



A NEW GENERATION

CSIP has created the market's first 5 Function Underwater Electric Manipulator arm, ARM 5E. Using techniques developed for its advanced 7 Function hydraulic arm, CSIP has designed a 5 Function Electric arm rated for use at depths down to 3,000 metres with a minimum lift capacity of 25kg.

The arm is formed of HE30 hard anodised aluminium, 316 stainless steel and nickel aluminium bronze. The arm has a radius of 1.044m reach, a slew of 120° and the following gearbox ratios: slew 15:1, shoulder 47:1, elbow 15:1, jaw rotate 15:1, jaw open/close 3.8:1. As with other manipulator arms, the jaws can be grabber or parallel, or replaced with brushes or cutters.

Deepwater environments are extremely inhospitable for humans. Remotely operated manipulator arms attached to subsea vehicles are a far safer alternative for performing subsea work. Remote manipulation allows research vessels to pick up and move underwater objects. Manipulator arms are the mechanical equivalent of a human's arms and hands.

TV cameras, lights and sonar systems can be added to allow operators to navigate and complete the task.

Manipulator arms are used in a variety of applications including oil and gas, offshore operations and work on various submerged underwater structures. The most basic remote manipulator systems contain only an operator-input device and a jointed manipulator arm. More sophisticated systems can also contain control electronics, with the manipulator arm attached to a tool such as jaws, drills or a pair of snips.

The design of manipulator arms has improved dramatically over the past few years. This has been achieved through integrating effective ease of use along with power, dexterity and control. The arms have become much easier to operate and maintain in terms of flexibility and modularity. They are now lighter in weight, fitted with larger bore arms and have integral centreline extenders. Almost all manipulators on the market are hydraulic, requiring a pump and valve pack to provide power for the arms. Hydraulic arms struggle to

perform incremental accurate movement and fail to match the capabilities of the current electric Remotely Operated Vehicles (ROVs).

With the creation of the electric arm, CSIP has therefore responded to the need for manipulator arms to have the technology to keep pace with the electric ROVs. The all-electric arm has therefore been designed to compete with hydraulic arms on the market but has several advantages.

The arm can be mounted in the same footprint as conventional hydraulic arms but does not require a 'skid' underneath the vehicle, as traditional hydraulic paraphernalia such as a hydraulic pump or valve pack are not necessary. This saves weight and allows greater vehicle manoeuvrability.

Like hydraulic arms, the 5 Function Electric Arm can be used for clearing debris, turning valves and cutting but it has more incremental movement, allowing for greater accuracy and more precision in operation. The arm's digital positioning feature can achieve an accuracy of approximately 0.5mm and the computer control electronics use position feedback to

showing where the slave arm is positioned at the present time in 'x', 'y', 'z' and 3D with further 'menu' screens showing current status and diagnostic information (and for setting the manipulator arm offset, span and gain), a screen showing pressure loading on each manipulator joint (either as a bar graph or numbers) and a screen for setting the recording or playback of arm positions and movements.

The user-friendly surface control unit comprises of a joystick which controls left/right (slew) and up/down movement, with a twist function for jaw rotate. A thumbwheel controls jaw open/close.

Function Manipulators produced at CSIP are formed from either aluminium or titanium and expect to have life spans of over 25 years.

CSIP was founded 25 years ago to service, maintain and repair the Royal Navy's fleet of RCMDs (Remote Controlled Mine Disposal System) submarine vehicles. Defence remains at the heart of the organisation, with 14 Navies around the world using CSIP's expertise to deal with mine disposal and feasibility studies. Although CSIP still has a large involvement in this activity it has now diversified to utilise core skills to develop other related business areas.

As part of the ECA Group, CSIP has access to some of the most advanced technology in the robotic systems field. The CSIP team has expertise in the design and the manufacture of

A world's-first in manipulator arms is unveiled, writes **Simon Gilligan**, CSIP MD

complex mechanical, hydraulic, electro-mechanical and electronic systems. The company has comprehensive test facilities and deploys engineers and technicians worldwide for product service and support of ECA systems and system integrations and trials. ■

CSIP is a wholly owned subsidiary of ECA SA and is based in Weymouth on the south coast of England. The business was founded over 20 years ago as the service support centre to the UK MoD for the Remote Controlled Mine Disposal System supplied by ECA. Accredited to BS EN ISO 9001, CSIP designs, develops and manufactures remote controlled systems for hostile environments

About the author

Simon Gilligan is managing director of CSIP and has 25 years' engineering experience



detect where the arm is at all times. The arm also has a learning function which stores the manoeuvres performed by the arm and is combined with a memory function for repeated actions.

The system is based on three sections, the control PC, the master unit and the slave unit with three types of multiplexed serial interfaces, selectable by the customer between the master and slave units. The master unit is a stand-alone box designed to accommodate the master arm with the electronics mounted within the box unit. The control PC is based on a standard Windows™ machine; either a laptop or a base unit and the interface to the master unit is via a single USB interface.

A processor provides the power to monitor the slave arm positioning, forces applied to joints and any limit switch operations. Information collected is then sent to the master electronics and on to the control PC. Diagnostic and status information collected by the electronics are then available for display on the control PC display screen.

The PC screen can be split into four sections,

The subsea electronics are contained in a small (OD 8cm, length 25cm) cylindrical pressure housing hard-wired to the arm and sealed to a proof depth of 7,500 metres. A flying lead with a connector provides the arm interface to the vehicle electronics package.

The power requirements of the arm are designed to be compatible with current vehicle onboard power availability. In the event of a different power supply being mandatory for a specific vehicle, CSIP will custom-wind the motor armatures to suit at no extra cost.

Developed for CSIP's 7 Function hydraulic arm, the electric motors are brushless and will operate in oil, all the actuator and junction box voids are therefore oil-filled and pressure compensated to 0.4 bar above ambient, with 7,500-metre rated seals. In the unlikely event of a seal breach, oil may leak out but water cannot leak in.

A keynote of the design is its modularity, if a part should break, spares can be used to repair the arm or a specific modular section can be flown out and fitted on site rather than returning the ARM 5E to a central repair base. All of the

CONTACT DETAILS UK CSIP Headquarters, 4 Granby Court, Granby Industrial Estate, Weymouth, Dorset DT4 9XB | +44 (0)1305 779 020 | info@csip.co.uk | www.csip.co.uk