Technical Specifications of PLC based control for Weld Inspection Manipulator (WIM)

1. SCOPE OF SUPPLY:

   Manufacture, Fabricate, Testing, Supply and Commissioning of PLC based control system along with Variable Frequency Drive for Weld Inspection Manipulator. The system comprised of following items to be supplied:
   1.1 A Programmable Logic Controller and its I/O module as described in section 3.1
   1.2 Variable Frequency Drive and its associated electrical component as described in section 3.2
   1.3 A drive panel which will house VFD, filters and contractors and a PLC panel which will house PLC, I/O modules, power supplies, Relays and terminal units as described in section 3.3.
   1.4 Absolute position encoder as per 3.5
   1.5 Cable and connectors as per section 3.6
   1.6 PLC programming software licensed to user as per 3.4
   1.7 HMI display panel as per section 3.7
   1.8 Configuration and functional testing of VFD/PLC as per section 4

2. APPLICATION:

   A PLC based control is required to control speed and acquire position of a Grappler System at TAPS-1&2, Tarapur. Grappler is coupled to an induction motor having detail as follows:

   Frame size-160M
   Capacity- 3KW/4HP
   Full load current-7.5A
   Speed (RPM) -1405

   A variable Frequency Drive with PROFIBUS communication interface will control speed and direction of the grappler. An absolute encoder to be mounted on the shaft of motor for monitoring of grappler position. The encoder will have PROFIBUS interface to communicate through PLC/VFD. VFD will be operated in two modes:
2.1 Remote Control: VFD will be operated through PLC. The control logic and GUI (Graphical User Interface) will be developed by purchaser hence not in the scope of supply.

2.2 Manual Control: VFD will be operated through manual panel. The manual panel is available at site and hence not in the scope of supply. The panel consists of Joystick and switches to operate the motor. Detail of IO requirement is provided in Annexure-A.

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3. TECHNICAL DESCRIPTION:

The PLC based control system will be comprised of following component

3.1 PLC based control modules:

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Fig 1: Schematic block diagram of PLC based control for WIM-2M

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A PLC based control unit along with input output modules will be housed inside control panel. A PC, having Operator Interface Program, will communicate the PLC through PROFINET or MODBUS TCP/IP communication bus. Distance between PC and PLC will be approx 30 mtr. PC and Operator Interface Program are not in the scope of the tender. PLC, having control logic, will communicate with Variable Frequency Drive and Absolute Encoder to control speed and direction of motor. The communication between PLC, Encoder and VFD will be through PROFIBUS network. The PLC and its I/O module will have following features:

**Diagnostics Functions:**
- Diagnostic and fault finding feature with the aid of LED’s on each module/channel.
- Diagnostics Indication: LEDs for “Power”, “Run”, “Error”
- In built LCD Display for detailed error codes
- Possible to diagnose the system errors without connecting the programming software PC.

**Mechanical & Environmental specification**
- Protection: Fully EMC Certified, IP20 according to IEC 529
- Standard 35mm DIN Rail mounting
- I/O modules should work for 55º C ambient temperature.
- Independent electronics of modules to allow replacement of faulty modules without disconnecting wiring.

**Network Interfaces:**
- **Ethernet**: PROFINET or Modbus TCP/IP for PC
- **PROFIBUS**: for VFD and Encoder

**Codes and Standards**:  
The PLC system shall comply to EN 61131-2 IEC 61131-2 standards as a minimum operating and Ambient Conditions

**Input Output module:**
Bidder should quote for suitable Input Output modules compatible with the CPU. Number of channels required for different type of modules are as per Annexure A
3.2 Variable Frequency Drive and associated component (Quantity as described)

The Grappler is driven by an induction motor having following detail:

- Frame size: 160M
- Capacity: 3KW/4HP
- Full load current: 7.5A
- Speed (RPM): 1405

A Variable Frequency Drive having following details is required to control speed and direction of motor:

A) **Power Module (Quantity 1 Nos):** Siemens Sinamics G120 A.C. VVF PM250 for drive rated 5.5Kw with integrated line filter class 'A'

B) **Control Units (Quantity: 1 Nos):** Siemens Sinamics drive CU240E-2DP PCB control card with PROFIBUS INTERFACE

C) **Basic Operating Panel (1 No):** Siemens make BOP2 for parameterization of Drive

VFD along with its accessories to be housed in a separate panel and will be mounted on Fuelling platform near PLC panel. VFD should have PROFIBUS interface to communicate with PLC as well as the encoder. The VFD will have inbuilt controller with analog input and digital input interface as per Annexure-A.

3.3 Control Panel:

There will be two separate panels to house all hardwares. These panels are to be accommodated in 580mm X 480mm size plateform. Following are detail of panels:

**PLC Panel (1 No):** The PLC Panel will be used to house PLC controller unit, Input/output modules, power supplies (required for PLC modules), power supplies (for field sensor and actuator). Supplier should design the panel to suit the requirement duly approved by user. The panel is required to have following features:

A. Panel will be free standing enclosed operator console type IP42 protected and shall be suitable for side entry cable connection through proper glanding. Panel shall be fabricated from CRCA sheet of minimum 1.6mm
thickness.

