



BOILER HOUSE DCS AND PLC SPECIFICATIONS

**DISTRIBUTED CONTROL SYSTEM (DCS)
And
PROGRAMMABLE LOGIC CONTROLLER FOR
EMERGENCY SHUTDOWN SYSTEM (ESD)
SPECIFICATION**

For

**HIGH EFFICIENCY BOILERS (HEB) AND IT'S
BALANCE OF PLANT (BOP)**

BPCL

MUMBAI REFINERY – MAHUL

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LEGENDS:

BMS : Burner Management System
BOP : Balance Of Plant
BPCL : Bharat Petroleum Corporation Limited
CPP : Captive Power Plant
CPU : Central Processing Unit
DCS : Distributed Control System
EFCD : Enhanced Field Control Duplex
ESD : Emergency Shut Down
FAT : Factory Acceptance Test
FLD : Functional Logic Diagram
HEB : High Efficiency Boiler
HRSG: Heat Recovery Steam Generation
IEC : International Electric Commission
ISA : Instruments Society OF America
LBCC : Local Burner Control Console
LCP : Local Control Panel
LED : Light Emitting Diode
L&T : Larsen and Tubro
LSHS: Low Sulphur Heavy Stock
MCB : Miniature Circuit Breaker
MCC : Motor Control Center
MFR : Master Fuel Reset
NC : Normally Closed
NO : Normally Open
OEM : Original Equipment Manufacturer
PBs : Push Buttons
PDB : Power Distribution Board
PLC : Programmable Logic Controller
POC : Process Operating Console
PTR : Performance Track Record
QAP : Quality Assurance Plan
RTC : Real Time Clock
SAF : Scanner Air Fan
SAT : Site Acceptance Test
SIL : Safety Integrity Level
SOE : Sequence Of Events
SER : Sequence Of Event Recording
SR : Short Residue
T/C : Thermocouple

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1.0 INTRODUCTION

The specification defines the minimum requirement of a Distributed Control System (DCS) and Programmable Logic Controllers (PLC) for Emergency Shutdown System design for reliable, effective & optimum control and ESD of High Efficiency Boilers (HEB) & its Balance Of Plant (BOP) in Boiler house area. The existing M/s Yokogawa make CENTUM XL DCS and general purpose, YASKAWA make U84 model PLC at BPCL, Mumbai Refinery, required to be replaced by latest technology, state of the art DCS and ESD system. As the existing 4 sets of DCS stations with of Process Operators Consoles (POC) & PLC system shall be replaced in phased manner, vendor to consider the required additional hardware if any for operating and monitoring the running unit while submitting the offer.

BPCL, Mumbai refinery Steam load is mainly catered by 3-nos Utility Boilers and 3-nos Heat Recovery Steam Generator (HRSG) boilers. The three numbers of utility Boilers are termed as High Efficiency Boilers (HEB). Each HEB is designed to produce High pressure Steam capacity of 1500 MT/D. The Boiler furnace is fired by either Fuel gas or LSHS or both as fuels. There are 4-nos of Oil burners and 4-nos of Gas burner with 4-nos pilot gas burners for starting the any of the respective burners. The High Efficiency Boilers (HEB) are designed to operate with air from 2-nos FD fans one running and other being in hot standby mode.

Each HEB is controlled and monitored by CENTUM XL EFCD station and the BMS logic of each boiler is taken care by an independent YASAKAWA make U84 PLC. The Balance OF Plant (BOP) of all the three boilers is controlled by one CENTUM XL EFCD and the corresponding logic is controlled by a YASAKAWA make U84 PLC. Monitoring of all the three boilers and BOP is done through three numbers of Process Operators Consoles (POC) in control room and one remote console which located around 400 meters away from the control room. The engineering of all the four DCS stations being done through a common Engineering station and the Engineering of all the four PLC is done through a common engineering station. There are three dot matrix printers for alarm and log printing and one color printer for hardcopy printing.

Each boiler BMS PLC and BOP PLC is connected to the corresponding CENTUM XL station through MODBUS serial communications. The data of all the three boilers and BOP is available in IP 21 through a communication gateway unit which is present in another Domain of CENTUM CS 3000 DCS of CPP. Refer Annexure I and II for detailed system architecture drawing for existing PLC and DCS.

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The objectives of the existing DCS and PLC are

- a) Safe startup of the HEB
- b) Safe shutdown of the HEB
- c) Controlling and monitoring of the HEB
- d) Trending and recording of the events.
- e) Protection of the Boiler under any abnormal condition.
- f) Troubleshooting of the plant trip by using SER.
- g) Communication with DCS and other PLCs for Integration.

The vendor shall not deviate from this specification without the prior written approval from BPCL. In case of any deviation vendor shall highlight clearly the deviations of the offered system from the specification with proper justification. BPCL reserves the right to decide technical acceptability of the system.

1.1 PLANT DESCRIPTION

1.1.0 REFINERY STEAM SUPPLY

Steam produced is mainly used as motive power and process steam. 65% of the total generation of steam is used as motive power, to run turbines which drive compressors and pumps. The remaining 35% is used as process steam for Reboilers, heating coil, steam tracing of lines and stripping in columns. Sometimes it is used for purging of furnaces, columns, lines etc., for gas freeing and as fire fighting media

Boiler House plant is one of the utility plant in the BPCL Mumbai refinery, which is supplying Steam, Instrument air, Process air Fuel oil and drinking water to the entire refinery. The steam is produced in three independent High Efficiency boilers and distributed to the plants through the steam distribution header. There are 8 numbers of instruments air compressors for instrument air and process air production. Fuel oil is stored in two numbers of tanks and distributed to the plant through fuel oil pumps. Drinking water taken from BMC is stored in a sump and pumped to storage tanks. From the storage tank the water is pumped to various plants of the refinery.

Since all the utilities supplied from boiler house are essential for plant operation, at any point of time no utility is stopped fully. If this scenario happens, that will

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lead to shutdown of the entire refinery. Hence up keeping of the entire boiler house plant is very essential and critical.

The boiler control and monitoring is done through four numbers of Process Operators Consoles (POC). The BMS startup and shutdown operation will be controlled from both local & remote control panel located in the field and control room respectively with status indication in the control room/local. Switches, Selector switches and PBs are provided in local/remote to light up each respective Burner manually. The Switches, Selector switches and PBs are linked to the burner management system for further logic execution and lighting up the Burners. The total BMS Logic control system is divided into sixteen main control sequences namely,

- 1) FD FAN-A START / STOP
- 2) FD FAN-B START / STOP
- 3) S.A FAN-A STARTING / TRIPPING
- 4) S.A FAN-B STARTING / TRIPPING
- 5) BOILER PURGE / MFR RESET
- 6) MFR TRIP
- 7) COMMON
- 8) PILOT GAS S.O VALVE OPEN / CLOSE
- 9) MAIN GAS S.O VALVE OPEN / CLOSE
- 10)LSHS / SR SHUT-OFF VALVE OPENING / CLOSING
- 11)PILOT GAS BNR-1 to 4 STARTING
- 12)PILOT GAS BNR-1 to 4 TRIPPING
- 13)MAIN GAS BNR-1 to 4 STARTING
- 14)MAIN GAS BNR-1 to 4 TRIPPING
- 15)LSHS / SR BNR-1 to 4 START
- 16)LSHS / SR BNR-1 to 4 SHUT-DOWN.

1.1.1 ABOUT EXISTING DCS/PLC SYSTEM

The entire Boiler house plants is controlled and monitored by M/s YOKOGAWA make CENTUM XL DCS system. The DCS system is having 4 numbers of control stations and 4 numbers of Panel operated consoles. Each boiler is controlled and monitored by independent and dedicated control station (EFCD). The Balance of plants like, Dearator, fuel oil system, instruments air system, Boiler feed water pumps, Makeup water pumps, and drinking water pumps, steam distribution headers etc is controlled and monitored by separate control station. Similarly the logic part of the each boiler is taken care by an independent YASAKAWA make U84 PLC and the BOP logic part is controlled by the separated YASAKAWA make U84 PLC. The monitoring of the entire plant is

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done through four numbers panel operated consoles, three are in control room and one is located in remote location (Boiler House officer room) which around 400 meters from control room. Refer Annexure I and II for detailed layout of the PLC and DCS system components.

Each control stations are mounted in separate cabinets along with bulk power supply units, signal conditioning units. The analog marshaling cabinet for each control station is independent and mounted with field termination blocks and barriers.

Each PLC is mounted in a separate cabinet along with necessary power supply, I/O cards, relays, I/O Drivers and Modem and terminal strips, Hardware Consoles, LBCC, LCP and BMS Plaque accommodating Selector switches and PBs with feedback bulbs. The cabinets are installed in control room.

The new DCS and PLC panels and Consoles need to be installed in the existing space in the control room. The necessary layout drawing is attached as hard copy. Refer Annexure IX.

1.1.2 The architecture of the existing Boiler house system

The detailed Architecture for PLC is given in [Annexure I](#) and Common architecture for DCS is given in [Annexure II](#).

1.1.3 GENERAL OPERATION REQUIREMENTS

1. The DCS described in this requisition shall be State- of-the- art microprocessor based process control and data-acquisition system. The system shall permit control and data-acquisition functions to be distributed to remote plant locations with the operator interface consoles located in the control room.
2. The plant operators shall run the plant through operator consoles consisting of high resolution Monitor's and keyboards. All screens and keyboards shall be of the same design and shall enable the operator to view the process, controller outputs, and shutdown status and to manipulate parameters to control the plant.
3. The overall control system shall be structured to function in an integrated fashion, comprising of regulatory control and advanced control. The regulatory control level shall form the foundation for the overall system

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with the advanced control level added above the regulatory control. The regulatory level shall be capable of functioning without the advanced control.

4. The ESD PLC described in this requisition shall be State- of-the- art microprocessor based TUV/SIL approved with Fail safe operation. The system shall be capable of executing complete start-up and shut down logics pertains to HEBs BMS and BOP.
5. Operator shall start up and shut down the HEB BMS through BMS Plaque, LBCC and Field/control room selector switches and pushbuttons for lighting up the burners.

1.1.4 AMBIENT CONDITIONS

The site environmental conditions are as follows

Ambient Conditions: The site environmental conditions are as follows:

- Maximum ambient temperature (Max./ Min) : 42/ 15 Degree C
- Relative humidity (Max.): 100% @ 32 Deg.
- Maximum recorded rainfall: 436.8 mm

1.1.5 PLANT DATA

The plant is electrically hazardous and following philosophy shall be followed

Intrinsic Safety for all Analog Inputs (4-20 mA DC) and Analog Outputs (4-20mA DC), suitable for Zone-I Gas Groups IIA, IIB as per IEC. All process switches and solenoid valves shall be explosion proof

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2.0 SCOPE OF WORK FOR DCS

The proposed DCS shall replacing the existing M/s.Yokogawa make CENTUM XL DCS systems with 4 nos of Control stations and four numbers of Process Operators Consoles manufactured and engineered by M/s YOGOGAWA. The job includes removal of existing System, Marshaling, PDB panels & associated hardware consoles and design, engineering, supply, erection installation & commissioning of new DCS along with associated panels and hardware/software for the Boiler House plant.

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. This HEB DCS System is replacing YOKOGAWA CENTUM-XL DCS System. Vendor to consider the following while quoting:
 - i. All related panels of existing YOKOGAWA system for HEB1,2,3 and BOP is to be removed from base frame.
 - ii. Tag identification of all signals from field before removal of existing panel and hardware consoles. The I/o count is as per the attached Annexure VII
 - iii. Existing Ferrule to be replaced with new ferrules as per new detailed engineering.
 - iv. Removal of field cable terminations.
 - v. Deglanding of field multicore cable with proper identification tags.
 - vi. Removal of existing panels along with base frame.
 - vii. Erection of new panels on new base frames, including supply and erection of new base frame. General arrangement drawing of base frame shall be approved by BPCL before fabrication.
 - viii. Reglanding of field multicore in the new panel and retermination of the same with proper identification and tagging. Supply of weather proof Glands and lock nuts shall be in the vendor's scope.
- d. System furniture for Engg PCs, documentation PC, AIMS, HMS, Consoles, Printers etc.

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- e. Packing, forwarding, transportation, custom clearance, insurance, storage etc. of the system.
- f. Installation, field testing, loop checking, commissioning and field acceptance of the system
- g. DCS system cabinets shall have hardened plastic transparent doors to look through various components status without opening the door.
- h. Documentation, training, warranty etc.
- i. Installation and commissioning assistance of the free issue if any (owner supplied) items in the control room.
- j. As part of engineering, vendor shall develop documents required for total system configuration including existing system configuration and communication hook-up points for new control stations for HEB1,2,3 and BOP.
- k. Vendor shall develop functional schematics, control scheme, dynamic graphic display drawings and logic diagrams etc.
- l. Removed Panels shall be shifted to the location as instructed by BPCL Engineer in-charge inside the refinery. The list of panels to be removed is as per Annexure V. The item shown in Annexure V is only tentative, the actual quantity shall be as per site condition.
- m. All control panels / Stations, free issue cabinets and PDB's (UPS and NON UPS) are to be mounted on new Channel Base.
- n. Supply of Hardware 20 window annunciator 3 nos. for HEB1, 2 and 3 shall be vendor's scope.
- o. New dedicated earth pit shall be provided by BPCL and That may be connected to the existing earth pit if required. Vendor to submit the detailed grounding scheme and earth pit drawing to BPCL.
- p. DCS shall be supplied with latest version of system and application Software, controller Firmware and latest hardware.
- q. Vendor's documentation shall be considered part of the global project documentation to be issued to BPCL at the end of the Factory Acceptance Test.
- r. Tentative Bill Of material attached as per Annexure III.
- s. Details of formats to be provided will be defined at Kick off Meeting, maintaining the following general guidelines:
 - i. All the documents shall show Client's reference and document name.
 - ii. An Index of documents shall be prepared, listing all the provided documents and their revision number.

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iii. Revisions shall be clearly identified on each sheet and erased at the last issue, which will be labeled as "issued for construction".

- t. **Vendor to visit BPCL Control room and understand the job before submitting the offer. Vendors offer shall not be considered for technical evaluation in absence of this activity.**

2.1 FOREIGN DEVICES INTERFACE

All the foreign interfaces considered for this project shall have comprehensive diagnostics for serial interface modules / connectivity on DCS console in the event of any failures.

1. **DCS - ESD PLC communication**

- a) The ESD PLC will be connected to DCS by redundant (or double) serial link to DCS system or direct connectivity (preferably) on the DCS network shall be considered which will communicate between ESD to DCS and visa versa.

2. **Communication with Plant Network System**

- a) The operators shall be able to access entire Plant Information network through the operator consoles. A gateway from the DCS data highway and the Ethernet LAN shall be provided, to allow the Plant Information System to exchange data.
- b) This Plant network information system shall collect data from DCS for data validation, history management, advanced process control, material balances.

3. **Computer Gateway:**

- a) The gateway will be used for two way communication with computer (DEC Alpha or Intel Server) for implementing Advanced Process Control. The gateway will be connected directly to the refinery network (FDDI) through a switch and will communicate with the computer (also on the network) using TCP/IP.
- (1) Ethernet Port
 - (2) Communicate Protocol : TCP/IP

b) **DCS-Computer Interface**

- (1) Capable of two way communication
- (2) Data scan frequency shall be one minutes for all the tags

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- c) **Interface with Real-Time database software:-** Infoplus-X/Infoplus.21 from M/s Aspen Tech, USA.

All the necessary hardware required shall be considered. Hardware firewall between IP21 server and DCS OPC server must be provided.

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3.0 SCOPE OF WORK FOR PLC

The proposed 4 nos PLC systems shall be replacing existing M/s.Yaskawa make PLC (4 nos) manufactured and engineered by L&T Mumbai and supplied by M/s.ABB-ABL Calcutta. The job includes removal, replacement of the existing, PLC and its associated panels & hard wares & design, fabrication, supply, erection, installation and commissioning of new ESD PLC along with associated panels and hardware for the Boiler House plant.

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 IEC61508 certified.
- e. PLC shall have dual redundant processor as a minimum. 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. Preferably PLC shall connected to DCS system network, otherwise serial interfaces between PLC and DCS shall be redundant and through dedicated controller in 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. The programming format shall be only FLD type using functional blocks. User defined functional blocks shall be possible to develop.

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- 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 digital 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 per relay shall be free for owner use for future.
- l. The PLC system scan time shall be less than 200ms.
- m. Sequence of Event recording with resolution of 1 mSec scan time shall be provided as inbuilt feature with PLC. A dedicated PC with 21inch monitor and Ink Jet printer shall be provided in addition to PLC workstation.
- n. Preferably the entire PLC engineering work station/ SOE station shall be connected to same network DCS/PLC. In case the distance between the PLC work station/ SOE station and DCS network exceeds beyond the allowable limit, necessary hardware viz fibre optic converter shall be considered.
- 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. 24VDC redundant Bulk power supply unit with Diode O ring 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 including in/out MCB.
- q. New dedicated earth pit shall be provided for each PLC system by BPCL and the same may be interconnected with the existing earth pit if required. Vendor to submit the details for earth pit requirement as per system.

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- r. Supplier shall include involving qualified Engineers and technicians for participation in engineering, installation, field testing and commissioning of PLC system.
- s. Packing, forwarding, transportation, custom clearance, insurance, storage etc. of the system.
- t. Installation, field testing, loop checking, commissioning and field acceptance of the system
- u. Documentation, training, warranty etc.
- v. Installation and commissioning assistance of the free issue if any (owner supplied) items in the control room.
- w. Tentative Bill of Material attached as per Annexure III

3.1 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.

3.2 As this HEB PLC System is replacing Yaskawa/L&T make U84 PLC System. Vendor to consider the following while submitting the offer.

- 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 VI. The item shown in Annexure VI is only tentative, the actual quantity shall be as per site condition
- b. Identification of all the loops, replacing the existing ferrule with new ferrule. The I/O count is as per the attached Annexure VII.
- c. The removed panels shall be shifted to a location shown by BPCL engineer in charge inside the refinery only.
- d. 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. Vendor's offer shall not be considered for technical evaluation in absence of this activity.

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3.3 POWER SUPPLY AND ELECTRICAL REQUIREMENTS

110VAC UPS

Supplier shall be provided with redundant feeders of 110VAC from existing UPS cabinet. Supplier shall consider 100 mtrs 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.

ESD PLC 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.

All the MCB shall be mounted in such a way that ON/OFF knob shall be at the bottom when MCB is kept ON. This will facilitate accidental tripping of MCB by falling some unforeseen material or force etc.

Electrical power supply to the PLC (ESD) system shall be:

- 110 VAC \pm 5%
- 50 Hz + 1Hz / -1.5 Hz

Electrical power supply to the PLC Modules will be:

24 V DC \pm 2%

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

Earthing system will be provided strictly as per Vendor standards, the necessary details to be submitted by vendor for this.

