Annexure-A

Power Controller and Closed Loop Control System for IR Heater & Vacuum

Objective:-

To simulate real time heat flux history and real time pressure history on a test samples in feedback mode through controller. Test sample is positioned in front of the IR heater assembled inside a vacuum chamber.

1. Scope of Work

The scope of work is to design, supply, installation and commissioning of PLC based Power Controller panel with Thyristor, SCADA based operational interface workstation and PLC system. The proposed PLC shall be with 32DI, 32DO, 8AI (Current & Voltage Input), 8AI K-Type Thermocouple (Range -270...+1370 °C), 8AI R-Type Thermocouple R (Range -50...+1769 °C) and 8AO channels.

The SCADA system shall be latest version with at least 1000 power tags for runtime and development version along with all necessary licensed software & hardware's for Operator Workstation and its networking interfaces. The Power Controller with thyristor E-power 500A 3phase or equivalent shall be supplied for integration. Digital three phase thyristor, 500A, 600V with one standard analogue output and second analogue output in optional IO board, inbuilt semiconductor fuse and standard alarm relay output to be considered.

Party shall consider design of full system, supply of items, installation of software and logic development of the complete system as turnkey basis. Installation of the system shall be carried at TERLS area at VSSC, Thiruvananthapuram.

After placement of purchase order party shall submit a detailed design document for approval from VSSC including control philosophy, drawing and electrical wiring diagram.

2. PLC Specifications

Following are the minimum components of PLC system.

Description	Qty
PLC 8 slots Ethernet backplane rack	1
PLC AC Power Supply Module, 240 V AC	1
PLC CPU Modbus / Ethernet, M/s Schneider make M340 or equivalent	1
Digital Input Module, 32 channels, 24 V DC, Positive (sink)	1
Digital Output Module, 32 channels, 24 V DC, Positive	1
Analog Input Module, High Speed, 8 channels, isolated (Current Input 4-20mA & Voltage Input 0-10V,+/-10V)	1

Analog Input Module, 8 channels, isolated, Resistor, Thermocouple & Temperature probe (K/J/E/R Types).	2
Analog Output Module, 8 channels, isolated	1
3m pre-equipped cable with 1 connector and free wires	3
3m pre-equipped cable with 1 connector and 2 free wires	2
3m shielded cord set - 20 ways terminal and one end flying leads	1
3m shielded cord set - 28 ways terminal and one end flying leads	1
PLC Programming Software with perpetual License	1

- ➢ The automated platform processors should manage the entire PLC station, which is made up of a set of discrete and analogue I/O modules, safety, communication modules, in both local rack close to the CPU and remote I/O racks.
- ➢ The processors must have an internal non-volatile memory to store application and data. Processor must also have a reserved slot for a removable storage so that the application and data backup can also be resident on a removable component. It must be possible to connect a computer (programming terminal) via a USB port integrated in the CPU module.
- ➢ The PLC system should have processors with built-in Ethernet ports featuring a web server, compliant with various operating systems: minimum is Windows 10.
- ➢ Embedded web server must provide CPU diagnostic, including detailed information on ethernet system networking.
- ➢ The embedded web server must be customizable by the user to display application variables and advanced diagnostics features (rack viewer, alarm buffer, complete PLC application)
- ➢ The date and time should be managed even when the processor is switched off.
- ➢ The processors must be equipped with ground connection contacts without additional cabling.
- ➢ The memory area must consist of an executable internal memory for the application which can be saved both in an internal flash memory embedded, and in a flash type removable memory card.
- ➢ No battery supply shall be required for non-volatile backup.
- ➢ The offered in the range must provide integrated non-volatile memory to save whole application and data, even in redundant configurations.
- ➢ Operating system running the user application on this removable memory storage must ensure a high level of reliability to be compliant with industrial constraints. The PLC controller should be capable of handling Multiple PID Close loop systems with at least cycle time of 100msec.
- ➢ All analogue data acquired by the controller shall be process in higher sampling rate with moving average methods.

➢ Supplier must provide an opened system where it must be possible to integrate third party device based on standard.

➢ PLC Programming software shall be perpetual licensed version and to be activated and handed over to VSSC during acceptance.

3. PLC Power Controller Panel Specifications

MS powder coated custom fabricated fully wired control panel including PLC system & power supply, relays & switch gears, Digital Ammeter & Digital Voltmeters, Terminals, Alarm beacon & Industrial hooter, Panel shall be water proof and suitable rain guard shall be provided for protection from rain and will be installed inside Control room. Panel can be freestanding type Panel should have dust filters, lighting, service socket and air circulation fans. All the internal wirings shall be done through terminals with proper ferrules & crimping with legs.

