

XLX 150

Heavy Workclass ROV System

TECHNICAL SPECIFICATION

Technical Specification

Issue: 2



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1. XLX 150 VEHICLE GENERAL SPECIFICATIONS

Depth Rating	3050 MSW (10,000 FSW)
Weight in Air (approx)	4.8 Tonnes
Length including manipulator mount	3563 mm (140.26 in.)
Width	1905 mm (75 in.)
Height	2051 mm (80.75 in.)
Forward Speed	3 knots
Lateral Speed	2.5+ knots
Reserve Payload	250 Kg
Turning Rate	40 deg. per second.
Auto Heading Control	Automatic to +/- 2.0 degree
Pitch and Roll Control	+/- 5.0 degrees.
Depth Control	Automatic to +/- 150 mm. (6.0 in.)
Altitude Control	Automatic to +/- 150 mm. (6.0 in.)
ENVIRONMENTAL CONDITIONS	
Air Temperature	-20 to 45°C
Water Temperature	4 to 32°C
Storage Temperature	-20 to 60°C
Humidity	Up to 100%
Saltwater	Designed for intermittent submersion
Vibration	0.5g Peak, sine-sweep 5 Hz to 55 Hz

Note: Final weights and dimensions to still be confirmed

1.1. FRAMEWORK AND MATERIALS

Frame Material 6061-T6, uncoated, sandblasted to uniform finish.

Cathodic protection is provided by the placement of anodes as required. Anode material is to be determined by Forum.

The ROV frame is manufactured from materials suitable for saltwater submersion. The design configuration ensures, component placement allows for ready access to maintenance and interconnect points, specifically electrical connectors, hydraulic connections, and filters.

The open frame concept allows resident ROV components to be located for easy access while retaining a large open volume for mounting of additional tooling components. The open available volume within the framework is approximately 20-cubic feet with a lower frame mounting area of 9-square foot available.

Fiberglass grating will be mounted underneath the lower frame for ease of mounting mission specific tooling. Wooden skids will be mounted underneath the port & stbd. lower frame members for protection of the frame during launch / recovery.

1.1.1. ROV Lift Point

The XLX vehicle is configured to accept a standard XLX lift point for use with “Top Hat” type TMS systems.

Standard Handling and Emergency Lifting Points are provided at the top of the vehicle and a manufacturer certified Transport and Emergency Lift Strap is provided for lifting the ROV during handling operations.

1.1.2. Load Attachment

The vehicle has a 3000 kg through frame lift capability to support under-slung work packages. Connection of work packages is by a simple pin and socket arrangement. No frame modification, such as drilling or tapping, is required to fit a work package. The through frame lift capability is verified during the frame load test and witnessed by DNV.

Load attachment is by:

Standard MRV:	Using MRV style cones / receptacles with standard spacing on 795 (f/a) x 428 (p/s) centers. Securing rod is 35 mm diameter.
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1.1.3. Manipulator Tray

Facility for mounting two manipulators is provided. The starboard position is occupied with a seven-function spatially correspondent manipulator; the port position is occupied with a five-function grabber manipulator. The manipulators are fully contained within the vehicle outer dimensions in the stowed position.

1.2. BUOYANCY

The Perry® XLX 150 vehicle is delivered neutral and in level trim for freshwater operation with sufficient ballast lead to adjust buoyancy for saltwater operation. Buoyancy consists of five (5) syntactic blocks, four (4) blocks for the upper flotation in identical pairs, and one (1) single block in the vehicle center. Additional buoyancy blocks are incorporated in the individual work packages as necessary.

The blocks consist of syntactic foam with a test depth rating 15% greater than the system depth rating. As-built weight is documented for the foam block with a defined maximum increase in weight as a result of water absorption. Samples taken from the foam batches mixed during manufacture of the block are cured using the same method as the main block and tested. Testing results are supplied as deliverable documentation.

The flotation blocks are faired and finished with a high build urethane primer coat and two high gloss urethane topcoats. Each block is engraved with serial number and manufacture date for trace back to test records. The outer surfaces of the blocks have an array of inserts for customer mounting of additional bumpers and small equipment. Anti-skid material is used on the top of the vehicle. Customer logo is applied to port & starboard sides.

NOTE: Base vehicle includes allowance for the following payload in addition to the reserve payload of 250 Kilograms:

- Manipulators (2) 1 X Orion 7P 4 and 1 X RigMaster
- Sonar head (Kongsberg MS1000 or equivalent)
- Cameras (4)
- Lights and brackets (12)
- DVL – TOGS/NAV
- Hydraulic pan & tilt (2)
- IHPU and 12 station tooling Manifold
- Survey Junction Box
- Frame protection, including fiberglass grate

1.3. MAIN HYDRAULIC SYSTEM

The Hydraulic Power Unit provides the capability of powering dual hydraulic pumps (for the main and auxiliary systems). A 150 Hp main pump provides for pilot selectable pressure operation of all system thrusters, as well as auxiliary equipment such as manipulators. A second power take-off interface is provided for installation of a tooling pump, which will allow for operation of auxiliary equipment, as well as other hydraulic tools on a separate hydraulic circuit that is isolated from the main thruster circuit.

Gauges to monitor pump output pressure, total compensator pressure, and system return pressure are panel mounted with an unobstructed view from a P&T camera. All gauges are pressure compensated and not affected by depth.

Pressure (bar).	Pressure (psi).	Flow (lpm)	Flow (US gpm)
241 max	3500 max	242	64
186	2700	316	83.5
34.5 min	500 min	348	92

Hydraulic Tube Fittings 37 deg. JIC, 316 SS or SealLok (1/2" and larger)

Pressure Filter (1) Norman	5 micron	No bypass
Return Filter (1) Norman	5 micron	50 psi bypass
Case Drain Filter (1) Norman	10 micron	15 psi bypass

Cardev water removing oil filter are installed on the low pressure side of the main hydraulic system.

Compensation

The hydraulic compensator(s) or reservoirs have proportional volume feedback linked to the surface graphic display and alarms. The HPU is automatically shut down in the event that compensator volume drops below a preset level. The operator is provided with the ability to override the shut down as required. Total compensator volume is sized to allow for oil volume changes due to temperature and pressure variations likely to be experienced over the full operating range of the Perry® XLX 150 ROV. Each compensation group is equipped with an air vent point as well as a 20psi relief valve, to prevent over pressurization during maintenance procedures.

Fill and Drain Connections

Fill and drain connections are provided for maintenance to the system, from the customers hydraulic deck pack.

½ inch Pressure connection	Main System	Quick disconnect, with isolation valve
1 inch Return connection	Main System	Quick disconnect, with isolation valve
¼ inch vent connection	Main System	Isolation valve

1.3.2. Electric Motor – 150 HP

The electric motor is a 4-pole dual shaft model. The motor is suitable for continuous operation at full horsepower through the operating depth and environmental conditions specified. Ground fault monitoring and indication with automatic shutdown capability is supplied for the electric motor. Manual override of the shutdown is included.

Manufacturer	Sub-Atlantic
Operating Voltage	3000 VAC,
Frequency	50/60 Hz (reduced HP @ 50 Hz)
Maximum in air Run Time	2 min

The HPU is mounted on rails to assist in removal and replacement by sliding the assembled unit in and out of the vehicle frame. Extension rails are provided for the HPU, which supports the assembly, outside the frame. The HPU is capable of sliding to a position suitable for sling attachment and lift by independent lifting devices without requiring human support.

1.3.3. ROV Thruster Manifold

A single 16-station manifold contains all the necessary valves to control the total compliment of vehicle thrusters. In addition to the compliment of thruster control valves (vlv nos 1-16), three additional MVPPM33 valve stations (vlv nos 18-20) are available for high flow tooling requirements, up to 160 LPM.

The hydraulic connection points are fitted with tees that allow the user to connect a circuit to utilize the full hydraulic horsepower capability of the Perry® XLX 150 ROV. The supply and return fittings are:

Pressure Supply Fitting	1 ¼"	Seal Lok
Return Fitting	1 ½"	Seal Lok

The manifold also contains two (2) proportional relief valves (vlv nos 21, 22 & 17) for adjustable pressure control of the main and auxiliary pumps and for the main manifold respectively, two (2) NG3 solenoid or proportional valves (vlv nos 23 & 24), pressure transducer and temperature probe. A relief valve allows venting to atmosphere in the event of pressure build up in the manifold compensated area. Fill, vent, and compensator connection points for compensated areas are included.

The drain and fill points are large diameter (1 inch) to provide for quick drain and fill during cold weather service.

A clear cover is provided on the manifold.

The vent point and relief valve are located at the high point of the compensated area of the manifold. All hydraulic fittings are stainless steel; all fittings into the manifold are SAE parallel thread with "O" ring. NPT fittings into the manifold are not used.

Thruster Valves

Manufacturer
Model

Wandfluh
MVPPM33

The thruster manifold valve allocation is shown in the following table:

VLV No	Stn Des	Function	Valve	Max Flow (lpm)	Max Pressure (bar)
1	1a	port forward vertical thruster	Prop pressure reducing MVPPM33	160	System
2	1b	port forward vertical thruster	Prop pressure reducing MVPPM33	160	System
3	2a	port forward horizontal thruster	Prop pressure reducing MVPPM33	160	System
4	2b	port forward horizontal thruster	Prop pressure reducing MVPPM33	160	System
5	3a	stbd forward horizontal thruster	Prop pressure reducing MVPPM33	160	System
6	3b	stbd forward horizontal thruster	Prop pressure reducing MVPPM33	160	System
7	4a	stbd forward vertical thruster	Prop pressure reducing MVPPM33	160	System
8	4b	stbd forward vertical thruster	Prop pressure reducing MVPPM33	160	System
9	5a	port aft vertical thruster	Prop pressure reducing MVPPM33	160	System
10	5b	port aft vertical thruster	Prop pressure reducing MVPPM33	160	System
11	6a	port aft horizontal thruster	Prop pressure reducing MVPPM33	160	System
12	6b	port aft horizontal thruster	Prop pressure reducing MVPPM33	160	System
13	7a	stbd aft horizontal thruster	Prop pressure reducing MVPPM33	160	System
14	7b	stbd aft horizontal thruster	Prop pressure reducing MVPPM33	160	System
15	8a	stbd aft vertical thruster	Prop pressure reducing MVPPM33	160	System
16	8b	stbd aft vertical thruster	Prop pressure reducing MVPPM33	160	System
17	9	Main manifold pressure	Prop pressure reducing MVPPM33	160	System
18	10	Spare	Prop pressure reducing MVPPM33	160	System
19	11	Spare	Prop pressure reducing MVPPM33	160	System
20	12	Spare	Prop pressure reducing MVPPM33	160	System
21	13	Main pump pressure control	Prop pressure relief BDPPM18	8	System
22	14	Main pump pressure control	Prop pressure relief BDPPM18	8	System
23	15a	Spare / Aft camera P & T right	Prop flow control NG3 WPDFA03	5	System
23	15b	Spare / Aft camera P & T left	Prop flow control NG3 WPDFA03	5	System
24	16a	Spare / Aft camera P & T up	Prop flow control NG3 WPDFA03	5	System
24	16b	Spare / Aft camera P & T down	Prop flow control NG3 WPDFA03	5	System

In the standard configuration, three Uni-directional valves (Stations 10, 11 and 12) are available as spares. When hydraulic pan and tilt units are fitted, the aft one is controlled from the spare valves 23 and 24. If not used for pan and tilt operation, these valves are spare and are controlled by on screen buttons on the GUI.