B. Panel has to accommodated in 580mm X 480mm X 300mm space

C. In order to remove dissipated heat from the panel, suitable cooling arrangement should be provided.

D. Panels will be equipped with front access doors. Doors will be equipped with lockable handles.

E. Panel gland plate will be freely removable.

F. Illumination will be provided in the panel by fluorescent lamps and door operated micro switches.

G. Equipment in the panel will be laid out in an accessible and logically segregated manner. All metal parts in the panel including doors will be suitable earthed.

H. The panel will be powder coated with shade RAL7032 / Siemens Grey.

I. All termination will be done with reputed make or equivalent tin plated crimped copper lugs. All termination should be equipped with relevant ferrul tags to identify the source and destinations of wire.

J. Panel internal wiring will run through PVC channels with covers. All wiring will be bunched and supported without causing any tension at terminals. The wiring going to the equipment on the door will be laid through PVC flexible conduit / tubing and well supported so as to prevent any twisting and strain on wires.

K. Proper labels will be provided inside the panels indicating the designation / tag no. of the equipment. Labels will be of aluminium black anodized plates with engraved letters / figures.

L. Design and manufacturing of panel should be of high quality and with good
aesthetic look.

M. Panel wiring diagram indicating the internal connection should be provided along with system

N. Panel should also consists suitable size copper bus bar for earthing

O. Panel will have suitable place for mounting power supplies required for PLC, internal relays and I/O modules and encoder.

P. Panel will be provided with 5A/ 230V AC power socket.

Q. All digital outputs will be wired up through fuse terminals to terminals through relay cards.

R. All Analog inputs will be wired through fuse terminals. Provision will be made for configuring each analog input connection as 2 wire / 4 wire at the terminal end.

Drive Panel (1 No): The drive panel will be used to house VFD and accessories (brake resistor, line filter etc.) associated with motor. The entire feature mentioned from A to N in above para will also applicable to drive panel.

Design of panel should be duly approved by purchaser before fabrication

3.4 Software (Quantity: 1 No)

PLC programming software with License Key.

3.5 Absolute Encoder (Quantity: 1 No)

Absolute encoder is required to monitor absolute position of motor. The encoder should have following feature:

 Mechanical characteristics

Type: Multiturn absolute encoder
Resolution (singleturn): 1 ... 65536 (16 bit), scalable default: 8192 (13 bit)
Number of revolutions: 1 ... 4096 (12 bit), scalable
Total resolution: 28 bit scalable default 25 bit
Interface: PROFIBUS-DP / RS485 driver galvanically isolated

Working temperature range: -40°C ... +80°C
Coupling: solid shaft with a suitable flexible coupler compatible with motor shaft of 19mm
Housing: stainless steel flange aluminum housing
Shock resistance: acc. to EN 60068-2-27 2500 m/s², 6 ms
Vibration resistance: acc. to EN 60068-2-6 100 m/s², 55 ... 2000 Hz

Electrical characteristics
Power supply: 24 V DC
Power consumption (no load): max. 120 mA
Protection: Reverse polarity protection of the power supply
           External reset button
Diagnostic LED
Sensor error (Profibus error)

3.6 Cable and Connector (Quantity as describes):

Following cable and connectors shall be supplied and tested for the application:

1. PROFIBUS Cable (5 mtr X 3 + 50mtr X 1):
   PLC, VFD and Absolute Encoder will be interconnected through a PROFIBUS cable. All these equipments will be located at Refuelling Platform and distance will not be more than 5 mtr. Apart from these cables and connectors a spare 50 mtr cable along with connectors are also required

2. Ethernet Cable (50 mtr): PC will be communicated with PLC through Ethernet cable hence 50 mtr cable to be supplied for the purpose along with connectors

3. Multi Core instrument cable (2 pair, 300 mtr): 0.5 sqmm stranded tinned copper conductor with 650V grade, twisted configuration (10 twist per meter) individual shielded pair combination, overall screened with aluminium Mylar tape 125% over lapping, PVC sheathed, un armored Instrumentation/Signal Cable.
3.7 HMI Display panel (Quantity 1 No):

A 5.6” basic color HMI on Profibus DP in a wall mounting enclosure is required to display position value from absolute encoder. The HMI panel shall be configurable to display any parameter however default is encoder position.

