION ALARM

To check this, a condition must be simulated where the CMU (via the hydraulics)cannot command the Steering Deflector to move to a given commanded position (as input from the Helm Wheel).
Use the following procedure to carry out this operation:
1. Set the Control Mode to NORMAL.
2. Set the Steering Joystick to the CENTRE HELM position.
3. Stop the JHPU running by switching off the JHPU Field Driver.
4. Move the Steering Joystick a small distance either way from CENTRE HELM and hold it there.
5. The CONTROL ALARM lamps should start flashing and both the Audible Alarms should turn on.
6. Press the ALARM CANCEL (& TEST) button on either Control Station. The Audible Alarms should both turn off, but the CONTROL ALARM lamps should both continue to flash.
7. To correct the alarm condition, select 'Neutral' gear again. The CONTROL ALARM lamp should stop flashing.

PROGRAMMING EXAMPLES

A: Master Single Lever Control (SLC) "Idle Forward" Position

1. This operation can be done at the dock side. The engines do not have to be running but the Control System must be operational.
2. Connect the CMU Field Programmer to J9 of the CMU Circuit board.
3. Turn on the ignition to "Power-Up" the CMU. The Control software will select the Programming Mode after about 1 second and the CMU Field Programmer will become active.
4. Move the Master SLC to the position that is required to become "Idle Forward" as shown in the SLC Diagram in Sub Section "CMU Parameter Numbers and Meanings".
5. Select Parameter Number 34 on the CMU Field Programmer, wait for about 1 second, and then press ENTER.
6. If necessary, repeat this sequence of position setting and parameter 'Entering' for any other SLC Positions while still in Programming Mode.
7. Unplug the CMU Field Programmer.
8. The CMU will "reboot" and start running with the new SLC position.

B: Reverse Duct "Neutral" Position

1. This operation can be done at dock side. Hydraulic power must be available to move the Reverse Duct with the Emergency Controls.
2. Connect the CMU Field Programmer to J9 of the CMU circuit board.
3. Turn on the Ignition to "Power Up" the CMU. The Control software will select the Programming Mode after about 1 second and the CMU Field Programmer will become active.
4. On the Master Control Panel, select 'Emergency' Mode operation for the Jet Unit.
5. Use the Emergency Controls to move the Reverse Duct to the "Neutral" position as described in **Section 4.3 "Emergency Operation".**
6. Select Parameter 26 on the CMU Field Programmer, wait for about 1 second, and then press ENTER.
7. If necessary. repeat this sequence of position setting and parameter 'Entering' for any other Reverse Duct positions while still in Programming Mode.
8. Unplug the CMU Field Programmer.
9. The CMU will "reboot" and start running with the new Reverse Duct position.

3.1.10. Setting-Up the Bosch Hydraulic Valve Controller Printed Circuit Boards

There are Bosch Hydraulic Valve Controller Printed Circuit Boards (PCB's) mounted on the door of the Jet Interface Units. One for the Steering Hydraulic System and one for the Reverse Duct Hydraulic Systems. The CMU's provide a symmetrical control signal (in the range +/- 9 V approx.) to the Bosch PCB's.

The Controllers convert the signal into a Proportional Solenoid Deflection Drive Signal to move the Spool inside the Hydraulic Valve. A Positive Control Signal will cause the Spool to be moved in one direction, a Negative Control Signal will cause the Spool to move in the opposite direction. This controls the flow of hydraulic oil to the Hydraulic Cylinders and controls the overall hydraulic movement. The magnitude of the CMU Control Signal determines the flow of hydraulic oil and therefore the speed of the hydraulic movement.

Each Bosch PCB needs to be set up individually by adjusting potentiometers on the front panels of the Circuit Boards.

If at any stage, the Valve or the Valve Driver PCB is changed, the following set-up procedure must be repeated.

Incorrect tuning of the Control Cards will result in the CMU's being unable to 'move' the hydraulic cylinders to their correct 'target' location. Alternatively, the hydraulics may become unstable and the whole system will oscillate.

NOTE:

1. **Hydraulic power must be available to complete the following fine-tuning procedures i.e. Gearbox in Drive.**
2. **The Engine throttle should be set to idle.**
3. **All the relevant position parameters must have been entered into the system.**
4. **The hydraulic oil should be at operating temperature.**

Refer to Figure 3.26 "Bosch Valve Driver Card" showing the Front Panel of the Controller Board.

NOTE the following details:

1. **The two LED's at the bottom of the panel turn OFF when the corresponding Solenoid is being driven by the CMU Processor.**
2. **All the adjustment Potentiometers are multi-turn (25 turn) and rotate clockwise to increase a setting.**
3. **Only the gain and dead-band compensation are used.**

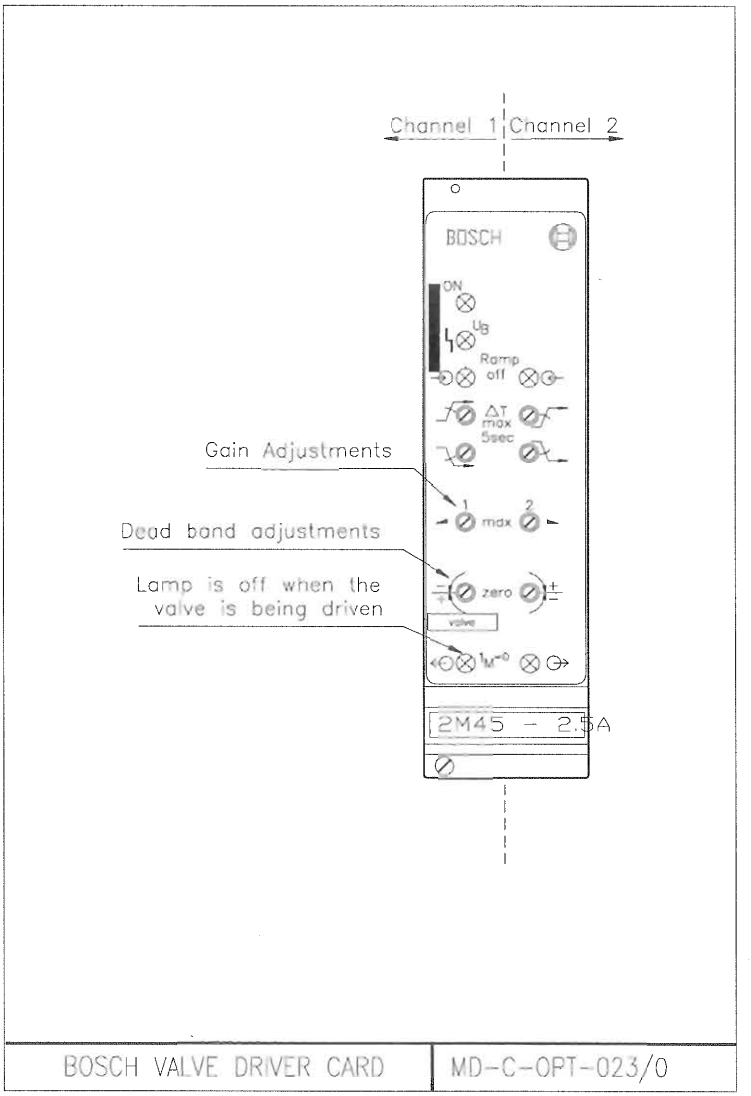


Figure 3-26 Bosch Valve Driver Card

STEERING CONTROL

1. Do NOT move the Reverse Duct Control Levers during this procedure.
2. The Gain Pots are set by winding them anti clockwise 25 turns then winding them 1 turn clockwise.
3. The Dead-Band Pots are set by winding them anti clockwise 25 turns, then winding them 1 turn clockwise.
4. Program '1' into parameter 20 using the Hand Held Programmer. Leave the programmer attached. This sets the CMU Drive Signal to the Steering, alternating Port and Starboard drive signals, every 5 seconds.
5. Each channel on the Bosch PCB relates to one Directional Valve. In the case of the Steering, one channel is for Port, one channel is for Starboard.
6. Adjust the Dead-Band Pot on the channel that is being driven (it's LED will be off) until the hydraulics move at 0.5 cm per second.
7. Remove the Hand Held Programmer.

REVERSE DUCT CONTROL

1. Do NOT move the Helm Controls during this procedure.
2. Set the Gain Pots by winding both gain Pots clockwise 25 turns and then winding anti clockwise 6 turns.
3. Set the Dead-Band by Compensation Pots anti clockwise 25 turns then wind clockwise by 1 turn.
4. Set-up is similar to the Steering in that Parameter 20 should be programmed with value '1'.
5. Adjust the Dead-Band Pot on the channel that is being driven (it's LED will be off) until the hydraulics move at 0.5cm per second.
6. Remove the Hand Held Programmer.

Generally the Reverse Duct System will not become unstable. If the Reverse Duct System becomes unstable during operation, reduce the Dead-Band compensation (and Gain if required).

PRESSURE VALVE CONTROL

NOTE:
The Pressure Valve is not fitted on all installations.

A Pressure Enabling Valve is used on the Jet Unit Hydraulics to reduce stress on the hydraulics when they are not in use.

The Pressure Enabling Valve on the Hydraulic Unit is turned on by the CMU whenever Steering OR Reverse Duct hydraulic movement is required. (The Pressure Enabling Valve is also turned on in Emergency Mode).
The operation of this valve indicates how well the hydraulics system has been "Set-Up".
The "Valve On" LED on the "Emergency Relay Control Module" PCB shows when the pressure valve is activated. This PCB is located in the Jet Interface Cabinet.

This Valve (and LED) will be turned on for either a Steering or Reverse Duct hydraulic motion demand.

When both the Steering and Reverse Duct hydraulics are at their respective target positions, this Valve will be turned off after about 3 seconds (or less).

Use the LED to verify that the Bosch PCB fine-tuning is correct. The Pressure Valve should be consistently turning off 2 to 4 seconds after hydraulic movement has stopped. The control inputs need to be static also.

If the LED stays on for a long time (over 8 seconds) then a Bosch PCB drive LED will be constantly off too. Increase the Dead-Band compensation for this solenoid as per **Section 3.1.10.** "

Setting-Up the Bosch Hydraulic Valve Controller Printed Circuit Boards" instructions to re-tune the system.

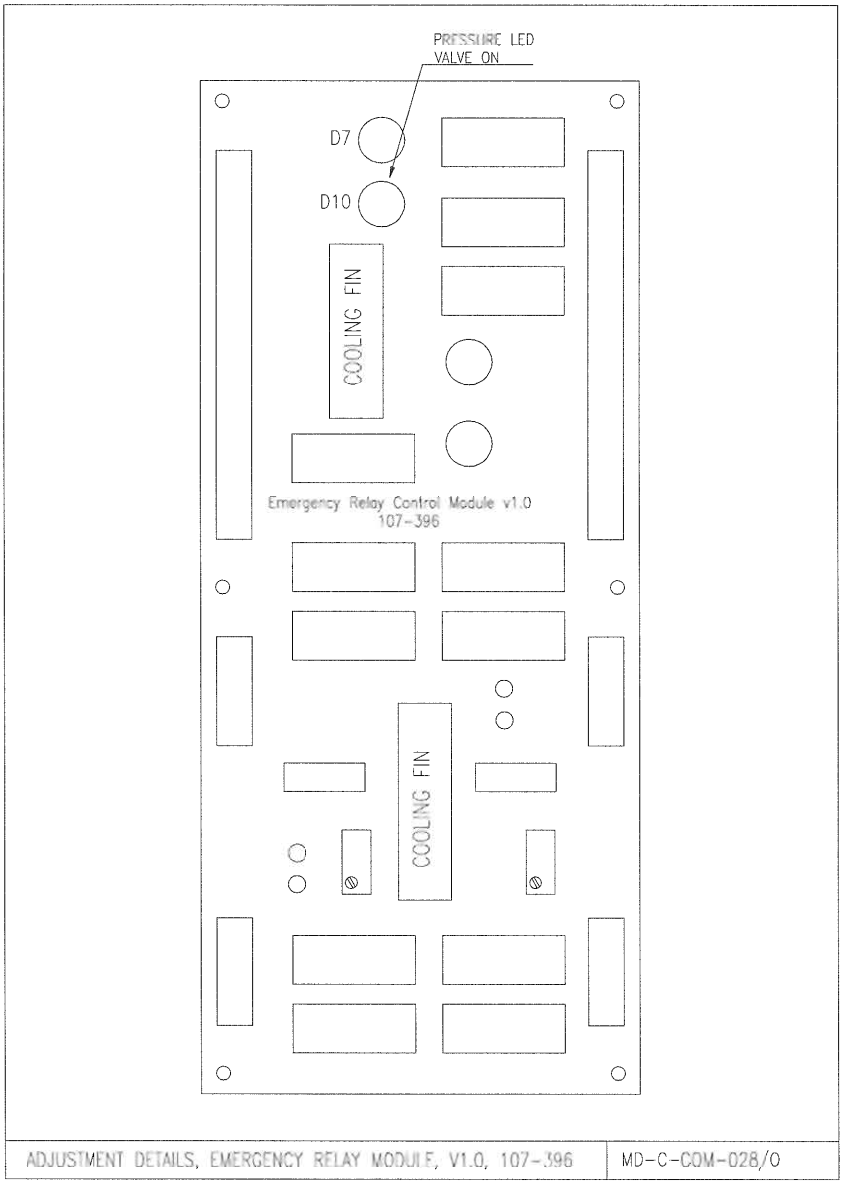


Figure 3-27 Emergency Relay Module

3.1.11. Adjusting the Signal To Throttle Actuator (Not Fitted to all Installations)

Refer to the Drawings located in the "Electronics" Section of the drawings package, for details.

On some installations an analogue voltage (0 to 5v) or current (4 to 20 mA) signal is required by the Throttle Controllers - be it a mechanical actuator or an electrical engine controller. The PMW Integrator Board converts the CMU derived Pulse Width Modulator (PWM) signal to those Analogue Voltage / Current Signals.

This Section outlines how to adjust the PWM Integrator Board to provide the correct output signal.

The Throttle Signal to the Engine comes from the CMU and passes through the ***P.W.M. Integrator Board,*** before going to the Throttle Controller. The P.W.M. Integrator Board must be adjusted to provide the correct signals to the Throttle Controller.

NOTE:

This procedure can only be correctly done after the CMU has been programmed, as described in Sub Section 13.1.8 " Setting Option Switches on the CMU and MSU Circuit Boards ".

THE P.W.M. INTEGRATOR BOARD

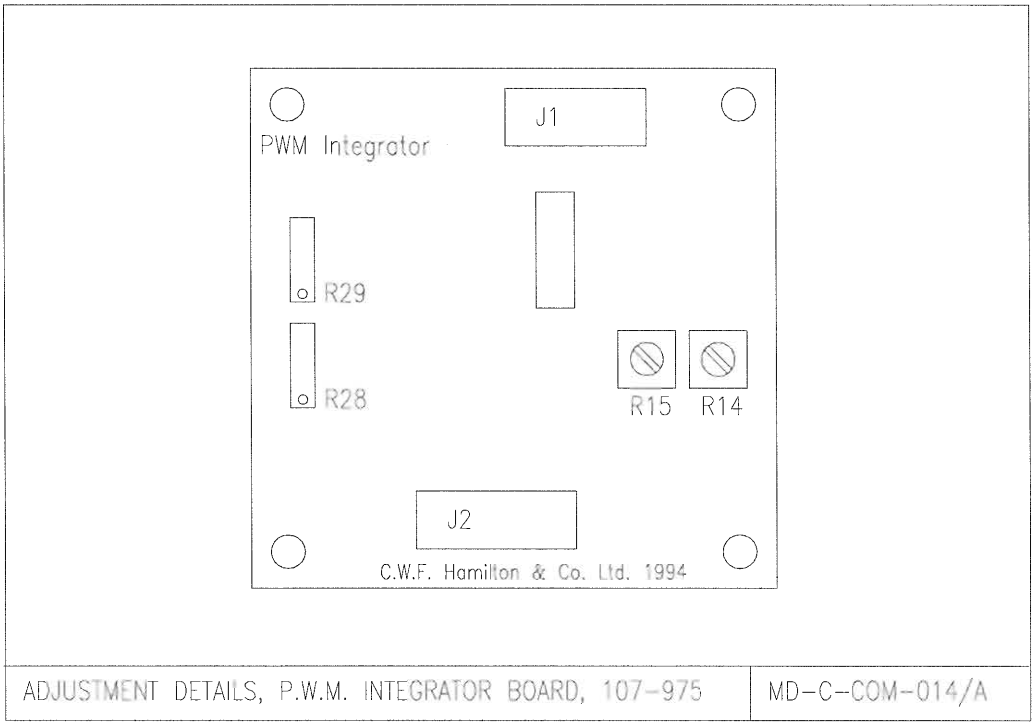


Figure 3-28 The P.W.M. Integrator Board

ADJUSTING THE SIGNAL FROM THE P.W.M. INTEGRATOR BOARD

Note that for PMC Actuators:
Determine the signal range required by the Engine Controller.
The PMC Actuator can be powered up, and be made to move as the signal from the P.W.M. Integrator Board varies. Refer to the Engine Service & Installation Manual to determine the correct Throttle Actuator positions.

Setting the Signals to the Throttle Actuator

1. Move the Throttle Control Lever to the maximum throttle position. This causes the CMU to produce the maximum P.W.M. signal to the P.W.M. Integrator Board.
2. Adjust the potentiometer R15 to produce the required maximum signal to the Throttle Controller. For 4-20 mA system, adjust R29 until 20 mA is measured on the wire connected to J1 Pin 3.
3. Move the Throttle Control Lever to the minimum Throttle position. This causes the CMU to produce the maximum P.W.M. signal to the P.W.M. Integrator Board.
4. Adjust the potentiometer R14 to produce the required minimum signal to the Throttle Controller. For 4-20 mA system, adjust R28 until 4 mA is measured on the wire connected to J1 Pin 3.
5. Repeat Steps 1 to 4 until no adjustment is necessary.

3.1.12. Removal of the JHPU Field Driver

Refer to the Drawings located in the "Hydraulic Power Units" Section of the drawings package, for details.

REMOVAL OF THE JHPU FIELD DRIVER

To Remove JHPU Field Driver from the Jet Unit, carry out the following procedure:

1. Disconnect the Motor Hoses from the JHPU Field Driver Pump Unit via the quick release connectors.
2. Loosen the Nuts holding the JHPU to the Jet Unit and slide the JHPU towards the Mainshaft.
3. Remove the V-Belts from the JHPU Pulley.
4. Remove the JHPU Field Driver. To carry out this operation:
   a) Unscrew the 2 M8 Bolts with Washers that secure the JHPU Field Driver Motor to the front face of the JHPU Pulley.
   b) Remove the JHPU Field Driver Motor.
5. Reattach the V-Belts to the JHPU Pulley.
6. Adjust the V-Belt tension as described in the **Section 6.3. "REVERSE AND STEERING SYSTEM SERVICING DETAILS" Item No 8.**
7. Refit the Belt Guard to the JHPU.

3.2. AFTER LAUNCH

3.2.1. Before Engine Start Up

WARNING:

ENSURE THAT THE VESSEL IS SECURELY MOORED AS DURING COMMISSIONING THE JET UNITS MAY PRODUCE LARGE THRUST FORCES.

Before starting any engines:

1. Ensure that all gearboxes are in the NEUTRAL position.
2. Ensure that the Control Mode of all Jet Units is NORMAL, all SLC Controls are in the ZERO SPEED position, and the Steering is set to dead ahead position.
3. Ensure that a person is at the Bridge ready to move the controls if required.
4. Check that all hydraulic hose connections are tight.
5. Check that the Bypass Valves on the JHPU Manifold Block are closed by turning them fully clockwise.

CAUTION:

Do not proceed if any Control System fault alarms are still activated.

3.2.2. After Engine Start-Up

In Vessels with more than one Jet Unit, perform the following checks on each Jet Unit and Control System individually before moving on to the next one. Switch off the engines of all Jet Units except the one being checked.

IMMEDIATE TASKS

1. Adjust engine speed to low idle (if required) using the SLC Lever.
2. Confirm that no alarm conditions exist.

Then, carry out commissioning as follows:-

CHECK ENGINE THROTTLE OPERATION

Checking In Normal Control Mode:

1. Change to NORMAL Control Mode.
2. Change to NEUTRAL gear.
3. Use the SLC to modify the engine speed demand and verify the result on the engine RPM Indicator.
4. The SLC range should cause the engine to change from low idle to Max RPM.
5. Note that maximum SLC engine demand is a programmable parameter. First check both forward and reverse maximum parameters.
6. Change to DRIVE gear with SLC at ZERO SPEED.
7. Verify that the Idle Adjust switches operate correctly by increasing and then decreasing the engine idle speed.

NOTE:

The maximum idle speed is a programmable parameter. Check the value of the parameter first.

Checking In Emergency Control Mode:

1. Switch to Emergency Control Mode.
2. Change to "Neutral" gear.
3. Confirm that moving the SLC does not affect the engine speed.
4. Verify that the RPM & IDLE ADJUST Switches cause the engine speed to ramp up and down in 14 steps from low idle to maximum RPM.

3.2.3. Gearbox Systems

1. Perform gearbox manufacturer's checks.
2. Check that the gearbox controls work correctly. To carry out this check:-
   a) Check the correct functioning of all push buttons on all Gearbox Control Panels.
   b) Verify Mainshaft engagement and disengagement.
   c) Check and Verify the correct state of all Indicator Lights.
3. Leave the engine at idle speed and the gearbox in DRIVE.

3.2.4. Hydraulic Power Systems

1. Set engine speed to low idle.
2. Move SLC to AHEAD IDLE and ASTERN IDLE and confirm that the Reverse Duct moves to within 5 mm of full stroke in each direction.
3. Return to the ZERO SPEED position.
4. Move Helm to FULL PORT and then to FULL STARBOARD.
5. Check that "P0" on the pressure gauge on the JHPU rises to about 500 psi for Reverse movement and to about 300 to 600 psi for Helm movement.
6. Perform a JHPU "V" Belt slippage check as described in **Section 6.3. "Reverse and Steering System Servicing Details". Item 9**.

3.2.5. SLC Systems

OBTAIN A FINAL EXACT ZERO SPEED SETUP

1. Set the CMU to NORMAL Control Mode.
2. Set the SLC Control to ZERO SPEED.
3. Check that the Steering is at the CENTRE HELM position.
4. Attach the CMU Field Programmer to the appropriate CMU.
5. Set the CMU to EMERGENCY Mode.
6. Set engine speed to 1100 RPM using the IDLE ADJUST controls on the Control Station.
7. Note that higher Mainshaft speed results in a more sensitive adjustment of ZERO SPEED.
8. Adjust the position of the Reverse Duct using the EMERGENCY JOGSTICK so that there is no forward or reverse thrust. This can be detected by observing signs of tension on the mooring ropes.
9. Enter and store the current position of the Reverse Duct as parameter NEUTRAL (26) using the CMU Field programmer.
10. Remove the CMU Field Programmer.

Check for Correct Water Flow in the Full Astern Position

11. Move SLC to the fully lowered position and set the Engine Speed to 1100 RPM. Ensure the vessel is still securely tied to the wharf.
12. Place a pole directly behind the Reverse Duct. If any flow is passing directly rearwards, this pole will be deflected rearwards. This indicates that the Reverse Duct is not fully lowered.
13. Adjust the Reverse Duct as necessary, using the CMU Field Programmer.

SETTING UP THE CENTRE JET SLC POSITION RATIO

(This only applies to Vessels fitted with three Jet Units)

The aim of this procedure is to find the Centre Jet SLC Position Ratio (parameter 70) which gives the best control of the Vessel when differential thrust is selected. (i.e. when the Port and Starboard SLC levers are in different positions). This is best done using a trial-and-error approach as shown below:

1. Ascertain the differential thrust performance of the vessel with the current value of the SLC Position Ratio.
2. Adjust the Centre Jet SLC Position Ratio to a new value using the CMU Field Programmer.
3. Reassess the thrust performance of the vessel with the new value.
4. Continue this process until the thrust performance of the vessel cannot be further improved.

3.3. DURING TRIALS

3.3.1. Hydraulic System Checks

Check the hydraulic oil temperature in the JHPU Reservoir after a 10 to 15 minute run and then if satisfactory, after a 1 hour run at high engine RPM. Maximum allowable temperature is 70°C.

NOTE:

Oil temperature will vary depending on engine speed, engine room temperature and water temperature.

3.3.2. Steering Deflector Checks

Check for correct water flow from the Steering Deflector. To do this, the vessel should be running at a speed high enough so that the Waterjet is clear of Transom wake and is thus clearly visible.

1. When the steering is at CENTRE HELM, check that the Waterjet is clear of the Steering Deflector. Water spray from the waterjet should be equal on both sides of the Steering Deflector and flow cleanly.
2. Confirm that all waterjets are synchronised. (i.e. all waterjets should point in the same direction at all helm positions). If the Waterjets are not synchronised, then readjust the CENTRE HELM positions of all Jet Units using the CMU Field Programmer.

4. Operation

NOTE:

The Operation Section in the Jet Unit Manual contains additional information.

