Specification for Replacement of Prosafe Model Quadlog PLCs in CPP and CCU by SIL 3 Certified Prosafe-RS PLC.

CAPTIVE POWER PLANT (CPP) & CATALYTIC CRACKING UNIT (CCU)

BPCL

REFINERY – MAHUL
MUMBAI
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Replacement of Prosafe Model Quadlog PLCs in CPP and CCU by SIL 3 Certified Prosafe - RS PLC.

LEGENDS:

CPP : Captive Power Plant
CCU : Catalytic Cracking Unit
BOP : Balance Of Plant
HRSG : Heat Recovery Steam Generation
LBCC : Local Burner Control Console
LCP : Local Control Panel
BMS : Burner Management System
ESD : Emergency Shut Down
SIL : Safety Integrity Level
IEC : International Electric Commission
DCS : Distributed Control System
MCB : Miniature Circuit Breaker
PDB : Power Distribution Board
MCC : Motor Control Center
LED : Light Emitting Diode
PLC : Programmable Logic Controller
FLD : Functional Logic Diagram
BPCL : Bharat Petroleum Corporation Limited
OEM : Original Equipment Manufacturer
SOE : Sequence Of Events
PBs : Push Buttons
NO : Normally Open
NC : Normally Closed
T/C : Thermocouple
PTR : Performance Track Record
CPU : Central Processing Unit
ISA : Instruments Society OF America
FAT : Factory Acceptance Test
SAT : Site Acceptance Test
RTC : Real Time Clock
QAP : Quality Assurance Plan
1.0 INTRODUCTION AND PLANT DESCRIPTION

1.1 INTRODUCTION
The specification defines the minimum requirement of a Programmable Logic Controller for Emergency Shutdown System design for reliable, effective and optimum control and ESD system of CPP & CCU process sequential logic. The existing Quadlog Prosafe model PLC at BPCL, Mumbai Refinery, to be replaced by latest technology and state of the art Prosafe RS ESD system. As the existing 6-nos PLC system shall be replaced in phased manner, vendor to consider the Integration of this PLC with existing DCS of Yokogawa make CS3000 in CPP and CCU. Essential and necessary hardware and Software for this purpose shall also be considered while quoting.

The objectives of the existing PLC are,

a) Safe startup of the various units of CPP & CCU  
b) Safe shutdown of the various units of CPP & CCU  
c) Protection of the plants under any abnormal condition.  
d) Troubleshooting of the plant trip by using built in SER.  
e) Communication with DCS and other PLCs for Integration.

1.2 PLANT DESCRIPTION

The CPP (Co-Generation plant) consists of two numbers Frame 5 and one number Frame 6 Gas Turbines (GT) with Heat Recovery Steam Generators (HRSG) to meet the Refinery Power and Process steam demand. The power requirement of the Refinery is met from the two Frame 5 Gas turbines each having designed capacity of 21.646 MW and one Frame 6 Gas Turbine having designed capacity of 33.89 MW. Around 75 to 77 MW power is generated depending on the ambient conditions and rest of the power is imported from TATA through three feeders namely TEC-1, TEC-2 and TEC-3. The GTs are always running in parallel with the Grid.

All 3 GT sets are suitable for firing BHAG/RLNG and BHGO in combination. As a standard facility, automatic changeover of fuel has been given from BHAG/RLNG to BHGO and Naphtha to BHGO in all 3 GTs’. All other changeovers like BHGO to BHAG/RLNG, BHGO to Naphtha are manual. BHAG/RLNG to Naphtha direct changeover and Start-up on Naphtha are not given.

Design steam generation capacity of HRSG1 & 2 are 60 TPH each and HRSG3 108 TPH with full supplementary firing . Make up water is supplied by 3 nos DM water pumps (one running and two
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stand/by) to the deaerators via make up water heater sections of all 3 HRSGs. There are two feed water systems in CPP. Both systems consist of one deaerator and 3 feed pumps with interconnection facility at pump discharge. Normally, both feed water systems run in isolation i.e. the interconnection valve is kept closed. Old system caters to HRSG1&2 whereas new system caters to HRSG3.

Catalytic Cracking Unit (CCU) is one of the oldest unit in BPCL, Mahul Refinery. The Shell design unit had a dense bed type reactor commissioned in 1954. The objective of cracking is to convert heavy petroleum distillates into lighter fractions, balancing in the gasoline and middle oil ranges. Heart of the unit is Reactor, Regenerator, Stripper (RRS) system, which is very rare 3 vessel system in existence across the globe. After subsequent de-bottlenecking, the current unit capacity is 3500 T/d.

CCU complex consists of RRS, gas plant, 2 LPG Meroxes, 1 Gasoline merox, Depropanizer (C3/C4 unit) and a Gasoline splitter. In addition to this CCU maintains the refinery fuel gas pressure by making up the pressure using LPG/RLNG. The flare is continuously monitored by CCU. The refinery LP steam pressure is monitored and maintained by CCU (except monsoons).

Feed to the unit consists of HVU/FPU waxy, along with LR ex CDU/HCP. Major products include Gasoline (42%), LPG (16%), LCO, HCO and CLO. C3/C4 unit takes CCU LPG as well as FCCU LPG as feed. Similarly Gasoline Splitter takes both CCU & FCCU Gasoline as feed. HCP/CDU LPG can be processed in merox 1.

1.3 ABOUT EXISTING PLC

Prosafe model Quadlog PLCs are used in CPP (1-Nos) and CCU (1-No) for plant process Safety Controls. In CPP these PLCs are used for Heat Recovery Boilers BMS Logic Control, Diverter Damper Tripping logics, Gas and Liquid Fuel to GTs tripping Logic, Deareator and BFW pumps /Make up water pumps tripping logic, Seal air Fan and Scanner Air Fans sequential control Logics etc. In CCU it is used for complete CCU process sequential control logics. PLCs are essential equipment of any process plant to control and monitor the process and thereby to ensure the safety of the plant. Existing Prosafe PLC is originally M/s. Moore make supplied by M/s. Yokogawa, along with M/s. Yokogawa DCS at CPP and CCU unit.

These PLCs are to be replaced with latest state of the art Yokogawa make SIL3 Certified Prosafe-RS PLC proprietary basis. The new PLC panel needs to be installed in the existing space in the control
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Vendor has to inspect the existing site/PLC before submission of the offer. The segregation of PLC wise unit controls is as below.

**HRSG#1 BMS PLC Prosafe 1-No**
- Diverter damper logic.
- HRSG trip logic.
- Pilot gas burners logic.
- Main gas burners logic.
- De-super heater isolation valves logic.

**CCU PLC**
- BHAG_INTERLOCK
- BURNER_MANAGE
- RRS_MISC
- CHFD_DOD

1.4 The architecture of the existing PLC

The detailed Architecture is given in Annexure I for CPP and CCU respectively.

1.5 GENERAL OPERATION REQUIREMENTS

The PLC (ESD) described in this requisition shall be State-of-the-art microprocessor based TUV/SIL3 approved with Fail safe operation. The system shall be capable of executing complete start-up and shut down logics pertains to CPP & CCUs sequential logics in addition to following.

By replacing existing Prosafe PLC with new generation Prosafe-RS PLC following shall be the advantages in addition to overcome the limitations as mentioned above.

1. Prosafe-RS will be integrated with DCS over V-net seamlessly and making One window operation and One network solution.
2. Proposed integration with DCS on Data highway level shall be extended to Prosafe-RS PLC as the existing DCS data highway is upgraded to Vnet I/P.
3. The proposed Engineering Workstations/SEI stations shall be having Windows7 or latest operating system which is more reliable and stable.
4. The dedicated products and tools are available for the effective migration to Prosafe-RS. No Re-Engineering due to existing database can be converted to Prosafe RS and no need to re engineering or Reverse engineering of System Software. Huge cost saving of Application Engineering & Man-Hours.
5. Existing signal conditioning barriers & relays along with panel will be retained to minimize the downtime.
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6. New Controller & I/O racks can be housed in existing system cabinet; the entire job can be done in less downtime.

7. Marshalling Panels will be retained and due to this changeover can be carried out in minimum down time with Minimum need of Rewiring of field signal, Loop checking & commissioning.

8. Operators can monitor and access to DCS and PLC data by the same, HIS and take quick action in case of unexpected circumstances or at the time of emergency.

1.6 AMBIENT CONDITIONS

The site environmental conditions are as follows

- Maximum ambient temperature : 40 °C
- Minimum ambient temperature : 10 °C
- Maximum humidity : 85%

1.7 PLANT DATA

The plant is electrically hazardous and following philosophy shall be followed Intrinsic Safety for all Analog Inputs (4-20 mA DC) suitable for Zone-I Gas Groups IIA, IIB as per IEC.

The PLC (ESD) described in this requisition shall be latest and State-of-the-art microprocessor based system. The overall ESD system shall be structured to function in an integrated fashion.
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2.0 SCOPE OF WORK

The proposed PLCs system shall be replacing existing M/s. Prosafe Quadlog model PLC manufactured and serviced by Siemens. The job includes removal, replacement of the existing PLC and its associated panels and hardware and design, fabrication, supply, erection, installation and commissioning of new PLC (ESD) along with associated panels and hardware for CPP & CCU.

The scope of work shall comprise of the following but not limited to:

a. System Design and Engineering
b. Manufacture / supply of all hardware and software necessary to meet specified functional requirements including system configuration, system integration, factory testing and acceptance of the system.
c. PLC shall have latest version of Software, Firmware and hardware.
d. The PLC shall be TUV AK5 /SIL3 as per IEC 61508 certified.
e. PLC shall have dual redundant processor as a minimum unless otherwise specified. Additional redundancy for I/Os/Power supply/Communication network shall be provided as a minimum requirement.
f. PLC system cabinets shall have hardened plastic doors to look through the various components system status without opening the door.
g. The quoted PLC shall be a node to the existing DCS architecture of CS3000 DCS.
h. The software shall include operating system and application program. The application program shall include software for performing functions like interlock and shutdown logics, programming, programming modifications and documentation etc.
i. The system shall be supplied with programming tools and related accessories.
j. No two shutdown circuits shall be shared by same I/O modules unless specified otherwise.
k. All inputs from MCC to PLC and outputs from PLC to MCC and Solenoid valves and Field lamps as well as Field switches shall be through interposing relays. All interposing relays shall be provided with LED indication and minimum one spare contact shall be freed for owner use for future.
l. The PLC system scan time shall be less than 200ms.
m. Sequence of Event recording with resolution of 1mSec shall be provided as inbuilt feature with PLC. A dedicated Pentium PC with 21 inch monitor and Ink Jet printer shall be provided in addition to PLC workstation.
n. As the existing each 1-no PLC system shall be replaced in phased manner, vendor to consider that Integration of this PLC with DCS to be carried out as and when it is commissioned. Required hardware’s for this purpose shall also be considered while quoting.
o. Application program shall be capable of showing the dynamic status of the input variables even after respective signal forced. This feature will facilitate the easy removal of the force after required maintenance carried out.
p. Vendor to establish communication with DCS for data transfer. Unless this communication is established, the system shall not be considered as commissioned.
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q. 24VDC redundant Bulk power supply unit along with individual MCBs for individual consumers shall be installed in Power Distributions (PD) cabinet. The power supply to each of Marshalling cabinet, Relay Cabinet, Termination cabinet, Electrical/Instrument Termination cabinet shall be redundant.

r. Analog/Digital marshalling and PDB cabinets make shall be of Rittal only and necessary panel standard specification of for panels shall be of Rittal only.

s. Marshalling and PDB cabinets engineering shall be mutually agreed detailed engineering by both vendor and BPCL. The same drawing shall be approved by BPCL.

t. New dedicated earth pit shall be provided for each PLC system and the same may be interconnected with the existing earth pit if required.

u. Supplier shall include involving qualified Engineers and technicians for participation in engineering, installation, field testing and commissioning of PLC system.

v. Packing, forwarding, transportation, custom clearance, insurance, storage etc. of the system.

w. Installation, field testing, loop checking, commissioning and field acceptance of the system.

x. Documentation, training, warranty etc.

y. Installation and commissioning assistance of the free issue (owner supplied) items in the control room.

z. Tentative Bill of Material attached as per Annexure V

aa. Necessary new System cabinet shall be supplied. And the same to be installed in existing rack room. Existing Terminal Boards shall be replaced with new ProSafe-RS Terminal board. Signal cable termination shall be done by vendor. Power supply units shall be supplied.

bb. **Following Site Activity to be considered.**

- Shifting of New panels & Consoles from stores to Control room.
- Supply & Installations of required mounting arrangement (base Frames) or civil jobs for panel & operator console if any.
- Removal & Shifting of all the existing consoles furniture’s, PC, etc.
- Removal of existing System panels.
- Installation/Erection of New panels in Rack Room.
- Laying of any Prefab, Power, Signal cables within Rack Room & Control room.
- Identification and Glanding / Termination of new / or existing cable into panels & consoles.
- Vendor to consider commissioning assistance for 30 man Days at Site. Scope shall be restricted to control room side only.
- The scope of work and supply is exactly as detailed in the Bill of Materials. All changes resulting in hardware increase shall be intimated before or latest by CKOM and before placement of order. All the panels, wiring, tests & inspections, FAT, SAT shall be as per YIL standards. Documents shall be submitted to client for approval.
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2.1 As part of engineering, vendor shall develop documents required for system configuration for different areas in the unit. Vendor shall develop functional Logic Diagrams (FLD) etc on the basis of existing Logic schemes which shall be made available by BPCL Mumbai refinery to the vendor.

2.2 As this PLC System is replacing existing Prosafe RS PLC System. Vendor to consider the following while quoting.
   a. All the existing components along with cabinets/BMS Plaque etc shall be removed including removal and re-glanding of Field cables, termination and loop checking of the same. The detailed list is attached as Annexure II.
   b. Vendor to visit BPCL Mumbai Refinery Control room for items to be removed/replaced as per the above list and understood fully the job before submitting the offer.
   c. Vendor’s offer shall not be considered for technical evaluation in absence of this activity.