1.3.4. Propulsion System

Thruster configuration is a quad arrangement of Sub Atlantic 15-inch longitudinal thrusters with clear entry and exit paths for water flow in either direction for all thrusters. Four (4) Sub Atlantic 12-inch vertical thrusters provide, in addition to normal ascend, and descend functions, the ability to adjust vehicle fore/aft trim (pitch), and port/stbd trim (roll).

Minimum Bollard Pulls

(Horizontal @ 45 degrees, Vertical @ 30 degrees)

	4 x 15" Horizontal, 4 x 12" Vertical
Fore/Aft	1100 Kg. Forward @ 45 degrees 1100 Kg. Aft @ 45 degrees
Vertical Lift	1130 Kg. @ 30 degrees
Lateral	1100 Kg. @ 45 degrees

Thruster Drive Motors

Motor Model	SA 300 & 380 Bent Axis Volvo
Nozzle Model	SA 300 & 380 (12" & 15") Thruster

1.3.5. Main Solenoid Manifold

A single 16-station solenoid manifold provides control of standard vehicle functions outfitted as shown on the following page:

VLV No	Stn Des	Function	Valve	Max Flow (lpm)	Additional Valves
1	1a	5 fn Grabber jaw open	Prop flow control NG3 WPDFA03	8	No
1	1b	5 fn Grabber jaw close	Prop flow control NG3 WPDFA03	8	No
2	2a	5 fn Grabber wrist rotate CW	Prop flow control NG3 WPDFA03	8	Ctr/bal
2	2b	5 fn Grabber wrist rotate CCW	Prop flow control NG3 WPDFA03	8	Ctr/bal
3	3a	5 fn Grabber Extend	Prop flow control NG3 WPDFA03	8	Ctr/bal
3	3b	5 fn Grabber Retract	Prop flow control NG3 WPDFA03	8	Ctr/bal
4	4a	5 fn Grabber shoulder up	Prop flow control NG3 WPDFA03	8	Ctr/bal
4	4b	5 fn Grabber shoulder down	Prop flow control NG3 WPDFA03	8	Ctr/bal
5	5a	5 fn Grabber shoulder slew stbd	Prop flow control NG3 WPDFA03	8	Ctr/bal
5	5b	5 fn Grabber shoulder slew pt	Prop flow control NG3 WPDFA03	8	Ctr/bal
6	6a	7 fn Grabber or Pos 1 P&T right	Prop flow control NG3 WPDFA03	8	Ctr/bal
6	6b	7 fn Grabber or Pos 1 P&T left	Prop flow control NG3 WPDFA03	8	Ctr/bal
7	7a	7 fn Grabber or Pos 1 P&T up	Prop flow control NG3 WPDFA03	8	Ctr/bal
7	7b	7 fn Grabber or Pos 1 P&T down	Prop flow control NG3 WPDFA03	8	Ctr/bal
8	8a	Spare or Aux Pump Clutch	Directional control NG3 BM4D32	15	No
8	8b	Spare or Aux Pump Clutch	Directional control NG3 BM4D32	15	No
9	9a	Spare or Pos 1 P&T right	Prop flow control NG3 WPDFA03	8	Ctr/bal
9	9b	Spare or Pos 1 P&T left	Prop flow control NG3 WPDFA03	8	Ctr/bal
10	10a	Spare or Pos 1 P&T up	Prop flow control NG3 WPDFA03	8	Ctr/bal
10	10a	Spare or Pos 1 P&T down	Prop flow control NG3 WPDFA03	8	Ctr/bal
11	11a	Spare	Directional control NG3 BM4D32	15	Ctr/bal
11	11b	Spare	Directional control NG3 BM4D32	15	Ctr/bal
12	12a	Spare	Directional control NG3 BM4D32	15	Ctr/bal
12	12b	Spare	Directional control NG3 BM4D32	15	Ctr/bal
13	13a	Spare	Directional control NG3 BM4D32	15	Ctr/bal
13	13b	Spare	Directional control NG3 BM4D32	15	Ctr/bal
14	14a	Spare	Directional control NG3 BM4D32	15	Ctr/bal
14	14b	Spare	Directional control NG3 BM4D32	15	Ctr/bal
15	15a	Spare	Directional control NG3 BM4D32	15	Ctr/bal
15	15b	Spare	Directional control NG3 BM4D32	15	Ctr/bal
16	16a	Spare	Directional control NG3 BM4D32	15	No
16	16b	Spare	Directional control NG3 BM4D32	15	No

The main manifold can be configured either with conventional solenoid valves or with proportional valves for Variable speed control. Two stations (vlv no 8 and 16) are reserved, being solenoid only. Proportional valves are used for the grabber and any hydraulic pan and tilt units.

The drain and fill points will be of large diameter (1 inch) to provide for quick drain and fill during cold weather service.

The valve type selected allows the fitting or removal of cross-port check or load holding valves as required. The valve manifold cover is clear with LED's to provide visual indication of application of coil voltage to each solenoid valve coil.

Note: The standard configuration for valves 11 to 15 is solenoid.

Manufacturer	Wandfluh		
Model	NG 3/Proportional		
Flow Range	Solenoid	15 lpm max	(4 US gpm)
		8 lpm nom	(2.1 US gpm)
	Proportional	8 lpm max	(2.1. US gpm)
		5 lpm nom	(1.3 US gpm)

1.3.6. Pan & Tilt Units

Two Hydraulic Pan and Tilt units are fitted to the Perry® XLX 150. Brackets are included for the mounting of cameras and lights specified.

Manufacturer	Sub-Atlantic
Model	SA-A-5375-MAS
Tilt Range	±180° with hardware stops
Pan Range	±180° with hardware stops

The survey junction box has bulkhead interfaces to enable three electric pan and tilt units to be fitted at a later date. The units themselves are not part of the scope of supply so only the interfaces are provided. These bulkhead interfaces are to suit the type of electric pan and tilt shown below:

Manufacturer	Kongsberg
Model	OE10-102SS-0409 Compact Ruggedised
Tilt Range	±180° with settable physical and software stops
Pan Range	±180° with settable physical and software stops

1.3.7. Electrical Compensators

Electrical compensators with proportional volume feedback linked to the surface display and alarms are fitted. Multiple compensators are included with surface readouts for the compensator volume that will reflect total system volume accurately. Each compensation group is equipped with an air vent point as well as a relief valve, to prevent over pressurization during maintenance procedures. Total compensator volume is sized to provide for oil volume changes due to temperature and pressure variations likely to be experienced over the full operating range of the ROV.

The core, survey and termination junction boxes will be compensated separately from the manifold assemblies.

1.4. ICE™ SUBSEA CONTROL AND ELECTRICAL SYSTEM

Standard features of ICE™ system include:

- One Control Can with Core Junction Box.
 - Subsea computer and control system with all required interface PCBs.
 - Single mode CWDM fiber optic multiplex system capable of supporting all the communication and video capability on one single mode fiber, with redundant fiber back up.
 - DC power supplies as required with sufficient capacity for all control system components, fiber mux system, manifolds, sensors, and client components.
 - AC power supplies as required with sufficient capacity for all control system components, fiber mux system, manifolds, and sensors. GFD sensors for each AC & DC power source.
 - 12 (low latency) serial survey channels available through the video multiplexers.
 - Temperature sensors in critical areas.
 - Salt water detect sensor in each PV or J-Box
 - DC current sensors for each DC supply, and each port.
 - AC current sensors for each AC supply, and each port.
 - All connectors are laid out to insure ease of installation and removal of cable connectors. All bulkhead and cable connectors are open face pressure rated to at least 25% above the seawater pressure at the maximum operating depth of the ROV.
 - Test ports for the confirmation of PV seal integrity (vacuum method).
 - Junction box for the tether termination with instrument transformer.
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1.4.1. Fiber Optic Multiplexed Communication System

The Telemetry/Video fiber optic mux system is capable of reliable operation with up to 5000 meters of total cable length (fibre type G.652.C) including deck cables, slip rings, umbilical, and tether . The fiber mux system uses CWDM wavelengths on one single mode fiber (with a redundant fiber) for video and bi-directional telemetry transmission. The Standard ROV includes the ability to simultaneously transmit as a minimum:

- Eight (8) each Real Time (Standard Definition) SD Video Signals (NTSC, PAL, or YC)
- Eight (8) each Full Duplex RS 232 Data Channels @ 115 kbps (low latency)
- Four (4) each Full / Half Duplex RS 422/485 data channels @ 115kbps (low latency)
- Two spare wavelengths are used for the 4 channel survey 1Gb Ethernet mux
- Fibre type is G.652.C

A typical system has three fibres connected from the surface through to the vehicle. Two of these fibres are fitted with CWDMs while the 3rd is left for client expansion either using a further CWDM or direct to non-CWDM compatible survey equipment.

The following table shows the typical arrangement and truly spare wavelengths & fiber.

Location	Fibre	CWDM	CWDM Wave length	Devoted Optical Interface	Client Use/Options	Function
Core JB	1	1	1471nm	VOI1 Tx		Video 1-4 & Serial Channels
Core JB	1	1	1491nm	VOI1 Rx		Video 1-4 & Serial Channels
Core JB	1	1	1511nm	Spare	Client Use/VOI3 Tx	Client Use /Video 9-12 & Serial Channels
Core JB	1	1	1531nm	Spare	Client Use/VOI3 Rx	Client Use /Video 9-12 & Serial Channels
Core JB/CC	1	1	1551nm	EOI Tx		Ethernet Vehicle Control Channels (4 Port 10M/100M/1G with Switch)
Core JB/CC	1	1	1571nm	EOI Rx		Ethernet Vehicle Control Channels (4 Port 10M/100M/1G with Switch)
Core JB	1	1	1591nm	Spare	Client Use/HDC1 Tx	Client Use /HD Camera 1
Core JB	1	1	1611nm	Spare	Client Use/HDC2 Tx	Client Use /HD Camera 2
Survey JB	2	2	1471nm	VOI2 Tx		Video 5-8 & Serial Channels
Survey JB	2	2	1491nm	VOI2 Rx		Video 5-8 & Serial Channels
Survey JB	2	2	1511nm	Spare	Client Use/SOI1 Tx	Client Use /ECL Survey Chl 1
Survey JB	2	2	1531nm	Spare	Client Use/SOI2 Tx	Client Use /ECL Survey Chl 2

Location	Fibre	CWDM	CWDM Wave length	Devoted Optical Interface	Client Use/Options	Function
Survey JB	2	2	1551nm	Spare	Client Use/EOI2 Tx	Client Use/Ethernet Survey Channels (See Below)
Survey JB	2	2	1571nm	Spare	Client Use/EOI2 Rx	Client Use/Ethernet Survey Channels (See Below)
Survey JB	2	2	1591nm	Spare	Client Use	Client Use (CWDM Compatible Equipment)
Survey JB	2	2	1611nm	Spare	Client Use	Client Use (CWDM Compatible Equipment)
Survey JB	3	None		Spare	Client Use	Client Use (None CWDM Compatible Equipment)
		or		or		or
Survey JB	3	3*	1471nm	Spare	Client Use	Client Use (CWDM Compatible Equipment)
Survey JB	3	3*	1491nm	Spare	Client Use	Client Use (CWDM Compatible Equipment)
Survey JB	3	3*	1511nm	Spare	Client Use	Client Use (CWDM Compatible Equipment)
Survey JB	3	3*	1531nm	Spare	Client Use	Client Use (CWDM Compatible Equipment)
Survey JB	3	3*	1551nm	Spare	Client Use	Client Use (CWDM Compatible Equipment)
Survey JB	3	3*	1571nm	Spare	Client Use	Client Use (CWDM Compatible Equipment)
Survey JB	3	3*	1591nm	Spare	Client Use	Client Use (CWDM Compatible Equipment)
Survey JB	3	3*	1611nm	Spare	Client Use	Client Use (CWDM Compatible Equipment)

The 3rd CWDM would be an option subject to how the spare fiber was to be used.