4.1. DESCRIPTION OF CONTROLS AND INDICATORS

OVERVIEW

A "Control Station" is an area where the operator controls the vessel. There can be more than one Control Station on a vessel, but only one Control Station can be used at any one time.

If there are more than one Control Station, then each Control Station will have a Transfer Panel to allow transfer of control between Control Stations. One Control Station will be designated as the "Master Control Station".

A Control Station will have the following main components:

- A Helm Wheel or Joystick.
- A Control Lever.
- A Main Control Panel.
- A JHPU Oil Level Alarm Panel.
- A Gearbox Control Panel (optional).
- An Auto Pilot Indication Panel (optional).
- A Transfer Panel (On Multi Station Systems only).
- Remote Control (optional).

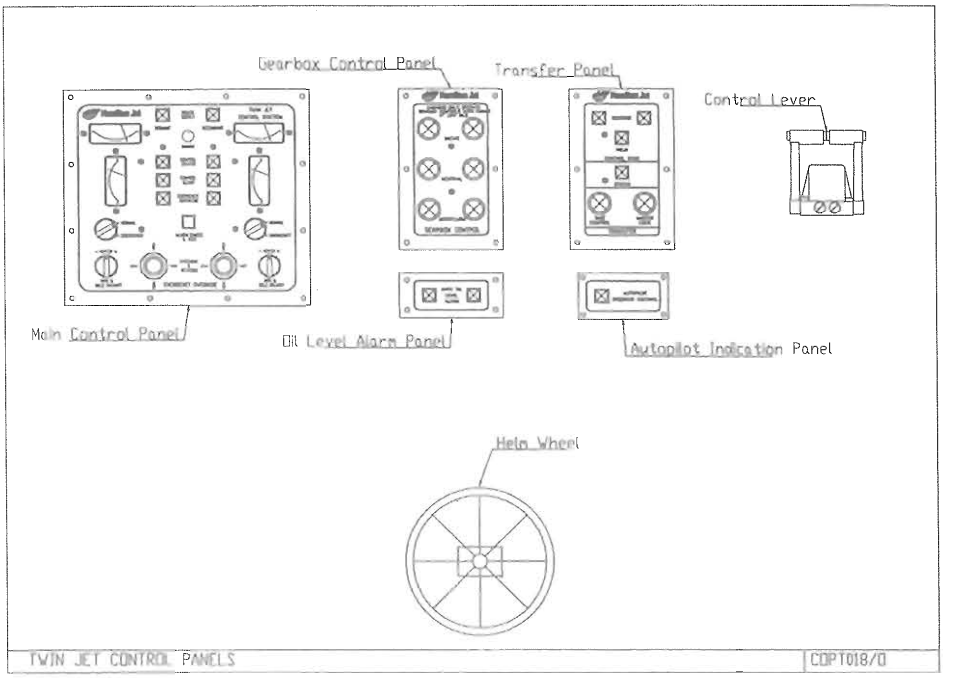


Figure 4-1 Jet Control Panel for CMU Controls System

The Controls Consist of 2 completely independent Systems, the "NORMAL MODE" Controls and the "EMERGENCY MODE" Controls.

NORMAL MODE Controls are used for normal operations. NORMAL Operation provides 'Follow Up' Control where the system checks via Sensors that the Jet Unit has responded to the controls demand.
Normal Mode makes the NORMAL Operator Controls for a Jet Unit active and the EMERGENCY Controls for that Jet Unit inactive.

EMERGENCY MODE Controls are used only when NORMAL Controls become inoperative. EMERGENCY Operation provides 'Non-Follow Up' Control whereby knowledge of correct operation is by movement of the vessel or by feedback indicators.
Emergency Mode makes the EMERGENCY Operator Controls for that Jet Unit active, and the NORMAL Controls for that Jet Unit inactive.

It is possible to switch from "NORMAL" Control to "EMERGENCY" Control of a Jet Unit or back again at any time using the NORMAL / EMERGENCY Switch for that Jet Unit **(Refer to Sub Section "Normal / Emergency Switch" found in Section 4.1.3. "Main Control Panel").**
There is a separate NORMAL / EMERGENCY Switch for each Jet Unit.
Switching to Emergency Control on one Jet Unit does not affect the operation of any other Jet Unit.
The following Sections describe the operation of the various components used in Jet Control.

4.1.1. Helm Wheel, Joystick

Figure 4.2 "Helm Module" shows the two types of Helm Control available. The Helm Wheel or the Joystick.

The Helm Wheel / Joystick controls the Steering Deflector of all the Jet Units that are switched to NORMAL Control Mode.

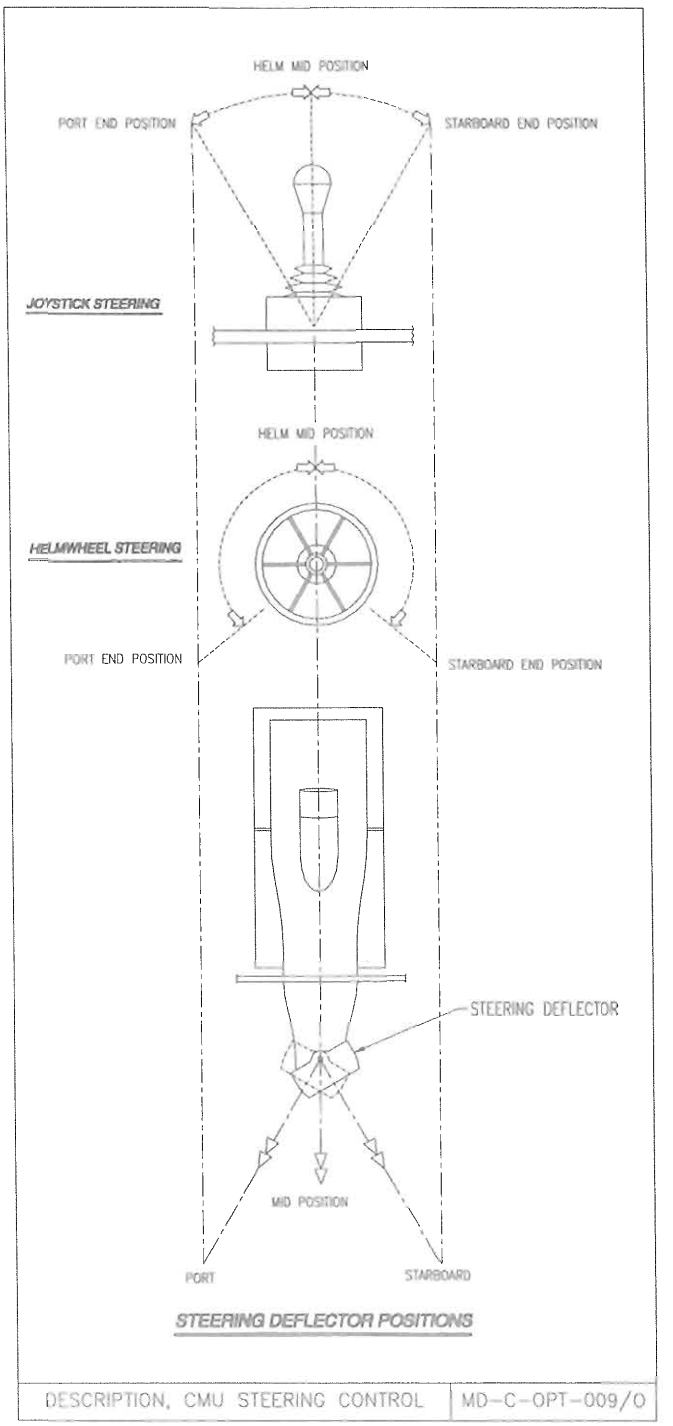


Figure 4-2 Helm Module

4.1.2. Control Lever.

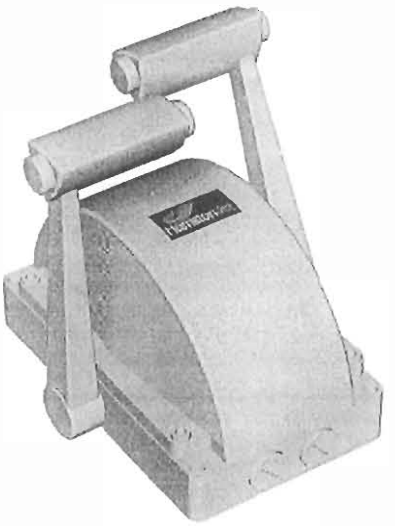


Figure 4-3 SLC Type Control Lever

There are two types of Control Lever available: the "SLC (Single Lever Control) type" and the "Separate Lever Type" . They look identical but their operation is different. This is explained in greater detail below.

"SLC TYPE" CONTROL LEVER"

The NORMAL Control system uses the SLC as an integrated "Thrust" input signal. The SLC lever position controls both the position of the Reverse Duct and the Engine speed demand. The diagram below shows the relationship between the SLC position and the corresponding Reverse Duct position (thrust direction) and engine demand (thrust magnitude).

1. When the SLC lever is in the "Manoeuvre" zone the engine speed is fixed at the current value of IDLE SPEED which is set by the RPM & IDLE ADJUST Switch. **(Refer to Sub Section "RPM & Idle Adjust Switch" in Section 4.1.3. "Main Control Panel").** In the "Manoeuvre" zone on the SLC and Steering Control Panel. The position of the SLC only controls the position of the Reverse Duct.

2. When the SLC lever is moved into the "Astern" or "Ahead" zones, the Reverse Duct is "parked" at either the Up or Down position as shown in **Figure 4-4 "Single Lever Type Controller"** above. The position of the SLC only controls engine speed in the "Astern" or "Ahead" zones.

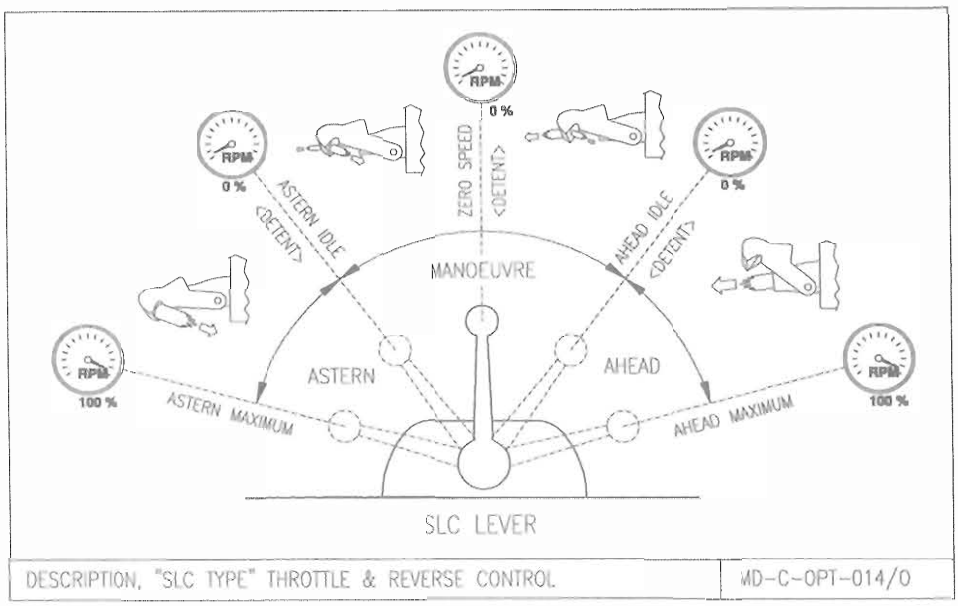


Figure 4-4 Single Lever Type Controller

"SEPARATE LEVER TYPE" CONTROL LEVER

The Throttle and Reverse Duct are controlled by separate levers as shown on the following diagram.

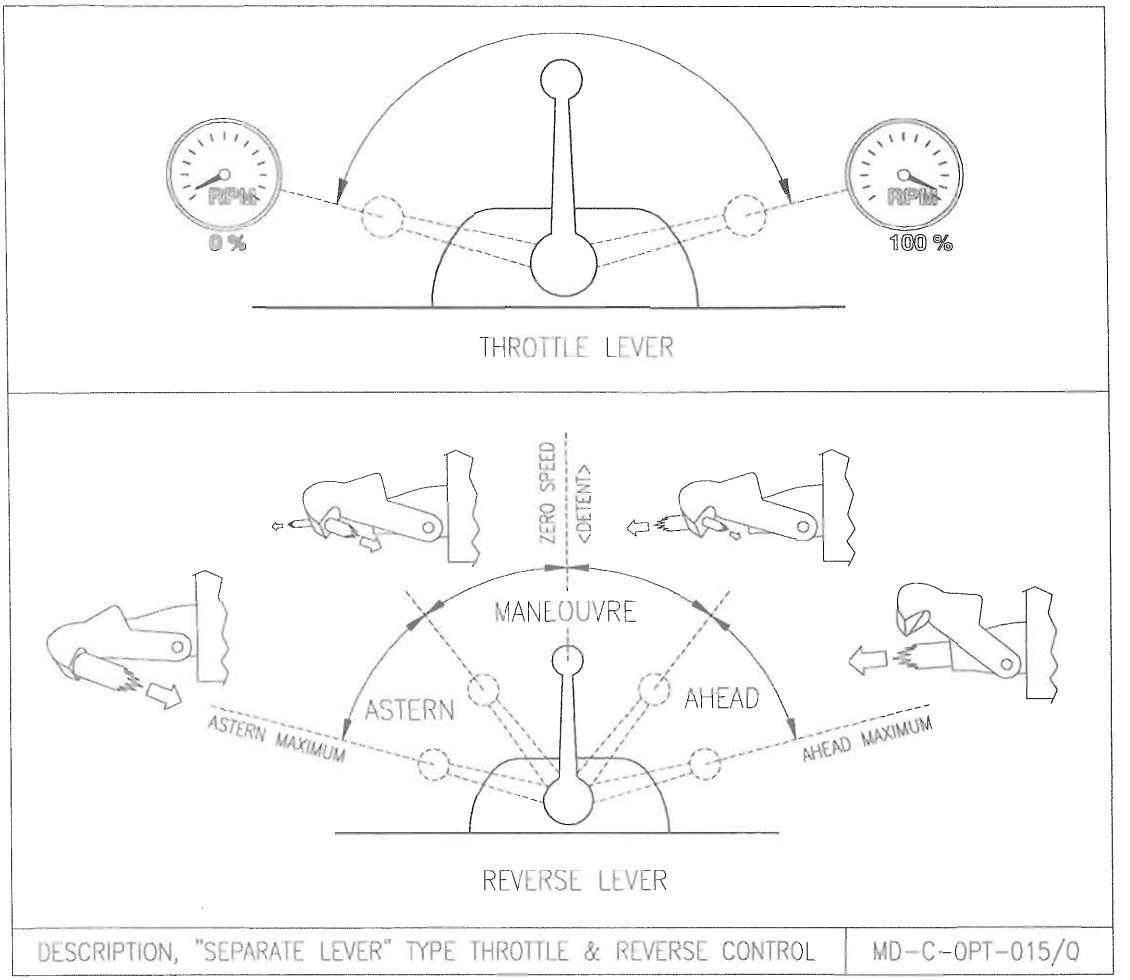


Figure 4-5 Separate Lever Type Control

4.1.3. Main Control Panel

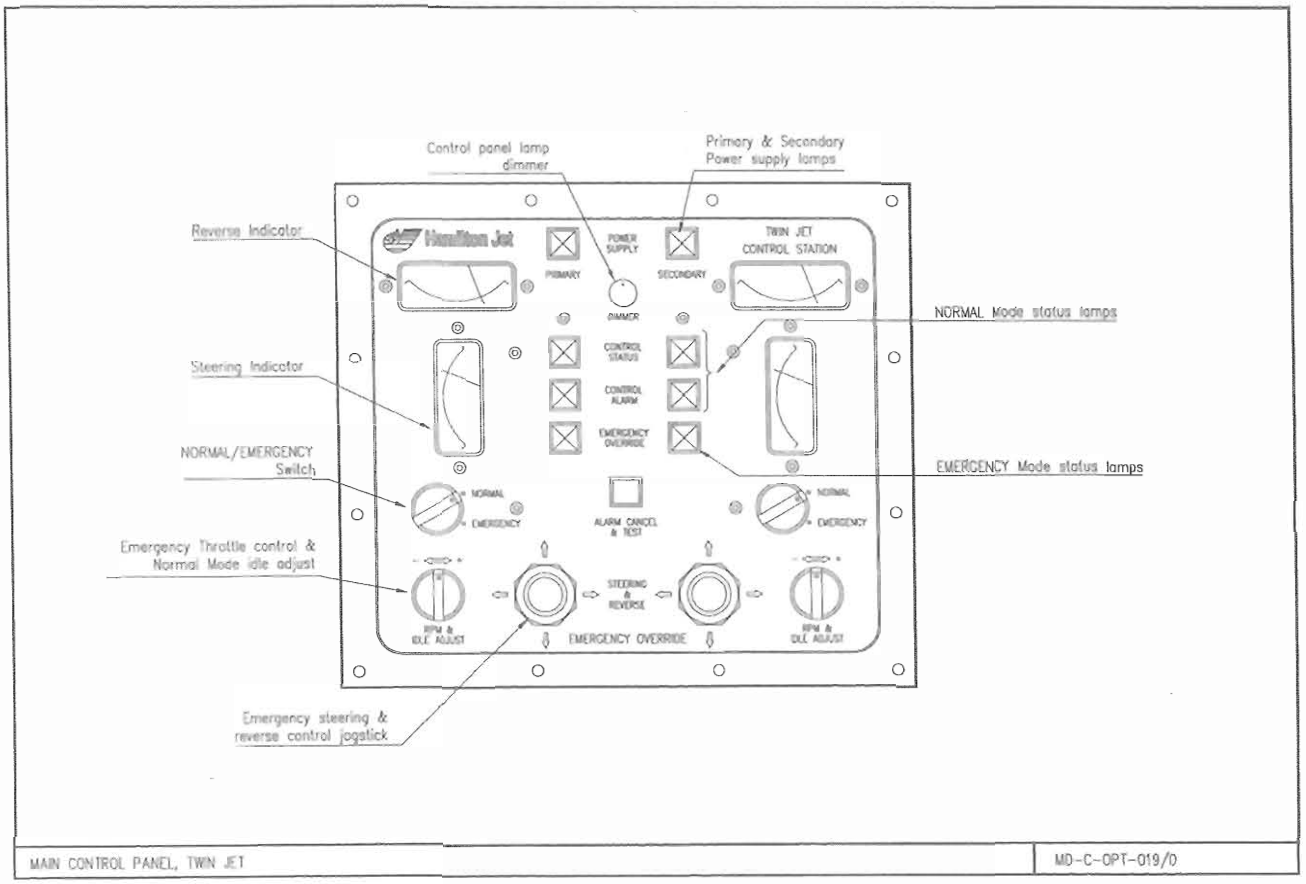


Figure 4-6 CMU Main Control Panel

The Main Control Panel performs a number of functions:

- Provides indication of the position of the Reverse Duct and the Steering Deflector.
- Provides Emergency / Normal Mode switching.
- Provides Normal Mode Idle speed control.
- Provides Emergency Mode Throttle control.
- Provides 'Emergency Mode' Steering and Reverse Duct control.
- Provides Power Supply Monitoring indication.
- Provides Manual Lamp dimming.
- Provides Control Status indication.
- Provides Warning and Alarm indication.
- Provides "Emergency Mode On" indication.
- Provides an Alarm Cancel Button.

REVERSE AND STEERING INDICATORS

Each Jet Unit has indication on the Main Control Panel of the position of the Reverse Duct and the Steering Deflector. This is NOT an indication of Helm Wheel / Joystick and Reverse Lever position.

RPM & IDLE ADJUST SWITCH

Each Engine has an RPM & IDLE ADJUST Switch.

In the NORMAL Mode: This switch controls the Engine Idle speed.
When the SLC or Twin Lever is in the "MANOEUVRE" zone, **(Refer to Section 4.1.2. "Control Lever.")** the engine speed demand is controlled only by the "RPM & IDLE ADJUST" switches on the Main Control Panel.

The minimum idle speed is fixed at about 8% of maximum engine RPM (depending on the engine type). The maximum idle speed can be programmed in the range of approximately 12% to 50% of maximum engine RPM. **(Refer to Section 3 "Commissioning").** The RPM & IDLE ADJUST switches allow the operator to adjust the idle speed within this range.

NOTE:

1. **When not in DRIVE gear the idle speed is fixed to the minimum value. The RPM & IDLE ADJUST switches are ignored. The engine speed can be controlled using the SLC or Throttle Lever.**

2. **Whenever the SLC is moved past the 95% position, the idle speed is reset to the minimum speed. Thus, any adjustments to the idle speed will be cancelled. This is a safety feature to ensure that a high idle speed does not remain set after cruising.**

In the EMERGENCY Mode the "RPM & IDLE ADJUST" switches control the engine throttle.

NORMAL / EMERGENCY SWITCH

Each Jet Unit has a Normal / Emergency Switch.
This switch controls the "Mode" of operation **(See Sub Section "Overview" found in Section 4.1. "DESCRIPTION OF CONTROLS and INDICATORS").**

EMERGENCY OVERRIDE INDICATOR

This lamp provides indication of whether or not the "Emergency" Controls are in operation. When the lamp is on, the Emergency Controls are active at all Control Stations. (In Normal Mode only one Control Station can have control at any time).

JOGSTICK

This Jogstick is active only in the EMERGENCY Mode. This Jogstick moves the Reverse Duct or Steering Deflector in a simple OFF / ON manner. The Indicators **(Sub Section "Reverse and Steering Indicators" found in Section 4.1.3. "Main Control Panel" refers)** can be used to determine the actual position of the Reverse Duct or Steering Deflector.

CONTROL STATUS LAMP

There is a separate Control Status Lamp for each Jet Unit. This lamp provides indication of the status of the Control System.
Upon system power up the status lamp will be on continuously and a single "Beep" will be heard every 3 seconds, this indicates that the system is waiting to be "activated". Activation occurs when the gearbox is in neutral (when gearbox control is part of the system), the SLC / Twin Levers are in their mid-idle position, and the Helm is centred.

Figure 4-7 Control Status Lamp Condition Table

LAMP STATE	MEANS
OFF continuously.	Either a lamp circuit failure or CMU failure.
ON continuously.	CMU running and waiting to be "activated".
ON for 1 second / OFF for 1 second.	Normal "activated" state.

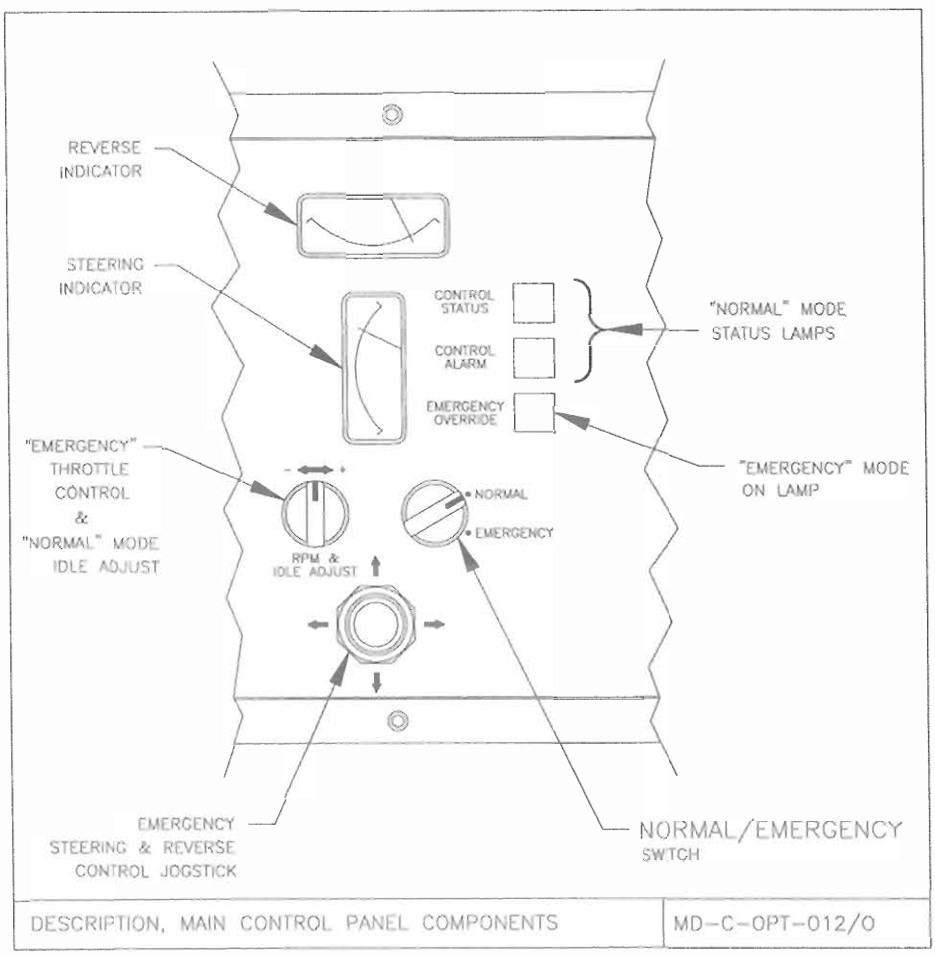


Figure 4-8 Main Control Panel Components

CONTROL ALARM LAMP

There is a separate Control Alarm Lamp for each Jet Unit. This lamp provides indication of whether a Control Warning or Alarm has occurred.
The Cause of the Warning or Alarm should be found and rectified. Once it has been rectified and the "Alarm Cancel" has been pressed **(Refer to Sub Section "Alarm Cancel & Test")** the Control Alarm Lamp will turn off.