- There should be separate compartment for PLC & Power Controller Section.

- The Power Controller shall be designed for IR heating lamp load of 3 phase delta, 270kW, 415V, 500A capacity. The Power Controller Thyristor shall be integrated to the control panel.

    a) Power Controller with thyristor E-power 500A 3phase or equivalent
    b) Current Rating :- 500A
    c) Control type - Three phases
    d) Rated voltage - 240V to 600V line to line (+10%, -15%).
    e) Operating voltage - 100V to 415V line to line
    f) Supply frequency - 42Hz to 68Hz with automatic sensing.
    g) Auxiliary supply - 150V to 240V (+10%, -15%),
    h) Environment Pollution degree 2 (IEC 664)
    i) Storage temperature -10°C to 70°C
    j) Operating temperature 0°C to 50°C with unit mounted vertically.
    k) Humidity 5% to 95% RH non condensing
    l) Enclosure protection IP20 (IEC 529)
    m) Built in high speed fuses for thyristor protection.
    n) Display Indication of process values and diagnostic information.

- PLC shall be able to operate the Dry Screw Vacuum Pump, vacuum valves and chamber operations and monitor the status through Digital Inputs & Output in Auto mode. All these operations in manual mode shall be done through Panel Push buttons and show the status in panel indications. Vacuum Transmitters & Pump parameters also to be connected to PLC system for monitoring. Auto/Manual Selector Switch required in Panel. In Manual mode the Thyristor should be made ON/OFF using panel ON/OFF switch and controlled by Panel Potentiometers for open loop control. In Auto mode, PLC shall give the ON/OFF

command through relays and thyristor command Analog Output and monitor parameters through Ethernet communication.

- 24V DC Power supply and ON/OFF status indication lamps to be assembled in a control panel and supplied.

- For thermal controllers, 4Nos of Signal Converters to be supplied and installed in the PLC cabinet for Heat Flux Sensors Input. 16Nos (8Nos K Type & 8Nos R Type) of Thermocouple sensors also to be taken into PLC Analog Input connections.

- Fuse for over current protection for thyristor shall be provided prior to the contactor having 3phases 600A rating. Emergency Stop Push Button in the Panel.
- Networking with Thyristor, Switches etc to be provided in the wired panel.

- Panel should have network switch and necessary cabling for communication of PLC & SCADA system.
- The Incoming power, IR Heating Modules and its field connections will be provided by VSSC. All other required cabling and internal wiring shall be considered by the party along with the scope of work.

4. Field Instruments Specifications

- Pneumatic Rotary Actuator with Electro Pneumatic Valve Positioner having Input Signal 4~20mA DC, Air Piping Connection 1/4" NPT, IP 66 – Qty 4Nos to be supplied and integrated to loop control based on the profile given to control the vacuum level using four levels operations.
- High performance compact Pirani Gauge Sensor Atmosphere to $1x10^{-4}$ mbar, Supply Voltage 15 to 48V DC, Electrical connection:RJ45, Flange Size NW16, IP 40, Integrated filter, 3M active gauge Cable – Qty 2Nos to be supplied and integrated.
- Solenoid Isolation Valve, 240V, Single Phase, 50/60 Hz, Stainless Steel / Aluminium Valve actuation type: Single acting, electrically opened, spring closed, Leak rate: < $1 x 10^{-9}$ mbar ls^{-1}, Valve-port flange size: NW25 – Qty 1No to be supplied and integrated for vent operations.
- 2-core x 1.0 sq mm signal cable, with stranded copper conductors, insulated with PE 0.4 mm (nom), cores laid up, overall shielded with Al-Mylar tape and drain wire, inner PVC sheath, GI strip armouring, outer PVC sheath, HV test between cores: 1.5 KV for 1 min, - Qty 100 Meters for field instrument signals from PLC panel shall be supplied and cabling to be done at site.

5. SCADA System Specifications

The SCADA software shall consist of a scalable software package for both HMI and

SCADA applications, and I/O interfacing software (communication drivers).

The SCADA software will read and write data to field controllers, archive and display historical data, perform alarm processing, and provide graphics screens and reports so that operators, supervisors and maintenance personnel can quickly and easily maintain and operate the system. The SCADA shall be licensed for Runtime and Development at least for 1000 Variables (Power Tags) and license must be activated and handed over to VSSC.

