SOIL MACHINE DYNAMICS LIMITED

MONTEREY BAY AQUARIUM RESEARCH INSTITUTE

TIBURON II, QUANTUM ROV SYSTEM DOCUMENTATION

ROV OPERATIONAL MANUAL

VOL.1 PART 2

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CONFIDENTIALITY

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1 INTRODUCTION

This Chapter outlines suggested procedures for operation of the ROV and its' attachments. The procedures described are intended only to provide guidelines, rather than rigorous instructions that must be adhered to, and are not comprehensive. Improved procedures will be developed through continued use of the system by the customer. The procedures are based around the ROV and do not include procedures for the deck equipment.

2 PRE / POST OPERATIONAL CHECKS

2.1 General

Pre-Launch Checks (Table 1) should be carried out prior to any launch of the vehicle to ensure that the system is fully functioning.

It is assumed that before operational checks commence that the operating team is generally satisfied that the system is in good working order.

Before commencing the preliminary checks described above, ensure that the following steps have been taken:

- Control system software running correctly.
- Sub-sea Pod is switched on and telemetry is running.

The following list is intended to serve as a general reminder rather than an exhaustive checklist.

2.2 Nominate a Deck Officer

A deck officer should be appointed to take overall control of pre-launch checks and launch and recovery operations to ensure that they run safely and efficiently he is responsible for the safety of personnel. The nominated person should be visible to all personnel and have a clear view of the whole deck area.

The deck officer will need to ensure that he is able to communicate with relevant personnel in the following stations: -

- Bridge – who ensure the ship is clear to launch the ROV
- Deck Control Console – for operation of the Launch and recovery System (LARS)
- ROV Pilot and Co-pilot – for ROV control and limited deck control if required.

2.3 Pre-Launch Checks

2.3.1 General

Pre-Launch Checks should be carried out prior to any launch of the ROV to ensure that the system is fully functioning. These checks should be carried out in conjunction with the checklists shown in (Table 1).

The checks fall into three main categories:

1. **Preliminary Checks**: These checks can be done with the system powered but without the main motor running.

2. **Hydraulic Checks**: These checks require the deck hydraulic unit to be connected or the main motor to be running. If these checks are carried out from the main motor then these checks should be limited, as the system is not ideally suited to running in air.

3. **Submerged**: These checks require that the ROV be submerged. The ROV can easily be recovered if necessary.

Before commencing the checks described below, ensure that the following steps have been taken:

1. Ensure that the deck earth lead is attached between ROV and deck.

2. Ensure control system software is operational.

3. Power the sub-sea pod and establish telemetry to the ROV. If the pod fails to start, please refer to Volume 2 Part 2 for instructions.

4. A careful visual inspection of the ROV should be made to ensure that all tools and loose equipment have been removed from the ROV. This is particularly important after maintenance work.

5. **Fasteners Secure**: Check that all components are securely fastened in position. Check that all fasteners are fitted and are adequately tightened. Ensure all pins and pivot points have been adequately lubricated.

6. **Connectors**: Check that all other connectors are properly mated and secure. Refer to harness drawing AB5060 for connector types and locations.

7. **Harnesses**: Check that all harnesses are securely fastened using the appropriate clamps or cable ties. This is important as an insecure harness could be drawn into a thruster resulting in damage to harness and possibly the thruster.

CAUTION

Lubricate electrical connectors with Silicone Spray Only. Use of grease based lubricant will cause premature failure of connectors.

(Use PE6812 - Silicone Spray Aerosol RS691-892 or equivalent)

8. **Hoses**: Check that all hose fittings are secure and that there is no evidence of leaks. Ensure that all hoses are securely fastened using the appropriate clamps or ties. This is important as an insecure hose could be drawn into a thruster resulting in damage to the hose and possibly the thruster. Ensure that none of the hoses are under tension or are kinked.

2.3.2 Preliminary Checks

1. **Motor Compensation**: When the motor is initially oil filled a small quantity of air will be trapped which will progressively migrate to the highest point within the motor as it is run. Remove this excess air by loosening both plugs on the motor top. With the motor cold the compensator should be between 60-70%, this will increase slightly as the motor temperature rises. If the motor oil requires replenishing, use a compensator-filling bottle filled with new clean hydraulic oil and fill through the compensator fill point.

2. **Motor LIM**: Check that the LIM reading in the Control Cabin is showing close to infinity. The LIM unit should also be tested and then reset using the front panel control.

