SOIL MACHINE DYNAMICS LIMITED

MONTEREY BAY AQUARIUM RESEARCH INSTITUTE

TIBURON II, QUANTUM ROV SYSTEM DOCUMENTATION

ROV DESCRIPTION & SPECIFICATION MANUAL

VOL.1 PART 1

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CONFIDENTIALITY

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1 SAFETY

1.1 SMD Statement on Product Safety

SMD view system safety as a critical property of all equipment that they manufacture.

SMD strive to:

- Remove or minimise hazards inherent in a system to the greatest practical extent.
- Provide control measures for residual hazards.
- Provide the users with the required information and warnings to avoid, or take precautions against, residual hazards.

Client Responsibilities: -

- Equipment supplied by SMD is as safe as practicality permits regarding standard operation, maintenance and direct access to equipment, however due to the variations in installation SMD cannot foresee all hazards once installed on the clients vessel, therefore SMD shall not be liable for safety in the area where the equipment is installed, or for any deviations from standard operations or installation.
- During standard operations, it is unnecessary for personnel to be in close proximity to the machinery apart from when routine operational maintenance is carried out.
- It is the client's responsibility to provide adequate safety measures and procedures for the protection of personnel, including guards or other means to prevent unauthorised access to equipment.
- As the equipment is normally operated in a marine environment, safety measures pertaining to this must be taken into account and incorporated in the client's safety procedures.
- Training on the equipment and compliance with safety procedures are the responsibility of the client.
- All personnel must observe established safety procedures

1.2 Recommended Safety Precautions

Safety guidelines for handling, installing, operating and maintaining SMD equipment are given below. Specific precautions for protection of personnel and equipment are also provided.

The client is urged to incorporate these safety guidelines into their own safety procedures and make sure that all personnel are fully aware of these.

1.3 General Precautions

Safety devices provided by SMD are primarily intended for the protection of personnel and secondarily for the protection of the equipment.

Only suitably qualified and competent personnel should install, operate or maintain this equipment.

Personnel must fully understand and follow safe operating procedures at all times during the operation and maintenance of the equipment covered by these manuals.

The person in charge of operations must always have a clear view of the deck equipment.

When operations are conducted at night or in poor visibility, ensure that the equipment and immediate area around it are adequately illuminated.

Ensure that the work area is easily accessible without obstruction.

Route cables and hoses through separate protection channels or conduits wherever possible.

Ensure that all guards, guardrails and other protective devices are in position before commencing any operation.

Never wear loose clothing when working with moving machinery.

When there is uncertainty that a circuit is de-energised, it must be considered “live” at all times. This may be taken to mean electric or hydraulic circuits.

Isolate, lock-off and tag all electrical power sources before making any connections or disconnections or working on circuits.

Many critical components of the equipment may be subject to wear or damage and other deterioration, which reduces their normal useful life.

The equipment design provides safety margins taking into account normal wear and tear, however, in the case of extreme wear duty or known overload; the appropriate steps should be taken to rectify any problem and return the system to within its original specification.

If replacement is neglected, components can reach a point where they constitute a safety hazard; similarly, failure to maintain mechanisms necessary to assure correct and proper operation may also constitute a safety hazard.

Safety guidance may also be found in the relevant Maintenance and Operation Manuals, including proprietary information manuals.

1.4 Specific Precautions

The equipment is manufactured from various types and grades of steel and aluminium.

On no account should welding be undertaken on any of the equipment without implementing approved weld procedures appropriate to the materials involved; failure to do this could endanger life and invalidate the certification of manufacture.

Hydraulic relief valves are one of the most important safety features and must never exceed manufacturer's recommended settings.

Only suitably qualified and competent personnel may perform any testing and re-adjustment of pressure relief devices.

Written records of inspection and maintenance activities should be maintained and regularly updated.

1.5 Warnings and Cautions

WARNING statements outline minimum safety requirements to be observed when operating the equipment and during maintenance procedures.

Ignoring these warnings could result in serious injury or death of personnel.

CAUTION statements call particular attention to a step in a procedure that, if not followed, could result in damage to, or destruction of, equipment.

1.5.1 Hydraulic System

WARNING

There is a risk of injury to personnel's skin and eyes from hydraulic fluid.

Even when the Hydraulic Power Unit (HPU) is isolated residual pressure may be present unless the system is de-pressurised.

Never attempt to remove any hydraulic hose or component while the HPU is in operation or when the system is known to be under pressure.

Never disconnect hydraulic hoses unless it is KNOWN that the system is de-pressurised.

Hydraulic fluid under pressure may have sufficient force to penetrate the skin causing serious injury.

Serious tissue damage can develop if proper medical treatment is not administered immediately. The fluid may also be hot enough to cause burns.

The release of hydraulic fluid under pressure presents a risk of eye injury to personnel. Always wear adequate eye protection; goggles are the best protective equipment for this.

A competent first aider must treat any eye injury immediately as particles of debris may be contained in oil and some oil additives are irritants to the eye. The eye must be flushed with copious amounts of clean, fresh water or sterile saline; this must be immediately available.

CAUTION

Equipment damage may occur if the following precautions are not taken.

Prior to all maintenance activities ensure that the system is de-pressurised.

Maintenance activities involving breaking into the hydraulic system must be planned in such a manner that they are conducted in a clean environment to prevent ingress of dirt, rust or other extraneous particles.