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4.0 SPECIAL INSTRUCTIONS TO VENDOR FOR DCS

1. Vendor shall submit the BOM & price schedule with price break-up including mandatory spares, recommended spares, site services for DCS shall be clearly separated out for all items.
2. Vendor shall study the existing system configuration of total Boiler house and propose the system.
3. M/s BPCL will provide the all existing Yokogawa make CENTUM XL programming documents, by which vendor shall decode the programming and make the necessary functional schematics which shall be submitted to M/s BPCL for approval.
4. Vendor shall quote for Alarm Management system which shall be stand alone system and will be connected to DCS through serial link / other communication network.
5. PLC related DI/DO signals shall be configured in DCS for alarm purpose.
6. Documentation System Software/hardware for DCS along with printer and necessary furniture (table and chair) mounted with necessary receptacles to be considered.
7. As we have segregation of control stations for HEB#1, 2, 3 and BOP, vendor should also follow the same segregation in new DCS. Accordingly engineering of control stations, Marshalling panels, PDB power supply segregation etc. shall be considered in proposed new HEB#1, 2, 3 and BOP DCS system.
8. Vendor shall take the total DCS backup of existing system configuration for system engineering and connectivity.
9. Vendor to study the existing HF bus and V-net communication and hook up scheme for stage wise execution to be submitted for BPCL approval.

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10. Vendor shall provide four sets of back-up configuration storage for each system, containing operating programs, diagnostic programs and system configuration etc.
11. Vendor to note that the following makes of switches, lamps etc. only used

SR. NO	TYPE	MAKE
1	PUSH BOTTON	IDAC ZUMI / FUJI
2	SELECTOR SWITCH	IDAC ZUMI / FUJI
3	LAMP	YAMATAKE HONEYWELL TYPE MICRO
4	TERMINALS	WAGO TYPE
5	PC	DELL/HP
6	BARRIERS	P&F
7	FUSED TERMINALS	WAGO TYPE
8	MCB'S	MDS
9	REALYS	OMRON WITH LED JAPAN make

12. All digital input terminal blocks shall be wago type and all digital output terminal blocks shall be fused wago type.
13. All PCs provided as part of this requisition shall be equipped with the latest available processor with maximum processing speed.
- 14. Input - output considerations**
- a. 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 DCS is powered.

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- b. Removal and insertion of a DCS I/O card shall not affect the supply of field power to other loops connected to the DCS.
- c. 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.
- d. 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.
- e. The following type of I/O modules shall be provided for as a minimum in the DCS but not limited to:

(1) Digital input

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

(2) Analogue Inputs/outputs

- (a) 4-20 mA dc , 1-5 V dc two wire type
- (b) All I/O circuits must be provided with galvanic isolation using isolating barriers.

(3) Digital Outputs

- (a) All digital outputs shall be equipped with protection against voltage surges caused by inductive loads.
- (b) Digital outputs shall be static type, free voltage contacts. The outputs shall be galvanic ally or optically isolated.
- (c) Outputs shall be without any common wiring and no looping in the terminal end is allowed.
- (d) The interposing relays shall be provided in the DCS Marshalling to match the required ratings.
 - (i) for Solenoid valves and MOV's 110 V dc - 3 Amps.
 - (ii) for MCC 110 V dc - 5 Amps.

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(iii) for Shutdown Consoles

110 V dc - 1 Amp.

15. Vendor shall consider IO Modules to be used with 10 % De-rated channel Density for AI/AO Modules and DI/DO Modules.
16. 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 be permanently affixed with fasteners or Bonding to the Cabinets / equipment. Vendor to provide the Nameplate and labeling schedules for approval by BPCL.
 - b. 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.
 - c. 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.
 - d. 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.
 - e. 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.

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17. SYSTEM TERMINATIONS

- a. The termination in DCS panels have to be segregated per voltage level and voltage category.
 - (1) Analog (Intrinsicly safe)
 - (2) Analog (Non- intrinsicly safe)
 - (3) Discrete (Explosion proof)
 - (4) Power supply cables.
 - (5) Control signal cables between MCC and control room.
 - b. Terminals shall be WAGO (spring loaded) type and shall be adequate for wiring of flexible wires of 1.0 - 1.5 mm² section. No double terminal blocks may be used.
 - c. Terminal panels with electronic devices and/or relays mounted shall have a dedicated mechanical protection.
 - d. Each terminal panel shall have the individual identification tag and each channel shall be identified by the instrument connected with tag name.
 - e. The terminal panel connection to the I/O cards shall be through prefabricated cable with plug-in connector.
 - f. 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.
 - g. The terminals shall be of Wago type or equivalents with knife edge isolation with spring loading 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.
 - h. The digital outputs shall have LED/Lamps for indicating Fuse blown status.
18. Unauthorized access to the system shall be protected by means of suitable Hardware Key locks and Software passwords. Different levels of

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access shall be provided for the Operators and Engineers by means of passwords and key locks.

19. COMMUNICATION SUB SYSTEM

- a. The Communication sub system cable shall be secured in conduit inside the control room. In such installations where communication subsystem extends outdoor and subjected to intermittent exposure to water or condensed moisture, it must be enclosed in rigid conduit. The communication subsystem, in such case must perform to the offered specifications for error rate, signal attenuation, noise immunity etc.
- b. DCS Bus shall be fully deterministic based on IEEE802.4.
- c. Communication speed on the system bus shall be minimum 100Mbps and overall system performance shall not be degraded whether communication subsystem is 10% loaded or 100% loaded.
- d. Vendor must furnish BUS LOADING calculations for each system. I.e. controller & Data Acquisition subsystem, console subsystem and communication subsystem. The Loading figures shall be demonstrated by vendor at FAT and finally during SAT. Vendor quoted Hardware and software shall meet these loading requirements. In case actual loading is found to be higher than the specified figure, vendor shall supply additional hardware / software to meet the requirements of this requisition without any commercial implications.
- e. System bus, subsystem bus and I/O Bus redundancy shall be true redundant with 2 sets of Bus and redundant Cards.
- f. DCS communication sub system shall be OPC compliant.

20. SELF TUNNING

- a. It shall be possible to tune control loops automatically on selective basis. The operator shall either load tuning parameters computed by the system automatically or manually.

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- b. The software for the loop tuning may reside / run on any system hardware including controller and Data acquisition subsystem, Operator console subsystem, supervisory computer etc. The tuning package shall ensure that the system not disturbed whenever a loop is being tuned. Tuning package shall not slow or load the system performance.

21. POWER SUPPLY

- a. Vendor to ensure the DCS component shall not get affected or failed due to blackouts. Fail Safe Operation of the system to be ensured under the following conditions.
- (1) Total Power failure
 - (2) Voltage Variation more than $\pm 10\%$
 - (3) Frequency variation More than $\pm 3\%$
 - (4) Air conditioning failure resulting in temperature exceeding 40 deg C.
- b. 110V AC, 50HZ UPS and 110 V DC redundant feeder shall be made available to the vendor at one point in UPS room which is around 100 meters from control room.. Any other voltage requirement shall be derived from the above source by the vendor.
- c. Bulk power supply provided by vendor for transmitter power or for any other application shall have the following specifications:
- (1) Bulk power supplies shall be redundant floating with +, - 0.5V tolerance.
 - (2) Separate power supplies shall be provided for controller /subsystem.
 - (3) Status indication for each power supply at operator console
 - (4) Switch / Fuse for each loop.
- d. Each power supply shall be sized for 150% of load.
- e. The system shall restart without manual intervention after resuming the power sully with in CPU battery life.
- f. Separate Diode O ring/ Isolator unit shall be provided for each bulk power supply. Scheme attached as per Annexure X

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22. EARTHING REQUIREMENT

- a. Vendor to specify the earthing requirements and provide the required drawing as per their standards.
- b. Vendor to provide the connectivity of existing or new earth pit and any additional requirement of earth pit and other details.

23. CABINETS, RACKS AND PANELS

- a. All cabinets, panels and racks shall be designed without congestion for ease of maintenance. Racks / cabinets shall be designed to take care of the following:
 - b. No marshalling rack / cabinet have more than 600 terminals in any case.
 - c. All the spare cores shall be terminated on the marshalling rack. No cable / core shall be left unterminated in the rack / cabinet.
 - d. All spare cores shall be terminated in TB's at top of the each marshalling cabinets with proper ferrule details.
 - e. No terminal or terminal strip, MCB shall be located on the side panel of the rack / cabinet.
 - f. Quality of all the panels and consoles shall be of highest quality as per good engineering practice and to the satisfaction of BPCL engineer in charge.
 - g. Manufacturer of the panel shall be Rittal or equivalent, this shall be finalized during detailed engineering.

24. SPARES PHILOSOPHY

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- a. Installed engineering spares of 10% shall be provided in each subsystem for each type of module to enhance the system functional requirements including DCS and hardwired instruments.
- b. In addition, the system shall have the following minimum spare capacity.
 - (1) The controller and Data acquisition racks, Analog and digital marshalling racks shall have 20% usable spare space for installing additional I/O modules for future use.
 - (2) Each operator console shall contain 20% usable spare group and related display capability.
 - (3) The system shall have capability to extend its historical trending, logging and user's memory by 20% to meet future expansion with / without adding additional memory modules.
 - (4) I/O racks of DCS 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 up to the I/O terminals.
 - (5) Processor system of DCS shall have capability to execute additional 20% logic. Further it shall be possible to extend the memory by 20% at a later stage.
 - (6) 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 spares shall be 10% of each type of module with minimum of one module for each type or whichever is higher shall be supplied.
- d. System spare capacity shall be provided as follows:
 1. Bus capacity : 40%
 2. No. of nodes : 50%
 3. Vendor shall provide Min. 50% expandability on node connectivity on redundant communication subsystem for each kind of devices connected to the network.

25. System loading

- (a) DCS shall be sized in such a way to guarantee further expansion to End-User.
- (b) Details about software loading of DCS are referred in the different sections of this specification. They will apply to:
 - (i) Communication loading : 60 %
 - (ii) Mass memory loading : 60 %
 - (iii) Process computations : 60 %

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- (iv) Operator console : 60 %
(c) The above software loading figures shall apply to the fully configured system, comprehensive of spare.

26. Vendor to supply and install 2 Nos. of six pens assignable paperless recorders and 3 alarm annunciator (4x5 Windows).

27. Vendor has to submit the compliance and deviation statement along with this offer, without this offer will not be evaluated.

28. Vendor to confirm offered controller card 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.

29. Scope of work for OPC connectivity

- a. Vendor to provide necessary Hardware and Software for two way connectivity between DCS and Supervisory Computer (for Advance Control System and IP21 database)
- b. Vendor to provide OPC Compliant Interface Software. The interface software should be an OPC Server, which complies with version 1.0a or version 2.0 OPC Specification developed by the OPC Foundation.
- c. Vendor to ensure communication with Aspen tech's CIMIO for OPC which is an interface which communicates with any OPC server that complies with the version 1.0a or version 2.0 OPC specification developed by the OPC foundation. The interface communicates with the OLE 2.0 methods provided by compliant OPC servers.
- d. Vendor to ensure that the time zone of the machine on which both the OPC server and CIMIO for OPC are loaded is set to Indian Standard Time.
- e. Vendor to generate Data buffers, Timers, Switches etc in respective stations as may be required for developing Advance control logic's at DCS (sequence tables, calculation blocks etc).
- f. Configuring of logic's at the DCS (sequence tables, logic tables, calculation blocks etc) for loops (as per BPCL requirement) to go to computer mode.
- g. To ensure all loops (as per BPCL requirement) have been configured to go to computer mode.
- h. Vendor to develop operator entry graphic screens (as per BPCL requirement) at the DCS for Advance control purpose.
- i. Vendor to establish proper data communication for each loop as per the logic tables, sequence tables, calculation blocks etc.

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- j. All logic tables, sequence table, calculation blocks etc to be tested for computer mode operation as well as for backup mode (by simulating failure conditions).
 - k. All Data buffers, Timers, Switches etc to be configured in the gateway.
 - l. The DCS vendor to provide the necessary Hardware / software specifications for the gateway, as required to access all tags (analog, digital, data buffers, timers, switches etc) at the frequency of 15 sec.
 - m. Data transfer should be Bi-directional (i.e.; read data from the DCS and send data to the DCS).
 - n. DCS vendor to provide all the necessary Hardware and Software (2 sets) to read and write data from DCS to the supervisory computer.
 - o. The DCS vendor to ensure that all tag information that is available in the tuning panel (like tag number, tag description and tag attributes like PID controls, lead blocks, anti windup status etc) should be accessible at the supervisory computer.
 - p. The DCS vendor to incorporate Anti-windup status as a smart data type parameter at the DCS.
 - q. The DCS vendor to ensure that all the loops (as per BPCL requirement) to be configured for accepting remote set value (RSV) or control valve opening (RMV) as per BPCL requirement.
 - r. Provision to be made for setting the Basic scan for all manipulated variable process tags to be set at 1 sec.
 - s. The OPC server should be able to support minimum 8 clients (all simultaneously) with no restriction on number of points / groups access etc.
 - t. Switches for Advance controls should be 3 point switch (SRVIND):
 - 1. 0 - OFF
 - 2. 1 - ON
 - 3. 2 - FFW
 - u. Provision for Data buffer ranges changing online.
 - v. Provision for input Filtering, integral windup status (not antiwindup status), PID tuning algorithm.
 - w. Provision to be made for all PID loops to go to CAS, CMP mode.
 - x. Steam tables to be incorporated in DCS.
30. Vendor to submit **PROVEN TRACK RECORD (PTR)** for DCS for a period of minimum two year of continuous successful operation in hydrocarbon Industry Worldwide. 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,

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Software, etc. The name of the concerned person at customer end with contact details and installed architecture details should be provided along with PTR.

5.0 SPECIAL INSTRUCTIONS TO VENDOR FOR PLC

1. The ESD PLC system shall be a high availability Quadruple Modular Redundant (QMR) PLC / Triple Modular Redundant (TMR) PLC with Hardware and Software Fault Tolerance.
2. Both processors shall be inline and both shall scan the input, solve logics and generate outputs. No selection of primary and secondary and no switching over of primary and secondary concepts are acceptable. The offered PLC shall be TUV approved for AK5/SIL3 as per IEC61508
3. Safety system shall be protected from Cyber attacks like Virus etc. the required software/hardware shall be considered.
4. Chassis for Main and Redundant Processor shall not be common and placed in separate chassis.
5. Identification of field cable inside control room and hooking up to new marshalling panel is in vendor's scope.
6. 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 to DIN V 19250. Vendor to furnish the Test certificates & Report of TUV at time of submitting the offer.
7. The ESD system shall operate in a TRIPLE MODE (3 -2 -0) redundancy mode in TMR PLC System OR quadruple (4 -2 -0) redundancy mode in quadruple PLC System.
8. Failure of a card shall not affect with the other parts of the system
9. ESD PLC shall be sized in such a way to guarantee further expansion to end user.

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10. 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 % |
11. Hardware loading will be organized to guarantee 10 % spare signals already installed and wired plus an additional 20 % of free space in the cabinets.
12. 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.
13. Interposing relays for both input/output shall have free wheeling diode protection for Inductive load.
14. For AI points existing input barriers MTL3046B to be replaced with latest Barrier /repeater and to be terminated the field signal. One output shall be retained for DCS indication as existing and other output shall be connected to PLC AI card. Required installation of AI barrier/Signal repeater and power supply distribution for the same shall be in vendor's scope.
15. DI/DO relays shall be having 4NO/4NC contacts. Coil Voltage for Input Relays shall be 110VDC and for output 24VDC.
16. 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.
17. List of Forced signals shall be displayed in PLC workstation.
18. 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.
19. 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

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passwords. Different levels of access shall be provided for the Operators and Engineers by means of passwords and key locks

5.1 Scan Time

1. The ESD processors shall continuously scan the inputs, outputs and program & execute commands to appropriate outputs.
2. The Scan time of the PLC is defined as the total time required for reading input, program execution and changing the Output state.
3. The vendor shall also state and guarantee at the time of offer the following
 - i. Guaranteed Scan time = **less than 200msecs**
 - ii. The communication time between ESD PLC 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 less than 1 mSec.

5.2 Vendor to note that the following makes of switches, lamps etc. only to be supplied and used in this project.

SR. NO	TYPE	MAKE
1	PUSH BOTTON	IDAC ZUMI / FUJI
2	SELECTOR SWITCH	IDAC ZUMI / FUJI
3	LAMP	YAMATAKE HONEYWELL
4	TERMINALS	PHOENIX / WEIDMULLER/WAGO
5	PC	DELL/HP
6	BARRIERS	P&F

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7	FUSED TERMINALS	PHOENIX / WEIDMULLER
8	MCB'S	MDS
9	REALYS with base	OMRON WITH LED (4NO+4NC) JAPAN make
10	BMS Plaque	PHOENIX / WEIDMULLER

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

5.4 Input - output considerations

All cards shall 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. Online removal/replacement of all type of cards shall not affect the functionality of PLC.
- 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 PLC.

i) Digital input

Dry contact

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

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ii) Analogue Inputs

4-20 mA dc, two wire type

iii) 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 galvanic ally 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.

iv) All I/O circuits must be provided with galvanic isolation using isolating barriers.

5.5 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 acrylic with white dull surface finish and information engraved in Black. These labels shall be permanently affixed with fasteners or Bonding to the Cabinets / equipment. Vendor to provide the Nameplate and Labeling schedules for approval by engineer in charge of BPCL Mumbai refinery
- b) 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.
- c) 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

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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.

- d) 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.
- e) 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.

5.6 SYSTEM TERMINATIONS

The ESD PLC 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 / push fit spring loaded type and shall be adequate for wiring of flexible wires of 1.0 - 1.5 mm² section. No double Decker terminal blocks shall be used.

1. Interconnection between field and control room shall be from Marshalling rack only. All inter connection between marshalling and system cabinets shall be through prefabricated cables with plug in connectors only. The prefab cable shall be installed in separate cable trays in the control room below false flooring. Cable trays shall be supported properly with cover on each cable tray to protect from rats.
2. Following color codes shall be considered.

VOLTAGE	TYPE	COLOR
POWER SUPPLY 110V AC	PHASE	RED

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	NEUTRAL	BLACK
	EARTH	GREEN
DC WIRING Both 24VDC and 110VDC	POSITIVE	RED
	NEGATIVE	BLACK
ALARM SYSTEM		WHITE
CONTROL & SHUTDOWN		YELLOW
ANALOG SIGNAL		LIGHT BLUE

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

a) 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 engineer in charge of BPCL Mumbai refinery before finalization.

b) BMS Plaque Lamps /Switches and PBs.

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i) **Push-buttons**

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

ii) **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. Size of tag plates shall be finalized before execution with engineer in charge of BPCL Mumbai refinery

iii) **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).

iv) **Lamps**

1. Colors will be:

- RED (for alarm)
- GREEN (normal)
- 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.

v) **Push-buttons and switches**

Switch contacts will be wired as follows:

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

vi) BMS plaque accessories

- 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.
- d) Suppliers to consider individual fused terminal strips for power wiring to barrier, isolators and Relays.
- e) Terminal panels with electronic devices and/or relays mounted shall have a dedicated mechanical protection.
- f) 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.
- g) The terminal panel connection to the I/O unit shall be through plug-in connector multiwires cable.
- h) 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

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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.

- c) The following points must be taken into consideration for engineering of PLC
 - a) Power supply distribution for Processors, inputs and outputs must be from respective Bus bar only.
 - b) 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.
 - c) I/O modules must be segregated shutdown circuit-wise. No more than 60% of the module I/O capacity shall be utilized.
 - d) PLC system engineering shall be done by PLC manufacturer at their works. No subcontracting shall be entertained.