Ethernet capability:

For vehicle control Forum use a Focal 907-GBES which is a 4 port 10M/100M/1G (including Ethernet switch) which provides 1GB of total bandwidth to the corresponding surface Focal Mux.

Survey Ethernet channels:

The XLX vehicle is fitted with a dual channel 907-GBE2 unswitched Ethernet Mux.

1.4.2. Control Can

One small diameter pressure vessel is used to house the subsea processor and power supplies. The subsea processor is the onboard intelligence for the vehicles automatic functions and control loops.

The control tray is removable by the blind mate stabbing connectors. The control tray may be connected directly to the Pilots Console, for troubleshooting. Interconnection cables for the control tray are included with the system.

The mating end cap bulkhead connectors are laid out to insure ease of cable connector removal. Salt-water detection sensors are included. Each end cap contains a test port for confirming the dual o-rings seal.

1.4.3. Core Junction Box

The Core ROV junction box connects to required base vehicle sensors, lights, cameras, hydraulic manifolds and provides the ability to access spare telemetry channels with spare switched AC and DC power. The spare capacity is normally used to connect tooling or survey equipment to the workclass ROV.

The drain and fill points will be of large diameter (1 inch) to provide for quick drain and fill during cold weather service. Each compensation group is equipped with an air vent point as well as a relief valve, to prevent over pressurization during maintenance procedures.

Clear cover is provided on the junction box.

The box connection points are labeled for ease of connector identification.

Standard JB features include:

- All required interconnect cabling back to control can and standard sensors.
- All connectors are laid out to ensure ease of installation and removal of cable connectors. Normally no cable connector interferes with removal of any other connector.

The fitted connectors on the Core J-Box are as follows:

- Eight (8) SD Cameras ports with current feedback and electronic automatic resetting circuit breakers and Focus and Zoom controls (Analog or Serial).
 - Six (6) dual feed lights (2x250W ea, dimmable or on/off)
 - Ten (10) ICENet channels for (3) Hydraulic Manifolds and four (4) ROV Sensors (Depth, AHRS, DVL, OCTANS/TOGS) and three (3) ICENET Local Boards (LAM, LCI, LPD)
-

-
- One (1) 20A, 120VAC Tool power feed (DMaC Connector)
 - Twelve (12) Survey channels for customer use (8 X RS232, 4 X RS485)
 - Sixteen (16) switched DC power circuits on two switching boards. Each channel can be configured to output 12, 24, 48 V. and can provide up to 10A. The switching board monitors the total current demand from all channels and limits the maximum current draw on the board. Each individual channel has current feedback and electronic automatic resetting circuit breakers.

The fitted configuration is as follows:

Smoothed (Instrument) Supplies:

Board 1 Bank 2 quantity 3 24V at 10A max each, maximum 18A combined

Board 1 Bank 3 quantity 1 12V at 10A max

Board 1 Bank 4 quantity 1 12V at 10A max

Board 2 Bank 1 quantity 3 24V at 10A max each, maximum 18A combined

Board 2 Bank 2 quantity 3 24V ISO at 10A max each, maximum 18A combined

Board 2 Bank 3 quantity 1 24V at 10A max

Board 2 Bank 4 quantity 1 24V at 10A max

Un-smoothed Supply:

Board 1 Bank 1 quantity 3 29V at 10A max each, maximum 18A combined

- Eight (8) switched AC power sources with current feedback and electronic automatic resetting circuit breakers and adjustable interrupt. 8 switched 120Vac 4A channels.
- Circuit breaker ratings are
 - CB1 Instruments supply 20A
 - CB2 Tooling supply 20A
 - CB3 Lights 10A
 - CB4 Lights 10A
 - CB5 Lights 10A
 - CB6 Core AC 5A

Circuit breakers CB2 to CB6 can be remotely reset from the surface, CB1 can be manually reset using J340 on the Core JB.

Core J-box Interface details

Core		Power 1		Signal 1		Power 2		Signal 2				
Conn ID	Desc	Volt	Interf	Type	Interf	Volt	Interf	Type	Interf	Hole	Conn	Notes
J300	C-Can 1									1"	MINM-37	Signal
J301	C-Can 2									1"	MINM-37	Signal
J302	Motor									5/8"	1503	
J303	Thruster	29Vdc	LPD1-1	ICENet	110					5/8"	1508	10A max
J304	Main Manif	29Vdc	LPD1-2	ICENet	111					5/8"	1508	10A max
J305	Aux Manif	29Vdc	LPD1-3	ICENet	112					5/8"	1508	10A max
J306	Depth	12Vdc	LPD1-7	ICENet	106					5/8"	1508	10A max
J307	AHRS	24Vdc	LPD1-4	ICENet	107					5/8"	1508	10A max
J308	DVL/Alt	24Vdc	LPD1-5	ICENet	108					5/8"	1508	10A max
J309	OAS	24Vdc	LPD1-6	EIA485	SP1-1					5/8"	1508	10A max
J310	Manip	24Vdc	LPD2-1	EIA485	SP1-2					5/8"	1508	10A max
J311	Resp 1	24Vdc	LPD2-2	EIA232	SP1-3					5/8"	1508	10A max
J312	HD 1			Fibre	1591nm					5/8"	OPT-F-19S	HD Camera 1
J313	HD 2			Fibre	1611nm					5/8"	OPT-F-19S	HD Camera 2
J314	Cam 1	24Vdc	LCI1-1	Video	VP1-1					5/8"	1508	
J315	Cam 2	24Vdc	LCI1-2	Video	VP1-2					5/8"	1508	
J316	Cam 3	24Vdc	LCI1-3	Video	VP1-3					5/8"	1508	
J317	Cam 4	24Vdc	LCI1-4	Video	VP1-4					5/8"	1508	
J318	Spare	24Vdc	LPD2-5	EIA232	SP1-6					5/8"	1508	
J319	OAS	24Vdc	LPD2-6	EIA232	SP1-4					5/8"	1508	
J320	Togs/Nav	24Vdc	LPD2-3	ICENet	105			EIA232	SP3-6	3/4"	2013	
J321	Blank									3/4"		
J322	Cam 5	24Vdc	LCI3-1	Video	VP3-1					5/8"	1508	
J323	Cam 6	24Vdc	LCI3-2	Video	VP3-2					5/8"	1508	
J324	Cam 7	24Vdc	LCI3-3	Video	VP3-3					5/8"	1508	
J325	Cam 8	24Vdc	LCI3-4	Video	VP3-4					5/8"	1508	
J326	Spare	24Vdc	LPD2-4	EIA232	SP1-5					5/8"	1508	10A max
J327	Aux	24Vdc	LPD2-7	EIA232	SP3-1					5/8"	1508	LVC TTCS
J328	Resp 2	24Vdc	LPD2-8	EIA232	SP1-3					5/8"	1508	10A max
J329	Hydro				AIB					5/8"	1508	Hydrophone
J330	Blank									3/4"		
J331	Blank									3/4"		
J332	Blank									3/4"		
J333	Blank									3/4"		
J334	LT 1	120Vac	AAC1-1							5/8"	1503	
J335	LT 2	120Vac	AAC1-2							5/8"	1503	
J336	LT 3	120Vac	AAC2-1							5/8"	1503	
J337	LT 4	120Vac	AAC2-2							5/8"	1503	
J338	LT 5	120Vac	AAC3-1							5/8"	1503	
J339	LT 6	120Vac	AAC3-2							5/8"	1503	
J340	CB1 Reset									5/8"	1508	CB1 Reset
J341	Temp			uA/K	LCI3					5/8"	1508	
J342	Power	DC				120Vac				1"	2412	DC from C-Can
J343	DMAc	120Vac	SSR1A	EIA232	SP3-6	120Vac	SSR1B	Video	LCI3-1to4	3/4"	BHS-16C-FS	20 Amps

Note: DMAc interface will be wired with 2 X 120 vac outputs, 1 X RS232 serial channel and 4 video inputs

1.4.4. Tether Termination Junction Box

The termination junction box provides reusable connection points for the high voltage conductors and fiber optic components. Covered in the rear portion of the box is the toroidal step down transformer for conversion of the Instrument power. The instrument power is converted to 120Vac Subsea and is available for Lights, General instrumentation and Tool power, up to 8KW. Full wave rectified 30VDC is also available for hydraulic solenoid power. Tool power is an independent secondary winding of 120V, 20A for Tool Packages and Customer auxiliary use. All power is earth fault sensed.

The 3000 volt, 3 phase HPU power conductors connect through the Termination junction box. Instrument Power is single-phase 3000 volts. All high voltage is earth fault protected.

Clear cover is provided on the junction box.

The drain and fill points will be of large diameter (1 inch) to provide for quick drain and fill during cold weather service. Each compensation group is equipped with an air vent point as well as a relief valve, to prevent over pressurization during maintenance procedures.

1.4.5. Standard Sensors

The following sensors are part of the base vehicle and are fully integrated with the Perry® XLX 150 control system:

Depth Transducer

This is Integral to the TOGS/NAV Unit. However, an additional bulkhead interface is provided so an independent sensor can be used if the TOGS/NAV is replaced with a standard DVL.

Ambient Temperature Sensor

Installed into J423 (Survey JB) and J341 (Core JB)

Attitude & Heading Reference System (AHRS)

This is Integral to the TOGS/NAV Unit. However, an additional bulkhead interface is provided so an independent sensor can be used if the TOGS/NAV is replaced with a standard DVL.

Altimeter/DVL

This is Integral to the TOGS/NAV Unit. However, an additional bulkhead interface is provided so an independent sensor can be used if the TOGS/NAV is replaced with a standard DVL.

Compensator level sensors

Manufacturer	Rota
Resolution	3 mm
Output	4-20 mA

Lighting

The ROV is configured with Interfaces for Six (6) 120VAC, 500W groups of lamps, two (2) lamps in parallel in each group (12 lights total). Each interface can be configured for two (2) standard 250-watt incandescent lamps with dimming capability or On / Off control for High Intensity Discharge lamps (HID) or LED. Total available light power is 3000 watts. The lighting circuit is monitored for ground faults and each group can be independently electrically isolated from the AC supply. All lamps have fault protection and the overload can be reset from the surface.

LED Lamps

Manufacturer	Deep Sea Power and Light
Model	Sealite Sphere
Quantity	10 Total –75° Beam Angle
Connector	Burton 5507-1503

2. INSTALLED STANDARD OPTIONS

2.1. ISOLATED HYDRAULIC 50 HP SYSTEM

A second 50 Hp variable displacement pump is fitted to the starboard shaft of the electric motor. This pump provides a independent hydraulic supply for additional hydraulic tools, and is completely isolated from the main ROV hydraulic supply. Operation of the auxiliary HPU pump is controlled through the co-pilots panel whereby the pump demand can be adjusted as required. During operations where the IHPU system is not required the demand can be set to minimum to allow the main hydraulic system to use the maximum amount of power available from the motor.