The system proportional hydraulic directional control valves require hydraulic oil of cleanliness superior to NAS1638 class 6. Only use oil of this quality or superior.
The system has been charged with oil in accordance with NAS 1638 class7.
Always filter replacement oil through a primary filter prior to filling the system via the designated fill-point.

Oil received in manufacturers sealed containers should not be assumed to be clean to NAS 1638 class 8.

Conduct regular oil analysis; rapid increase in particle count may indicate the onset of component failure and should be followed by thorough inspection of the related equipment.

When replacing hydraulic hoses or damaged hose end fittings replace with the exact type of hose or hose end fitting removed; use of different types of hose and end fittings could cause premature failure and damage to components.

1.5.1 Pressure Tests

Pressure tests have been conducted on hydraulic components at source by the individual manufacturers therefore no additional pressure test is normally required.

In the event that any additional pressure testing is required it is recommended that SMD or the component manufacturer is contacted.

1.5.2 Equipment Handling and Associated Payloads

Be particularly vigilant and proceed with caution when raising payloads from the seabed.

Unforeseen extreme and unexpected forces may be applied to the handling system if the payload becomes jammed.

WARNING

Injury may occur to personnel if the payload or equipment is incorrectly used or personnel are in a place of danger.

Deck equipment and payloads are subject to a certain amount of movement and instability during normal deployment and recovery operations; this is compounded by the unpredictable nature of the vessels movement.

Never allow personnel to be close to the payload until it is either clearly outboarded or securely landed on the deck and the lifting slings are slack.

During inboarding or outboarding, all personnel must keep clear of the payload and any areas of anticipated swing.

1.5.3 Access

Keep all access to equipment and escape routes clear of obstructions that would hinder emergency escape.

Where access ladders are provided on equipment they are intended for maintenance, inspection and fault rectification purposes only.

The access ladders should only be used when the equipment is powered down and stationary. The use of access ladders other than for their intended use may present a risk of serious injury to personnel.

1.5.4 Working above deck level

All precautions must be taken to prevent personnel or equipment falling and any safety equipment necessary made available.

WARNING

There is a risk to the safety of personnel where work is necessary that could result in a fall of two metres or more. Similarly, anyone working below such work may be at risk of falling items.

Whenever personnel work on systems at a height of two metres or more above deck level a safety harness with fall arrest system, or a safe access platform must be used.

If there is a risk of falling objects whilst working at high levels then it is recommended that a safety net is erected under the work area and the area cordoned off to prevent entry of other personnel.

If personnel are working above deck level on access platforms, isolate the HPU power supply by removing the isolation key to prevent movement of equipment and place a tag informing personnel of the isolation on the console.

1.5.5 Earth System

Each part of the deck equipment must be provided with a secure earth link to the deck.

Sub-sea vehicles must also have a secure earth link attached to the deck when onboard. This should be copper cored earth cable of at least 10mm2 CSA.

Where equipment is skid mounted the recommended link is to place an earth bond from an electric motor to the skid, then an earth bond from the skid to the deck.

Always check the earth connections and keep them clean and lubricated. An approved electrical silicone is acceptable as the lubricant.

If an item is earth bonded through a boss welded to the deck of the ship a good earth is normally guaranteed, however to ensure a sound electrical connection it is recommended that an extra conductor of 10mm2 minimum is attached to the external earth stud.

1.5.6 Electrical Safety

Normal ship voltages are generally 380V to 440V for most deck equipment; sub-sea equipment supplied by SMD uses 3000Volts AC.

THESE VOLTAGES ARE LETHAL.

WARNING

There is a risk of electric shock if control measures are not implemented whilst working on the HPU electric systems.

Sub-sea systems are generally powered by 3000V AC

Prior to any work being conducted on the control system or motor contacts, isolate and lock-off the power at the main supply and place isolation tags on the isolator and equipment to indicate that the system is being worked on; place WARNING notices on the operating consoles.

Press in the relevant EMERGENCY STOP buttons prior to commencing electrical work.

Always assume that a circuit is “live” if it is uncertain that it is not de-energised.

Installation and management of cable(s) across the deck requires extra care due to their exposure. Cables must have robust shields placed over them to protect personnel and reduce the risk of accidental damage.

Whenever power to equipment is not required it must be switched off and positively isolated.

Before making electrical connections or disconnections, confirm that the power is switched off and isolated.
Where control room panels are fitted with keyed switches for isolation, they must be used. Pressing the switch down and turning to the lock position then withdrawing and removing the key achieves isolation.

Fused switches and circuit breakers must be locked off with a padlock to isolate them.

Cables carrying high voltages may have a residual voltage present, even when isolated from the power source. They should be checked to ensure safe, using a calibrated high voltage test probe. Each connection should be tied to earth before work commences.

It is recommended, and considered good practice, to discharge motor windings wherever possible prior to placing them in storage.

When placing motors into storage, take care when inspecting the terminal boxes, as they may contain connections for thermistors, heating elements, bimetallic switches or PT-100 resistance elements.

Always check for voltage with an appropriate test meter prior to proceeding. Voltages may be connected for heating elements or direct winding heating even when the motor is at a standstill.

2 DESCRIPTION

2.1 General

The ROV, pictured in Figure 1, is a powerful thruster controlled free-swimming vehicle capable of operating down to a water depth of 4000m.