3. **Motor Temperature Alarms**: Check that 'motor temperature high' alarms are set (Windings: 130°C).

4. **Compensation**: Check that all valve packs and junction boxes are full of oil, all isolator valves are open, and that the relevant compensators are full of oil. Bleed any trapped air from the compensators and valve packs by lifting the cap on the pop-off valve or unscrewing the sealing plugs. Re-check the level and fill if necessary

5. **Umbilical Termination Box Compensation**: Check that this is full of oil and that the compensator has sufficient oil. Bleed any trapped air from the system by lifting the cap on the pop-off valve. Re-check the level and fill if necessary.

CAUTION

Do not operate any of the lamps for more than 5-10 seconds in air as they become hot and may be damaged. Allow the lamp to cool before re-testing or launching the ROV. HMI ballast should not be ignited in air for more then 15 mins and there must be at least 15 seconds between strikes.

6. **Lamp Tests**: Turn each HMI lamp on momentarily and confirm that the relevant status indication is displayed at the console. Turn each of the incandescent lamps on in turn, working through full dimming range of 0-100%

CAUTION

Avoid leaving the camera covers off for prolonged periods and pointing the cameras to bright lights or the sun as the life of the camera is reduced.
This is particularly important for SIT cameras.

7. **Camera Operation**: Switch the cameras on, remove camera covers and select viewing screens as appropriate. Clean camera lenses if necessary. Verify that the appropriate status indicator is displayed on the pilot graphics screen for each camera. Verify operation of the focus facility and the zoom facility on those cameras that are provided with this function.

8. **Sonar and Profilers**: Ensure the sonar PC is on and the software is running. Switch on the sonar heads' sub-sea power from the keypad. Ensure that communication is established with the sonars and that they are scanning correctly.

   Refer to proprietary information for the operation of the sonar equipment.

   When the tests are complete, switch off the power to the sonar heads until the ROV is in the water.

9. **Echosounder**: Switch on the echo sounder from the keypad and ensure that the status indicator is displayed correctly on the graphics display. In air, the altitude should be at its maximum value i.e. 50m, corresponding to an analogue input to the control system from the Echosounder of 10V. It should also be possible to hear a slight ticking noise from the Echosounder itself if it is functioning correctly. Switch off the echo sounder and ensure that the displayed reading is approximately zero. Leave the echo sounder switched off until the ROV is in the water.

10. **Responder**: Switch on the power to the sub-sea unit from the keypad and ensure that the status is correctly displayed at the console. The topside HPR processor usually located on the bridge should be set to interrogate the responder approximately once every second. A 1Hz ticking should be heard at the responder head. If this can be heard, then the responder trigger system is functioning correctly.

    The responder enable should be switched on at all times whenever possible, allowing the internal battery to be kept fully charged.

    It is important that the unit is set to the correct channel prior to launch. Refer to the manual provided with the HPR equipment for details.

11. **Gyro**: The gyro must be switched on from the survey page. After initial power-up, the displayed heading may be slightly erratic. This should settle after several minutes. When the heading becomes steady, the displayed reading should be compared with a known heading such as the ship's gyro.

    Whilst on the deck of the ship, it is possible that external magnetic disturbances could influence the gyro flux detector and affect the accuracy of the gyro so that an erroneous heading may be displayed.

    The gyro heading is used for auto-steer control and umbilical turns count (i.e. twist) calculations.

    The gyro also provides pitch and roll information. When the gyro reading has settled, observe the pitch and roll indications and confirm that they change in sympathy with the motion of the ship and that the zero indications are correct.

2.3.3 Hydraulic checks

1. **Hydraulic Pressure**: Verify that the transducers are operating by checking that the raw data value displayed on the database screen is approximately 2000 when no pressure is applied. The value displayed on the graphics screen should be zero and adjusted if necessary via the scaling routines.

CAUTION

In order to protect the hydraulic system from serious damage in case of oil loss, the motor is automatically shutdown when the low-level alarm is reached. It is vital that this alarm is operational before starting the ROV motor.

2. **Oil Reservoir**: The oil reservoirs should be approximately 80% full. Add more oil to the reservoir if required, through the appropriate auxiliary pressure connection mounted at the side of the ROV.

   Allow oil to settle and bleed any air off from the valve on top of the reservoir.

   Check that the oil volume low and high alarms (via the analysis screen) are set to 30% and 90% respectively and are enabled.

3. **Manipulator (if fitted)**: Switch on the manipulator power via the keypad. Activate the manipulator surface control system and confirm telemetry is established (refer to proprietary information for full details).