The IHPU circuit is fitted with over pressure relief and return filters. The pump produces a pressure up to 3200 psi at a flow rate up to 106 LPM (28 GPM). Delivery pressure is adjustable via pilot's console selection, using the same scheme as the main pump. Pressure feedback for the IHPU system will be displayed on the surface GUI.

The output of the pump is supplied to the IHPU manifold. The hydraulic compensator(s) or reservoirs have proportional volume feedback linked to the surface graphic display and alarms. The system has multiple compensators and the volume readout reflects total system volume accurately. In the event that compensator volume drops below a preset level the motor will shutdown to protect the IHPU circuit.

The operator is provided with the ability to over-ride the shut down as required. Total compensator volume is sized to allow for oil volume changes due to temperature and pressure variations likely to be experienced over the full operating range of the Perry® XLX 150 ROV.

2.1.1. IHPU Pump

Manufacturer	Kawasaki
Pressure Range	34 to 210 bar (500 to 3200 psi)
Flow Range	106 LPM (28 GPM)
System Oil Volume	6.5 L
High Pressure filter	2 micron nominal/10 absolute
Low Pressure filter	20 micron nominal/40 absolute

2.1.2. IHPU Full flow manifold

In order to provide the full flow of the IHPU system to a single function, a separate, line mounted, Hi flow proportional control block is included (Danfoss PVG32, passing 0 – 100 lpm).

This provides a proportional flow up to the maximum auxiliary pump output. It is piloted from a proportional pressure-relief valve mounted under the number 11 directional control valve in the

auxiliary manifold. The DCV controls direction and the PPRLV determines the flow output from the Hi flow valve.

2.1.3. IHPU Manifold

A single 12-station solenoid manifold provides control of customer tooling functions outfitted as;

VLV No	Stn Des	Function	Valve	Max Flow (lpm)	Additional Functions
1	1a	Spare	Prop flow control NG6 WPDFA06	40	PP & PT
	1b	Spare	Prop flow control NG6 WPDFA06	40	PP & PT
2	2a	Spare	Prop flow control NG6 WPDFA06	40	PP & PT
	2b	Spare	Prop flow control NG6 WPDFA06	40	PP & PT
3	3a	Torque Tool	Prop flow control NG3 WPDFA03	8	PP & PT
	3b	Torque Tool	Prop flow control NG3 WPDFA03	8	PP & PT
4	4a	Spare	Directional control NG3 BM4D32	15	Ctr/bal
	4b	Spare	Directional control NG3 BM4D32	15	Ctr/bal
5	5a	Spare	Directional control NG3 BM4D32	15	Ctr/bal
	5b	Spare	Directional control NG3 BM4D32	15	Ctr/bal
6	6a	Spare	Directional control NG3 BM4D32	15	Ctr/bal
	6b	Spare	Directional control NG3 BM4D32	15	Ctr/bal
7	7a	Spare	Directional control NG3 BM4D32	15	Ctr/bal
	7b	Spare	Directional control NG3 BM4D32	15	Ctr/bal
8	8a	Spare	Directional control NG3 BM4D32	15	None
	8b	Spare	Directional control NG3 BM4D32	15	None
9	9a	Spare	Directional control NG3 BM4D32	15	None
	9b	Spare	Directional control NG3 BM4D32	15	None
10	10a	Spare	Directional control NG3 BM4D32	15	None
	10a	Spare	Directional control NG3 BM4D32	15	None
11	11a	High Flow Bi-Directional Pilot	Directional control NG3 BM4D32	15	PP Relief
	11b	High Flow Bi-Directional Pilot	Directional control NG3 BM4D32	15	PP Relief
12	12a	Spare	Directional control NG3 BM4D32	15	PT
	12b	Spare	Directional control NG3 BM4D32	15	PT
Key for the Additional Functions Column					
PP		Proportional Pressure Reducing Valve			
PT		Pressure Transducer			
PP Relief		Proportional Pressure Relief Valve			
Ctr/bal		Counter Balance Valve			

The IHPU manifold is supplied with solenoid valves at stations 4 to 12. Proportional valves may be substituted for the DCVs at stations 4 to 10 and station 12. In this case the proportional control uses a single potentiometer at the ROV pilot's panel and selected by the normal valve actuation switches.

The two (2) high flow, NG 6, stations include adjustable pressure control and pressure differential feedback across the service ports.

Standalone torque tool control software is run on a separate laptop unit, to control valve number 3 in the IHPU manifold. This gives flow and pressure to control the speed and torque applied by a torque tool. Pressure feedback is included after the proportional pressure reducing valve, to show the selected pressure to the torque tool. This enables users familiar with Forum "smart manifold software" carry out torque tool functions independently from the ICE control system. Upgrades or modifications can then be carried out without the need to change the ROV system software. All other functions in the IHPU manifold are controlled via the standard ICE controls. The Forum Strain Gauge Amplifier PCB is mounted inside the manifold. A connector is provided for torque tool feedback connection.

The valve manifold cover is clear with LED's to provide visual indication of application of coil voltage to each solenoid valve coil.

The drain and fill points are large diameter (1 inch) to provide for quick drain and fill during cold weather service.

2.2. SURVEY JUNCTION BOX

The survey junction box contains additional interfaces required to access spare data channels with switched AC and DC power.

The drain and fill points will be of large diameter (1 inch) to provide for quick drain and fill during cold weather service.

Clear cover is provided on the junction box.

- Four (4) SD Cameras ports with current feedback and electronic automatic resetting circuit breakers and Focus and Zoom controls (Analog or Serial).
- Fourteen (14) Survey channels for customer use 12 X RS232, 2 X RS485
- Sixteen (16) switched DC power circuits on two switching boards. Each channel can be configured to output 12, 24, 48 V. and can provide up to 10A. The switching board monitors the total current demand from all channels and limits the maximum current draw on the board. Each individual channel has current feedback and electronic automatic resetting circuit breakers.

The standard configuration is as follows but can be altered to suit specific requirements:

Smoothed (Instrument) Supplies:

Board 1 Bank 1 quantity 3 24V at 10A max each, maximum 18A combined

Board 1 Bank 2 quantity 3 24V at 10A max each, maximum 18A combined

Board 1 Bank 3 quantity 1 24V at 10A max

Board 1 Bank 4 quantity 1 24V at 10A max

Board 2 Bank 1 quantity 3 24V at 10A max each, maximum 18A combined

Board 2 Bank 2 quantity 3 24V at 10A max each, maximum 18A combined

Board 2 Bank 3 quantity 1 48V at 10A max

Board 2 Bank 4 quantity 1 48V at 10A max

- Sixteen (16) switched AC power sources with current feedback and electronic automatic resetting circuit breakers and adjustable interrupt. 2 x 8 switched 120Vac 4A channels. AC Supply is through an independent supply from a Circuit breaker in the core junction box.
 - Four (4) Ethernet interface Channels
 - Intermediate interface boards to simplify replacement of penetrators.
-

Survey J-box interface details

Core		Power 1		Signal 1		Power 2		Signal 2	
Conn ID	Desc	Volt	Interf	Type	Interf	Volt	Interf	Type	Interf
J400	C-Can								
J401	Blank								
J402	SC7	120Vac	LPA1-1	EIA232	SP2A-1				
J403	SC8	120Vac	LPA1-2	EIA232	SP2A-2				
J404	SC9	120Vac	LPA1-3	EIA232	SP2A-3				
J405	SC10	120Vac	LPA1-4	EIA232	SP2A-4				
J406	SC11	24Vdc	LPD4-1	EIA232	SP2A-5				
J407	SC12	24Vdc	LPD4-2	EIA232	SP2A-6				
J408	SC13	24Vdc	LPD4-3	EIA232	SP2A-7				
J409	SC14	24Vdc	LPD4-4	EIA232	SP2A-8				
J410	SC15	24Vdc	LPD4-5	EIA485	SP2-1	120Vac	LPA1-5		
J411	SC16	24Vdc	LPD4-6	EIA485	SP2-2	120Vac	LPA1-6		
J412	SC17	24Vdc	LPD4-7	EIA232	SP2-3				
J413	SC18	24Vdc	LPD4-8	EIA232	SP2-4				
J414	Blank								
J415	Blank								
J416	Cam 9	24Vdc	LCI3-1	Video	VP3-1				
J417	Cam 10	24Vdc	LCI3-2	Video	VP3-2				
J418	Cam 11	24Vdc	LCI3-3	Video	VP3-3				
J419	Cam 12	24Vdc	LCI3-4	Video	VP3-4				
J420	SC19	24Vdc	LPD5-1	EIA232	SP3-5				
J421	SC20	24Vdc	LPD5-2	EIA232	SP3-6				
J422	Blank								
J423	Temp Sensor	-	LPA3	µA/K	LPA1				
J424	Blank								
J425	Blank								
J426	Blank								
J427	Blank								
J428	Blank								
J429	Blank								
J430	Eth1	120Vac	LPA1-7	Ethernt	EP-0				
J431	Eth2	120Vac	LPA1-8	Ethernt	EP-1				
J432	Eth3	24Vdc	LPD5-3	Ethernt	EP-2				
J433	Eth4	24Vdc	LPD5-4	Ethernt	EP-3				
J434	P+T 1	120Vac	LPA3-1	ICENet	122				
J435	P+T 2	120Vac	LPA3-2	ICENet	123				
J436	P+T 3	120Vac	LPA3-3	ICENet	124				
J437	Blank								
J438	Blank								
J439	Blank								
J440	Blank								
J441	Blank								
J442	Power	DC							
J443	Blank								

2.3. SEVEN-FUNCTION SPATIALLY CORRESPONDENT MANIPULATOR

A spatially correspondent manipulator interface and fused power isolation is provided. Supply voltage, telemetry and hydraulic supply will meet requirements of the manufacturer. Surface control interface connector is supplied. An additional filter will be installed at the manipulator hydraulic supply.

Depth Rating (standard)	6500MSW (21,325fsw)
Weight in Air	54 kg (120 lb)
Weight in seawater	38 kg (83 lb)
Maximum Reach	1,532mm (60.3 in.)
Lift at full Extension (nominal)	68 kg (150lb)
Maximum Lift, (nominal)	270 kg (550lb)
Maximum Gripper opening (nominal)	97 mm (3.8in)
Grip force (nominal)	4,003 N (900 lb)
Wrist Torque (nominal)	205 Nm (150 ft-lb)
Wrist rotate, (continuous)	360 degrees, 6-35 rpm
Oil Type measurements based upon	Shell Tellus 32 hydraulic fluid
Input pressure	207 bar (3,000psi)
Flow required	19 lpm (5 gpm)
Jaw Type	Standard 3 finger intermeshing jaws

2.4. FIVE FUNCTION RATE MANIPULATOR

The five-function Schilling Robotics' RigMaster rate manipulator is fitted, interfaced and tested on the Perry® XLR ROV typically on the port side. The RigMaster manipulator functions hydraulically from the main manifold. Refer to OEM manual for more detailed manipulator specifications and procedures.

