طرح نگهداشت و افزایش تولید ۲۷ مخزن

SPECIFICATION FOR ESD SYSTEM

نگهداشت و افزایش تولید میدان نفتی بینک

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REVISION RECORD SHEET

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1.0 INTRODUCTION

Binak oilfield in Bushehr province is a part of the southern oilfields of Iran, is located 20 km northwest of Genaveh city.

With the aim of increasing production of oil from Binak oilfield, an EPC/EPD Project has been defined by NIOC/NISOC and awarded to Petro Iran Development Company (PEDCO). Also PEDCO (as General Contractor) has assigned the EPC-packages of the Project to "Hirgan Energy - Design and Inspection" JV.

GENERAL DEFINITION

The following terms shall be used in this document.

CLIENT:	National Iranian South Oilfields Company (NISOC)
PROJECT:	Binak Oilfield Development – General Facilities
GENERAL CONTRACTOR (GC):	Petro Iran Development Company (PEDCO)
EPC CONTRACTOR:	Joint Venture of : Hirgan Energy – Design & Inspection(D&I) Companies
VENDOR:	The firm or person who will fabricate the equipment or material.
EXECUTOR:	Executor is the party which carries out all or part of construction and/or commissioning for the project.
THIRD PARTY INSPECTOR (TPI):	The firm appointed by EPD/EPC CONTRACTOR (GC) and approved by CLIENT (in writing) for the inspection of goods.
SHALL:	Is used where a provision is mandatory.
SHOULD:	Is used where a provision is advisory only.
WILL:	Is normally used in connection with the action by CLIENT rather than by an EPC/EPD CONTRACTOR, supplier or VENDOR.
MAY:	Is used where a provision is completely discretionary.

2.0 SCOPE

This document covers the minimum requirements for the Emergency Shutdown System dedicated to new trains of Binak Compressor station and extension of manifold in Binak Cluster. New ESD system (PLC-Based, SIL 3) which has interfaces with other new/existing systems .For pipeline work package, considering that the new devices at siahmakan GIS will be connected to the new relay based devices located on the existing panel (only one ESD valve witch shall be connected to

new added relays/push button/lamps), so existing devices specification shall be followed and SIL 3 for relays of ESD shall be considered.

This specification so intends to cover the minimum requirements for:

- The designing,
- Supplying,
- The Manufacturing,
- The Integrating
- Configuration
- The Factory and Site tests,
- The inspections of the Emergency Shutdown (ESD) system.

All systems and components, as far as mechanical and electrical characteristics and performances are concerned, shall conform to the present general Specification.

Any deviation from the present specification at any stage of the project shall be subject to CLIENT's approval.

This specification defines the main principles to be considered for the design and the implementation of the control & safety instrument systems for monitoring, control and safety of project.

3.0 NORMATIVE REFERENCES

3.1 LOCAL CODES AND STANDARDS

- IPS-C-IN-100 Construction and Inspection Standard for General Instrument Field Inspection, Calibration and Testing Of Instrument and Instrument System
- IPS-C-IN-190 Installation and Construction Standard for Transmission Systems
- IPS-E-IN-180 Engineering Standard for Instrument Electrical Power Supply and Distribution Systems
- IPS-E-IN-190 Engineering Standard for Transmission Systems
- IPS-G-IN-220 Engineering and Installation Standard for Control Centres
- IPS-G-IN-250 Engineering & Construction Standard for Distributed Control System (DCS)
- IPS-G-IN-260 Engineering and Installation Standard for Indicating Lights, Alarms and Protective Systems
- IPS-G-IN-290 Engineering and Construction Standard for

Programmable Logic Controllers (PLC)

- IPS-M-IN-190 Material and Equipment Standard for Transmission Systems
- IPS-M-IN-220 Material Standard for Control Panels and System Cabinets
- IPS-M-IN-250 Materials and Equipment Standard for Distributed Control System (DCS)
- IPS-M-IN-260 Material and Equipment Standard for Alarm and Protective Systems
- IPS-M-IN-290 Material and Equipment Standard for Programmable Logic Controllers (PLC)
- IPS-I-IN-100 Inspection Standard for General Instrument Systems

3.2 INTERNATIONAL CODES AND STANDARDS

BS

- BS 4683 Electrical apparatus for explosive atmospheres
- BS 5345 Code of practice for the selection, installation and maintenance of Electrical apparatus for use in potentially explosive atmospheres.
- BS 4590 Determination of the volume percentage of open cells and of closed cells
- BS 5501 Electrical Equipment for Potentially Explosive Atmospheres
- BS 5750 The Quality Systems
- BS 5887 Code of practice for testing of computer-based systems
- BS 9000 General requirements for a system for electronic components of assessed quality

EN

- EN 50014 Electrical apparatus for potentially explosive atmospheres - Flameproof enclosure 'd'
- EN 50020 Electrical apparatus for potentially explosive atmospheres Intrinsic safety 'i'.
- EN 50081-2 Electromagnetic compatibility (EMC)
- EN 50082-2 Electromagnetic compatibility. Generic immunity standard

IEC

- IEC 60068/2 — Basic Environmental Testing Procedures for Electronic Components and Electronic Equipment
- IEC 60073 — Basic & safety principles for Human Machine Interface
- IEC 60079 — Electrical apparatus for explosive gas atmospheres
- IEC 60092-375 — General Instrument, control and communication cables
- IEC 60332 — Tests on electric cables under fire condition
- IEC 60529 — Degrees of protection provided by enclosures (IP Code)
- IEC 60605 — Equipment Reliability Testing
- IEC 60794 — Optical fibre cables
- IEC 60801 — Electromagnetic Compatibility for Industrial Process Measurement and Control Equipment
- IEC 61000 — Electromagnetic compatibility for Industrial process measurement and control equipment
- IEC 61131 — Programmable controllers
- IEC 61508 — Functional safety of electrical/electronic/programmable electronic safety related systems.
- IEC 61511 — Safety Instrumented systems for the process Industry

IEEE

- IEEE 472 — Surge Protection Criteria
- IEEE 802.1~6 — Local Area Network
- IEEE C62 — Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits

ISA

- ISA S 5.1 — Instrument symbols and Identifications
- ISA S5.2 — Binary logic diagrams for process operations
- ISA S5.3 — Graphic symbols for distributed control/shared display Instrumentation, logic and computer system
- ISA S5.4 — Instrument loop diagrams
- ISA S5.5 — Graphic symbols for process displays
- ISA S 18.1 — Annunciator sequences and specification

VDE

- VDE 0100 — Instrument symbols and Identifications
- VDE 0165 — Explosive atmospheres

Vendor shall state the additional Codes and Standards if necessary. The latest published issue or amendment shall apply unless otherwise stated.

3.3 REFERENCE DOCUMENTS

- BK-GENRL-PEDCO-000-PR-BD-0001 Process Basis of Design
- BK- GENRL-PEDCO-000-IN-SP-0001 Specification For Instrumentation
- BK- GENRL-PEDCO-000-IN-SP-0002 Specification For Control system
- BK- GENRL-PEDCO-000-IN-SP-0012 Specification For F&G System
- BK- GENRL-PEDCO-000-SA-SP-0002 Spec. For Hazardous Area Classification
- BK- PPL-PEDCO-320-IN-BD-0001 Block Diagram Config. For Control/ESD/F&G Sys.
- BK- GCS-PEDCO-120-IN-BD-0001 Control/ESD/F&G Sys. Block Diagram Config.
- BK- W007S-PEDCO-110-IN-BD-0001 Block Diagram Config. For Control/ESD/F&G Sys. - Extension of Binak B/C Manifold.
- BK-SSGRL-PEDCO-110-IN-DC-0002 Instrument & Control System Design Criteria
- BK-PPL-PEDCO-320-IN-DC-0001 Instrument & Control System Design Criteria
- BK-GCS-PEDCO-120-IN-DC-0002 Instrument & Control System Design Criteria
- BK-SSGRL-PEDCO-110-PR-PH-0005 ESD Philosophy
- BK-00-HD-000-IN-SP-0011-D00 Specification For Control Panels

Note: This document shall be used in conjunction P&IDs and PFDs of each work packages of the Project.