CAUTION

It is best to limit the duration of the hydraulic checks on the main motor, as the system is not intended for prolonged operation in air. Operation from the deck cart can be done as follows.

4. **Hydraulic Circuit**: Connect the deck hydraulic power unit to the appropriate connection points on the ROV. See Figure 1 over leaf.
   Check the oil pressure readings: TCU Pressure should be equivalent to deck cart pressure. When the HPU is switched off, the reading should fall to zero.

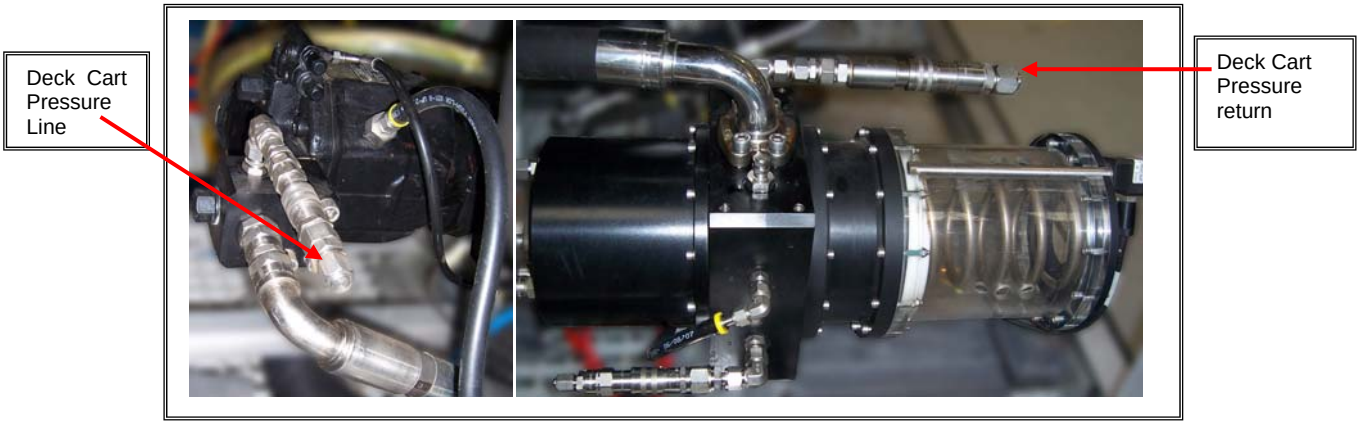

Figure 1 - Deck Hydraulic Unit, ROV connection points

CAUTIONS

(1) Ensure the deck cart relief is set to approximately 150-230 bar. Ensure correct line is pressurised, as incorrect connection may result in damage to the reservoir.

(2) Monitor the reservoir level when using the deck cart to ensure the system is not overfilled.

WARNING

BEFORE ENERGISING OR OPERATING THE THRUSTERS, ENSURE THAT THRUSTERS ARE CLEAR TO ROTATE AND THAT ALL PERSONNEL ARE CLEAR OF THE ROV.

5. **Thruster checks**: Set the thrusters to operate at reduced power via the control screen. (The actual amount of reduction can be changed on the database screen.) Operate the horizontal and vertical thrusters SLOWLY and verify correct response to the joystick movements. Do not take the thrusters above 30% demand. Verify that the thruster operation is correctly displayed on the graphics screen and that the thrusters turn in the correct direction on the ROV. With the controls set to zero, ensure that all the thrusters are stationary.

6. **12F HCU checks**: Test the function of the Launch Release and any other hydraulic components connected to the 12F pack.

7. Operate all **pan and tilt units** through their full range and ensure that the viewing envelope is adequate. Check for clashes with surrounding equipment or structure and that the harnesses are not subjected to any undue strain and are adequately secured. If necessary, rearrange the placement of the harnesses.

8. **Variable Buoyancy System**: check the function of the Variable Buoyancy pump.

2.3.4 Submerged Checks

1. Deploy the ROV and submerge. In this scenario the ROV will have to be released from the docking head and lowered into the splash zone to complete the tests.

2. Reset the umbilical turns counter.

3. Zero the depth sensor.

4. Check that thruster controls are in their null position (on controls and graphics display) and then enable the thrusters. Verify that thrusters do not rotate.