- d) The system shall be internally protected against system errors and hardware damage resulting from: (Detailed write-up / description on how to achieve this by vendor should be explained)
 - 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.

5.11 COMMUNICATION SUB SYSTEM

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

5.12 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.

5.13 POWER SUPPLY

- a. Vendor to ensure the equipment not get affected or failed due to blackouts. Further vendor to indicate the following. Steps to be

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taken for Fail Safe Operation of the system under the following conditions:

- Total Power failure
- Voltage Variation more than $\pm 10\%$
- Frequency variation More than $\pm 3\%$
- Air conditioning failure resulting in temp exceeding 40

Deg C

The start up procedure for the system including system databases loading during start-up and power on shall be submitted. The system shall restart without manual intervention after resuming the power supply with in CPU battery life.

- b. 110V AC, 50HZ UPS and 110 V DC will 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.
 - Separate Diode O ring /isolator shall be provided for each power supply unit. Detailed scheme is as per annexure X

5.14 EARTHING REQUIREMENT

Two separate earth pits will be provided by the BPCL 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. The earth pit requirement shall be submitted by vendor for executing the job at site by BPCL Mumbai refinery.

5.15 CABINETS, RACKS AND PANELS

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- 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:
 - All the spare cores shall be terminated on the marshalling rack. No cable / core shall be left unterminated in the rack / cabinet.
 - No terminal or terminal strip/MCB shall be located on the side panel of 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.
- c. Manufacture of panel shall be Rittal or equivalent, this shall be finalized with engineer in charge of BPCL.

5.16 SPARES PHILOSOPHY

- a. Installed engineering spares of 10% 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 20% capacity to handle these I/Os. In addition, internal wiring for the same shall be completed up to 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 up to the I/O terminals.
 - Processor system of PLC shall have capability to execute additional 20% logic.
 - 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

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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 | : | 50% |

Vendor shall provide Min. 50% expandability on node connectivity on redundant communication subsystem for each kind of devices connected to the network.

5.17 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.

5.18 Vendor to submit **PROVEN TRACK RECORD (PTR)** of two years for ESD PLC 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.

5.19 DIAGNOSTIC CAPABILITY

- i) The system shall have a High diagnostic coverage per channel.
- ii) 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.

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iii) 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.

iv) 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.

V) 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.

This status 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 out by the vendor at the time of submitting the technical offer.

5.20 Refer Annexure VIII for list of documents issued by BPCL Mumbai refinery after placement of PO.

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6.0. FUNCTIONAL SPECIFICATIONS FOR DCS

6.1 FUNCTIONAL REQUIREMENTS

1. The system, as a minimum, shall meet the following requirements without the supervisory computer:
 - (1) Control
 - (2) Data acquisition and monitoring
 - (3) Alarming
 - (4) Logging and report generation
 - (5) Historical data storage
 - (6) Trending
2. System shall have some free memory space available for the user and CPU shall have the additional capability to perform advance control functions, process optimization programs or generate management reports as specified in job specification in addition to space requirements. The availability of process control language shall be preferred.
3. Plant process and safety shutdown shall be independently performed by programmable logic controller. (PLC shall be communicating with other sub-systems via communication sub-system)
4. Whenever information network is specified, the system shall meet any or all the following requirements:-
 - a. Centralized information system
 - b. Statistical process control/statistical quality control
 - c. Computer integrated manufacturing with information transfer to achieve functions like production and preventive maintenance scheduling and plant wide coordination etc.
 - d. Self documentation
 - e. Asset Management System(AIMS)

6.2 CONTROLLER AND DATA ACQUISITION SUB-SYSTEM

The controller and data acquisition sub system shall be used primarily for plant control and data acquisition. However, the hardware and software

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used to achieve these functions must meet the following requirements as a minimum:

6.2.1 Controller sub-system

- (1) The control function of the system shall be executed by microprocessor based multi-loop controller consisting of I/O ports and a set of algorithms which are easily field configurable using user friendly software.
- (2) The hardware capability of the controller shall primarily be exploited for regulatory control functions only. However, the sequencing and interlocking capability shall be used whenever specified in the job specification.
- (3) The controller shall have advanced control algorithms to implement regulatory and advanced control strategies. These shall include PID, adaptive, feed forward, dead time, lead-lag, high-low, signal selection, real time computational capability etc. apart from other algorithms as specified in the job specification.
- (4) Controller shall be able to scan close loop in less than 250msec for critical loops (30%) and 500 mSec for Non-Critical Loops (70%) unless otherwise specified in job specifications. The scan time for a close loop shall be as defined in the data sheets.
- (5) Controller shall be capable of accepting process signals from various process sensors and switches preferably without requiring external or auxiliary signal conditioning devices. The system inputs shall include 4-20 mA DC, thermocouple, resistance temperature detector (RTD) and discrete inputs as a minimum, apart from others as specified in the job specifications. The controller shall be capable of processing linear and non-linear analog inputs, providing square root extraction for flow signals, linearization and compensation for thermocouple.
- (6) The controller shall be able to generate 4-20 mA DC current signals for analog outputs and potential free contacts for the discrete outputs as a minimum, apart from others as specified in the job specification.

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- (7) Controller shall be able to operate in either manual, auto, cascade or computer mode. Mode change-over in either direction shall be procedure-less and bump-less. It shall be possible to change set point, tuning constant, operating mode, controller configuration from the central level i.e. operator's interface keyboard and engineer's interface keyboard.
- (8) Loop integrity shall be maintained in controller sub-system architecture in the following way, unless otherwise specified.
 - (i) By providing one to one controller back-up. In case failure is detected in the active controller all the control shall be transferred to back up controller.
- (9) The controller sub-system shall have automatic transfer switching which shall transfer the entire configuration and data base of failed controller to the back-up controller. Design must ensure that data integrity is maintained during switch over and no portion of data to be transferred is corrupted before and during switch over to the back-up controller. The back-up controller must be dedicated to perform only control functions. The indication of the failed controller shall be displayed at local as well as on the central level. The switch-over time shall be less than 1msecond.
- (10) Loop integrity shall also be applicable to closed loop I/O cards and any other device associated with the controller sub-system
- (11) The controller shall have facility for slow and fast ramping of set point and output. Also all controllers shall have anti-reset wind up as a standard.
- (12) In computer mode, controller shall be able to track computer generated set point and shall hold the last generated value in case of computer failure. In such case, controller shall fall back on auto-mode and continue to operate at the last received set point, in general. Other options like pre-defined set point operation and fail safe condition shall also be possible. On the resumption of computer set point again, the controller shall not return to the computer mode automatically. Computer failure indicator shall be provided at central and local level.
- (13) In cascade loops, the primary controller shall be able to track the set point of the secondary controller when the secondary controller is not operating in cascade mode.

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(14) All controller and input/output racks shall be provided with redundant floating power supply.

6.2.2 DATA ACQUISITION SUB-SYSTEM

1) Data acquisition sub-system shall interface and multiplex analog and discrete inputs from open loops. The inputs shall include 4-20 mA DC, thermocouple, resistance temperature detector (RTD) and discrete contacts, as a minimum, apart from others as specified in the job specifications.

2) The system shall be capable of processing linear and non-linear analog inputs, linearization and compensation for thermocouple, linearization of RTD inputs, and square root extraction for flow inputs apart from others as specified in the job specifications.

3) No. of inputs per I/O module shall not exceed either of the following :-

SL.NO.	TYPE OF INPUT	NO. OF I/O PER MODULE
1	Analog	16
2	Analog output	8
3	Discrete	32

4) In case, an I/O module is capable of handling both discrete inputs/outputs, only either type of inputs shall be connected to such modules.

5) Redundancy must be provided for the data acquisition sub-system processor. The redundant component shall takeover in case of main component failure automatically. Design must ensure that the integrity of the data to be transferred is maintained before and during switch over. The switch over time shall be less than 1 mSec.

6) The system shall have capability to provide analog outputs for driving indicator/recorders. In addition it shall provide contact outputs suitable for connecting this to alarm annunciation. The analog outputs shall be of 4 to 20 mA DC unless otherwise specified

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- 7) The critical open loop inputs shall be scanned at maximum of 500 mSec. interval in case of non-critical open loop shall be scanned at maximum of 1 sec.
- 8) All data acquisition cabinets shall be provided with redundant floating power supply.
- 9) It shall be possible to display all variables in the data acquisition sub-system on the operator consoles on addressing from keyboard.

6.2.3 CONTROLLER AND DATA ACQUISITION SUBSYSTEM LOADING:

- (a) The system loading for controller and data acquisition subsystem shall not exceed 60%. The loading as indicated here is the worst case of high system activity referred to the use of memory, CPU time and communication capacity for this sub-system.

6.3 OPERATOR INTERFACE SUB-SYSTEM

6.3.1 GENERAL

- 1) The operator interface sub-system shall provide the centralized information to the plant operator/Engineer in the following fields:
 - (b) Indication of all analog and digital process variables of control loops, open loops and all loop related parameters.
 - (c) Manipulation of control loops including changing set point, mode output, configuration, tuning and computational constants.
 - (d) Alarm displays and annunciation
 - (e) Graphic displays and status indication
 - (f) Logging and trending including historical trend recording
 - (g) Trend recording on assignable trend recorders
 - (h) Self diagnostic messages
- 2) The operator interface sub-system shall consist of operator consoles. Number of operator consoles shall be three numbers in control room and one number at remote location.

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- 3) Touch screen feature shall be provided for the entire operator console.
- 4) Each operator console shall consist of three set stacked monitor and three set of keyboards, each driven by independent electronics or common redundant electronics. The operator console as a minimum shall also have one logging printer, one alarm and event printer and a hardcopy unit unless otherwise specified in job specifications. In case of each electronics drives two monitors the operation of peripherals shall remain unaffected by the failure of one electronics.
- 5) The system shall have global data base available at each operator console electronics at operator console. However in case distributed data base/console functions are offered, each data base electronics must be dual.
- 6) All the displays on all the monitors of an operator console shall be interchangeable. However, under normal operating condition, each MONITOR in the operator console shall be able to assign a specific task, for example, one may display on overview of the plant, second might display a specific point or group and third may be dedicated to display alarm summary.
- 7) All the functions of monitors and keyboards on an operator console shall be fully interchangeable. Further any change made in the data base of one MONITOR shall automatically update the data base of other monitors of the same console.
- 8) The real time clock of each operator console shall be crystal controlled one which shall be independent of line frequency.
- 9) All the real time clocks in the system shall be synchronized with master clock.
- 10) Each MONITOR shall have an industrial high resolution 21" color screen capable of displaying alpha-numeric and graphic displays. Multiple colors shall be used to distinguish parameters such as control, information, process and alarms etc.
- 11) Each monitor screen shall be able to display the full alpha-numeric tag number of a process variable. A minimum of eight (8) digits shall

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be required for the tag number and 24 digits for the process description.

12) Data display update rate shall not be more than one (1) second.

6.3.2 KEY BOARD

1) Keyboard shall be self explanatory, easy to operate and shall meet all the functions to configure, operate and maintain the system. Conventional user friendly software shall be used for operation, configuration and maintenance of system.

2) Key board shall preferably be touch sensitive membrane type. Each key board entry shall be registered with an audio beep. However, if press type key board is provided it shall be ensured that the key board is not susceptible to dust and moisture.

3) The operator, as a minimum, shall have access to the following through the operator key board at all times:

- Selection of all the displays including the direct selection of loop in alarm, page turning facility, overview, group view and loop view selection etc.
- Selection of loop for operation.
- To acknowledge alarms as and when they are annunciated on the operator console.
- Facility to enter any changed parameter like set point, manipulated variable, digital commands and to cancel any wrong entry while making such change.
- Facility for easy positioning of cursor for the selection of any parameter.
- Selection of hardcopy printout, logging printout, alarm history printout and assignable trend recorder points.
- Auto/manual/cascade/computer mode changeover of each controller.

4) In addition to above keyboard shall have the following capabilities for restricted user/engineer through a key-lock.

- Data base configuration including overview, group, loop, multi-loop and multi-variable control configuration.
- Group or multi-group alarm inhibit from a plant under maintenance.
- Reconfiguration of alarm settings and their values, addition and deletion of components in a loop.

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- Tuning of control loops including change of P.I.D. dead time etc.
- On-line compilation of graphic displays using standard user defined symbols.
- Changing of parameters to be logged
- Setting of real time clock
- Assigning of parameters for historical trending
- To call detailed self diagnostic for maintenance

5) Any change made for any parameter for an input from any display shall be automatically updated on all displays configured for that input.

6) It shall not be possible to override any process variable or digital status from operator keyboard.

7) Each keyboard shall have a set of dual function user configurable keys minimum 64. These keys shall be configured to access important pages in single key stroke. Also keys shall have LED's which flash on pre-configured alarm conditions.

6.3.3.0 ALARM MONITORING AND DISPLAY

1) It shall be possible to display process as well as system alarms on the operator console for operator's attention and action. Alarms shall appear immediately on the operator console as and when they occur.

2) It shall be possible to set process alarm limits from the engineering keyboard i.e. alarm limits on absolute value of measured variable, rate of change of measured variable, high and low deviation set points, and high, extra-high and low, extra-low points on process variable and output. In addition, it shall be possible to derive alarm conditions on the basis of few calculations performed by the system.

3) Alarm messages shall be displayed by flashing the page and group number of the input under alarm irrespective of type of display. It shall be possible to access the group or tag in alarm condition with a maximum of two key-strokes of operator's console keyboard. The plant overview display, operator guided message display in addition to display alarm message, shall also be able to provide warning by changing color of excessive deviation of process variable from their set value.

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4) All alarms shall be displayed as they occur or generated with change in the color of display in the following sequence, activating an audio signal:

- i. Continuous flashing : Un-acknowledged alarm
- ii. Steady display : Acknowledged alarm

5) The system shall not put off the audio alarm and visual flashing even after the condition returns to normal unless it is acknowledged by the operator.

6) In addition to alarms appearing on the different displays, the system shall also be able to display alarm summary and alarm history as per data sheets.

6.3.3.1 Alarm Information Management System (AIMS).

1. The package shall have the following minimum features.
 - a. Logical processing of events and alarms and present in an efficient way for analysis.
 - b. The offered package shall have the facility to analyze frequency of occurrence of events in pre defined period.
 - c. **AIMS system shall be stand alone system with server PC connected to DCS.** The connectivity to DCS shall be through one of the operator station printer port. This system shall have one MONITOR minimum. AIMS shall store the collected alarms from the DCS for minimum of one year and facility of archival on to disc.
2. The report print of alarms shall be possible as and when required in the user defined format.
3. The AIMS package shall be M/s IMAC or equivalent proven make. In case, the vendor offers other than IMAC package, it shall have proven track record of running references satisfactorily for minimum period of 2 year.
4. If the offered AIMS functionality is a part of DCS functionality, it must not affect the system performance and shall meet the above mentioned points. It shall be provided with separate monitor and shall not utilize the operator stations /monitor.

6.3.3.2 Alarm summary display

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1. It shall be possible to display summary of all alarms in the sequence of their occurrence and shall disappear from display only when they are acknowledged and cleared. The alarm display shall list the following for each alarm as a minimum.

- (i) The date and time of occurrence
- (j) Point identification (i.e. Tag number)
- (k) Point description
- (l) Type of alarm (absolute value or deviation)
- (m) Serial number of alarm in the sequence of its occurrence

2. The system shall be able to display on alarm summary a minimum of 1000 alarms.

3. Alarms shall be listed, in the form of alarm list like current, List I, List II etc. The minimum number of alarms per list shall be 1000.

6.3.3.3 ALARM HISTORY

1. The history of alarm conditions shall be maintained in the data base for alarm history display and printed on shift wise basis for the parameters specified in the job specifications. The alarm display and print out shall list the following for each alarm as a minimum:-

- (i) The date and time of occurrence
- (ii) Point identification (i.e. Tag number)
- (iii) Point description
- (iv) Type of alarm (absolute value or deviation)
- (v) Time of acknowledgement
- (vi) Time of return to normal
- (vii) Serial number, of alarm in the sequence of occurrence

2. The system shall be able to display and print out the alarm history of minimum of 10000 alarms.

3. Alarms shall be listed in the form of alarm lists like List I, List II, List III etc. The minimum number of alarm points per list shall be 1000.

6.3.3.4 SYSTEM ALARM

1. System shall have capability of on-line self diagnostics and to be displayed to operator as a system alarm.

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2. Any abnormal conditions in and sub-system or any other functional device shall be displayed as system alarm message on the operator console irrespective of the display selected.

6.3.3.5 ALARM AND ANNUNCIATION SYSTEM

1. Alarm and annunciation system shall be modular and programmable and it shall be possible to program by the engineer.
2. Lamps shall be LED based and replaceable from the front. Hooter in general, shall be solid state type with audibility 100 db at a distance of 3 meters. Hooter shall have provision to set different tone for different functions.
3. An interruption of power supply of 20 mSec or less shall not affect the function of Annunciator.

6.4 CONFIGURATION DISPLAY

1. Configuration display shall provide a separate detailed display for each loop indicating the configuration of that loop. When control requires more than one loop, all interrelated loops shall also be displayed. Following information is required to be available for configuration display:

- i) Loop configuration giving designation of each block.
- ii) Control block interconnection showing soft wiring or hardwiring value of each block parameter like P&ID, ratio, bias, dead-time, lead-time etc.
- ii) It shall be possible to configure and reconfigure the loops from this view using user friendly software.

6.5 LOGGING FUNCTION

1. It shall be possible to log all measured and computed parameters, operator actions, alarms etc. from operator consoles.
2. Logs shall be required on hourly, shift wise (8 hourly) and daily basis and some cases for weekly and monthly basis as specified in job specification.

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3. All parameters required for logging shall be stored in memory in accordance with data base update rate. However it shall be possible to perform basic arithmetic calculations such as averaging, summing, efficiency calculations etc. priority logging.
4. The log format shall be user definable, in general. However the typical log formats for hourly, daily and shift wise reports shall be as defined in the job specifications. For extended logging like weekly and monthly reports, system shall have capability of writing programs in high level language. High level language compiler software, sufficient free memory space and necessary hardware shall be provided.
5. Number of log reports shall be as per number of log formats defined like hourly report format, daily reports format etc. Number of pages in each log report shall be sufficient to accommodate all the parameters for logging as defined in the job specifications.
6. Hourly report shall be printed only as and when initiated on demand by the operator and shall not be printed automatically at the end of the pre-defined time as well as on demand by the operator. The maximum storage time for log information shall be 15 minutes after the pre-defined print out time for a format.

7. Logging hardware

a) Logging printer

- (i) Printing of hourly shift wise and daily log
- (ii) Shutdown report printing

b) Alarm and even printer

- i) Alarm printer shall log the process and system alarm messages as and when they occur and alarm history for every shift of operation or on demand from operator console.
- ii) Print out shall show as a minimum the tag number, description, date and time of occurrence, time of acknowledgement and time of return to normal.

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6.6 SELF DIAGNOSTICS

- 1) The self diagnostic message for a subsystem failure shall appear on the operator console irrespective of display selected. The choice of the detailed self diagnostic displays shall be made by a key-lock switch.

- 2) The system shall have an extensive set of self-diagnostic routines which shall locate and identify the system failure at least up to module level including redundant components.