Maximum Reach	1372 mm
Shoulder Slew	105 deg
Shoulder Pitch	105 deg
Extend	305 mm
Wrist rotate	Continuous
Jaw Size	284mm
Jaw type	4 finger inter-meshing
Lift capacity (Extended)	181 kg
Lift capacity (Retracted)	270 kg
Wrist rotate torque	205 Nm

2.5. INSTALLED ENHANCED SENSORS

A fully integrated inertial navigation system that provides heading attitude and DVL data

Manufacturer	CDL
Model	TOGS/NAV Unit
Heading Accuracy:	0.5 deg sec lat
Pitch & Roll Accuracy:	0.1 deg
Heave Accuracy:	5cm or 5%

For the obstacle avoidance sonar, a bulkhead connector is provided as standard in the Core J-Box, this provides 24Vdc power and an RS485 serial channel to the ICE control system for the Sonar.

2.6. Manufacturer	Kongsberg
Subsea Sonar Head	MS1071
Frequency	675kHz
Max. Range	100m
Depth Rating	6000m
Type	Mechanically Scanned 360° cont.
Surface Control Unit	MS 1000
Subsea Cable	Supplied

3. SURFACE CONTROL SYSTEM

The control system and power system includes the following major components:

- Control & Video Console
- High Voltage Transformer Units (HVTU)
- High Voltage Junction Box (HVJB)
- Power Distribution Unit (PDU)

The Control Console consists of the following;

- 4 – bay central desk with inset panels for ROV and pilot and co-pilot.
- Bank of 12-off 24" Dell U2410 monitors arranged in a 3 x 4 matrix.
- 1 x full height Auxiliary rack, adjacent to main console (see section 3.3)
- 2 x HMI touch screens
- 32 x 32 Comp Video Matrix
- 16 x 16 DVI Video Matrix
- Overlay and recording suite CFE

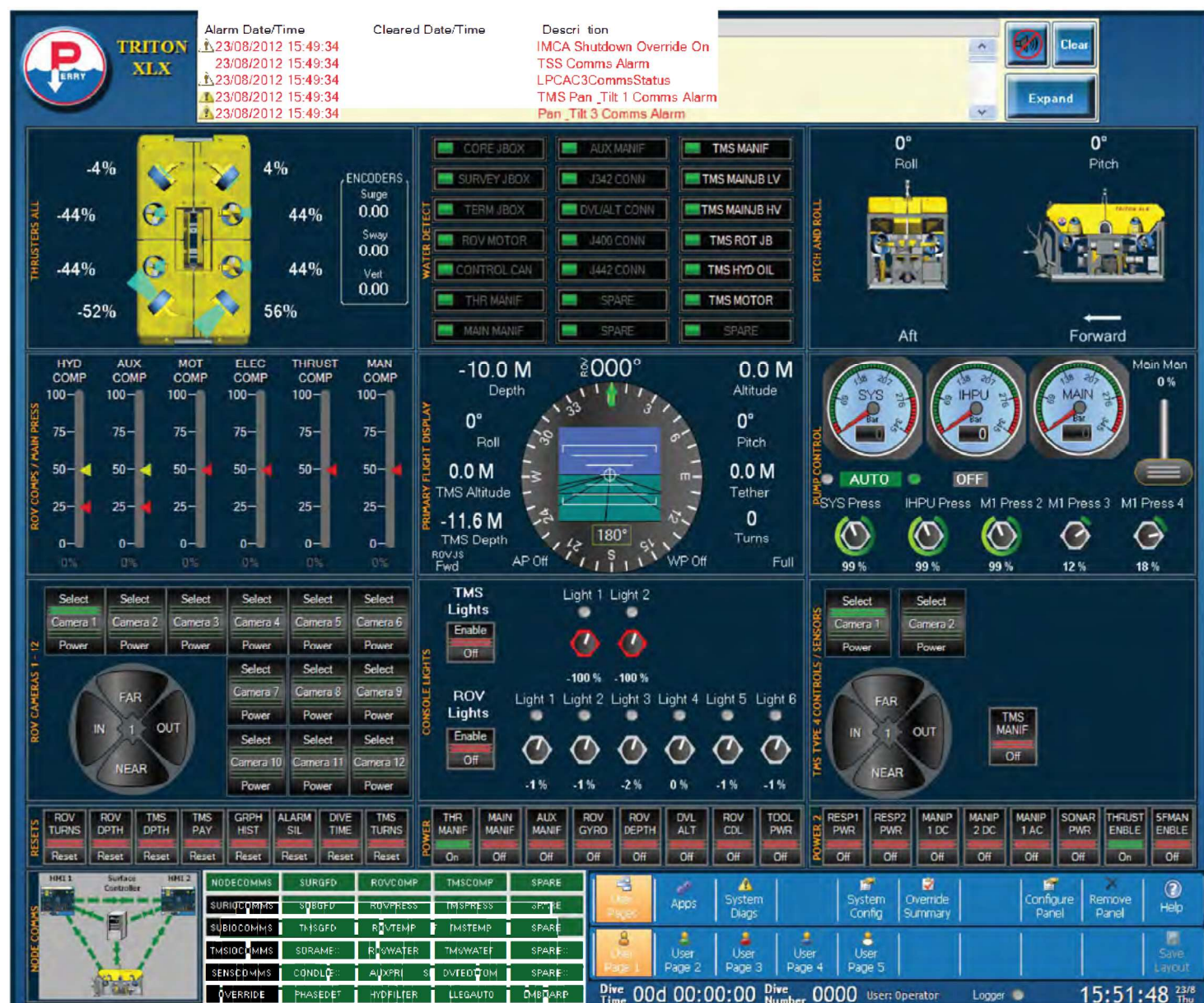
Single phase input power of 120VAC is over current protected and distributed through the Console Interconnect Panel. The UPS is sized to protect sensitive computer loads from input power fluctuations.

The control console and equipment racks are shock mounted to withstand typical shipboard and transportation motions. All rack-mounted components are fully supported on shelves or fitted with slides for maintenance access.

3.1. GRAPHICAL USER INTERFACE

A Graphical User Interface (GUI) with a modern, ergonomic “look and feel” is implemented in the control system. Microsoft® Windows® XP serves as the base operating system for the GUI. Windows® offers a platform that is suitable for graphical displays, familiar user interface functions, data logging, diagnostics, and networking with third party systems.

Two (2) HMI PCs serve as Pilot and Co-Pilot stations. These give mutual redundancy to the HMI system. The two HMI PCs are connected to the control system network via Ethernet. The HMI PCs are completely independent of each other; if one fails the second is not affected. Each HMI PC produces two (2) graphical outputs, one connected to a dedicated touch screen and the other is available for customer use producing a total of four (4) graphic displays; 2 for the pilot and 2 for the co-pilot.



A combination of touch screens and hard controls are used to form the most ergonomic user interface required by each customer. The displays on the touch screens can be customized in the field and saved per user login. A “GUI Builder” allows the user to customize each screen by simply adding or removing GUI functional panels. Once the user is satisfied with their configuration, they can save it, and when they log on again, the panels are placed in the last save configuration for that user.

3.2. ROV AND TMS CONTROLS

The operator station contains a touch screen for soft controls and 1 pilots control panel for hard controls. In addition, a pilot’s joystick with ROV motion control thumb switches and a main thumb switch for pan and tilt. Joystick ‘reverse’ functionality is also provided, allowing the vehicle to be piloted normally with the aft face of the vehicle being ‘forward facing’.

Certain devices may be controlled via soft controls on the touch screen or hard controls on the small control panels.

Typical soft controls included on the Touch Screens are:

- Page Select
- Camera Controls (Power, Focus and Zoom)
- Counter Resets for ROV & TMS Depth, Turns and Tether Payout
- Light Controls (Power, Dimming and Presets)
- Power Controls for Gyro, Altimeter, Scanning Sonar and Responder, etc.
- Alarm Silence button

Typical hard controls included are:

- High Voltage Start Circuits (4).
 - ROV Joystick Forward / Reverse Select Switch
 - ROV Joystick Sensitivity Switch
 - ROV Pan and Tilt Controls (3 Joysticks provided)
 - Alarm Silence button
 - Rate Manipulator Controls
 - Tether In/Out Control (Foot Pedal and switch)
 - TMS Latch Open/Close
 - ROV Propulsion Trim Pots, five (5)
 - Auto function switches for control of:
 - Depth
 - Altitude
-

-
- Heading
 - Heading Park
 - Auto Position/Dynamic Positioning

3.3. VIDEO CONSOLE

Integrated within the Auxiliary 19 inch rack, video console (as detailed in section 3), for installation of customer video recording suite will be provided. Video console will match the finish and appearance of the Control Console.

All rack-mounted components are fully supported by shelves, rack mounts, or rack slides. The console, mounting components, and fitted equipment are capable of withstanding the typical shocks and loads associated with trucking and shipping. The console is able to be mounted and compliantly secured.

3.3.1. Video Annotation

Customer Furnished Equipment

3.4. AUTO FUNCTIONS

In the automatic modes, the Subsea computer uses feedback signals from the on board sensors to compute the proportional valve control signals required to maintain the ROV's heading, depth, altitude or dynamic positioning.

To enable an automatic mode, the appropriate control panel switch must be set and the joystick and corresponding trim pot must be in the neutral position. While in an automatic mode, the trim pot may be used to offset the position for fine control. The joystick will override the automatic mode when moved from the neutral position and a new set point will be determined when the joystick returns to the neutral position.

The following automatic modes are on the PERRY® XLX ROV System:

- Auto Heading Mode (+/- 2 degrees)
 - Auto Heading Park Mode (vehicle is anchored to a structure)
 - Auto Depth Mode (+/- 6 inches)
 - Auto Altitude Mode (+/- 6 inches)
 - Auto Position/Dynamic Positioning (Doppler Velocity Log)
 - Auto Position/Dynamic Positioning (Kalman Filter based Positioning System, incorporating use of the DVL)
 - Auto Waypoint Mode
-

-
- Remote Mission Navigation/Auto Pilot Command Interface
 - Auto Attitude Mode
 - Auto Track/Follow Mode
 - Auto Failsafe Mode

3.4.1. Auto Heading Control

Auto heading is controlled by using the heading reference sensor. Rotating around the centre of the free-swimming vehicle the heading will be maintained using the four horizontal thrusters. Adjustments in heading are made with the joystick.

3.4.2. Auto Heading Park Control

In this mode, the vehicle may be attached to a structure in front of it and be able to rotate around that anchoring point. This auto mode is similar to the auto heading mode. It differs in the way the thrusters are controlled. When heading park is selected, the Sub-sea computer maintains heading, using primarily lateral thrust. Adjustments in heading and lateral movement are made with the joystick.

3.4.3. Auto Depth Control

Auto depth is controlled by using a digital depth sensor. The set depth may be offset by using the vertical trim pot control. The joystick may be used to override the auto depth mode and adjust the depth to a new set point.

3.4.4. Auto Altitude Control

When engaged this automatically maintains the vehicles current pitch and roll. This auto function controls the appropriate vertical thrusters.

Auto altitude is controlled by using a Doppler Velocity Log (DVL) or Altimeter. This requires accurate inclinometers that are fast to react and are stable to detect the vehicles attitude. The joystick can be used to change altitude and the pitch and roll set point can be adjusted using the pitch and roll trim controls.

3.4.5. Auto Position Control (Doppler Velocity Log)

In the Auto Position mode, the ROV will automatically hold geocentric position to an established bottom position. Dynamic Positioning or Station Keeping is maintained relative to an established point on the seafloor or bottom feature. With the initialization of the Auto Position function and a bottom position referenced, the vehicle will maintain its position concurrently with all other auto functions, and hold position subject to a : $\pm 1.5\text{kt}$ current with a Position Error = $\pm 0.25\text{m}$.