5. Operate the thruster controls gently to about 5% demand and quickly confirm all thrusters are working correctly.

The table on the following pages shows the items to be checked before the ROV is launched. The table should be copied and used to provide a permanent record of the items checked prior to each dive. This record should be retained and filed as part of the dive log.

2.4 Post-Dive Checks

After each dive a full set of post dive checks should be performed using Table 1 with the exception of the submerged checks as a guide,

2.5 Pre-Launch Check List

Table 1 below, gives the Pre-Launch Check List for the ROV.

ROV PRE-LAUNCH CHECK LIST				
Project:	Dive No:	Date:	Time:	Operator:
TYPE OF CHECK		Acpt	Comments	
PREPARATION				
Pod ON?				
Telemetry / Data links OK?				
General	Personnel Clear			
PRELIMINARY				
General Visual Check				
Mechanical Check				
Connectors				
Fittings & Hoses				
Sub-sea Electric Motor	Motor Comp			
	Motor LIM			
	Motor Alarms			
Lamps				
Camera Function/Display				
OA Sonar	Operational			
Echo Sounder	Operation			
	Status Display			
Responder 1	Trigger			
	Channel			
Gyro	Heading Pitch Roll			
Depth Sensor	Alarms			
Oil Volume %	Configuration			
Manipulator Telemetry	Operational			
Pressure Transducers	TCU			

ROV PRE-LAUNCH CHECK LIST				
Project:	Dive No:	Date:	Time:	Operator:
TYPE OF CHECK		Acpt	Comments	
	12F HCU			
Thrusters	Port Forward Lateral			
	Starboard Fwd Lateral			
	Port Rear Lateral			
	Starboard Rear Lateral			
	Port Vertical			
	Stbd Vertical			
	Rear Vertical			
	Cabin Joysticks			
	Cabin Trim Sliders			
	Graphics Display			
	Operation			
Manipulator				
Manipulator				
Variable Buoyancy Pump	Operation			
Launch Release Key	Operation			
Xenon Beacon	Switch on			
SUBMERGED CHECKS				
Motor	Running, Pump Loaded			
Motor Start	Motor Amps Unloaded			
	Motor Amps Loaded			
Thrusters	Graphics Display			
	Stationary at Null			
	Operation			
Turns Counter	Reset			
Depth Sensor	Zero Pressure Reading			

Table 1 - Pre-Launch Check List

2.6 Umbilical Management

2.6.1 Establishing the Catenary

The operators should aim to maintain the umbilical in the shape of a lazy 'S' which extends from the vehicle upstream to the vessel. This configuration will safely absorb variations in the current and ship's position without the umbilical either going slack or becoming too tight.

It is vitally important that the umbilical is managed correctly as incorrect management can result in two undesirable consequences:

1. Slack Umbilical: If the umbilical is allowed to go too slack it may form a bight or 'throw a loop'. This occurs when the negatively buoyant part of the umbilical dips below the buoyant section close to the vehicle. As tension increases on the umbilical the bight will tighten and damage the umbilical.

2. Excessive Umbilical Tension: If the tension in the umbilical becomes too great it may pull the ROV.

2.6.2 Umbilical Deployment

Once the ROV reaches the seabed the winch should continue to payout 5-10m more umbilical to allow the ROV some freedom on the seabed.

Figure 2 shows the maximum allowed umbilical for a given offset and water depth, when operating in shallow waters. Some offsets will only be achievable when operating in a current. Exceeding the maximum calculated length of umbilical will allow the umbilical to become slack, which may induce loops.