3.4 ENVIRONMENTAL DATA

Refer to "Process Basis of Design; Doc. No. BK- GENRL-PEDCO-000-PR-BD-0001"

4.0 ABBREVIATIONS

API	:	American Petroleum Institute
AFC	:	Approved For Construction
AFD	:	Approved For Design
AC	:	Alternative Current
BASEEFA	:	British Approvals Service for Electrical Equipment for Flammable Atmospheres
B/W	:	Black/White
CCR	:	Central Control Room
CD	:	Compact Disc
CPU	:	Central Processing Unit
CMS	:	Custody Metering System
CR	:	Control Room
CRC	:	Cyclic Redundancy Check

CSA	:	Canadian Standards Association
˚C	:	Centigrade Degree
D/A	:	Digital/Analog
DC	:	Direct Current
DCS	:	Distributed Control System
DIN	:	Deutsches Institut für Normung (Standards organization)
EDP	:	Emergency Depressurization
EMC	:	Electromagnetic Compatibility
EMI	:	Electromagnetic Interference
EPROM	:	Erasable Programmable Read-only Memory
ER	:	Electrical Room
ESD	:	Emergency Shut Down System
ESDV	:	Emergency Shut Down Valve
EWS	:	Engineer Work Station
FAT	:	Factory Acceptance Test
FDS	:	Functional Design Specification
F&G	:	Fire and Gas
FGS	:	Fire and Gas System
HART	:	Highway Accessible Remote Transducer
HMI	:	Human Machine Interface
HVAC	:	Heating, Ventilation, Air Conditioning
I/O	:	Input / Output
IEC	:	International Electro technical Commission
ICIE	:	ICIE International Conference Innovation in Engineering
IS	:	Intrinsically Safe
IP	:	Ingress Protection
IPCS	:	Integrated Process Control System
IPS	:	Iranian Petroleum Standard
ITR	:	Instrument Technical Room
JIS	:	Japanese Industrial Standards
KV	:	Sequence On/Off Valve
LCD	:	Liquid Crystal Display
LED	:	Light-Emitting Diode monitor
LV	:	Low Voltage
Mbit/Sec	:	Mega Byte per Second
MCB	:	Miniature Circuit Breaker
MCC	:	Motor Control Center
Min.	:	Minimum
MMI	:	Man Machine Interface
MMS	:	Machine Monitoring System
MOS	:	Maintenance Override Switch
MTTR	:	Mean Time To Repair
MTU	:	Master Terminal Unit
MV	:	Medium Voltage
NIS	:	Non Intrinsically Safe
NISOC	:	National Iranian South Oil Company
OCD	:	Operator Control Desk
OCS	:	Operator Control Station

OLE	:	Object Linking & Embedding
OPC	:	OLE for Process Control
OWS	:	Operator Work Station
PB	:	Push Button
PC	:	Personal Computer
PCS	:	Process Control System
PDP	:	Power Distribution Panel
PID	:	Proportional–Integral–Derivative Controller
P&ID	:	Piping and Instrument Diagram
PLC	:	Programmable Logic Controller
PMS	:	Power Management System
POS	:	Process Override Switch
QA/QC	:	Quality Assurance/Quality Control
QMR	:	Quadruple Modular Redundant
RAM	:	Random-access memory
RFI	:	Radio Frequency Interference
RTU	:	Remote terminal Unit
SAT	:	Site Acceptance Test
SD	:	Shut Down
SDV	:	Shut Down Valve
SIL	:	Safety Integrated Level
SOE	:	Sequence of Event
SPDT	:	Single Pole Double throw
TMR	:	Triple Modular Redundant
UCP	:	Unit Control Panel
UPS	:	Uninterruptible Power Supply
VDU	:	Visual Display Unit

5.0 ORDER OF PRECEDENCE

In case of any conflict between the contents of this document or any discrepancy between this document and other project documents or reference standards, this issue must be reported to the CLIENT. The final decision in this situation will be made by CLIENT.

6.0 TECHNICAL REQUIREMENTS

6.1 GENERAL

6.1.1 Environmental Condition

For detail of site condition refer to “Process Basis of Design” Doc. No. “BK-GNRAL-PEDCO-000-PR-BD-0001”

6.1.1.1 Normal Conditions

CCR and ITRs will be equipped with HVAC system. The HVAC system shall be designed to obtain:

- A temperature inside the rooms between 22°C and 27°C
- A relative humidity maintained within a range of 30 % to 60%

The VENDOR shall state, for all equipment supplied, the heat dissipation to be taken into account for the HVAC design.

6.1.1.2 Tropical service

All instruments shall be suitable to utilize in tropical condition and must completely meet and comply with the environmental conditions of the site. In tropical condition all printed circuit cards shall be protected against corrosion and humidity by means of appropriate varnish coating and gold plated contacts on connectors (even for those located within control and technical rooms).

6.1.1.3 Abnormal Conditions

VENDOR shall state the temperature and relative humidity limits of the equipment supplied in operating conditions and storage.

6.1.2 Ingress Protection

Instrument and Panel enclosure's "degree of protection" shall be in accordance with IEC 60529. For enclosures containing electronic components or coils (solenoid valves) the minimum degree of protection shall be IP 65. Large size outdoor local panels, for which IP 65 may not be applicable, shall be pressurized. Minimum ingress protection for all indoor panels shall be IP 54.

Instruments & Junction boxes located in areas subject to deluge shall be IP66.

6.1.3 Interference Protection

The Control System equipment shall guarantee an EMC for an electromagnetic environmental of level 2 as per the IEC61000-4-3 and IEC61000 4-4.

All instruments and microprocessor based system shall meet the following Radio Frequency Immunity (RFI) requirements that shall be tested at the acceptance test stage. Basic reference standard is IEC 60801 (part 3) for design and manufacturing considerations.

6.1.4 Hazardous Protection

Gas group and ignition level (temp class) will be in accordance with area classification according to IEC and CENELEC.

Classification of hazardous area shall be defined in accordance with API 500 & 505, while zone definition shall be based on IEC 60079.

All electrical or electronic instrumentation equipment shall conform to electrical area classifications. The type of protection for electrical or electronic instruments or devices for use in hazardous area shall be as follows:

Equipment	Zone 0	Zone 1	Zone 2
General Instruments	EEx ia	EEx i	EEx i
Thermocouples/RTD	EEx ia	EEx i	EEx i
Switches	EEx d	EEx d	EEx d
Valve Positioners	EEx ia	EEx i	EEx i
Lamps	Shall not install	EEx d or EEx e	EEx d or EEx e
Solenoid Valves	EEx d	EEx d	EEx d
Local Panels	Shall not install	EEx d or EEx p	EEx d or EEx p
Junction Boxes	Shall not install	EEx d or EEx e	EEx d or EEx e
Level Gauge Illuminator	EEx d	EEx d	EEx d
F&G Devices	EEx d	EEx d	EEx d

In case EExi apparatus is not available in the manufacturer's standard products, type EExd can be selected as an alternative for Zone 1 and 2 installations.