- 3) At the local level, failure of a module in a sub-system shall be identified by an individual LED display.

- 4) Failure of sub-system shall be annunciated with the change in colour. To aid system maintenance and for effective fault location, following displays shall be provided as a minimum.

6.6.1 Communication system status display

The display shall show on overview of different sub-systems connected over the communication sub-system showing status of each sub-system. When a failure is detected by the system self diagnostic routine, the display shall indicate the location and nature of malfunction. Display shall as a minimum have

- a) Type of sub-system
- b) Failure of communication bus/link with the sub-system

6.6.2 Sub-system diagnostic display

1. One display page shall be available for each sub-system on the communication sub-system, which can be called on demand.
2. The display as a minimum shall contain:
 - a) Sub-system number and type
 - b) Error code and description
 - c) Details of failed module

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6.7 DATA STORAGE, ARCHIVAL AND RETRIEVAL

- 1) Historical data shall be stored on a non-volatile memory device like hard disc which can be subsequently recalled by operator on any screen.
- 2) It shall also be possible to store and retrieve this data on removable mass storage media like Compact Disc, cartridge or tape etc.

6.8 HARD COPY UNIT

- 1) Hard copy unit shall be used to make permanent copy of any graphics page and when demanded through the operator console/Engineer console.
- (2) Graphics page shall not be locked for more than 1 second while taking the video-copy.
- (3) Copies of display shall be in full color.

6.9 ENGINEER INTERFACE SUB-SYSTEM

- (1) Engineer interface sub-system shall be primarily an engineer's interface which shall normally be used for configuring, tuning and maintenance of the Distributed Control System.
- (2) It shall consist of an engineering console. In general engineering console shall be able to perform all engineering functions required for each operator console and its related sub-system.
- (3) Each engineering console shall consist of single or multiple color monitors, each provided with one operator key-board and one engineering keyboard. This, as a minimum shall also have one configuration and maintenance printer.
- (4) Engineering console shall have, as a minimum, the same capability as operator console. However, the operation of the plant shall not be possible from this console except in tuning mode. All the plant views as specified under operator console shall also be available on engineering console.
- (5) Engineering console like any other –system shall be capable to communicating with all other sub-systems over the communication sub-system.
- (6) Engineering console can have either common or individual electronics.

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- (7) It shall be possible to perform all system configuration functions from the engineering console typically.
- (8) Data base configuration including overview, group, loop, multiloop and multi-variable control configuration.
- (9) Group or multi group alarm inhibit from the plant under maintenance
- (10) Configuration or re-configuration of alarm settings, their values, addition or deletion of any control block or component in a loop.
- (11) Tuning of control loops like changing, P.I.D. dead time values etc.
- (12) Compilation of graphic displays
- (13) Setting of real time clock
- (14) Compilation of logs/reports/historical trend points
- (15) To call detailed self diagnostic displays for maintenance aid
- (16) Tuning of a control loop shall be possible from engineering as well as from operator console, the location shall be selected by the operator using a 'Tuning mode' key-lock switch provided on the operator console. In Tuning mode it shall be possible to operate only the loop under tuning from engineering console. In case of simultaneous commands from operator and engineering consoles, operator console shall over-ride.
- (17) During the normal operation, the engineering console, in no case, shall interfere with the process operation or system software. However any change in the configuration shall be down loaded into the system with proper knowledge of the operator.
- (18) All detailed diagnostics of the system shall appear on the engineering console with a print out on the configuration and maintenance (CM) printer. A common diagnostic message on the operator console shall indicate the need of the maintenance.
- (19) To aid the system maintenance and effective fault location following displays shall appear on the engineering console :
 - (a) Communication system status display
 - (b) Device diagnostic display and system diagnostics up to module level should be possible from the diagnostic software.
- (20) Printer shall be used for printing the configuration made or configuration changes, printing system alarms as and when they appear and to print out any engineers command from engineering console.
- (21) Hard copy unit, if specified, shall be used to take hard copy of the engineer's console.
- (22) Accesses to the engineering station shall be protected by using soft key or hard key.

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6.10 COMMUNICATION SUB-SYSTEM

1. The communication sub-system shall be a digital communication bus, that provides a high speed data transfer rapidly and reliably between the operator consoles, process I/O devices, process computer and other devices connected to it.
2. Communication system shall be full deterministic based on IEEE802.4, dual redundant, consisting of two separate communication buses and two separate communication system interfaces for each device. In case of systems having traffic directors, redundant traffic directors shall also be provided.
3. Communication speed on the communication bus shall be sufficient to update the operator console data base once in every second. The overall system performance shall not be degraded whether communication sub-system is 10% loaded or 100% loaded.
4. In case of main bus failure or any communication device failure, the transfer to the back up device or bus shall be automatic without interrupting the system operation and without any operator's intervention. Information about the failed device/bus shall be displayed on the operator console.
5. It shall be possible to switch over the communication from main bus to the redundant bus manually without disturbing the system operation.
6. It shall be possible to connect or disconnect a device from the system without disturbing the operation.
7. The mechanism used by the communication system for error checks and control shall be transparent to the application information. Error checking on all data transfer shall be done by cyclic redundancy check (CRC) and other advanced codes.

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7.0 FUNCTIONAL SPECIFICATIONS OF ESD PLC

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

7.1 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 deg C. 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 Functional Block Diagram (FLD) type only.

7.2 Diagnostic functions

Minimum following diagnostic features are required:

- a) Battery monitoring
- b) 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

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- include CPU, Memory, communication systems, power supply, etc., shall cause the watch dog timer to report processor failure.
- c) Reference number checking
 - d) CPU/memory diagnostics.
 - f) In case of dual redundant processor, both processor shall be energizing the outputs. Secondary Means OF De-energization (SMOD) features shall be provided through watchdog timer.
 - 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 quadruple 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.

7.3 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.

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- 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.

7.4 PLC /SOE CONSOLE

- a) Programming terminal shall be used for programming, program storing, altering, deleting, adding, fault diagnostic, and alarm monitoring.
- 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 monitor 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:

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- 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.

7.5 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. In case 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.
- 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.

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7.6 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.

7.7 FIELD TESTING

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.

7.8 The output contact rating shall be as follows:

S.NO.	APPLICABLE FOR	VOLTAGE RATING	CURRENT RATING
1.	All output cards driving solenoid valve and alarm annunciator system unless otherwise specified.	110 V D.C.	3A /1A
2.	All LT motor/pumps/compressor output cards unless otherwise specified.	240 VAC.	5.0 A
3.	All HT motors/pumps/compressor (6.6 KV Inductive and above) output cards unless otherwise specified.	229 V DC.	2.0 A

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7.9 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
 - k. Performance of final acceptance test.
 - l. All civil works in the control room including false flooring
 - m. Cable laying and identification of field cables

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.

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- 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 MONITOR 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 and MIS reports
- 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 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

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8.0 DATA SHEETS FOR DCS

1. **Type of system distribution** : Functional
2. **Location** : Control room
3. **System size**
 - a. **Closed loops** : Ref Annexure VII
 - b. **Open loops** : Ref Annexure VII
 - c. **Digital loops** : Ref Annexure VII
4. **System availability for the specified:** 99.99%
Configuration
5. **Maximum permissible communication bus length:**
 Standard : _____ (to be filled by Vendor)
 With expander : _____ (to be filled by Vendor)
6. **Max. Number of sub system on the communication sub system:**
(to be filled by Vendor)

	No. OF NODES	No. OF CONSOLES	COMPUTER INTERFACE	OTHER SYSTEM
STANDARD				
WITH BUS EXPANSION				

7. **Type of sub system**
 - a. **Controller & Data-acquisition Subsystem** : Required: Model no. _____
 - b. **Controller subsystem** :
 - c. **Data-acquisition sub system** :
 - d. **Communication sub system** Required Model no. _____
 - e. **Operator Interface Subsystem:** Required
 - f. **Engineer interface subsystem** : Required Model no. _____
 - g. **Programmable Logic Controller (PLC)** Not Required
 - h. **Supervisory computer & workstations** : N.A
(For Advanced Control)
 - i. **Foreign Device Interface** : Required Model no. _____
 - j. **Personal Computer** : Required Model no. _____
 - k. **Hardwired Instruments** : Required Model no. _____

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8. **Standard Interface available for Supervisory Computers:** Vendor to specify.
9. **Online self-diagnostic message** : Required
10. **Redundant Floating Power Supply Required Cabinet-wise for:**
- a. **Controller & Data-acquisition Subsystem:** Required Model no. _____
 - b. **Controller subsystem** : N.A
 - c. **Data-acquisition sub system** : N.A
 - d. **Communication sub system** : Required
Model no. _____
 - e. **Operator Interface Subsystem (Individual Power supply)** : **Not Required**
 - f. **Engineer interface subsystem** : Required
Model no. _____
 - (Individual Power supply)
 - g. **Programmable Logic Controller (PLC) (Individual Power supply)** : **Not Required**
 - h. **Supervisory computer & workstations (For Advanced Control)** : N.A
 - i. **Foreign Device Interface** : Required
Model no. _____
 - j. **Personal Computer** : Required
Model no. _____
 - k. **Hardwired Instruments** : Required
11. **Power Supply availability:**
- a. **AC Voltage for the System:**

DESCRIPTION	SUPPLIED	PERMISSABLE	REMARKS
VOLTAGE(V)	110 +,- 10% UPS	110 + 10% -15%	
FREQUENCY(Hz)	50 +,- 3%	50 +3%- 6%	
MAXIMUM STATIC TRANSFER TIME(ms)	5	20	

- b. **DC Voltage for Output Devices** : 110V +, - 10%
- c. **AC Voltage for Lighting/fan** : 110V AC, 50 Hz.

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12. **Total power requirement** : _____ (to be filled by Vendor)

13. **Earthing Requirements:**

a. **Type of earthing system** :

TYPE OF EARTHING SYSTEMS	REQUIRE D	RESISTANCE UPTO EARTH PIT	REMARKS
ZENER BARRIER EARTH		1 OHMS OR LESS	
SYSTEM EARTH		1 OHMS OR LESS	
ELECTRICAL EARTH		1 OHMS OR LESS	
PLC EARTH		1 OHMS OR LESS	

b. **No. Of Earth pits** : Vendor to specify.

14. **Installation details**

a. **Type of foundation required** : On false flooring

b. **Max. Loading for foundation design** :592 kg/m3

15. **Operating Environment**

Temperatura :25 ° C +, - 2 ° C

Humidity :50 +, - 5 %

8.1 COMMUNICATION SUB SYSTEM

1. **Communication Topology** : Open-ended
2. **Redundancy in Communication** : Required
3. **Type of Bus Redundancy** : Active
4. **Switchover of Communication buses** : Auto & Manual
5. **Type of communication Bus** : Full Deterministic
6. **Type of Communication** : Floating Master
7. **Type of Protocol** : Token Passing
8. **Communication Speed** : Min. 100 MBPS
9. **Message error checking** CRC : Required
10. **Bus controller** : Not required
11. **Redundant Communication Interfaces required for:**
 - a. **Controller & Data –Acquisition Sub system** : Required
 - b. **Controller sub system** :Not required
 - c. **Data – acquisition sub system** :Not required
 - d. **Operator Interface sub system** : Required

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- e. **Engineer's Interface sub system** : Required
- f. **Programmable logic controller** : Required
- g. **Foreign device interface** : Required
- 12. **Switchover to redundant Communication Interface:** Auto and Manual
- 13. **Power supply for Communication Interface** redundant Floating
- 14. **Communication Bus Model No.** : _____
- 15. **Max. No of nodes on the bus** : _____

8.2 CONTROLLER AND DATA ACQUISITION SUB SYSTEM

8.2.1

- 1. **Offered System Details** : Required
- Combined controller and Data acquisition**
- 2. **Type of Controller** **Multi loop** : As Required
- 3. a. **Controller Sub System** : Model no. _____
- b. **Data Acquisition subsystem** : Model no. _____
- c. **Controller & Data Acquisition when offered combined** : Model no. _____

8.2.2 GENERAL

- 1. **Number of Controllers per 19" racks (Nest)** : Vendor to specify
- 2. **Number of 19" racks (nests) per cabinet** : Vendor to specify
- 3. **Number of Controller Cabinets** : _____ (to be filled by Vendor)
- 4. **Cabinet-wise MTBF** : _____ (to be filled by Vendor)
- 5. **Cabinet-Wise MTTR** : _____ (to be filled by Vendor)

8.2.3 SPECIFICATION

- 1. **Type** Microprocessor Based 32 bit : Required
- Configurable type : Required
- 2. **Enclosure** : General purpose

8.2.4

- 1. **Type of controller** : Multi Loop
- 2. **Multi loop Controller** Indicating : Blind
- Display : Not Required

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3. **Number of Inputs / Output per Processor:** Vendor to specify
- Mounting : Rack
- No of loops per Controller : _____ To be filled by vendor
With 60% of loading.
- Backup Controller : Required For ONE to ONE
- Switchover Time : 1 mSec.
- Scan time (closed loops) : For critical loopsMax.250 mS. For other loops max. 500 ms.
- Configuration from : Central Level (From Operating Station)
- Conformal coating for : Required for Corrosive atmosphere
- MTBF : _____(to be filled by Vendor)
- MTTR : _____(to be filled by Vendor)
4. **Control Mode**
- Manual : Required
- Auto : Required
- Cascade : Required
- Computer : Required

Tuning Constants

TUNING CONSTANT	REQUIRED	OFFERED	REMARKS
PROPORTIONAL BAND	1-180 %		
INTEGRAL RATE	0.05-100 REPEATS PER MIN		
DERIVATIVE	0.01 – 10 MIN		
DEAD TIME	0.07 – 10 MIN		
LEAD LAG TIME	0.005 – 10 MIN		

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- | | | |
|----|--|--------------------------|
| 6. | Direct / Reverse Selection | : Required |
| 7. | Anti – Reset wind up feature | : Required |
| 8. | Output Status on controller failure FLUNK | : Required |
| | FREEZE | : Required |
| | Engg. CONFIGURABLE | : Required |
| 9. | Self Tuned Controller Function | :Required for all Ctrls. |

8.2.5 DATA ACQUISITION SUB SYSTEM

- | | | |
|-----|---------------------------------------|---|
| 1. | Mounting | : Rack Mounting |
| 2. | Number of Inputs per Processor | |
| | Analog | : Max. 16 points |
| | Digital | : Max 32 Points. |
| | Conformal coating | : Required for Corrosive atmosphere |
| 3. | Processor Redundancy | : Required ONE to ONE. |
| 4. | Processor Switch- over time | : 1 mSec. |
| 5. | Control Cycle time | : _____ (to be filled by Vendor) |
| 6. | Configuration from | : Central level (from Operator Station) |
| 7. | MTBF | : _____ (to be filled by Vendor) |
| 8. | MTTR | : _____ (to be filled by Vendor) |
| 9. | Model No | : _____ (to be filled by Vendor) |
| 10. | Input Isolation | :Required (galvanic / optical) |
| 11. | Output Isolation | :Required (galvanic / optical) |
| 12. | TYPE OF INPUT MODULES | |

TYPE OF INPUT MODULE	MODEL NO.	ISOLATION	NO. OF INPUT PER MODULE	MODULE AVAILABLE	MODULE OFFERED
4-20mA DC (2 WIRE)		IS BARRIER			
4-20ma Dc (non 2 wire)		IS BARRIER			
1-5 V DC (2 WIRE)		IS BARRIER			
THERMOCOUPLE		IS			

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TYPE J,K,R, GROUNDED & UN GROUNDED AS PER ANSI MC 96.1		BARRIER			
RTD TYPE :-PT 100 3 WIRE AS PER DIN 43760		IS BARRIER			
CONTACT TYPE :- POTENTIAL FREE		N.A			
RS 232 / R485					

13 TYPE OF ANALOG OUTPUT MODULES

TYPE OF OUTPUT MODULE	MODEL NO.	ISOLATION	NO. OF INPUT PER MODULE	MODULE AVAILBLE	MODULE OFFERE D
4-20mA DC (2 WIRE)		IS. BARRIER			

14 TYPE OF DISCRETE INPUT/OUTPUTS MODULES

TYPE OF DISCRETE MODULE	MODEL NO.	ISOLATIO N	NO. OF INPUT PER MODULE	MODULE AVAILBL E	MODULE OFFERE D
POTENTIAL FREE CONTACT					

15 Power supply for Transmitter 24 v DC : Required

16 Intrinsically safe : Yes

17 A/D Converter Resolution 1500 steps (Min.) : Required ___

19 D/A Converter Resolution 1500 Steps (Min) : Required _____

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20 Load Driving Capability for output 750 Ohms: Required _____

21 Load driving capability 650 Ohms of Transmitter at 24 V DC:
Required

22 Max. allowable source resistance T/C input Module: Required

RTD input Module : Required _____

23. Online Diagnostic available at local : Required

Centralized level : Required

24 Memory Type for Configuration

IF RETENTIVE	OFFERED BY VENDOR	IF VOLATILE	OFFERED BY VENDOR
ERASIVE		BATTERY BACK UP	
NON ERASIVE		BATTERY LIFE	
ERASING BY		BATTERY TYPE	
		CHARGEABLE	
		CONTINUOUS TRICKLE CHARGE	
		CONFIGURATION 72 HRS.PROTECTION TIME (INCASE OF POWER FAILURE)	
		BATTERY DRAIN INDICATION.	