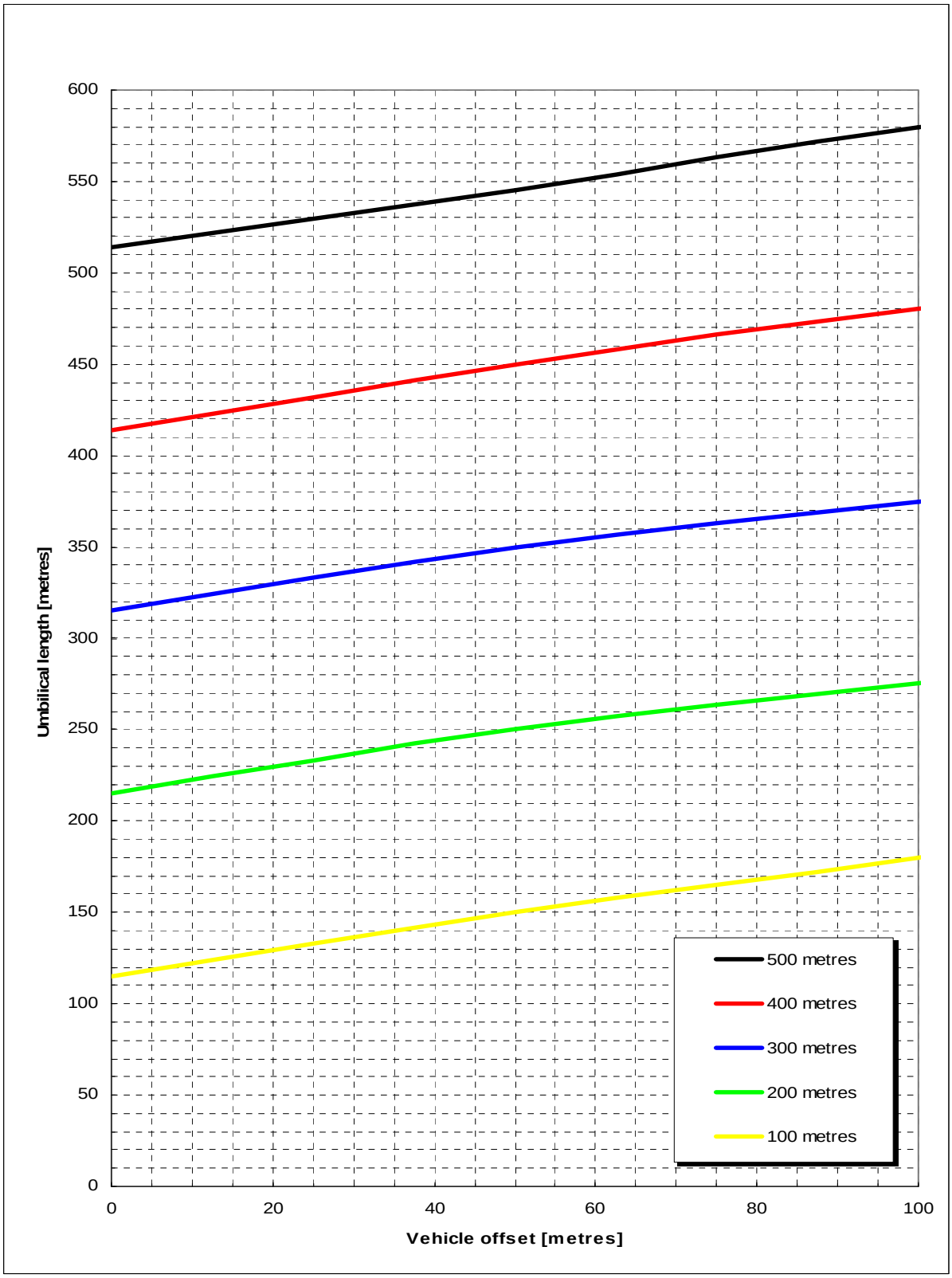

Figure 2 - Umbilical Offsets

3 OPERATING THE ROV

3.1 Starting the Electronics

Refer to Volume 2, Part 2 (Surface Control).

3.2 Starting the motor

Refer to Volume 2, Part 2 (Surface Control).

Once the motor is operating, none of the hydraulic functions can be operated on either circuit until the “Vehicle Pump Load” key has been pressed. This function is located on the “Home” screen on the touch screen.

3.2.1 Power Limiting

Due to the hydraulics configuration of this vehicle and the size of the electric motor, it is possible to demand more power than the motor is capable of delivering. The motor is therefore protected by power monitoring via the software. If the power monitoring detects an overload, it reduces the demand to the horizontal thrusters.

3.3 Flying

3.3.1 General

It is assumed that the electric motor is running and that the hydraulics for the thruster circuits has been activated.

CAUTION

If the thrusters are to be operated on deck ensure that all personnel are clear of the vehicle.

The thrusters are controlled from the joystick on the pilot’s active chair. Before the thruster controls become active the “thrust enabled” button must be depressed.

CAUTION

Ensure thruster demands are zero before activating.

Once the thrusters are activated, the joysticks will have an effect on the thrusters.

3.3.2 Launch and Recovery

Outside the scope of supply.

A “Belly Pack” is provided to aid with Launch and Recovery, see section 3.4.9, for more information.

3.3.3 Auto-Heading

The vehicle control system contains an auto-heading function. This allows the operator to hand the control of the ROV heading over to the control system. The control system then maintains a fixed heading with reference to the vehicle gyrocompass.