The positioning of equipment and components within the ROV frame is designed to allow easy access for maintenance. Components are able to be removed without the need for disassembly of any other unrelated component.

All equipment is mounted in such a way as to protect each component from the effects of vibration and thruster wash.

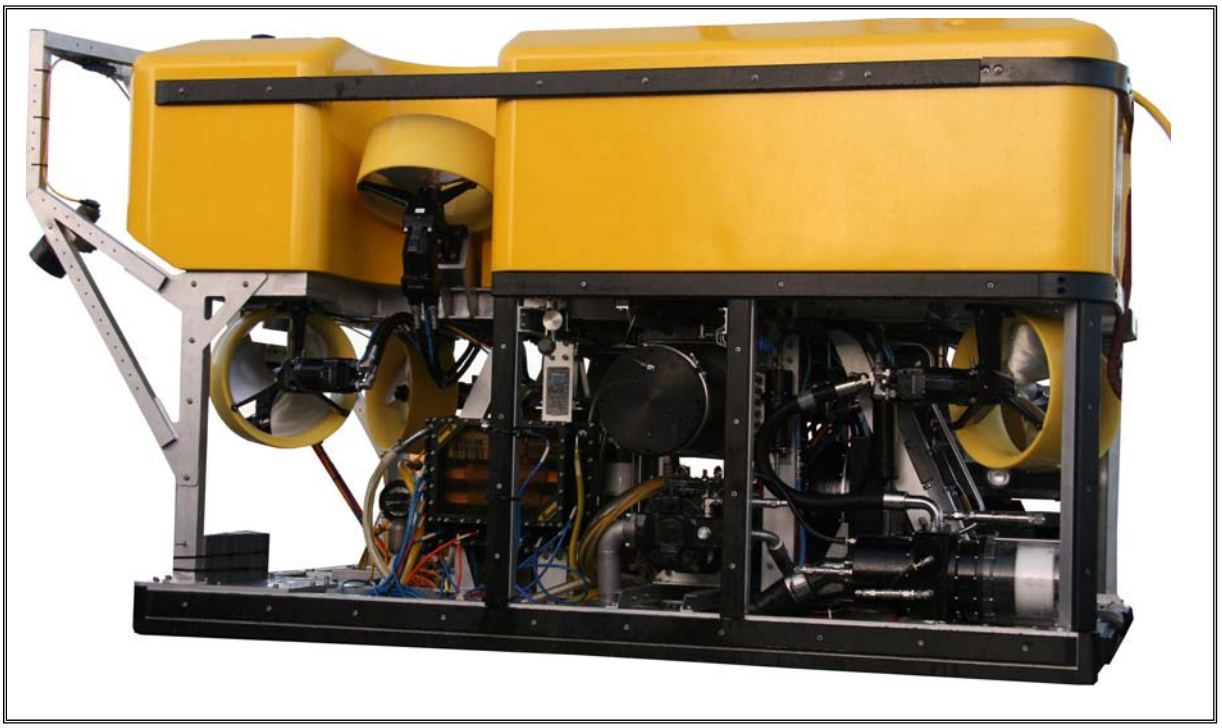

Figure 1 – TIBURON II, QUANTUM ROV

2.2 Hydraulics

2.2.1 Power Pack

The ROV has one 55KW (75hp) electric motor, shown in Figure 2, providing hydraulic power. To one end of the motor is fitted a piston pump with integral constant pressure control. Oil flow from this pump is automatically adjusted to meet demand at constant pressure (internally within the pump).

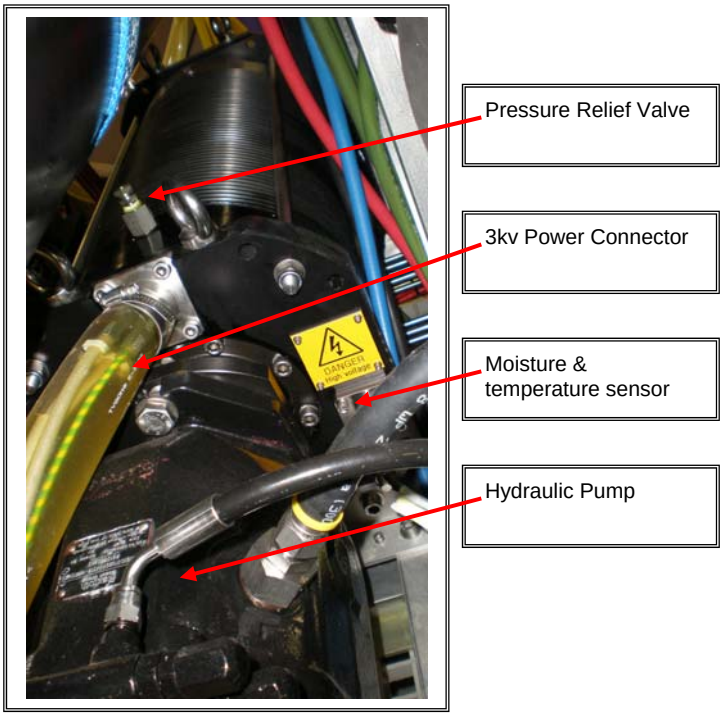

Figure 2 – Sub-sea Power Unit (75hp)

The pump draws oil from a positively pressurised reservoir, to provide the hydraulic power for the vehicle. The reservoir is constantly monitored to give an early warning of oil loss via the alarm system.