25 ALGORITHMS

ALORITHIMS	REQUIRED	OFFERED BY VENDOR
PID FUNCTIONS	a. PID BASIC CONTROLLER b. PID CASCADE c. PID BIAS d. PID DIFFERNTIAL GAP	

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	<ul style="list-style-type: none"> e. PID NON-LINEAR f. PID SELF TUNING g. EXTERNAL OUTPUT TRACKING h. RESET LIMITING 	
BASIC FUNCTIONS	<ul style="list-style-type: none"> a. MANUAL LOADER b. CASCADE (WITH SET POINT TRACKING) HIGH ALARM LIMIT c. EXTRA HIGH ALARM d. LOW ALARM e. EXTRA LOW ALARM f. RATE OF CHANGE ALARM g. DEVIATION ALARM 	
CONTROL ALORITHMS	<ul style="list-style-type: none"> a. PROPORTIONAL CONTROL b. PI c. ERROR SQUARE PID d. ADAPTIVE GAIN e. RATIO CONTROL f. PID WITH DEAD BAND 	
ARITHMETIC FUNCTIONS	<ul style="list-style-type: none"> a. ADDITION / SUBTRACTION b. DIFFERENCE c. MULTIPLICATION d. DIVISION e. ABSOLUTE VALUE f. SQUARE ROOT h. SQUARE i. AVERAGE j. SUMMATION(INTEGRATION) k. BIAS 	

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	<ul style="list-style-type: none"> l. RAMP FUNCTION m. EXPONENTIAL n. LOGARITHM 	
LINEARISATION	<ul style="list-style-type: none"> a. SQUARE ROOT EXTRACTION b. FLOW COMPUTATION (PR&TEMP. COMPENSATION) c. THERMOCOUPLE d. LINEARISATION & COLD JUNCTION COMPENSATION e. RTD LINEARISATION f. POLYNOMIAL 	
DYNAMIC FUNCTIONS	<ul style="list-style-type: none"> a. LEAD / LAG b. DEAD TIME c. TIMER d. FEED FORWARD e. VELOCITY LIMIT f. TOTALIZE 	
LIMITER	<ul style="list-style-type: none"> a. LOW OUTPUT LIMITER b. HIGH OUTPUT LIMITER c. ALARM LIMITER d. SET POINT LIMITER 	
COMPARISON	<ul style="list-style-type: none"> a. GREATER THAN b. LESS THAN c. GREATER OR EQUAL e. LESSER OR EQUAL d. EQUAL e. NOT EQUAL 	
SELETOR	<ul style="list-style-type: none"> a. LOW SELECTOR b. HIGH SELECTOR 	

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	<ul style="list-style-type: none"> c. MEAN VALUE SELECTOR d. AUTO RANGING FOR DUAL for TRANSMITTERS e. OVER RIDE 	
LOGIC FUNCTION	<ul style="list-style-type: none"> a. AND b. OR c. NOR e. NOT f. XOR g. ON / OFF DELAY h. FLIP-FLOP i. PULSE 	
SEQUENCE FUNCTION	<ul style="list-style-type: none"> a. SET BLOCK ON / OFF, AUTO / MAN. b. SET ALARM LIMITS c. SET POINTS d. SET RAMP RATES,RAMP ON/OFF e. GET / SET BLOCK PARAMETERS f. ACTIVATE / ABORT SEQUENCES g. OPEN/CLOSE VALVES h. START / STOP PUMPS / MOTORS 	
MISCELLANEOUS FUNCTIONS	<ul style="list-style-type: none"> a. BUMPLESS TRANSFERS BETWEEN ALL CONTROL MODES b. RAMP TO SET POINT c. RAMP OF OUTPUT d. RAMP OF CACULATED VALUES e. DIRECT OR REVERSE OUTPUTS 	

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8.2.6 ENGINEER INTERFACE SUB SYSTEM

A. GENERAL

1. **No. of engineering console** : One
2. **No. of MONITOR per Engg. Console** : One
3. **Type of Electronics Individual per MONITOR** : Required
4. **Microprocessor type** : 32 Bit
5. **Microprocessor make / Model No.** : _____ (to be filled by Vendor)
6. **Memory size** :Min 1 GB
7. **No. of Engg key Board** : One per MONITOR
8. **No. of Operation key Board** : One per MONITOR
9. **Maintenance Key Board** : Required
10. **Functional Capability** : Same as Operator
11. **Basic functions of Engg. Console** :
 - a. **System Configuration and Reconfiguration** : Required
 - b. **Group & Multi Groups alarm inhibiting** : Required
 - c. **Plant views with / without plant operation** : Required
 - d. **Graphic page Compilation** : Required
 - e. **Setting/resetting of real time clock** : Required
 - f. **Loop Tuning on selectable basis** : Required
 - g. **System Maintenance and diagnostics** : Required
12. **MONITOR specification** : As per Operator Console Sheet
13. **Key board Specifications** : As per Operator Console Sheet
14. **High Voltage Isolation Protection** : Required
 Type : Optical Barrier
15. **Peripheral requirements**
 - a. **Printer (Laser)** : Required
 - b. **Hard Copy Unit Color** : Required

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8.2.7 LOGGING PRINTER

1. **Type of printer** Line / High Speed serial : Required
Offered _____
2. **Number of Character type** Approx. 96 Characters : Required
Offered _____ ASCII
3. **Printing speed** 300 Lines per minute : Required
Offered _____
4. **No. of print columns** Min 132 Character per line : Required
Offered _____
5. **Paper width** Approx. 381 mm : Required
Offered _____
6. **Paper type** Continuous fan fold : Required
Offered _____
7. **No. copies** :
8. **Bi-directional printing feature** : Not required
9. **Acoustic cover** : Required
Offered _____
10. **Paper feed** Pin feed : Required
Offered _____
11. **Test pattern generation** : Required
12. **Cord length offered** As Read. : Required
Offered _____
13. **Mounting** self Contained with Integral stand : Required
Offered _____

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14. Noise level (in DBA) while printing at 1 Meter distance :

	OFFERED
LESS THAN	WITH COVER
45 DBA	WITHOUT COVER

15. No. printers : ONE Model no. _____

8.2.8 ALARM / EVENT PRINTER

1. **Type of printer** Line / High Speed serial : Required
Offered _____
2. **Number of Character type** Approx. 96 Characters : Required
Offered _____
3. **Printing speed** 300 Lines per minute : Required
Offered _____
4. **No. of print columns** Min 132 Character per line : Required
Offered _____
5. **Paper width** Approx. 381 mm : Required
Offered _____
6. **Paper type** Continuous fan fold : Required
Offered _____
7. **No. copies** : **(to be filled by Vendor)**
8. **Bi-directional printing feature** : Required
9. **Acoustic cover** : Required
Offered _____
10. **Paper feed** Pin feed : Required
Offered _____
11. **Test pattern generation** : Required

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12. **Cord length offered** As Reqd. : Required

Offered _____

13. **Mounting** self Contained with Integral stand : Required

Offered _____

14. **Noise level (in DBA) while printing at 1 Meter distance** :

REQUIRED	OFFERED
LESS THAN	WITH COVER
45 DBA	WITHOUT COVER

15. **No. printers** : One

Model no. _____

8.2.9 CONFIGURATION AND MAINTENACE PRINTER (LASER TYPE)

1. **Type of printer** Line / High Speed serial : Required

Offered _____

2. **Number of Character type** Approx. 96 Characters : Required

Offered _____

3. **Printing speed** 300 Lines per minute : Required

Offered _____

4. **No. of print columns** Min 132 Character per line : Required

Offered _____

5. **Paper width** Approx. 381 mm : Required

Offered _____

6. **Paper type** Continuous : Required

Offered _____

7. **No. copies** :

8. **Bi-directional printing feature** : Not Required

9. **Acoustic cover** : Required

Offered _____

10. **Paper feed** Pin feed : Required

Offered _____

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11. **Test pattern generation** : Required
12. **Cord length offered** As Reqd. : Required
Offered _____
13. **Mounting** self Contained with Integral stand : Required
Offered _____
14. **Noise level (in DBA) while printing at 1 Meter distance** :

REQUIRED	OFFERED
LESS THAN	WITH COVER
45 DBA	WITHOUT COVER

15. **No. printers** : ONE
Model no. _____

8.2.10 COLOR HARD COPY UNIT

1. **Type of Hard copy unit** : Laser type
2. **Screen Lockout time Max.2 SEC.** : Required
Offered _____
3. **Screen Selection from Operator consoles & Engg console** : Required
Offered _____
4. **Max. distance from Operator Console** As per control room layout : Required\
Offered _____
5. **No. channels** from any operating consoles : Required
Offered _____

REQUIRED	OFFERED
Printer type	
Paper size	
Resolution 640 dots / line	
High voltage protection Reqd.	

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Paper type	
Connection to Multiple Monitor's	
Copier swathing Auto / Manual	
Noise level	
Acoustic cover Reqd.	
Max. No. Channels offered	

6. **Card length Offered** As Reqd. : Required
Offered _____
7. **Mounting** self contained with Integral Stand : Required
Offered _____

8.3.0 FOREGIN DEVICE INTERFACE

8.3.1 INTERFACE-WITH-PLC

1. **Type of interface** SERIAL : Vendor to specify
2. **Type of Redundancy** DUAL REDUNDANT : Required
Processor system ACTIVE : Required
3. **Standard Interface software available for** MODBUS PROTOCOL : Vendor to specify
4. **Functional Requirements** Type of Communication : DUPLEX
Automatic time Synchronization : Required
Interface with PLC diagnostic messages : Required
Interface diagnostics available at : Central Level (at
And LOCAL LEVEL)

5. DCS operator station

The Resetting of activated interlocks shall be done through the DCS operator station. The status of all the inputs, interlocks, Bypass switches and the diagnostics of the ESD shall be reported on the DCS for monitoring and alarming

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8.3.2 INTERFACE WITH SUPERVISORY (ALPHA) COMPUTER

- 1. **Type of interface** ETHERNET : Required
- IEEE 802.3 Communication Protocol : Required
- 2. **No. of Interfaces per System** : Min ONE.
- 3. **Input Capability** All the Tags in DCS : Analog & digital
- 4. **Functional Requirements** Type of Communication : DUPLEX
- Automatic time Synchronization : Required
- 5 **Proven Interface software available for the following Supervisory computers** : Make DEC VAX
- : Model No. _____
- Make DEC ALPHA
- : Model No. _____
- 6. **Time Taken to transfer Data from supervisory Computer to DCS** : **1 Sec**
- Offered By vendor** _____

8.4 Constructional details

- a. control panel Front plate CRCA 3 mm THICK STEEL Welded to frame : Required
- b. System cabinets Front door: transparent shutter proof Glass Panel Color : Vendor to specify
- c. Door panel thickness : CRCA 2 mm THICK
- Concealed hinges : Required
- Flush pull handle : Required
- Both sides hinges : Required
- d. Frame angle size : 50 x 50 x 4 mm
- Lifting Bolt : Required
- e. Card rack size 19" : Required
- Type : Fixed
- f) Ventilation : Yes, required with fan and filters Also
Fan failure Alarm

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shall and Cabinet Temperature
High alarm shall be
provided in DCS.

8.5 Wiring

110v AC UPS Wiring

- I. External to Cabinet / panel Min. 3 x 2.5 Sq.mm copper Conductor PVC insulated :Required
- II. Inside the cabinet / panel Min 19 strnds,16 AWG Copper Conductor PVC Insulated :Required
- III. 230v AC Wiring 2.5 Sq.mm. copper Conductor PVC insulated :Required
- IV. Low Voltage Internal to cabinet / panel Min 19 strnds,16 AWG: Required Copper Conductor PVC Insulated

8.5.1 SIGNAL WIRING

- 1. External to Cabinet / panel Min 2 x 1.5 Sq.mm copper :Required
Conductor PVC insulated with Overall drain
PVC insulated armoured
- 2. inside the cabinet / panel Min 7x20 AWG : Required
Copper Conductor PVC Insulated twin shielded

8.5.2 TERMINALS TYPE

- Wago type with pressure plate : Required
- Terminal size for signal : Suitable for 2.5Sq.mm
- For power dist. : Suitable for 4. 0Sq.mm
- Terminal block Clip-on Channel Mounted Stack type : Required

8.5.3 WIRING COLOR CODE

VOLTAGE	TYPE	COLOR	OFFERED
POWER SUPPLY 110V AC	PHASE	RED	
	NEUTRAL	BLACK	
	EARTH	GREEN	

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DC WIRING (24VDC)	POSITIVE	RED	
	NEGITIVE	BLACK	
DI SIGNAL	POSITIVE	YELLOW	
	NEGITIVE	YELLOW	
DO SIGNAL (WET)	POSITIVE	RED	
	NEGITIVE	BLACK	
DO SIGNAL (POTEN. FREE)	POSITIVE	WHITE	
	NEGITIVE	BLACK	
RTD SIGNAL	POSITIVE	WHITE, WHITE	
	NEGITIVE	BLUE	
ANALOG I/O SIGNAL	POSITIVE	BLUE	
	NEGITIVE	WHITE	

8.6 Engineering Guidelines

As a general rule, push-buttons and lamps shall be organized according to the plant areas they are related to, and according to plant handling needs:

a. Push-buttons

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

b. Labels:

(a) Close to each switch an Acrylic engraved label shall be provided and the tag name, description of the device shall be indicated on it.

(b) Labels shall be black with white engraving.

c. Terminations

(a) 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).

d. Lamps

Colors will be:

(1) RED

(2) GREEN

(3) YELLOW (enable/disable of interlock)

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- e. The lights shall be provided by white multi-LED elements, and the colored caps shall be easily replaceable.
- f. Typical connections of lamps shall be as follows:
 - (a) 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);
 - (b) One (1) lamp (for indication of motor status or valve equipped with single limit switch indication).
 - (c) Some lamps will be installed inside push-buttons, others will be independent.
- g. Push-buttons and switches
 - (1) Switch contacts will be wired as follows:
 - (a) Normally closed: open the contact (2 NOs)to initiate the interlock and to stop dedicated motors;
 - (b) Normally open: close the contact (2NCs) to disable (bypass) an interlock sequence.
 - (2) All the switches and lamps shall be wired to a marshalling strip installed inside the hardwired console. The numbers of strips and terminals shall cover the number of switches and lamps foreseen on the consoles considering the spares.
 - (3) 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.
 - (4) The switches shall be realized with modular components, to guarantee easy replacement of colored caps, or to allow change from two position switch to push-button and vice versa.
 - (5) **Security covers** shall be provided, to avoid accidental operation of switches and push-button.
 - (6) A push-button for the plant emergency shutdown shall be provided.
 - (7) A lamp-test push-button and the necessary diodes and wirings, shall be provided on the hardwired consoles.

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9.0 DATA SHEET FOR PLC

9.1 FUNCTIONAL REQUIREMENT

To execute all Burner Management System (BMS) shutdown logic and interlocks with Interposing relays at input and output levels and also sequence recording function as a part of the PLC system.

9.2 SYSTEM CONFIGURATION TYPE

PLC Configuration shall be QMR and redundant dual I/O with built in Diagnostic features for Processors and I/O or TMR Configuration. PLC shall be monitored by Watch Dog and in the event of any discrepancy found by the Watch Dog, it shall supersede the CPU outputs and De-energize the outputs to bring the plant to Safe Operation. All the Processor shall read the Inputs, Solve the Application logics and generate Outputs and energize the Output modules in parallel.

9.3 TUV-CERTIFICATION /SIL

1. Required (class AK-5 minimum/SIL3) as per IEC61508 and the copy of the certification shall be enclosed with the bid.

9.4 PROCESSOR SYSTEM

a) Functional Capability

1. Logic functions
2. Timer function (Both off-delay and on-delay timer) Range 0 to 99,999 Sec. least count: 0.1 sec
3. Counter functions: (up/ down counter)

b) Interfacing Capability

1. With I/O racks : required
2. With DCS : required
3. With PLC console : required
4. With SOE PC : required
5. With printer of PLC Console and SOE PC : required

c) Memory Type

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- Flash Memory : required
- d) Memory Capacity : vendor to specify
- e) Memory Capacity Used : vendor to specify
- f) Spare Memory Available : should be >50%
- g) Memory type : Volatile / Non-volatile (vendor to specify)
- h) Memory If Volatile : Vendor has to specify the following
1. Battery backup : required
 2. Battery life : (vendor to specify)
 3. Battery type : (vendor to specify)
 4. Chargeable : yes, required
 5. Battery drain indication : required
 6. Incase of power Failure protection of configuration required : Minimum 72 hours
- i) Maximum scan time 200 ms or less : required
offered _____
- j) Power supply redundancy : required
offered _____
- k) Output on processor system failure : vendor to specify
- l) Max. Distance between processor & PLC console : vendor to specify
- m) System Clock : RTC
- n) SOE : User Defined SOE
- o) Time Stamp for SOE : 1 mSec
- p) Processor loading philosophy : 60% (maximum)

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q) Online Downloading feature shall be provided. The same shall be possible for all the functions viz Addition/Deletion of System and I/O Modules, Addition/Deletion of all the Variables, Addition/ Deletion of FLDs including Functional Blocks etc.

9.5 INPUT / OUTPUT SYSTEM:

- a) Type
- | | |
|----------|--|
| Discrete | : required with LED for Module and I/O status. |
| Analog | : required with High speed A/D conversion.
: required with Channel to Channel isolation |
- b) Dual I/O configuration : required
- c) On line replacement of I/O modules : required
- d) I/O Status indication : required (both on PLC I/O cards with LED for Module and status and in PLC workstation)
- e) Input isolation : required (optical isolation)
- f) Output isolation : required (optical isolation)
- g) Auto testing of I/O : required
- h) Power supply to I/O rack : Dual redundant power supply
- i) I/O rack to processor comm. Link : Dual redundant
- j) Maximum number inputs per module : max. 16 (offered: vendor to specify)
- k) INPUT MODULE:
- | | |
|--------------|---|
| Input type | : potential free contact rated 110VDC,1A required |
| Analog input | : Intrinsic Safe required |

:

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- l) Input interrogation voltage : 110VDC/ 24VDC (vendor to specify)
- m) I/O Capacity : Refer attached Annexure VII.
- n) Output Module
- Output type
- 1) Output capable of driving 110VDC, 23W solenoid valves through interposing relays, indicating lamps etc.
 - 2) Output for communication with centum – DCS system.
 - 3) Output capable for energizing ignition transformer (transformer input supply is 110VAC)
 - 4) Potential free contact outputs for alarm annunciation
- o) Max. Number of outputs per output module : 16
(Offered:
vendor to specify)
- p) Maximum distance between processor and I/O rack : (vendor to specify)
- q) Mounting rack : 19" rack.
- r) Process input bypass switch (Rotary) : required
(hardwired with indication lamps)

9.6 PLC /SOE CONSOLE:

- a) Installation Location : Indoor and Control room
- b) Monitor : 21 inch TFT color

(Independent PC shall be provided, capable of communicating with both the CPU. The necessary hardware and software shall be provided.)

- c) Redundant communication link between processor and PLC/SOE console : required
- d) Keyboard : required
- e) Printer : required

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- f) Type of printer (laser/monochromatic/color) : vendor to specify
- g) Printer speed : vendor to Specify
- h) Printer power supply : 110VAC, 50 Hz (UPS)
- i) System boot-up on power on : Automatic
- j) Password protection for opening the file : required
- k) Password protection for modifying/forcing/Unforcing the inputs/outputs (Edit mode) : required
- l) Programme storage : required (USB /CD)
- m) Online programming facility : required
- n) Online programming modification : required
- o) Disable / enable facility : required
- p) Power flow indication on ladder / logic : required
- q) Self diagnostics : required
- r) I/O mapping : required
- s) List of forced signal shall be displayed in PLC work station : required
- t) Forced signal field dynamic status displayed : required
- u) Alarm printing : required
- v) Function Logic Diagrams/Ladder logic monitoring : required
- w) paper width for printing : 381 mm
(Vendor to specify)

9.7 SYSTEM/APPLICATION SOFTWARE:

- a) All the software to be supplied shall be of latest version.
- b) Software shall be Engineer friendly for ease of configuration and troubleshooting.

9.8 INTERFACE WITH DCS:

- a) Type of communication
Serial /Bidirectional/RS232C interface : vendor to specify
- b) Communication protocol : vendor to specify
- c) Total time for displaying alarm generated by PLC on DCS : vendor to specify.

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9.9 POWER SUPPLY:

110VAC will be made available to PDB cabinet. AC voltage and DC voltage distribution (110VAC/110VDC and 24VDC) distribution inside the PLC cabinet will be in vendor's scope. Also the voltage conversion from 110VAC to 24 or 5VDC will be in vendor's scope.

- a) Power supply available for PLC system : 110VAC+/-10%, 50Hz (+/-3%)
- b) Interrogation voltages for switches (vendor to state) : 110DC/24VDC
- c) Energizing voltage for solenoid valves : 110 VDC
- d) Energizing voltage for indicating lamps (vendor to state) : 110VDC/24VDC
- e) Voltage output for energizing ignition Transformer : 110VAC
- f) Power supply available for PLC /SOE console : 110VAC (UPS)
- g) AC and 110V/24VDC/5VDC voltage distribution : vendor's scope

9.10 DIAGNOSTIC CAPABILITY:

The system shall have a high diagnostic coverage. This diagnostic system will be automatic and run on continuous basis without operator intervention. It shall be capable of detecting errors or fault conditions in any part of the control system before system integrity is lost. Fault in the communication system shall also be identified by the diagnostic routines.