Additionally the ROV can be displaced from this established position via the existing control shelf trim pots (Surge, Lateral) or with keyboard entry when in Auto Position/Dynamic Positioning mode to allow controlled movement or offset distance in the X, Y, or Z directions. The function will allow

for manual override by Joystick movement while the auto function is engaged. This feature will incorporate the use of a DVL with Bottom Lock sensor and the ROV Motion Reference Unit. As a departure from convention, whilst in auto position mode, the rotary trim controls apply a change to the vehicle position set point, rather than an offset. The net result is that the “return to origin” feature no longer functions, when the trim functions are depressed.

3.4.6. Auto Position Control (Kalman Filter based Positioning System)

When the XLX is fitted with a Kalman Filter based positioning reference system and this is aided with USBL, INS and DVL sensors then it extends the auto position features allowing them to operate throughout the water column, as well as providing absolute referencing in real world coordinates (longitude and latitude).

The Kalman filter based position reference system calculates the most accurate vehicle position. This computational filter assimilates heading data from the North Seeking Gyro, attitude data from accelerometers and the gyro, rapid position changes from the inertial sensors, relative position and altitude (to seabed) information from a Doppler Velocity Log (DVL), absolute position from the USBL system (which intern is typically integrated with a DGPS) and depth data from a depth sensor.

This Kalman filter based system is typically incorporated within a North Seeking Heading, inertial and attitude reference system. Then a standard DVL is fitted immediate underneath. Other sensors are connected accordingly including depth and USBL.

Relative positioning is controlled using the joystick or the graphical user interface. However absolute positions are commanded via keyboard entry (longitude and latitude), by using a simple record and play system or through the remote mission navigation/auto piloting command interface. The record and play system allows for positions to be recorded in memory allowing operations to be more easily repeated or reversed.

3.4.7. Auto Waypoint Control

Auto waypoint control allows multiple positions/waypoints to be entered and executed in succession. This allows more complex pre-planned courses to be traversed.

3.4.8. Remote Mission Navigation/Auto Piloting Command Interface

The external navigation interface allows users to remotely command the auto functions and fly the vehicle remotely. This requires a remote mission planning and navigation or auto piloting system.

Note: This interface uses a Forum standard communications protocol and therefore any mission planning and navigation system will need to be configured appropriately for this command interface.

3.4.9. Auto Attitude Control

Auto attitude is controlled by using the pitch and roll sensors. Rotating around the centre of the free swimming vehicle the heading will be maintained using the four vertical thrusters. Adjustments in attitude are made with the trim controls.

3.4.10. Auto Track/Follow

Auto track/follow is controlled by using data from an external tracking sensor. This allows external heading control to be received while the pilot determines the speed. When using this feature an object such as a pipe can be tracked automatically.

The most typical fitted tracking sensor is a pipe or cable tracker is a TSS Dual Track and support for this device is provided.

3.4.11. Auto Failsafe Mode

If downlink data communication between the Surface Computer and the Subsea Computer fails, the Subsea Computer is programmed for a Failsafe mode as follows:

- All horizontal and vertical thruster commands are set to zero.
 - All other automatic control modes are turned off.
 - All other commands are maintained as they were prior to losing communications, (e.g. cameras, lights, and sensors stay on.)
-

4. SURFACE POWER DISTRIBUTION SYSTEM

POWER DISTRIBUTION SYSTEM GENERAL

The power system provides monitoring, distribution and control of power to the console bank, TMS and ROV. The physical arrangement minimizes the number of enclosures required and provides the smallest volume and footprint achievable within applicable regulations. Access to all operator serviceable components is provided via doors with safety locks. Provision of physical lockouts and earthing straps for primary power supply to ROV system high voltage transformers is provided.

4.1. POWER DISTRIBUTION UNIT (PDU)

The PDU provides control and monitoring of the incoming supply voltage and distributed power to the consoles and high voltage transformers as appropriate. Display of the status of incoming and distributed supplies is presented on the front panel display on the PDU and by remote display integrated into the pilots GUI computer.

Incoming supply voltage is assumed to be 440-690 VAC 3Ø, 50/ 60Hz.

Supply voltage monitoring shall include as a minimum:

- Voltage Level
- Phase Rotation
- Phase Loss
- Current Draw
- Total Hours

Control is provided for:

- | | |
|-----------------------------------|------------------------|
| • Pilots Console Power | (120 VAC 1Ø 50/ 60Hz) |
| • TMS Instrument Power | (3000 VAC 1Ø 50/ 60Hz) |
| • TMS HPU Power | (2400 VAC 3Ø 50/ 60Hz) |
| • ROV Instrument Power | (3000 VAC 1Ø 50/ 60Hz) |
| • ROV HPU Power (with soft start) | (3000 VAC 3Ø 50/ 60Hz) |

Distributed Power Monitoring shall include:

- Console Current Draw
- TMS Instrument Current Draw
- TMS HPU Current Draw
- ROV Instrument Current Draw
- ROV HPU Current Draw
- TMS Instrument Hours
- TMS HPU Hours
- ROV Instrument Hours
- ROV HPU Hours

4.2. HIGH VOLTAGE JUNCTION BOX

The HVJB contains all the control and monitoring components necessary for the safe operation of the high voltage components associated in the ROV system within applicable regulations. Ground Fault Detection is provided on all high voltage supplies with automatic shutdown at a preset level. Manual override of Ground Fault Interrupters (GFI) trip is included. Input tapings are provided to accommodate supply voltages variations 420 VAC to 690 VAC. Output tapings are provided to ensure correct voltage can be supplied to the system components with an umbilical length variation from 1000 to 4000 meters.

The components include as a minimum:

- TMS Instrument Power High Voltage Transformer
- TMS HPU Power High Voltage Transformer
- ROV Instrument Power High Voltage Transformer
- Ground Fault Detectors/Interrupters for each HVTU as required linked to pilots GUI display
- TMS Instrument Current Draw Sensors
- TMS HPU Current Draw Sensors
- ROV Instrument Current Draw Sensors
- ROV HPU Current Draw Sensors
- Open Circuit Conductor Sensors for Multiple Conductor Supplied Circuits

4.3. HIGH VOLTAGE TRANSFORMER UNIT

The HVTU contains the 3000-volt 150 HP transformer for the ROV HPU supply, cooling fans and tap selections for the safe operation of the high voltage transformer in the ROV system within applicable regulations.

Input tapings are provided to accommodate supply voltages variations 420 VAC to 690 VAC. Output tapings are provided to ensure correct voltage can be supplied to the system components with an umbilical length variation from 1000 to 4000 meters.

4.4. INTERCONNECT CABLES (INTERNAL CONTROL VAN CABLES)

All internal interconnect and power cables to connect and operate the ROV controls and system are compliant with IEEE 45 requirements.

4.4.1. Deck Interconnect Cable (Deck Umbilical)

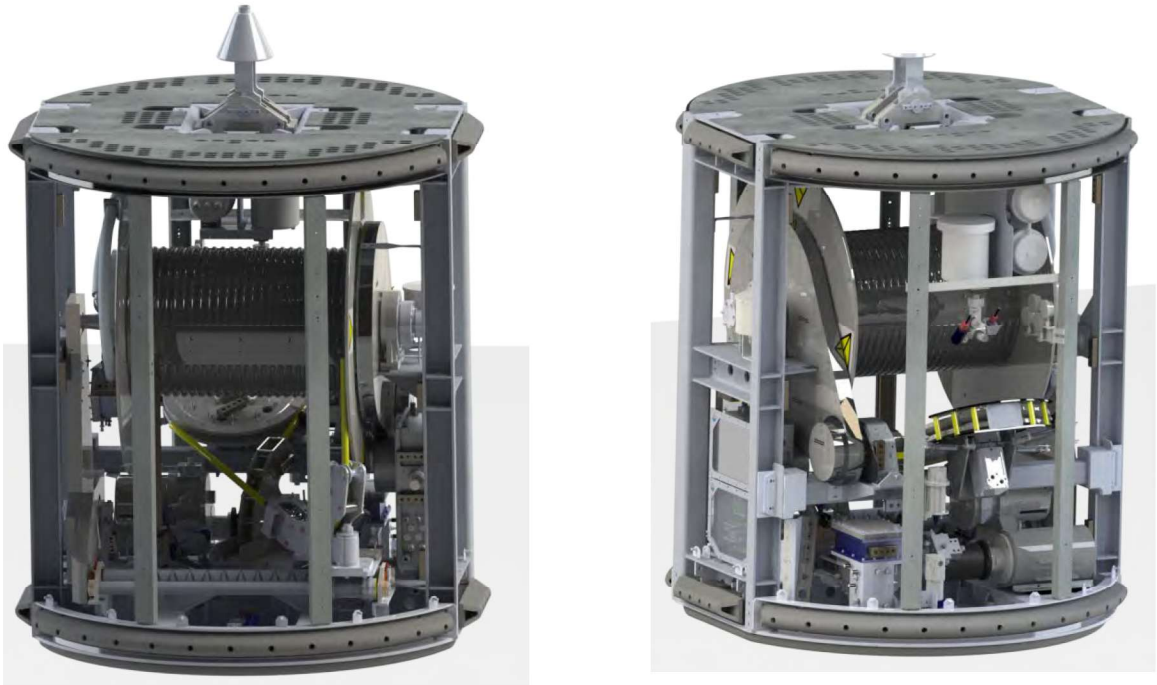
The deck interconnect cables are not included in the scope of supply.

4.4.2. Power Cables

Power cables are not included in the scope of supply.

5. TETHER MANAGEMENT SYSTEM

5.1. GENERAL SPECIFICATIONS



The Tether Management System (TMS) provides the physical and electrical interface between the main lift umbilical and the free-swimming tether. The TMS also provides the method for latching and holding the Perry® XLX 150 during deployment and recovery of the ROV. The TMS is capable of handling all mechanical loads associated with the deployment and recovery of the ROV/TMS assembly given the operating conditions and system weights contained in this document. The weight calculations include the ROV weight complete with allowances for the payload and thru frame lift capability of the ROV.

Note: See the overall system drawing B201-084-124 for full weight and dimensional information of the whole system.

5.1.1. Standard Features

Type	Top-hat design
Depth Rating	4,000 msw
Frame Material	Aluminum 6061T6
Height	2203 mm
Diameter	2020 mm
Weight in Air (Excluding tether and lift cone)	2,589 kg
Weight in Water (Excluding tether and lift cone)	2,001 kg
Horsepower	10 HP
Tether Line Pull (Proportional)	
Full Drum	250 Kg
Empty Drum	450 Kg
Tether Line Speed	
Empty Drum	42 mpm
Full drum	54 mpm
Latch Load Capability	9,000 Kg
Tether Capacity	
35 mm diameter	750 m
27 mm diameter	1150 m
Payout Counter	
Depth Sensor	
Latch Status	
Altimeter (Optional)	
Tether Load Sensor (Optinal)	
Tether In/Out Control	
Instrument Power	2400 volts, single phase
Hydraulic Power	2400 volts, three phase
Cameras	Color Zoom, OE14-366, Kongsberg
Lights	
Pan & Tilt Unit	
Hydraulic Tubing	Seamless 316 SS
Hydraulic Tube Fittings	Seal lock (1/2" and larger and JIC below this size

5.2. FRAME

The TMS core frame is manufactured from Aluminum, 6016T6. The component placement allows for ready access to maintenance and interconnects points of the electrical connectors, hydraulic connections/adjustments and filter. Cathodic protection is provided by the placement of anodes as required. The entire frame is to be painted in order to provide further protection against corrosion. All weldments are in accordance with ASME Section IX, 1989 Code Requirements.

