



## Cable Engines, Linear

### FHP 3 WP Engine, AC Vector Drive

Asset No. CT9-1 & 2

Manufacturer	FHP (Project No R12787/88)
Size: -	
Length	3.5m
Width	1.5m
Height	1.8m
Weight	3.5 Tonne
Cable Line Height	1.025m
Cable Size	21 - 120mm Diameter
Maximum Wheel Opening	350mm
Speed	0 to 6 knots
Cable Tension (Maximum )	2.2 Tonne @ 3 knots
Cable Pinch Force	1 Tonne
Speed & Distance Measurement	Encoder on Cable Guide Roller
Hydraulic Power Pack	Integrated in LCE Frame
Electrical Supply	440V, 60Hz, 125A

## 5. ELECTRICAL CONTROL SYSTEM DESCRIPTION

The control of the six AC motors, which are fitted to the three wheel pair transporter is by ac inverter drives, one for each wheel motor. The drives being set up in sensorless vector mode, which are capable of holding speed to 0.3% with automatic slip compensation. As simple speed matching arrangement would not be able to take account of different tyre wear, pressures or diameter it would provide too rigid a control alone. Therefore a trim of speed for each motor is provided dependent on torque sensed at each motor, giving load sharing between all of the motors which are been used.

One drive acts as the master and is automatically selected dependent on the direction of operation of the machine. This is the first set of motors the cable comes in contact with, but if this pair is open the next pair are selected as the master pair. This drive/motor runs in speed control and is used to set the speed of the cable passing through the transporter. The torque taken by the master motor is communicated to a controlling PLC (programmable logic controller) which then adjusts the speeds of the other follower drives using PI control. This allows the load to balance the load between the remaining selected motors.

The speed of the transporter is set via an adjustment knob (potentiometer) mounted on the operator's control desk, but for this control to operate the direction switch must be selected. The signal from the potentiometer feeds into an analogue input on the PLC. After processing, using torque measurement the speed demand signal is communicated to each drive. Adjustment of zero to full is possible using the speed control potentiometer. Direction is selected via a direction switch.

An encoder is fitted to the guide rolls to provide a distance measurement of cable and also for stall detection. The stall sensing is to act as a safety feature, should the load on the system go beyond the torque setting and the encoder senses a stall occurring, the HMI will stop the drive to the motors and indicate stall. The operator will have to reset the control to restart the machine after a stall (see operating instructions) The encoder feeds into high speed counter inputs in the PLC, which scales a display of cable length in metres. The display is on an HMI (human machine interface) which is connected to the plc and mounted on the operators control desk. The HMI provides a display of Speed, Distance and torque; these can be read in meters/sec or knots, the load can be read in % or tons. There is also a range of operation and diagnostic information available within the HMI. The keypad on the HMI provides a means of selecting screens and making adjustments to the control system (max torque etc).

The drive control and associated equipment is mounted in two stainless steel control panels mounted on either end of the transporter (see GA). The controlling plc and operator controls are mounted in a remote operators control desk. The operators control desk will be situated to suit the operator, by the means of an umbilical cable. The drives will operate in ambient temperatures between -10 and 50 degrees C due to the specially designed enclosures which provide for separate cooling paths for the heatsinks of the drive power components. A fan filter arrangement with cowls, provide the cooling air with the enclosure sealing maintained to IP55. Should it become necessary to change a Vector

drive unit, care must be taken to reseal the control panel correctly to maintain the IP65 rating.

The motors are marine standard motors sealed to IP56 and capable of a wide operating speed range due to forced cooling utilising separately driven cooling fans. Over temperature protection is provided in case of fan failure.

DC link chokes are fitted to each drive unit along with AC mains input reactors. As well as introducing impedance between the generator and the drives to minimise possible fault currents, these components have been calculated to reduce harmonics to an acceptable level. The harmonics produced by the drive system have been calculated by Mitsubishi to be well within the requirement of the DNV Standard applicable to this transporter installation on board ships supplies.

## **6. SPECIFIC INSTRUCTIONS**

The control system PLC (programmable controller) has a software programme specifically written for the machine operation and human machine interface (HMI – keyboard/display). Should a fault develop in the PLC system then in addition to replacing the faulty part it may be necessary to reload the software in either the PLC or HMI. If a fault occurs in the PLC it is recommended a specialist engineer be employed by referring back to Fraser Hydraulic Power.

To access or reload the PLC or HMI software programmes the PLC engineer must have the following equipment:

- a) Connecting cable to connect from laptop computer to HMI, Mitsubishi Part Number MAC-PROG/9-CAB
- b) Laptop computer with programming software loaded, Mitsubishi Part Number MP + 1E for the HMI and Melsec A software or GX Developer for the PLC.