Industrial type non classified instruments could be utilized in non-hazardous safe area.

All electrical apparatus in hazardous area shall be certified to CENELEC for the European countries or the recognized authority in the manufacturer country i.e.:

PTB : For Germany
BASEEFA : For England
LCIE : For France
CESI : For Italy
CSA : For Canada
INIEX : For Belgium
F.M. : For USA
U.L. : For USA
J.I.S. : For Japan

6.1.5 Language

All documents and drawings produced by vendor to satisfy the requirements of this specification shall be in English language. Operating, maintenance and commissioning manual shall also be prepared in English language.

6.2 SCOPE OF WORK/SUPPLY

The VENDOR shall be responsible for supply of the following, in accordance with the criteria defined within this specification for Binak GCS and Manifold area(ESD in Siahmakan GIS will be limited to on push button in existing panel door and related SIL 3 relay so below devices are excluded for pipe line work pack) :

- All system hardware, including I/O modules, processor units, power supplies, system racks and system cables, work station, safety Panel, Printers as defined by this specification.
- ESD Console:
  - ESD Console (only for Gas Compressor Station (GCS)) which include(s) the shutdown & Reset Pushbuttons and switches. The ESD Console is located in the Control Room (CR) of the Control Building.
- Operator Workstations : (only **For Manifold**)

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  - For manifold, One Industrial PC with the latest technology along with one 32" LED/LCD monitors & industrial keyboard and mouse common for ESD and DCS (with separate operating software for ESD and DCS) will be considered resides the Control Room (CR) of the Control Building so this equipment are out of scope ESD VENDOR that shall be supplied by DCS VENDOR, only ESD monitoring/configuration software will be provided by ESD vendor.
- Engineering Workstations : (only **For Manifold**)
  - One Industrial PC with the latest technology along with one 32" LED/LCD monitors & industrial keyboard and mouse shall be considered for configuration purposes (for manifold area). All required hardware and software with licenses shall be included and provided by ESD vendor.
- Engineering / Operator Workstation : (only **For GCS**)
  - One Industrial PC with the latest technology along with one 32" LED/LCD monitors & industrial keyboard and mouse shall be considered for configuration & monitoring purposes (for GCS). All required hardware and software with licenses shall be included and provided by ESD vendor.
- Maintenance Workstations : (For **GCS and manifold)**

  (Semi-Rugged Laptop, with the up to date technology to be used in ITR of control building, IP54 at least, CPU: Core i5, RAM: 8GB, HDD: 1 TB, Display: 14 inch). Separated lap tops will be provided by ESD vendor in GCS and manifold work pack for maintenance purpose.
- Licenses for control & monitoring must be separate from operator & engineering

workstations & industrial computers. All of licenses shall be valid & original.

- All DC power supplies for the system cabinets, IS isolators (if any) and field I/O
- ESD System cabinets to house the required hardware, terminals, power supplies, ferrules, panel wiring
- ESD marshalling cabinets, including IS isolators (if any), terminals, power supplies, ferrules, panel wiring, and a suitable capacity circulation fan for cooling and thematically anti-condensation heater.
- All interconnection cables between the marshalling cabinets and system cabinets and all system internal power wiring cables. This excludes all field-cabling between the field devices and the marshalling cabinets and power cabling from site power supply to the Power Distribution Cabinet.
- Wiring, network connection and other accessories that is required for interfacing the ESD panel(s) and the ESD Workstation with the ESD system cabinet, as well as its interconnections with other systems as mentioned in section 6.12.
- ESD event/alarm printer (B/W A4 Laser)
- All cabling between PDP and other equipment supplied under this document.
- All software needed for installation, engineering, configuration, testing, documentation, etc., and firmware complete with licenses.
- System configuration
- Design, verification, FAT, SAT and SIT
- Provision of after sales services, including, but not limited to Commissioning, Training, Spares Special Tools.

The system shall be composed of manufacturer's standard hardware, system software and firmware that can be configured to meet the stated requirements. Equipment supplied as part of the system shall be the latest version currently available at the time of placement of order. All hardware, firmware and software supplied with the system, which has to be registered, shall have been field-proven with referenced applications on Plant.

Software design shall ensure that future revisions or updates of the system operating software will not affect the successful operating of the system.

Documents and parameters necessary for ESD design and configuration shall be prepared by CONTACTOR and approved by CLIENT. Therefore the VENDOR shall implement the ESD construction and configuration in accordance with the above.

6.2.1 Functional Design Specification (FDS)

The ESD systems shall be supplied in accordance with the Functional Design Specification (FDS), which will be developed by the VENDOR after award of Purchase Order. The

Functional Design Specification will be based on this specification, and approved by the CLIENT prior to start of procurement of materials.

The Functional Design Specification shall include as a minimum:

- Detailed planning network showing all hardware/software production and test facilities
- Complete Bill of Materials
- Interface details, including connections
- I/O allocation rules
- Configuration/programming details
- Graphic display details
- Performance calculations
- Availability/reliability analysis
- System constraints and limitations
- Electrical Load/Heat Release Calculations
- Physical dimensions of the cabinets and ESD console
- Details of the components within the scope of supply
- Details of the Operator Interfaces, and EWS/OWS

6.2.2 Sizing

The quantity of hardware and software necessary to safety monitor and control the plant shall be in accordance to the detail design developed by CONTACTOR and approved by CLIENT.

The base PCS I/O list for the PLANT is indicated in IO list documents.

6.2.3 Spare Capacity

6.2.3.1 Operator consoles and communication system

The ESD maintenance performance and memory capacities shall be adequate to allow an increase of 50% in the size of the configured database, without requiring additions, modifications or upgrading and without sacrificing the stated performance criteria.

The system supplied shall have a minimum installed spare capacity of 70% with regard to software and CPU load.

Similarly, the communication system shall be capable of handling the above specified expansion.

6.2.3.2 Controller, I/O Modules and Marshalling Cabinet

Total number of 25% installed spare per I/O type & Push Button for future use. These spares IO Channels shall be installed, wired to marshalling and terminated to terminals & barriers and ready to be used.

At least 25% spare capacity shall be available for ducting when all wiring is complete.

25% spare breakers and fuses shall be provided.

20% of spare space in cabinets shall be provided for future expansion.

Provided marshalling cabinets shall allow the connection all the installed field cables and shall include in addition 25% terminal spares without need to add marshalling cabinet.

The safety panel shall be provided with a minimum of 25% spare push buttons and light indicators and 10% space for future expansion. These spares IO Channels shall be installed, wired to marshalling and terminated to terminals & barriers and ready to be used.

6.2.3.3 Serial link

It shall be possible to add 25% points on each serial link without any hardware addition.

6.3 SYSTEM AVAILABILITY

The availability of the ESD system shall be greater than 99.99%. The system architecture shall be such that common cause failures are avoided to the highest possible degree.

Furthermore, no single failure in the system shall prevent safe operation of the trip outputs. Consequently, the ESD shall have complete built-in dual and redundant power supplies, and central buses, as well as central processing units. The dual CPU's shall perform active self-tests and complete system functional checks, including a CPU watchdog (hardware) and leave the system running in single channel, bus or CPU operation mode, if a fault is detected. The system shall be capable of on-line replacement of faulty modules through accurate diagnostic messages generated immediately upon fault detection, so that repair can be carried out without a shutdown. System failures shall start an audible alarm and be logged on the printer. The Trip Logic programs shall be stored in dual EPROM memory.