The TMS structure is designed with guidance from Lloyds Rules for Lifting Appliances in a Marine Environment, to specify material allowable stresses and minimum load factors. A load test is carried out by the manufacturer and witnessed by a third party certified body.

5.2.1. TMS Lift Specifications

Lift Point Load :	Through Center Lift Point
Safe Working Load :	12.5 Metric tonnes (27,550 lbs.)
Design Load :	37.5 Metric tonnes (82,670 lbs.)

5.2.2. Latch System Specifications

Fail Safe Latch:	Fail-Safe spring to capture, hydraulic drive to open
Vehicle depressors	Hydraulically driven open/close.

5.3. TETHER

300 meters of 35 mm Nexans RT337 tether is installed on the TMS and terminated. The tether supplied has a history of successful operation. The tether may have a quantity of spare high voltage conductors and fiber elements to allow substitution for failed elements without re-termination. A detailed specification for the tether including electrical and optical element details, mechanical details, electrical and optical tests and optical properties are provided as deliverable documentation.

5.4. HYDRAULIC SYSTEM

The hydraulic system is capable of starting reliably through the entire depth rating of the TMS system. Operation in water is consistent through the entire water column allowing for typical seawater temperature and pressure variations over the full operating depth.

Gages to monitor pump output pressure, total compensator pressure and pump inlet pressure are panel-mounted with an unobstructed view from P&T camera. All gages are pressure compensated and not affected by depth and include appropriately rated seals.

5.4.1. TMS Hydraulic Power Unit

The TMS HPU consists of a proven, reliable electric motor/pump combination. The motor can sustain continuous operation at full horsepower through the operating depth and environmental conditions specified. The motor is suitable for operation in air to allow successful completion of:

- Normal pre and post dive checks.
- System set-up and maintenance.

Ground fault monitoring and indication with automatic shutdown capability is provided for the electric motor. Manual override of the shutdown is also provided. On/Off control of the motor is available at the pilot's console.

HYDRAULIC PUMP

Manufacturer	Rexroth
Model	A A10VSO (Modified) (or Hydra-Perm equivalent)
Operating Pressure	3000 psi
Displacement	12 cc/rev

ELECTRIC MOTOR

Manufacturer	SME
Model	10 HP Submersible
Operating Voltage	2,400 VAC, 3 ph
Poles	4
Frequency	60 Hz (reduced power at 50 Hz)
Power	10 Shaft HP (7.5 kW)
In Air Run Time	2 minutes

FILTERS

The hydraulic system includes pressure and return filters. All filters are readily accessible for filter change out with no horizontal filter bowl orientations. The filtration system ensures that component failure such as sheave drive motors does not result in ingress of potentially damaging materials into the compensator system or the main pump. The filtration system is designed to preclude the potential to create case pressures beyond specification in any hydraulically powered components.

Pressure Filter (1) Pall	22 micron	65 psi bypass
Return Filter (1) Pall	12 micron	65 psi bypass

CARDEV WATER FILTER

A Cardev water removing oil filter is installed on the hydraulic system.

HYDRAULIC COMPENSATORS

Hydraulic compensators are fitted with proportional volume feedback linked to the surface display and alarms. When multiple compensators are fitted per system, the compensator volume readout reflects total system volume accurately. The hydraulic low-level alarm will result in automatic shutdown of the electrical motor. Manual override of the shutdown is required. Total compensator volume is sized to deal with oil volume changes due to temperature and pressure variations likely to be experienced over the full operating range of the TMS. Each compensation group is equipped with an air vent point as well as a 10psi relief valve, to prevent over pressurization during maintenance procedures.

ELECTRICAL COMPENSATORS

Electrical compensators with proportional volume feedback linked to the surface display and alarms are fitted. When multiple compensators are fitted per system, the compensator volume readout reflects total system volume accurately. Total compensator volume is sized to deal with oil volume changes due to temperature and pressure variations likely to be experienced over the full operating range of the TMS. Each compensation group is equipped with a 10-psi relief valve, to prevent over pressurization during maintenance procedures

FILL AND DRAIN CONNECTIONS

Fill and drain connections are provided for maintenance to the system, from the customers hydraulic deck pack.

½ inch Pressure connection	Main System	Quick disconnect, with isolation valve
¾ inch Return connection	Main System	Quick disconnect, with isolation valve

OIL TYPE

The TMS operates on a single oil type over the full rated depth and environmental operating range and is the same type as used with the ROV.

SAFETY RELIEF VALVE

A safety relief valve that dumps to ambient is provided on the reservoir, and is set to 15psi, not to allow any over-pressurization of the system return or case drain circuits and their associated components during vehicle operation, filling and maintenance procedures. The safety relief valve does not allow water ingress during normal operation of the TMS.

5.4.2. TMS Hydraulic Manifold

The TMS hydraulic manifold provides control of the following hydraulic functions:

VLV No	Stn Des	Function	Valve
1	1a	Main Latch - Open	Directional control NG3 BM4D32
	1b	Main Latch - Close	Directional control NG3 BM4D32
2	2a	Fail Safe Latch - Close	Directional control NG3 BM4D32
	2b	Fail Safe Latch - Open	Directional control NG3 BM4D32
3	3a	Spare	Directional control NG3 BM4D32
	3b	Spare	Directional control NG3 BM4D32
4	4a	Spare	Directional control NG3 BM4D32
	4b	Spare	Directional control NG3 BM4D32
5	5a	Spare	Directional control NG3 BM4D32
	5b	Spare	Directional control NG3 BM4D32
6		TMS Control Valves Haul In	Prop flow control NG6 WDPFA06
7		TMS Control Valves Pay Out	Prop flow control NG6 WDPFA06

5.5. TMS SLIP RING ASSEMBLY

The slip rings are oil compensated with accessible fill and vent ports. The vent ports are positioned at the highest point for the compensated volume allowing complete removal of any air from the slip ring assembly. The slip rings are compensated in association with junction boxes and are isolated from the junction boxes to prevent drain down of the slip rings if the junction boxes are opened. All hoses containing electrical wires and fiber elements to the slip rings are clear and UV resistant. The slip rings have a quantity of spare high voltage, low voltage and fiber passes to allow substitution for failed elements without replacement or repair of the slip rings.

Manufacturer	Focal Technologies
Model	176 TMS
Fiber Passes	2 SM

5.6. TMS SURFACE CONTROLS AND DISPLAY

All TMS controls and displays are readily available to the Perry® XLX 150 ROV pilot. The tether in/out, latch and Pan and Tilt controls are contained in the pilot control shelf or console. Displays and status indicators are fitted in the Pilot console and displayed on the Operator Display. The controls and displays include:

- TMS Instrument Power On/Off
 - TMS Hydraulic Power On/Off
 - Tether In/Out (Joystick and Foot Pedals)
 - Latch Open/Close
 - Light On/Off and Dimming Control
 - Pan and Tilt Control
 - Camera On/Off
 - TMS Depth
 - Tether Length Deployed
 - Latch Status
 - TMS Motor Ground Fault Level
 - Light Ground Fault Level
 - Hydraulic and Electrical Compensator Levels
 - Altitude (optional)
-

5.6.1. TMS Subsea Control and Electrical System

The standard features include:

- Subsea computer and control system complete with all required interface PCB's.
- Single mode fiber optic multiplex system capable of supporting all the communication and video capability on one single mode fiber.
- DC power supplies as required with sufficient capacity for all control system components, fiber mux system, manifolds and sensors.
- AC power supplies as required with sufficient capacity for all control system components, fiber mux system, manifolds and sensors.
- GFD sensors for each separate power source.
- Salt water detect sensor.
- Interface for Digiquartz depth transducer (connector and circuit)
- Interface for Altimeter (connector and circuit)
- Interface for responder (connector, circuit and trigger)

All connectors are laid out to insure ease of installation and removal of cable connectors. No cable connector interferes with removal of any other connector. All bulkhead and cable connectors are to be open face pressure rated to at least 25% above the seawater pressure at the maximum operating depth of the TMS (3,000 msw).

5.6.2. Junction Boxes

Fixed junction box contains all circuit boards for TMS sensors and controls. Control system components will match the ROV PCB's for commonality of spares.

Termination junction box (part of Fixed junction box) houses a toroidal step down transformer for TMS instrumentation. Instrument power for the TMS is 2400volts, single phase. A boot gland fitting accommodates the umbilical electrical jacket sealing into the box.

Rotary junction box contains the connection between the slip rings and the tether. A boot gland accommodates the tether electrical jacket sealing into the box.

The drain and fill points of the fixed box will be of 1 inch diameter to provide quick drain and fill during cold weather service. Each compensation group is equipped with an air vent point as well as a relief valve, to prevent over pressurization during maintenance procedures.

Clear covers are provided on the junction boxes. The junction box frames will be labeled for ease of connector identification.

5.6.3. TMS Sensors

The following sensors are part of the base TMS and are fully integrated with the TMS system:

TMS CAMERA

A single colour zoom camera (P&T mounted) and a fixed mono inspection camera are included in the scope of supply.

PAN & TILT UNITS

A Hydraulic Pan and Tilt unit is fitted to the TMS. Brackets are included for the mounting of cameras and lights specified.

Manufacturer	Sub-Atlantic
Model	SA-A-5375-MAS
Tilt Range	±180° with hardware stops
Pan Range	±180° with hardware stops

TMS LIGHTS

Dual 250-watt light supply is installed and interfaced. Individual on/off control with dimming for the lights is provided. The light model is the same as used on the Perry® XLX ROV. GFD sensing is provided with audible and visual alarms including display of the ground fault level.

LED lamps

Manufacturer	Deep Sea Power and Light
Model	Sealite Sphere
Quantity	2 Total
Connector	Burton 5507-1503

OTHER SENSORS

Payout Counter	Digital readout (Both Pilots Graphics Display)
Depth Display	Digital readout (Both Pilots Graphics Display)
Latch Status	Latched/Unlatched (Both Pilots Graphics Display)
Tether In/Out Control	Pilot Operated Foot Pedals and Pilot Console Switch Control

Altimeter (Optional)

Tether Load

6. LAUNCH AND RECOVERY SYSTEM EQUIPMENT

Customer furnished equipment

7. UMBILICAL / SLIP RING / TERMINATION KIT

UMBILICAL CLEVIS / TERMINATION KIT

The umbilical clevis and umbilical are Customer supplied and are compatible with the TMS lift weldment. The termination kit contains all connectors and instructions to perform the termination but does not contain the clevis.

7.1. UMBILICAL WIRING

During manufacture, commissioning and Factory Acceptance Testing, the TMS will be configured to accept a Customer nominated free-issue umbilical. Forum will recommend initial wiring details and conductor allocations for the umbilical top and bottom connections.

The supply of this wiring recommendation is the limit of Forum's obligation and does not imply any umbilical warranty or guarantee of any kind.

8. VANS AND EQUIPMENT

CONTROL VAN

Control van is not included in the scope of supply.

WORKSHOP VAN

Workshop van is not included in the scope of supply.