4. System Testing before delivery:
The control system performance will be tested at supplier premises in the presence of purchaser or his authorized representative. Full functionality shall be tested after simulating the input/output as per Annexure-A. An electrical motor should be arranged by supplier for the testing purpose. Supplier should have adequate facility to conduct the test and should arrange required instruments and power supplies to perform the tests as mentioned below:

- **4.1** Testing of all hardware and software will be done at the supplier premises before delivery. Absolute encoder shall be tested and acquired in PLC. The PLC program and Graphical User Interface (GUI) shall be developed by purchaser and will be tested at supplier’s premise.
- **4.2** Supplier shall be responsible for the Programming/Configuration of Variable Frequency Drive for the application.
- **4.3** Manual panel shall be simulated by supplier and all operation will be tested
- **4.4** Control system will be accepted and delivered after complete testing at supplier premise

5. Configuration and Testing at Site:
Supplier shall be responsible to commission the system at TAPS-1&2, Tarapur, Maharashtra after delivery. Commissioning of system consists following work:

- Configuration of Variable Frequency Drive (VFD) as per application and functional testing of grappler using manual panel.
- Installation and calibration of absolute encoder and HMI display at designated location
- Functional testing of grappler through PC based Graphical User Interface (GUI) after establishing connection between PC and PLC.
6. Documentation

Supplier should provide hard copy as well as soft copy of following document along with the system:

a) Design & Operation manual of VFD along with technical detail of accessories supplied along with.

b) Wiring diagram of PLC panel and Drive panel

c) Calibration & test certificate of all sensors supplied
### Annexure-A

**List of Inputs & Outputs for Programmable Logic Controller**

<table>
<thead>
<tr>
<th>Ch No</th>
<th>Sensor/Actuator</th>
<th>Location</th>
<th>Signal Range</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>AI-1</td>
<td>Potentiometer</td>
<td>Manipulator</td>
<td>0 – 10V dc</td>
<td>Cross Travel position</td>
</tr>
</tbody>
</table>

**Digital Input**

<table>
<thead>
<tr>
<th>Ch No</th>
<th>Sensor/Actuator</th>
<th>Location</th>
<th>Signal Range</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>DI-1</td>
<td>Handshake signal1</td>
<td>ULTVIS</td>
<td>Potential free contact</td>
<td>Start Area Scan command</td>
</tr>
<tr>
<td>DI-2</td>
<td>Emergency Button</td>
<td>Workbench</td>
<td>Potential free contact</td>
<td>Shutdown the operation</td>
</tr>
</tbody>
</table>

**Digital Output**

<table>
<thead>
<tr>
<th>Ch No</th>
<th>Sensor/Actuator</th>
<th>Location</th>
<th>Signal Range</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>DO-1</td>
<td>Flow/MVD (SOL-A)</td>
<td>Work bench</td>
<td>24V dc, 0.1A</td>
<td>Move probe holder right</td>
</tr>
<tr>
<td>DO-2</td>
<td>Flow/MVD (SOL-B)</td>
<td>Work bench</td>
<td>24V dc, 0.1A</td>
<td>Move probe holder left</td>
</tr>
<tr>
<td>DO-3</td>
<td>Handshake signal 2</td>
<td>ULTVIS</td>
<td>24V dc, 0.1A</td>
<td>M-SOFT Ready</td>
</tr>
</tbody>
</table>

**Analog Output**

<table>
<thead>
<tr>
<th>Ch No</th>
<th>Sensor/Actuator</th>
<th>Location</th>
<th>Signal Range</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>AO-1</td>
<td>Grappler speed</td>
<td>VFD</td>
<td>4 – 20mA</td>
<td>Speed of Grappler</td>
</tr>
</tbody>
</table>

*There must be minimum 30% spare channels of each type for future expansion*
# List of Inputs & Outputs for VFD

<table>
<thead>
<tr>
<th>Ch No</th>
<th>Sensor/Actuator</th>
<th>Location</th>
<th>Signal Range</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>AI-1</td>
<td>Joystick</td>
<td>Manual Panel</td>
<td>0 – 10V dc/ ±10V</td>
<td>Speed of grappler</td>
</tr>
</tbody>
</table>

**Digital Input**

<table>
<thead>
<tr>
<th>Ch No</th>
<th>Sensor/Actuator</th>
<th>Location</th>
<th>Signal Range</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>DI-1</td>
<td>Switch</td>
<td>Manual Panel</td>
<td>Potential Free Contact</td>
<td>Hoist down cont</td>
</tr>
<tr>
<td>DI-2</td>
<td>Switch</td>
<td>Manual Panel</td>
<td>Potential Free Contact</td>
<td>Hoist up cont</td>
</tr>
<tr>
<td>DI-3</td>
<td>Switch</td>
<td>Manual Panel</td>
<td>Potential Free Contact</td>
<td>Trip signal for grappler</td>
</tr>
<tr>
<td>DI-4</td>
<td>Switch</td>
<td>Manual Panel</td>
<td>Potential Free Contact</td>
<td>Grappler down jog</td>
</tr>
<tr>
<td>DI-5</td>
<td>Emergency Switch</td>
<td>Work bench</td>
<td>Potential Free Contact</td>
<td>Stop the grapple</td>
</tr>
</tbody>
</table>

**Analog Output**

<table>
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<tr>
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<tbody>
<tr>
<td>AO-1</td>
<td>--------</td>
<td>---------</td>
<td>0 – 10V dc/ ±10V</td>
<td>Speed of grappler</td>
</tr>
</tbody>
</table>