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1 SPECIFICATIONS

1.1 Plough

Trench depth	: 1.6m nominal, providing 1.5m cable burial, 2m in soft ground through programmed sinkage
Weight in air	: 12.2 tonnes
Dimensions	: Approx. 9.1m long (with skids down) x 3.5m high x 4.0m wide
Design strength	: Structure will withstand a sustained pull of 50 tonnes
Cable/joint size	: Cable passage 200mm wide, allows joint diameters up to 180mm to be buried.
Cable bend radius	: 1.5m minimum in bellmouth and share
Depth control	: Hydraulically adjustable 0-1.6m, remotely controlled from surface
Sub-sea HPU	: 7.5kW vehicle mounted unit
Steering	: Hydraulically adjustable, min 70m radius approx.
Deployment & Recovery	: Hydraulically adjustable drawbars used for deployment and recovery, lowered into horizontal position for towing.
Operating water depth	: 300m maximum (limited by electronics pod pressure vessel and umbilical). EB would be pleased to advise on the possibility of upgrading to 1000m operating water depth.

1.2 Plough Hydraulic System

Hydraulic Functions	: Subsea manifold incorporating counterbalance valves for load holding Hydraulic cylinder for operation of depth control skid Hydraulic cylinder for operation of cable depressor Hydraulic cylinders for operation of steering Hydraulic cylinders for operation of port and starboard drawbars Hydraulic cylinder for operation of HPU Frame lift
Hydraulic Power Source	: 1000v, 7.5kW motor Hand pump for manual operation of cylinders Quick release connections for connection of an auxiliary HPU
Hydraulic Cleanliness Requirement	: NAS 10 suggested

1.3 Plough Oils and Lubricants

Hydraulic oil	: Standard hydraulic oils e.g.: <ul style="list-style-type: none">➤ Tellus T37➤ Hydrodrive HPE118 (recommended)➤ DEA Econa E46 (biodegradable)
Grease for pins	: Aqualube (recommended)
Oil for junction box	: Standard hydraulic oil as used in the hydraulic system.

**1.4 Paint and protective coatings**

Vehicle external surfaces	: Leigh's Paints 3 Coat Epoxy System: Shotblast to Swedish Standard Sa 2½ average surface profile 50-75 microns 100 micron coat DFT Epigrip L425 150 micron coat DFT Epigrip L653 50 micron coat DFT Resistex M137 Zinc Yellow (RAL 1018)
Vehicle internal surfaces	: Hammerite Waxoyl (clear)

1.5 Control Cabin

Format	: ISO 20' Container. (20' x 8'6" x 8')
External Dimensions (mm)	: 6096L x 2438W x 2590H
External Surface Treatment	: Steam Cleaned, Marine paint specification,
Electrical Services	: Externally mounted plough power module (See below). Feeds 100A 1Φ distribution board inside cabin (40A required) providing circuits: Lighting, Power Outlets, Air Conditioner, Spares. All circuit breakers are double pole. Separate external termination cabinet for interfaces.
Lighting:	: <ul style="list-style-type: none">➤ 4 off Fluorescent lights (twin 36W) for maintenance➤ Dimmed low voltage dichroic downlighters for operations➤ 1 off Battery backed emergency light
Power Outlets	4 off twin BS1363 Standard British 3 Pin socket outlets 230V AC nominal to a total of 16A, protected by a 30mA RCD. Mounted on trunking above desk level. 1 off Air conditioner outlet, protected by a 20A MCB with a double pole isolator / junction box to allow removal of the ACU in transit.
Furniture	: Heavy duty non-slip vinyl flooring with 100mm PVC skirting. Heavy duty desk for pilot, two LCE operation stations. Filing cabinet. Three operators chairs.
Environmental	: Insulated for comfort with 100mm glasswool behind melamine faced chipboard walls. Air conditioning unit fitted in wall between pilot area and "plinth" area
Lifting	: ISO corner blocks (8 corners), Fork lift pockets in base
Doors	: Steel single personnel door
Windows	: Two 1000H x 1500W windows double glazed, non opening with venetian sun blinds. One small window in short end. Supplied with steel covers for transport.
Other	: 100V line speaker provided for connection to the vessel general alarm system. 1 white magnetic board. (900mm wide x 1200mm high). CO ₂ fire extinguisher