2.3 **POWER SUPPLY AND ELECTRICAL REQUIREMENTS**

**110VAC UPS**

Supplier shall be provided with redundant feeders of 110VAC from existing UPS cabinet. Supplier shall consider 75mtrs approximate distance from UPS to PDB. However the same shall be reconfirmed during pre-bid site visit. The cabling from UPS cabinet to Inst PDB is in vendor’s scope including sizing of the cables. Supplier to distribute 110VAC to all the consumers from PDB. Complete power consumption calculation shall be submitted by the vendors and on that basis MCBs and fuses with appropriate rating shall be provided.

PLC (ESD) shall include redundancy of DC power supply units / regulators for internal supply to the electronic cards, with automatic back up, such that microprocessor controller power supply failure shall not affect loop or sequence control.

Electrical power supply to the PLC (ESD) system shall be:
- 110 VAC ± 5%
- 50 Hz + 1Hz / -1.5 Hz
Electrical power supply to the PLC Modules will be:
24 V DC± 2%

Input /Output interrogation voltage shall be 110VDC±5%.

Earthing system will be provided strictly as per Vendor standards

2.4 **Tentative Execution methodology**

   a) This job is to be done during plant shutdown period.
   b) Installation / commissioning of PLC will be done in **one of the** CPP & CCU shutdown. The PLC cabinet, hardware mounting, internal wiring shall be completed in the manufac-
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trer’s facility and to be tested at the OEM facility in presence of BPCL Mumbai refinery representatives before dispatch to BPCL Mumbai Refinery site.

c) Removal of existing PLC cabinet and mounting of new PLC cabinet at BPCL Mumbai refinery site is to be done during shutdown. (Approx. 15 days).

d) Erection and Commissioning of the new CPP & CCU BMS PLC (ESD) System will have to be done phase wise during respective plant shutdown. Duration of the shutdown is approx 15 days however; the above PLC job shall be completed within 10 days. If required vendor to consider for working round the clock basis. The post commissioning start-up assistance for period of max. 15 days shall also be considered.
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3.0 SPECIAL INSTRUCTIONS TO VENDOR

1. The ESD system shall be a high availability Dual Redundant PLC / Triple Modular Redundant PLC with Hardware and Software Fault Tolerance.

2. The ESD system shall be used to continuously monitor the Safety parameters of the plant and shall take actions to maintain the Safety of the plants on demand. The ESD system shall provide a dependable and reliable means of executing the above functions and shall confirm to the Safety Integrity Level (SIL) 3 of the IEC 61508. The ESD system shall be TUV approved for class AK5 according DIN V 19250. Vendor to furnish the Test certificates & Report of TUV class at time of quoting.

3. The ESD system shall operate in a DUAL MODE (2-1–0) redundancy mode in Dual PLC System.

4. Failure of a card shall not interact with the other parts of the system.

5. ESD shall be sized in such a way as to guarantee further expansion to end user.

6. Details about software loading of ESD are referred in the different sections of this specification. They shall apply to:
   - Communication loading : 60 %
   - Process computations : 60 %

7. Hardware loading will be organized to guarantee 10 % spare signals already installed and wired plus an additional 20 % of free space in the cabinets.

8. The instrument philosophy used for the plant is Contact CLOSED during NORMAL or HEALTHY state and OPEN / BREAK to ALARM. Safety and interlock functions are generally performed by dedicated instruments for Safety shutdown.

9. Interposing relays for both input/output shall have free wheeling diode protection for Inductive load.

10. The ESD system shall be capable of accepting signals which may have to be triplicated / duplicated at the Card level to provide Triple Redundancy / Dual Redundancy.

11. Each SOE PC shall communicate to respective PLC where as one common PLC workstation shall communicate to all three PLC by Integrating all three PLC using multi dropping network (considering future two more PLC). Required hardware/software shall be considered for this purpose while quoting in this offer.

12. List of Forced signals shall be displayed in PLC workstation.

13. PLC Workstation and SOE PC along with necessary furniture shall be provided with insulated anti-virus software and virus protection card to avoid software corruption.

14. All PCs provided as part of this requisition shall be equipped with the latest available processor. Unauthorized access to the system shall be protected by means of suitable Hardware Key locks and Software passwords. Different levels of access shall be provided for the Operators and Engineers by means of passwords and key locks.

15.0 Scan Time

15.1 The ESD processors shall continuously scan the inputs, outputs and program & execute commands to appropriate outputs.
15.2 The Scan time of the PLC is defined as the total time required for reading input, program execution and changing the Output state.

15.3 The vendor shall also state and guarantee at the time of offer the following

   i. Guaranteed Scan time = less than 200mSec

   ii. The communication time between PLC (ESD) and DCS = less than 500 msecs

   iii. The vendor shall clearly state and guarantee the offered Scan time of the Emergency Shutdown System in their offer based on the figures. Without the above Scan times clearly stated in the offer and guaranteed the offer would be treated as incomplete.

   iv. Time resolution for SER of ESD PLC shall be Maximum 1mSec

15.4 Vendor shall provide four sets of back-up configuration storage for each system, containing operating programs, diagnostic programs and system configuration etc.

15.5 Vendor to note that the following makes of switches, lamps etc. only used, as applicable.

<table>
<thead>
<tr>
<th>SR. NO</th>
<th>TYPE</th>
<th>MAKE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PUSH BOTTON</td>
<td>IDAC ZUMI / FUJI</td>
</tr>
<tr>
<td>2</td>
<td>SELECTOR SWITCH</td>
<td>IDAC ZUMI / FUJI</td>
</tr>
<tr>
<td>3</td>
<td>LAMP</td>
<td>YAMATAKE HONEYWELL TYPE MICRO</td>
</tr>
<tr>
<td>4</td>
<td>TERMINALS</td>
<td>PHOENIX / WEIDMULLER</td>
</tr>
<tr>
<td>5</td>
<td>PC</td>
<td>WIPRO / COMPAQ</td>
</tr>
<tr>
<td>6</td>
<td>BARRIERS</td>
<td>MTL</td>
</tr>
<tr>
<td>7</td>
<td>FUSED TERMINALS</td>
<td>PHOENIX / WEIDMULLER</td>
</tr>
<tr>
<td>8</td>
<td>MCB’S</td>
<td>MDS</td>
</tr>
<tr>
<td>9</td>
<td>REALYS with base</td>
<td>OMRON WITH LED (4NO+4NC)</td>
</tr>
<tr>
<td>10</td>
<td>BMS Plaque</td>
<td>PHOENIX / WEIDMULLER</td>
</tr>
</tbody>
</table>

15.6 All digital output terminal blocks shall be fused type with LED indication.

16.0 Input - output considerations
All cards will be provided with diagnostic features with High diagnostic coverage per channel at component level, able to detect any failure and giving a diagnostic alarm. Replacement of I/O cards shall be possible while the ESD is powered.

a) Removal of a ESD I/O card shall not affect the supply of field power to other loops connected to the ESD.
b) Shut down switches will work as follows: when the contact coming from the switch is OPEN, the shut down sequence will start. This solution guarantees that plant shut down is initiated only if requested by operator and not as a consequence of a single hardware failure.
c) Bypass switch will deactivate a cause (or a group of causes, according to interlock process requirements) only when the contact coming from the switch is CLOSED. This way if there is a hardware fault interlock deactivation will not occur.
d) The following type of I/O modules shall be provided for as a minimum in the ESD.

17. **Digital input**

   Dry contact
   110V DC loop Voltage (interrogation voltage provided by ESD Marshalling) inputs
   Shall be provided with filter and isolation.

18. **Analogue Inputs**

   4-20 mA dc, two wire type

19. **Digital Outputs**

   All digital outputs shall be equipped with protection against voltage surges caused by inductive loads.
   Digital outputs shall be static type, free voltage contacts. The outputs shall be galvanically or optically isolated.
   Outputs shall be without any common wiring.
   Interposing relays shall be provided in the ESD Marshalling to match the required ratings.
   
   - For Solenoid valves 110 V DC - 3 Amps.
   - For MCC 110 V DC - 5 Amps.
   - For Shutdown Consoles 110 V DC - 1 Amp.

20. All I/O circuits must be provided with galvanic isolation using isolating barriers.
21. The following Tagging and Identification philosophy for Equipment, wiring and terminals shall be followed.
   a) Each Cabinet, Workstation, operator station, card file, equipment, shall have identification label/Nameplate on the front and rear. The identification label shall be of laminated plastic or approved equal with white dull surface finish and information engraved in Black. These labels shall
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be permanently affixed with fasteners or Bonding to the Cabinets / equipment. Vendor to provide the Nameplate and Labeling schedules for approval by BPCL Mumbai refinery.

a. All the instruments, pushbuttons, switches, lamps etc. mounted in the Cabinets/ Consoles shall be identified by two identical nameplates, one on the front and one on inside the cabinet/ Console. The nameplates shall be made of plastic or stainless steel inscribed with tag no. and service. The nameplates shall be attached with non-corrosive fasteners.

b. All wires connected to Terminal blocks, including I/O module termination panels shall be tagged with 2 identification tags. The first Tag shall (closest to the end of the wire) identify the terminal number to which the wire is physically connected. The second tag shall identify the terminal or device number to which the opposite end of the wire is connected. Wires markers shall be slip-on, heat shrink, permanently embossed, sleeve type.

c. Each terminal block shall be labeled with a sequential terminal identification number. Each row or column of terminal blocks shall be labeled with a unique identification name or number.

d. Multicore cables with connector plugs shall be labeled with 2 identification tags. The first tag (closest to the plug) shall identify the cabinet identifier, device and socket to which the plug is to be connected. The second tag shall identify the cabinet identifier, socket or device to which the opposite end of the cable is connected.

22. SYSTEM TERMINATIONS

The ESD / PLC (ESD) terminal panels have to be segregated per voltage level and voltage category.

Analog (Intrinsically safe)  
Discrete (Explosion proof)  
Power supply cables

Terminals shall be screw type and shall be adequate for wiring of flexible wires of 1.0 - 1.5 mm² section. No double terminal blocks may be used.

a. Interconnection between field and control room shall be from Marshalling rack only. All interconnection between marshalling and system cabinets shall be through prefabricated cables with plug in connectors.

b. Following color codes shall be considered.

<table>
<thead>
<tr>
<th>VOLTAGE</th>
<th>TYPE</th>
<th>COLOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>POWER SUPPLY 110V AC</td>
<td>PHASE</td>
<td>RED</td>
</tr>
<tr>
<td></td>
<td>NEUTRAL</td>
<td>BLACK</td>
</tr>
<tr>
<td></td>
<td>EARTH</td>
<td>GREEN</td>
</tr>
<tr>
<td>DC WIRING Both 24VDC and 110VDC</td>
<td>POSITIVE</td>
<td>RED</td>
</tr>
<tr>
<td></td>
<td>NEGATIVE</td>
<td>BLACK</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>ALARM SYSTEM</th>
<th>WHITE</th>
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</thead>
<tbody>
<tr>
<td>CONTROL &amp; SHUTDOWN</td>
<td>YELLOW</td>
</tr>
<tr>
<td>ANALOG SIGNAL</td>
<td>LIGHT BLUE</td>
</tr>
</tbody>
</table>

a) 100 metres of loose wires shall be supplied as spares for each cabinet.

b) Power cables to individual barriers, Isolators and Relays shall not be looped together. Separate wires shall be laid from bus bar to individual devices.

23. **Identification and Marking**

1) All electrical terminations and equipment on the cabinet and other accessories shall be identified with appropriate tag, cable marker etc.

2) All terminals in terminal strip shall be identified by their individual numbers located integral with the terminal itself.

3) Interconnecting multi core cables if any shall be identified by metal tags.

4) Wiring at terminals shall be identified by the terminal numbers and termination service at the other end of the wire. Writing at instruments and accessories like alarm relays, pushbuttons etc shall have ferrules indicating tag numbers, terminal and the termination service at the other end of the wire.

5) Ferruling shall be cross and straight both with heat shrink sleeves.

6) Looping connections if any shall be identified by the termination services at both ends of the wires.

7) Identification markers as mentioned above shall be repeated in suppliers drawings also.

8) Sample identification method shall be discussed with BPCL Mumbai refinery before finalization.

9) Vendor shall consider 30% engineering changes in wiring that is rewiring if required for better engineering during FAT and Erection and commissioning.

24. **Lamps /Switches and PBs.**

24.1 **Push-buttons**

Related push-buttons shall be organized in isles, and a label shall be provided to identify the general function of each switch

24.2 **Labels**

Close to each switch a plastic label shall be provided and the tag name of the device shall be indicated on it. Labels shall be black with white engraving.

24.3 **Terminations**

Each termination shall be identified with a global label and each terminal shall be clearly identified through a number/letter (details will be defined during project development).
24.4 Lamps

1. Colors will be:
   - RED
   - GREEN
   - YELLOW (enable/disable of interlock)

2. The lights shall be provided by white multi LED elements, and the colored caps shall be easily replaceable.

3. Typical connections of lamps shall be as follows:
   - Two (2) lamps (for valve equipped with two limit switches): a lamp shall be always lit according to the status of the valve (green=open; red=closed);
   - One (1) lamp (for indication of motor status or valve equipped with single limit switch indication).