Auto heading is selected / deselected by pressing the trigger button on the joystick through to the second detent. When auto head is selected the set point can be adjusted by rotating the control joystick (clockwise to increase heading set point). The head will then control around this adjustable set point. It is recommended that auto head should be used instead of free flying.

3.3.4 Auto-Altitude / Depth

Auto-altitude and auto-depth are mutually exclusive. Both controls are selected / deselected by their respective buttons shown in Figure 3 below. Selecting the opposite function when the other is engaged will automatically deselect the set function and engage the selected function. The button will have an illuminated blue ring when activated.

The set point is taken as the current reading and can be adjusted by pushing / pulling on the vertical thruster joystick.

3.3.5 Vertical Lock

When activated the vertical lock holds the vehicle at its current depth. The set point can come from either the altitude or depth.

3.3.6 ADV NAV

The Adv Nav button puts the ROV under the control of the Advanced Navigation system which is discussed in more detail in Volume 4 Part 2 Engaging ADV NAV will automatically enable Auto Altitude/Depth and Auto Heading.

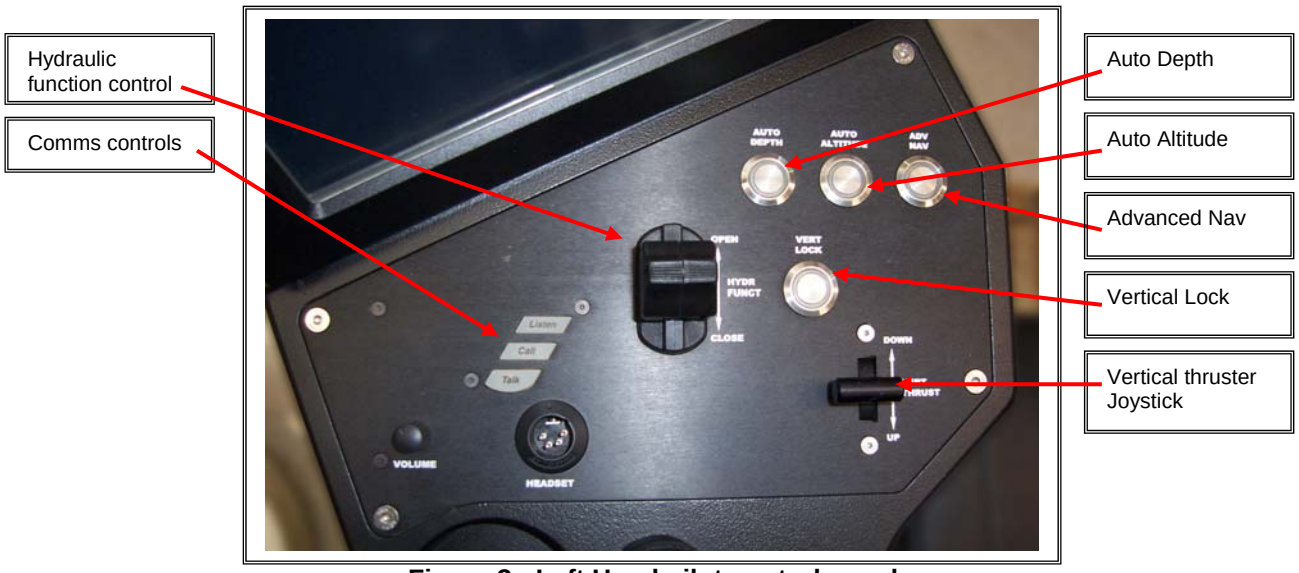

Figure 3 - Left Hand pilot control panel

3.3.7 Spare Hydraulic Functions

There are a total of seven spare proportional valves with load holding capability. They are operated via the controls found on the touch screen view, HCU B, for a more in depth description on adjusting these functions see Volume 2, Part 2

3.4 Surveillance Operation

3.4.1 General

Please refer to the control system manual (Volume 2) and the Proprietary information for the relevant piece of equipment.

3.4.2 Surveillance

Surveillance equipment including OA sonar are fed into a dedicated surface PC for operation and control. Some data may be passed between the surveillance equipment and the ROV control system for logging or control purposes.