The hydraulic pump provides oil to the following:-

1. Intelligent Thruster Control Unit (8 function iTCU)
2. Intelligent proportional 12 function hydraulic control unit (iCHU)

2.2.2 Filtration

The main circuit is filtered on pressure and return lines to protect all the major components. All filters are positioned to allow easy access for element replacement. The HPU cooling circuit is also filtered on the pressure side.

2.2.3 Valve Packs and Hoses

Valve packs are provided to minimise the quantity of hydraulic plumbing and consolidate the valve wiring on to a single cable. The valve packs group together valves of similar function. Spare functions are provided in both valve packs. The oil filled housing for each valve pack is fitted with a clear Perspex cover for visual inspection of valves, oil quality, and LED

indicators. The manifolds are manufactured from aluminium and are hard anodised for corrosion protection.

The valve packs and hydraulic components are easily accessible for maintenance.

Where possible, the hydraulic hoses are routed in the form of a loom, together with electrical cables for tidiness and protection.

2.2.3.1 Intelligent Thruster Control Unit (iTCU)

The intelligent thruster control unit (iTCU) (Figure 3) is mounted centrally at the rear of the vehicle.

The iTCU contains eight servo valves,of which seven are connected to the thrusters; the eighth servo valve outlet is available as a spare.

The iTCU is fitted with an overall system relief and adjustable load valve.

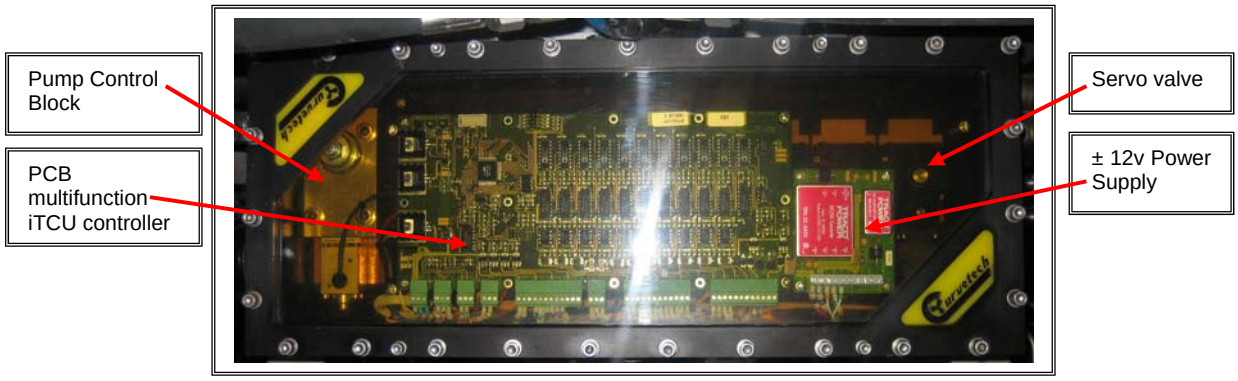

Figure 3 – iTCU Valve Pack

2.2.3.2 12-Function Hydraulic Control Units (iHCU)

- The ROV is fitted with one 12-function HCU (Figure 4).
- One function is fitted with a directional control valve for launch line release function.
- A thermal over-pressure relief protects each working port.
- The iHCU is fitted with a pressure reducing valve.
- The reducing valve limits the overall working pressure of the valve pack independent of the feed pressure.
- Four functions are fitted with proportional control valves, which can be controlled through the control system
- Seven functions are fitted with proportional control valves and pilot operated load holding check valves.

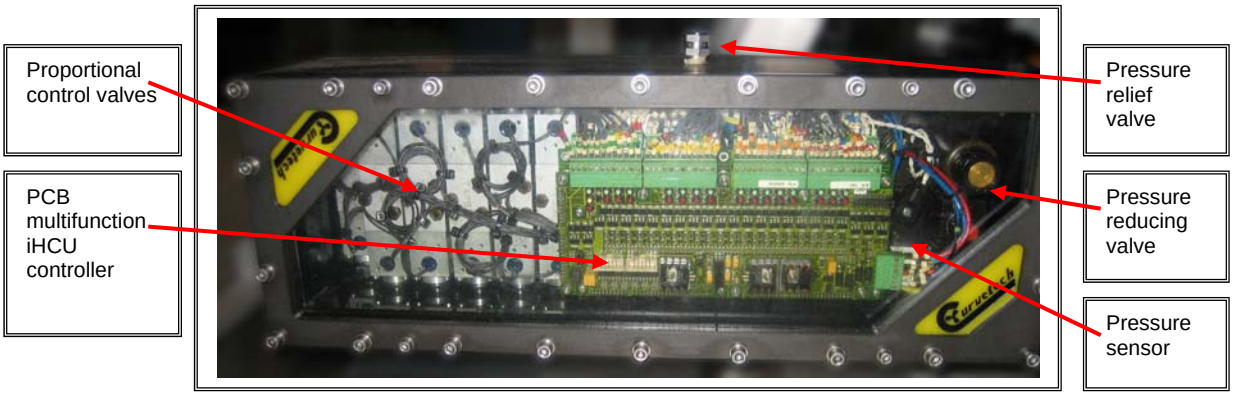

Figure 4 – 12-Function HCU Valve Pack

2.2.4 Thrusters

The vehicle is fitted with seven (4 horizontal vectored, 3 vertical) highly efficient, lightweight, reversible hydraulic "Curvetech" thrusters, (Figure 5).