Figure 4-9 Control Alarm Lamp Condition Table

LAMP STATE	MEANS
OFF continuously	Either no error is present or the lamp circuit has failed.
ON for 1/6 second / OFF for 5/6 second	A Warning or an Alarm exists. **Refer to Section 5** "Error! Not a valid result for table.".

CONTROL ALARM BUZZER

When a Status Change, a Control warning or an Alarm occurs, the buzzer will sound. The various signals and their meanings are outlined below.

Figure 4-10 Control Alarm Buzzer State Table

BUZZER STATE	MEANS
Short Beep	a) A CMU has been "activated" and is "In Gear". b) A Gearbox changed from NEUTRAL to DRIVE or BACKFLUSH gear. c) A Gearbox changed from DRIVE or BACKFLUSH to NEUTRAL gear. d) A CMU Field Programmer has been detected
2 Short Beeps	A CMU has been activated and is in "Neutral".
A 2 second Beep.	A CONTROLS WARNING has occurred. **Refer to Section 5** "Error! Not a valid result for table.".
Continuously on.	A CONTROLS ALARM has occurred. **Refer to Section 5** "Error! Not a valid result for table.".
Short 'Beep' every 3 seconds.	Waiting to be activated.

POWER SUPPLY MONITOR LAMPS

The Control System has two independent power supplies, a Primary Supply which is usually used, and a secondary supply which is used if, for any reason, the Primary Supply should fail.
There are two Power Supply Monitor Lamps, one for the Primary Power Supply, and one for the Secondary Power Supply. The power supply monitor lamps provide Power Supply Status Information for the complete system.
During normal operation both lamps should be constantly lit. If a Power supply fails, the relevant lamp will flash. Once a Power Supply fault has been rectified the alarm can be cancelled using the Alarm Cancel & Test button **(See the Sub Section "Alarm Cancel & Test" overleaf).**

Figure 4-11 Table of Power Supply Monitor Lamps and Buzzer State

PRIMARY LAMP

LAMP STATE	MEANS
ON continuously.	Primary power is On.
Rapid flashing.	Primary power is outside allowable limits. **Refer to Section 5 "Faultfinding".**
OFF.	Lamp failure / Power disconnected to Control system

SECONDARY LAMP

LAMP STATE	MEANS
ON continuously.	Secondary power is OK.
Rapid flashing.	Secondary power is outside allowable limits. **Refer to Section 5 "Faultfinding".**
OFF.	Lamp failure / Power disconnected to Control System.

POWER SUPPLY BUZZER

BUZZER STATE	MEANS
On for 2 seconds.	A fault has occurred in the Power Supply System. **Refer to Section 5 "Faultfinding".**

ALARM CANCEL & TEST

The Alarm Cancel & Test button is used to acknowledge alarms and to check that all Control Panel Lamps work.

When an alarm sounds it can be silenced with the Alarm Cancel & Test button. For Power Supply Alarms (signified by flashing Power Supply Monitoring Lamps) the flashing lamps will only return to the normal continuously on state when the fault is rectified and the Alarm Cancel and Test button has been pressed.

For Control System Alarms, the button will silence the sounder and if the Alarm condition has been rectified, the flashing Alarm Status Lamp will return to it's normally off state.

To test the lamps and buzzers, press the ALARM CANCEL AND TEST button. This should illuminate all lamps on all control panels, and all buzzers. Any lamps failing to illuminate need to be replaced.

LAMP DIMMER

The lamp dimmer provides control of the brightness of the lamps on all the controls at the Control Station. Anti-clockwise rotation dims the lamps. Clockwise rotation brightens the lamps.

4.1.4. Gearbox Control Panel (Optional)

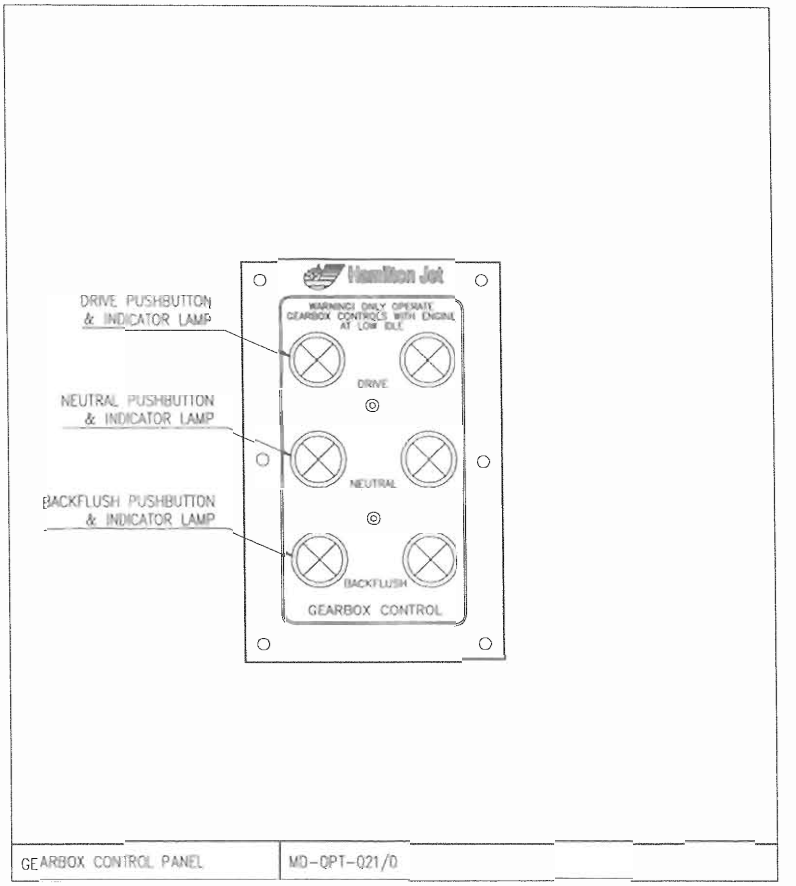


Figure 4-12 Gearbox Control Panel

CAUTION:

Gear changing in Normal Mode can only occur when the Engine is running at IDLE speed.
In Emergency Mode the operator must ensure that the engine is at low idle before changing gear.

The Gearbox Control Panel enables the engaging and disengaging of the gearbox. Pressing the 'Drive' button will engage the forward gear. The 'Drive' Button will illuminate when the Drive Gear is engaged (for Systems with gearbox feedback). For Systems without gearbox feedback the 'Drive' lamp will illuminate immediately. All other gearbox lamps should be off.
Pressing the 'Neutral' button will disengage the gearbox and the 'Neutral' lamp will illuminate while all others on the panel will go off.
For systems with BACKFLUSH implemented: By pressing the 'Backflush' button, reverse gear will be engaged and the 'Backflush lamp will be illuminated while the other lights will go off.

NOTE:

Backflush is only to be used to clear the Jet intake. It does not provide reverse thrust.
The 'Drive' and 'Backflush' gears can only be engaged from 'Neutral'. It is not possible to engage 'Drive' from 'Backflush' or vice versa.

4.1.5. Transfer Panel

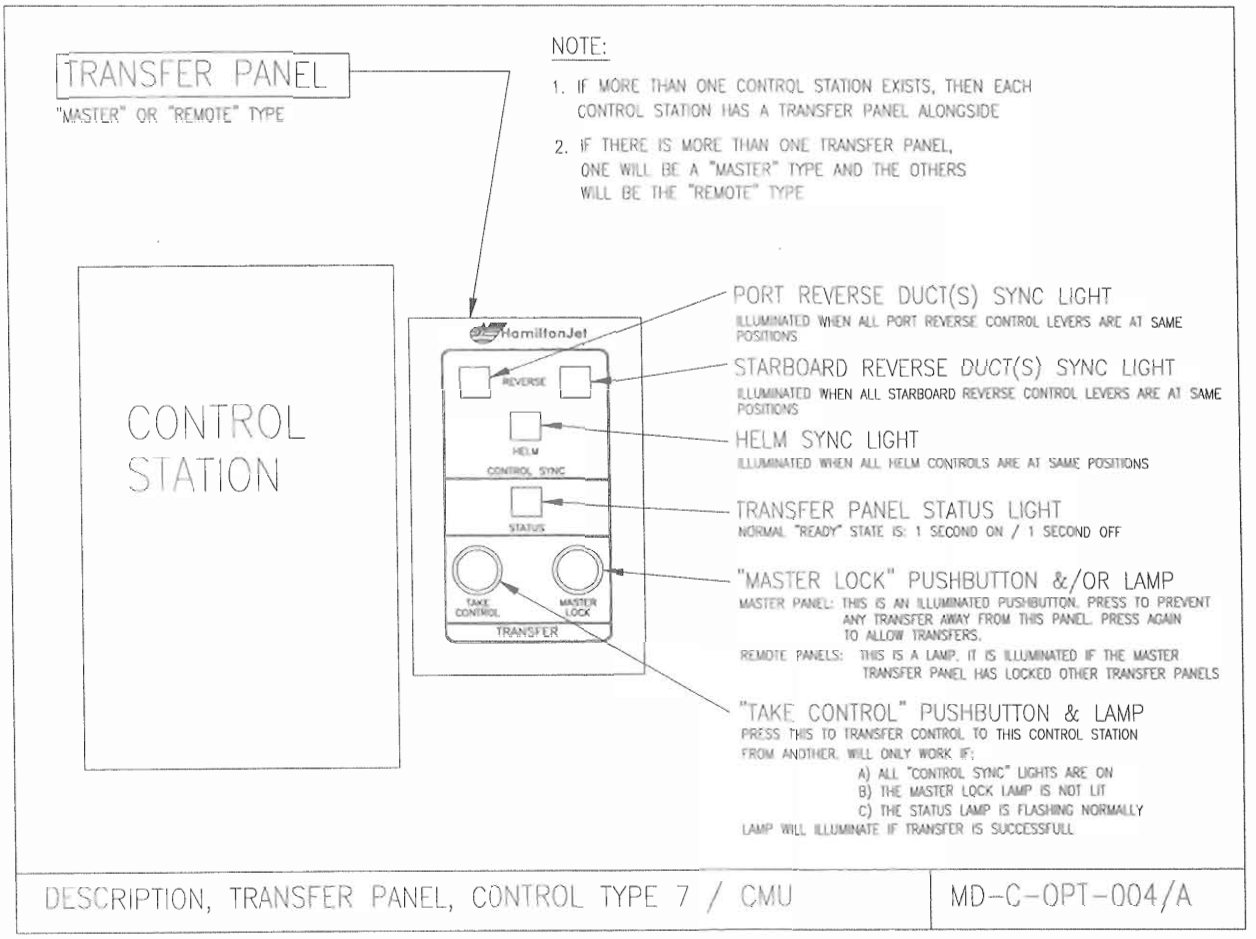


Figure 4-13 CT7 / CMU Control Station Transfer Panel

NOTE:

This Section only applies to vessels fitted with more than one Control Station.

For Systems with more than one Control Station, in Normal Mode, only one Control Station at a time can have control of the Jet Units. To allow for transfer between stations, an extra set of functions are provided at the Control Stations by means of the TRANSFER PANEL.
The following diagram and information explains the functions of all Controls and Indicators on a Transfer Panel.

REVERSE CONTROL SYNC LAMPS

The Reverse Control Sync Lamps illuminate when the local Control Levers **(See Section 4.1.2. "Control Lever.)** are in synchronisation with the In-Control, Control Station.

HELM CONTROL SYNC LAMP

The Helm Control Sync lamp illuminates when the local Helm **(See Section 4.1.1. "Helm Wheel, Joystick")** is in synchronisation with the In-Control Control Station.

STATUS LAMP

The Status Lamp provides indication of the status of control at a Control Station.

Figure 4-14 Table of Status Lamp Conditions

LAMP STATE	MEANS
ON for 1 second / OFF for 1 second.	Normal "Activated" state.
Rapid flashing.	A fault has occurred. **Refer to Section 5 "Faultfinding".**

"TAKE CONTROL" BUTTON AND LAMP

The "TAKE CONTROL" BUTTON is pressed to transfer control to the Local Control Station.
The "Take Control Lamp" illuminates to indicate the Local Control Station is in control.
A Control Station can only take control when all it's 'Sync' lights are illuminated, the 'Transfer Status Lamp' is flashing normally, the 'Master Lock Lamp' is off and the 'Control Status Lamp' (See Section 0 Control Status Lamp) is flashing normally.
The success of a control transfer is signified by 3 short beeps.
The failure of a control transfer is signified by rapid beeping **(Refer to the Sub Section 4.1.5"Transfer Panel Buzzer" below).**

MASTER LOCK BUTTON AND LAMP

The Master Lock Button is only fitted on the Main Control Station. All other stations only have Master Lock Lamps.
The "Master lock button" is pressed to prevent control being taken from the master station, or if it is already locked then pressing the "Master Lock Button" will release the control lock and allow other stations to take control
The "Master lock lamp" illuminates to indicate that the Master station is locked in control.
When the Master Control Station is locked or unlocked 2 beeps will be heard **(Refer to the Sub Section 4.1.5"Transfer Panel Buzzer" below).**

TRANSFER PANEL BUZZER

Figure 4-15 Table of Transfer Panel Buzzer States

BUZZER STATE	MEANS
2 short beeps with short gap between.	Master Control Station has been LOCKED.
2 short beeps with long gap between.	Master Control Station has been UNLOCKED.
3 short beeps with short gap between.	Control transferred to Master Control Station.
3 short beeps with long gap between.	Control transferred to Remote Control Station.
Rapid beeps.	Transfer request denied.
1, 2, 3, or 4 short beeps every 10 seconds.	An error has occurred. **Refer to Section 5 "Faultfinding".**

CONTROL STATION TRANSFER PROCEDURE AND OPERATION

The Control Station that has a Master Transfer Panel alongside is called the "Master Control Station".
A Control Station that has a Remote Transfer Panel alongside is called a "Remote Control Station".

Functional Description

Control Station transfer requests may be made from any of the transfer panels by pressing the TAKE CONTROL button. This will initiate a Control Station transfer provided the following conditions are met:

1. All local Lever and Helm positions are synchronised to the Lever and Helm positions at the Active Control Station. (i.e. All 'CONTROL SYNC' lamps on the Local Transfer Panel are illuminated).
2. The Master Transfer Panel is not 'locked'. (i.e. The MASTER LOCKED lamp is off).
3. The TRANSFER STATUS lamp is flashing normally on all Transfer Panels.
4. The CONTROL STATUS lamp is flashing normally on all Main Control Panels.

- A successful transfer is accompanied by the TAKE CONTROL lamp on the now Active Transfer Panel illuminating, the TAKE CONTROL lamp on the previously Active Transfer Panel extinguishing and three audible tones indicating that the transfer is complete.
- An unsuccessful transfer will result in no change to the TAKE CONTROL lamps and an audible warning that the transfer has been denied.
- If a transfer is requested by an already Active Transfer Panel, there is no action to be taken and no warning is given.
- Control transfers are only attempted when a new button press has been detected. Keeping the TAKE CONTROL button pressed will not generate continuous transfer requests.
- At any time only one of the transfer panels can be in control of the vessel and therefore have it's TAKE CONTROL lamp illuminated.
- Whilst the Master Transfer Panel is active, transfer requests from any other stations may be prevented by locking the Master Transfer Panel. This is accomplished by pressing the MASTER LOCK button on the Master Transfer Panel. Acceptance of the master lock command is verified by illuminating the MASTER LOCK button on the Master Transfer Panel and the MASTER LOCKED lamps on each of the Remote Transfer Panels.

Example: Transferring control from the Master Transfer Panel to the Remote Control Station.

1. Check that the MASTER LOCKED lamps on the Transfer Panels are extinguished. If illuminated press MASTER LOCK on the Master Transfer Panel in order to allow transfers to take place. Two beeps will be heard and the MASTER LOCKED lamps will extinguish.
2. Using the Remote Station controls synchronise the Helm Wheel and Reverse Lever positions on the Remote Station with those on the Master Station using the three CONTROL SYNC lamps on the Remote Transfer Panel.
3. When all three CONTROL SYNC lamps are illuminated press the TAKE CONTROL button on the destination transfer panel.
4. A successful transfer will be accompanied by 3 beeps and the TAKE CONTROL lamp on the destination transfer panel will illuminate. Transfer is now complete and the vessel is under the control of the remote station.
5. If the transfer is denied then a short sequence of rapid beeps will be heard and the TAKE CONTROL lamp will not illuminate. This will only normally occur if the remote controls were improperly matched to the master controls.

4.1.6. The Autopilot Indication Panel

WARNING:

WHENEVER THE AUTOPILOT IS SWITCHED TO AN ACTIVE MODE, THE AUTOPILOT IMMEDIATELY OVERRIDES THE CMU CONTROL SYSTEM HELM INPUT. THIS CAN RESULT IN A SUDDEN CHANGE OF STEERING DIRECTION. THEREFORE WHENEVER ENGAGING OR DISENGAGING THE AUTOPILOT, ENSURE THE HELM CONTROLS ARE SET TO THE CENTRE POSITION.

NOTE:

The Autopilot Indication Panel is an option only and is only fitted where Auto Pilot Equipment is used.

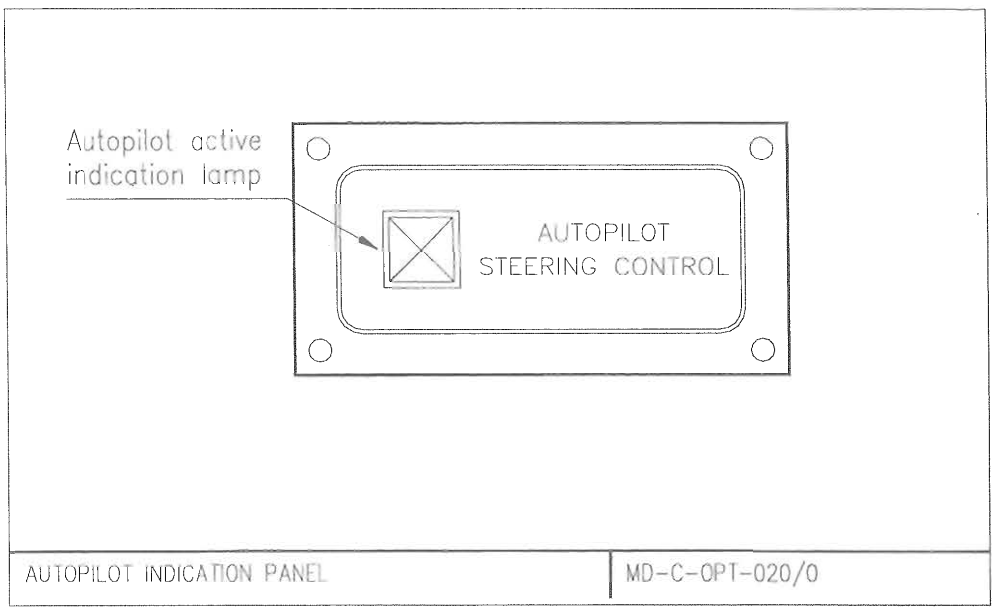


Figure 4-16 Autopilot Indication Panel

Only Jet Units operating in NORMAL Mode will respond to the Autopilot.

The Autopilot equipment can act as an extra Control Station in the system, controlling only the Helm, all other controls are unaffected. This occurs when the Autopilot is switched to an ACTIVE Mode. The CMU System will detect the Active Mode of the Autopilot and start using the Autopilot Helm signal immediately.

Whenever the CMU System is using the Autopilot signal, the lamp on the Autopilot Indicator Panel will be lit.

4.1.7. Oil Level Alarm Panel

The Oil Level Alarm Panel has a lamp for each Jet Unit.
When the Hydraulic Oil level is low in a Jet Unit an Alarm will occur and the lamp for that Jet will illuminate. The alarm can be cancelled by pressing Alarm Cancel and Test button and rectifying the fault.

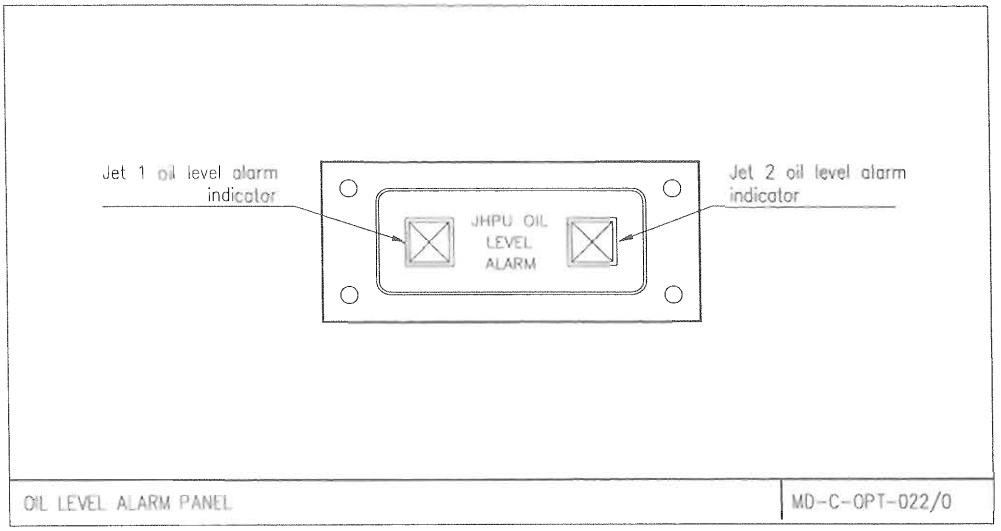


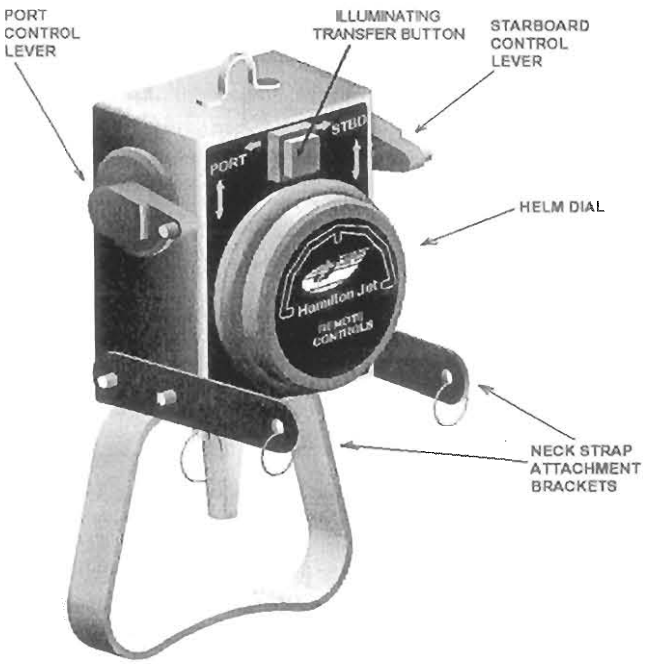
Figure 4-17 Oil Level Alarm Panel

4.1.8. Hand Held Remote (H.H.R.)

NOTE:

The Hand Held Remote (HHR) Control Unit is an Optional Device that is not fitted to all systems.

HAND HELD REMOTE CONTROL UNIT (H.H.R.)



DESCRIPTION

The HHR is a portable control device. It provides Helm Control, also Port and Starboard Thrust Control.
It is attached to a Control Panel via a lightweight cable and a junction box.

HELM FUNCTION

The Rotary Control on the top of the HHR acts as the Helm input. It rotates to control the Jet steering in the same way as a Helm Wheel. Markings on the Rotary Control and HHR indicate the Helm centre position.

SINGLE LEVER CONTROL FUNCTIONS

The two small control levers act in the same way as the larger levers at the main station **(Refer to Section 4.1.2. "Control Lever.),** combining Reverse Duct operation with engine throttle control. Each Control Lever has three detents to mark the Jet Control positions.

CONTROL TRANSFER

Station transfer to and from the HHR is performed via the Transfer Panel exactly the same way as for any 'Normal' Station **(Refer to Section 4.1.5. "Transfer Panel").**

SAFETY CONSIDERATIONS

The HHR is designed for use while manoeuvreing at low speeds. Although it can be used under all conditions, it is not recommend to be used at high speed or in rough conditions where there is a significant risk of the operator losing balance.
The HHR should only be used in locations near to a set of Emergency Controls so that in the event of a Control System failure the operator can quickly change to these Emergency Controls.
The lanyard attached to the Safety Switch should always be worn around the wrist. In the event that the HHR is accidentally dropped, a lanyard will withdraw a pin from the HHR which will operate a safety switch which generates a Control Alarm.