The system shall be designed for a MTTR (Mean Time to Repair) of less than 4 hour, for proof test interval of 12 month dependent upon CLIENT facilities and maintenance start conditions.

System modules shall be provided with LEDs for normal and fault indication.

The safety system shall be designed to allow hot on-line replacement of any failed component without any loss of system performance and plant safety level.

ESD system shall restart automatically after a power supply restoration without extensive time consuming for system rebooting procedures (Vendor to define maximum time) and without system qualified technician (to be performed by operator or maintenance technician).

All the system hardware and software shall be the latest proven types and versions.

6.4 SAFETY CLASSIFICATION

The system, i.e. CPU's and I/O modules shall function as part of the safety systems according to IEC 61508.

The ESD PLC shall be high available and have TUV approval for the SIL 3 class according to IEC 61508 or AK6 class according to DIN V 19250.

The I/O hardware cards, slots, and relays will be fail-safe type also ESD system shall be failsafe, fault tolerant & energize to trip.

The vendor shall submit calculations to prove the safety integrity level of the ESD system, MTTF calculations for the system, together with MTTF calculations for individual system components, i.e. CPU's, I/O modules, etc.

6.5 PANEL CONSTRUCTION

The cabinets will be freestanding rigid, self-supporting and floor lying. Generally they shall be constructed and assembled of modules with the following dimensions:

- For front/rear accessibility: W x D x H = 800 x 800 x 2100 mm
- For only front accessibility: W x D x H = 800 x 600 x 2100 mm

(Including the base frame of 100 mm)

The supporting structure and the front plate will be carefully reinforced in order to support instruments and devices mounted thereon, and in order to prevent buckling or distortion during shipment, handling or erection.

The cabinets will be provided with:

- key lock and handle (all doors will be provided with the same lock and key combination)
- fan for air circulation with filter (when heat dissipation is required);
- rubber gaskets;
- pocket for drawings.

The cabinets will be accomplished with:

- mounting frame for floor anchor;
- Eyebolts for lifting and transport.

- Gland plate with suitable hole size for cable entry at the bottom side of panel as per IPS

Cable inlet will be from the bottom of the cabinet; the bottom of cabinets shall be closed by means of sliding bottom plates. A fastening rail for incoming cables shall be provided in the bottom frame.

Generally in the front side will be installed all electronic equipment, in the rear side will be installed all terminal strips for in/outgoing cables and cable tray channels.

Following detailed requirements shall be satisfied:

Panel structure shall be entirely self-supporting by the use of 50 mm structural angle iron frame. Framing and brackets shall be as necessary to achieve a rugged design and to insure a smooth, flat surface with a maximum deflection of 4 mm over total surface of panel after installation of all instruments and accessory equipment. Design and fabricate panel lengths from a smooth, continuous panel surface. Provide holes at panel joints complete with bolts, nuts, and washers for panel assembly, shop-assemble the entire unit and check for accurate alignment and surface matching.

- Provide removable end side plates.
- Bottom and rear of the panel shall be easily accessible.
- ~~Minimum thickness of panel shall be 3 mm~~

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- Construction of the control cabinets shall be in accordance with standard RITTAL type front & rear access cubicles.

For handling purposes, each shipping section shall be provided with removable lifting lugs designed for lifting without deforming the panel.

All burrs produced around cutouts or bolt hole drillings must be ground smooth.

The equipment installed inside the cabinet (e.g. racks, power supply, etc.) shall be completely wired to the terminal strips including the “spare”.

The “spare” provided will be 20% of spare terminals, of circuit breakers (No 1 minimum spare for each kind), of power supply capacity. Also, 40% spare shall be considered for wire-ways space (duct).

Other 20% of empty space in the cabinet will be provided as well.

6.6 LABELLING AND NAMEPLATES

Panels shall be clearly labeled with plant instrument numbers and duties at the front and rear.

Labels shall be transparent plastic material and engraved on reverse side. The engraving to be filled in either black or white depending on which is most legible. Provision shall be made in the panel mounted instruments, for insertion and removal of meter constant cards and control valve action.

The material for name-plates should normally be a laminated bicolor plastic, which when engraved; the top layer is cut through allowing the letter to show in the second color.

Continuous panels for control of a number of process units, as in the case of integrated plant, shall have the panel sections clearly defined by arrow-headed lines and labeled with the plant designation at the top of the panel.

6.7 IDENTIFICATION

Each cabinet shall have a nameplate of corrosion resistant material fixed on to the front of the cabinet, with screws, and giving the following information:

- Name of purchaser,
- Serial number of the unit,
- Rating in watt,
- Voltage and frequency,
- Purchase order number,
- Year of manufacture.

Live parts of equipment and terminations carrying voltages above 50 volt shall be covered with a transparent insulation plate, bearing the warning text: DANGER.

All equipment, relays, sockets, wiring, terminals, etc. shall be clearly identified by nameplate in accordance with the relevant drawings included in the data sheet.

All equipment, relays, sockets, wiring, terminals, etc. shall be clearly identified by nameplate in accordance with the relevant drawings included in the data sheet.

These nameplates shall be properly fixed using 2 component epoxy resin cement near to the equipment on non-removable parts of the cabinet.

6.8 SUMMARY FUNCTIONAL DESCRIPTION

The ESD system shall scan analog and on / off inputs from field sensors, perform numerical operations, analog limit detection, logical functions and shutdown of plant units or parts thereof, according to the strategy shown on the cause and effect diagram.

The output modules shall be designed to operate solenoid valves or ESD logics as shown on the cause and effect diagram.

Communication between the Operator and the ESD system is done via the DCS screens.

Furthermore, all status information, including analog inputs shall, via the data transfer facilities, be available for use in the DCS system.

6.8.1 MAN/MACHINE INTERFACE

Operator Interfaces dedicated to safety are provided as follows:

6.8.1.1 In CCR

- **ESD Console:** Dedicated to each process sections incorporated to the ESD console. They shall be composed of PBs and light indicators, hard wired to the ESD I/O modules to provide shutdown actions/status, Annunciator for acknowledge and lamp test switches will be provided for on it (besides the annunciator will be also shown on HMI). Horn test/function test will be added if applicable. All critical alarms will be located on control console, and shall be both visible and audible. Non-critical alarms may be displayed on control room video display units associated with digital instrument systems or computer systems.

6.8.1.2 Engineering room

Engineering/Operation Workstation dedicated to ESD system will be provided in the engineering room.

The configuration database / information must be capable of being backed up on to a media such as Removable Magnetic disks or tape, or Recordable CD/DVD. The Engineering Workstation shall be capable of downloading the configuration data into the system, and other components of the system via a high-speed communications link.

The Engineering Workstation shall be capable of testing application logic on an offline mode without initially downloading the logic to the PLC. It shall be capable of analyzing system configuration and application logic online as well as offline, after downloading the information to the PLC. The Engineering Workstation shall be capable of capturing and analyzing information from the PLCs on the network, without having to be connected to each PLC directly.

The systems shall be capable of accepting configuration changes from the Engineering Workstation whilst executing the application logic on a ‘live’ plant and this shall not cause interruption or stoppage to the control actions, affect SIL rating, information processing and data transfer to the DCS.

The Engineering Workstations shall have self-documentation facilities to assist in logic analysis and record archiving. The Engineering Workstation shall have the capability to print out any part of the configuration and application logic on to local or networked printers.