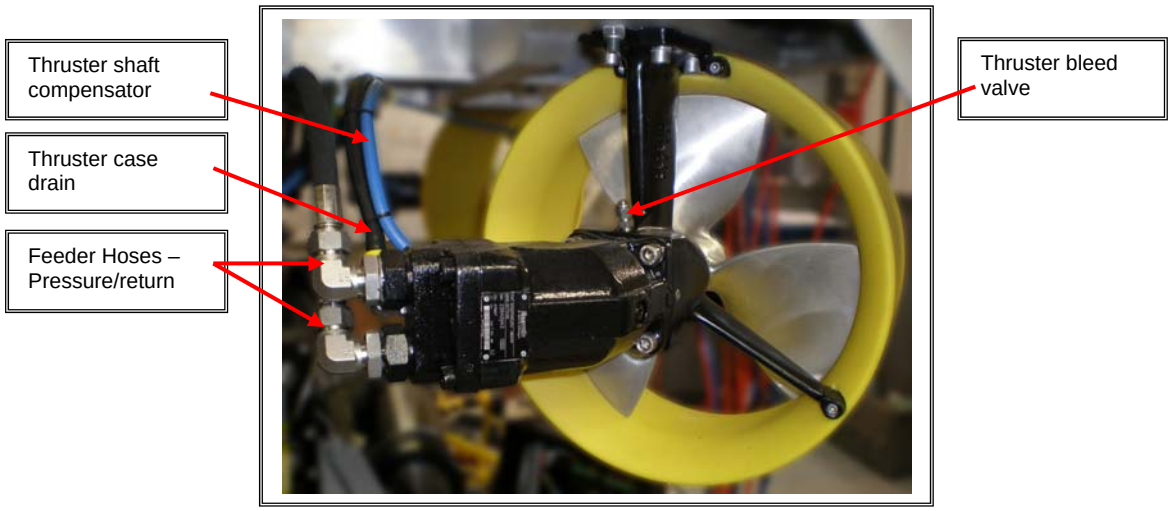

Figure 5 – HTE380 Thruster

The pilot can control the motion of the vehicle manually with the joysticks or switch into automatic control of some vehicle movements. The following Auto Functions are available: -

- Depth
- Altitude
- Heading
- Position Hold
- Position Step
- Auto Home
- Auto Track
- Auto Route

2.3 Sub-sea Electronics

2.3.1 General

The vehicle electrical systems are designed and built in accordance with the IMCA (AODC) Code of practise for the safe use of electricity underwater.

The connection to the surface control system is provided by an umbilical containing power conductors and fibre optics. The power for the sub-sea electronics is transmitted at 3000V and reduced to 178VAC, 110VAC and 18VAC by a transformer in the electrical termination.

The communication is via one single mode fibre. This is routed to the sub-sea electronics, containing a fibre optic multiplexer, which acts as a power and communication hub for the junction boxes and hydraulic valve packs.

The valve packs are each connected to the sub-sea electronics by a simple cable containing only 24V power and an RS485 communication connection. The junction boxes are powered via a dedicated power harness and have a separate signal cable to transmit the signals directly back to the multiplexer.

Each of the junction boxes and valve packs contain a dedicated remote I/O module to allow multiple sensors/instruments to be switched on / off remotely. An approximation of the subsea control is shown below on Figure 6.