1.6 Power Cabinet

Format	:	Heavy Duty, floor standing, Sheet Steel Enclosure (800W x 500D x 770H), Enclosure electrophoretic dipcoat primed and powder coated with RAL 7032 finish.
Electrical Supply In	:	440V 60Hz 125A, 3Φ ships supply. Approx. load 40kVA
Subsea Supplies Out	:	Nominal 1000V, 3Φ, 60Hz, 10kVA Subsea Motor Supply, isolated and insulated to 3.3KV Nominal 600V, 1Φ, Subsea Pod Supply isolated and insulated to 3.3kV,
Subsea Supply Protection	:	Line Insulation Monitor (x2), Earth Continuity Monitoring (x2), Emergency Stop, Under voltage release, Motor Protection Relay, Primary short circuit protection
Subsea PSU Control (Remotely Positioned)	:	Start button (x2), stop button (x2), emergency stop button, ECM reset button, overload reset
Subsea PSU Indication (Remotely Positioned)	:	Incoming supply voltage meter (x3), motor supply current meter (x3), Supplies on LED (x2), LIM warning LED (x2), LIM Fault LED (x2), ECM OK LED (x2), motor overload LED
Domestic Supply Out	:	Nominal 230V 60Hz 1Φ, 63A, 40kVA for cabin domestic distribution board
Preservation Supply Required	:	Nominal 2kVA 230V AC supply for control cabin heaters
Plough Deck Cable	:	50 metres of armoured umbilical linking to umbilical winch

1.7 Video & Network Rack

Format	:	19" Telecoms Rack, 600mm x 600mm footprint, nominal 40U space
Electrical Supply	:	Domestic supply 230V AC 1kVA
Power Display Panel	:	Metering, indication and control for the power module as specified above
Network Hub	:	8 Port 10BaseT Ethernet: Netgear EN108TP
PLC	:	<ul style="list-style-type: none">➤ Allen-Bradley SLC5/05 (1747-L551)➤ Remote I/O Scanner (1747-SN)➤ 8 Channel Analogue Input (1746-NI8)➤ Power Supply (1746-P2)➤ 7 Slot Rack (1746-A7)➤ 16 Channel Digital Input Card (1746-IB16)➤ 8 Channel Digital Relay Output Card (1746-OX8)



1.8 Pilot's Desk Station

- Format : Professional heavy duty desk module with inset 19" telecoms rack.
Concealed wiring panels
- PC Type : TBA as the system has recently been upgraded, including operating system
➤
- UPS : Fortress 700VA
- Printer : Epson LX-300 Line Printer
- LCD Screens : Three 15.1" SVGA LCD displaying 1024x768 pixels Truecolour at 60Hz refresh rate. One unit has an auxilliary SVHS/composite video input. Displaying Pilot's graphics, Sonar, Plough & Deck TV Pictures.
An additional LCD monitor is mounted in the telcoms rack to display navigation/survey images.
- Video Interfaces : Quad splitter allowing four plough/deck cameras to be displayed simultaneously on one LCD display
Two Vine Micros CorioSCAN to converters for the pilot's screen and sonar output into SVHS/composite video for recording on VCR
Video switches and distribution amplifiers to allow composite video pictures to be selected for video recording and distribution to the bridge.

1.9 Bridge PC Computer Station

- Format : PC computer as above mounted in 19" transit case (15U), components in rack cases / rack trays
 - UPS : Fortress 700VA
 - Modem : US Robotics / 3COM Sportster External (V90)
 - Screen : 15.1" SVGA LCD displaying 1024x768 pixels Truecolour at 60Hz refresh rate.
 - Video Interfaces : WinTV video input card to display composite video/SVHS on VGA LCD screen
➤
-

**1.10 Umbilical System**

- Cable : Hydrocable “Scorpio 8” pattern cable. 1100m supplied on umbilical winch. 50m length supplied terminated as deck cable from winch to plough control.
- Power Carried :
 - 1000V AC 3Φ for Subsea Motor
 - 600V AC 1Φ for Subsea electronics
 - Protective earth
- Signals :
 - Telemetry (Allen Bradley Remote I/O at 57.6 kbits/sec)
 - Video (Three co-ax available, 2 used)
 - Two ECM loops for pod & motor
 - Responder trigger
 - Sonar
 - Water Ingress
 - Hydrophone audio
- Electrical Terminations : Glanded in to rotating junction box at “dry” end. Electrical bundle passes through mechanical termination into oil filled junction at the “wet” end. “Wet” end has two Hydrobond connectors for pod and motor whips.
- Slip Ring : Trolex TX4820 type. Space allocated for future upgrade for Fibre Optic Rotating Joint. “Nova Scotia” mounting pattern.

1.11 Subsea Junction Box

- Mechanical : Stainless steel box of welded construction with bolted Perspex lid (neoprene gasket)
- Compensation : Hydraulic oil filled with rubber bellows volume compensation. Air bleed and fill/drain ports.
- Connectors : Electromek bulkhead, generally 2-pin, 4-contact
- Terminals : Standard DIN rail mounting from Weidmuller Klippon
- Harnesses : Each transducer is connected to the junction box by means of an individual harness. See harness GA drawing for details.