4. Some lamps will be installed inside push-buttons, others will be independent.

24.5 Push-buttons and switches

Switch contacts will be wired as follows:

- Normally closed: open the contact (2 NOs) to initiate the interlock and to stop dedicated motors;
- Normally open: close the contact (2 NCs) to disable (bypass) an interlock sequence.

a) All the switches and lamps shall be wired to a marshalling strip installed inside the shut down console. The numbers of strips and terminals shall cover the number of switches and lamps foreseen on the consoles considering the spares.

b) To allow easy reconfiguration of the console during the plant commissioning and start-up, all the switches shall have three contacts per section and internal lamp(s), all wired to the terminal strip.

c) The switches shall be provided with modular components, to guarantee easy replacement of colored caps, or to allow change from two position switch to push-button and vice versa. Security covers shall be provided, to avoid accidental operation of switches and push-button. A mushroom pull-button for the plant emergency shutdown shall be provided. A lamp-test push-button and the necessary diodes and wirings, shall be provided on the hardwired consoles.
Suppliers to consider individual fused terminal strips for power wiring to barrier, isolators and Relays.

terminal panels with electronic devices and/or relays mounted shall have a dedicated mechanical protection.

each terminal strip and group of terminal strips shall have the individual identification tag and each channel shall be identified by the instrument connected with tag name.
The terminal panel connection to the I/O unit shall be through plug-in connector multiwires cable.
The Terminals provided in the Marshalling cabinets shall be single tier and of suitable size depending upon the current rating and the size of the cable being terminated. The terminals shall be of Weidmuller type SAKS or equivalents with knife edge isolation of the signal from / to field. Individual fuses and indicating LED/Lamps for indicating signal status shall be provided for each Digital O/P channel. The digital outputs shall have LED/Lamps for indicating Fuse blown status.

25.0 The following points must be taken into consideration for engineering of PLC

- Power supply distribution for Processors, inputs and outputs must be from respective Bus bar only.
- Redundant part of I/O modules shall be mounted in a different I/O rack and shall have separate back plane.
- All power supply distribution shall be designed to have no common mode failure. Separate DC/AC feeders shall be used for each processor and each I/O rack.
- I/O modules must be segregated shutdown circuit-wise. No more than 60% of the module I/O capacity shall be utilized.
- PLC system engineering shall be done by PLC vendor at their works. No subcontracting shall be entertained.
- PLC cards should be G3 coated minimum for Corrosive atmosphere.

26.0 The system shall be internally protected against system errors and hardware damage resulting from:

- Electrical transients on power wiring
- Electrical transients and signal wiring, and
- Connecting and disconnecting devices or removing or inserting printed circuit boards in the PLC (ESD) system.

27. COMMUNICATION SUB SYSTEM

- PLC and PLC Bus shall be Fully deterministic based on IEEE802.4
- I/O Bus redundancy shall be true redundant with 2 sets of Bus and redundant Cards.

28. For all thermocouple signals, which are connected to PLC (ESD) system, proper barrier/Converter shall be used for converting T/C to mA converter to connect to AI Module.

29. POWER SUPPLY
a. Vendor to ensure the equipment shall not be damaged due to blackouts. Further vendor to indicate the following. Steps to be taken for Fail Safe Operation of the system under the following conditions.
   - Power failure
   - Voltage Variation more than ± 10%
   - Frequency variation More than ± 3%
   - Air conditioning failure

   The start up procedure for the system including system databases loading during start-up and power on shall be submitted.

b. 110V AC, 50HZ UPS and 110 V DC shall be made available to the vendor at one point in control room. Wherever 24vdc supply required the same shall be made available by using redundant bulk power supplies. Separate sets of power supplies shall be used for each of these applications.

c. Bulk power supply provided by vendor for transmitter power or for any other application shall have the following specifications:
   - Bulk power supplies shall be redundant floating with +, - 0.5V tolerance.
   - Separate power supplies shall be provided for each Processor and its associated I/O cards.
   - Status indication for each power supply shall be provided at DCS.
   - Switch / Fuse for each loop.
   - Each power supply shall be sized for 150% of load.

30. EARTHING REQUIREMENT

   There shall be two separate earth pits shall be provided by the vendor outside the control room, one for signal grounding (IS) and another for instrument (SYSTEM) grounding. It may be interconnected with existing earth pits if required.

31. CABINETS, RACKS AND PANELS

   a. All cabinets, panels and racks shall be designed to avoid congestion for ease of maintenance. Design shall be as per the data sheets enclosed. Additionally, racks / cabinets shall be designed to take care of the following:
      - No marshalling rack / cabinet have more than 800 terminals in any case
      - All the spare cores shall be terminated on the marshalling rack. No cable / core shall be left un-terminated in the rack / cabinet.

   b. Quality of the all panels and consoles shall be of highest quality as per good engineering practice and to the satisfaction of BPCL Mumbai refinery.

32. SPARES PHILOSOPHY
a. Installed engineering spares of 25% shall be provided in each sub system for each type of module to enhance the system functional requirements including PLC and hardwired instrumentation.

b. In addition the system shall have the following minimum spare capacity.
   - The Processor and I/O cards racks shall have 20% usable spare space for installing additional I/O modules in future. However, the Processor and I/O cards shall have additional 25% capacity to handle these I/Os. In addition, internal wiring for the same shall be completed upto I/O terminals.
   - I/O racks of PLC shall have 20% usable spare space for installing additional I/O cards of each type in future. However, internal wiring for the same shall be connected upto the I/O terminals.
   - Processor system of PLC shall have capability to execute additional 20% logic. Further it shall be possible to extend the memory by 20% at a later stage.
   - Usable spare space in cabinets and marshalling racks to install 20% spare hardwire items like barriers, trip amplifiers, and relays etc. including terminals in future.

c. Mandatory spare modules of 10% or more module whichever is higher must be supplied for each type of modules being used including for consoles. This shall include spare modules for hardwired instruments. Personnel Computers, PLC etc.

d. System spares for future shall be provided as follows
   - Processing capacity : 40%
   - No. of Nests/Nodes : 100%
   - Vendor shall provide Min. 100% expandability on node connectivity on redundant communication subsystem for each kind of devices connected to the network.

33. **System loading**

   PLC (ESD) shall be sized in such a way to guarantee further expansion to End-User. Details about software loading of PLC (ESD) are referred in the different sections of this specification. They will apply to:

   - Communication loading : 60 %
   - Mass memory loading : 60 %
   - Process computations : 60 %
   - SOE Point Loading : 60 %

   The above software loading figures shall apply to the fully configured system, comprehensive of spare and uninstalled interfaces.
34. The training requirements for PLC (ESD) and PLC shall be as follows. This training shall be conducted at vendors/OEM works.

- Engineering, Maintenance and trouble shooting training for 100 Man days
- Site Training shall be carried out by the vendor for five engineering mandays.

35. Vendor to submit PROVEN TRACK RECORD (PTR) for PLC (ESD) and PLC and also list of installations in India and aboard. PTR shall be given of the same Model of system proposed for this project, including all major components like Controller, CPU, I/O cards, I/O racks, Communication Bus, Operator Station, Software, etc. The name of the concerned person at customer end with contact details and installed architecture details should be advised along with PTR.

36. **DIAGNOSTIC CAPABILITY**

The system shall have a High diagnostic coverage per channel.

The Diagnostic coverage factor shall be confirmed by the vendor at the time of offer. The Diagnostic Coverage factor per channel of ESD shall be provided by the vendor.

This diagnostic system will be automatic and run on a continuous basis without maintenance person’s intervention. It shall be capable of detecting errors or fault conditions in any part of the PLC system before system integrity is lost. The diagnostics shall report the location of the faulty device, the type of device and the type of malfunction. Faults in the communication system shall also be identified by the diagnostic routines.

Vendor to detail the diagnostic programs available in the ESD system for the maintenance people for debugging the system hardware and software faults and normal maintenance activities.

The ESD system diagnostics shall show the following minimum fault / healthy state status but not limited to

- Power feeders healthy
- Circuit breakers tripped
- Fuse Failure
- Battery failure
- Power supply failure
- Power supply removed
- CPU fault
- Input/Output Module failure
- Input/Output Module removed
- Communication Failure
- Each channel failure
- Panel internal temperature high
• Others as supplied by the manufacturer.
  These states shall be transmitted to DCS via hardwired digital outputs in addition to serial link. The Fault recovery procedures for the above faults shall be detailed by the vendor at the time of offer.

### 37. INTERFACE WITH DCS (Yokogawa CS3000)

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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>1. Type of interface</td>
<td>Shall be one of the Node to existing CS3000 DCS is required</td>
</tr>
<tr>
<td>2. Type of Redundancy</td>
<td>DUAL REDUNDANT</td>
</tr>
<tr>
<td></td>
<td>Processor system</td>
</tr>
<tr>
<td></td>
<td>ACTIVE</td>
</tr>
<tr>
<td>3. Standard Interface software available for MODBUS PROTOCOL</td>
<td>Not Required</td>
</tr>
<tr>
<td>4. Functional Requirements</td>
<td>Type of Communication</td>
</tr>
<tr>
<td></td>
<td>Automatic time Synchronization</td>
</tr>
<tr>
<td></td>
<td>Interface with PLC diagnostic messages</td>
</tr>
</tbody>
</table>

38. Refer Annexure IV for list of documents issued by BPCL Mumbai refinery after placement of PO.
39. Refer Annexure V for tentative bill of material
4.0 General Instructions to Vendor.

4.1 Common

a. Vendor to note that they shall be fully responsible for the Bill of Material submitted by them to meet all hardware and functional requirements as indicated in this requisition.

b. In addition, vendor shall be fully responsible for the total scope of work indicated in this requisition on turnkey basis and meeting all functional requirements through hardware and software during detail engineering.

c. Vendor shall be fully responsible for proper engineering, integration, installation, performance and operation of all equipments including I/O and marshalling racks, and bought-out items supplied by them as per the requirement.

d. In case of conflicts with respect to specifications given in various documents of this requisition, any other engineering requirement or legal regulations, the vendor shall consider the most stringent requirement by default while selecting the PLC system.

e. All bought-out items shall be procured from BPCL approved vendor list. In case vendor list of any item is not included, vendor must obtain the approval for the same from Owner/consultant during detailed engineering. Owner’s decision in this regard shall be final and binding on vendor without any exception.

f. All bought out sub system shall be designed, engineered, manufactured and tested by the manufacturer at their works only. All such subsystems (typical) shall also be made available during integrated factory acceptance test at PLC vendor works. All bought-out items/subsystems shall be fully tested at manufacturer's shop prior to shipment by manufacturer to PLC vendor’s works for integration. All such test reports shall be submitted to Owner for review.

g. Preliminary testing of the PLC hardware shall be carried out by the PLC vendor before connecting the system to field instrumentation. The laying of field cables and core identification shall be done by other agencies. PLC vendor shall carry out the termination of the cables in the cabinets/racks and interconnections within the control rooms, including supply of glands at cabinet side.

h. Vendor shall be fully responsible to coordinate all the jobs related to various activities covered under this contract with various agencies. This shall include,

i. Coordination with OWNER and other sub-contractors for gathering information necessary for generation of point data base, hardware connectivity i.e. cable laying, termination details in cabinet / panel wherever necessary for vendor to complete the job.

j. Coordination with site contractor during loop modifications, terminations/ re-terminations and loop checking.
PLC vendor shall take single point responsibility for establishing interface and data communication between their system (DCS&PLC)

Vendor to support the site till commissioning of last unit and SAT without any implication to the owner. Accordingly the system engineering, FAT, installation, integration etc. shall also be considered. The schedule shall be as given in commercial sections attached along-with in this requisition.

There could be a time span of maximum 6 months between commissioning of units. DCS vendor shall consider all the necessary equipments, logistic services etc. for site activities accordingly.

4.2 System design

In general, the system design shall be carried out based on the I/O summary. At any stage of the projects, if one or more units are found to have actual requirement less than the provision indicated, the same shall be considered for adjustment with other unit(s) for which the actual requirements exceeds the provision given, with the approval of owner. The above adjustment is for I/O. Any changes with respect to wiring, cabinets, system sizing etc. shall be considered by vendor without any implication. No change order is permissible as long as the overall I/O

4.3 System Modification / Change Management

i. Vendor shall carry out all the modifications/changes/revisions necessary to be incorporated and pointed out at the time of FAT including graphic changes, wiring changes, I/O assignments, logic changes etc.

ii. Vendor shall carry out all changes/modifications/revisions which are to be carried out during installation including additional inputs for sub-package items, configuration of new tags, termination changes, incorporation of cable schedule connections, modification and addition of new graphics modification of group trend history etc.

iii. Vendor shall carry out any changes required during loop checking and pre-commissioning activities such as range change, graphic display changes, reassignment of I/O, termination changes etc. shall be performed by vendor.

iv. Vendor shall carry out changes/modifications required in the system during commissioning and start up due to operational requirements like graphic changes, tag reassignment, tags new assignment, history trend and grouping, format changes, set point range changes, logic modifications etc.

v. Vendor scope shall include incorporation of all such software/hardware configuration, engineering changes that may occur for normal engineering project execution.

4.4 Mandatory Spares
Replacement of Prosafe Model Quadlog PLCs in CPP and CCU by SIL 3 Certified Prosafe - RS PLC.

a. These spares are in addition to 20% installed spares

b. Vendor shall provide the following mandatory spares
   a. 5% or minimum 1 no. module of each type of I/O module
   b. 10% or minimum 2 nos. of module of each type (processor module, communication module, power supply module etc.) being used inclusive of those used in consoles. This shall include spare modules for hardwired instruments also.
   c. 10% or minimum 2 nos. of each type of Safety Barriers, Signal converters, Trip Amplifiers etc. as mandatory spares.
   d. 20% or minimum one no. of each type of set of fuses, Fused terminals, MCBs, Auxiliary relays etc.
   e. 2 Nos. of bulk power supply unit of each rating
   f. 10% or minimum 2 nos. of communication system components such as hubs, switches, routers, etc. whichever is higher.
   g. 5% or minimum 1 no of Disks, disk drives, CRT, switches, lamps, push buttons, etc, whichever is higher

c. Mandatory spares including Installed engineering spares and spare space shall be provided over and above the I/O count furnished in the I/O Summary table.

4.5 Consumable spares including Laser printer cartridges, paper or any other consumable items supplied along with the required for a minimum period of 6 months duration after system acceptance are required.

4.6 Vendor to list out the ‘consumable spares under separate heading in the list of ‘2 years operational spares’ in their bid.