4.2. NORMAL OPERATION

The preceding Sections explained how to use the operator controls, and how the CMU Control System works. This Section explains how to use the Control System to operate the vessel.

4.2.1. Start-Up

The Control System will always start with control at the Control Station that was "In Command" when the system was shut down. Once the Control System has started, control may be transferred to another Control Station as described in **Section 4.1.5. "Transfer Panel".**

INITIAL OPERATIONS:

1. Ensure that the vessel is securely moored, or well clear of other objects.
2. Set all Controls to the following positions:
   - Control Mode: NORMAL.
   - SLC or Reverse Levers: ZERO SPEED.
   - Helm: CENTRE HELM.

STARTING THE CMU SYSTEM

1. Turn on the electric power to the engines and the Control System.
2. Check that all CONTROL STATUS lamps and all TRANSFER STATUS lamps are slowly flashing.
   - This should occur within 5 seconds of switching on the electrical power.
   - There will usually be some spurious alarms at power-up, particularly from the power supply monitor. Use the ALARM CANCEL switch to cancel these.
   - Check that the Primary and the Secondary Power Lamps are both on.
3. Check all indicator lamps and buzzers by pressing the ALARM CANCEL & TEST Push-Button on both the Main Control Station and the Remote Control Stations.

STARTING ENGINES & JET UNITS

1. Start the engines, and adjust the idle speeds to LOW IDLE if required using RPM & IDLE ADJUST Controls.

NOTE:
The gearbox must be in NEUTRAL to start the engine.

2. Engage each Jet Unit by pressing the appropriate DRIVE Gear Push-Button.

NOTE:
The Controller will not allow the gearbox to engage the engine with the Jet Unit unless:

- **The SLC or Reverse Lever is in the ZERO SPEED position.**
- **The engine RPM is at LOW IDLE.**

3. Adjust the SLC or Reverse Levers and Helm Controls as necessary to control any vessel movement.

CHECK FOR THE CORRECT OPERATION OF "*EMERGENCY MODE*"

Check for correct operation of the EMERGENCY Control Mode for each Jet Unit. To carry out this operation:-

1. Switch to EMERGENCY Mode.
2. Move the EMERGENCY STEERING & REVERSE JOGSTICK in each direction and confirm that the correct movement occurred on the Steering Deflector or Reverse Duct. Use the Steering Deflector and Reverse Duct Indicators to confirm positions.
3. Return the Steering Deflector to the CENTRE HELM position and the Reverse Duct to the ZERO SPEED position.
4. Check the operation of the RPM & IDLE ADJUST Switch by increasing and then decreasing engine speed.
5. Change each Jet Unit back to NORMAL Mode once correct operation of EMERGENCY Mode has been verified.

PREPARE FOR OPERATIONS

NOTE:

Backflushing can only be carried out if the Jet Unit is fitted with a "Reverse Gearbox".

1. Clear any Debris from each Jet Unit by "Backflushing" the Jet Unit. To carry out this operation:-
   - Ensure that the SLC or Reverse Lever is in the ZERO SPEED position.
   - Ensure the engine RPM is set at LOW IDLE.
   - Initiate backflushing by engaging NEUTRAL and then BACKFLUSH Gear using the Gearbox Control Panel.
   - Execute backflushing by increasing the engine speed for a few seconds using the SLC or Throttle Lever.
   - Return to the NEUTRAL and then DRIVE Gear.
2. **Normal Vessel operations can now commence.**

4.2.2. Steering

WARNING:

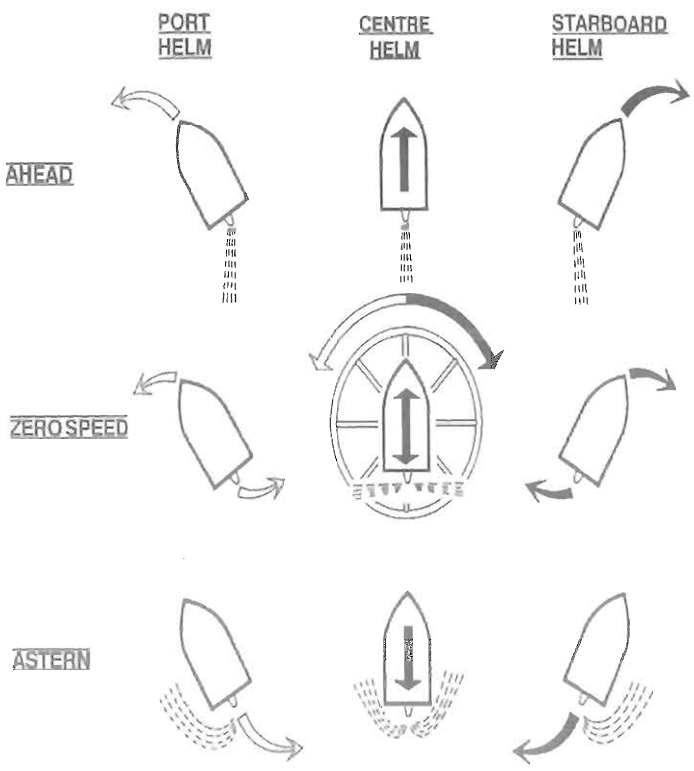
USE OF A WATERJET STEERED VESSEL IS DIFFERENT FROM A PROPELLER DRIVEN VESSEL BECAUSE THE WATERJET MAINSHAFT MUST ALWAYS BE ROTATING WHENEVER STEERING THRUST IS REQUIRED.

Also Note the following points:

1. **The Mainshaft *must always* be rotating whenever steering may be needed.**
2. **Never stop the engine or disengage the drive to the Jet Unit when approaching a mooring or at any time when control of the vessel may be required.**
3. **Do not confuse hydraulic operation of the Jet Unit steering mechanism with the actual steering thrust generated by the Waterjet.**

   The following reasons explain why:
   a) **The Steering Deflector cannot provide a steering force without the presence of the Waterjet. The Waterjet only exists when the Mainshaft is rotating.**
   b) **The Mainshaft also provides hydraulic power. Thus, if the Mainshaft is not rotating, there is no hydraulic power available to move the Steering Deflector and no steering control is available.**

STEERING OPERATION



The Steering Deflector deflects the waterjet to port or starboard causing the vessel to steer to port or starboard respectively. The following points should be remembered when operating a Waterjet steered craft:

1. Larger thrusts selected on the Reverse Lever result in a larger steering effects and hence sharper turns.

2. Steering is available at ZERO SPEED as well as all AHEAD and ASTERN thrusts: a feature which gives waterjet steered vessels unrivalled manoeuvreability.

3. The bow of the vessel will always turn the way the Helm is moved, irrespective of whether the Reverse Lever is set to ZERO SPEED, or any AHEAD, or ASTERN thrust. (i.e. Move the Helm to port and the bow of the vessel will move to port and vice versa).

Figure 4-18 Steering Control (1)

4. This means that when going astern the vessel has the opposite steering to a motor car, a feature which can be used to advantage when manoeuvering.

4.2.3. Thrust Control

NOTE:

The term "Reverse Lever" or "Control Lever" means a Lever of either the "SLC Type" or the "Separate Lever Type".

Thrust from the Jet Unit is controlled by the position of the Reverse Duct and Engine RPM.

1. Use the MANOEUVRE area of the Reverse Lever for manoeuvering.
2. Use the AHEAD and ASTERN areas of the Reverse Lever for normal travel.
3. The ZERO SPEED position of the Reverse Duct should not be confused with the NEUTRAL position of a gearbox when the driveline stops rotating.
4. Do not use high Engine RPM while reversing.

CAUTION:

Never select a position of the Reverse Lever close to FULL ASTERN while the vessel is proceeding at high speed, as the resultant "braking effect" can be more severe than full braking of a motor car.

NORMAL SLOWDOWN

Reducing Engine speed results in a prompt slowing of the vessel down to a lower speed.
With SLC Levers, move the Lever to the AHEAD IDLE position.
With Separate Levers, move the Throttle Lever to reduce Engine speed.

POWER ASSISTED SLOWDOWN

A faster slowdown can be achieved by applying reverse thrust. This can be done by moving the Reverse Lever to a position on the ASTERN side of ZERO SPEED, but not near ASTERN MAXIMUM.

WARNING:

1. POWER ASSISTED SLOWDOWN CAN PRODUCE A VERY RAPID DECELERATION.
2. NEW OPERATORS SHOULD USE THIS FEATURE VERY CAREFULLY.
3. SELECT ZERO SPEED AS SOON AS THE VESSEL HAS SLOWED.
4. DO NOT USE FULL HELM CONTROL UNTIL THE VESSEL HAS SLOWED.

4.2.4. Low Speed Manoeuvering

NOTE:

The term "Reverse Lever" means a Lever of either the "SLC Type" or the "Separate Lever Type".

Full steering thrust is available at all positions of the Reverse Lever, including the ZERO SPEED position.

IDLE SPEED ADJUSTMENT

- Adjust engine RPM using the RPM and IDLE ADJUST controls or the Throttle Lever to suit wind and current conditions.
- Further adjustment during manoeuvering should not be necessary.
- Higher engine RPM result in faster vessel response.

ROTATION:

Keep one hand on the Helm and one hand on the Reverse Lever(s).
a) ROTATE the vessel using the Helm control.
b) Remember that the bow will always move the way the Helm is turned
c) To stop vessel rotation, apply opposite steering. Centre the helm once rotation stops.

FORWARD / REVERSE

Keep one hand on the Helm and one hand on the Reverse Levers(s).
a) Move AHEAD or ASTERN by moving the Reverse Lever(s) within the MANOEUVRE zone.
b) To stop the vessel moving AHEAD or ASTERN, apply opposite thrust either AHEAD or ASTERN. Select ZERO SPEED once movement stops.

MULTI JET VESSELS

With multi Jet vessels, manoeuvering is best done by moving the Helm with one hand and the Reverse Levers together with the other hand. Setting Levers AHEAD and ASTERN is not as effective except when moving sideways.

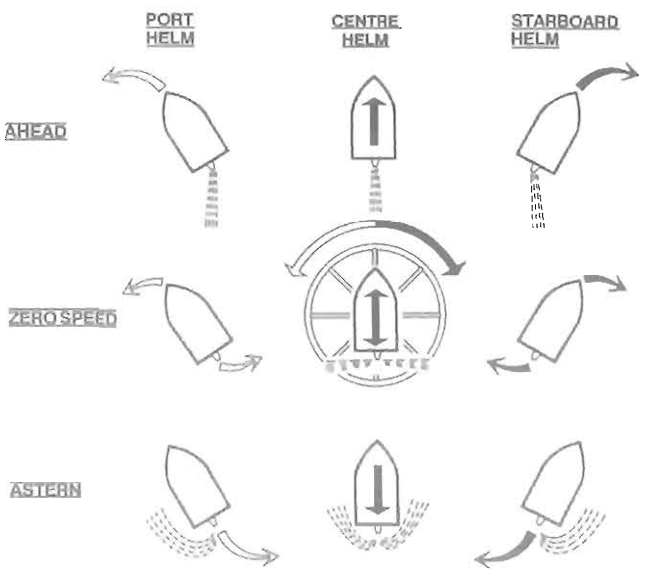


Figure 4-19 Steering Control (2)

4.2.5. Moving Sideways

NOTE:

The term "Reverse Lever" means a Lever of either the "SLC Type" or the "Separate Lever Type".

In vessels with two or more Jet Units, direct sideways movement can be obtained using the reverse thrust capabilities of the Jet Units.

IN VESSELS HAVING TWO OR FOUR JET UNITS

Initially set all Reverse Levers to ZERO SPEED, set the steering to the CENTRE HELM position and adjust all engines to the same speed. The engine speed required for manoeuvering will depend on the prevailing sea conditions. Higher engine speed will improve response. The vessel should be stationary.

Moving to Port:
(To move to starboard, reverse the operations described for moving to port)

Stage A

1. Move the port Reverse Levers to the ASTERN part of the MANOEUVRE zone, and the starboard Reverse Levers to the AHEAD part of the MANOEUVRE zone.

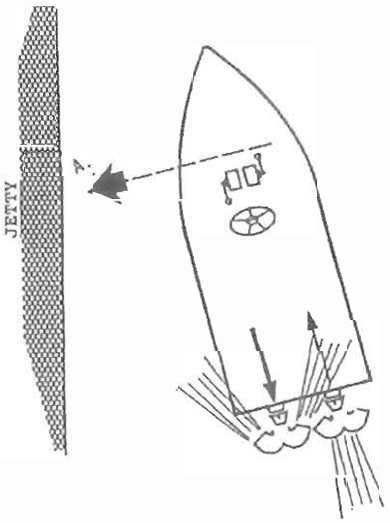


Figure 4-20 Jet Manoeuvering (1)

Stage B

2. As the bow begins to swing to Port, turn the helm to starboard to keep the vessel pointing in the same direction.
3. The vessel will now move sideways to Port.
4. Adjust the speed of the port engines to prevent fore and aft movement. (Higher engine speed will move the Vessel aft). This may also be done by bringing the starboard Reverse Levers back towards the ZERO SPEED position.
5. To slow down, select ZERO SPEED on all Reverse Levers and centre the Helm. This will cause the vessel to slow down naturally.

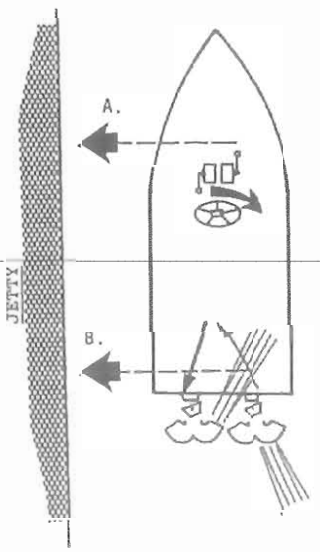


Figure 4-21 Jet Manoeuvering (2)

IN VESSELS HAVING THREE JET UNITS

Using all three Jet Units to move sideways gives 33% more thrust than using just two Jet Units.

Initially set all Reverse Levers to ZERO SPEED, steering to CENTRE HELM and all engines to the same speed. The engine speed required for manoeuvring will depend on the prevailing sea conditions. Higher engine speeds will improve response. The vessel should be stationary.

Moving to Port:
(To move to starboard, reverse the directions of control movement used for moving to port).

Stage A

1. Move the port Reverse Levers to ASTERN IDLE and the starboard Reverse Levers to AHEAD IDLE.

Stage B

2. As the bow begins to swing to Port, turn the helm to starboard to keep the vessel pointing in the same direction.
3. Use the centre Reverse Lever to control fore and aft movement. The Reverse Duct should be approximately 80% reversed.
4. The vessel will now move sideways to Port.
5. To slow down, select ZERO SPEED on all Reverse Levers and centre the Helm. This will cause the vessel to slow down naturally.

STOPPING SIDEWAYS MOVEMENT

There are two ways to stop sideways movement:

a) A "natural" slowdown can be achieved by setting helm to CENTRE HELM and Reverse Levers to ZERO SPEED before the vessel reaches the required position.

OR

b) An "active" slowdown can be achieved by:
   I. Setting the controls to start sideways movement in the opposite direction.
   II. When the vessel stops, Set helm to CENTRE HELM and Reverse Levers to ZERO SPEED.

4.2.6. Shutdown

1. Ensure the vessel is securely moored.
2. Before shutting down the engines, Centralise the Steering Deflectors and ensure all Reverse Levers are in the ZERO SPEED position. This ensures an orderly and fast start-up for the next trip.
3. Disengage all Jet Units by pressing the NEUTRAL push buttons on the Gearbox Control Panels.
4. Shutdown engines.
5. Turn off electric power to the Control System.

4.3. EMERGENCY OPERATION

4.3.1. Failure of 'NORMAL' Control Mode

SYMPTOM OF FAILURE OF NORMAL MODE:

If at any stage Control of a Jet Unit in NORMAL mode is lost, it should be switched over to EMERGENCY CONTROL.

CHANGEOVER TO EMERGENCY MODE:

This is achieved by changing the NORMAL / EMERGENCY Mode switch to EMERGENCY. This only affects the relevant Waterjet unit. The other Jet Units can still run in NORMAL Mode if they do not have any faults and their CONTROL STATUS lights flash normally.

OPERATION IN EMERGENCY MODE:

In EMERGENCY Mode, all controls for the affected Waterjet Unit revert to a basic "non-follow up" type of control. The 'Normal' Helm and Reverse Lever for the Waterjet Unit will become inoperative. The gearbox controls remain unchanged.

1. **Steering Deflector and Reverse Duct Positions.**
   The Steering Deflector and Reverse Duct are controlled using the EMERGENCY OVERRIDE Jogstick which is located on the Main Control Panel.
   a) The Steering Deflector and Reverse Duct cannot be controlled simultaneously.
   b) Push the Jogstick in the direction that the Steering Deflector or Reverse Duct are required to move to.
   c) Hold the Jogstick until the Steering or Thrust Indicators move to the desired positions.
   d) There is no automatic limitation of movement when the Steering Deflector or Reverse Duct reaches full travel. Take care not to drive either item past it's travel limits, as shown on the Indicator. Occasional excursions over the limits are acceptable, but can lead to overloading of the hydraulic components if they occur too frequently, or for prolonged periods.

2. **Engine Throttle**
   The throttle is controlled independently by the RPM & IDLE ADJUST switch on the Master Control Panel. Use it to "jog" the engine speed higher or lower.

4.3.2. Failure of Both 'NORMAL' and 'EMERGENCY' Control Modes

Refer to the Drawings found under "HYDRAULIC POWER UNITS" Section of the Drawings Package

This is unlikely, and will normally be due to a total failure of electrical power. Hydraulic power will still be available if the Mainshaft is turning. The Jet Units may be controlled manually as shown below. In Multi Jet Installations a better option may be to shut down the failed Jet Unit and proceed using the remaining Jet Units.

Steering

The Steering Cylinder can be made to move in the desired direction by manually activating the Steering Solenoid Valve [V37] as well as the Pressure Valve [V5]. This is done by pressing a blunt probe into the end of the appropriate Valve Drive Solenoids.

Thrust Control
The Reverse Duct Cylinder can be made to move in the desired direction by manually activating the Reverse Solenoid Valve [V3] as well as the Pressure Valve [V5]. This is done by pressing a blunt probe into the end of the appropriate Valve Drive Solenoids.

Throttle Control
Refer to engine manufacturer's manual for means of controlling the throttle.

Gearbox Control
Refer to the Gearbox manufacturer's manual for means of controlling the gearbox.

4.3.3. Failure of Hydraulic Power

Refer to the Drawings found under "HYDRAULIC POWER UNITS" Section of the Drawings Package.

If hydraulic power fails or both Control Modes (NORMAL and EMERGENCY) fail, the Jet Units may be controlled manually as described below. Alternatively, in Multi Jet Installations, a better option may be to shut down the failed Jet Unit and proceed using the remaining Jet Units.

Manual Steering
1. Switch to EMERGENCY Control Mode.
2. Open the Steering By-Pass Valve [V32B] on the JHPU.
3. Fit a Tiller Extension over the stub on the Steering Crank.
4. Move the Tiller Extension as required. The Deflector position is indicated at the Helm by an indicator while a pointer on the Steering Crank indicates the Steering Deflector position at the Jet Unit.

Manual Thrust Control
Can be provided by manually raising (forward thrust) or lowering (reverse thrust) the Reverse Duct.
1. Switch to EMERGENCY Control Mode.
2. Operate at engine idle RPM.
3. To RAISE the Reverse Duct:
   a) Attach a rope to the Reverse Duct lifting eye.
   b) Take the weight of the Reversed Duct.
   c) Open the Manual By-Pass Valve [V32A] on the JHPU.
   d) Pulling on the rope, move the Reverse Duct to new position and close the Manual By-Pass Valve (Observe the cylinder stroke for position).

4. To LOWER the Reverse Duct:
   a) Check and ensure that any lifting rope is removed.
   b) Open the Manual By-Pass Valve slightly until the Reverse Duct moves under its own weight.
   c) Close the Manual By-Pass Valve when the Reverse Duct is in the desired position (Observe the cylinder stroke for position).

5. Faultfinding

WARNING:

IF AT ANY TIME CONTROL OF THE VESSEL USING NORMAL CONTROL IS LOST, CONTROL SHOULD BE SWITCHED TO EMERGENCY CONTROL.

NOTE:

Section 5. "Faultfinding" in the Jet Unit Manual and Section 3. "Commissioning" in this Manual contains additional information.

5.1. FAULT TYPES AND INDICATIONS

The Control System is self monitoring and reports Alarms via lamps and buzzers on the Control Panels at each of the Control Stations.

Use the Tables overleaf to determine what or if an Alarm has occurred. There are separate Tables for Each Panel.

5.1.1. Main Control Panel

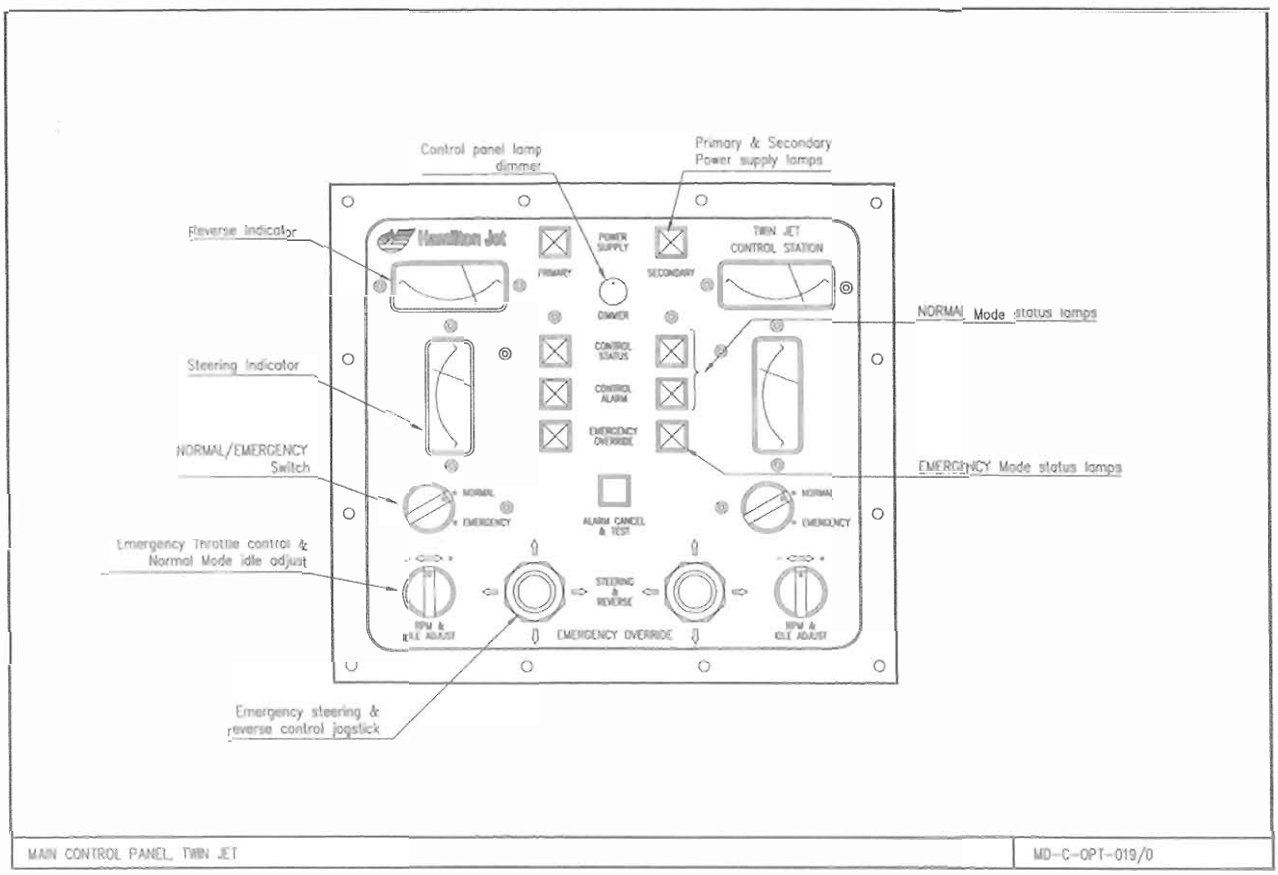


Figure 5-1 Main Control Panel for a Standard Twin Jet System.

Figure 5-2 Control Panel Alarm Indication Table

Control Status Lamp	Control Alarm Lamp	Primary Power Supply Lamp	Secondary Power Supply Lamp	Buzzer	Alarm Type
Continuously On	Off	On	On	Off	**No Alarm**, the system is waiting to be activated by setting the Control Levers to mid-idle, centreing the Helm and engaging neutral gear.
Slow Flash	Off	On	On	Off	**No Alarm**, the system is in Normal Active Mode.
Slow Flash	Off	On	**Flashing**	**2 Second beep**	**Power Supply Alarm,** for the secondary supply **(see Section 5.2. "POWER SUPPLY ALARMS").**
Slow Flash	Off	**Flashing**	On	**2 Second beep**	**Power Supply Alarm,** for the primary supply **(see Section 5.2. "POWER SUPPLY ALARMS").**
Continuously On	**Flashing**	On	On	**2 Second beep**	**Control Warning. (Refer to details in this Section and Section 5.3. "Control Warnings and Alarms").).**
Continuously On	**Flashing**	On	On	**Continuous beep**	**Control Alarm. (Refer to details in this Section and Section 5.3. "Control Warnings and Alarms").**
Off	Off	On	On	Off	**Serious Control Alarm. (Refer to details in this Section).**

POWER SUPPLY ALARMS

For detailed information, refer to Section 5.2. "Power Supply Alarms".