1.12 Subsea Electronics Pod

- Mechanical : Cylindrical 316 stainless steel pressure vessel with separate faceplate attached by a bolted flange with “o”-ring seals (barrel & face). The other end plate is welded to the tube.

Contents mounted on frame cantilevered off faceplate, resting on plastic runners bonded to the inside of the cylinder to allow contents to be easily withdrawn.
- Electrical Connectors : Five Hydrobond HRS308-29P/BS mounted on faceplate (one spare)
- Power System : Two off Switch mode primary power supplies, 86-264V AC input, 24V DC output at up to 10A. Primary protection through internal MCB.

24V DC power supplies fed through individual isolation relays and self-resetting fuses.
-



- Internal Sensors : Pitch & Roll Inclinometer
- Water Ingress Sensor
- PLC I/O : Allen Bradley Flex I/O:
 - 2 off Remote I/O Interface (1794-ASB/C)
 - 3 off 8 Channel analogue input (1794-IE8)
 - 6 off 8 Channel relay output (1794-OW8)
 - 1 off 2 Channel Digital Pulse Counter (1704-ID2)

1.13 Instrumentation

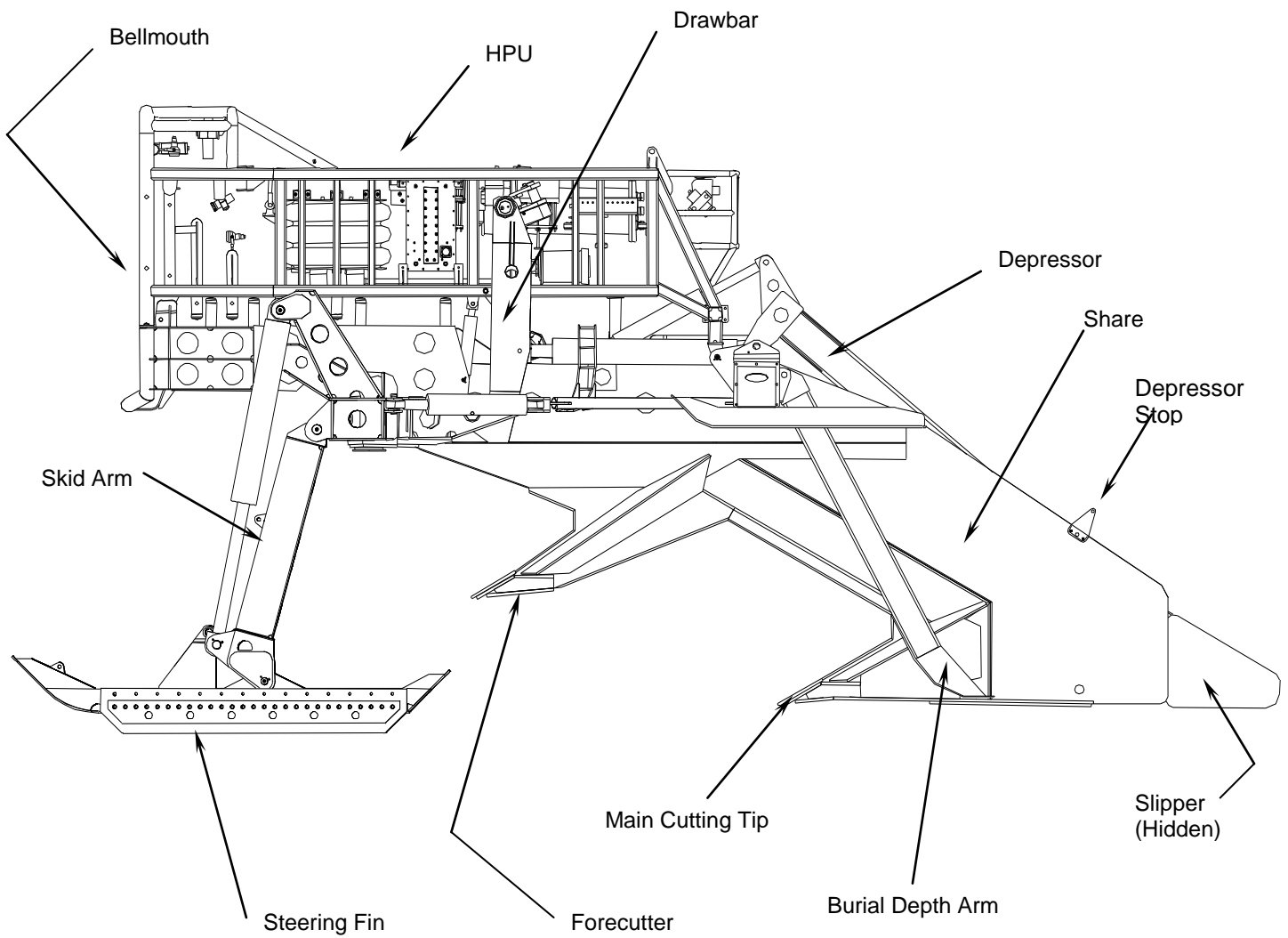
Monitoring	:	Plough pitch	Inclinometer inside pod
		Plough roll	Inclinometer inside pod
		Water depth	Druck 0-50 bar pressure transducer
		Hydraulic system pressure	Druck 0-400 bar pressure transducer
		Oil volume	Rota displacement transducer
		Motor temperature	PT100 temperature sensor
		Port tow load	DLM 50t load cell in port tow point
		Starboard tow load	DLM 50t load cell in starboard tow point
		Cable tension	DLM 5t load cell (calibrated for 2t max. cable tension)
		Port vertical tow angle	Sub Atlantic Rotary potentiometer in port tow point
		Starboard vertical tow angle	Sub Atlantic Rotary potentiometer in stbd tow point
		Cable horizontal entry angle	Sub Atlantic Rotary potentiometer in cable feelers
		Skid arm position	Baluff in-cylinder displacement transducer
		Trench depth	Sub Atlantic rotary potentiometer fitted to trailing arm
		Port drawbar position	Baluff in-cylinder displacement transducer
		Starboard drawbar position	Baluff in-cylinder displacement transducer
		Steering position	Baluff in-cylinder displacement transducer
		Distance travelled	Sub Atlantic rotary encoder in cable travel wheel
		Depressor fully-down position	Rota displacement transducer
		Pod moisture ingress	Raychem moisture-sensitive cable in electronics pod
		Compensator low level detection	Electromek Reed switches fitted to compensators for valve tank, junction box and umbilical termination