Engineering/Operation Workstation shall include plant overview and detailed displays to identify any abnormal condition

- ESD
- alarm of process and equipment shutdown conditions,
- ESD alarm and status information of all inhibited sensors (Start-up and maintenance inhibit), including dedicated summary pages of all inhibits
- Acknowledge and reset ESD alarm
- System alarm of ESD equipment
- Discrepancy alarm command/position for safety valves
- Transmitter fault monitoring (bad value - and to allow soft ESD commands from keyboard (reset, MOS, etc.) and to display ESD measures on a DCS diagnostic view.

Simplified dynamic ‘interlock displays’ shall be built according to interlock diagram on DCS graphic display showing status for logic tracing and fault locating.

The EWS/OWS shall be equipped with

CPU: Core i5
RAM: 8GB
HDD: 1TB
Display: 32 inch

6.8.1.3 On Field

Field emergency PBs for manual shutdown, wired to ESD system will be available in the plant as mentioned on PIDs.

6.9 SYSTEM HARDWARE

The following requirements are also described in documents IPS-M-IN-220, IPS-M-IN-290, and IPS-G-IN-290 for PLC and control panel designs. For auxiliary panel also refer to IPS-G-IN-260 and IPS-M-IN-260.

6.9.1 General

The ESD system is high available and certified by TÜV to class AK6 according to DIN V 19250 and certified by Factory Mutual to SIL 3 according IEC61508 standard.

Availability shall be better than 99.99% with a MTTR of 4hr.

System components design shall be modular with rack mounting and plug-in type assemblies.

Each system module shall be equipped with light indicators for fault and status display.

The system shall have self-diagnostic programs that run independently from the application programs on a continuous basis with fault detection capability down to the I/O module individual channel. Safety system shall provide full status information on operator interfaces.

It shall be possible to replace cards without switching off the power. Modules shall be replaceable without requiring special tools. All modules shall be replaceable on-line without degrading the system performance. Re-initialization of newly installed module shall be automatic.

Where anti-static precautions are necessary when handling cards, they shall be clearly identified. If such precautions are required, grounding wrist straps shall be supplied as permanently fixed items.

To assess the recommendation for spare parts, theoretical failure rate figures of all boards, power supply units etc. in the system shall be provided.

6.9.2 Architecture for CPUs and I/O modules

The system is fully redundant for CPU's and all I/O's. Each part of the redundant system is composed of two legs: 1 automation leg "input, CPU, output" in parallel with a diagnostic and protection leg which can take direct action on output.

Failure of any single component shall not result in a failure to correctly execute safety functionality and process shut-down shall not occur as a result of any single component failure in the ESD system (as defined by this specification).

CPU, communication modules, power supply, I/O cards and I/O bus shall be redundant.

As much as possible, redundant cards shall be installed on separate racks.

6.9.3 Intrinsic safety

As a general rule if field device is Eex i certified, The Vendor shall provide intrinsic safety barriers for inputs/outputs as per ESD system sizing data"

These barriers shall insure a galvanic isolation. The Vendor shall provide EEx i certificates for legal inspection of the installation. The Vendor shall bear the legal and technical responsibility of the arrangement of EEx i equipment into the cabinets. The vendor shall provide all relevant calculation loops. The barriers shall be plug-in type with the socket on base unit and will be installed in the marshalling cabinets.

6.9.4 Input / Output modules

All printed circuit cards shall be protected against corrosion and humidity by means of appropriate varnish coating and gold plated contacts of connectors.

Each I/O channel shall be fully isolated and shall operate in parallel.

I/O cards shall be designed such that a short-circuit or a high-voltage on one I/O will not induce a fault on any other I/O of the card.

LED status indicators shall be provided in front edge of Input / Output modules, as a troubleshooting aid, to indicate status of Inputs / Outputs, fuse blow-out and fault condition.

6.9.4.1 Analogue Inputs

The safety systems shall be able to receive the following types of analogue signals where required:

4-20 mA, HART, loop powered free from earth, active, 24V DC, 2 wires (Standard signals).

Analogue inputs shall have incorporated monitoring function (open, short and out-of-range circuit detection). The range shall be software configurable per input channel.

The power supply for field mounted passive 4-20 mA transmitters connected to the safety systems shall be supplied by input modules.

Dielectric strength for analog input shall be tested to 19-50 vdc between I/O terminals and chassis.

The negative terminal to be at isolated signal ground level. The inputs shall be capable of sourcing or sinking the current.

The analog modules shall also accommodate transmitter-powered inputs, which have a grounded common at the transmitter, i.e. signal isolated from earth at the I/O module.

Analogue signal scan rate: 0.25sec max.

1-5 Vdc input option to be provided, input resistance equal to 500k ohms or greater.

Individual A/D converters to be provided for each input channel

6.9.4.2 Digital Inputs

The safety systems shall provide the power (24V DC) for digital inputs, which are connected to volt free contacts.

Input modules shall include circuitry (filtering, etc.) to ensure that any "chatter" or "bounce" encountered during contact closure does not initiate erroneous information. Filter time shall be configurable.

Dielectric strength for digital input shall be tested to 2640 vac between I/O terminals and ground for 2 seconds.

24 VDC as input “1” and open circuit (infinite resistance) as “0”

Negative terminal to be at isolated ground level.

Sense voltage (24 VDC) to field contacts and inputs for proximity switches shall be provided by the ESD systems.

Inputs shall be individually isolated.

The input modules/isolators shall include line monitoring function to detect open and short circuits for non-fail-safe signals.

Digital signal scan rate: 100msec max.

6.9.4.3 Digital Outputs

Output circuits shall be short circuit proof. Short-circuiting of one output shall not affect any other output.

The contact outputs shall be configurable by output to allow:

- Normally open or normally closed output
- Maintained, latching or pulse contact

The output contacts are volt-free or powered by the ESD system using internal 24VDC power supply.

Relays for volt-free digital outputs shall be hermetically sealed provided with LED.

Full line monitoring output card (open and/or short circuit detection) shall be used only for non-fail-safe type, high integrity outputs.

The following outputs shall be supported:

- Solenoid valves with coil voltages of 24VDC (Eexi type or Eexd type if Eexi not available) powered by interface isolator relays
- MCC stop/trip commands powered by ESD system to interface isolator relays located in marshalling cabinets. Relay contact shall be powered by others.
- Panel lamp, etc., activation powered by the ESD system,
- Trip signals to other systems (Package PLC, etc.) via volt-free contact, powered by others. Dielectric strength for digital output shall be tested to 26-40 vac between I/O terminals and ground for 2 seconds.

6.9.5 Main Processor Module

Each processor shall be provided with battery back-up to retain its memory for six (6) months. Low battery level alarm shall be included as part of the diagnostic alarm.

Basically two types of control shall be supported by the main processor: logic and sequential. As a minimum, the processor shall contain the following configurable functions stored in non-volatile memory:

Selection	: High high, high, low, low low, average.
Math Computation	: Add/Subtract, Multiply/Divide.
I/O	: Analogue Input/Output, Digital Input/Output, linearization, Square root, threshold, filter, vector and matrix calculation.
Boolean	: And, or, Nand, Nor, Xor, Nxor.
Miscellaneous	: Timer, Delay counter, Sequencer, Flip-flop memory.
Ladder Symbols	: NO contact, NC contacts, Energized/De-energized Output, Latch/Unlatch, On/Off Delay Timer, Counter, etc.
Grafcet	: Transition, state and facility (initialization ...).

The Vendor shall state the list of available standard functions or algorithms.