Vendor should detail the diagnostic programs available in the PLC system for the debugging the system hardware and software faults and normal maintenance activities.

The PLC system shall have minimum following diagnostic features. These false contact output shall be hardwired to DCS addition to serial link communication.

1. Power feeder's trouble
2. Power supply failure
3. Fuse failure
4. Battery failure
5. CPU fault.
6. Input/ output module fault
7. Communication bus failure etc.

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9.11 PLC CABINET:

- 1) Location : Control room
 - Flooring : False flooring
 - Air Conditioning : Available

- 2) General details
 - a) Type of cabinet
 - Self supported : yes
 - Free standing : yes
 - Enclosed cubicle : yes
 - b) Lighting : Yes, required inside the panel / cabinet
 - Door switch : yes, required
 - Power supply : 230 VAC, 50 Hz
 - c) Ventilation : Yes, required with fan and filters
 - Also Fan failure Alarm shall and Cabinet Temperature High alarm shall be provided in DCS/PLC.
 - d) Doors : Required (both front and rear doors required) Doors should be provided with door locks.
 - e) Special features
 - Cable entry : bottom
 - Cable gland : required
 - f) Space available for mounting PLC cabinet in the control room : Yes
 - g) Panel painting : vendor to submit panel/console painting and the approval shall be taken from BPCL Mumbai refinery.
 - painting color /type of
 - h) Constructional details:
 - control panel
 - Front plate : 3mm Thick steel
 - Welded to frame : required
 - Panel thickness : 2mm thick CRCA
 - Flush pull handle : required
 - Channel base : CRCA
 - Lifting bolt : required

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Cable Entry : Bottom
Receptacles : For 110VAC/230VAC,
Telephone socket : required.

3) WIRING:

a) 110VAC power supply wiring : min.19 strands, 16 AWG copper conductor, and low voltage inside panel PVC insulated.

b) Signal wiring : minimum 7 strand, 20 AWG copper conductors with PVC insulation.

c) Wiring color code

110 VAC

PHASE : RED
NEUTRAL : BLACK
EARTH : GREEN

DC WIRING

POSITIVE : RED
NEGATIVE : BLACK
ALARM SYSTEM : WHITE
CONTROL/SHUTDOWN CABLE : YELLOW
MCC WIRING : GREY

d) Terminal block : clip-on channel mounted stack type

e) Terminal size for power cable : suitable for 2.5 sqmm cable

f) Terminals type : Screw clamp type with pressure plat

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10.0 FACTORY/SIT ACCEPTANCE TEST PROCEDURE

10.1.0 INTRODUCTION

10.1.1 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.

10.1.2 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 (DCS and PLC, Cabinets), or if separate tests will be conducted on each item, performing a final integration test (for example at the end of the 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 marshalling cabinets.

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.

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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 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.

10.1.3 Packing

System packing and shipment shall be done as per BPCL Mumbai refinery procedures, defined at the Purchase Order.

10.1.4 Shipping and Installation

Control System shipping details will be defined during project development; Vendor is required to evaluate the possibility (and the

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costs) to ship Control System complete or to divide shipping in different phases (e.g. marshalling cabinets, PLC (ESD) cabinets and DCS cabinets at different time).

Control System Vendor's qualified personnel will be present to check system installation and to supervise the initial system power up activities.

Checks listed in chapters 3 and 4 will be repeated during the Site Acceptance Test in the field. These tests are intended to re-check control system's functionalities to verify no problems arose during packing, shipping and installation.

BPCL engineers will define for each test if the complete check or a representative subset, will be repeated.

Vendor's technicians will be on site during field test

10.2.0 F.A.T. ORGANIZATION

10.2.1 Facilities

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 DCS and PLC consoles.

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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.
 - a. Digital multimeter;
 - b. 4 to 20 mA signal generators;
 - c. 1 to 5 V signal generators;
 - d. Potentiometers to simulate different readings for analogue signals powered by PLC (ESD)
 - e. Decades resistances box to simulate RTDs readings;
 - f. Simulation panel for digital inputs and outputs;
 - g. Tool kit (with screwdrivers, jumpers, etc.).

10.3.0 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.

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10.4.0 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

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

Test Description	DCS	PLC		
Check of supply completeness	X	X		
Check of proper change-over of the back-up units in case of unit failure	X	X		
Demonstration of diagnostic features	X	X		
Power off and power on of any single unit	X	X		
Check of auxiliary devices	X	X		
Check of correct functionality of keyboards	X	X		
Testing of proper working of the printers	X	X		
Simulation of power-off and restart	X	X		
Test of system interfaces working	X	X		
Check of power supply load	X	X		
Check of analogue channels accuracy	S	S		

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NOTES:

X = test to be performed for all the equipment

S = test to be performed as sample

10.5.0 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.

Test Description	DCS	PLC		
Check of database configuration	X	X		
Check of batch sequences (if any) and interlocks configuration	X	X		
Check of MONITOR displays (all kind of displays)	X	X		
Check of all kind of reports	X	X		
Check of system internal loading (processors, communication system, etc.)	X	X		
Check of printing functions (alarm, reports, etc.)	X	X		
Check of time stamping and continuous operation after year 1999	X	X		
Scan time checking	S	X		

NOTES:

X = test to be performed for all the equipment

S = test to be performed as sample

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10.6.0 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 DCS/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.

10.7.0 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).
- Application Data Base- 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.

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10.8.0 TESTING ACTIVITIES

10.8.1 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.

10.8.2 Completeness of Supply 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

10.8.3 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
 - 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

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7. Communication fail: For redundant Cables/Busses and Serial links:
 1. Master line and relevant switch over Reserve line and relevant system alarm
 - For single Serial Links and Ethernet:
 - 2 . Communication fail and relevant system behavior.

10.8.4 Input output working

Analogue (4-20 mA) Inputs check
Analogue (4-20mA) output
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.

10.8.5 System configuration check

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

10.8.6 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...)
- 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.

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- 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.

10.8.7 Auxiliary devices

- a) The proper working of printers is to be checked.
- b) The proper working of trip amplifiers, temperature converters, relays, etc is to be checked.
- c) The proper working of other special modules (if any) is to be checked and software which are related functioning of the DCS/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

10.9 **Site Acceptance Test (SAT)**

Procedure for carrying out SAT shall be submitted by vendor for BPCL approval. All the equipment shall be checked thoroughly after its installation and commissioning. The Tests. As a minimum shall include,

- Visual and mechanical testing.
- Redundancy checking of all the redundant units like, Controller, Communication bus, Sub communication I/O modules, power supply unit etc.
- Demonstration of all system diagnostics features.
- Checking of communication between DCS and PLC and PLC and Programming unit.
- Checking of changeover of redundant devices.
- Demonstration of all system functions.
- Checking of proper functioning of DCS/PLC programming unit, PLC printer.
- Complete checking of DCS/PLC system.
- Complete engineering configuration of DCS and PLC including Graphics tuning, FLD.

11.0 **GENERAL TERMS AND CONDITIONS.**

11.1 **General**

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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.

11.2 FACTORY ACCEPTANCE TESTING (FAT) & ACCEPTANCE and SAT

- 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.
- SAT shall be carried out as per mutually agreed approved SAT procedures.
- 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.

11.3 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.

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- Vendors 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 identification before removal of marshalling panel.
 - d) Field cable termination.
 - e) Check out equipment installation
 - f) Loop checking
 - g) Commissioning and online debugging of the system.
 - h) Involvement during plant commissioning and performance of final acceptance test.

11.4 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.

11.5 Documentation:

- a) Vendor shall furnish all manuals & engineering drawing as required review/approval after order as per agreed QAP.
- b) Vendor shall provide four sets of back-up configuration storage for each system, containing operating programs, diagnostic programs and system configuration etc.
- c) 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. Vendor to provide following as built documents.

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- Operating and maintenance manuals
- Software manuals, soft application data and soft copy of as built drawings
- Work sheets, engineering drawings, and documentation prepared for the Configuration of the offered system.
- Loop drawings containing full information of each loop with field termination, junction box nos., cables No., device address, power supply connection etc.
- All these documentation shall be furnished in hard cover loose ring folders in "A4" size (216 mm x 239 mm).

11.6 Warranty:

- a) 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.
- b) It may be noted that during the defect liability / warranty period, vendor will take complete responsibility for any defect observed in the system.
- c) Further, vendor shall provide written guarantee that the back-up engineering, maintenance and spare parts shall be available for a minimum of 15 years.
- d) It shall be obligatory on the part of vendor to modify and/or replace any hardware and modify the operating, application and diagnostic software free of cost, in case any malfunction is revealed even during online operation after taking over within the warranty period.
- e) Vendor shall provide the total maintenance of system during warranty period including replacement of equipment / component at no extra cost.
- f) Vendor to provide extended warranty for all supplied hardware and software for a minimum period of 4 years trouble free operation for DCS and PLC. This extended warranty period shall commence from expiry of standard warranty of 12 months. On any failure, Service Engineer shall report to the site within 24 hours.

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11.7 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.

11.8 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.

11.9 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) Vendor's organ gram involved for this project.
- f) Test plan.
- g) QAP.
- h) Post Warranty Spares list with part no & unit price information.
- i) Certificate from statutory bodies.

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- j) Loop schemes.
- k) Bill of Materials.
- l) Recommended spare parts for :
 - a. Commissioning
 - b. Post Warranty Annual Maintenance

Any other drawings not mentioned above but required for erection, commissioning or re-configuration 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 DCS/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.

11.10 Training of DCS/PLC:

This training shall be conducted at vendors/OEM works. All the training are to be imparted by the manufacturer's experts in the respective fields.

Efforts shall be made to arrange factory training for the BPCL personnel at manufacturer works prior to factory acceptance test.

The training requirements for ESD PLC and DCS shall be as follows

- a) Engineering, Maintenance and trouble shooting training for DCS 20 Man weeks.

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- b) Engineering, Maintenance and trouble shooting training for PLC 20 Man weeks.
- c) Site Training shall be carried out by the vendor for 10 Trainer man days for the operator.
- d) Operator training shall be 10 Man weeks for DCS.

11.11 Vendor shall submit the following calculation sheets along with the offer.

1. DCS/PLC loading calculation
2. Historical trend memory utilisation
3. power/load calculation sheet
4. HVAC calculation sheet
5. Air quality requirement
6. list of Sub-vendor/ manufacturer for BPCL engineer in charge approval

11.12 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. Failing which vendors offer shall not be considered for technical evaluation.
- b) The UPS calculation sheet must indicate: actual UPS load under normal and start up condition. (consider all loads are powered on simultaneously)
- c) No new UPS has been envisaged at this stage, however vendor to check the adequacy of the existing UPS w.r.t new load (which is to be furnished by the vendor) and to confirm the same in their offer.
- d) Vendor shall be responsible for their recommendations regarding UPS requirement.
- e) Vendor to ensure any equipment supplied by them shall not be damaged due to blackouts/ brown outs. Further, vendor to indicate the following:
 - (a) Steps to be taken for fail safe operation of the system under the following conditions:
 - i. Power Failure
 - ii. Voltage variation more than +/- 10 %
 - iii. Frequency variation more than +/- 3 %
 - iv. Air-conditioning failure
 - (b) The start-up procedure for the system including system data base loading during start-up, and power on.

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- f) Vendor to furnish information related to their and / or their principal's experience and the proven ness of the equipment (computers, hardwares, software's etc.) in the **PROVEN TRACK RECORD** The information should specifically be related to the similar applications. Vendor should submit documentary evidence to substantiate above along with their quotation. Vendor is wholly responsible for the correctness of the information submitted or provided otherwise by them as a part of their bid. BPCL reserves the right to verify the correctness of documentary evidence furnished by the Vendor.
- g) Vendor to produce documentary evidence for service support and supply of spares for minimum 15 years. Vendor shall have full-fledged service support team; the detail of the service support team shall be submitted along with the offer.
- h) Vendor shall furnish a certificate for providing necessary support services. The certificate shall be duly signed by them and their principal(s)
- i) Certificate from sub vendors for systems such as computers, printers etc. shall also be furnished. The certificate issued by the local agents shall not be acceptable.
- j) 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.
- k) 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.
- l) Vendor to consider Supply of all installation material including trays ,conduits, fasteners, supports, base-channel frames, glands ,earth electrodes, earthing cables and other accessories as necessary.
- m) The storage of equipment at site shall be vendor's responsibility for all the equipments supplied by them. Non air-conditioned space could be provided to the vendor if the control room is not ready at the time of equipment receipt at site.
- n) All necessary hardware/software/licenses and engineering required for successful augmentation/ up-gradation / extension of present system without affecting the existing system shall be provided by the vendor.
- o) Vendor to note that all hard discs of server/ PC grade machines shall be sized with at least 50% spare availability for application area.
- p) As a execution methodology vendor shall prepare a detailed work schedule for the phase wise installation and commissioning of the system which shall be approved by BPCL..
- q) As a part of engineering, testing, loop checking, pre-commissioning and commissioning of the system, vendor shall ensure the following as a part of their scope of work;

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- a. Any consequential changes in hardware / software configuration and / or necessary engineering
- b. Any changes necessary in the system during pre-commissioning and loop checking because of either inadequate information, wrong engineering, front desk engineering etc related to operational and maintenance requirements like configuration change, graphic change, I/O reassignment, termination modifications, addition of input / outputs within the scope of specification.

11.13. Proposal of Vendors offer.

- a) The proposal shall comprise of the following sections:
 - SECTION I- Synopsis of the Proposal
 - SECTION II- Vendor's Capability
 - SECTION III- Project Execution
 - SECTION IV- System Description/ Operation
 - SECTION V- Technical Specifications
 - SECTION VI- Deviations
 - SECTION VII- Quality Assurance, Factory Testing and Field Acceptance
 - SECTION VIII- Price Details
- b) Section I and II shall be used by the vendor to establish their capability in the field of Distributed Control Systems/PLC. The details shall be forwarded as under:
 - Introduction
 - Company profile
 - Vendor's experience (in PTR format)
 - System engineering capability
 - Sub-vendor list (for all bought-out items)
 - Vendor's Organization chart
 - Miscellaneous
- c) Section III shall be used by the vendor to provide details about execution of the project. . The details shall be forwarded as:
 - Proposed project management
 - Man-power Deployment Chart
 - Bio-data of Key persons
 - Estimated engineering and delivery schedule including bar chart.
 - Methodology of execution
 - Vendor's responsibility

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- Sub-vendor's Responsibility Chart To be filled separately for each bought-out item.
- d) Section IV shall include the following details separately for each system item i.e. DCS, PLC etc.
- System proven-ness
 - A drawing showing the offered system architecture and all subsystems offered by the vendor.
 - A single line diagram showing interconnection of all hardware functional modules subsystem-wise, e.g. I/O modules, controller modules, communication subsystem interface module etc. for each system item.
 - Detailed functional description for each system item explaining how the system meets each of the functional requirements specified in the requisition.
 - Vendor to explain redundancy levels and methodology of change-over at each
 - processor level i.e. I/O module, Processor module and communication at Processor and network level (for controller, console)
 - Vendor to explain availability of Diagnostics at various levels with the system.
 - Vendor to explain data storage and retrieval capability of the system.
 - Vendor to explain with respect to offered add-on hardware and software explaining how Time Synchronization of Complete System from external clock is achieved.
 - Vendor to forward detailed explanation as to how they propose to meet the 20% future expansion requirements with respect to hardware and software
- e) Section V shall include the following details separately for DCS./PLC
Vendor shall include printed literature to support and clearly explain as to how each subsystem fits into the functional requirements specified in the requisition.
- a) Vendor to furnish the following documents
- i) Sizing calculation for controller and data acquisition sub-system considering loading and scan time requirements specified in the detailed specification. Considering the additional I/O are in each system.

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- ii) Sizing calculation for PLC processor considering loading and scan time requirements.
- iii) Communication network sizing calculation.
- b) Storage Capacity
 - a) Trending Capability (No. of points with respect to sample time and maximum storage time.
 - i. Real-time Trend
 - ii. Historical Trend
 - c) Data Base and History Memory Sizing
 - d) Calculations for 30 days Historical Trending for all analog points at the rate of 1 (one) minute sample time.
 - e) Vendor to specifically indicate the availability of the following system alarms:
For DCS and PLC
 - Channel failure alarm of main as well as back-up I/O module.
 - Module failure alarm of main as well as back-up module.
 - Availability of PLC system alarms on DCS operator console.
 - Power supply failure alarm.
 - Fan failure and cabinet temperature high alarm
 - Main and redundant bus failure alarm
 - I/O channel latent fault (permanent open / short) detection and alarming –
 - for PLC only.
 - Barrier failure diagnostic
 - Disc failure alarm. In case of dual disc configuration, Main as well as Redundant disc.
 - Redundant device failed to take-up
 - f) Vendor to furnish following details
 - a) Update rate on DCS console.
 - b) Update rate for data from PLC to DCS console and vice versa.
 - c) Console switch over time in case of Redundant Console electronic type systems.
 - g) Vendor shall include any other information not mentioned in the data sheets but important or required to be furnished to support and explain the functional requirements for the system. The additional information shall be provided on separate sheets and shall be attached to appropriate data sheet.
 - h) Vendor shall furnish all the data and drawing required . Vendor shall also furnish data for power consumption, ventilation and air conditioning

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requirements. Since this information is being used for engineering, vendor must certify the correctness of the data provided.