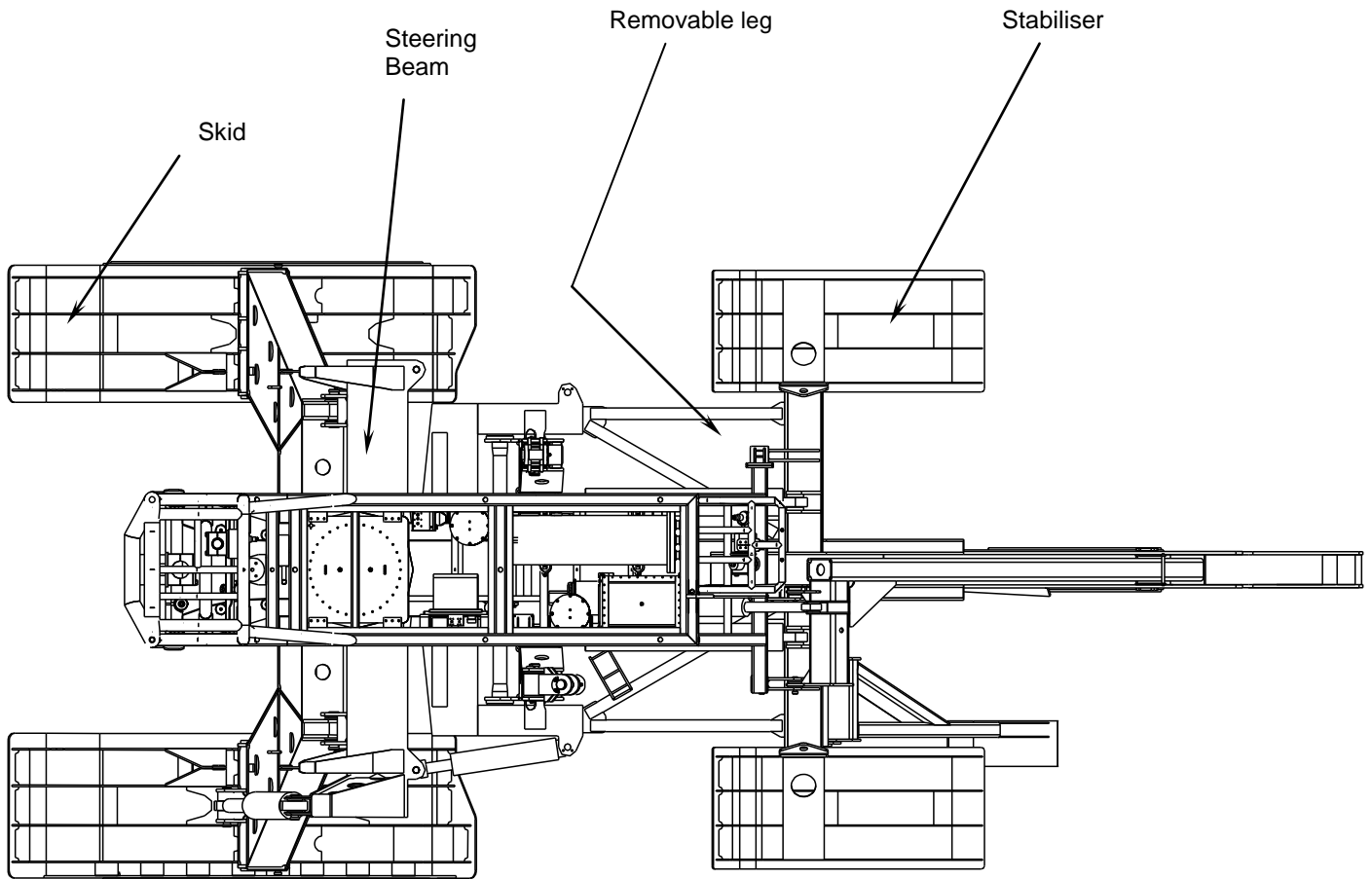
2 DESCRIPTION OF PLOUGH

2.1 Construction

The plough comprises a number of sub-assemblies that are welded, pinned or bolted together.



PORT SIDE ELEVATION



PLAN VIEW

2.2 Chassis

The chassis is the main load-bearing member, constructed of high-strength steel plate. A front clevis is positioned below the bellmouth to mount the steering beam. Arms either side of the main chassis spine support the drawbars in their towing position and have brackets for attaching the steering cylinders. Legs at the rear of the plough provide flange mountings for the rear stabilisers. There are brackets for mounting the HPU Frame and drawbar cylinders. On the port side, brackets for the depressor and the depth measurement arm are included. The chassis spine also has an attachment point for the depressor hydraulic cylinder. Struts between the arms and legs of the chassis provide structural stiffness and strength.

Auxiliary lift points are provided at the end of the chassis legs, together with lifting points on the steering beam skid restraint towers these would suit a 4-legged sling for lifting.

2.3 Share

The share is welded onto the underside of the chassis. It is mainly constructed from 20mm thick abrasion resistant steel plate. The share extends 1.84m below the bottom of the chassis beam. The share is sloped backwards and forms a channel 200mm wide in which the depressor holds the telecom cable. The 200mm internal width allows joints up to 180mm diameter to pass through the plough and be buried.

The lower part of the share is raked forwards and carries out most of the soil cutting. The front plates are angled out sideways by a small amount so that as the plough is pulled through the seabed the soil is



pushed upwards and outwards to provide a passage for the share. These front plates and the bottom "heel" plate are made of wear-resistant "Trimay" material.