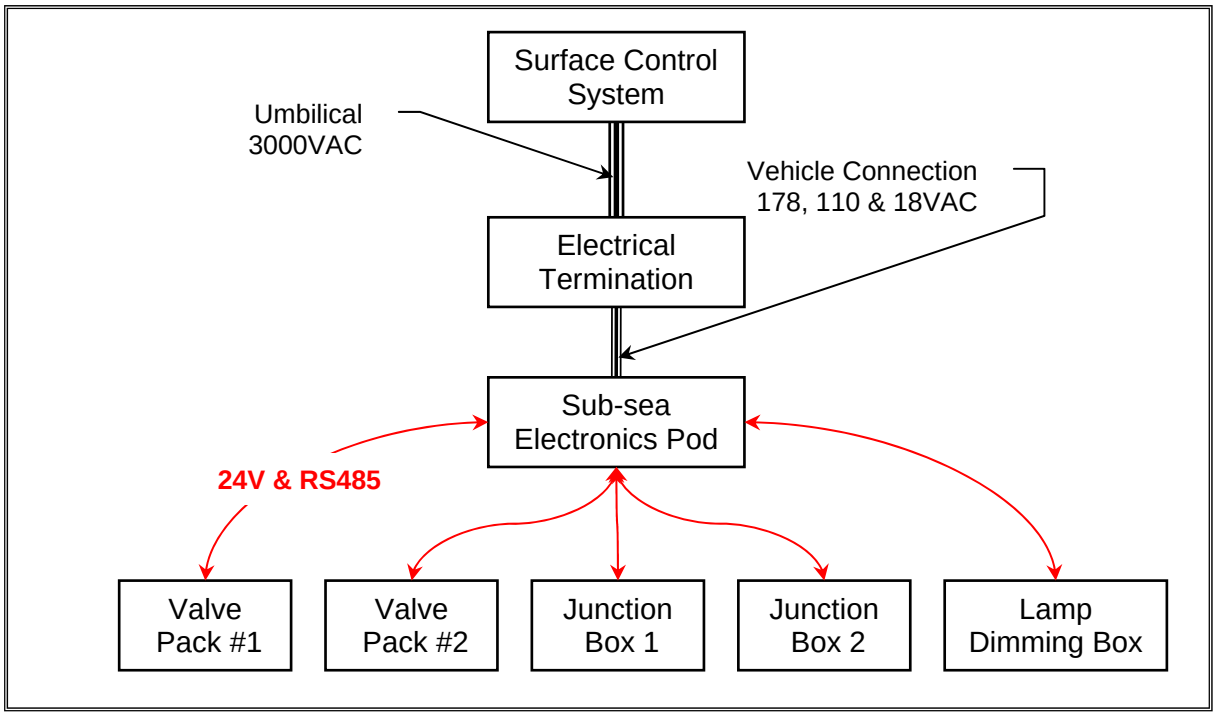

Figure 6 – Sub-sea Control Schematic

2.3.2 Umbilical Electrical Termination

The umbilical electrical termination, shown in Figure 7, houses all the connections between the umbilical and the sub-sea motor and electronics vessel. The rear of the termination also contains the step down transformer for the electronics. Access to the fibre optic and electrical connections is gained by simple removal of the Perspex front cover. There are two blank ports which can be used to add extra fibre connectors.

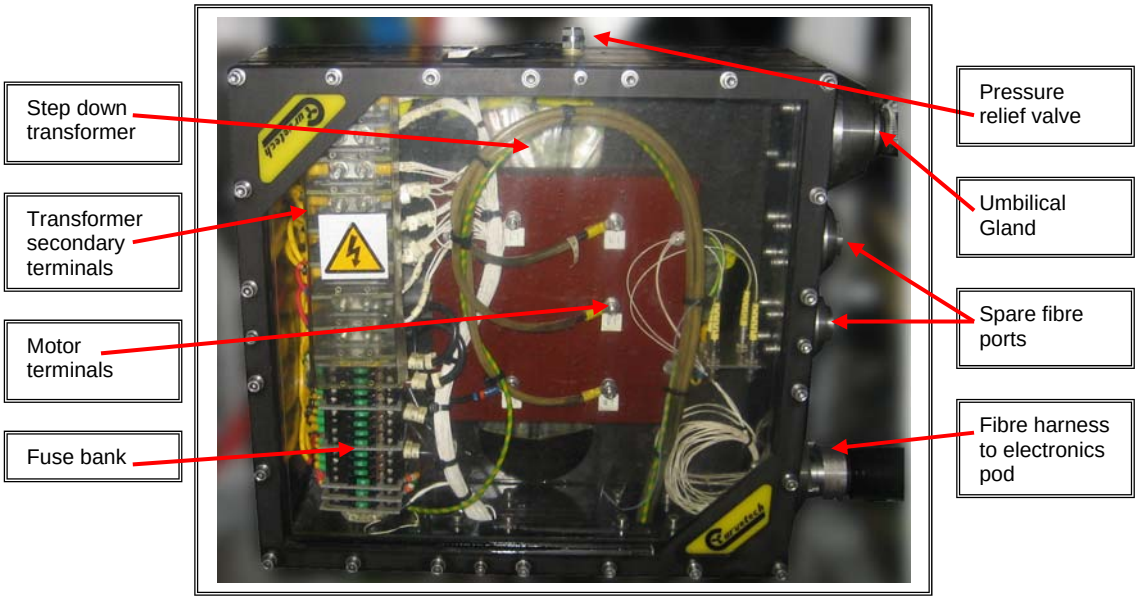

Figure 7 – Umbilical Electrical Termination

2.3.3 Pressure Vessels

The main sub-sea electronics package is housed in a cylindrical pressure vessel (pod), Figure 8. The components of the pod are mounted on a chassis which may be withdrawn from one end of the vessel for maintenance access on the vehicle. Disconnection of the power connector and fibre connector from the main pod allows the chassis to be removed from the vessel completely.

The pod contains: -

- Power supplies for all the surveillance and instrumentation on the vehicle.
- Fibre optic multiplexer to combine video, signals, and control for transmission to the surface control.
- Fibre optic gyro
- Line insulation monitor for sub-sea 110V AC & 240V AC.
- Ground Fault Monitoring for sub-sea 24V DC & 48V DC.
- Switching and isolation for each communication and video line.
- Switching and isolation for each valve pack and junction box.

Bulkhead electrical connectors connect to a network of harnesses linking to individual valve packs and junction boxes.