A single integrated SCADA software package from same PLC manufacture to reduce support requirements is essential. It is expected that all the core SCADA functionality offered, such as communications drivers, graphics capabilities, reporting, historical storage, trend and alarm displays, and the development environment are offered as a single integrated software package or suite of packages.

Any additional software required that meets this specification, other than a standard Windows® 11 operating system and Internet Explorer®, shall be listed and included within the vendors pricing proposal.

Based on the configuration, graphical display call-up time of one second maximum could be achieved for all graphics. Display refresh update time of one second for tags from multiple PLCs could also be achieved on a single display.

Total time to call up a graphic display (displaying 100 variables from a total of 5,000 tags anywhere in the system) shall be between one and two seconds, complete with well-defined current data read from the field device(s).

The vendor shall have a package available to users that provides the facility for user-written device drivers. The package shall supply examples including source code for sample types of working drivers, that are similar to the requirements of the user (e.g. Serial Driver, TCP/IP Driver, report by exception, proprietary board etc).

The SCADA software shall perform all report generation, scheduling and management internally and shall not require a third-party package to perform these functions. The SCADA shall have functions available for this purpose and shall not require scripting to achieve such functionality

The software shall permit reports to be scheduled for a specific time of day, on a periodic basis, upon operator request, or event initiated (such as an alarm condition or end of batch.

The software shall support logging of all operator actions to disk, printer or screen. The software shall be capable of logging the following information: Username, Action, Time, Date, Value, and Comment in a user definable format.

The software shall be able to monitor and adjust PID Loop parameters. Tuning trend pages for each loop shall be provided with facility for adjusting PID parameters: Setpoint, Output, Control mode, Gain, Proportional, Derivative, etc.

Help screens shall be available to facilitate loop tuning.

Party shall develop the software as per the requirements from VSSC including multiple SCADA screens for Operation, Setpoint Inputs, Configuration, PID Tuning, Graphical Trend, Alarm & Reports in Excel. There shall be a provision to enter the control setpoints of around 2000 values using excel.

6. Scope of Supply

a) Supply of PLC System hardware along perpetual software license as per the technical specification.

b) Supply of Fully wired PLC & Power Controller Panel along necessary display, Indicators & signal converters for Heat flux sensors (4Nos) as per the technical specification.

c) Supply of the latest version of SCADA software of minimum 1,000 Power tag/points with SCADA Software key (perpetual license) for development compatible with Windows 11 Pro.

d) Supply of SCADA operator workstation with configuration: Intel Core i7 (2.9GHz, 8 core), 16 GB x 2 DDR4 RAM, 256GB SSD, 4TB (2+2) SATA 7200 rpm with 3.5" HDD with in-built data backup feature RAID, 4 GB NVIDIA Quattro. Dell/Lenovo/HP equivalent. Supply of pre-installed Windows 11 Pro and Microsoft office with lifetime

e) Industrial Ethernet switch and networking cable as per requirement.

f) Signal Converters/ multipliers for Heat Flux 4Nos

g) Supply of digital three phase thyristor 500A – 1No as per the specification.

h) High performance compact Pirani Gauge Sensors -2Nos as per the specification given.

i) Pneumatic Rotary Actuator with Electro Pneumatic Vacuum Control Valve – Qty 4Nos

j) Solenoid Isolation Vent Valve– Qty 1Nos

k) Field Signal Cable 2Core x 1.0 sq. mm -Qty 100 Meters.

l) Installation & commissioning of the total system.

m) Software installation, code upgradation & modification required for system, testing and commissioning, training VSSC personal after successful commissioning.

n) Software User Manual to be supplied.

o) Final as built PLC logic, SCADA Logic along with license activation details of software's to be handed over to VSSC after successful.

p) Any additional hardware or cables required for functioning of the system.

7. Other Conditions

➢ Party must supply brand new system and no refurbished components are acceptable.

➢ Software licenses shall be taken exclusively for this work and shall be handed over to VSSC after activation for acceptance.

➢ All developed software's shall be property of VSSC and shall be handed over to VSSC.
➢ Installation and commissioning of the unit at VSSC
➢ Warranty: Minimum One-year from commissioning date

8. VSSC SCOPE

- Input power for power controller
- Heat Flux sensor, output: 0-10mV
- Dry Screw Vacuum Pump -1No.
- Vacuum chamber integrated with IR Radiant Heater system – 1No.