The programmable controllers shall be programmed and configured to meet the functional requirements. At start-up, the system shall be immediately and automatically available without human action.

Vendor shall clearly explain how his system is designed to avoid the processor to be permanently locked in a sequence loop.

Logic functions, timing data and operating subroutines shall be loaded and tested into the programmable logic controllers at the manufacturer premises and shall be stored in not volatile memory.

It must be possible to reprogram the system using simple language. Vendor shall confirm.

The system must be protected from unauthorized modification of programs and configuration by key lock and/or password.

All facilities necessary for making modification to the logic system should be provided on a EWS.

6.9.6 Panel Hardware

6.9.6.1 General

ESD Console shall be provided fully equipped with PBs and/or LEDs/lights, and ready to be mounted in CR. it shall be equipped with common audible alarm , test lamp as well as acknowledge and reset PBs.

Emergency hand switches shall be protected against accidental operation.

Switches & PBs shall be hardwired to input modules of relevant safety system.

Lights shall be hardwired to ESD output modules.

Lamp test facilities, color engraved nameplates and plug-in terminal boards for external wiring shall be provided.

LEDs or light indicators shall be powered under external 24V DC at marshalling cabinet level.

Panel design and related equipment shall be submitted to CONTRACTOR approval.

6.9.6.2 Common alarms on panel

Each light indicator will be flashing when an alarm is activated and will stay "on" after acknowledgement until the cause of alarm is removed.

6.9.6.3 Emergency PBs

Emergency PBs shall be equipped with protection to avoid accidental operation.

For each shutdown sequence, an emergency shutdown shall be installed on the ESD console as per process requirement.

6.9.7 Field Signals

The following field signals are available:

Analog inputs:

- 4-20mA, HART Protocol type , two-wire transmitters powered (Loop powered) from input board
- 4-20mA active generators

Binary inputs:

- Contacts powered with 24 V DC from I/O panel

Binary outputs:

- Relay contacts, voltage-free; powered from the MCC
- 24 VDC powered contacts for solenoid valves from ESD system
- Relay contacts for DCS or 24V dc (others).

Emergency Shutdown switches shall be connected with dedicated state of the art hardware, operating from the field with analog or digital signals directly to the ESD.

The ESD fault diagnosis system shall check the I/O signals and modules for correct operation.

Temperature transmitters shall have burnout detection (selectable up or down scale), and 4-20mA signals shall have open and short circuit detection.

Each external signal must be totally isolated from the internal bus systems, from the power supplies and from other I/O signals. The I/O boards must be protected against transients and surges.

The overall calibrated accuracy of the ESD system's analog measuring, conversion and display shall be equal or better than 0.2% as much as commercially available.

Safety related inputs/outputs must be with check functions.

6.9.8 Maintenance Station

A laptop shall be provided in ITR (Instrument Technical Room) for pre-commissioning, and maintenance operations including monitoring/configuration/troubleshooting etc.

ESD equipment located in the ITR and field devices shall be considered as write protected

All arrangements shall be taken for easy operator working.

The programming, configuration and maintenance tool shall be provided to perform the following functions:

- Display of all process and system alarm with time and date stamping, the associated communication link with the safety system shall be carefully designed and insured highly secured communication.
- Configuration,
- Definition of application through functional logic,
- Cross referenced I/O list,
- Transfer of application program,
- Test and simulation program,
- Saving of the configuration on external support,
- Monitoring of process status and system status,

- Retrieval and storage of diagnostics,
- Off line test and simulation of the compiled ESD system program,
- Audit trail of all ESD system program modifications.

The system shall be protected from unauthorized or accidental program modification.

6.10 SIGNAL OPERATION MODE

Analog Input modules must be dual or triple channels with check and voting functions to achieve the required safety and availability.

Binary Inputs operate in failsafe mode with the switch closed in normal operation and open during trip condition. Digital input modules shall be dual or triple-channel with mutual check and voting functions.

Binary Outputs for solenoid valves and motor relays shall be contacts.

The output modules shall be dual or triple-type to enable checks and redundancy. These outputs shall energize the final output relays, switching on the 24V DC power supply to the solenoid valves and the interposing relay with the MCC.

1-out-of-1 circuit: All trip alarms are generated from "one" field sensor, and an alarm signal from this sensor will lead to a corresponding trip in a "1-out-of-1" trip action.

2-out-of-3 circuits: For special inputs. A 2-out-of-3 configuration shall be possible. The logic software shall include program blocks for 2-out-of-3 voting with associated alarm warning (2 of 3).

6.11 SOFTWARE

The application software shall be configured by utilizing standard program blocks for the following functions:

- Analog signal conditioning and scaling
- Allocation of engineering units to analog signals
- Analog arithmetic
- Limit detection
- Delay actions
- Logic language (in ladder logic or logic symbols) -Logging of all status changes
- Text strings for alarm and event-logging -Time, date and numbering of log printouts

The programs shall also have facilities for function blocks for:

- Alarm routines
- First-up, flash generation, acknowledgement and tests

- ESD Logic execution

Trip conditions are generated by a contact or by an analog input exceeding a certain value. However, a few trip conditions are functions of analog values and logic functions, which require program blocks to perform algorithms, such as square root extraction, pressure, temperature and mole weight compensation, density compensation, multiplication, division and comparison, i.e. signal comparison and selection.

The above software shall, to the extent possible, be covered by the safety requirement classification.

6.12 ALARM OPERATION MODE

Alarm shall be in DCS.

6.13 ESD LOGIC

It may be necessary to inactivate some Trip Alarms during start-up in order to reset the ESD logic.

This is done by activating the corresponding inactivation switch in DCS.

Inactivation status shall clearly be indicated in DCS for all inputs.

The trip will be executed if the operator brings an input that has reached its trip value out of inactivation.

For operational purposes, inactivation switches shall be key-operated. It shall only be possible to remove the key when the input is activated.

Manual trip switches shall be protected by a cover in order to prevent accidental activation.

6.13.1 Test Facilities

Testing shall cover the complete system including all hardware, software and interfaces to other systems and equipment. It shall be possible to see all analog values and calculation results in the system from the Engineering Workstation. When forcing status in the PLC from the engineering or maintenance workstations, the functions that are forced, shall be clearly indicated on the DCS screens.

6.13.2 Reset of ESD Logic

It shall not be possible to reset ESD logic as long as a Trip is on, unless it is inactivated.

When the ESD logic is reset (restarted), the solenoid valves should be energized simultaneously, but there may be solenoid valves to be individually energized. Separate resetting shall only be possible when the ESD logic is reset.

The output status for each solenoid valve or rotating equipment shall be indicated. In cases where the solenoid valves or rotating equipment have a local reset function, the signal to the output status shall be derived directly from the final trip element.

6.14 EVENT- RECORDING SYSTEM

Shutdown or trip alarms time and date stamping will be implemented on ESD system and will be accessible on relevant maintenance station for diagnostic after shutdown.

Only the alarm status will be transmitted via data communication links to the DCS where they will be displayed and printed with time and date stamping performed at DCS level.

When the transmission delay and/or the DCS discrimination time do not allow a correct sequencing of alarms and events, first alarms will be detected at PLC or ESD level and transmitted to DCS with "first out" status for display and print out

The time stamped events shall be integrated to the plant servers and stored in an event module.

The time stamping of events shall be done within the CPU controllers.

The ESD system shall be provided with the first-out event recorder function. This function will be included in the engineering/ maintenance station.

6.15 INTERFACE WITH OTHER SYSTEMS

The only software connection permitted is for sending alarm and status signals to the DCS.