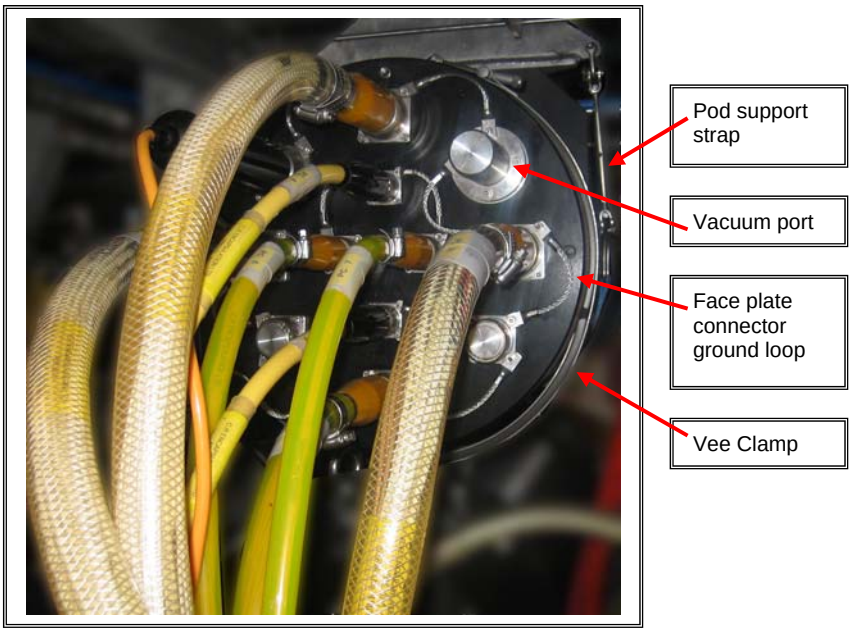

Figure 8 – Sub-sea Electronics Vessel (Pod) External

2.3.4 Harnesses

Main interconnecting, multi-way, harnesses between the electronics pod, main junction box, lamp junction box and valve packs are oil filled.

Surveillance / Instruments / Transducer connections are made by moulded cables from the oil filled, compensated junction boxes for individual electrical connections.

2.3.5 Surveillance

The vehicle is fitted with three core junction boxes, Junction Box 1, which houses the connections for the surveillance equipment, Junction Box 2 houses the connections for the cameras and Pan & Tilts and Junction box 3 the connections for the vehicles lighting system.

All three are oil filled and pressure compensated, constructed in galvanised aluminium and plastic, detailed in Figure 9. Junction boxes 1&2 are designed in two layers, the first contains the Dorn glands, through which the power, signals and connecting harnesses pass. The second which a removable Perspex cover to allow easy access to the internal electrics, negating the need to remove the box from the vehicle for basic fault finding and repairs.

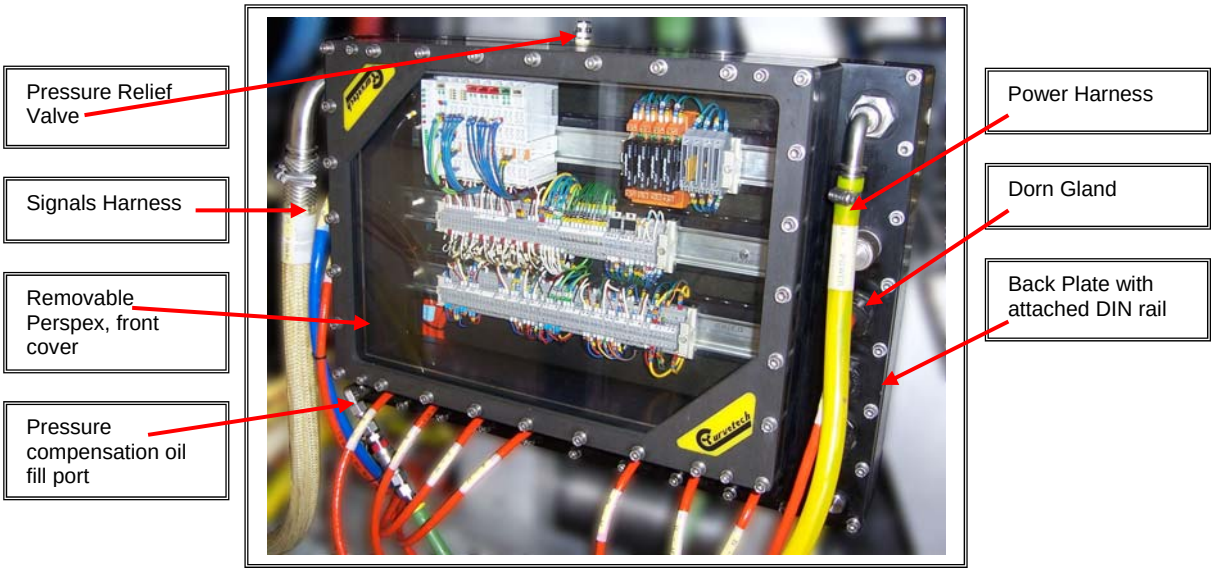

Figure 9 – Junction Box

2.3.5.1 Junction Box 1

Junction Box 1, contains the through connections for the following pieces of equipment: -

- Tritech iGC
- Depth Sensor
- Octans Gyro
- ROV Homer
- Responder
- Sonar
- Altimeter
- Doppler Velocity Log
- CTD
- Accoustic Modem
- Oxygen Sensor
- Two spare ports, 24v@1A, RS232.
- Flood Valve for variable buoyancy
- 100mps Ethernet port.
- Manip Interface Port

2.3.5.2 Junction Box 2

Junction Box 2, contains the through connections for the following pieces of equipment: -

- HDTV Camera – Power only.
- Pilots Cam
- Digi Still Cam
- Digi Still strobe
- Internal Pan & Tilt camera
- Two, ROS PT-25

- Two, ROS PT-10
- Umbilical Camera
- Four Aux Cameras
- Two spare ports, 24v@1A, RS232.