4.7 All spare items required for commissioning namely spare fuses, lamps terminals etc. shall be supplied by vendor.

4.9 Upon receipt of order, vendor to submit finalized list of commissioning, operation & maintenance spares for approval. The list shall indicate all details namely part description, reference drawing no., part no., MOC, quantity, bearing make& model no. The list shall also be submitted in "EXCEL" format.

4.9 20% spare field bus junction boxes along with all accessories over and above the quantity required as per I/O summary table shall be supplied as loose.

5.0 Control system requirement

   a. Single Integrated ESD system network to be considered for this project. When same make of DCS and ESD PLCs are supplied, common communication bus can be used provided the same is allowed as per SIL certification / TUV guidelines.
b. All the system provided by vendor shall be upward compatible i.e. new enhancements can be incorporated in the system for future up-gradation.

c. In case of any operating system becoming obsolete during warranty period vendor shall upgrade operating system/ application software at free of cost to latest proven system.

d. Application software shall be designed in a manner that requires no modification to the system operating software. Software design shall be such that future revisions or updates of the system operating software will not affect the successful operation of the system.

e. All software, exclusive of application software, shall be the most recent revision that is applicable to the system hardware at the time of the placement of order on vendor. The system shall allow for upgrading of system operating software on all redundant modules of the system without the necessity of shutting down the process, without losing the operator interface and without the loss of access to any control function.

f. Channel to channel isolation shall be provided in each I/O card of PLC

g. All digital I/Os and Field digital I/Os (Non IS) shall be connected through interposing relay. Vendor to note that input and output relays shall be provided for each DI/DO signal. Relay board is not acceptable.

6.0 Loading philosophy:

<table>
<thead>
<tr>
<th>Control Processor</th>
<th>60%</th>
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<tr>
<td>Communication Processor</td>
<td>50%</td>
</tr>
<tr>
<td>Communication Bus</td>
<td>50%</td>
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</table>

The maximum number of nodes in the network shall not exceed 60% of the maximum capacity. Loading shall be inclusive of peer to peer communication.

a. I/O Cards, Processor modules of PLC shall have factory standard conformal coating (preferably G3 or equivalent) to suit the environmental conditions specified elsewhere.

b. All repeat signals to field shall be multiplied at control room side only.

c. The selected model of IS barriers meet the requirement of isolation indicated in the requisition document i.e. all the barriers provide isolation between Input-Output, Input-Power supply and Output-power supply.

6.1 PLC shall have software “wizards” to effectively manage the process of decommissioning the failed device, commission the replacement device and reconcile the configuration

6.2 All the software packages supplied shall be original license.

The PLC system software supplied shall not have any recurring license fee. The license shall be valid up to the entire 15 years period of logistic support except for PCs for which the logistic support shall be 10 years only.
6.2 Vendor to confirm that the proposed systems application software shall not require modifications in order to be able to run under new releases of the system operating software. Any new release of system software shall be backward compatible with files created using the previous software releases.

6.2 Vendor to categorically confirm that the proposed control system shall be of design such that it can be upgraded to new software revisions and I/O modules while the system is online, running a process with no re-start is required.

6.2 Vendor to categorically confirm that online upgrade capability shall allow the user to update the system to the next software release without any impact on process operations. The system design shall ensure the same.

6.2 Vendor to categorically confirm that the proposed control system has Online upgrade capability allowing the user to migrate to newer revision levels of software and thereby to take advantage of continuing technical enhancement.

6.2 The Supplier shall indicate whether anti-static precautions are necessary when handling cards. If such precautions are required, grounding wrist straps shall be supplied as permanently installed items.

6.30 BATTERIES: The Supplier shall provide a list detailing all the batteries within the system. The list shall contain information on battery type, rating, shelf life, location, duty and renewal frequency.

6.31 Vendor to note that long term trending package software shall be provided in at least 2 operating stations and control view package in engineering stations.

7.0 Communication sub system

7.1 The communication subsystem cable shall be secured in flexible SS conduit routed through GI trays inside the control room

7.2 The communication subsystem, in each case must perform to the specifications for error rate, signal attenuation, noise immunity, etc. No other cable (signal, alarm, power) should be kept in the conduit.

7.3 All communication cables, data highway cable routed in the field (i.e. between Rack room and CPP control room shall be via dual redundant fibre optical type if applicable. The OFC shall be with two layers of steel tape for the same. Vendor shall provide specific converters wherever necessary for the same. All fibre optical cables shall be routed through hard HDPE conduits and shall be totally enclosed within using HDPE matching fittings. The HDPE conduits shall be as per IS-4984 or equivalent IS standard. Separate conduits shall be used for laying redundant fibre optical cables. The outer colour of the conduit shall be orange with black fittings throughout the run. For redundant system / fibre optic / serial link, the two cables shall be laid apart as far as possible in same cable duct.
7.4 All fibre optical cables shall be rodent resistant and armoured type only.

7.5 Vendor to note that the configuration diagram is indicative only. Exact sequence of connection of nodes and mode of connectivity shall be decided by vendor based on the geographical proximity and operation requirement after physically surveying the site by them.

7.6 Data highway cable installation work including design, fabrication, supply of HDPE conduits shall be in PLC vendor’s scope.

7.7 Vendor has to physically survey the actual site conditions to assess the actual route. Vendor is required to submit a drawing showing the proposed route plan before actual work commencement for approval by site Engineer.

7.8 Inside control room/control station, suitable box type cable tray with cover shall be made use of, drawn through a separate route away from power/control cables.

7.8 One FO cable per conduit shall be used.

7.9 Network Switches or Media Converters and its power supply units shall be of Industrial Grade

7.10 All PLC configurations shall be TMR/Quadruplicate with SIL3 certification as per IEC 61508 as a minimum.

7.11 Interposing relays for DO cards in PLC shall be provided for all outputs whether they are used or not, including spare DO cards. All digital inputs/MCC/hardwired console shall also be connected via interposing relays for both ESD.

7.12 Fuse indicating type TB shall be provided for individual DI and DO channel.

7.13 Input interrogation voltage shall be 24V DC. 24V DC power supply shall be provided through redundant power supply modules.

7.14 The PLC shall be sized considering I/Os and other sizing requirements like scan time, CPU loading etc as per the requisition. The sizing calculations shall be reviewed during detail engineering. Vendor shall be fully responsible to supply number of PLCs as required meeting above requirements.

7.15 The main PLC processor and I/O cards replacement should be possible on line without compromising the plant safety and TUV guidelines. The PLC system shall have high availability.

7.16 Power supply units shall be TUV certified. For barriers of PLC, both SIL-3 and SIL-2 certified barriers are acceptable. SIL 3 relays are not required.

7.17 In case of two out of three inputs in PLC, the inputs shall be wired in three different cards. Instrumentation shutdown and interlock shall be de-energizing to trip.

7.18 For analog input to PLC provide necessary barriers.

7.19 All PLC I/O signal shall be two wired, with no looping or common sharing of power supply or negative points.
7.20 Report for list of input, output under forced conditions, bypass switch under bypass condition shall be generated from the operator consoles.

7.21 The supplier shall clearly list out the type of online changes /modifications which are possible in their ESD PLC system with complete details and examples. The Supplier shall specify if there are cases where replacement of a component can lead to a complete ESD PLC stop, de-energising of outputs or any loss of functionality (e.g. detection of trip conditions).

7.22 The system shall have an automatic and on demand data protection scheme for the preservation of all data during a planned or unplanned outage. The entire control software shall be backed up including vendor software, control database, user-built programs, source code and data files.

7.23 The programming terminal shall not be online under normal operating conditions (either powered off or have multiple password protection). Printer provided with programming terminal shall be able to print alarms (system and process) and documentation.

7.24 The functionality of PLC engineering stations shall be as per specification. The switching arrangement shall be provided by vendor for programming from SRR and data base equalisation. Further engineering personality in operator console is not required.

8.00 COMMUNICATION BETWEEN ESD PLC AND DCS:

The common communications bus (in case of same make DCS/PLC) shall be based on the following in addition to the other requirements in 6-52-0055.

For each hard wired analogue input:
- Analogue measurement to DCS (the Supplier shall indicate units and resolution);
- Trip setting to DCS;
- Trip alarm to DCS;
- Measurement diagnostic status to DCS; (Transmitter Malfunction)
- Feedback on maintenance override to DCS;
- First-up indication to DCS.
- Input force status to DCS.

For each hard wired digital trip input:
- Trip alarm to DCS;
- Feedback on maintenance override to DCS;
- First-up indication to DCS;
- Input force status to DCS.

9.0 SOE/SER:


Sequence of Event recording is required in PLC. SOE resolution time for digital inputs shall be 1ms. For Analog inputs SOE resolution time shall be same as PLC scan time. Separate Work station with printer shall be provided for SOE capturing.

For digital inputs Sequence of Event (SOE) recording shall be with maximum 1 msec. resolution between two events i.e. the accuracy of time stamping recording between two events shall not exceed 1 msec. This shall be achieved with time stamping at digital Input card level itself. In case the same is not possible at Input cards level, vendor shall consider necessary external hardware (SER) ensuring 1 msec resolution between two events.

The printing shall be automatic and shall not need any human intervention such as selecting and dumping to print. The printout shall have “time stamping” with the resolution as mentioned above. The SOE A&E printer shall automatically be updated on SOE PC as and when they occur and shall have automatic periodic archive and retrieval facility to prevent database overflow errors.

9.1 The PLC system shall be so designed/ selected that the following on line maintenance/ rectification jobs can also be carried out without affecting the functioning of the system in addition to other requirement already specified in the standard specification:

i) It should be possible to make online changes to the trip settings for analogue inputs, setting of timers and selection of normally open or normally closed configuration for digital I/O etc in the ESD PLC.

ii) Scan time of PLC is as defined elsewhere. Other activities like diagnostics routines, output / dump of data to peripherals, or any other activity which consume processor time shall also be accounted while computing scan time. In case any plant unit requires faster scan time, the same may be adopted for that application.

iii) All the relays shall be low power continuously rated type and shall have LED for status.

10.0 EARTHING REQUIREMENT

Dedicated redundant two earth pits (minimum) shall be provided for both signal and chassis (system) grounding for PLC Earthing system for each SRR/CR. Preparation of earth pits outside control room shall be under PLC vendor scope. Supply of earth electrodes, grounding cables (separate for signal grounding and instrument grounding) and other related accessories required for barrier earth, system earth and installation shall also be in the scope of work of PLC vendor.

11.00 FACTORY ACCEPTANCE TEST AND SITE ACCEPTANCE TEST:

11.1 Vendor shall prepare detailed pre-FAT report and submit for BPCL review.

11.2 Factory acceptance test shall be as per the Standard Specification for PLC and this special instruction to vendor.
11.3 Following minimum test shall be performed:

- I/O and Linking Device Redundancy
- Application Software Test for Controller
- I/O and Linking Device Test
- Set up for Fieldbus Tests
- Field Devices with the Host system
- Remote Calibration (Field Device Adjustment) Test
- Field Devices Function Blocks
- No. of Devices in a Segment

12.0 Panels/Cabinet wiring/termination

a) Vendor to use OMRON make or equivalent relays wherever required. Other reputed make with requisite PTR shall be accepted. Minimum no. of contacts for all relays shall be 2.

b) All PLC hardware including engineering console/operator console shall be proprietary equipment and shall be supplied through original manufacturer of the system.

c) All bulk power supply (BPS) shall also be provided with cooling fans as per manufacturer standard and with bulk power supply alarm indications in DCS. Further bulk power supply failure alarm shall be provided for each redundant pair.

d) The ferruling philosophy/type shall be decided during detail engineering based on overall philosophy for the refinery. Ferrules used shall be single sleeve with source destination type. Ferrules shall be white silicone based with black printing.

e) In all analog marshalling cabinets provision shall be kept for mounting hand held configurator/fieldbus tester for smart/fieldbus transmitter.

f) Size of all power supply cables specially the cables within the panel must be properly selected with respect to load.

g) Inter panel wiring of input/output parameter are to be avoided by suitable configuration of I/O to the system.

h) All field multicore cables shall be terminated in spare TBs with spare ferruling for future use.

13.0 Control system security:

“Defense-in-depth” strategy shall be applied to design and implement robust security network for control system i.e. strategy involving two (or more) different overlapping security mechanisms shall be used to mitigate security vulnerabilities and threats. A defence-in-depth architecture strategy includes the use of multiple firewalls, the creation of demilitarized zones, intrusion detection capabilities along with effective security policies, training programs and incident response mechanisms “Bastion model” of securing industrial network shall not be used.

13.1 Critical cyber security issues that need to be addressed include those related to:

- Backdoor Attacks via Network Perimeter
Replacement of Prosafe Model Quadlog PLCs in CPP and CCU by SIL 3 Certified Prosafe - RS PLC.

- Attacks Using Common Protocols, i.e. OPC/DCOM attacks
- Attack into control system via field devices
- Database and SQL data injection attacks
- Communications hijacking and ‘Man-in-the-middle’ attacks

13.2  Vendor shall ensure that security of the system is addressed from both IT and control system perspective. Vendor shall design multiple layers of network, system and application security. Vendor shall ensure that industry, regulatory and international standards are taken into account while designing the security system.

13.3  The use of any unauthorized CDs, DVDs, floppy disks, USB memory sticks, or similar removable media on any node that is part of or connected to the PLC system should not be permitted in order to prevent the introduction of malware or the inadvertent loss or theft of data. Where the system components use unmodified industry standard protocols, mechanized policy management software can be used to enforce media protection policy.

13.4  Recommendations of the National Institute of Standards and Technology, NIST Special Publication 800-82 “Guide to Industrial Control Systems (ICS) Security” may be followed for developing the security system.

13.5  Vendor’s security system shall fully comply with ISA99 Industrial Automation and Control Systems Security Standards.
Vendor shall submit the architecture of control system security network.