3.4.3 Surveillance isolation

The Signals Isolation Board is located in the subsea pod and consists of 5 relay boards, connected via IDC connectors to a motherboard. Each of the communication signals passes through its own dedicated relay on one of the relay boards and out to it's relevant piece of surveillance equipment. This is primarily for use when tracking down Ground Faults and not designed to be used during normal operations therefore, it is currently only controllable through the analysis screen, shown in Figure 4 below. Each of the relays is a normally open relay and is closed automatically when the control system is running; each piece of equipment is listed on the analysis screen under data type "RL" for relay. To isolate a given piece of equipment uncheck the red box next to the channel number for that item.

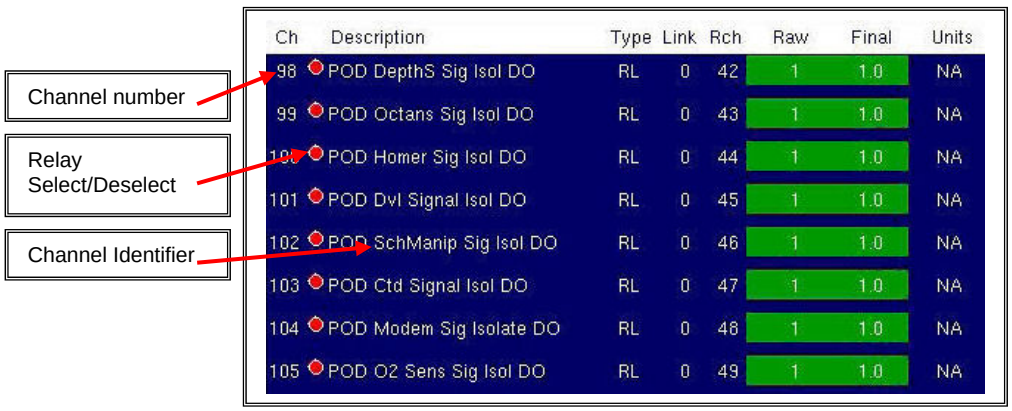

Figure 4 – Analysis screen for control of signals isolation relays

If necessary a dedicated screen can be created for this function, for details on modifying the control system or further information on navigating the analysis screens, please refer to volume 2, part 2.

As the channels are polled in software, LED's as shown in Figure 5, give a visual indication of the channels status. When the LED is lit, the relay is closed, when the LED if off, that channel is isolated.

Figure 5 – Signals Isolation Board LED display

3.4.4 Ground Fault Monitoring

Free Issue Item.

3.4.5 Cameras

All cameras are free issue items, for a more detailed description of any camera, see relevant datasheet.

For more information on control of any camera, see volume 2, part 2.

3.4.6 Pan & Tilts

Pan and tilts are selected via the left hand button on the pilot's joystick and controlled via the middle button, they will only respond to control once the relevant power button has been depressed.

P&T supply "1 and 2" powers PT-25(1) and PT-10(1)
P&T supply "3 and 4" powers PT-25(2) and PT-10(2)

3.4.7 Lamps

3.4.7.1 Incandescent Lamps

Control of all lamps is from the relevant touch screen page. The lamps are turned on in pairs and dimmed individually from 0% (effectively turned off) to 100% (fully on). There are four lamps fitted to the vehicle and the Lamp Dimming PCB has the capability to control a further two.

For further information on the lamps, please see proprietary information for the relevant piece of equipment.

3.4.7.2 HMI Lamps

Control of the lamps is from the relevant touch screen page. The lamps are turned on individually and powered through the ballast.

For further information on the lamps, please see proprietary information for the relevant piece of equipment.

3.4.8 Spare channels

There are four spare RS232 channels available on the system and one spare RS485 channel. All but one the RS232 channels are wired through to dedicated connectors on the subsea junction boxes and have the capability of providing 24volts at 2amps to which ever piece of equipment is wired to it. The wiring and power allocations are listed below in Table 2. Power to the spare channels is controlled via the touch screen, under "Serial Comms" on the right hand side of the "Surveillance" page.

	Termination Point	**Allocated Voltage**	**Max Current requirement**
Spare RS232 (1)	Junction Box 1 Connector 13	24v	2A
Spare RS232 (2)	Junction Box 1 Connector 14	24v	2A
Spare RS232 (3)	Junction Box 1 Signals harness terminals 34 – 36	-	-
Spare RS232 (4)	Junction Box 2 Connector 15	24v	2A
Spare RS485 (1)	Junction Box 2 Connector 16	24v	2A

Table 2 – Spare serial comms and power allocations

3.4.9 Remote Belly Pack

CAUTION

The belly pack will not be active until initiated in the control software.