In front of the main share is a secondary blade or "forecutter". The forecutter helps to reduce the pull force required to cut the soil, particularly in dense, impermeable sands and stiff clays. The total force required to cut a deep trench in two shallow cuts is less than the force required to make a single, deep cut in these conditions.

Where the cable enters the top of the share, a 12mm thick abrasion resistant plate with a bend radius of 1.5m supports it. If the plough is lifted with the cable in the share, the cable is free to exit vertically from the bottom of the share behind the heel. The bend radius here is 0.5m as the cable is only subject to very low tension during deployment or recovery of the plough.

2.4 Depressor

The cable is held into the share by the depressor. The depressor is pivoted on the chassis to allow it to be lifted clear of the share for loading and unloading of the cable and to allow joints that are larger than 180mm diameter to be passed over the back of the share. The depressor is cantilevered from the pivot so that there is a clear passage for loading and unloading the cable on the starboard side of the plough.

A fabricated stop is bolted to the inside of the share. This allows the depressor to be raised enough for joints to pass through the share without the cable escaping. At the rear of the share, the gap between the rear edge of the share plates and the depressor plates is about 10mm, so there is no risk of the cable becoming trapped even if the share rides out of the ground.

With the depressor fully down, the top of the cable is approximately 100mm above the bottom of the trench. This prevents the cable from supporting the weight of the plough (unless it is greater than 100mm diameter) and accounts for the difference of 100mm between trench depth and cable burial depth.

A double-acting hydraulic cylinder provides a means of enabling the depressor to be lifted out easily from the share and to push down a cable under tension after passing a wide joint. This cylinder can be operated using the control system provided by The Engineering Business or by means of a manual hand pump located within the HPU Frame.