13.6  USB Mass Storage Monitoring Software:
USB mass storage media drive monitoring software shall be provided on all computers/servers (wherever USB port is given). This shall alert administrator by playing selected sound or by CPU warning beep sound when any USB stick is being connected or removed. Surveillance utility explains entire details of connected USB storage device including manufactures company name, hardware ID, storage capacity with client machine name, IP address and save information in txt or html file. USB data protection software enables or disables access permission (read / write) of any storage media in domain. Data theft protection application applicable for all USB storage media devices such as pen drive, thumb drive, memory stick, mp3 player, mp4 player, memory card, digital camera etc.

13.7  Vendor to ensure that PLC systems shall not be damaged due to black out/brown-outs. Further vendor to provide:
Steps to be taken for fail safe operation of the system under the following conditions;
- Power failure
- Voltage variation more than ±10%
- Frequency variation more than ±3%
- Air conditioning failure
- The start-up procedure for the system including system database loading during start-up and power up for each subsystem.
Other instructions:

a. All panels, cabinets shall be of make Rittal or equivalent.
b. The system and documentation and instruction manual CD/DVD shall be submitted with proper labelling with CD storage/carry case and not loosely.
c. Site acceptance test for all the subsystem/packages to be considered
d. Vendor to provide / select the best possible accessories / peripherals of PC during detail engineering for PLC. Make shall be HP/DELL.
e. Wiring for Inputs and outputs to the PLC system shall be as per the OEM recommended philosophy. The PLC FTA shall be from the OEM and shall be as per the TUV certificate. Any I/O multiplication hardware required for wiring of the field inputs to PLC I/O module as per standard architecture of the PLC shall be TUV certified meeting requirements of SIL3 as specified.
f. Static transfer time will be verified during SAT or before SAT by online changing over the UPS, by pass UPS, UPS on battery bank etc. The functionality of PLC should not be affected. Vendor to demonstrate at site after the Power on the system.
g. All the necessary Chairs and furnitures etc shall be supplied vendor industrial standard.
h. Kick off Meeting, System definition Meeting, Software Definition Meeting & other Engineering review meeting.
   i. Factory acceptance test at sub vendor works for bought out items & FAT for PLC.
   ii. Loop Checking / testing & commissioning.
   iii. The Project schedule shall be made during KOM for achieving the various milestones.
   iv. Any meetings considered necessary by Owner in order to achieve the Project schedule with DCS vendor, the vendor shall consider the same at discretion of Owner.

15.0 STANDARD & EXTENDED WARRANTY –
a. Vendor shall be fully responsible with respect of proper design, quality workmanship and operation of all the equipment, accessories etc supplied by vendor under this package. Standard warranty shall be for a period of 12 months from the date of commissioning (SAT) or 18 months from the date of supply whichever is earlier.
b. In addition to the standard warranty vendor to provide four years(4) extended warranty for all the Hardware/software/accessories/bought out items supplied by vendor.
c. Any deficiency observed during this standard and extended warranty period shall be set right by the vendor without any cost implication to the owner.
d. It shall be obligatory on the part of the vendor to modify and/or replace any hardware and modify the operating, application and diagnostic software free of cost, in case of any malfunction is revealed during normal operation within warranty period.
Replacement of Prosafe Model Quadlog PLCs in CPP and CCU by SIL 3 Certified Prosafe - RS PLC.

e. Any third party equipment supplied along with the system namely PCs/Monitors / printers / network switches etc under this project shall be part of the extended warranty and to be maintained by DCS vendor with the required support from respective manufacturer to resolve the problem within stipulated time.

17.0 For items not appearing in vendor list, Bidder shall furnish proposed sub-vendor list for Purchaser’s approval.

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Item</th>
<th>Make</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Miniature Type Hardwire Console Items</td>
<td>Honeywell/ IZUMI / EAO/ Equivalent</td>
</tr>
<tr>
<td>3</td>
<td>Cabinets</td>
<td>Rittal / Equivalent</td>
</tr>
<tr>
<td>4</td>
<td>Bulk Power Supply</td>
<td>DELTA/ LAMDA/ Mitsubishi/ Co-sel/Weidmuller/Equivalent</td>
</tr>
<tr>
<td>5</td>
<td>Barriers / Isolator</td>
<td>MTL 5000 series / P&amp;F equivalent</td>
</tr>
<tr>
<td>6</td>
<td>Relays</td>
<td>OMRON / Equivalent</td>
</tr>
<tr>
<td>7</td>
<td>Terminal blocks</td>
<td>Phoenix/ Wago/ Weidmuller</td>
</tr>
<tr>
<td>8</td>
<td>Busbar terminal blocks</td>
<td>WAGO / Equivalent</td>
</tr>
<tr>
<td>10</td>
<td>PC and Server</td>
<td>HP/ DELL</td>
</tr>
<tr>
<td>11</td>
<td>Firewall</td>
<td>CISCO / Equivalent</td>
</tr>
<tr>
<td>12</td>
<td>Network Switches</td>
<td>CISCO / Equivalent</td>
</tr>
<tr>
<td>14</td>
<td>Furniture</td>
<td>Godrej /Equivalent</td>
</tr>
</tbody>
</table>
5.0 FACTORY ACCEPTANCE TEST PROCEDURE

5.1 General

This document specifies Factory Acceptance Test (hardware and software) and procedure to be performed before accepting the system, the certificates (if any) to be presented by Vendor, the assistance to be guaranteed as a minimum during testing, shipping and installation and Vendor's responsibilities.

This document shall be checked and integrated by Control System Vendor during the project development to include additional tests, or to modify some of them below described to match the requirements of the system.

The document will be revised at a meeting prior to the F.A.T. to include these additional comments. As a general rule, anyhow, test defined in this document's revision shall be considered mandatory.

5.2 Factory Acceptance Test

The Factory Acceptance Test (F.A.T.) will concern all the equipments and SW activities that are within Control System Manufacturer's scope of supply.

During the System development, it will be agreed if the test will be performed on the complete Control System (PLC, Cabinets), or if separate tests will be conducted on each item, performing a final integration test (for example at the end of the PLC FAT) with a suitable subset of the other equipment.

In this case, the present procedure shall be applied to the item under test, unless otherwise specified. In any case Vendor is requested to propose, a procedure to perform F.A.T. without marshaling cabinets (where PLC (ESD) terminal boards will be placed; see PLC (ESD) Specification for details)

Prior the F.A.T. all the equipment shall be fully assembled, wired and properly connected each other, to test all the functionalities of the package.

Supplier shall perform a complete system functional test before advising the Purchaser that the system is available for witnessed testing.

The entire Control System shall be submitted to a complete shop acceptance test prior to shipment at Vendor's workshop by Vendor's technicians in presence of BPCL Mumbai refinery.

Major objective of the test is to get confidence that the System will work on site as foreseen during engineering activities; positive result of this test does not release Vendor from his responsibilities.
Replacement of Prosafe Model Quadlog PLCs in CPP and CCU by SIL 3 Certified Prosafe - RS PLC.

to provide a system completely working and to perform all the modifications which could be necessary to assure system correct working in the field.

This document outlines a procedure for Factory acceptance Test (FAT) to be witnessed by the BPCL Mumbai refinery; it is not intended to explain the hardware and software tests which are part of Vendor internal testing procedures. It covers vital system functionality tests

The F.A.T. procedure shall be considered as an addition to Vendor's standard procedure to clarify and define tests which BPCL Mumbai refinery considers necessary: they form the minimum list of check to be performed and they do not substitute the checks foreseen by Vendor.

In case of discrepancy between this document and Vendor's internal FAT procedure, BPCL Mumbai refinery engineers will decide which document shall be followed, and the decision will be reported in the FAT report. Anyway, as a general rule, this document shall be considered prevailing on Vendor procedure.

All defects detected during Supply testing, shall be corrected by Vendor at its own expense prior the end of testing, if possible, or at least before shipment.

5.3 F.A.T. ORGANIZATION

Factory Acceptance test shall be organized by Vendor at their staging area.

Vendor shall assign qualified personnel during the entire test period to perform all kind of tests and operations on the system and to assist BPCL Mumbai refinery

The proposed staging area shall satisfy the following minimum requirements:

1. Area dimensions shall be enough to easily accommodate all cabinets inside supply and equipments supplied by other Parts if they will be necessary to the complete test.
2. A warehouse containing at least one item per device type in the supply shall be available to change within one working day any device found defective during the test.
3. An office (key-locked) shall be available to accommodate engineers, to keep documentation necessary during the test, to arrange meetings; this room shall have a telephone line available.
4. The area where cabinets are placed shall be organized to avoid that other people present in the staging area can overlook the test; a couple of desks shall be available near the PLC consoles.
5. Power supply lines for system equipments shall be suitable for testing purposes; in addition power supply lines shall be available to power a Personal Computer (not in Vendor's scope) both in the meeting room and near the system under test.
6. Auxiliary tools to perform a complete test shall be provided by Vendor. In addition to the tools necessary for system working, at least the following shall be provided (for PLC (ESD) and test only)
5.4 Test procedure

Duration will depend upon the real status which will be checked at the factory acceptance test beginning; if system conditions request more time to complete the test in the foreseen period, BPCL Mumbai refinery will request to Vendor to provide additional assistance and, if necessary, also out of normal working time. Vendor shall communicate he is ready to test the system two weeks prior the scheduled start beginning. Failure to this communication will result in an automatic delay of the F.A.T. beginning, due to Vendor's problems.

Exact time schedule will be defined at the F.A.T. kick of meeting to be attended by Vendor's representatives the first day of F.A.T. The actual time period will depend upon the actual progress during F.A.T.

Each day an informal meeting will be held to state:
- Progress;
- pending points;
- Modifications (due to configuration errors, specification changes, etc.);
- Re-scheduling of activities (if needed).

At the end of the meeting a "punch list" stating activities to be performed, due date and final approval of change (if any) shall be issued by Control System Manufacturer and submitted to Buyer.

5.5 HARDWARE TEST

Factory tests shall be performed using hard-wired simulated inputs, with simulators to be provided by the Supplier.

The system shall be tested with all the inputs and outputs wired to the simulators.

During the test, the system shall perform as required by Material Requisition, System specifications and engineering documents provided by BPCL Mumbai refinery. Control System Vendor shall provide monitors and equipment to determine the performance of the system under test with respect to the loading and response time requirements.
Replacement of Prosafe Model Quadlog PLCs in CPP and CCU by SIL 3 Certified Prosafe - RS PLC.

The following table details the applicability of the Hardware tests to the items under scope of supply.

<table>
<thead>
<tr>
<th>Test</th>
<th>Description</th>
<th>PLC</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check of supply completeness</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Check of proper change-over of the back-up units in case of main failure</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Demonstration of diagnostic features</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Power off and power on of any single unit</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Check of auxiliary devices</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Simulation of power-off and restart</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Test of system interfaces working</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Check of power supply load</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Check of analogue channels accuracy</td>
<td></td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>Check of correct functionality of keyboards</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Testing of proper working of the printers</td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:**

- X = test to be performed for all the equipment
- S = test to be performed as sample

### 5.6 SOFTWARE TEST

All the functions both standard and specific for the project will be checked to verify that the system will work as desired and needed by process requirements to give BPCL Mumbai refinery effective and friendly means to handle the plant.

The following table details the applicability of the Software tests to the items under scope of supply.

<table>
<thead>
<tr>
<th>Test</th>
<th>Description</th>
<th>PLC</th>
<th>Observations</th>
</tr>
</thead>
</table>

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BHARAT PETROLEUM CORPN.LTD. 
REFINERY, MAHUL, MUMBAI-400 074.

PROJECT NAME : REPLACEMENT OF PROSAFE PLC IN CPP & CCU PLANTS

SPECIFICATION
SHEET 38 OF 69
Replacement of Prosafe Model Quadlog PLCs in CPP and CCU by SIL 3 Certified Prosafe - RS PLC.

| Check of database configuration | X |
| Check of interlocks configuration | X |
| Check of system internal loading (processors, communication system, etc.) | X |
| Check of time stamping and continuous operation | X |
| Scan time checking | S |
| Check of CRT displays (all kind of displays) | X |
| Check of all kind of printouts | X |

NOTES:

X = test to be performed for all the equipment
S = test to be performed as sample

5.7 INTEGRATION TEST

Part of the Hardware and Software tests listed in the previous paragraphs, does not require the presence of the complete system, but could be performed separately on any single component of the system. In any case, those "individual" tests require the completeness of the item under test: for example, during the PLC FAT all the equipment composing the system (Processors, Operator Consoles, I/Os, serial cards, gateways, cabinets, remote racks, etc...) shall be present, wired and properly working.

5.8 DOCUMENTATION

Prior to FAT, Vendor shall prepare documentation and deliver one copy of it to BPCL Mumbai refinery two weeks before FAT beginning.

The following list of documents to be provided before test shall be considered as a minimum.

- System database: -One copy on removable media to BPCL Mumbai refinery.
  -One copy on paper at FAT beginning in testing area (database and system configuration).

- Logic diagrams: - One copy on paper (printout from system) to BPCL Mumbai refinery
  - One copy at FAT beginning in testing area.
After Factory Acceptance Test, Vendor shall provide to BPCL Mumbai refinery, PLC (ESD) configuration/Logic diagram on soft and hard copy one each.

5.9 TESTING ACTIVITIES

a. General

The following points outline the tests which will be performed during the Factory Acceptance Test and how they will be carried out. The system shall be always under power during the entire check period with one printer always on line to print any kind of errors which could occur (where applicable). The print out can be attached to the Factory Acceptance Test report.

The applicability of the following tests is for reference only and shall be integrated with all the Software functions detailed by the system documentation.

b. Supply completeness and documentation consistency

a) Visual check of hardware against Manufacturer's documentation

b) Item list check:
   i. number of Item's modules
   ii. quantities of auxiliary equipments
   iii. quantities of switches and push buttons
   iv. check of system documentation
   v. quantities of consumable

c) System drawings check:
   1. System cabling and wiring check

c. System hardware check

The usual standard check defined by Vendor in His procedures will be performed; they will include at least the following:

a) Power loss Simulation

b) Shut Down of Operator Stations and their Reloading

c) Shut Down of Process Stations and their Reloading

d) Fail on (for redundant systems):
   1. Processor MASTER CARD
Replacement of Prosafe Model Quadlog PLCs in CPP and CCU by SIL 3 Certified Prosafe - RS PLC.