ESD system communicates with (hardwired signals unless specified otherwise) below systems and packages. The detail will be shown and finalized in Doc. No. BK-GCS-PEDCO-120-IN-BD-0001-D01 (Control ESDF&G System Block Diagram Configuration):

- DCS, via redundant serial link, for non-safety actions such as reset, alarms, statuses, bad values,
- DCS, via redundant serial link, for analog inputs for the display of measures on a DCS diagnostic view,
- ESD console for shutdowns, and critical alarms (hardwired),
- F&G, (transmitting some Causes to ESD for proper Effects; hardwired)
- Command signals shall be transferred from ESD to MCC via hardwired signals through Electrical Marshalling cabinet installed in substation. These signals shall be provided by dry contact of relays in ESD individual marshalling panels located in ITR.

- Status signals shall be transferred from MCC (Electrical Marshalling cabinet) to DCS/ESD. These signals shall be wetted by Electrical to drive relays in DCS and ESD individual marshalling panels located in ITR.
- Hardwired digital signals between DCS/ESD and PLCs shall be wetted (powered) by destination system.
- HVAC system for shutdown signals (hardwired), (if any)
- Package PLCs for shutdown signals (hardwired).
- Existing ESD system (hardwired).

The communication protocol for DCS interface shall be considered in accordance with “Specification for Control System” Doc. No. “BK-00-HD-000-IN-SP-0002”

In case of the same Manufacturer being used for DCS & ESD Systems, where standard and proven DCS communication interface is available this module shall be used.

The ESD System SUPPLIER shall provide (during the detail engineering phase) the specification of the ESD System data link interface with all information necessary to configure the DCS gateway.

Full link diagnostics shall be provided with error detection and correction. Communications link shall be provided with galvanic/optical isolation.

SUPPLIER shall present any other proven communication protocol with the selected DCS system that the safety system can interface, for review and approval.

Cable and cabling of all these interfaces (only serial link) are in charge of the vendor of DCS system.

6.16 POWER SUPPLY SYSTEM

The external power for the ESD system shall be fed from dual redundant 110VAC 50 HZ UPS by two separate (dual redundant) feeder from UPS, which is outside the ESD vendor's scope of supply. Any other necessary power shall be generated within the ESD equipment. The ESD vendor shall state the required consumption. RAM memories shall have the necessary built-in backup battery. DC power distribution to individual cabinets and racks shall be done without soldered joints.

The supply voltage for the I/O modules and for the CPU's shall come from two independent, dual-redundant power supplies. The two systems shall be galvanic ally isolated from each other and their functions shall be supervised and logged. In case of failure in each power supply there should not be any degradation in system power.

The voltage level of inputs is 24V DC whereas the voltage level of the CPU shall be according to supplier's standard.

The voltage output from the ESD to final relays shall be 24V DC. Solenoids are powered from ESD with 24V DC. Outputs for motor interlocks are via interposing relays with contacts powered from the MCC.

Complete functional check to demonstrate that the system operates in the manner defined in this specification and relevant documents, after all system equipment has been connected and inputs/outputs fully simulated.

6.17 CABINET AND CABLING

6.17.1 Marshalling Cabinet

Relevant field cables should be terminated in a marshalling cabinet which is devoted to ESD system.

In addition to ESD cabinet, the Vendor may have to supply equipped marshalling cabinet to receive all field cabling and wiring from the ESD system, EEx"i" galvanic isolation barriers and/or interposing relays where necessary and to supply interconnecting cables between the I/O cabinet and marshalling.

The marshalling cabinet shall be sized and set out to accommodate the "cross wiring" technique, in which:

- Field wiring terminates on terminal strips located on one side of each cabinet. The terminals will include protections and features to easily isolate the signal from the plant without disconnecting wire.
- System wiring from the ESD terminates on separate terminal strips located opposite the Field Wiring terminal strips. (Alternatively, if the Vendors I/O termination assemblies are small and can perform connection via plug terminated system cables to the controllers, then these I/O termination assemblies may be mounted in the marshalling cabinets themselves.)
- Bulk 24V DC power feeders shall be wired to separate terminal strips, and shall be used as required.
- Cross wiring shall be installed as required to connect field devices to galvanic isolation barrier and 24V DC power supply.

6.17.2 Cabinet Mechanical Requirements

The cabinet shall have the following characteristics:

- Standard size of cabinet or frames (e.g. D x W x H: 800x800x2000), + 100 mm plinth,
- Key lock system with the same key for all cabinets,
- Internal door pocket for drawings,
- IP 54 of IEC 60529, as the minimum

- Standard type with eyelets, painted according to IPS and CLIENT Approval
- Modular structure accessible from both sides for the marshalling and system cabinets,
- General earth for metallic parts,
- Separated and isolated earth for electronic circuits,
- Fans as required, with failure detection or natural draught, based upon finalized heat dissipation
- Cable entry from bottom, with supporting bar and sealing plate,
- All cables and wires shall be installed in cable duct or on cable tray
- All cables and wires shall be installed using proper glands.
- Outside standard color ***RAL 7035.***

Also illumination levels on control panels, and desks, shall be in accordance with electrical part of IPS standards IPS-E-EL-100 "Lighting and Wiring". Adequate illumination shall be provided at the rear of the panel, based on IPS-G-IN-220(1), paragraph 6.2.3.

6.17.3 Cabinet Equipment

The cabinet design should allow full and easy access to all components, connections, terminations and assemblies by installation, maintenance and repair personnel. All cabinets supplied by Vendor shall be fully equipped/wired (frames and racks, terminal strips and rail, wire markers and ferrules, etc.) and shall be ready to be installed on site.

Also cabinet of ESD system & marshalling should be equipped with illuminator lamp and fan for exhaust and also heater for avoiding of vapor condensation.

6.17.4 Cabling

The cabling includes the wiring of all links internal to the equipment provided by the Vendor. The cabinets shall be entirely wired from the field terminals to the Control system hardware.

Segregation of cables shall be in accordance with voltage and level of redundancy.

Sufficient room shall be left inside the cabinets for good access to the spare terminals.

All cables shall be adequately supported and secured to prevent dislocations at the connectors.

Internal wiring of cabinet shall be 1.5mm2 for signal and 2.5mm2 for power cable as a minimum.

6.17.5 Grounding, Lightening Protection and Noise Immunity

Vendor shall fully describe the preferred method for grounding power, signals and signals shields in the system proposal. In particular, the Vendor shall indicate the effect of equipment installation in different locations on the grounding design.

The conductive part of instrumentation equipment installed in the ER and CR building shall be connected to a specific earth loop which is connected to the main earth loop through existing earth dispatchers.

In order to avoid electronic noise and interference, the instrument earth shall remain totally isolated from the electrical protective earth. Instrument earth shall be individually separated for intrinsically safe & none intrinsically safe instruments. The impedance of the instrument earth shall be less than 0.5 ohm. (In construction, integration, arrangement, and installation of control system panels, the vendor shall meet all considerations related to Noise and Vibration according to IPS-G-SF-900, and use adequate isolation solution for the damping any shock and vibration by any internal/external cause.)

Vendor shall describe his philosophy for powering transmitters and insuring good noise immunity. Specifically, the Vendor shall point out the general philosophy on isolated signal reference and galvanic insulation.

The Vendor shall state the performance in terms of common Mode Voltage rejection, normal Mode Voltage rejection, and maximal over voltage protection, maximum common mode voltage, and maximum permanent voltage.