A Power Supply Alarm occurs when either the Primary or Secondary Power Supplies to any part of the Control System falls below a pre-set voltage level.

Symptom:
One or both of the Power Supply Lamps on the main Control Panel will flash. The Alarm Buzzer will sound for 2 seconds.
Action:
Perform faultfinding on the power supply until the problem is rectified.

CONTROL WARNING

NOTE:

For detailed information refer to Section 5.3. "CONTROL WARNINGS AND ALARMS".

A Control Warning occurs when the CMU detects a signal out of range for an item that does not affect the safe operation of the system.

Symptom:
The Control Alarm lamp flashes while the warning condition occurs and the buzzer sounds for 2 seconds.
Action:
Perform fault finding until the problem is rectified.

CONTROL ALARM

NOTE:

For Detailed information refer to Section 5.3. "CONTROL WARNINGS AND ALARMS".

A Control Alarm occurs when either:-

a) A DEMAND signal has gone out of range **or,**
b) A FEEDBACK signal has gone out of range **or,**
c) The delay between the Jet position demand signal being given and that position being reached by the Jet (the FOLLOW UP time) is greater than it's pre-set limit.

Symptom:
The CONTROL ALARM lamp flashes. The BUZZER sounds continuously. For most Alarms the control of the hydraulics associated with the alarm is locked until the Alarm condition has been removed. The exception is for FOLLOW UP ALARMS also known as SERVO POSITIONING ALARMS for which the associated hydraulics DO NOT lock.

Action:
The BUZZER can be silenced by either pressing the CANCEL button or by switching to EMERGENCY. Fault finding should be performed to establish the cause of the alarm.

If control of any of the system is lost using NORMAL controls then the EMERGENCY controls should be used for system operation.

SERIOUS CONTROL ALARMS

NOTE:

For Detailed information see Section 5.3.3. "CMU Warning and Alarm Codes"

A Serious Alarm occurs when a parameter required for safe operation has been detected to be out of it's pre-determined range.

The Controls will lock in their current state. The operator must change to the EMERGENCY Mode to continue operations. These Alarms will only ever occur during START UP or RESET of the Control System.

Symptom:
The STATUS LAMP and the ALARM LAMP do NOT illuminate. The BUZZER does NOT sound. The NORMAL Controls (Helm and SLC, etc.) are not operative.

Action:
Continue voyage using EMERGENCY Controls. Perform Fault Finding until the problem is rectified.

5.1.2. Hydraulic Oil Level Panel

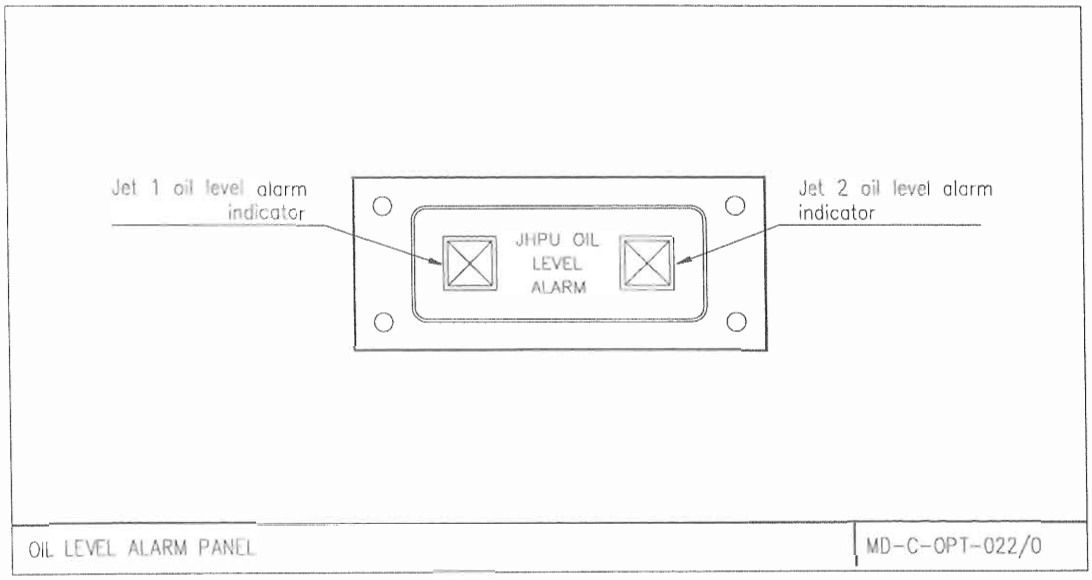


Figure 5-3 Hydraulic Oil Indicator Panel

Figure 5-4 Hydraulic Oil Indicator Panel: Table of Alarms

Hydraulic Oil Level Alarm	Buzzer	Alarm Type
Off	X	No Alarm
On	2 second beep	**Hydraulic Alarm (Refer to Section 5.4. "HYDRAULIC FAULTS").**

5.1.3. Transfer Panel

NOTE:

The Transfer Panel is only fitted on installations with more than 1 Control Station.

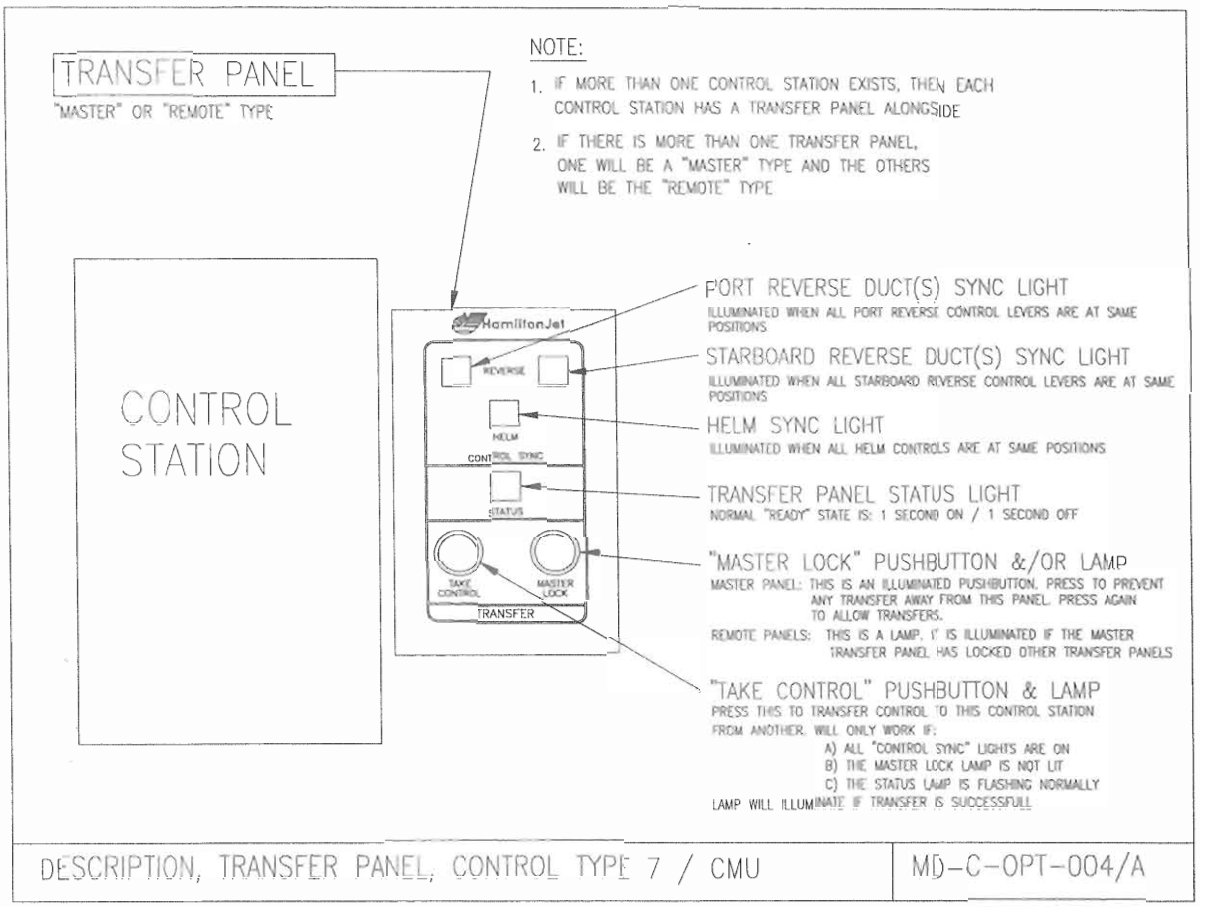


Figure 5-5 Transfer Panel

Figure 5-6 Table of Transfer Panel Alarms

Transfer Panel Status Alarm	Transfer Panel Helm Sync Lamp	Transfer Panel Port Control Lever Sync Lamp	Transfer Panel Starboard Control Lever Sync Lamp	Buzzer	Alarm Type
Slow Flash	X	X	X	X	No Control Transfer Alarms.
X	Flashing	X	X	X	**Transfer Alarm.** The Helm signals at this station are faulty. **(see Section 5.5. "CONTROL STATION TRANSFER FAULTS").**
X	X	Flashing	X	X	**Transfer Alarms.** The Port Control Lever Signals at this station are faulty. **(see Section 5.5. "CONTROL STATION TRANSFER FAULTS").**
X	X	X	Flashing	X	**Transfer Alarm.** The Starboard Control Lever Signals at this station are faulty. **(see Section 5.5. "CONTROL STATION TRANSFER FAULTS").**
Fast Flash	X	X	X	Continuous Beep	**Transfer Alarm.** Serious Control Transfer Fault. **(see Section 5.5. "CONTROL STATION TRANSFER FAULTS").**
X	X	X	X	From 1 to 4 short beeps, repeated every few seconds	**Transfer Alarm.** Serious Control Transfer Fault. **(see Section 5.5. "CONTROL STATION TRANSFER FAULTS").**

5.2. POWER SUPPLY ALARMS

WARNING:

PRIOR TO REPLACING ANY FUSES, ALL POWER TO THE ELECTRONIC CONTROL SYSTEMS MUST BE TURNED OFF.

WARNING:

SPECIAL CARE MUST BE TAKEN WHEN REPLACING FUSES ON THE AUXILIARY INTERFACE CIRCUIT BOARDS TO ENSURE THE FUSE HOLDERS DO NOT TOUCH ADJACENT FUSE HOLDERS.

5.2.1. Power Supply Overview

The Control System has independent Primary and Secondary 24V supplies connected to the Electronics at the Control Stations and to the Electronics at each Jet.
If at any stage the Primary or Secondary Power Supply to the Control Stations should fail there is no effect on the operation of the system. If both supplies fail the Control System utilises the supply connected to the Jet(s) Electronics to keep the Control Panels and Emergency Controls Operative. Normal Control however will be shut down.

If a supply fails, the corresponding lamp on the Main Control Panel will flash and the Alarm buzzer will sound for 2 seconds. The Lamp will continue to flash until the supply fault has been rectified and the 'Alarm Cancel & Test' button has been pressed.

NOTE:

While it is usual for a supply fault to be a result of complete loss of supply, the system will also generate a Power Supply Alarm for low voltage situations. The Control System can operate down to a supply voltage of 20V. Below 20V a Power Supply Alarm will be generated.

The most common fault that occurs with the power supply system is that a fuse has blown. This is due to the fuses being stressed over time due to the spurious power supply "spikes" that are common in any vessel installation.
A fuse will also blow whenever a genuine fault occurs thereby providing protection to the Control System Electronics.
The fuses consist of a thin piece of wire inside a small glass tube. When a fuse blows the thin piece of wire burns and breaks. To inspect a fuse, visually check that the wire is complete within the glass tube. If a multimeter is available use it to check the fuses by turning the Control System power off and checking the continuity across the fuse.

The Figures 5.7, 5.8 and 5.9, on the following pages show the locations of the fuses to be checked:

Auxiliary Interface Circuit Board in the Power Supply Unit:

FUSES AND CONNECTORS

ITEM	FUSE No	VALUE	CONNECTOR	DESCRIPTION
1	F1, F16	5A	J1	PRIMARY SUPPLY, 24V & 0V FUSED
2	F2, F15	5A	J2	SECONDARY SUPPLY, 24V & 0V FUSED
3	F4	2A	J8	PORT METER DRIVER BOARD
4	F5	2A	J11	STARBOARD METER DRIVER BOARD
5	F9	2A	J13	STARBOARD CMU BOARD
6	F11	2A	J14	PORT CMU BOARD
7	F13	2A	J15	MSU BOARD
8	F7	3A	J4	SMOOTHING CAPACITOR

FORCE SECONDARY SUPPLY

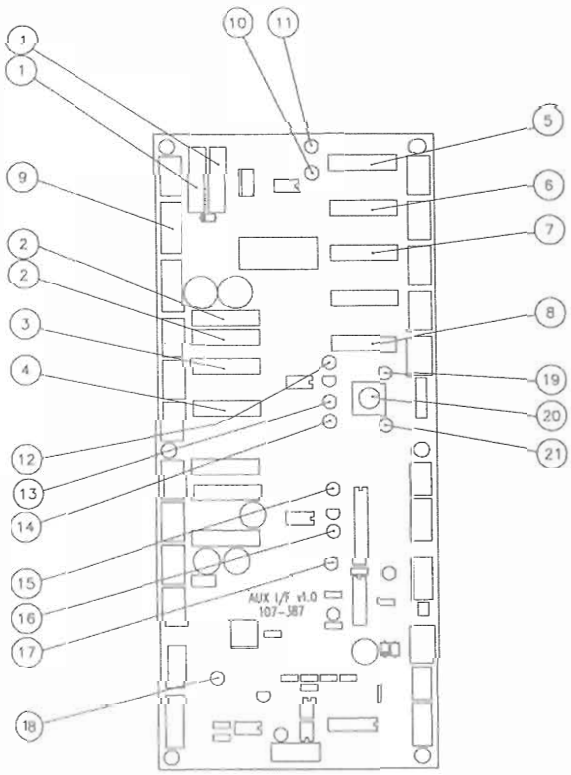
ITEM	NAME	DESCRIPTION
9	J3	REMOVE THIS PLUG TO FORCE SYSTEM TO USE SECONDARY POWER SUPPLY

POWER SUPPLY LED's

ITEM	NAME	DESCRIPTION
10	D2	PRIMARY SUPPLY OK & IN USE
11	D3	PRIMIMARY SUPPLY OVER VOLTAGE
12	D6	SECONDARY SUPPLY OK
13	D5	SECONDARY SUPPLY OVER VOLTAGE
14	D4	SEC SUPPLY UNDER VOLTAGE
15	D18	EMERGENCY SUPPLY OVER VOLTAGE
16	D19	EMERGENCY SUPPLY OK
17	D17	EMERGENCY SUPPLY UNDER VOLTAGE
18	D14	EMERGENCY SWITCHMODE OPERATIONAL

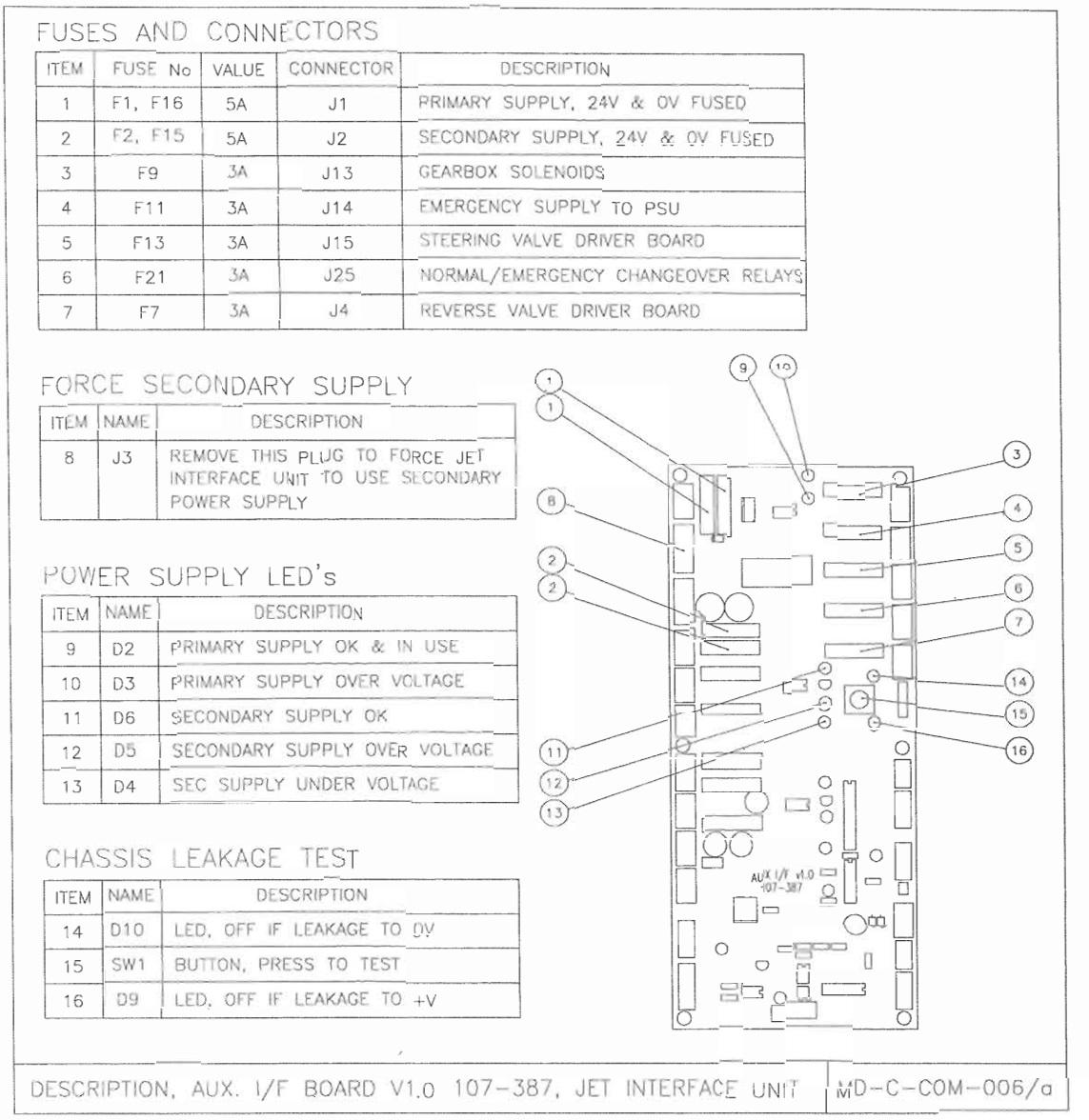
CHASSIS LEAKAGE TEST

ITEM	NAME	DESCRIPTION
19	D10	LED, OFF IF LEAKAGE TO 0V
20	SW1	BUTTON, PRESS TO TEST
21	D9	LED, OFF IF LEAKAGE TO +V



DESCRIPTION, AUX. I/F BOARD V1.0 107-387, POWER SUPPLY UNIT | MD-C-COM-004/a

Figure 5-7 Auxiliary Interface Circuit Board in the Power Supply Unit (PSU)



FUSES AND CONNECTORS

ITEM	FUSE No	VALUE	CONNECTOR	DESCRIPTION
1	F1, F16	5A	J1	PRIMARY SUPPLY, 24V & 0V FUSED
2	F2, F15	5A	J2	SECONDARY SUPPLY, 24V & 0V FUSED
3	F9	3A	J13	GEARBOX SOLENOIDS
4	F11	3A	J14	EMERGENCY SUPPLY TO PSU
5	F13	3A	J15	STEERING VALVE DRIVER BOARD
6	F21	3A	J25	NORMAL/EMERGENCY CHANGEOVER RELAYS
7	F7	3A	J4	REVERSE VALVE DRIVER BOARD

FORCE SECONDARY SUPPLY

ITEM	NAME	DESCRIPTION
8	J3	REMOVE THIS PLUG TO FORCE JET INTERFACE UNIT TO USE SECONDARY POWER SUPPLY

POWER SUPPLY LED's

ITEM	NAME	DESCRIPTION
9	D2	PRIMARY SUPPLY OK & IN USE
10	D3	PRIMARY SUPPLY OVER VOLTAGE
11	D6	SECONDARY SUPPLY OK
12	D5	SECONDARY SUPPLY OVER VOLTAGE
13	D4	SEC SUPPLY UNDER VOLTAGE

CHASSIS LEAKAGE TEST

ITEM	NAME	DESCRIPTION
14	D10	LED, OFF IF LEAKAGE TO 0V
15	SW1	BUTTON, PRESS TO TEST
16	D9	LED, OFF IF LEAKAGE TO +V

DESCRIPTION, AUX. I/F BOARD V1.0 107-387, JET INTERFACE UNIT | MD-C-COM-006/a

Figure 5-8 The Auxiliary Interface Circuit Board in (each) Jet Interface Unit

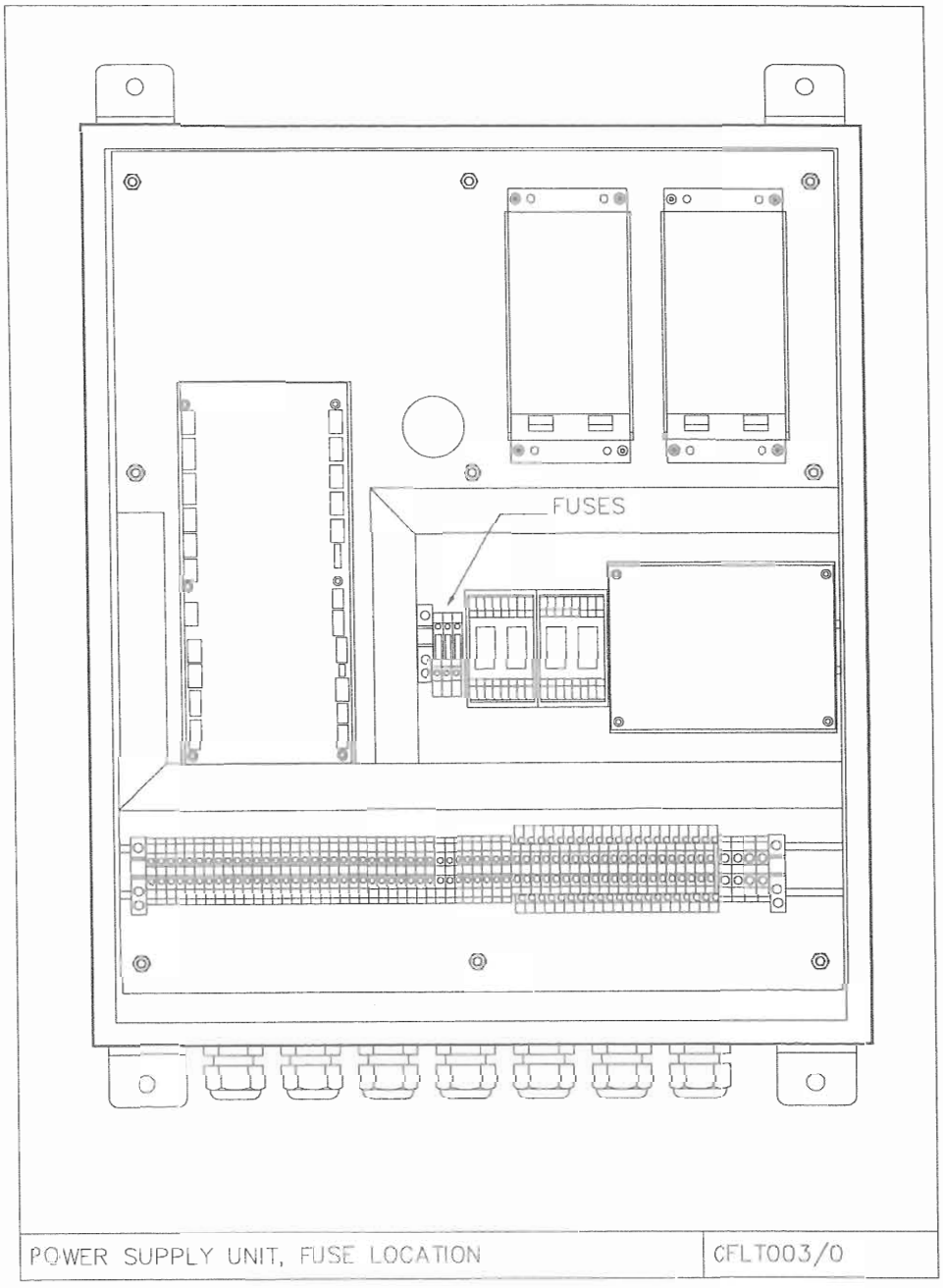


Figure 5-9 Power Supply Unit, Fuse Location

Mounted in Fuse Holders on DIN Rail adjacent to the Relay Circuit Board in the Power Supply Unit

If all fuses check out satisfactorily, but there is still an Alarm, check the vessels Primary and Secondary Power Supply.
If a fuse keeps blowing each time it is replaced, contact your Hamilton Jet Agent.