2. Communication MASTER CARD
3. Power Supply MASTER CARD
4. Processor BACK-UP CARD
5. Communication BACK-UP CARD
6. Power Supply BACK-UP CARD
7. Communication fail:

For redundant Cables/Busses and Serial links:
1 master line and relevant switch over
2 reserve line and relevant system alarm

For single Serial Links and Ethernet:
Communication fail and relevant system behavior.

d. **Input output working**

Analogue (4-20 mA) Inputs check

Digital Inputs check

Digital Outputs check

The proper correspondence between electrical signals and internal indications will be checked.

All the points are checked against detailed engineering documentation.

e. **System configuration check**

   a) Database configuration check (comprehensive of serial data)
   b) All the points are checked against detailed engineering documentation.

f. **Internal programs test**

   a) Energy measures check.
   c) Flow compensation formulas check.
   d) Optimization programs check: the proper working of the programs and their ease of handling will be verified.
   e) Special control algorithms check.
   f) Special functions check: all the functions implemented inside the system (i.e. data reconciliation checks, discrepancies, Mass balance, etc...).
Replacement of Prosafe Model Quadlog PLCs in CPP and CCU by SIL 3 Certified Prosafe - RS PLC.

g) Interlocks checks: the proper working of all the interlock schemes will be checked against Engineering Contractor's documentation using external simulators to simulate the field.

h) The following connections shall be provided:

- Analogue inputs:
  Each signal shall be connected to an external potentiometer to easily modify input readings and to simulate different values;
  Digital outputs to one solenoid valve:
  Output shall be wired to input corresponding to "OPEN" position.

- Digital outputs for motors:
  start and stop output shall be wired to a motor starter simulator (hard-wire or software) whose output signal is in turn connected to motor status input.

- Digital inputs not related to valves or motors:
  Simulation panel shall be provided to simulate their state.

g. **Auxiliary devices**

  a) The proper working of printers is checked.
  b) The proper working of trip amplifiers, temperature converters, relays, etc is checked.
  c) The proper working of other special modules (if any) is checked.

and software which are related functioning of the PLC system. Prior to F.A.T. the system shall be fully assembled, wired and properly connected to test all the functioning of the system. Vendor shall perform a complete system functional test before advising...
6.0 FUNCTIONAL SPECIFICATIONS OF PLC (ESD)

System configuration shall be as per the job specifications. However the basic system shall consists of the following major sub-system.

6.1 PROCESSOR MODULE:

a) The processor module shall have capability to implement all the control functions to implement logic scheme attached along with, as logic diagram.

b) The processor memory shall be capable of dealing with all types of discrete inputs / outputs and shall be sufficient for storage of the program instructions required to implement the logic functions. Offer shall indicate the amount of memory capacity utilized by actual program and space available for later modifications and additions.

c) Memory shall be non-volatile. However in case of volatile memory is provided, battery backup shall be provided. Battery life shall minimum 5 years and the memory contents holding time shall be at least 1 year at 27 degC. Battery drain indication shall be provided at least one month before the battery gets discharged. A potential free contact shall be provided for hardwired annunciation in the control room.

d) The processor shall be capable of implementing all logic functions such as arithmetic operations, double precision arithmetic, relays, timers(on-delay/off-delay timers), counters(up/down), square root arithmetic, MATRIX (AND, OR, NOR, XOR, COMP, etc) operations.

e) The programming type shall be of relay ladder diagram symbol.

6.2 Diagnostic functions

Minimum following diagnostic features are required:

Battery monitoring

a) Watch dog timer shall be provided. The healthiness of processors shall be continuously monitored by watch dog timer. Any software/hardware problem in the processor system, which shall include CPU, Memory, communication systems, power supply, etc. shall cause the watch dog timer to report processor failure.

b) Reference number checking

c) CPU/memory diagnostics.

f) In case of dual redundant processor, both processor shall be energizing the outputs. SMOD features shall be provided through watchdog timer.
Replacement of Prosafe Model Quadlog PLCs in CPP and CCU by SIL 3 Certified Prosafe - RS PLC.

g) It shall be possible to manually switch over from main processor to standby processor without interrupting the system function if required.

h) The redundancy shall be provided for complete processor system including CPU, memory, and power supply and communication subsystem.

i) Failure of single processor shall not affect the system. In case of failure of complete processor system failure i.e. both processors in case of dual configuration and two or more in case of triple redundant system outputs shall take fail safe state automatically.

j) It shall be possible to generate first out alarm contact by the PLC in case where group of parameters are likely to trip a system.

k) CPU module shall have visible indication to indicate the healthiness of the processor module.

6.3 **Input / output system**

a) Maximum number of input/output per I/O module shall be not more than sixteen.

b) Each I/O shall be isolated from external control circuit by suitable means. The minimum isolation level between I/O and logic circuit shall be 1000 volts DC.

c) Each I/O shall be protected against the reversal of polarity of the power voltage to I/O.

d) Each I/O module shall have a status LED per channel to indicate the status of each input and output.

e) Response time for I/O( ON to OFF and OFF to ON) shall be 10ms maximum.

f) Each input shall be provided with filters to filter out any noise in the input line and contact bouncing noise.

g) The PLC inputs shall be provided with only dry contacts (potential contacts) unless otherwise specified, all inputs shall preferably be double ended. i.e. two wires per input and not with common return for all inputs.

h) The interrogation voltage to the input contacts shall be powered from separate power supply/supplies or shall be part of PLC.

i) Each I/O shall be short circuit proof and protected by fuse. Visual inspection of fuse blown shall be provided for each module.

j) The communication of I/O system with central processor shall be carried out redundant.

k) PLC shall have interposing relays at both input side and output side.

l) Hardwired bypass switches shall be provided for selected inputs (which are trip logic) with key lock arrangement and lamp ON indication.

m) All the inputs shall be routed through diode terminals. Each output shall be short circuit proof and protected by fuse. Visual indication of fuse blown must be provided for each module.

n) The communication of I/O system with central processor shall be carried out redundant with complete error checking.

6.4 **PLC /SOE CONSOLE**

a) Programming terminal shall be used for programming, program storing, altering, deleting, adding, fault diagnostic, and alarm monitoring.
Replacement of Prosafe Model Quadlog PLCs in CPP and CCU by SIL 3 Certified Prosafe - RS PLC.

b) It shall consist of 21" size TFT screen and one programming keyboard and printer.

c) The keyboard shall preferably be touch sensitive sealed type. It shall be provided with a lock and key to prevent any unintentional program modifications.

d) Manual forcing of any input or output contact connected to PLC shall be possible from PLC console key board.

e) It shall be possible to modify, add, and delete the application program online without affecting the outputs and process.

f) All illegal entries shall be rejected by terminal and shall be identified by warning signal on TFT.

g) PLC console CRT shall display logic and/or ladder diagram indicating power flow and shall show description and status of each input and output and other elements used in the ladder diagram.

h) It shall be possible to display I/O map in user defined format.

i) PLC console shall be provided with self diagnostics feature which shall display error messages and initiate an audible alarm if the fault is detected.

j) Dedicated screens/displays shall be available in the PLC console for the diagnostics of the PLC system. The displays shall show all components modules status including the redundant equipment and communication system.

k) It shall be possible to print out the ladder/ logic diagram on the dedicated PLC printer. The printer in addition shall also print out:

   I. All diagnostic messages as and when generated and diagnostic reports, when called for.

   II. Process alarm connected to the PLC as and when they appear and alarm report whenever initiated.

   III. The I/O maps showing status of all inputs and corresponding outputs in a user defined format.

6.5 PLC COMMUNICATION SUBSYSTEM

a) The PLC communication subsystem shall be a digital communication bus that provides a high speed data transfer rapidly and reliably between processor, I/O subsystems, PLC console and other devices connected in the PLC system.

b) Redundancy in PLC communication system shall be provided as follows:

   1. For dual I/O processor configuration, each I/O subset shall have a separate communication interface and bus for connecting to PLC processor.

   2. The communication sub-system between processor and PLC console shall be dual redundant, consisting of two separate communication interfaces and two communication buses.

   3. Incase of redundant PLC communication subsystem, on the failure of the active device, the redundant device shall take over automatically without interrupting the system operation.

   4. It shall be possible to switchover from main bus/device to redundant bus/device without interrupting any system function.
Replacement of Prosafe Model Quadlog PLCs in CPP and CCU by SIL 3 Certified Prosafe - RS PLC.

c) Interface with Distributed Digital Control System: The PLC system should have the facility to interface it with DCS. A suitable interface shall be offered in order to achieve the following functions:
   1. To display diagnostic messages of PLC.
   2. Display of all input points under alarm/first out alarm connected to PLC and outputs generated by PLC on operator console.

d) The communication interface (between PLC and DCS) shall be dual redundant.

6.6 SYSTEM SOFTWARE

a) The system software shall include all programs for the PLC and PLC console, which are required to perform all PLC functions including communication and self-diagnostics. A soft copy of the system software shall be delivered in triplicate with the system.

b) Soft copy of the logic program shall be delivered in triplicate together with the system.

6.7 FIELD TESTING (SITE ACCEPTANCE TEST):

All the equipment shall be checked thoroughly after its receipt at site. The Tests. As a minimum shall include,

a) Visual and mechanical testing.
   b) Demonstration of all system diagnostics features.
   c) Checking of communication between DCS and PLC and PLC and Programming unit.
   d) Checking of changeover of redundant devices.
   e) Demonstration of all system functions.
   f) Checking of proper functioning of PLC programming unit, PLC printer.
   g) Complete checking of PLC system.

6.8 The output contact rating shall be as follows:

<table>
<thead>
<tr>
<th>S.NO.</th>
<th>APPLICABLE FOR</th>
<th>VOLTAGE RATING</th>
<th>CURRENT RATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>All output cards driving solenoid valve and alarm annunciator system unless otherwise specified.</td>
<td>110 V D.C.</td>
<td>3A /1A</td>
</tr>
<tr>
<td>2.</td>
<td>All LT motor/pumps/compressor output cards unless otherwise specified.</td>
<td>240 VAC.</td>
<td>5.0 A</td>
</tr>
<tr>
<td>3.</td>
<td>All HT motors/pumps/compressor (6.6 KV Inductive and above) output cards unless otherwise specified.</td>
<td>229 V DC.</td>
<td>2.0 A</td>
</tr>
</tbody>
</table>
6.9 Interface with Distributed Digital Control System

The PLC shall be required to be interfaced with the existing Distributed Digital Control System (CS3000). PLC shall be a node to DCS bus and (no serial interface is acceptable) shall meet the following.

a. Display of all input points under alarm/first out alarm connected to PLC or generated by PLC on DCS.
b. To display diagnostic messages of PLC.

The interface shall be dual redundant unless otherwise specified meeting all requirements as specified.

6.10 System software

a. The system software shall include all programs for the PLC and PLC console which are required to perform all PLC functions including communication and self-diagnostics.
b. Logic program shall be recorded on the floppy disc or cassette tape which shall be delivered in duplicate together with the system

6.11 INSTALLATION, TESTING AND COMMISSIONING

1. Vendor shall offer the services of the installation team which would install the equipment in the control room, lay the interconnecting cabling inside the control room, check out, test and commission the system

2. All technical personnel assigned to site by the vendor shall be fully conversant with the supplies system and software package, and shall have both hardware and software capability to bring the system on line quickly and efficiently with a minimum of interface with other concurrent construction and commissioning activities.

3. Vendor’s responsibility at site shall include all activities necessary to be performed to complete the job as per material requisition including
   a. Receipt of Hardware / software and checking for Completeness of supplies
   b. Installation of the system including free supply equipment and field cable termination in the system
   c. Check out of the equipment installation
   d. Identification of field cables and Termination of the same.
   e. Necessary Interpanel cabling to be carried out .Supply of cables in BPCL Mumbai refinery scope.
   f. Checking of interconnection, hardware & software configuration, overhaul system functioning etc.
   g. Loop checking
   h. Liaison with vendor’s home office
   i. Field test
   j. Commissioning and On line debugging of the system
4. Loop Checking

   a. Loop check shall be carried out by the vendor and checking of interconnection configuration and over all system functioning.
   b. Loop checking shall be carried out to check the functional performance of all elements comprising the loop and thereby ensuring proper configuration, functioning and interconnection.
   c. Vendor shall co-ordinate with field contractor for smooth and proper loop checking. If any discrepancy found during checking shall be brought to the notice of Engineer – in –Charge. All readings shall be recorded on a suitable format and shall be submitted for approval.
   d. After loop checking is completed, Vendor shall connect back any terminals and connections removed for loop checking.

5. Field Testing

   All the equipment shall be checking thoroughly after its receipt at site. The tests, as a minimum shall include

   a. Visual and mechanical testing
   b. Complete system configuration loading
   c. Demonstration of all system functions
   d. Checking of loop configuration
   e. Checking of CRT displays
   f. Checking of correct functioning of all keyboards
   g. Demonstration of all system diagnostics
   h. Checking of Correct change over of redundant devices
   i. Checking of communication between PLC, PLC and other foreign devices
   j. Checking of Bus- degradation
   k. Checking of proper functioning of all printers and hard copy units, ample printing of all log reports, shutdown reports etc
   l. Checking of all disc drives, historical trending points, alarm summary and alarm history.
   m. Complete checking of shutdown system
   n. Complete checking of hardwired instruments
   o. Demonstration of proper operation of the system at specified power supply specifications
   p. Loading of user's program and check out results.

6. Final Acceptance Test

   The owner will take over the system from the vendor after the final acceptance test, which is defined as successful uninterrupted operation of the integrated system for three weeks for all units.
Replacement of Prosafe Model Quadlog PLCs in CPP and CCU by SIL 3 Certified Prosafe - RS PLC.

of the plant. Vendor’s personnel shall be present during the test. Any malfunctioning of the system components shall be replaced / Repaired as required. Once the system failure is detected, the acceptance test shall all over again from the beginning. The warranty period commences from the day owner takes over the System.