A cable wear plate covered 'slipper' is fitted at the bottom of the depressor foot. This contains a 5 tonne shear pin load cell to allow measurement of the tension in the lay cable as it exits through the plough.

2.5 HPU Frame/Upper Bellmouth

The HPU Frame pivots towards the rear of the chassis in three brackets. Raising the frame by means of the hydraulic cylinder enables cable loading. The starboard leg of the frame must be disconnected from its flange connection by means of four bolts to allow the cable to be loaded.

The frame contains the Sub-sea power pack, pod, junction box, electrical termination and surveillance gear. It also incorporates the upper half of the bellmouth which, when the frame is fully lowered meets the lower half by means of locating spigots and is locked in position by pins at the front of the bellmouth. The upper and lower halves of the bellmouth provide a smooth surface with 1.5m bend radius for cable entry $\pm 30^\circ$ laterally and 30° below the horizontal. The top surface comprises a series of tubes forming a 1.5m radius bend to 60° above the horizontal.

The cable travel wheel is fastened underneath the frame to provide an indication of plough movement along the cable.

Cable feelers attached within the frame at the front of the bellmouth detect the horizontal cable entry angle of the cable. Extreme angles of entry would indicate the need to use the steering on the plough or re-align the tow vessel.

2.6 Steering Assembly

The two front skids are pivoted on a single skid arm to provide depth control adjustment. Each skid is approximately 3m long by 1m wide to reduce the ground bearing pressure for operation in very soft muds without excessive sinkage. Fins are bolted (High Tensile Grade 12.9 bolts) to the outer sides of the skids and provide the turning effect when the steering is activated.

The skid arm is pivoted about the steering beam and the double-acting hydraulic cylinder sets its position. Extension of the cylinder pushes the skids downwards and reduces the depth of cut of the



plough share. The steering beam can be rotated $\pm 6^\circ$ by means of two hydraulic cylinders either side of the chassis to provide a 70m turning radius.

To prevent the fronts of the skids from 'hanging down', a restraining chain is fixed between each skid and the steering beam.

The bottom plate of the skids and the steering fins are Hardox 400 material to reduce wear. New wear plates can be welded on to increase the life of the skids. The steering fins are subject to severe wear and should be replaced when required.

2.7 Rear Stabilisers

The rear stabilisers are bolted to the rear crossmember of the chassis. The purpose of these is to increase surface area and prevent the rear end of the plough from sinking in very soft muds where the heel cannot generate adequate support area. The stabilisers are set to allow a maximum trench depth of about 2 metres.

2.8 Lifting Drawbars

The plough is towed using a wire rope bridle attached to two drawbars. Each drawbar is designed to withstand the full working tow load of the plough (50 tonnes). The drawbars can be raised to an upright position for deployment and recovery of the plough but are lowered to a horizontal position for towing. For cable loading it is necessary to have the starboard drawbar in its horizontal (lowered) position with the wire rope removed from the tow swivel.

2.9 Wearing Parts

Various parts of the plough are subjected to wear, either through soil abrasion or by contact with the telecom cable.

The soil cutting surfaces on the share are made from "Trimay" plate, which is a chrome carbide deposit fusion welded onto a steel base plate. This has excellent abrasion resistant characteristics. Welding with hard-facing electrodes can repair local areas where wear is high. Eventually the complete plates can be removed and replacements welded on to the share using a straightforward weld procedure.

The main share side plates, the front skid bottom plates and cable route bends are made from Hardox 400 material.

2.10 Load Cases and Materials

The plough structure is fabricated from high strength steel plates, structural hollow sections and tubes. In general, materials equivalent to BSEN 10025 S355 J2 are used (minimum yield stress, 355 MPa). Where abrasion resistance is required, the steel used is Hardox 400 or equivalent (yield stress 1000 MPa). Pins are machined from high strength stainless steel BS970 431S29 (minimum yield stress 680 MPa).

The plough is designed to withstand the following principal load cases:

Normal ploughing - sustained pull force of 50 tonnes, 0-15° vertical tow angle.

Obstructed share - 50 tonnes pull load, skids operated to full system pressure.

Obstructed skid - 20 tonnes longitudinal or 10 tonnes lateral load applied to one skid.

Lift points - designed to withstand 3 x plough weight in air.

Cable tension - maximum 2 tonnes cable tension.

The design provides a factor of safety over yield stress that depends upon the likely occurrence and severity of exceptional loads that may be generated.

2.11 Instrumentation and Surveillance

The following most critical parameters are monitored on the plough. There are other sensors fitted.