9. SPARES

A spares kit will be suggested and provided as agreed by the Seller and Buyer.. The Seller will provide a detailed list of recommended spares to the Buyer for review and approval. The list shall include the part number, quantity recommended, and a drawing reference. The spares are exclusive of the deliverables and should be audited and accepted separate to this scope of supply.

10. DOCUMENTATION AND TRAINING

10.1. DOCUMENTATION, CERTIFICATION, TESTING CERTIFICATES

Documentation as per main contract requirements

Copies of all applicable testing or type rating certificates are supplied as part of the documentation deliverables. These shall include ROV or TMS load testing certificates for lift or attachment points and lifting slings.

10.2. SYSTEM MANUALS

The manuals shall allow an ROV operator to understand and/or complete:

- Theory Of Operation
- System Architecture
- Operational Limits
- System Maintenance
- Trouble-Shooting and Repair

The manuals contain the Sellers recommended operation/maintenance procedures, system general arrangement drawings complete with bill of materials and Seller or Vendor part numbers. Copies of the manuals in electronic format on compact disk are provided.

10.3. VENDORS MANUALS

OEM original manuals are provided on CD for all third party supplied equipment i.e. winch, printed circuit boards, thrusters, hydraulic components, tether, etc. If electronic files are not available, a hard copy is provided. Any components modified by Seller are clearly identified in the manuals.

11. STANDARDS

For a complete list of design and manufacturing standards see document A001-001-010.

11.1. STRUCTURAL AND TESTING.

Standards Body	Document No	Document Description	Rev date	Applicable to Specific ROV System
Lloyds		Lloyd's Register for Shipping - Code for Lifting Appliances in a Marine Environment	2010	Design Load factors Ch 3 – Sect 3 and Rope safety factors Ch 3 – Sect 3.8
DNV	2.22	Standard for Certification Lifting Appliances	2008	Permissible Stresses Ch 2 –Sect 3B and Test Loads Ch 2, Sect 6, B300
DNV	2.7-3	Standard for Certification of Portable Offshore Units	2006	Section 3.4.1 Pad Eyes
Lloyds		Lloyd's Register for Shipping – Rules and Regulations for the Classification of Ships	1993	Ships' deck accelerations.

11.1.1. Design Loading.

Forum specify the LARs components of ROV systems (Deployment Frame/Crane, Lifting Winches and Over boarding Sheaves etc) using the design criteria outlined in the following documents:

Lloyds Register	Code for Lifting Appliances in a Marine Environment.
DNV	Standard for Certification No 2.22, Lifting Appliances.
IMCA	The Initial and Periodic Examination, Testing and Certification of ROV Handling Systems.

When required by the client, the LARs design is certified and the items produced under the survey by one of these external bodies. The proof test of LARs systems is witnessed by an external body.

The sea parameters for various sea states are defined by Lloyds Register, Code for Lifting Appliances in a Marine Environment.

For operations in sea state 5-6, Forum design the structures of the ROVs and the TMSs to comply with the load cases listed in the above documents, or a Dynamic Amplification Factor of 3, whichever is the highest. For operations in sea state 7 ROV structures are designed to the load cases listed in DNV 2.22 (this generally equates to a DAF of 4).

The ROV and TMS frames are type tested to the above load cases.

11.1.2. First article design verification load test

The first article shall have a design verification load test performed to 3 x SWL for vehicles certified for Beaufort No. 6 Wind Force (Sea State 5-6) and 4g for Beaufort No. 8 (Sea State 7)

11.1.3. Production article load test.

Production articles are to be load tested to 2 x SWL.

The production load test requirement is based on DNV's Standard for Certification of Lifting Appliances, Ch 2 Sect 6, B300. Per Table B1 in this section, the test load for offshore cranes is 1.25 X SWL where SWL is redefined as the greater of:

$0.75 \cdot \psi \cdot \text{SWL}$
SWL

ψ = Design dynamic coefficient for the crane as calculated in Section 3, B300

Forum standard 3G vertical load implies a dynamic load factor of 2 for Load Case I defined in Section 3, C100. Therefore the redefined SWL is $.75 \cdot 2 \cdot \text{SWL}$ or $1.5 \cdot \text{SWL}$. This gives a test load of $1.25 \cdot 1.5 \text{ SWL}$ or 1.875 X SWL . Rounding this to 2 X SWL is then the Forum standard load test requirement. This also covers the load test requirement for loose gear as defined in Table B2, which is 2 X SWL for SWL's less than 25 tonnes.

11.1.4. Umbilical Factors

The minimum in air strength for main lifting umbilicals is based on the Lloyd's Register for Shipping - Code for Appliances in a Marine Environment, Rope safety factors Ch 3 – Sect 3.8.

This is enhanced by conservative practical experience that recognises that the wire rope armouring not only has to support the load in a safe manner, but also has to prevent the conductors in the umbilical from being damaged.

Forum therefore apply the following factors of safety:

	Typ FOS in Air	Min FOS in Air	Typ FOS in Water	Min FOS in Water
Sea State 5-6 Beaufort 6	8	7	5	4.3
Sea State 7 Beaufort 8	10	9	6	5

11.2. MATERIALS.

Lloyds		Lloyd's Register for Shipping - Code for Lifting Appliances in a Marine Environment	2010	Allowable Stresses Ch 3 – Sect 2.18
Lloyds		Lloyd's Register for Shipping – Rules for Manufacture, Testing and Certification of Materials.	2005	
DNV	2.22	Standard for Certification Lifting Appliances	2008	Permissible Stresses Ch 2 –Sect 3D
BS EN	10204	Metallic materials – types of Inspection Documents.	2004	Type 3.1 for Load Path Materials
DVN	OS-E101	Offshore Standard Drilling Plant	2006	Austenitic st st fasteners
DNV		Rules for the Classification of Ships	2011	Material chemical and mechanical properties Pt2, Ch2, Sec 1 B, C & D
BS EN	1999-1-1	Design of Aluminium Structures – General Structural Rules	2007	Aluminium Alloy Structures

11.2.1. Standard Material Properties

Forum use Lloyds/ DNV to define the design strength allowable stresses for elastic analysis of ROVs and associated structures, unless otherwise stated by contract.:

11.2.2. Load Path Hardware Certification Requirements

Primary structural members in main load path require material Mill Certifications. The certification standard for this is defined as BS EN 10204 Type 3.1, to include full mechanical and chemical analysis.

11.3. HYDRAULIC.

Standards Body	Document No	Document Description	Rev date	Applicable to Specific ROV System
Lloyds		Lloyd's Register for Shipping - Code for Appliances in a Marine Environment section Rules for piping systems	2010	Piping system design and testing
	PED (97/23/EC)	Pressure Equipment Directive		As appropriate as defined by pressure & volume
ISO	1219 Ed 2	Fluid Power Systems and Components	2006	Hydraulic symbols
Forum	A001-000-013	Hose Testing and Flushing Procedure – in line with ASTM D-380	2011	Hydraulic line validation and records.
BS EN ISO	D-380	Standard Test Methods for Rubber Hose	2006	Hydraulic hose testing
ASTM	D-380	Standard Test Methods for Rubber Hose	2006	Hydraulic hose testing
BS EN ISO	4413	Hydraulic fluid power. General rules and safety requirements for systems and their components	2010	Safety
PD ISO/TR	10949	Hydraulic fluid power, Component cleanliness	2002	Component cleanliness
NAS	1638	Hydraulic fluid cleanliness	1999	Fluid cleanliness
BS EN ISO	4406	Hydraulic fluid cleanliness	1999	Fluid cleanliness

11.4. ELECTRICAL

Standards Body	Document No	Document Description	Rev date	Applicable to Specific ROV System
BS EN	60076-1	Power Transformers, General	1997	Surface transformers
BS EN	60439-1	Low Voltage switchgear - superseded	1999	Surface power distribution
BS EN	61439-1	Low Voltage switchgear	2009	Surface power distribution
BS EN	60204-1	Safety of Machinery, Electrical Equipment of Machines – general requirements	2006 +A1 2009	Surface power distribution
BS	6883	Specification for elastomer insulated cables	1999	Surface power & instrumentation cables
BS	8450	Code of Practice for the Installation of Electrical & Electronic equipment in ships	2006	Surface equipment installation
BS EN	61000-6-4	Electromagnetic Compatibility, Generic Standards, Emission Standards for Industrial Environments	2007 +A1 2011	Surface equipment installation
BS EN	61000-6-2	Electromagnetic Compatibility, Generic Standards, Immunity Standards for Industrial Environments	2005	Surface equipment installation
BS	7671	IET Wiring Regulations	2008 +A1 2011	Surface Wiring
IMCA	D045 R 015	Code of Practice for the Safe Use of Electricity Underwater	2010	Surface and Subsea electrical systems
EEC	LVD 2006/95/EV	Low Voltage Directive	2006	Some Surface Electrical Equipment.

11.4.1. CE Marking Directive

The ROV surface power equipment comes supplied with a CE declaration of conformity. The surface control consoles will be supplied with a CE declaration of incorporation. They have been designed and constructed in accordance with the CE directive requirements to the standards listed, however no formal EMC or EMF testing has been performed.

A1. FLUID COMPATIBILITY

Mineral Oils for Hydraulic Systems and Motor Compensation:

Hydraulic Fluid Operating Temperatures vs. Viscosity Grade Recommendations

	Cold Start Temp °F (°C)	Min Operating Temp °F (°C)	Max. Operating Temp °F (°C)	Max. Intermittent Temp °F (°C)
Allowable Viscosities	4600 SUS Max.	165 SUS Max.	80 SUS Min.	60 SUS Min.
Shell Tellus 22	-0 (-18)	85 (30)	115 (46)	130 (54)
Shell Tellus 32	10 (-12)	100 (38)	130 (54)	150 (65)
Shell Tellus 46	25 (-4)	115 (46)	150 (65)	165 (74)
Shell Tellus T22	-5 (-21)	80 (27)	115 (46)	130 (54)
Shell Tellus T32	5 (-15)	105 (40)	140 (60)	160 (71)
Shell Tellus T46	15 (-9)	115 (46)	155 (68)	168 (71)
Shell Tellus T68	25 (-4)	130 (54)	170 (76)	170 (76)

Motor Compensation Operating Temp vs. Fluid Viscosity Grade Recommendations are shown below:

	Cold Start Temp °F (°C)	Min Operating Temp °F (°C)	Max. Operating Temp °F (°C)
Allowable Viscosities	5000 SUS Max.	90 SUS Max.	60 SUS Min.
Shell Tellus 22	-5 (-21)	110 (43)	130 (54)
Shell Tellus 32	10 (-12)	130 (54)	150 (65)
Shell Tellus 46	20 (-7)	145 (63)	165 (74)
Shell Tellus T22	-15 (-26)	110 (43)	130 (54)
Shell Tellus T32	5 (-15)	135 (57)	160 (71)
Shell Tellus T46	10 (-12)	150 (65)	170 (76)

Environmentally Friendly Oils:

The following list of fluids have been investigated and found to be suitable for use in Forum supplied equipment. Note that this list is not exhaustive such that other fluids are potentially suitable for use, in addition to the fluids listed:

- Fina Biohydran 32.
 - Chevron Clarity 32.
 - Mobil EAL 224H 32.
 - Hydrosafe 32.
 - Terresolve Envirologic 132.
 - Enviro-Rite 32.
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