7.0 **Special Notes**

- a) Before submitting the offer, vendor to visit the site and understand all the jobs in detail then to submit the offer. This will enable minimum deviation from the BPCL Mumbai refinery specification and easy of technical evaluation further.

- b) Vendor to provide extended warranty for minimum four years trouble free operation after successful commissioning of entire system for PLC (ESD). This will be over and above the normal warranty of 12 months. On any failure Service Engineer’s attendance is to be ensured within 24 hours.

- c) Vendor to ensure produce documentary evidence for service support and supply of spares for minimum 15 years.

- d) Vendor has to submit the compliance and deviation statement for each and every clause of this offer including general terms and conditions, along with this offer, without this offer will not be evaluated.

- e) Vendor to confirm offered Processor and IO card shall be protected as per ISA GX CLASS 71.04 corrosive environment protection or better and relevant certificate shall be enclosed along with the offer.
Replacement of Prosafe Model Quadlog PLCs in CPP and CCU by SIL 3 Certified Prosafe - RS PLC.

7.0 DATA SHEET FOR PLC

**X - PROGRAMMABLE LOGIC CONTROLLER (Safety System)**

* MODEL NO._____

1. Functional requirement
   - Plant ESD and Interlocks [X]
   - F&G [ ]

2. System Configuration Type
   2.1 Single PLC [X]
   - a) Redundant dual processor with dual tested I/O [ ] I/O auto-testing [ ]
   - b) Three processors with simultaneous logic execution (TMR) [ ] 2oo3 vote output [ ]
   - c) Quad [X].
   - d) Safety Certification (as per IEC 61511) SIL 2 [ ] SIL 3 [X]
     (for both point b & c above)

3. PROCESSOR SYSTEM
   3.1 Functional capability
      - Logic Functions [X]
      - Timing Functions [X]
      - Range: 0-99,999 s
      - Least count: 0.01 s
      *Other available as standard_______

   3.2 Interfacing capability
      - I/O Racks [X]
      - DCS Bus [X]
      - PLC Console [X]
      - Printer [X]
      - Other_______

3.3 Memory capacity ________

3.4 Memory used <60 %

3.5 Spare memory available ________

3.6 Memory type
   - Retentive [ ] Volatile [ ]
   - If Retentive Erasive [X] Non-erasive [ ]
   *Erasing by_______
   - If Volatile Battery back-up [X]

| BHARAT PETROLEUM CORPN.LTD. REFINERY, MAHUL, MUMBAI-400 074. |
| PROJECT NAME : REPLACEMENT OF PROSAFE PLC IN CPP & CCU PLANTS |
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Replacement of Prosafe Model Quadlog PLCs in CPP and CCU by SIL 3 Certified Prosafe - RS PLC.

*Battery type________*Battery life____
Chargeable [X]
Continuous trickle charge [X]
Configuration protection time 72 hours [X]
Battery drain indication [X]
Retentive memory back up [X]

3.7 Scan Time 250 mSec [X] Actual ______ ms

3.8 Power supply Redundancy / Processor Individual
    Redundant [X]

3.9. Outputs on processor system failure
    Freeze [X] Open [X]
    Close [X] Configurable [X]

(Outputs shall be configured to open on processor failure, unless otherwise specified)

3.10* Maximum distance between PLC & Console - As per Control Room/SRR Layouts
    Allowable ____ m

4 INPUT/ OUTPUT SYSTEM
4.1 Type Discrete [X] Analog [X]
4.2 Mounting 19" Rack [X] Other ______

4.3 Input / Output Type
    a) Intrinsic safe [X] With external barriers [X]
    b) Non-Intrinsic Safe [X]
    With external isolator [X] (for Analog inputs)
    With interposing relays [X] (for Digital I/Os)

4.4 Remote I/O capability Required [X] Available [ ] Not Available [ ]
    Note: Only for signals shown in System Configuration
    a) Redundant [X]
    b) I/O rack to processor link
    Redundant [X] SIL 3 [X]
Replacement of Prosafe Model Quadlog PLCs in CPP and CCU by SIL 3 Certified Prosafe - RS PLC.

Separate Optical Fiber Cable from that of DCS Communication sub-system [X]

4.5 Online replacement of I/O modules Required [X]
   With installed cards in the hot slots only in case of TMR [X] (See Note)

(Note: One installed spare I/O card of each type for each PLC sub-system)

4. I/O status Indication Required [X] Local level [X]
   PLC Console [X]

4.7 Input Isolation Required [X] Optical [X]
   Other 
   Output Isolation Required [X] Optical [X]
   Other 

4.8 I/O Capability

<table>
<thead>
<tr>
<th>TYPE OF MODULE</th>
<th>MODEL No.</th>
<th>CAPACITY</th>
<th>I/O’s USED</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANALOG INPUT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIGITAL INPUT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIGITAL OUTPUT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>REMOTE ANALOG INPUT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>REMOTE DIGITAL INPUT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>REMOTE DIGITAL OUTPUT</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.9 Maximum distance between I/O rack & Processor - As per Control Room/ SRR Layout
   Allowable ___ m

4.10 I/O redundancy Required [X] Not Required [ ]
   Redundancy level As per PLC system configuration
   (Dual/ TMR/ Quad)
   Auto testing of I/O's Required [X]
Replacement of Prosafe Model Quadlog PLCs in CPP and CCU by SIL 3 Certified Prosafe - RS PLC.

4.1 Power Supply per I/O rack
   Individual [ ] Dual Redundant [X]

4.12 I/O Rack to processor link
   Individual [ ]
   Dual Redundant [ ]
   Triplicate [X] (for TMR)
   Redundant for each set of dual I/O [X] (for Quad)

4.1 I/O Conditioning for Dual/ TMR/ Quad configuration
   Required [X]

4.14 Input Module
   a) Input Type
      Volt free contact [X] 4-20 mA [X]
      Contact rating
      0.5 A @ 110 V DC [X] 2 A @ 24 V DC [X]
      (through interposing relay)
      Other ________

   c) Maximum number of Inputs per module:
      Single Eight [ ]
      Dual Sixteen [ ]
      TMR Thirty two [X]
      Quad Sixteen [X]
      Other - As per Safety Certification

   Note: The no. of channels per card shall be as per Safety Certification or the quantity specified above, whichever is lower.

   c) Input Interrogation voltage
      110 V DC [X] 24 V DC [X]
      Other ________

   d) Transmitter power supply
      24 V DC [X] With I/O module [ ]
      2-wire [X]
      3-wire [X] (Only for Gas detectors)

   e) TYPE OF MODULE | MODEL No. | INPUTS / MODULE | INPUT IMPEDENCE (Ω) | INRUSH CURRENT (A)
   -----------------|---------|-----------------|---------------------|---------------------
   4-20 mA DC       |         |                 |                     |                     
   1-5V DC          |         |                 |                     |                     

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<table>
<thead>
<tr>
<th>Contact</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Any Other</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Output module

a) Output Type
   Volt free contact [X] 4-20 mA [ ]

Contact rating
   0.5 A @ 110 V DC [ ] 2 A @ 24 V DC [X]
   5 A @ 240 V AC [X] 4 A @ 110 V DC [X]

Other: ___________

b) Maximum number of Outputs per module:
   Single Eight [ ]
   Dual Eighteen [ ]
   TMR Thirty two [X]
   Quad Sixteen [X]
   Other- As per Safety Certification

Note: The no. of channels per card shall be as per Safety Certification or the quantity specified above, whichever is lower.

c) O/P CONTACT RATING MODELL No. NUMBER OF OUTPUTS/MODULE

<table>
<thead>
<tr>
<th>24 V, 2 A DC (Inductive)</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>110V, 4 A DC</td>
<td></td>
</tr>
<tr>
<td>240V, 5 A AC</td>
<td></td>
</tr>
<tr>
<td>Any Other</td>
<td></td>
</tr>
</tbody>
</table>

d) # Output Load Capability
   600 Ω [X]

(Note: Required only for digital outputs of Gas detectors. Suitable End-of Line resistance / accessories shall be provided by vendor for Line monitoring upto field device. Additionally, Relays shall also be provided for these outputs which shall be used in case the loads are more than 12W in which case, line monitoring shall be upto the marshalling cabinet only. These relays shall be suitable to drive a load of approximately 20 Watts.)

e) # Line monitoring
   [X]
Replacement of Prosafe Model Quadlog PLCs in CPP and CCU by SIL 3 Certified Prosafe - RS PLC.

5. PLC CONSOLE

<table>
<thead>
<tr>
<th>Function</th>
<th>Engineering</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Monitor</td>
<td>One</td>
<td>Stacked Dual</td>
</tr>
<tr>
<td>Type</td>
<td>Colour-LED</td>
<td>Monochromatic</td>
</tr>
<tr>
<td>Size</td>
<td>21” Diagonal</td>
<td>Other</td>
</tr>
</tbody>
</table>

(Other specifications same as Operation console monitor. The number of Engineering Stations & SOE Stations shall be as per system Architecture)

5.2 Redundant Link between processor system & console Required [X]

5.3 Number of Keyboards One per monitor [X]

<table>
<thead>
<tr>
<th>Type</th>
<th>Spill Proof</th>
<th>Offered</th>
</tr>
</thead>
</table>

5.4 Printer Required [X] Model *

(Specification same as Network printers/ Configuration & Maintenance printer as per System Configuration Diagram)

5.5 Programme storage Required [X] On CD [ ]

<table>
<thead>
<tr>
<th>Capacity</th>
<th>GB</th>
<th>Access time</th>
<th>ms</th>
</tr>
</thead>
<tbody>
<tr>
<td>On CD</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.6 System Boot-up on power-on Auto [X]

5.7 Software features:

- a) Online Programming Required [X]
- b) Online Programme modification Required [X]
- c) Disable/Force facility Required [X]
- d) Power flow on Ladder/ logic Required [X]
- e) First out alarm Capability Required [X]
- f) Self diagnostics Required [X]
- g) I/O mapping Required [X]
- h) Plant operation Required [ ]
- i) Alarm Printing Required [X]
- j) Documentation Required [X]
- k) Ladder Logic Monitoring Required [X]
- l) Graphic capability Required [X] Thru DCS
m) ESD Report Generation & printing Required [X] Thru DCS

5.8* Additional special software:
   a) ____________________________________________
   b) ____________________________________________

5.9 Interface with DCS *Model No. ___________
   a) Type of Interface Serial [ ] Bi-directional [ ]
      OPC [ ] RS-232 [ ]
      Common Communication Sub-System for DCS and PLC [X]
   b) Protocol Type MODBUS [ ] TCP/IP [ ]
      Other _____
      Vendor to specify

c) Module details:

<table>
<thead>
<tr>
<th>CONFIGURATION</th>
<th>INTERFACE MODEL No.</th>
<th>NUMBER OF MODULES</th>
<th>NUMBER OF ADAPTERS PER MODULE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DUAL PROCESSOR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRIPLE MODULAR REDUNDANT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>QUAD</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

d) Total time taken to Display alarms generated by PLC on DCS operator console through the communication link _________s.

5.10# Power Supply
   a) System 110 V AC, 50 Hz UPS [X]
   b) Input Interrogation contact voltage & rating 24 V DC, 2A [X] (Note)
   c) Output Contact Voltage & rating 24 V DC, 2A [X]
Replacement of Prosafe Model Quadlog PLCs in CPP and CCU by SIL 3 Certified Prosafe - RS PLC.

<table>
<thead>
<tr>
<th>Specification</th>
<th>Scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>110 V DC, 4A [X]</td>
<td></td>
</tr>
<tr>
<td>(For solenoid valves)</td>
<td></td>
</tr>
<tr>
<td>240 V AC, 5A [X]</td>
<td></td>
</tr>
<tr>
<td>(For contactor fed LT motors)</td>
<td></td>
</tr>
<tr>
<td>110 V DC, 4A [X]</td>
<td></td>
</tr>
<tr>
<td>(For breaker fed LT motors &amp; HT motors)</td>
<td></td>
</tr>
</tbody>
</table>

**d) AC Voltage Distribution**
Vendor's Scope [X]

**e) Dual redundant 24 V DC**
Vendor's Scope [X]

Note: Interposing relays to meet the ratings specified above to be provided. If necessary, additional relay cabinets to meet the ratings specified above are proposed.
8.0 GENERAL TERMS AND CONDITIONS.

8.1 General

On the basis of guidelines specified in these specifications, vendor shall submit their own testing installation, commissioning and acceptance procedure. For hardware, the procedures shall include purpose of test, testing definition of input, procedure, results expected and acceptance criteria. The testing and acceptance of the system shall be carried out on the mutually agreed procedures and criteria based on these guidelines and vendor standard procedures.

8.2 FACTORY ACCEPTANCE TESTING (FAT) & ACCEPTANCE

- Vendor shall demonstrate functional integrity of the system hardware and software. No material or equipment shall be transported until all required tests are successfully completed and certified “Ready for Shipment” by BPCL Mumbai refinery.

- BPCL Mumbai refinery reserves the right to involve and satisfy himself at each and every stage of testing. They shall be free to request any specific test on equipment considered necessary by him, although not listed in this specification.

- The cost of performing all tests shall be borne by the vendor. Second phase of testing shall systematically, fully and functionally test all hardware and software in the presence of representative from BPCL Mumbai refinery. All sub-system shall be interconnected to simulate, as close as possible, the total integrated system.

Following minimum testing shall be carried out:
   a) Visual and mechanical testing
   b) Functional testing
   c) Vendor shall notify the owner at least three weeks prior to factory acceptance test. In the event that representative arrives and the system is not ready for testing, the vendor will be liable for back charges for any extra time and expenses incurred.