2.3.5.3 Lighting Junction Box

The lighting junction box, shown in Figure 10, provides on/off control for six 400watt SeaArc2 HMI lights through three dual ballasts and dimming capability for four 250watt incandescent lamps.

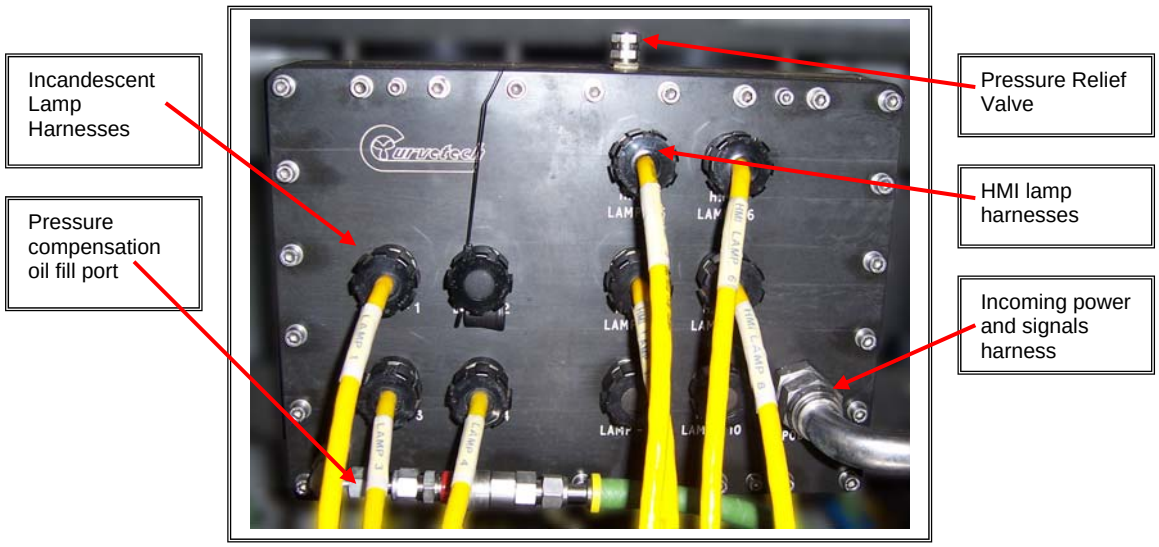

Figure 10 – Lamp Dimming Junction Box

2.4 SPECIFICATIONS

2.4.1 General

Depth rating	:	4000m
Dimensions	:	Length 3.5m Width 2m Height 2m
Weight in air (no ballast)	:	2000 kg
Heading control	:	Automatic on compass heading Manual
ROV power	:	75hp 3000V, 4-pole electro-hydraulic power pack driving single hydraulic pump
Lift Point	:	60kN SWL 180kN Test Load Fore / aft tilt beam

2.4.2 Hydraulics

Hydraulic Fittings	:	Stainless steel
Oil – System	:	Royal Purple Hydraulic Marine Oil
- Motor	:	Royal Purple Hydraulic Marine Oil
Filtration	:	Pressure filter (6-7 micron) Return filter (6-7 micron)
Hydraulic Pump	:	Rexroth 100cc, DFR
Compensators	:	1 x 1pnt Compensator 4 x 2.75L Compensator 1 x 18L Compensator
Thrusters		
Vectored	:	4 x 380mm “Curvetech” HTE380
Vertical		2 x 380mm “Curvetech” HTE380
Pitch		1 x 380mm “Curvetech” HTE380
Thruster Control Unit	:	8 Function servo valve pack.
1 x HCU Valve pack	:	12 function bi-directional valve pack with the following functions: - Seven proportional valves with pilot operated load holding. - Four proportional directional functions. - One Launch Line release

2.4.3 Sub-sea Electronics

Electronics Pod	:	One Atmosphere aluminium pressure vessel
Depth Rating	:	4000m
Test pressure	:	1.25 x max working pressure
Fibre Optic Multiplexer	:	Focal 903 System

2.4.4 Instrumentation

Pressure transducers	:	2 x hydraulic pressure (each valve pack) Digiquartz depth sensor Vacuum sensor in pod
Linear transducers	:	Compensator levels x 5
Temperature	:	Motor temperature Electronics pod temperature Oil temperature
Moisture	:	HPU x 1 Electronics pod x 2 Valve packs x 2 Junction box x 3 Umbilical Termination x 1 Humidity Sensor x 1 in electronics pod
Inclination	:	Pitch and roll inclinometers integral to the free issue gyro
Heading	:	Free issue FOG
Harnesses	:	Harness assemblies with junction boxes glanded with sub-sea connectors at pod end. Oil filled harnesses for all multi-way connections Moulded harnesses for all other connections

2.4.5 Surveillance

Cameras	:	Customer free issue
Lamps	:	Customer free issue
Pan and Tilt	:	Customer free issue Customer free issue
OA Sonar	:	Customer free issue
Echosounder	:	Customer free issue
Spare Connections	:	4 x 24V RS232 link to surface

2.4.6 Buoyancy

Depth Rating	:	4000m
Extra lift		350kg for tooling options