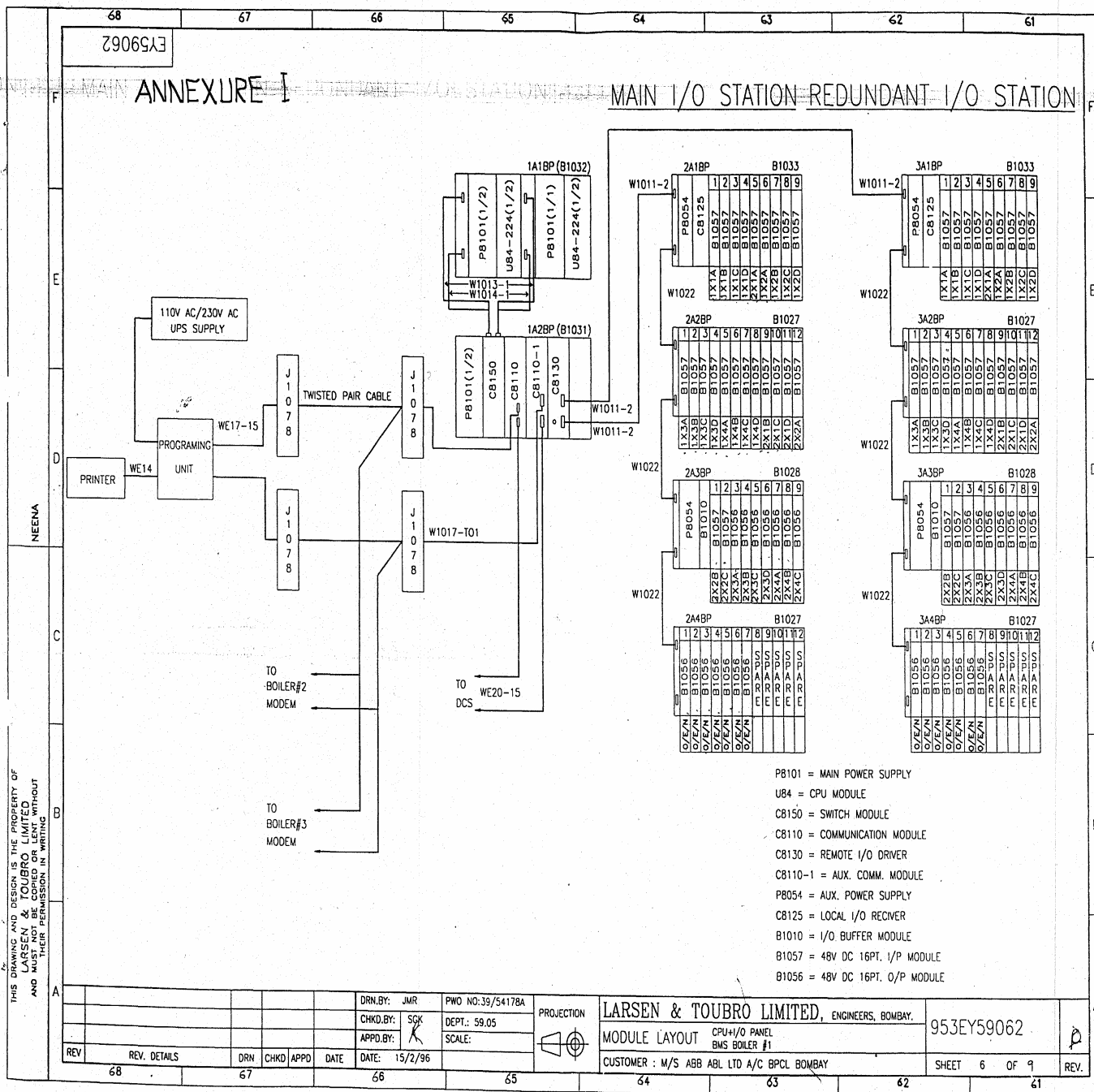
- i) Vendor to clearly indicate the 'G' classification as per ISA for each of the subsystem offered by them against this job. The information shall be given in the form of a Table indicating all sub-systems and systems and their corresponding 'G' class offered. In case any hardware is not listed in the , it shall be construed to have been complying minimum of 'G3' classification.
- j) Vendor shall include the detailed description and capabilities of all the software offered.
- k) Vendor shall include separate lists for mandatory spares, recommended spares for two (2) years normal operation, test equipment and tools, and consumables.
- f) Section VI shall list out deviations, if any separately. The list shall indicate Document name, Document no., Page no., Clause no., Requirement, Deviation asked, Technical reason for Deviation, Remarks, if any. Vendor should not give any explanation or comment on the specification.
- g) Section VII shall include - Quality Assurance, Factory Testing and Field Acceptance Vendor shall enclose "Vendor Standard" procedures including the test facilities available with them to perform the following:
- Quality Assurance
 - Factory Acceptance
 - Field Testing
 - Field Acceptance
- Vendor to provide procedure being adopted by them to demonstrate scan time, loading etc. Vendor shall enclose the details of simulation method of all process inputs. Vendor shall also enclose the detailed schedule for factory testing, installation, loop checking, field testing, commissioning and field acceptance of the system.
- h) Section VIII shall contain all the pricing information including Bill of Materials, as per the requirements of this requisition. Bidder shall submit the price details against each item.

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Annexure I - u84 PLC Architecture

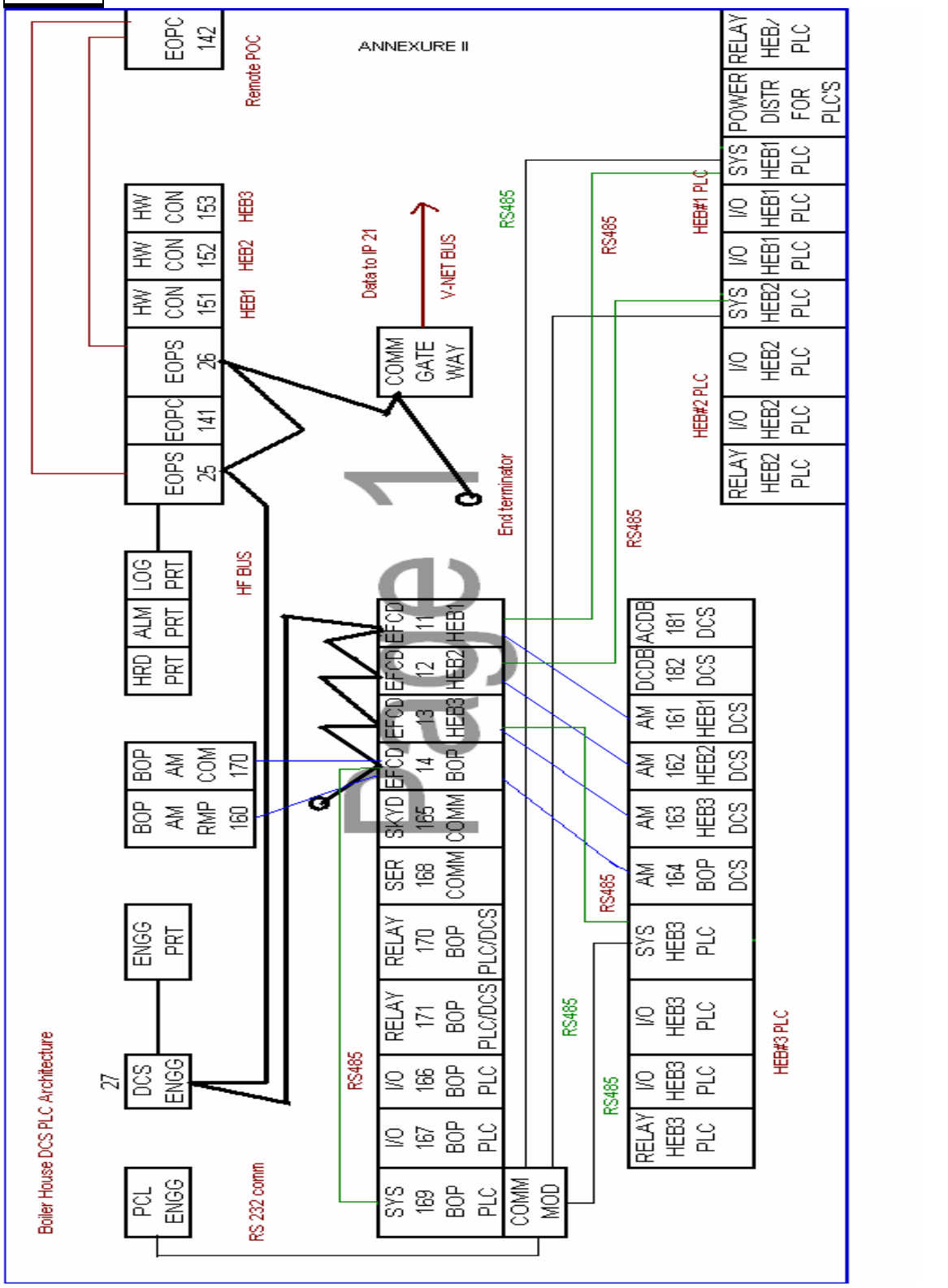


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Annexure - III

Tentative Bill of Material- DCS

S/N	Description	UOM
1.	Removal of Existing Centum XL DCS along with complete System, Analog and Digital marshalling and PDB Cabinets, Relays and accessories etc. as per annexure V.	Lot
2.	Supply of Redundant DCS Rack, CPU, Communications Modules etc.	4 set
3.	Supply of Redundant I/O modules (AI,DI,DO,T/C & RTD) details as per Annexure VII.	Lot
4.	Supply of System cabinets (2200mmHx1200mmWx1200mmD) with Glass door along with all the required accessories	4 set
5.	Supply of Analog and Digital Marshalling and Relay Cabinets with all the accessories like Relays/barriers, Converters etc mounted. And wired. (2200mmHx1200mmWx1200mmD)	Lot
6.	Supply of PDB cabinet (2200mmHx1200mmWx1200mmD) with Voltmeter, Ammeter, MCBs, Bus Bar with inter-panel wiring and termination etc.	Lot
7.	Supply of HWC along with PBS, Selector switches, Feedback lamps and terminal blocks including inter-panel wiring etc	Lot
8.	Supply of LED base Annunciator with inter-panel wiring and termination etc.	3 set
9.	Supply of Relays For DI/DO and Barriers, Converters and Signal repeaters etc including Signal Conditioning , wiring etc For Analog Inputs and Outputs.	Lot
10.	Supply of Field Termination Assembly for AI, AO, and DI and DO Modules as per project requirement.	Lot
11.	Supply of System cables, Prefab cables, Communication cables etc required for complete Integrity of the System	Lot
12.	Supply of Redundant Bulk Power supply Unit(110VAC/24VDC)	Lot

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13.	Supply of Operator Station, Remote Operator Station for DCS with Latest model and Latest O.S with 21" TFT Monitor etc along with printer necessary furniture (table and chair) mounted with necessary receptacles.	4 set
14.	Supply of OPC Server Client Station for DCS with Latest model and Latest O.S with 21" TFT Monitor etc along with printer necessary furniture (table and chair) mounted with necessary receptacles. OPC system shall be supplied with necessary Hardware firewall (is must) for protecting the system from cyber attack.	1 set
15.	Supply of Engineering Station for DCS with Latest model and Latest O.S with 21" TFT Monitor etc along with printer necessary furniture (table and chair) mounted with necessary receptacles.	2 set
16	Supply of Documentation System Software/hardware for DCS with Latest model and Latest O.S with 21" TFT Monitor etc along with printer necessary furniture (table and chair) mounted with necessary receptacles.	1 set
17.	Supply of Alarm Management System Software/hardware for DCS with Latest model and Latest O.S with 21" TFT Monitor etc along with printer necessary furniture (table and chair) mounted with necessary receptacles.	1 set
18.	Supply of Latest Version Software a) System Software b) Application Software c) Communication Software d) OPC Client Software e) AMS Software e) PC 's latest O.S f) Documentation Software. g) Any other essential software to make the system functional as per specification.	Lot
19.	Identification of Existing Field cables in Control room, De-glanding the same and Glanding to New Cabinets, Including Ferruling and Termination as per new Engineering.	Lot
20.	Laying of Power and Signal cables for Inter-panel wiring including cable supply. Supply and laying of power cable as per load requirement from UPS room to control room (Distance approx 100 meters)	Lot

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21.	Detailed Engineering service including generation of, DCS Engineering, Functional logic diagram and Project Engineering services etc	Lot
22.	Erection Installation and Commissioning of Complete system after removal of all the existing cabinets' termination, Loop checking and Handing over the system in totality to BPCL.	Lot
23.	Training as per Tender	Lot
24.	Factory Acceptance Test	Lot
25.	Site Acceptance Test	Lot
26.	Complete as built Documentation like Manuals, Engineering documents like i/o allocation, Loop wiring drawing etc	Lot
29	Furniture project needs/specification.	Lot

Note:

1. 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.
2. For Sr.13, 14 and 15 the furniture shall be mutually decided after discussing available options and suitability conditions etc.

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Annexure - IV

Tentative Bill of Material- PLC (Total 4-nos)

S/N	Description	UOM
1.	Removal of Existing General Purpose PLC along with complete Cabinets, BMS Plaque Panel, PDB, Relays and accessories etc. for detailed list refer Annexure VI	Lot
2.	Supply of Redundant PLC Rack, CPU, Communications Modules etc. as per project requirement.	4 set
3.	Supply of Redundant I/O modules (AI,DI,DO) as per I/O count listed in annexure VII.	Lot
4.	Supply of System cabinets (2200mmHx1200mmWx1200mmD) with transparent hardened plastic door along with all the required accessories.	4 set
5.	Supply of PDB cabinet (2200mmHx1200mmWx1200mmD) with Voltmeter, Ammeter, MCBs, Bus Bar with inter-panel wiring and termination etc. as per project requirement.	Lot
6.	Supply of Marshalling and Relay Cabinets with all the accessories like Relays/barriers etc mounted. (2200mmHx1200mmWx1200mmD) as per project requirement.	Lot
7.	Supply of BMS Plaque panel along with PBS, Selector switches, Feedback lamps and terminal blocks including inter-panel wiring etc	3 set
8.	Supply of Relays For DI/DO and For AI- Barriers, Converters and Signal repeaters etc including Signal Conditioning , wiring etc as per project requirement	Lot
9.	Supply of Field Termination Assembly for AI,DI and DO Modules as per project requirement	Lot
10.	Supply of System cables, Prefab cables, Communication cables etc required for complete Integrity of the System	Lot
11.	Supply of Redundant Bulk Power supply Unit(110VAC/24VDc)	Lot
12.	Supply of Engineering Station for PLC with Latest model and Latest O.S with 21" TFT Monitor etc along with printer necessary furniture (table and chair) mounted with necessary	2 sets

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	receptacles.	
13.	Supply of SOE Station for PLC with Latest model and Latest O.S with 21" TFT Monitor etc along with printer necessary furniture (table and chair) mounted with necessary receptacles.	2 set
14.	Supply of Latest Version Software a) System Software b) Application Software c) Communication Software d) SOE Software e) PC 's latest O.S f) Documentation Software. g) Any other essential software for system functionality as per project specification.	Lot
15.	Identification of Existing Field cables in Control room, De-glanding the same and Glanding to New Cabinets, Including Ferruling and Termination as per new Engineering	Lot
16.	Laying of Power and Signal cables for Inter-panel wiring including cable supply. Supply and laying of power cable as per load requirement from UPS room to control room (Distance approx 100 meters)	Lot
17.	Detailed Engineering service including generation of Functional Logic Diagrams, PLC Engineering and Project Engineering services etc	Lot
18.	Erection Installation and Commissioning of Complete system after removal of all the existing cabinets, termination, Loop checking and Handing over the system in totality to BPCL.	Lot
19.	Establishing Communication with existing DCS with required Hardware and Software etc.	
20.	Training as per Tender	Lot
21.	Factory Acceptance Test	Lot
22.	Site Acceptance Test	Lot
23.	Complete as built Documentation like Manuals, Engineering documents like i/o allocation, Loop wiring drawing etc (Soft +hard copy)	Lot

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24	Furniture	Lot
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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.

ANNEXURE V

List of Component to be removed for DCS			
SI No.	Item	Designation	Quantity
1	DCS and I/O cabinets	Cabinets with Cards and Terminals etc	6 set
2	Relay Cabinets	Cabinets along with all the Relays Terminals etc	2 set
3	Power Distribution Cabinets	Cabinet along with MCBs and Terminals etc	2 set
4	SER cabinet	Cabinets with Cards and Terminals etc	1 set
5	SKYD	Cabinets with Cards and Terminals etc	1 set
6	Process operators Console	Cabinets with Cards and Terminals etc	4 set
7	Hardware console	Cabinets with Cards and Terminals etc	3 sets
8	Engineering PC	Cabinets with Cards and Terminals etc	1 set
9	Omron relay with base	For BOP DCS and PLC	525
10	TB16 card	BOP digital i/p card	34
11	Bus bar	110 V dc and 24 Vdc	12
12	MCB	PDB and other Cabinets	80
13	Terminal strips		1300
14	SER unit	SER system	1 set
15	Bulk power supply	For system cabinets	5
16	SKYD	Alarm setter unit	48
17	TE08	Digital o/p	6
18	PS33	Processor power supply	8
19	Processor rack cards	FCS processor rack cards	28
20	PS31	I/O rack power supply card	50

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21	I/o cards	Open, close, digital and serial interface	170
22	PS40	Signal condition power supply	8
23	EX1/EA2	Signal conditioning unit	35 set
24	Barriers	Open loop/temp/close loop	570
25	Printer	Alarm, log, hard copy and engg	4
26	Recorder		2 sets
27	SLPC	BOP loops	10
28	Prefab cable		200

Note: The above list is indicative only; However the actual items/list/quantity shall be as per actual site condition.

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ANNEXURE VI

List of Component to be removed for PLC			
SI No.	Item	Designation	Quantity
1.	PLC and I/O cabinets	Cabinets with Cards and Terminals etc	7 set
2.	Relay Cabinets	Cabinets along with all the Relays Terminals etc	5 set
3.	Power Distribution Cabinets	Cabinet along with MCBs and Terminals etc	
4	Power Supply	A1PS, A2PS, A6PS, A7PS	16 pc
		A3PS to A4PS	8 pc
5	CPU	U84-224	8 pc
	Power Supply	P8101	12 pc
	Power Supply	P8054	16 pc
	Switch Module	C8150	4 pc
	Comm. Module	C8110	4 pc
	Aux Comm. module		4 pc
	Remote I/O driver	C8130	4 pc
	local I/O Receiver	C8125	8 pc
	I/O Buffer	B1010	8 pc
	Mount Base	A1BP	4 pc
	Mount Base	A2BP	4 pc
	Mount Base	2A1BP, 3A1BP	8 pc
	Mount Base	2A2BP, 3A2BP, 2A4BP, 3A4BP	16 pc
	Mount Base	2A3BP, 3A3BP	8 pc
	I/P Module	B1057A	155 pc
	O/P module	B1056A	100 pc
	Cable	W1013-1	8 set
	Cable	W1014-2	8 set
	Cable	W1011-2	8 set

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	Cable	W-1022	24 set
	Cable	W1017-T01	8 set
	Cable	WE02-15	8 set
	Cable	WE17-15	8 set
	Cable	WE14	4 set
	Modem	J1078	16 pc
6	Bus bar	BB1, BB3, BB5, BB7, BB9	20 set
		BB2, BB4, BB6, BB8, BB10	20 set
7	Illumination lamp	E11-E13	24 pc
8	Fuse	F1, F2	8 pc
		F3	4 pc
		F4, F5	8 pc
9	Lamps	H1 to H7	28 pc
10	Contactor	K111	4 pc
11	Switch Toggle	Q1, Q2	8 pc
12	MCB	Q3	4 pc
		Q4	8 pc
		Q5	8 pc
		Q6	8 pc
		Q7	8 pc
		Q8	8 pc
		Q9	8 pc
		Q10	8 pc
13	O/E/N Relay Board	RD1-RD30	120 set
14	Socket Switch	S30	8 pc
15	Door limit Switch	S50 to S52	12 pc
16	Transformer	T1	4 pc
		T2, T3	8 pc
17	Cable		800 set
18	Terminals	X1 to X4	4pc
19	Double Terminal Deck		1500 pc
20	Switch Toggle	S1, S2	8 pc
21	BMS Plaque panel	Complete BMS Plaque Panel along with its wiring, Selector switches and pushbuttons, bulbs etc.	3-set
22	Annunciator	IIC make Annunciator 5x4 window	3-set

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BOILER HOUSE DCS AND PLC SPECIFICATIONS

Note: The above list is indicative only, however the actual items/list/quantity shall be as per actual site condition.