8.3 Installation, Testing & Commissioning:

- Vendor shall offer the services of the installation team, which would install the equipment, lay the interconnecting cabling check out, test and commission the system.

- Vendor's responsibility at site shall include all activities necessary to be performed to complete the job including:
   a) Receipt of hardware/software and checking of completeness of supplies
   b) Installation of the system.
   c) Field cable termination.
Replacement of Prosafe Model Quadlog PLCs in CPP and CCU by SIL 3 Certified Prosafe - RS PLC.

d) Check out equipment installation

e) Loop checking

f) Commissioning and online debugging of the system.

g) Involvement during plant commissioning and performance of final acceptance test.

8.4 **SPARE PARTS:**

a) Vendor shall indicate spares, consumable including special tools, test equipment etc. for commissioning and operating the system smoothly. The same shall be supplied free of cost as a part of the contract. The vendor also to supply free of cost the consumable spares for at least six months operation after taking over the system.

b) In addition, Vendor has to quote for comprehensive list of spares with unit price information for post warranty Maintenance of Automation System.

c) The successful vendor shall warrant that spare parts for the system would be available for a minimum of fifteen years.

d) Vendor to consider Six Sets of Crocodile clip/ earthing clamp with Cable as spares.

8.5 **Documentation:**

a) Vendor shall furnish all manuals & engineering drawing as required review/approval after order as per agreed QAP.

b) Final as built documents shall be furnished within one month of final field acceptance after incorporating all modifications at site, if any. Numbers of copies of documents/drawings required for the above mentioned shall be four plus one set of soft copy. In addition to documents mentioned in 8.6.0(as built) vendor provide following as built documents.

c) Operating and maintenance manuals

d) Software manuals.

e) Work sheets, engineering drawings, and documentation prepared for the Configuration of the offered system.

f) Loop drawings containing full information of each loop with field termination, junction box nos., cables No., device address, power supply connection etc.

g) All these documentation shall be furnished in hard cover loose ring folders in “A4” size (216 mm x 239 mm).

8.6 **Standard Warranty and Extended Warranty:**

Vendor shall be responsible for the manufacture in respect of proper design, quality, workmanship, and operation of all equipment, accessories etc. supplied by vendor for a period of 12months from the date of taking over by the owner at site. Extended warranty for 4-years.

Details shall be referred in General instructions to vendor.
10.7 **AMC SCOPE OF WORK**

The details of work (under AMC) shall be given performed under each service are as detailed below.

- This maintenance contract shall be for Two years. This shall comprise of as follows:
  - Emergency Visits: As and When Required (Min four visits)
  - On Line/Preventive Maint: Four Visits in the Year (Quarterly basis)
  - Shutdown Maint: Three visits in a year.
Details shall be referred in General instructions to vendor.

10.8 **CERTIFICATE FOR LOGISTIC SUPPORT**

- Bidder shall furnish a certificate for providing necessary support services. The certificate shall be duly signed by them and their principal(s). Proposals received without the certificate, or with unsigned/unstamped certificate, or matter with revised text, or certificate not on company’s letterhead shall not be considered for further evaluation.
- Bidder shall provide bidder’s principal recommended antivirus software for the warranty period. However, all required software patches to fix bugs for DCS/PLC software supplied by bidder shall be provided by bidder free of cost for the entire period of logistic support.
Details shall be referred in General instructions to vendor.

10.9 **Packing & Shipping**

All the materials used for packing, wrapping seals, moisture resistant barriers and corrosion prevention shall be of recognised brands and shall confirm to the best standards for the article, which are packed.

a) Workmanship shall be in accordance with best commercial practices and requirements of applicable specifications.
b) There shall be no defects, imperfections or omissions, which would tend to impair the protection offered by the system as a whole.
c) The packing shall be suitable for storing in tropicalised conditions, as specified in data sheets.

Shipment shall be thoroughly checked for completeness before final packing and shipment. Vendor shall be fully responsible for any delay in installation or commissioning schedule because of incomplete supply of equipment.

10.10 **Rejection:**

Vendor shall make his offer in detail with respect to every item of the purchaser’s specs. Any offer not conforming to this shall be summarily rejected.

10.11 **Vendor data requirements & documentation along with offer:**

Following shall be submitted as a Minimum:
a) Catalogues for each equipment covering technical specification, principle of operation, design features, performance data, dimensional and monitoring details, power and heat dissipation etc.

b) System description.

c) General specification.

d) Systems configuration diagram.

e) Test plan.

f) QAP.

g) Post Warranty Spares list with part no & unit price information.

h) Certificate from statutory bodies.

i) Loop schemes.

j) Bill of Materials.

k) Recommended spare parts for:
   a. Commissioning
   b. Post Warranty Annual Maintenance

Any other drawings not mentioned above but required for erection, commissioning or reconfiguration of system. The following documents/drawings shall be supplied as a minimum for owner/engineer review/approval, after placement of order and along with shipment:

a) Functional design, specification of PLC, system and application software.

b) Engineering drawings documents consisting of detailed configuration diagrams, wiring diagrams, loop schemes, power supply distribution diagrams, grounding arrangement, assembly and installation diagrams.

c) As built documentation covering hardware, software uses, installation and maintenance manuals for all equipment.

d) Inspection and test plans, FAT, SAT and Test Plan procedures.

e) Quality assurance/quality control documents/rewards.

f) All report generation print outs.

g) Numbers of copies of documents/drawings required for the above mentioned shall be TWO.

h) Vendor shall note that the approval of drawings/documents as per vendor data requirements does not absolve vendor from the responsibility of providing safe efficient and functional system fully meeting the requirement.

10.12 Training of PLC:

The training requirements for PLC (ESD) and PLC shall be as follows.
Replacement of Prosafe Model Quadlog PLCs in CPP and CCU by SIL 3 Certified Prosafe - RS PLC.

a. This training shall be conducted at vendors/OEM works.
b. Engineering, Maintenance and troubleshooting training for 100 Man days
c. Site Training shall be carried out by the vendor for five engineering man days.

10.13 Special Notes

f) Before submitting the offer, vendor to visit the site and understand all the jobs in detail then to submit the offer. This will enable minimum deviation from the BPCL Mumbai refinery specification and easy of technical evaluation further.
g) Vendor to provide extended warranty for minimum four years trouble free operation after successful commissioning of entire system for PLC (ESD). This will be over and above the normal warranty of 12 months. On any failure Service Engineer’s attendance is to be ensured within 24 hours.
h) Vendor to ensure produce documentary evidence for service support and supply of spares for minimum 15 years.
i) Vendor has to submit the compliance and deviation statement for each and every clause of this offer including general terms and conditions, along with this offer, without this offer will not be evaluated.
j) Vendor to confirm offered Processor and IO card shall be protected as per ISA GX CLASS 71.04 corrosive environment protection or better and relevant certificate shall be enclosed along with the offer.
Replacement of Prosafe Model Quadlog PLCs in CPP and CCU by SIL 3 Certified Prosafe - RS PLC.

Annexure I

Existing CPP DCS Architecture
ANNEXURE II

Existing CCU DCS Architecture
ANEXURE III

I/O Summary

BPCL – HRSG1BMS- PROSAFE I/O Summary Base Count

<table>
<thead>
<tr>
<th>TYPE</th>
<th>BASE COUNT</th>
<th>ADD 20% *</th>
<th>COUNT ROUNDED</th>
<th>Actual MODULES</th>
<th>ACTUAL MODULE</th>
<th>TOTAL MODULES</th>
</tr>
</thead>
<tbody>
<tr>
<td>DI</td>
<td>121</td>
<td>145.2</td>
<td>145</td>
<td>9.065</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>DO</td>
<td>59</td>
<td>70.8</td>
<td>80</td>
<td>5</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>AI</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

* Considered as a new requirement for each PLC considering future MOC and RFW requirement.

BPCL – CCU- PROSAFE I/O Summary Base Count

<table>
<thead>
<tr>
<th>TYPE</th>
<th>BASE COUNT</th>
<th>ADD 20% **</th>
<th>COUNT ROUNDED</th>
<th>Actual MODULES</th>
<th>ACTUAL MODULE</th>
<th>TOTAL MODULES</th>
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<td>121.2</td>
<td>122</td>
<td>7.625</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>AI</td>
<td>64</td>
<td>76.8</td>
<td>77</td>
<td>4.8125</td>
<td>5</td>
<td>10</td>
</tr>
</tbody>
</table>

** 20% spare considered for arriving I/O Modules count and vendor to quote I/O modules accordingly.
Annexure IV

List of Documents to be issued after placement of P.O by BPCL.

1. Back up of existing Functional Logic Schematics
2. Existing Panel/Relay Arrangement Drawing
3. Existing Loop wiring Dwg
4. Existing PLC System Backup.
Replacement of Prosafe Model Quadlog PLCs in CPP and CCU by SIL 3 Certified Prosafe - RS PLC.

**Annexure – V**

Tentative Bill of Material for each HRSG1BMS and CCU PLCs Total = 6 nos PLC

<table>
<thead>
<tr>
<th>S/N</th>
<th>Description</th>
<th>UOM</th>
<th>QTY</th>
<th>Unit Rate (Rs)</th>
<th>Total (Rs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Removal of Existing PLC along with complete Cabinets, Accessories, etc.</td>
<td>Lot</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Supply of Redundant PLC Rack, CPU, Communications Modules etc.</td>
<td>Lot</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Supply of Redundant I/O modules (AI,DI,DO) and Terminal Boards,Interface Card, Data High Way cable, Prefab cable all, interconnecting cables and other accessories</td>
<td>Lot</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Supply of redundant Bulk Power supply unit with Diode O-Ring configuration with required rating.</td>
<td>Lot</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Supply of Server Grade Engineering and SOE Work stations with latest OS Server Machine: Intel Xeon, 2.6 GHz, Main memory: 8 GB RAM, Hard disk: RAID1 controller with 500GB x 2, 16x DVD RW drive, QWERTY keyboard, Optical mouse, Windows Server etc.</td>
<td>Lot</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Design and Supply of System cabinets (2200mmHx1200mmWx1200mmD) with Glass door along with all the required accessories and Metallic Consoles for mounting Work Stations.</td>
<td>Lot</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Design and Supply of Analog marshalling cabinets (2200mmHx1200mmWx1200mmD) with all the associated accessories like Barriers, Converters, BPSU, MCBs, Fused Terminal blocks, frame and signal earth bar etc fully mounted and tested.</td>
<td>Lot</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Design and Supply of Digital marshalling cabinets (2200mmHx1200mmWx1200mmD) with all the associated accessories like Re-</td>
<td>Lot</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Replacement of Prosafe Model Quadlog PLCs in CPP and CCU by SIL 3 Certified Prosafe - RS PLC.**

<p>| | | |</p>
<table>
<thead>
<tr>
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<th></th>
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</thead>
<tbody>
<tr>
<td>9</td>
<td>Design and Supply of PDB cabinets (2200mmHx1200mmWx1200mmD) with all the associated accessories like BPSU, MCCBs, MCBs, Fused Terminal blocks, frame earth bar etc fully mounted and tested.</td>
<td>Lot 1</td>
</tr>
<tr>
<td>10</td>
<td>Application Software Development and Engineering inputs/documents are not available with M/s BPCL for Existing units. Vendor to collect the engineering input from plant site post order and preparation of necessary documentations for PLC engineering for these units with retention of existing field cables. Single point responsibility lies with PLC vendor.</td>
<td>Lot 1</td>
</tr>
<tr>
<td>11</td>
<td>Installation, testing, pre-commissioning and commissioning of entire supplied system including Field-testing, loop checking which shall include interlock simulation, commissioning &amp; final acceptance of complete system.</td>
<td>Lot 1</td>
</tr>
<tr>
<td>12</td>
<td>Supply of consumables and commissioning spares as per PR for PLC system.</td>
<td>Lot 1</td>
</tr>
<tr>
<td>13</td>
<td>Supply of Mandatory spares as per Vendor</td>
<td>Lot 1</td>
</tr>
<tr>
<td>14</td>
<td>Identification of Existing Field cables in Control room, Deglanding the same and Glanding to New Cabinets, Including Ferruling and Termination as per new Engineering</td>
<td>Lot 1</td>
</tr>
<tr>
<td>15</td>
<td>Laying of Power and Signal cables for Interpanel wiring and providing fused TB with LED indication all the field I/Os cables.</td>
<td>Lot 1</td>
</tr>
<tr>
<td>16</td>
<td>Training as per Tender</td>
<td>Lot 1</td>
</tr>
</tbody>
</table>
Replacement of Prosafe Model Quadlog PLCs in CPP and CCU by SIL 3 Certified Prosafe - RS PLC.

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Lot</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.</td>
<td>Factory Acceptance Test as per Tender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>Site Acceptance Test as per Tender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td>Complete Documentation like Manuals, Engineering documents like i/o allocation, Loop wiring dwg etc including as-built documentation of complete PLC system.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20.</td>
<td>Extended Warranty of 4-years after Standard warranty as per tender scope.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.</td>
<td>Packing and Forwarding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22.</td>
<td>Transportation of All the System components till Site.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total Cost with all the charges and Taxes etc =

Note
The above BOM is indicative only. Vendor to quote as per their terms and condition. However make sure that all the above items are covered.

1) Vendor to note that any material/activity, which is not listed above but required to complete the job satisfactorily as per the tender requirements shall also be in vendor scope.

2) As part of engineering, vendor shall develop documents required for the system engineering of the project, as detailed below:
   a) For all the units, vendor shall develop functional schematics, ESD logic, loop wiring dwg, Nest Loading and I/O assignment, cable schedule etc.
   b) It is intend to keep the existing field side cable as it is and use of existing field cables. There is no upto date engineering documents available for PLC engineering for these existing units. It is vendor’s responsibility to fetch the existing information from site with co-ordination with owner and prepare required engineering documents such as Nest Loading, Logic Diagram, Loop Dwg etc for successful execution of the project.
Replacement of Prosafe Model Quadlog PLCs in CPP and CCU by SIL 3 Certified Prosafe - RS PLC.