5.3. CONTROL WARNINGS AND ALARMS

NOTE:

Often a fault can be easily corrected as it may be caused by incorrect settings of operator controls, for example.

If DRIVE gear is selected when the engine is not running and Steering or Reverse Duct Controls are used, a hydraulic positioning fault will be reported (Fault Numbers 45:BUCKETerr and 46:STEERerr). This is because the hydraulic operation requires the engine to be operating. When this occurs, cancel the alarm and select NEUTRAL gear again.

The Controls should be checked to ensure that there are no conflicting commands before serious fault finding is undertaken.

5.3.1. Control Codes

The key to faultfinding the Controls System is to determine the "Control Code". Once this is determined the faultfinding procedure for that code can be followed **(Refer to Section 5.3.4. "Correcting Faults").**

The CMU PCB for each Jet Unit keeps track of the OPERATING State of the Jet Unit as well as the Warnings and Alarms that occur. These are called the Control Code.

The Control Codes are displayed on the **L**ight **E**mitting **D**iode (LED) Array on the CMU circuit board. **Refer to Figure 5.10. "CMU / MSU Fault Indicator Position".**

The CMU(s) **P**rinted **C**ircuit **B**oards (PCB's) are located inside the Central Control Unit (CCU) cabinet(s). Note that a similar PCB, the MSU PCB may be located on the door of the CCU.

The last 10 occurring Warning/Alarm Codes can be interrogated by using the Hand Held Programmer. **(Refer to Section 3.1.8. "Setting Option Switches on the CMU and** M" **Sub Section "Using the CMU Field Programmer").**

When the LED Array is flashing at **1 flash per second**, it is displaying an OPERATING state. Except for Operating State Number 10 these are NOT Warnings or Alarms.

When the LED Array is flashing at **2 flashes per second** it is displaying a WARNING or ALARM Code.
When the LED Array is steady it is displaying the last occurring Warning or Alarm.

For a Warning, the LED ARRAY will flash at **2 flashes per second** while the cause of the Warning is present.

For an Alarm, the LED Array will flash at **2 flashes per second** until the Alarm is cancelled by pressing the ALARM CANCEL button, and the Alarm condition has been rectified, or by switching to the EMERGENCY Controls.

After an Alarm is cancelled and the Alarm Condition has been rectified, the Alarm Code will remain on the LED Array without flashing.

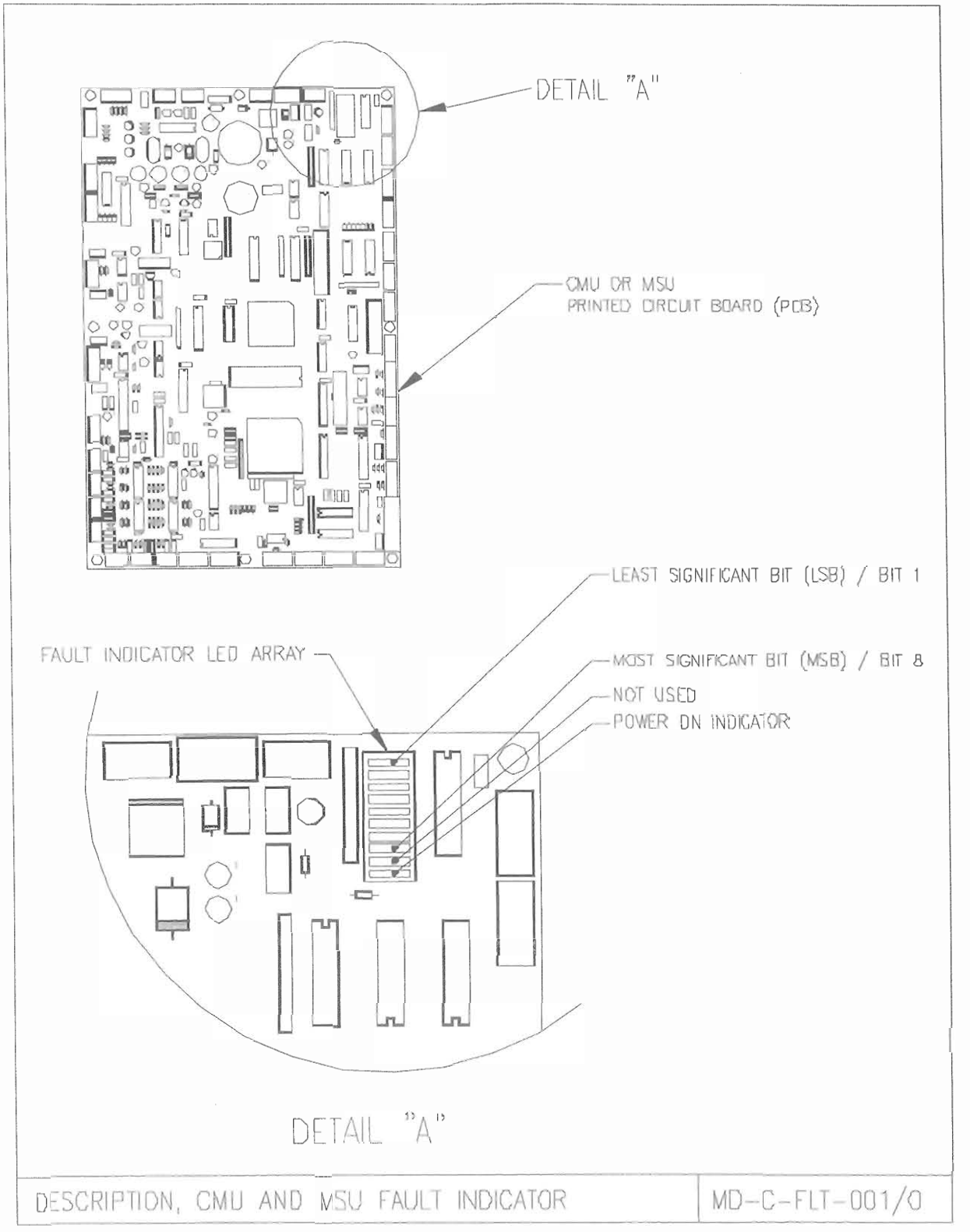


Figure 5-10 CMU / MSU Fault Indicator Position

5.3.2. CMU Operating State Codes

NOTE:

Except for Operating State Number 10, these are NOT Warning / Alarm Codes.

Figure 5-11 Table of CMU Operating State Codes

Operating State Number	Operating State Name	Description	Hex Code	LED Pattern MSB LSB
1	POWERUP	First State after a power-up / reset	01	0000 0001
2	MSUWAIT	Waiting for MSU communications to start (if applicable)	02	0000 0010
3	NEUTWAIT	Waiting for neutral control settings	03	0000 0011
4	FWD_DRIVE	System in "forward-drive" (according to the SLC)	10	0001 0000
5	FWD_IDLE	System in "forward-idle" (according to the SLC)	11	0001 0001
6	MID_IDLE	System in "mid-idle" (according to the SLC)	12	0001 0010
7	REV_IDLE	System in "reverse-idle (according to the SLC)	13	0001 0011
8	REV_DRIVE	System in "reverse-drive" (according to the SLC)	14	0001 0100
9	BUCKET_ILOCK	System in "bucket-interlock" (according to the Reverse Bucket)	15	0001 0101
10	FAULTY	Serious System Fault / Shutdown State	40	0100 0000
11	EMERGENCY	Emergency Controls active	41	0100 0001
12	BACKFLUSH	System not in "drive" gear	42	0100 0010
13	PROG_ATTACHED	External Field Programmer detected	64	0110 0100
14	PROGRAMMING	Parameter programming occurring	65	0110 0101

5.3.3. CMU Warning and Alarm Codes

NOTE:

This Table is a list of all possible Alarm conditions supported by the CMU Software. Not all Fault conditions and codes are applicable to every Control System Installation.

Figure 5-12 Table of CMU Warnings

Fault Number	Fault Name	Description	Hex Code	LED Pattern MSB LSB
WARNINGS				
1	SWITCHerr	Input Switch 'stuck' detected.	01	0000 0001
2	IDLESWerr	Both Inc and Dec switches active together.	02	0000 0010
3	NO_MSU	NO MSU detected at power-up.	03	0000 0011
4	PCB_too_hot	"Hot" PCB temperature error.	04	0000 0100
5	PCB_too_cold	"Cold" PCB temperature error.	05	0000 0101
6	MSTRstation_err	Fault with unused Master Station inputs.	06	0000 0110
7	REM1station_err	Fault with unused Remote Station 1 inputs.	07	0000 0111
8	REM2station_err	Fault with unused Remote Station 2 inputs.	08	0000 1000
9	REM3station_err	Fault with unused Remote Station 3 inputs.	09	0000 1001
10	MSUtimeout	Time-out for MSU communications.	0A	0000 1010
11	NO_RPMsignal	RPM feedback too low or absent.	0B	0000 1011
12	RPMsignal_err	RPM feedback signal too fast.	0C	0000 1100
13	HYDSWerr	Both hydraulic selector switches active.	0D	0000 1101
14	LOWoil_prim	Low primary hydraulic oil level.	0E	0000 1110
15	LOWoil_sec	Low secondary hydraulic oil level.	0F	0000 1111
16	LOWpress_prim	Low primary hydraulic pressure	10	0001 0000
17	LOWpress_sec	Low secondary hydraulic pressure	11	0001 0001
18	Nopress_sensor	Unconnected oil pressure sensor.	12	0001 0010
19	MOTORfailure	Primary oil pump AC motor failed.	13	0001 0011
20.	HOTbearing_oil	Jet bearing oil temperature too hot.	14	0001 0100
21	PMCact_err	Error signal from PMC Actuator.	15	0001 0101
22 - 32	Unused	These Fault Numbers are not used.	16 - 20	----------

Figure 5-13 Table of CMU Control Alarms

Fault Number	Fault Name	Description	Hex Code	LED Pattern MSB LSB
CONTROL ALARMS				
33	HELMmaster_err	Analogue input range errors on master helm	21	0010 0001
34	HELMremote1_err	Analogue input range errors on remote 1 helm	22	0010 0010
35	HELMremote2_err	Analogue input range errors on remote 2 helm	23	0010 0011
36	HELMremote3_err	Analogue input range errors on remote 3 helm	24	0010 0100
37	SLCmaster_err	Analogue input range errors on master SLC	25	0010 0101
38	SLCremote1_err	Analogue input range errors on remote 1 SLC	26	0010 0110
39	SLCremote2_err	Analogue input range errors on remote 2 SLC	27	0010 0111
40	SLCremote3_err	Analogue input range errors on remote 3 SLC	28	0010 1000
41	STEERfb_err	Steering hydraulic position feedback error	29	0010 1001
42	BUCKETfb_err	Reverse Duct hydraulic position feedback error	2A	0010 1010
43	LTC1290err	Error from LTC1290 1.2 V reference	2B	0010 1011
44	ANA12power	Analogue power failure	2C	0010 1100
45	STEERerr	Steering Servo positioning error	2D	0010 1101
46	BUCKETerr	Reverse Duct Servo positioning error	2E	0010 1110
47	SAFETYSWerr	Remote Safety Switch error	2F	0010 1111
48	INVALIDstation	New Control Station is invalid	30	0011 0000
49	HYDPOWERerr	No hydraulic power is available	31	0011 0001
50	THRUSTsig_err	Thrust input signal out of range	32	0011 0010
51	THROTTLEsig_err	Throttle input signal out of range	33	0011 0011
52-80	Unused	These Fault numbers are not used	34 to 50	

Figure 5-14 Table of Serious Control Alarms

Fault Number	Fault Name	Description	Hex Code	LED Pattern MSB LSB
Serious Control Alarms (usually occur at start up or after programming)				
81	EEPROMerr	EEPROM checksum data error	51	0101 0001
82	STATUSerr	CMU status code wrong (in EEPROM)	52	0101 0010
83	PARAMerr	EEPROM parameters invalid	53	0101 0011
84	M_HELMerr	Master Helm parameters invalid	54	0101 0100
85	M_SLCerr	Master SLC parameters invalid	55	0101 0101
86	R1_HELMerr	Remote-1 Helm parameters invalid	56	0101 0110
87	R1_SLCerr	Remote-1 SLC parameters invalid	57	0101 0111
88	R2_HELMerr	Remote-2 Helm parameters invalid	58	0101 1000
89	R2_SLCerr	Remote-2 SLC parameters invalid	59	0101 1001
90	R3_HELMerr	Remote-3 Helm parameters invalid	5A	0101 1010
91	R3_SLCerr	Remote-3 SLC parameters invalid	5B	0101 1011
92	NOZZFBerr	Steering Nozzle feedback parameters invalid	5C	0101 1100
93	BUCKFBerr	Reverse Duct feedback parameters invalid	5D	0101 1101
94	SPEEDerr	Idle / Forward/Reverse Max speeds > 9	5E	0101 1110
95	STCOEFFerr	Steering Nozzle position coefficient > 15	5F	0101 1111
96	RVCOEFFerr	Reverse Bucket position coefficient > 15	60	0110 0000
97	PERRMAXerr	Maximum position error > 20	61	0110 0001
98	STEERalarmerr	Steering position alarm parameter out of range	62	0110 0010
99	BUCKETalarmerr	Reverse Duct position alarm parameter out of range	63	0110 0011
100	APILOTalarmerr	Autopilot alarm time-out out of range	64	0110 0100
101	SLCratio_err	Centre Jet SLC ratio > 9	65	0110 0101
102	ADDRinvalid	Invalid CMU address (= 0 or > 6)	66	0110 0110
103	TMSint_err	Invalid TMS370 interrupt detected	67	0110 0111
104	SRAM_fault	Static RAM is faulty	68	0110 1000

5.3.4. Correcting Faults

Once the Fault Number has been found, use the following Tables to identify and correct the Fault.

Figure 5-15 "Warning": Operational Faults Correction Process Table

WARNING: OPERATIONAL FAULTS

Fault Number	Fault Description	Correction Process
1	input switch 'stuck' detected	Not implemented in this version of software
2	both Inc. & Dec RPM switches active together	• This is detected when the idle increment and decrement switches are both closed at the same time. • If more than one control station has idle adjust switches this error can be caused by the use of the increment switch at one station coinciding and clashing with the use of the decrement switch at another station. • Otherwise the error is caused by either the increment or decrement switch contacts remaining 'stuck' closed when the opposite switch is also used, e.g. the operator attempts to increment the idle speed when the decrement switch is stuck. • The problem switch can be identified by observing which way the idle speed changes when in idle drive state. Replace any faulty switch contacts.
3	NO MSU detected at power-up	• This error is detected whenever the CMU does not receive any data message packets from the MSU within 4 seconds after power-up. • Check that the MSU is running correctly (refer to the MSU documentation). • Compare the faulty CMU with any other CMU's in the system. If the others do not indicate any missing MSU then the problem is either the network cable/connectors or the network driver device on the CMU. If all the CMU's detect this error then the problem is with the MSU. • Check that the MSU and CMU's are correctly set-up for the system configuration. • Repair any cable or connector faults. • Replace any MSU or CMU with faulty network driver devices.
4	"Hot" PCB temperature error	• This error indicates that the CMU PCB temperature is over 60° C. • Check that the control cabinets are not overheating due to external factors such as direct exposure to sunlight. • Another cause can be device failure and overheating on the PCB. Turn off the system and wait 10 minutes for any 'hot' devices to cool down. Then restart the system. If the error re-occurs then the CMU needs replacing. • **Note that the control electronics are useable only in the range 0° to 70° C.**
5	"Cold" PCB temperature error	• This error indicates that the CMU PCB temperature is less than 5° C. • Condensation will be a problem below this temperature. Allow the system to 'warm-up' before attempting to operate the controls. • **Note that the control electronics are useable only in the range 0° to 70° C.**
6	fault with unused Master Station inputs	• This error indicates that an input (SLC or helm) from the Master control station is invalid while another control station is the 'active' station. • Check the wiring and signal ranges of the Master helm and SLC inputs.
7	fault with unused Remote Station 1 inputs	• This error indicates that an input (SLC or helm) from remote control station 1 is invalid while another control station is the 'active' station. Another cause is the hand-held remote safety switch being open. • Check the wiring and signal ranges of the remote 1 helm and SLC inputs. • Check that the safety switch is inserted and operating correctly.
8	fault with unused Remote Station 2 inputs	• As above except with regard to remote control station 2
9	fault with unused Remote Station 3 inputs	• As above except with regard to remote control station 3

continued...

WARNING OPERATIONAL FAULTS ...continued

Fault Number	Fault Description	Correction Process
10	Time-Out for MSU communications	• This error indicates that communications with the system MSU has failed sometime after the power-up checks had been passed. • Check that the MSU is running correctly (refer to the MSU documentation). • Compare the faulty CMU with any other CMU's in the system. If the others do not indicate any missing MSU then the problem is either the network cable/connectors or the network driver device on the CMU. If all the CMU's detect this error then the problem is with the MSU. • Repair any cable/connector faults. • Replace any MSU or CMU with faulty network driver devices.
11	RPM feedback too slow or absent	• This error indicates that the engine RPM signal is less than 300 rpm or missing completely. Therefore, this warning will always activate at power-up. • This signal is received via the RS-485 link from the corresponding Jet Cabinet Auxiliary Interface PCB. If the engine is running correctly and the engine instrumentation shows that the speed is greater than 300 RPM then check the incoming signal on J36-1 of the CMU PCB and also the 12 V fuse F7. • If the fuse is OK then check the interface components on the Auxiliary Interface PCB. Probable reasons for failure include the loss of 12 V power to the input/detector circuit or damage to the RS-485 transmitter (U14). • Also verify that the RPM signal is being received from the engine controller.
12	RPM feedback signal too fast	• This error indicates that the engine speed is greater than 2600 rpm! • Check that the engine speed is really above this level. Then check the quality of the RPM signal coming from the engine controller. • Only spurious noise pickup at the input to the Auxiliary Interface PCB should cause this alarm.
13	Hydraulic system selection switch error	• Both the primary and secondary hydraulic selection switch inputs are closed. • Usually caused by one of the mode selector switch contacts being 'stuck' closed or a faulty switch mechanism. • Check which system is being constantly selected when in the "Auto" position.
14	Low primary hydraulic oil level	• This error indicates that the oil level in the pump tank is too low. Refill with oil. • This error can also be caused by the level switch wiring being damaged.
15	Low secondary hydraulic oil level	• This error indicates that the oil level in the pump tank is too low. Refill with oil. • This error can also be caused by the level switch wiring being damaged.
16	Low primary hydraulic oil pressure	• This error indicates that the hydraulic oil pressure is below the acceptable minimum. • Check the functioning of the hydraulic pump and valves. Also check the hoses and couplings. • Check the pump motor operation.
17	Low secondary hydraulic oil pressure	• This error indicates that the hydraulic oil pressure is below the acceptable minimum. • Check the functioning of the hydraulic pump and valves. Also check the hoses and couplings. • Check the pump motor operation.
18	Unconnected hydraulic oil pressure sensor	• This error indicates that a hydraulic oil pressure sensor signal (primary or secondary) is invalid. Usually caused by a sensor wiring fault. • Check the functioning of the hydraulic pressure sensors and their wiring loops.
19	Primary hydraulic AC motor failure	• This error indicates that the primary hydraulic pump motor has stopped. • This can be caused by an AC power failure or by the motor protection circuits. • Check the power supply and the operation of the motor protection circuits.
20	Jet bearing oil over-temperature	• This error indicates that the Jet Mainshaft Bearing oil is above the acceptable maximum. • Check the operation of the bearing and its oil cooling system.
21	PMC Actuator status error	• Indicates that the PMC Actuator is in "Faulty" Mode. (refer to PMC document).

Figure 5-16 "Serious": Operational Faults Correction Process Table

SERIOUS OPERATIONAL FAULTS

Fault Number	Fault Description	Correction Process
33	Analogue input range errors on master helm	• This error indicates that the master control station helm signal is invalid while this station is the active control station. • Check the wiring and signal ranges of the helm signal. A cable may be damaged or a connector has come out of its header. It is possible that the position sensor potentiometer is damaged or the helm has moved relative to the shaft position. • Replace or repair any damaged parts.
34	Analogue input range errors on remote 1 helm	• This error indicates that the remote control station 1 helm signal is invalid while this station is the active control station. • Check the wiring and signal ranges of the helm signal. A cable may be damaged or a connector has come out of its header. It is possible that the position sensor potentiometer is damaged or the helm has moved relative to the shaft position. • Replace or repair any damaged parts.
35	Analogue input range errors on remote 2 helm	• As above except with regard to remote control station 2 helm signal.
36	Analogue input range errors on remote 3 helm	• As above except with regard to remote control station 3 helm signal.
37	Analogue input range errors on master SLC	• This error indicates that the master control station SLC signal is invalid while this station is the active control station. • Check the wiring and signal ranges of the SLC signal. A cable may be damaged or a connector has come out of its header. It is possible that the position sensor potentiometer is damaged or the SLC has moved relative to the shaft position. • Replace or repair any damaged parts.
38	Analogue input range errors on remote 1 SLC	• This error indicates that the remote control station 1 SLC signal is invalid while this station is the active control station. • Check the wiring and signal ranges of the SLC signal. A cable may be damaged or a connector has come out of its header. It is possible that the position sensor potentiometer is damaged or the SLC has moved relative to the shaft position. • Replace or repair any damaged parts.
39	Analogue input range errors on remote 2 SLC	• As above except with regard to remote control station 2 SLC signal.
40	Analogue input range errors on remote 3 SLC	• As above except with regard to remote control station 3 SLC signal.
41	Steering hydraulic position feedback error	• This indicates that the steering nozzle position feedback signal is invalid. • Check the wiring and signal ranges of the steering feedback signal. A cable may be damaged or a connector has come out of its header. It is possible that the position sensor potentiometer is damaged or the steering nozzle has moved relative to the shaft position. • Replace or repair any damaged parts.
42	Reverse duct hydraulic position feedback error	• This indicates that the reverse bucket position feedback signal is invalid. • Check the wiring and signal ranges of the reverse bucket feedback signal. A cable may be damaged or a connector has come out of its header. It is possible that the position sensor potentiometer is damaged or the reverse bucket has moved relative to the shaft position. • Replace or repair any damaged parts.
43	Error from LTC1290 1.2 V reference	• This indicates that the LTC1290 conversion result of the external 1.2 V reference is out of the expected range. • The fault can be caused by either the LTC1290 or 1.2 V reference failing, by other inputs being >5V, or by a problem with the Analogue power supplies. • Check all inputs to the LTC1290 to ensure that they are <5V. • Replace the LTC1290 first as it is the most susceptible to damage. Then check the 1.2 V signal and the power supplies. • Replace the CMU board if necessary.

continued.....

SERIOUS OPERATIONAL FAULTS (..continued)

Fault Number	Fault Description	Correction Process
44	Analogue power failure	• This error indicates that the CMU Analogue +/- 12 volt power supply has failed. • The +12 V and -12 V Analogue power supplies are used to power the orange LED's near to the DC converter in the top-left of the PCB. Check that both LED's are illuminated. Then check the +/- 12 V levels and feedback signal to the micro-controller. • Replace the CMU board if necessary.
45	Steering servo positioning error	• This error indicates that the hydraulic servo-positioning system cannot move the steering deflector to the desired position. • The fault can be caused by any of the following; 1. hydraulic valve controller failure. 2. hydraulic valve controller power supply failure. 3. hydraulic pump failure. 4. hydraulic hose blockage or rupture. 5. hydraulic valve failure. 6. faulty Pressure Valve or its Control PCB. • Each of the above has to be checked. Use the emergency controls to attempt to move the steering deflector. This will reveal if the problem is with the electronic valve control boards or the hydraulic components. • Replace or repair any faulty components.
46	Reverse duct servo positioning error	• This error indicates that the hydraulic servo-positioning system cannot move the reverse duct to the desired position. • The fault can be caused by any of the following; 1. hydraulic valve controller failure. 2. hydraulic valve controller power supply failure. 3. hydraulic pump failure. 4. hydraulic hose blockage or rupture. 5. hydraulic valve failure. 6. faulty Pressure Valve or its Control PCB. • Each of the above has to be checked. Use the emergency controls to attempt to move the Reverse Duct. This will reveal if the problem is with the electronic valve control boards or the hydraulic components. • Replace or repair any faulty components.
47	Remote safety switch error	• This indicates that the hand-held remote control safety switch is open. • Check that the switch 'plug' is in place. • The fault can also be caused by the safety switch circuit wiring being broken or the connectors being damaged. These have to be checked also. • Replace any faulty cable or connectors.
48	New control station is invalid	• This error is caused by the CMU receiving a MSU command to change to an invalid control station, i.e. one that does not exist. • This problem should be referred to the Hamilton Jet controls group.
49	No hydraulic power available	• This error is caused when both the primary and secondary hydraulic systems have faults and are unusable. • Check the operation of the hydraulic systems and their corresponding feedback signals.
50	Thrust signal out of range	• This fault can be caused by a faulty Reverse Lever, broken wiring or faulty connectors. • Repair or replace any faulty items.
51	Throttle input signal out of range	• This fault can be caused by a faulty Reverse Lever, broken wiring or faulty connectors. • Repair or replace any faulty items.