ANNEXURE VII

I/O COUNT FOR DCS AND PLC

DCS I/O COUNTS - PER BOILER

TYPES	QTY/BOLIER	20% SPARE	TOTAL QTY/BOILER	TOTAL COUNTS FOR THREE BOILERS
AI	100	20	120	360
AO	35	7	42	126
DI	40	8	48	144
DO	16	4	20	60

DCS I/O COUNTS - BOP

TYPES	QTY	20% SPARE	TOTAL COUNTS
AI	214	43	257
AO	36	9	45
DI	180	36	216
DO	16	4	20

PLC I/O COUNTS - PER BOILER.

TYPES	QTY	20% SPARES	TOTAL QTY/BOILER
AI	20	4	24
DI	285	57	342
DO	175	35	210

PLC I/O COUNTS - BOP

TYPES	QTY	20% SPARES	TOTAL QTY/BOILER
DI	125	25	150
DO	48	10	58

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BOILER HOUSE DCS AND PLC SPECIFICATIONS

Note: 1. Control Station shall be segregated boiler wise i.e. three control stations for three boilers and one separate Control station shall be for BOP.

2. PLC shall be separate for each Boiler i.e. three PLC for three boilers and one separate PLC shall be for BOP.

Annexure VIII

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

- 1. Cable/Junction Box Schedule**
- 2. Functional Logic Schematics**
- 3. Back up of existing Ladder Logics**
- 4. Existing Panel/Relay Arrangement Drawing**
- 5. Back up of DCS system/application software.**
- 6. Loop drawing of DCS and PLC.**
- 7. Existing Control room layout.**

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BOILER HOUSE DCS AND PLC SPECIFICATIONS

Annexure IX

Control room layout drawing

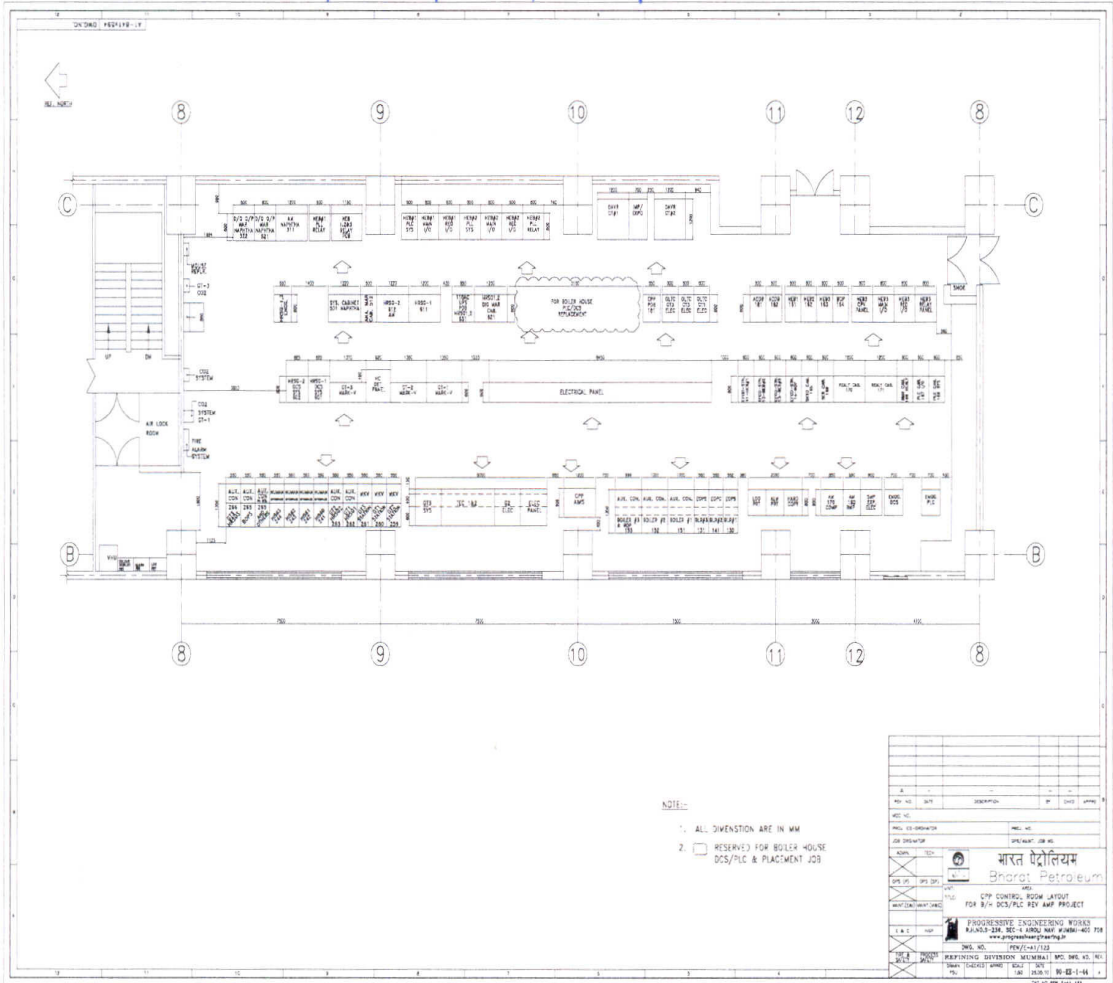
Softcopy/Hardcopy shall be provided on request.

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BOILER HOUSE DCS AND PLC SPECIFICATIONS

ANNEXURE - IX
CONTROL ROOM LAYOUT.

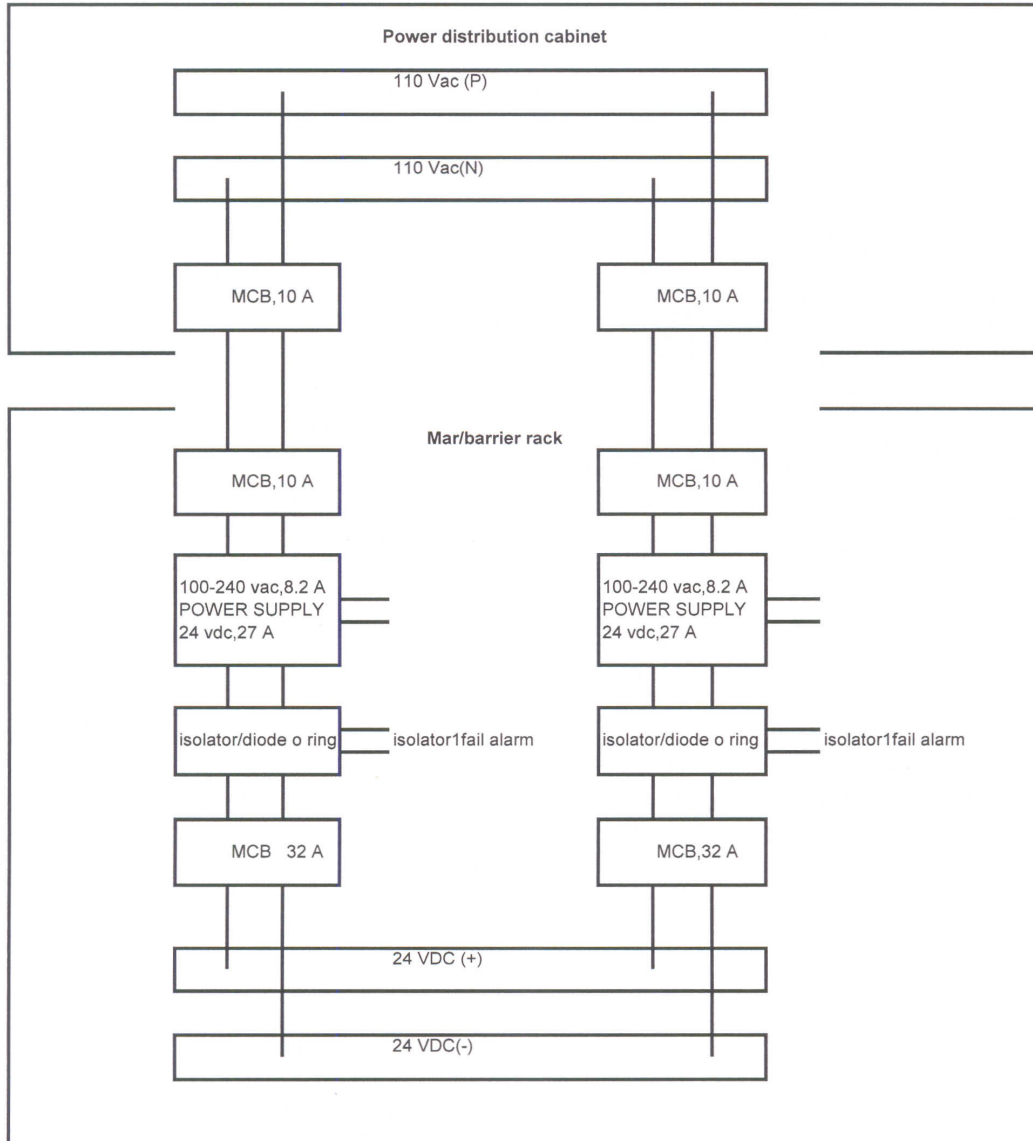


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BOILER HOUSE DCS AND PLC SPECIFICATIONS

Annexure - X



Note:

The above scheme of 24VDC power supply distribution dwg is only for reference / guidance. However actual rating of MCB and wiring shall be as per project requirement

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(To be executed on plain paper and applicable for all tenders of value above Rs. 1 crore)

INTEGRITY PACT

Between

Bharat Petroleum Corporation Limited (BPCL) hereinafter referred to as "The Principal",

And

.....hereinafter referred to as "The Bidder/Contractor/Supplier"

Preamble

The Principal intends to award, under laid down organization procedures, contract/s forThe Principal values full compliance with all relevant laws and regulations, and the principles of economic use of resources, and of fairness and transparency in its relations with its Bidder/s, Contractor/s and Supplier/s.

In order to achieve these goals, the Principal cooperates with the renowned international Non-Governmental Organisation "Transparency International" (TI). Following TI's national and international experience, the Principal will appoint an Independent External Monitor who will monitor the tender process and the execution of the contract for compliance with the principles mentioned above.

Section 1 - Commitments of the Principal

- (1) The Principal commits itself to take all measures necessary to prevent corruption and to observe the following principles:
 - a) No employee of the Principal, personally or through family members, will in connection with the tender, or the execution of the contract, demand, take a promise for or accept, for himself/herself or third person, any material or immaterial benefit which he/she is not legally entitled to.
 - b) The Principal will, during the tender process, treat all Bidders with equity and reason. The Principal will, in particular, before and during the tender process, provide to all Bidders the same information and will not provide to any Bidder confidential / additional information through which the Bidder could obtain an advantage in relation to the tender process or the contract execution.

- c) The Principal will exclude from the process all known prejudiced persons.
- (2) If the Principal obtains information on the conduct of any of its employees which is a criminal offence under the relevant Anti-Corruption Laws of India, or if there be a substantive suspicion in this regard, the Principal will inform its Vigilance Office and in addition can initiate disciplinary actions.

Section 2 - Commitments of the Bidder / Contractor/Supplier

- (1) The Bidder / Contractor/Supplier commits itself to take all measures necessary to prevent corruption. He commits himself to observe the following principles during his participation in the tender process and during the contract execution.
- a) The Bidder / Contractor/Supplier will not, directly or through any other person or firm, offer, promise or give to any of the Principal's employees involved in the tender process or the execution of the contract or to any third person, any material or immaterial benefit which he/she is not legally entitled to, in order to obtain in exchange, any advantage of any kind whatsoever during the tender process or during the execution of the contract.
 - b) The Bidder / Contractor/Supplier will not enter with other Bidders into any undisclosed agreement or understanding, whether formal or informal. This applies in particular to prices, specifications, certifications, subsidiary contracts, submission or non-submission of bids or any other actions to restrict competitiveness or to introduce cartelisation in the bidding process.
 - c) The Bidder / Contractor/Supplier will not commit any offence under the relevant Anti-Corruption Laws of India; further the Bidder / Contractor/Supplier will not use improperly, for purposes of competition or personal gain, or pass on to others, any information or document provided by the Principal as part of the business relationship, regarding plans, technical proposals and business details, including information contained or transmitted electronically.
 - d) The Bidder / Contractor/Supplier will, when presenting his bid, disclose any and all payments he has made, is committed to, or intends to make to agents, brokers or any other intermediaries in connection with the award of the contract.
- (2) The Bidder / Contractor/Supplier will not instigate third persons to commit offences outlined above or be an accessory to such offences.

Section 3 - Disqualification from tender process and exclusion from future contracts

If the Bidder, before contract award, has committed a transgression through a violation of Section 2 or in any other form such as to put his reliability or credibility as Bidder into question, the Principal is entitled to disqualify the Bidder from the tender process or to terminate the contract, if already signed, for such reason.

- (1) If the Bidder/Contractor/Supplier has committed a transgression through a violation of Section 2 such as to put his reliability or credibility into question, the Principal is also entitled to exclude the Bidder / Contractor/Supplier from future contract award processes. The imposition and duration of the exclusion will be determined by the severity of the transgression. The severity will be determined by the circumstances of the case, in particular the number of transgressions, the position of the transgressors within the company hierarchy of the Bidder and the amount of the damage. The exclusion will be imposed for a minimum of 6 months and maximum of 3 years.
- (2) A transgression is considered to have occurred if the Principal after due consideration of the available evidences, concludes that no reasonable doubt is possible.
- (3) The Bidder accepts and undertakes to respect and uphold the Principal's absolute right to resort to and impose such exclusion and further accepts and undertakes not to challenge or question such exclusion on any ground, including the lack of any hearing before the decision to resort to such exclusion is taken. This undertaking is given freely and after obtaining independent legal advice.
- (4) If the Bidder / Contractor/Supplier can prove that he has restored / recouped the damage caused by him and has installed a suitable corruption prevention system, the Principal may revoke the exclusion prematurely.

Section 4 - Compensation for Damages

- (1) If the Principal has disqualified the Bidder from the tender process prior to the award according to Section 3, the Principal is entitled to demand and recover from the Bidder liquidated damages equivalent to Earnest Money Deposit/Bid Security.
- (2) If the Principal has terminated the contract according to Section 3, or if the Principal is entitled to terminate the contract according to Section 3, the Principal shall be entitled to demand and recover from the Contractor/Supplier liquidated damages equivalent to Security Deposit / Performance Bank Guarantee.

- (3) The Bidder agrees and undertakes to pay the said amounts without protest or demur subject only to condition that if the Bidder / Contractor/Supplier can prove and establish that the exclusion of the Bidder from the tender process or the termination of the contract after the contract award has caused no damage or less damage than the amount of the liquidated damages, the Bidder / Contractor/Supplier shall compensate the Principal only to the extent of the damage in the amount proved.

Section 5 - Previous Transgression

- (1) The Bidder declares that no previous transgression occurred in the last 3 years with any other Company in any country conforming to the TI approach or with any other Public Sector Enterprise in India that could justify his exclusion from the tender process.
- (2) If the Bidder makes incorrect statement on this subject, he can be disqualified from the tender process or the contract, if already awarded, can be terminated for such reason.

Section 6 - Equal treatment of all Bidders / Contractors /Suppliers/ Subcontractors

- (1) The Bidder/Contractor/Supplier undertakes to demand from all subcontractors a commitment in conformity with this Integrity Pact, and to submit it to the Principal before contract signing.
- (2) The Principal will enter into agreements with identical conditions as this one with all Bidders, Contractors/Suppliers and Subcontractors.
- (3) The Principal will disqualify from the tender process all Bidders who do not sign this Pact or violate its provisions.

Section 7 – Punitive Action against violating Bidders / Contractors / Suppliers/Subcontractors

If the Principal obtains knowledge of conduct of a Bidder, Contractor, Supplier or Subcontractor, or of an employee or a representative or an associate of a Bidder, Contractor, Supplier or Subcontractor which constitutes corruption, or if the Principal has substantive suspicion in this regard, the Principal will inform the Vigilance Office.

Section 8 - Independent External Monitors

- (1) The Principal has appointed competent and credible Independent External Monitors for this Pact. The task of the Monitor is to review independently and objectively, whether and to what extent the parties comply with the obligations under this agreement.
- (2) The Monitor is not subject to instructions by the representatives of the parties and performs his functions neutrally and independently. He reports to the Chairperson of the Board of the Principal.
- (3) The Bidder/Contractor/Supplier accepts that the Monitor has the right to access without restriction to all Project documentation of the Principal including that provided by the Bidder/Contractor/Supplier. The Bidder/Contractor/Supplier will also grant the Monitor, upon his request and demonstration of a valid interest, unrestricted and unconditional access to this project documentation. The same is applicable to Subcontractors. The Monitor is under contractual obligation to treat the information and documents of the Bidder/Contractor/Supplier/Subcontractor with confidentiality.
- (4) The Principal will provide to the Monitor sufficient information about all meetings among the parties related to the Project provided such meetings could have an impact on the contractual relations between the Principal and the Bidder/Contractor/Supplier. The parties offer to the Monitor the option to participate in such meetings.
- (5) As soon as the Monitor notices, or believes to notice, a violation of this agreement, he will so inform the Management of the Principal and request the Management to discontinue or heal the violation, or to take other relevant action. The Monitor can in this regard submit non-binding recommendation. Beyond this, the Monitor has no right to demand from the parties that they act in a specific manner, refrain from action or tolerate action. However, the Independent External Monitor shall give an opportunity to the Bidder/Contractor/Supplier to present its case before making its recommendations to the Principal.
- (6) The Monitor will submit a written report to the Chairperson of the Board of the Principal within 8 to 10 weeks from the date of reference or intimation to him by the 'Principal' and, should the occasion arise, submit proposals for correcting problematic situations.
- (7) If the Monitor has reported to the Chairperson of the Board a substantiated suspicion of an offence under relevant Anti-Corruption Laws of India, and the Chairperson has not, within reasonable time, taken visible action to proceed against such offence or reported it to the Vigilance Office, the Monitor may also transmit this information directly to the Central Vigilance Commissioner, Government of India.
- (8) The word 'Monitor' would include both singular and plural.

Section 9 - Pact Duration

This Pact begins when both parties have legally signed it. It expires for the Contractor/Supplier 12 months after the last payment under the respective contract, and for all other Bidders 6 months after the contract has been awarded.

If any claim is made / lodged during this time, the same shall be binding and continue to be valid despite the lapse of this pact as specified above, unless it is discharged / determined by Chairperson of the Principal.

Section 10 - Other provisions

- (1) This agreement is subject to Indian Law. Place of performance and jurisdiction is the Registered Office of the Principal, i.e. Mumbai. The Arbitration clause provided in the main tender document / contract shall not be applicable for any issue / dispute arising under Integrity Pact.
- (2) Changes and supplements as well as termination notices need to be made in writing. Side agreements have not been made.
- (3) If the Bidder/Contractor/Supplier is a partnership or a consortium, this agreement must be signed by all partners or consortium members.
- (4) Should one or several provisions of this agreement turn out to be invalid, the remainder of this agreement remains valid. In this case, the parties will strive to come to an agreement to their original intentions.

.....
For the Principal

.....
For the Bidder/Contractor/
Supplier

Place

Witness 1 :
(Signature/Name/Address)

Date

Witness 2 :
(Signature/Name/Address)