The joysticks and buttons on the belly pack remain ineffective until such times as control is handed over by the pilot. To enable the belly pack, first press the "guard" button and then the "Belly pack control" both found on the home screen of the touch screen.

Note: - The user of the belly pack can only be given control of the vehicle, they cannot take it from the pilot.

The remote belly box has two joysticks for control of the thrusters during launch and recovery of the vehicle. The vertical thruster is aligned the same as the vertical joystick on the pilots chair, push forward to make the vehicle descend and pull back to ascend. The horizontal thruster similarly, moving it forward, back, left and right will move the vehicle, forward, aft, port and starboard, respectively. Twisting the horizontal joystick will allow the vehicle to rotate. Figure 6, below shows the user interface and internal wiring of the remote belly pack.

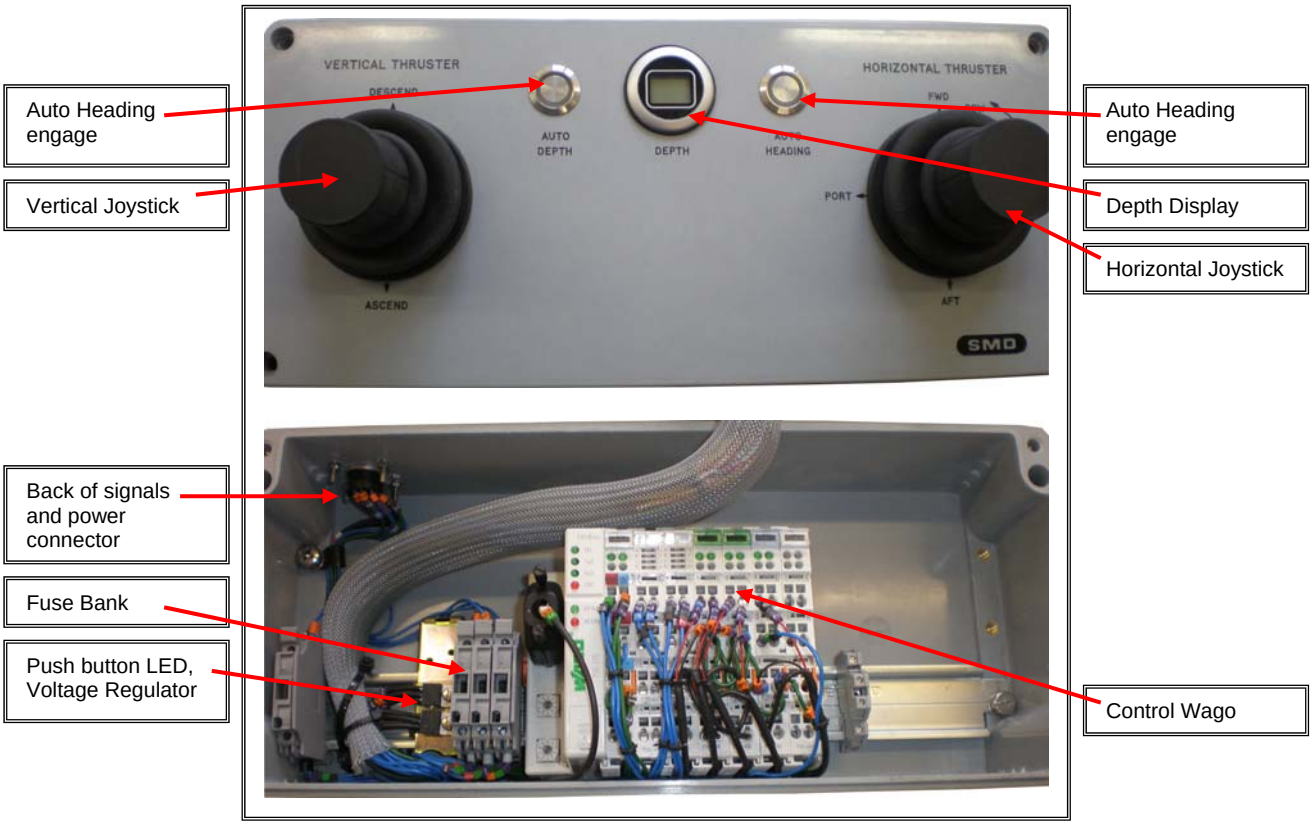

Figure 6 – Remote Belly Pack

Signals to and from the belly box and the control system is via the internal wago stack through the 12pin connector. The current depth of the vehicle is taken from the control system and displayed on the depth display on the front of the box.