Figure 5-17 "System" Faults, Correction Process Table

SYSTEM FAULTS

Fault Number	Fault Description	Correction Process
81	EEPROM checksum data error	• This is caused when the EEPROM data checksum verification fails. • Use the CMU Field Programmer to force a checksum recalculation. Check if the error re-occurs. • Replace the TMS370 micro-controller or the entire CMU board.
82	CMU status code wrong (in EEPROM)	• This is caused by attempting to run the control software with the incorrect status code in the EEPROM. • Use the CMU Field Programmer to 'Enter' parameter 0 again.
83	EEPROM parameters wrong	• This group of error codes indicates that their respective parameters are somehow invalid, e.g. a coefficient is greater than its allowed maximum or the helm positions are reversed. • Recheck the parameter values that have been entered and check the polarity of the input and output Analogue signals. Use parameter 60, the Analogue channel inverting byte, to reverse the polarity of any channels that are the opposite of what the software expects. Remember to reprogram any inputs that this affects.
84	master Helm positions wrong	As for error 83.
85	master SLC positions wrong	As for error 83.
86	remote-1 Helm positions wrong	As for error 83.
87	remote-1 SLC positions wrong	As for error 83.
88	remote-2 Helm positions wrong	As for error 83.
89	remote-2 SLC positions wrong	As for error 83.
90	remote-3 Helm positions wrong	As for error 83.
91	remote-3 SLC positions wrong	As for error 83.
92	steering nozzle feedback positions wrong	As for error 83.
93	reverse duct feedback positions wrong	As for error 83.
94	Idle/Forward/Reverse Max speeds > 9	As for error 83.
95	steering nozzle position coefficient > 15	As for error 83.
96	reverse duct position coefficient > 15	As for error 83.
97	maximum position error > 20	As for error 83.

Fault Number	Fault Description	Correction Process
98	steering position alarm parameter out of valid range	As for error 83.
99	reverse duct position alarm parameter out of valid range	As for error 83.
100	autopilot alarm time-out out of range (10..20)	As for error 83.
101	centre jet SLC position ratio > 9	As for error 83.
102	invalid CMU address (= 0 or > 6)	• This error code indicates that the CMU network address set by rotary switch SW2 on the CMU board is invalid. • The valid range is from 1 to 6 inclusive. Correct any invalid address. • The switch could also be damaged and giving an incorrectly decoded output. If this is the case then replace the CMU board.
103	invalid TMS370 interrupt detected	• This indicates that the micro-controller has reacted to an internal interrupt that is invalid. • This is a software Alarm and should be reported to the Hamilton Jet controls group
104	static RAM is faulty	Replace faulty static RAM.

5.4. HYDRAULIC FAULTS

Refer to the Drawings contained in the "Hydraulic Power Units" Section of the Drawings Package.

If the Hydraulics are found to be faulty, carry out the checks shown on the following table.
Ensure that the Hydraulic Pump is still being driven by the engine via the V-Belt.
Ensure that no Hydraulic Oil has been lost from the Hydraulic System.

CAUTION:

The Hydraulics System should never be operated without hydraulic fluid in the System.

Figure 5-18 Table of Hydraulic Faults

PROBLEM	CAUSE	SOLUTION
Cylinders do not move when Valves [V3] and [V37] are actuated.	Pressure Valve is not activating.	First, perform checks in **Section 3.1.4. "Commissioning the Hydraulic Systems",** to confirm that the Pressure Valve is not working. If the Pressure Valve is working then try the following solutions.
	This can be caused by air behind the Spool of Logic Valve [V8].	To solve: 1. Remove Valve [V8]. 2. Push the spool up and down several times whilst the valve is immersed in hydraulic oil. This should remove any air in the Valve. Take care not to scratch any internal surfaces of the Valve. This will also serve to check that the Spool moves freely and is not jammed with dirt. 3. Replace Valve [V8], taking care not to over tighten when refitting. 4. Commence activating Valves [V3] and [V37] which should now move.
Frothing of oil in the JHPU.		Usually caused by the JHPU running too fast. To solve, either: 1. Drain oil, and replace with non aerated oil. **Or** 2. Wait for at least 4 hours. This will allow air bubbles to dissipate out of the oil.

5.5. CONTROL STATION TRANSFER FAULTS

NOTE:

Transfer Faults will only occur on Systems with more than one Control Station.

5.5.1. Fault Indication

The **M**ulti **S**tation **U**nit (MSU) (which controls Control Station Transfers) continuously monitors the validity of it's internal operation and the validity of all input signals. If any faults are detected, they are reported by the following means:

1. Flashing lamps on the Transfer Panel(s).
2. A buzzer will sound.
3. The appearance of LED lights on a LED array Indicator on the MSU **P**rinted **C**ircuit **B**oard (PCB).

TRANSFER PANEL SYNC LAMP FLASH MEANINGS

- **Master Helm Sync Lamp flashing:**
  One of the two Master Helm Signals is out of range or they do not match one another.
- **Remote Helm Sync Lamp flashing:**
  One of the two Remote Helm Signals is out of range or they do not match one another.
- **Reverse Sync Lamp flashing:**
  The corresponding Reverse Signal is out of range.

BUZZER MEANINGS

Figure 5-19 Table of Fault Indication Buzzer Meanings

Buzzer Sound	Meaning
Regular short beeps. Can be from 1 to 4 beeps in each sequence.	Communications failure to a CMU. The CMU number is indicated by the number of beeps.
Continuous buzz.	General Fault Signal. Look at Fault Indicator LED array on MSU PCB. This is located in the CCU Cabinet.

FAULT INDICATOR LED ARRAY MEANINGS

The Fault Indicator LED array is located on the MSU printed circuit board (PCB). This is located on the door of the Central Control Unit cabinet. The following diagram explains how to locate and understand the LED's on the LED array.

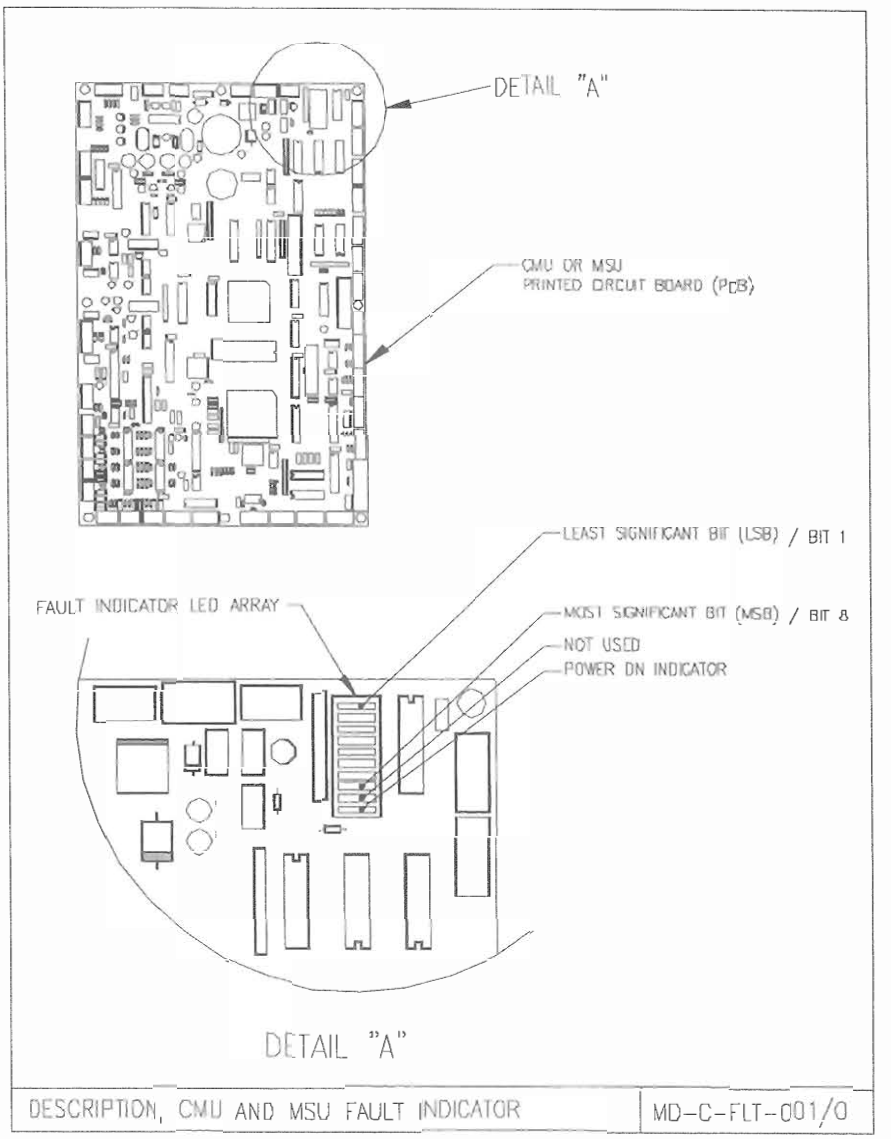


Figure 5-20 CMU / MSU Fault Indicator Detail Diagram

Figure 5-21 Table of Fault Indicator LED Meanings

LED Number	Meaning if ON
1	Communications failure with CMU1.
2	Communications failure with CMU2.
3	Communications failure with CMU3.
4	Communications failure with CMU4.
5	Non-volatile memory failure.
6	Processor fault (Unexpected Interrupt).
7	* 12V on-board supply failure.
8	Analogue converter failure.

5.5.2. Control Station Transfer Failure.

Symptom: Control Station Transfer request is denied, and the Transfer STATUS Lamp is flashing normally.

Cause: Can be either due to:
a) Incorrect control conditions prior to transfer attempt.
b) A fault condition exists in the control system.

Action: Use the steps in following Table to identify and rectify the fault.

Figure 5-22 Control Station Transfer Faultfinding Table

Test No.	Test Details	Result	Conclusion {remedial action}
1	Are all Control Sync lamps illuminated on the requesting Transfer Panel?	**No**	Transfer blocked due to Control mismatch. {Match the local Controls and try again}.
2	Is Master Locked lamp illuminated?	**Yes**	Control can not be transferred when the Master Control is locked. {Unlock the Master Control and try again}.
3	Is Take Control lamp on requesting Transfer Panel illuminated?	**Yes**	Control is already at the local station.{No action needed}.
4	Are any of the Control Sync lamps on the local Transfer Panel flashing?	**Yes**	Transfers to the local station are being blocked due to a fault on one of the Local Operator Controls (e.g. Helm or Reverse Lever). {Fault must be corrected before a transfer will be allowed.}.
5	Are any of the CMU's in Alarm ('CONTROL ALARM' lamp(s) or 'STATUS' lamp(s) on the control panels flashing rapidly)?	**Yes**	Transfers are being blocked by one of the CMU's because of a fault on one of it's Local Operator Control inputs.{Fault must be corrected before a transfer will be allowed}.
6	Is the MSU in Alarm?	**Yes**	The MSU will not transfer stations unless it has reliable communications with all of the CMU's, {Fault must be corrected before a transfer will be allowed}.
7	None of the above.		It is likely that a single failure was due to a momentary loss of control synchronisation due to vibration / control movement. {Try again and if still unsuccessful power down the system, when it is next safe to do so, then re-apply power so that the system will run a full self test}.

5.5.3. Transfer Panel STATUS Lamp Flashes Rapidly

Symptom: Transfer Panel STATUS lamp flashes rapidly.
Cause: The MSU has detected a fault either:
a) In it's internal operation.
b) In the validity of an input signal.

Action: Use the steps in the following Table to identify and rectify the fault.

Figure 5-23 Transfer Panel Status Lamp Faults Table

Test No.	Test Details	Result	Conclusion {remedial action}
1	Do all lamps illuminated when Alarm Cancel & Test is pressed?	**No**	Blown bulb or wiring fault. {Repair fault or replace blown bulb(s) and try again.}
2	Transfer Panel Status lamp slow flash?	**Yes**	Normal Operation.
3	Transfer Panel Status lamp fast flash?	**No**	Fatal MSU error or lamp test permanently on. {Check power to the MSU and all connectors in place - if all OK replace MSU and associated I/O buffer board.}
4	Transfer Panel Sync lamp(s) flashing?	**No**	No MSU Control Signal faults {Go to test 9}.
5	Master Transfer Panel Control Sync - Helm lamp flashing?	**Yes**	One of the two Master Helm signals is out of range or the two Master Helm signals do not match each other. {Wiring fault, potentiometer failure. If no CMU is in error then it is likely that the fault is local to the MSU wiring.}
6	Remote Transfer Panel Control Sync - Helm lamp flashing?	**Yes**	One of the two Remote Helm signals is out of range or the two Remote Helm signals do not match each other. {Wiring fault, potentiometer failure. If no CMU is in error then it is likely that the fault is local to the MSU wiring.}
7	Master or Remote Control Sync - Reverse lamp(s) flashing?	**Yes**	The corresponding command signal from the operator controls is out of range. {Wiring fault, potentiometer failure. If no CMU is in error then it is likely that the fault is local to the MSU wiring.}
8	MSU Fault LED 1/2/3/4 on?	**Yes**	Communications failure with CMU(s) 1/2/3/4 {MSU beeper gives audible warning(s) until Alarm Cancel is pressed}.
9	MSU Fault LED-5 on?	**Yes**	MSU memory fault. {Power down the system and try again. If the problem persists, replace the MSU.}
10	MSU Fault LED-6 on?	**Yes**	MSU processor fault. {Power down system and try again. If the problem persists, replace the MSU.}
11	MSU Fault LED-7 on?	**Yes**	MSU on-board 12V supply fault. {Power down the system and try again. If the problem persists, replace the MSU.}
12	MSU Fault LED-8 on?	**Yes**	MSU Analogue Converter fault. {Power down system and try again. If the problem persists, replace the MSU.}
13	MSU SW1-4 set to 'ON'.	**Yes**	Control Transfer Lever matching disabled - **Do not operate the vessel**. {Set SW1-4 to OFF.}

6. Maintenance General

The Control Equipment has been designed to require a minimum of maintenance. However, it is important to regularly maintain the Controls Equipment as described in this Section.

NOTE:

1. **This Maintenance Schedule has been prepared for normal operating conditions. If the Jet Unit is being used where the Controls Equipment is exposed to salt spray (e.g. An open vessel). Linkages should be greased on a weekly basis.**

2. **If the vessel is used in severe conditions where the oil is likely to become contaminated, the oil and oil filter should be replaced at more frequent intervals.**

HYDRAULIC EQUIPMENT

When servicing hydraulic equipment use the following general rules to ensure effective and trouble free servicing:

1. Minimise loss of oil to surrounding areas by liberal use of oil absorbent cloth.
2. If breaking a hydraulic connection to a part which is not going to be serviced, immediately plug the connection to prevent loss of oil and entry of foreign particles.

6.1. PRESERVATION: PRE-INSTALLATION

CAUTION

ANTI FOULING PAINTS

Do not use copper- based anti-fouling paints. Non metallic or any antifouling paint suitable for an aluminium hull may be used. Where these are not available, in extreme cases, tin base antifouling paints may be used. Leave all stainless steel parts polished and unpainted.

ANTI-SEIZE COMPOUNDS:

Do not use graphite based anti-seize compounds - these will cause corrosion.

The following storage requirements must be provided to ensure that no damage or deterioration occurs:

1. All exposed steel (except for stainless steel) parts should be protected from corrosion. To do this, coat these parts with a thin layer of rust preventative oil.
2. To protect hydraulic fittings, either:
   a) Coat with oil impregnated corrosion protection tape,
      OR
   b) Spray with a recognised corrosion protection product.

6.2. SERVICING INTERVALS

Please Note the following points:

1. **Vessel usage is assumed to be 2000 Operational Hours per year. This schedule should be adjusted to suit customer requirement.**

2. **The frequency of the following service items may be varied to suit actual operating conditions.**
   - ***Change JHPU Oil and Filter at 1000 hours* (Refer to Servicing Intervals Table below, and *Section 6.3. "REVERSE AND STEERING SYSTEM SERVICING DETAILS", Items 1 to 3).***

Figure 6-1 Table of Controls System Servicing Intervals

SERVICING INTERVAL										
ITEM	WHAT TO DO	REFER TO	FIRST 5 HOURS	1 DAY	100 HOURS	AFTER FIRST 100 HRS	1 MONTH	3 MONTHS	1000 HOURS	5000 HOURS
Hydraulic System										
JHPU OIL	CHECK VOLUME	6.3/1		●		●				
JHPU OIL FILTER	REPLACE	6.3/2	●			●			●	
JHPU OIL	CHANGE	6.3/5							●	
JHPU OIL COOLER	CHECK INTEGRITY	6.3/3	●				●			
TEMPERATURE SENSOR	CHECK OPERATION	6.3/7					●			
OIL LEVEL SENSOR	CHECK OPERATION	6.3/6					●			
JHPU V-BELTS	CHECK TENSION	6.3/8.					●			
JHPU V-BELTS	CHECK SLIPPAGE	6.3/9	●				●			
JHPU	EXAMINE / REPAIR	6.3/10								●
SYSTEM HOSES	CHECK INTEGRITY	6.3/11	●				●			
CMU Control System										
NORMAL OPERATION	CHECK OPERATION	4.2.					●			
BACKUP OPERATION	CHECK OPERATION	4.3.					●			
CABLES & CONNECTORS	CHECK INTEGRITY	3.1.7.							●	

6.3. REVERSE AND STEERING SYSTEM SERVICING DETAILS

Item No	Item	Operation
1.	JHPU Hydraulic Oil	**Check volume and condition daily.** **The oil used in the JHPU System should meet the requirements of ISO 4406 with an ISO Code of 18/14.** a) Unscrew the JHPU Remove the Dipstick and check the oil level. b) Remove the Filler / Breather Cap and top up the oil if necessary with the correct grade oil. c) Filter oil as it is added to ensure contaminants do not enter the oil. d) Check oil condition and replace if discoloured, contaminated or if the oil smells unusual. e) Use only recommended oils.
2.	JHPU Oil Filter	**Change after the initial first 5 Hours of running and then every 1000 hours.** a) Remove the Filter Cover and replace the JHPU Oil Filter with a new item. b) Replace the Filter Cover, taking care not to damage the Filter Cover Seal. c) Tighten the Filter Cover Retaining Screws.
3.	JHPU Oil Cooler	**Visually check for leaks or damage after the first 5 hours and then monthly.** Methodically check for leaks or damage at the sealing surface of the JHPU Oil Cooler and Oil Cooler Cover Plate. Replace the Cover Seal if leaking. Check the Hose connections for leaks.
4.	Bearing Housing Oil Cooler (If fitted)	**Visually check for leaks or damage after the first 5 hours and then monthly.** Methodically check for leaks or damage at the sealing surface of the JHPU Oil Cooler and Oil Cooler Cover Plate. Replace the Cover Seal if leaking. Check the Hose connections for leaks.
5.	JHPU Hydraulic Oil Replacement	**Replace every 1000 hours.** To replace JHPU oil: a) Locate a container with a capacity of at least 4 litres and position beneath the JHPU Reservoir Drain Plug. b) Remove the Drain Plug and allow the oil to flow into the container. c) Refit the Drain Plug and tighten to the recommended torque. d) Refill the JHPU with the correct grade and volume of oil as specified on **Drawing 85018**. e) Dispose of waste oil in accordance with current regulations.
6.	Oil Level Sensor	Check that the Oil Level Sensor and connections are secure and that it is functioning correctly. Replace if suspect of being faulty. **Refer to Section 8 Overhaul**.

Item No	Item	Operation
7.	**Temperature Sensor**	Check that the Temperature Sensor and connections are secure and that it is functioning correctly. Replace if suspect of being faulty. **Refer to Section 8 Overhaul.**
8.	**JHPU V-Belts**	**Check the V-Belt Tension every month.**

WARNING:

SPARE "V" BELTS WILL CAUSE A POTENTIAL HAZARD TO BOTH PERSONNEL AND MACHINERY IF NOT PROPERLY SECURED.

ENSURE THAT THE SPARE "V" BELTS ARE FASTENED SECURELY TO THE JET UNIT AND DO NOT COME LOOSE AND FOUL OTHER EQUIPMENT DURING VESSEL OPERATION.

The Coupling will have a set of spare "V" Belts attached to it. With a Note explaining what to do with the spare belts.

Ensure that the Mainshaft passes through the "V" Belts. This allows the spare "V" Belts to be used without disconnecting the Driveshaft from the Coupling.

CAUTION:

Over tensioned V-Belts will cause reduced JHPU and Jet Unit Bearing life.

1. To Check V-Belt Tension.

To check the V-Belt tension, carry out the following procedure:

a) Grip one of the JHPU Belts at mid point and attempt to twist the belt to 90º.
b) If the Belt rotates beyond the 90º, the Belt requires re-tensioning.

Should the Belt not rotate to 90º, then the Belt tension is too tight. Re-adjust the Belt tension.

2. To Adjust V-Belt Tension.

To adjust V-Belt Tension carry out the following procedure:

a) Loosen the JHPU retaining nuts at the top and bottom of the JHPU.
b) Adjust the Belt Tensioner until the correct tension is achieved as shown at Item 4/1.
c) When the correct tension is achieved, ensure that the top Stud is repositioned in the slot in the JHPU before tightening the retaining nut.
d) Tighten the JHPU Retaining Nuts and torque load to the recommended torque.

Correct Belt tension is achieved when a load of 2.8 kg applied to each Belt at mid span causes a deflection of 3 mm. Re-tensioning is required when a load of 1.9 kg or less causes the same 3 mm deflection.

3. To Check V-Belt Condition.

a) Mark or note a position on one of the Belts.
b) Work around the belts checking for cracks, frayed areas, cuts or unusual wear patterns.
c) Replace the Belts if any of the above signs are found.

Item No	Item	Operation

d) Check the belts for excessive heat generation.
e) The V-Belts do generate heat during operation, they should not be too hot to touch.
If the Belts cannot be held, this indicates that the Belt tension is incorrect, or that the Belts require replacement.

NOTE:

To replace the Belts, the top mounting screw must be slackened off completely to allow the Stud to slide into the end of the slot. Fit belts, one groove at a time.

VIEW LOOKING FORWARD
TOWARDS BOW

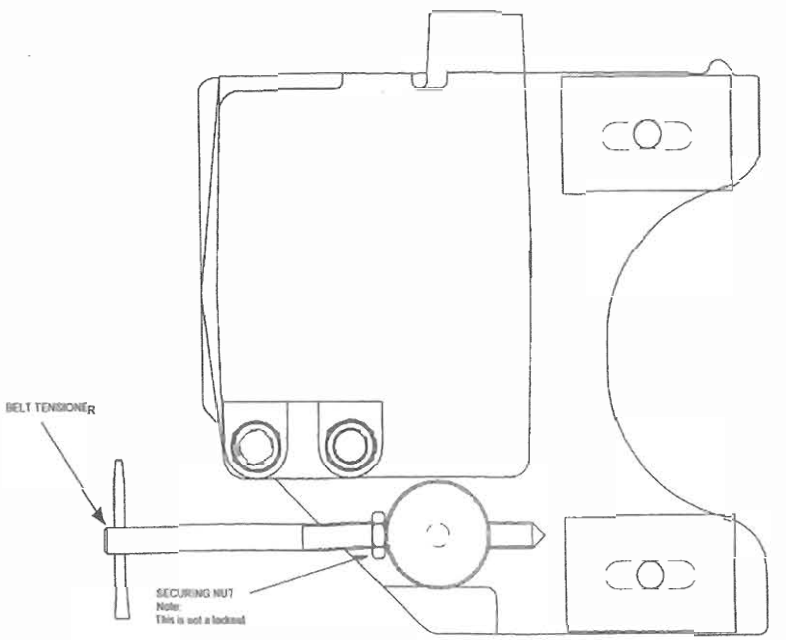


Figure 6-2 View of V Belt Tensioner Fitted to JHPU

9. **JHPU V-Belts Slippage Check**

1. **Perform a Slippage Check after the first 5 hours and then after the first month.**
This procedure serves as a check on the overall functioning of the JHPU V-Belts, and reveals problems that may not be detected by a check on belt tension and condition. This check should be carried out within the first month after installation because the V Belts will "Settle In" over an initial period.

2. **To perform a Slippage Check, carry out the following procedure:**
a) A Tachometer will be required to measure the speed of the JHPU Pulley. This can be carried out by using an optical tachometer (set up a timing mark on the Pulley), or by inserting a mechanical tachometer into the centre of the Pulley.
b) Set the Mainshaft speed to approx. 1000 RPM.
c) Measure the Pulley speed. This is RPM 1.
Load the JHPU Pump by operating a JHPU powered Reverse Cylinder with full stroke and full speed.
Record the JHPU Pulley speed. This is RPM 2.