Pitch: : Fore and aft pitch angle ($\pm 60^\circ$) is measured using an inclinometer mounted in the subsea pod

Roll: : Lateral roll angle ($\pm 60^\circ$) is measured using an inclinometer mounted in the subsea pod

Water depth: : Plough operating depth below sea level is measured using a transducer to determine



	:	ambient water pressure (0-50 bar range providing 0-500m submerged depth).
Tow load:	:	The towing load is measured at the port and starboard towing points, each fitted with a 0-50 tonne shear pin load cell. The total tow load is calculated in the monitoring software by adding the individual measurements
Cable tension:	:	The tension in the lay cable (0-2000kg) is measured using the shear pin load cell mounted in the cable slipper in the depressor
Horizontal cable angle:	:	Lateral lay cable entry into the bellmouth is detected by cable feelers connected to a rotary potentiometer
Cable travel:	:	Rotation of the cable wheel is detected by a rotary encoder that provides an indication of plough movement and speed along the cable.
System pressure:	:	Pressure in the hydraulic circuit is measured using a 0-400 bar pressure transducer. This pressure is corrected for ambient pressure
Skid position:	:	Position of the skids relative to the chassis is measured by a Balluff transducer mounted in the depth control cylinder. The cylinder extension reading is calibrated to provide the nominal height of the bottom of the skids above the bottom of the share (0-1.6m, ± 0.01 m).
Steering position	:	Position of the steering beam relative to the chassis is measured by a Balluff transducer mounted in the port steering cylinder. The cylinder extension reading is calibrated to provide an angle of 0-6° port and starboard
Drawbar position	:	A Balluff transducer mounted in the drawbar cylinders measures position of the drawbars relative to the chassis. The cylinder extension reading is calibrated to provide an angle of the drawbar relative to the chassis (horizontal)
Depressor position	:	A Rota transducer mounted in the depressor cylinder measures position of the depressor relative to the chassis. The cylinder extension reading is calibrated to provide a nominal height reading
Tow angle	:	Tow swivels at the end of each drawbar are connected to rotary potentiometers to give an indication of the tow angle
Trench depth:	:	A trailing arm is mounted from the rear crossmember of the chassis. A rotary potentiometer provides a measurement of the angle of the arm. From this, the depth of trench that the plough is cutting is calculated (0-2.2m, ± 0.01 m).
Hydrophone:	:	A Benthos AQ-17 hydrophone with integral pre-amplifier is fitted to the plough. The signal can be heard through speakers provided and gives an indication of the seabed conditions and whether or not the motor is running.
Transponder:	:	RPT 319 Transponder/Responder 90° beam pattern. Allows the plough to be tracked as an underwater target by a vessel mounted HPR system.
Cameras:	:	Fixed Camera in Bellmouth, fixed focus allowing product to be seen entering the bellmouth. Pan & Tilt Camera at rear, automatic iris lens, fixed focus, high light sensitivity allowing product to be seen entering share and umbilical direction to be observed.
Lamps:	:	Four 24v AC, 50W to provide illumination for the cameras
Sonar	:	6000m water depth RS485 digital telemetry, 24v DC Obstacle avoidance unit (fan beam) to allow underwater obstacles to be sensed and steered around.
Pan & tilt unit	:	24v, 360°, pressure compensated to allow aft camera to be moved.

2.12 Hydraulics

The plough has its own sub-sea power pack and all hydraulic functions may be controlled using the trenching control system software. The power source is a 7.5kW motor connected to a flexible hydraulic reservoir and both are mounted within the HPU Frame. The system pressure relief is set at 250 Bar. The



hydraulic gear pump is sized to give a hydraulic power of about 5kW at this pressure so that the motor/pump can be continuously run at full performance. The motor is fitted with a temperature sensor. A manual hand pump is also fitted for actuation of hydraulic functions without supply from the motor.

There are seven double acting hydraulic cylinders within the circuit. One adjusts the position of the skid arm to provide control over the trench depth, the port and starboard drawbars each have their own cylinders and the steering is controlled by two cylinders driven by a single directional control valve. The steering cylinders are connected so that the pressure and tank lines are each connected to a full bore on one cylinder and an annulus on the other. The HPU Frame has a cylinder to lift the frame giving access for cable loading. The depressor also has a cylinder for assisting with cable loading and helping to push the cable down to the bottom of the trench if it is under tension.

A manifold block incorporated into a valve tank directs the flow of oil from the motor using a series of solenoid operated directional control valves, each fitted with counterbalance valves to provide load holding. The drawbar functions also have a 'float' function. This enables the drawbars "ratchet up" when lifted for recovery in case of complete electro-hydraulic failure.

In the event of loss of oil from the system or for movement of the hydraulic functions without the use of the motor (or handpump) a deck power pack may be connected to the quick release couplings on the circuit. In this case the ball valve on the return manifold must be moved to its correct position.