Item No	Item	Operation

NOTE:

If the stroke of the Cylinder is too short to obtain a steady RPM 2 speed, it may be necessary to cause the Relief Valve to operate. This will load the JHPU Pump for long enough to obtain a steady RPM 2 reading.

To Operate the Relief Valve:

I. Switch Control Mode to "BACKUP".
II. Move the Backup Override Joystick so that the Reverse Cylinder moves to full stroke. **Take care to move slowly near the full stroke limit of the Reverse Cylinder to prevent damage to components.**
III. take a reading of RPM 2 as the Relief Valve operates.
IV. Switch Control Mode to "NORMAL".

e) Calculate the Belt Slip Ratio:

$$\text{Belt Slip Factor} = \frac{\text{RPM 1 - RPM 2}}{\text{RPM 1}}$$

f) The Belt Slip Ratio should be less than 0.1.

e.g. If RPM 1 = 1000 RPM and RPM 2 = 940 RPM, then :

$$\text{Belt Slip Factor} = \frac{1000 - 940}{1000} = 0.06$$

This is less than 0.1, so the belt slip is acceptable.

10.	**JHPU Examination and Repair**	**Carry out a complete Examination and Repair at 5000 hours.** **Refer to *Section 8.1.2.* "JHPU Examination and Repair".**
11.	**System Hoses.**	**Check the integrity of the system every after the initial first 5 Hours of running and then every 1000 hours.** Check for the following: a) Wear and chafing or signs of vibration of the hoses. b) Leaks in hoses or connections. c) Loose hydraulic connections. Recondition or repair as necessary. **Also refer to the Jet Unit Manual supplied with the Jet Unit for information on the overhaul of the Reverse Cylinder & Steering System.**

6.4. USING THREADED FASTENERS

TIGHTENING TORQUE'S

CAUTION:

Tightening Torque's: **Ensure all fasteners as tightened to torque's as described in Drawing 85018 or the relevant assembly drawings.**

All threaded fasteners should be tightened to the correct torque.

1. The tightening torque's for *standard fasteners* are given on the Drawing 85018 included in the Jet Unit Manual, Drawing Package.
2. Ensure that the recommended tightening torque's are always adhered to.

THREAD LOCKING AGENTS

Some fasteners require thread locking agents to prevent loosening. The relevant assembly drawings will specify on which fasteners thread locking agent is to be used.

6.5. TOOLS

6.5.1. Standard Recommended Tools & Accessories

The following tools and accessories are required to maintain the MECS Controls System:

Screwdrivers	Flat Blade & Posidrive (Range of sizes).	
Spanners	Metric A/F.	10mm, 13mm, 17mm. 19mm.
	Imperial A/F:	¾", $^{5}/_{8}$", $^{13}/_{16}$", $^{7}/_{8}$", 1", 1 $^{1}/_{16}$",1 $^{1}/_{4}$."
	Imperial A/F:	$^{13}/_{16}$", $^{7}/_{8}$".
Allen Keys:	Metric A/F:	2.5, 4, 5, 6.
	Imperial A/F:	$^{1}/_{8}$", $^{1}/_{4}$".
Torch.		
Thread Tape.		
Loctites,		262, 680.
Silica Gel.		
Electrical Contact Cleaner and Lubricant.		
Silicone Grease.		

6.6. RECOMMENDED OILS AND LUBRICANTS

6.6.1. JHPU Hydraulic Oil

The oil used in the JHPU System should meet the requirements of ISO 4406 with an ISO Code of 18/14.

The JHPU requires hydraulic oil. **Refer to Drawing 85018 for recommended hydraulic oils.**
This oil is located inside the JHPU Reservoir and is filled through the Filler Cap.
All oil added to the JHPU Reservoir should be filtered.

7. Precaution Against Corrosion

CAUTION

PREVENTION OF CORROSION

The Jet Unit has been designed to withstand the corrosive affects of operation in salt water through the use of materials that are resistant to salt water corrosion and by the placement of sacrificial zinc anodes in suitable locations. However, the Jet Unit is still vulnerable to the actions of the person who fits the waterjet system into the hull and to the actions of the electrician.

One of the major causes of corrosion of metal parts in salt water, are stray currents coming from the vessel's electrical system. These currents can be very small, often defying detection, but acting over a long period can cause significant corrosion.

Vessels using Hamilton Jet Units at sea, must be bonded and wired as described in the precautions against corrosion Section of the Jet Unit Manual.

Hamilton Jet manufactured components fitted to the CMU System are made of high quality materials selected for their good corrosion resistance properties. Some hydraulic fittings are made of plated steel. These are situated inside the vessel and should not corrode. If the Jet and JHPU are in a compartment separated from the engine room or if salt spray conditions are likely to be encountered, C.W.F. Hamilton & Co. Ltd. recommend the following precautions be taken:

1. Liberally grease Rod Ends and Linkages with a water resistant grease.
2. Wrap Anti Corrosion Tape (e.g.: Nippon Denso) around the hydraulic fittings.
3. If corrosion continues to be a problem. Hydraulic fittings manufactured from stainless steel are available at extra cost from C.W.F Hamilton & Co. Ltd.

8. Overhaul

8.1. HYDRAULIC SYSTEM

8.1.1. Spare "V" Belts

WARNING:

SPARE "V" BELTS WILL CAUSE A POTENTIAL HAZARD TO BOTH PERSONNEL AND MACHINERY IF NOT PROPERLY SECURED.

ENSURE THAT THE SPARE "V" BELTS ARE FASTENED SECURELY TO THE JET UNIT AND DO NOT COME LOOSE AND FOUL OTHER EQUIPMENT DURING VESSEL OPERATION.

The Coupling will have a set of spare "V" Belts attached to it. With a Note explaining what to do with the spare belts.

Ensure that the Mainshaft passes through the "V" Belts. This allows the spare "V" Belts to be fitted without disconnecting the Driveshaft from the Coupling.

8.1.2. JHPU Examination and Repair

The main elements that can fail or wear out in the JHPU are the pump [1], the Bearings [9] and [10] and the seal [11]. It is recommended that the bearings and seal be replaced automatically at each Examination and Repair period, and that the pump be fully tested by an authorised Casappa dealership to confirm it can continue working reliably till the next scheduled maintenance period. During the Maintenance and Repair, all other parts should be checked for damage and cleaned prior to refitting.

TOOLS

The following tools are required for various work on the JHPU:

To disassemble the JHPU:
(This does not include disassembly of the manifold block, just it's removal)

Allen Keys:	Metric A/F:	4, 5, 6.
Spanners:	Metric A/F:	10, 17, 19.
	Imperial A/F:	$^{5}/_{8}$", $^{13}/_{16}$", $^{7}/_{8}$", $^{11}/_{16}$".

To remove the JHPU Bearings [9] and [10], add the following:
"Expanding" Circlip pliers.
Light Manual Lever Press.
Oven to refit Bearings.

To Inspect and remove Manifold Orifices in manifold [V1]:

Allen Keys	Metric A/F:	2.5.
	Imperial A/F:	$^{1}/_{4}$".

To remove and Disassemble Manifold Block:

Allen Keys:	Metric A/F:	2.5, 4, 5, 6.
	Imperial A/F:	$^{1}/_{8}$", $^{1}/_{4}$".
Spanners:	Imperial A/F:	$^{13}/_{16}$", $^{7}/_{8}$", 1", $1^{1}/_{4}$".

1. **Drain oil from the Hydraulic System**
   Refer to *Section 6.3. "Reverse and Steering System Servicing Details".*

2. **Remove the JHPU from the Jet Unit**

   a) Disconnect the Plugs from the Reverse and Steering Senders.
   b) Disconnect and plug connections to oil cooler.
   c) Disconnect and plug connections to cylinders.
   d) Remove Belt Guard [4] by removing the Socket Head Cap Screws [44] and Spring Washers [62].
   e) Loosen the two Front Plate Mounting Nuts.
   f) Release the "V" Belt tension by unscrewing the Belt Tensioning Device [36] until the "V" Belts are loose and then slide the JHPU towards the Jet Unit Coupling to slacken the Belts.
   g) Remove the "V" Belts from the Driven Pulley [29].
   h) Remove the upper Mounting Nut [60] and Washer [33] from Stud [32].
   i) Remove lower Mounting Nut [60], Spring Washer [65] and Washer Rectangular [32] from the Stud [31].
   j) Take care not to loose any of the alignment Shims [35], [36], [37]' [38], and [39] located between the JHPU Unit and the Bearing Housing, whilst removing the JHPU. Record the quantity and size of the Shims for re-assembly of the JHPU to the Bearing Housing.
   k) Withdraw JHPU forward off Studs and remove from the vessel for examination and repair.

3. **Remove and Inspect the Level Sensor.**

NOTE:
Do not remove the Level Sensor unless it is suspect of being faulty.

   a) Unscrew the Nylon Conduit Connector from the Hex Adaptor [108].
   b) Unscrew the Hex Adaptor from the seat on the top of the Tank.
   c) Carefully withdraw the Bent Tube Level Sensor[109] from the Tank.
   d) Inspect the Nitrile Seal [111] on the Level Sensor for leaking or damage.
   e) Replace with a new Level Sensor [109] and Nitrile Seal [11]. Refit the to the Tank.

4. **Remove and Inspect the Temperature Sensor.**

NOTE:
Do not remove the Temperature Sensor unless it is suspect of being faulty.

   a) Unscrew the Nylon Conduit Connector from the Hex Adaptor [107].
   b) Unscrew the Hex Adaptor from the top of the Reservoir [1].
   c) Carefully withdraw the Temperature Sensor [106] from its seat on the top of the Reservoir.
   d) Inspect the O Ring [112] on the Temperature Sensor for leaking or damage.
   e) Inspect the sealing surfaces of the Temperature Sensor for leaking or damage.
   f) Replace with a new Temperature Sensor and refit the to the Reservoir

5. **Remove the Jet Unit Junction Box.**
   Drawing CT-ITF-03-007 refers.

   To remove the Jet Unit Junction Box from the JHPU Tank, carry out the following actions:-
   a) Disconnect the electrical connections to the Jet Unit Junction Box.
   b) Unscrew the 4 Capscrews (12) and Spring Washers (22) securing the Jet Unit Junction Box to the JHPU and remove the Jet Unit Junction Box.

6. Remove the Manifold Block [V1]

a) Remove Socket Head Cap Screws [19] holding the Manifold Block onto the Reservoir [5].
b) Remove Manifold Block as one unit away from the Reservoir.

7. Remove and Inspect the Pump.
To carry out this procedure the Front Plate has to be removed. Proceed as follows:

a) Remove the Pulley from the JHPU by unscrewing Cap Screws [13] and Washers [18].
b) Remove P-Port Tube [53] from the top of the Reservoir. This may have been removed when taking the Manifold Block off.
c) Unscrew the three Countersink Head Cap Screws [38] and Bolt [65], which attach the Reservoir Front Mounting Plate [6] to the Tank [5]. The Pump is mounted to this plate.
d) Separate the Tank Front Mounting Plate from the Reservoir.
e) Unscrew the four M10 hex head screws that attach the Pump [1] to the Reservoir Front Mounting Plate. These screws are part of the Pump. Note: do not remove the hex head screws at the rear of the pump.
f) The Pump may now be removed from the Reservoir Front Mounting Plate.
g) The Pump Coupling is loose and can be removed. This item is part of the Pump Assembly [1].
h) Clean and inspect all components.
i) Have the pump tested by an authorised Casappa dealership to confirm it can continue working reliably until the next scheduled overhaul.
j) Replace the Pump if its condition is suspect.

8. Dismantle and Inspect Drive Shaft & Front Plate

a) Remove Shaft Retaining Circlip [3].
b) Press out the Stub Shaft [12] with Bearing Spacer Inner [7] and Bearing (Inner Race) [9] attached.
c) Press off the Stub Shaft, Bearing (Inner Race) [9], Bearing Spacer (Inner) [7].
d) Press out the Bearing (Outer Race) [9], Spacer (Outer) [8] and Bearing [10] from the Front Plate [6].
e) Press out the oil seal [11].
f) Clean and inspect all components.
g) Reassemble in the reverse order, using a new Bearings [9] and [10] and Seal [11].

9. Reassemble Front Plate & Drive Shaft

a) Warm Front Plate up to 100° C.
b) Press in Oil Seal, ensuring that the Spring is facing towards the Bearings.
c) Press the Bearing [9] in behind the Seal [11], then fit Bearing Spacer (Outer) [8].
d) Fit the Bearing [10].
e) Oil the Stub Shaft and then press on the Inner Race of the Bearing [9] followed by Spacer [7].
f) Press the Stub Shaft through the Seal [11] then through the Bearings [9] and [10], whilst supporting the Inner Race of the Bearing [9].
g) Fit the Circlip [3].
h) Oil the Bearing and Seal.

10.Refit the JHPU Pump

a) Fit the coupling onto the Pump Shaft.
b) Insert the pump and coupling onto Stub Shaft and Reservoir Front Mounting Plate. Turn the Stub Shaft during this operation so that the Coupling engages with the Pump. The Pump and Stub Shaft Tangs fit into the Coupling at 90° intervals.
c) Attach and tighten the four hex head bolts and spring washers that attach the Pump [1] to the Reservoir Front Mounting Plate. Ensure that they are correctly tightened.
d) Unscrew and remove the four Cap Screws [52] with Washers [27] and remove the P-Port Block [2].
e) Fit new O-Ring [4] to Reservoir Front Mounting Plate.
f) Refit the Reservoir Front Mounting Plate [6] including the pump to the Reservoir [5]. Use new O-Rings [20]. Take care that the O-Ring seats correctly. Attach using the three Countersink Head Cap Screws [38] and Bolt [65]. Ensure that these are correctly tightened.
g) Oil the "P" Port Tube [53] and refit through the top of the Reservoir [5] so that it fits into the "P" Port Block [2].

11.Reassembly of Manifold Block

a) Coat a new O-Ring [17] with grease and insert in groove on underside of Manifold Block.
b) Refit new O-Ring [20] into the Manifold Block [V20].
c) Place the Manifold Block on top of the Reservoir and the protruding "P" Port Tube. Do not displace the O-Ring [17].
d) Replace and tighten Cap Screws [19] holding the Manifold Block onto the Reservoir [5]. Do not over tighten.

12.Refit the JHPU to the Jet Unit

The refitting of the JHPU to the Jet Unit should be carried out as follows:

a) Refit Shims [42-46] previously removed at ***Section 8.1.2. "JHPU Examination and Repair", Paragraph 2-j***). **Note** that the Shims should be refitted in the same quantity and position as previously removed from the JHPU.
b) Refit the JHPU onto upper mounting Stud [32] and lower Mounting Stud [67].

NOTE:

The Reservoir Front Mounting Plate [6] has two countersunk locating positions machined into the upper elongated slot to locate Washer [14] into. Due to the JHPU being fitted to different Jet Units. The Belt types and sizes vary in length. Ensure that when fitting the JHPU, that Washer [14] is located in the correct locating position to enable correct Belt tensioning of the JHPU.

c) Fit Washer [14] and Nut [48] to the upper mounting Stud and secure hand tight, ensuring that Washer [14] is located in the correct countersunk locating position.
d) Tighten Nut [48] hand tight. DO NOT TORQUE LOAD.
e) Fit Washer Rectangular [50], Spring Washer [49] and Nut [48] to Stud [67] and hand tighten. DO NOT TORQUE LOAD.
f) Ensure that the forward part of the Belt Tensioning Device [36] is correctly positioned against the side of the Bearing Housing.
g) Fit the "V" Belts onto the Jet Pulley and then onto the JHPU Pulley.
h) Adjust the Belt Tensioning Device until the correct Belt tension is achieved. **(Refer to *Section 6.3, "REVERSE AND STEERING SYSTEM SERVICING DETAILS", Item 4, for belt tensioning information*).**
i) On completion of Belt Tensioning ensure that the upper and lower JHPU securing Nuts [48] are torque loaded to the correct torque.

13. Refit the Electronics Pack to the JHPU.

To refit the Electronics Pack to the JHPU Reservoir, carry out the following actions:-

a) Secure the Jet Unit Junction Box to the JHPU with 4 Capscrews [12] and Spring Washers [22] and tighten to the recommended torque.
b) Reconnect the electrical connections to the Connectors [17] and [18] at the base of the Jet Unit Junction Box.

14. Check and Adjust V-Belt Alignment

JHPU "V" Belt alignment will have been checked at factory prior to dispatch of the Jet Units. It must always be checked whenever the JHPU has been removed, or if any pulley has been removed and refitted. The pulleys must be located so that the V-grooves are aligned to within 2 mm, but preferable to within 1mm. Use the following procedure to check alignment:

a) Place a straight edge along the front face of one pulley so that it extends across to the other pulley.
b) Measure the distance from the straight edge to the start of the V-groove of each pulley. The difference in the measurements is the value of the misalignment, which should be less than as specified above.
c) If the alignment is outside the recommended range, the JHPU Pulley [29] position can adjusted by fitting Shims [35] to [39] between the
d) JHPU Unit and the Bearing Housing. Place the Shims over the Studs [31] and secure with RTV Sealant. Ensure that the thickness of both Shims used are the same.

15. Check and Adjust "V" Belt Tension

Refer to the ***Section 6.3 "Reverse and Steering System Servicing Details"*** for directions on how to check and adjust "V" Belt tension.

16. Refill the JHPU with Oil.

Refer to Drawing 85018 for recommended oils.

The oil used in the JHPU System should meet the requirements of ISO 4406 with an ISO Code of 18/14.

8.1.3. Oil Cooler System

The Oil Cooler System should require minimum maintenance other than a visual inspection of Hydraulic Connections and the Cooler Cover Plate Gasket for leaks or visible damage. Ensure that if connectors are removed, blanking plugs are fitted to prevent the ingress of dirt, moisture and the loss of hydraulic fluid.

CONVERSION CHART

TORQUE

1 pound foot = 1.3558 newton metres

1 newton metre = 0.7375 pounds foot.

DISTANCE

1 inch = 2.54 centimetres
1 foot = 0.3048 metre
1 mile =1.609 kilometres
1 nautical mile = 1.8532 kilometre

1 millimetre = 0.03937 inches
1 metre = 3.2808 feet

1 kilometre = 0.6214 mile
1 kilometre = 0.539 nautical mile

SURFACE or AREA

1 square inch = 6.4516 square centimetres
1 square foot = 929.03 square centimetres

1 square centimetre = 0.1550 square inch
1 square metre = 10 .76 square feet

POWER

Horsepower
1 Horsepower = 0.7457 Kilowatts
1 Horsepower (Metric) = 0.7355 Kilowatts

Kilowatts
1 Kilowatt = 1.341 Horsepower
1 Kilowatt = 1.3596 Metric Horsepower

FORCE

I kilonewton = 224.86 pounds force

1 pound force = 4.448 newtons

WEIGHT

1 ounce = 28.35 grams
1 pound = 0.4536 Kilograms

1 gram = 0.0353 ounce
1 kilogram = 2.205 pounds
1 Tonne = 2205 pounds

TEMPERATURE

Farenheit	Celsius
248 °F	120 °C
212	100
176	80
140	60
104	40
95	35
86	30
77	25
68	20
59	15
50	10
41	5
32	0

LIQUID MEASURE (IMPERIAL)

1 pint = 0.5506 litre
1 gallon = 4.546 litres
1 (UK) gallon = 1.201 (US) gallon
1 litre = 0.2199 (UK) gallons

LIQUID MEASURE (U.S.)

1 pint = 0.473 litre
1 gallon = 3.785 litres

Fahrenheit to Celsius:
Subtract 32, then multiply by $^{5}/_{9}$.

Celsius to Fahrenheit:
Multiply by $^{9}/_{5}$, then add 32

SPEED

1 mile per hour = 0.8690 knots
1 kilometre per hour = 0.5396 knots
1 knot = 1.8532 kilometres per hour

1 mile per hour = 1.609 kilometres per hour
1 kilometre per hour = 0.621 miles per hour
1 knot = 1.151 miles per hour

PRESSURE

1 pound /inch ^{2} = 0.0689 bar
1 pound / foot ^{2} = 4.8824 kilogram / metre ^{2}
1 pound /inch ^{2} = 6.895 Kilopascal
1 Newton / millimetre^{2} = 145.04 pounds/square inch

1 bar = 14.5038 pound / inch ^{2}
1 kilogram / metre ^{2} = 0.2048 pound / foot^{2}
1 Kilopascal = 0.145 pound /inch ^{2}
1 bar = 100 Kilopascal

TERMS AND DEFINITIONS

AC — **A**lternating **C**urrent.
The name given to a type of electrical supply where the voltage and current alternates from positive to negative. Used in 'Mains' based systems.

ACHPU — **A**lternating **C**urrent **H**ydraulic **P**ower **U**nit.
Provides hydraulic power for the Steering and Reverse Controls Systems and is driven from an AC power source.

ADC — **A**nalog to **D**igital **C**onverter.
This is an electronic device fitted to the CMU and MSU printed circuit boards that is used to convert the various analog voltage measurements from the control and feedback devices into a digital signal that can be used by the processor.

Aux I/F — **A**uxiliary **I**nterface printed circuit board assembly.
This circuit board assembly monitors and controls power supplies for distribution. There is one in the Power Supply Unit, and one in each of the Jet Interface Units.

CCU — **C**entral **C**ontrol **U**nit.
The Electronics cabinet housing the main processor circuit boards. Usually situated near the Master Control Station.

CMU — **C**ontrol and **M**onitoring **U**nit.
The name given to the processor circuit board in the control system. Housed in the Central Control Unit. This name is also used for the whole system.

CT7 — **C**ontrol **T**ype **7.**
Hamilton Jet has a number of different Jet control types dependent on the application. CT7 is the top level of control system.

DC — **D**irect **C**urrent.
The name given to a type of electrical supply where the voltage remains constant and the current is in one direction. This is the type of supply most commonly used in battery supply systems. The Control System requires a Direct Current supply to operate.

EEPROM — **E**lectrically **E**rasable **P**rogrammable **R**ead **O**nly **M**emory.
This is an electronic device fitted to printed circuit boards that holds electronic 'memory' even when the power is turned off. It is used to 'remember' the various parameters that are configured during commissioning using the hand held programmer. It is also used for 'remembering' which Control Station is in control.

INC — **Inc**rement.

DEC — **Dec**rement.

IP66 — Ingress **P**rotection rating of **6 6.**
An IP rating of 66 means that dust cannot enter an enclosure and that the enclosure protects against a jet of water sprayed against the enclosure. It does not indicate proof of water protection.

JIU — **J**et **I**nterface **U**nit.
An Electronics Cabinet housing the components required to interface to a single Jet. Usually situated near the associated Jet.

JHPU — **J**et **H**ydraulic **P**ower **U**nit.
Provides hydraulic power for the Steering and Reverse Controls Systems and is driven from the Jet Unit.

LED — **L**ight **E**mitting **D**iode.

	A small electronic lamp usually soldered into a Printed Circuit Board.
LTC1290	This is an electronic device fitted to the CMU and MSU printed circuit boards that is used to convert the various analog voltage measurements from the control and feedback devices into a digital signal that can be used by the processor.
mm	**Mill**imetre. Unit of measurement. 1mm = 0.04inches.
MSU	**M**ulti **S**tation **U**nit. The name given to the circuit board that controls the transfer of control from one Control Station to another (in multi station systems). Housed in the Central Control Unit.
PCB	**P**rinted **C**ircuit **B**oard. The name used for both the assembly of electronic components soldered into a fibreglass and copper laminate (sometimes called a 'PCB Assembly'), as well as for just the fibreglass and copper laminate (sometimes called a 'Bare PCB').
PMC	**P**rime **M**over **C**ompany. A manufacturer of marine and industrial control components and systems.
PSU	**P**ower **S**upply **U**nit. The Electronics cabinet housing the Power Supply Monitoring, regulating and distributing components of the system. Usually situated near the Master Station Controls.
PWM	**P**ulse **W**idth **M**odulation. Signal interface format.
RAM	**R**andom **A**ccess **M**emory. This is an electronic device fitted to printed circuit boards that holds electronic 'memory'. It is used by the processor.
RCU	**R**emote **C**ontrol **U**nit (Hand Held). Hand held device allowing mobile control of both Steering and Reverse, intended to be used during manoeuvering and docking.
RPM	**R**evolutions **P**er **M**inute. A unit of measurement for engine speed.
RS-485	This is a communications protocol to facilitate communications between the CMU printed circuit boards and the MSU Circuit boards
SLC	**S**ingle **L**ever **C**ontroller. The operation of both the Reverse Duct and Throttle are controlled by a single lever of this controller. There is one lever for Port engine(s) and Jet Unit(s) and one lever for Starboard engine(s) and Jet Unit(s).
TMS370	This is the main processor component fitted to the CMU and MSU printed circuit boards. It is the 'brains' behind the system.
V	**V**oltage. A unit of measurement of electrical strength.