2.13 Control System

The control and monitoring system provides a means of gathering information about a burial process and direct control of the machine hydraulic functions. The equipment is supplied with a cable plough, but can readily be used with other machines.

The EB control system is designed to be reliable, flexible and easy to operate. It comprises a SCADA (Supervisory, Control and Data Acquisition) system based on modern PLC and PC and EB produced software.

Data collection and control is undertaken by the Allen-Bradley PLC. Managing the flow of data and providing a user-friendly operator interface is the task of a PC and distribution of information to and collection from other parts of the ship is through the provision of a Windows NT TCP/IP network.

Cable lay and plough operations are controlled from a single control cabin with information and monitoring available on a separate bridge station.

The information gathered is represented as follows:

- On LCD displays in the control van and bridge.
- As a digital data log stored on the hard disc drives of networked computers
- As a paper printed log from a line printer
- As video taped information from the pilot's display or a sub-sea camera
- As a series of data-links out to other equipment

2.13.1 Major Components

The purposes of the major components (as illustrated in the following block diagram) are outlined below.

2.13.2 Control Cabin

Where a vessel does not have a suitable space in the accommodation block to provide a control room, the control cabin provides a climate controlled "office" that can be placed on deck from which operations can be controlled. The container is designed to be road, sea or rail transported. The control cabin also houses the LCE control consoles so that plough and LCE operator can communicate easily.

2.13.3 Power Cabinet

The power cabinet provides the following functions:

- Houses the incoming power connections and switchgear
 - Houses the transformers for domestic, pod and motor supplies
 - Houses the power protection relays and monitoring components
-



- Provides electrical terminations for the umbilical system power cores

2.13.4 Video & Network Rack

- Houses the primary control computer (PLC)
- Houses the network transmission equipment (Ethernet Hub)
- Houses the video distribution switcher and amplifiers

2.13.5 Pilot's Desk Module

The pilot's desk provides:

- Displays of TV cameras on the plough and deck, operating MMI graphics and sonar
- Control buttons for the plough hydraulic functions, power system and screen displays
- Video Recorder
- Marine radio base station
- Computer to generate operational graphics
- Computer acting as sonar processor

The control PC computer provides the following functions:

- Draws the pilot's operator interface on screen
- Is the master data-logger
- Is the master node on the Ethernet Network

2.13.6 Bridge PC Computer

The bridge PC computer provides the following functions:

- Draws the bridge data display graphics screen
- Provides the interface to the vessel navigation or positioning system
- Houses the video display card for bridge display of camera pictures
- Provides the modem interface for external connection to the data network

2.13.7 Umbilical System

The umbilical system transmits power and control signals from the surface equipment to the subsea plough. The values read by transducers and signals from surveillance equipment mounted on the machine are then returned to the surface through the umbilical system.

2.13.8 Umbilical Termination

The umbilical termination comprises a mechanical strain termination for the cable armour wires and a separate electrical termination that is in an oil-filled and compensated housing. The electrical termination acts as the junction box between the umbilical cable and the separate cables for the motor and the electronics pod.

2.13.9 Subsea Electronics Pod

The subsea electronics pod is a stainless steel pressure vessel rated for operation to 300 metres of sea water. It contains a multiplexer which interprets the coded signals transmitted through the umbilical into power supplies for the subsea transducers, then measures all of the transducer signals and encodes them for transmission back up the umbilical. It contains the power supplies and switching for the transducers and surveillance equipment.

2.13.10 Subsea Junction Box

The subsea junction box provides the link between the electronics pod and the individual transducers and surveillance equipment. Each transducer and camera, lamp, etc. has its own individual subsea harness that enters the junction box through a bulkhead-mounted subsea connector. Connection from junction box to pod is by means of two multi-core harnesses fitted with 29-way Hydrobond connectors at



the pod faceplate. The junction box is fabricated from stainless steel with a clear plastic lid and is oil-filled and pressure compensated.

2.13.11 Subsea Sensors

There are a number of subsea electrical sensors. They are each given a local low voltage supply from the electronics pod. This power supply allows the transducer to convert some mechanical signal into an electrical signal thus measuring the performance of the machine.

2.13.12 Subsea Valve Tank

The subsea valve tank provides the interface space from electrical control signals to the plough hydraulic system. The valve tank is fabricated from stainless steel with a clear plastic lid and is oil-filled and pressure compensated. An 8 station hydraulic manifold supports valve stacks each topped with solenoid operated valves that energise the relevant functions. Sensors relevant to the hydraulic system are also connected to the valve tank which acts a central marshalling point.

2.13.13 Block Diagram