Vendor shall describe how the system will be protected against lightning. Vendor shall clearly detail all of the requirements which need to be followed by others to insure maximum efficiency for the lightning protection.

Noise immunity equipment shall be immune to spurious action or damage due to RFI in accordance with IEC 60801. Hand held personal radio equipment of 5W nominal output may be in operation near the equipment with the cabinet doors in the open position.

Standard limitation for acoustic noise of the devices shall be considered by vendor during design.

6.18 SYSTEM PERFORMANCES

The PLC-based safety system minimum performances shall be as follows:

PLC cycle time : 0.3 sec. max.

PLC time from input change to output order : 0.6 sec. max.

Analogue signal scan rate (signal used for safety loop) : 50 msec.

Digital signal scan rate : 10 msec.

Communication speed via serial link : 5 Mbit/s

First-out event recording time : 1 ms.

7.0 TEST AND INSPECTIONS

Note: All tests, operations, and procedures itemized here are as a minimum and shall be finalized as per vendor final document approved by company.

7.1 FACTORY ACCEPTANCE TEST

The acceptance test in the Vendor's factory shall be made with the overall equipment in normal operation, except for any Marshalling cabinets which may be delivered on site prior to the acceptance test.

The Vendor shall submit the test procedure, which takes into account the requirements of this specification.

The inspection shall include the following stages:

a) **Equipment inventory:**

The Inspection shall include but not limited to the following stages.

- That all equipment specified in the Contractor's documents (specification, requisition, etc.) is presented for inspection,
- The Vendor identification of cards, equipment, etc.
- The good presentation of equipment (cards, racks, cabinets, wiring, cables, etc.),
- That the overall documentation has been submitted and matches the hardware delivered.

b) Test of the system

This stage shall be used for:

- The demonstration of all system functions including the service functions of the supplied diagnostic equipment,
- The accuracy and operation of all I/O cards,
- The complete system reloads,
- The power failures and restarts,
- The immunity to radio interferences,
- The failure diagnostic, automatic back-up and recovery for all redundant devices,
- The design and wiring of each typical kind of loops by simulating the electronic signal,

- Non-standard software (tested 100 %),
- PLC and computer interfaces (tested 100 %),
- Standard software packages (100 %, functional check).
- Check of sequences and interlocks,

c) Integration and tests of connection to other systems

These tests shall be performed to validate the links with other systems, which will be incorporated into the final system network. They test shall include the good transfer of data with the selected transmission protocol, the configuration rules given by the ESD Vendor, the transfer and response time and the full transparency to the operator for the data exchanged by such links.

The Vendor shall provide all of the necessary simulation tools for these tests, including sufficient quantities of marshalling cabinets to perform the tests and the validation.

Errors detected during these tests in the system programming and configuration shall be preferably corrected before the end of the factory acceptance tests. The Vendor shall correct the errors in the concerned drawings and documentation within a short period after FAT.

7.2 SITE ACCEPTANCE TESTS

The Site Acceptance tests (SAT) shall be the duplicate of the FAT but shall include the test on all of the interfaces between systems. The vendor shall submit the test procedure for SAT.

For a period of thirty days, the system behavior and performances shall be monitored. The network load shall also be checked in the course of the SAT.

The SAT shall be divided into four main activities, as described below.

7.2.1 Individual System Functional Test

For each system, this test shall repeat all the FAT tests related to the system behavior:

- System power-up
- Power failure
- Redundancy
- Hardware diagnostics
- Test of all other system basic functions…

This test shall demonstrate that the system has been received in good condition that it is installed correctly and can successfully be used for further site activities.

7.2.2 Logic Function Check

The logic function check shall start only after the completion of the "Individual System Functional" test.

For each system, all internal logic functions shall be tested by simulation from the marshalling cabinets (test shall be done to check the Cause and effect charts and logic diagrams). This test aims to certify that the logic functions operate according to the relevant documents in order to allow the loop test to proceed loop by loop.

7.2.3 Test of System Integration

Test of system integration shall start only after the "Individual system functional" test.

When all systems are interconnected, the test of system integration is performed to certify that links between different systems operate according to specification and that any redundant link switches-over if the link in service fails.

This test shall also demonstrate that the time synchronization function between the ESD and the other systems operates according to specification.

Note: according to IPS-M-IN-250, some additional design considerations for controller include the following:

- The controller real-time clock shall be synchronized to a common system clock and have resolution capable of supporting required time tagging of events;
- The controller should be capable of scanning and updating the I/O, executing logic and analog functions, and supporting communication interfaces to achieve required performance (typically, logic functions- ten times per second and analog functions-four times per second);

7.2.4 Loop Test

Loop test shall start only after a successful "Test of system integration" and after the completion of the "Logic function check".

For each loop (hardware or software), the loop test shall be done with all systems connected and operating.

Note: Main reference document for Test shall be the last revision of IPS-I-IN-100 providing that be applicable for the vendor.

8.0 TRAINING

The Vendor shall provide detailed information on vendor factory and onsite training for plant personnel. The training program shall cover operation, maintenance and configuration topics.

The training program shall cover all areas of delivered hardware and software.

The training shall be performed in English (documents and courses).

The proposed training shall match the revision level of the software and hardware delivered.

The vendor shall state the terms and conditions of training, as stated below:

- The duration of each course
- The minimum and maximum number of students per course
- The required education level to attend the course.
- The locations where the courses will be offered
- Any equipment requirement
- The transportation, loading and out-of-pocket costs which will be incurred by the purchaser.

The vendor shall provide comprehensive documentation, course materials, technical notes, manuals, video cassettes, literature and other materials as required for the effective implementation of the training curriculum.

All such training materials shall become the property of the CLIENT. The vendor shall be required to update the course material documentation, technical notes and manuals in the event of changes due to revisions or modifications to the system as delivered.

The CLIENT shall approve the training proposal and reserves the right to request changes in the program. Training topics shall include the following:

- A detailed, Overall description and illustration of ESD principles,
- Descriptions of the configuration programs and the configuration files, including the theory of operation.
- Descriptions of program and associated subsystem programs, to include theory of operation.
- Detailed examination of ESD major components: material, interconnection, configuration settings,
- Analysis of routine/ scheduled/ emergency maintenance techniques; criteria and methods of trouble shooting,
- Spare parts ordering, coding, care of spares,
- Running and workshop testing.

The number of the attendees for each training courses shall be considered as per contract.

The training course will be organized for:

- Operators
- System engineers (including software design and system configuration)
- Maintenance engineers (including system configuration)

9.0 SITE SERVICES

9.1 GENERAL

- The services required from the Supplier will cover two periods:
- System Pre-commissioning: assistance during system installation and preliminary tests (power on & system loading).
- System Commissioning and start up: assistance to the COMPANY performing units pre-commissioning, commissioning and startup by DCS.
- The period of “on site” activity, pre-commissioning, start-up and SAT, shall be quoted, all inclusive, on a basis of eight (8) hour per day and six (6) day per week; travel and living
- Must be included.
- Any period consumed for system fault or trouble shooting where the supplier is responsible, will not be computed as site services activity.
- Any additional period will be computed on a daily rate base.
- Daily rates for additional period shall be quoted.

9.2 SYSTEM PRE-COMMISSIONING

- The Supplier shall include the necessary manpower in order to provide the following services:
- Interface for all problems concerning the system
- Check out that all facilities needed for the system are available (electrical power supply, air conditioning, suitable room, cable runs and trays, grounding etc.)
- Supervision of system internal cables installation
- “Power on” of the electrical power supply (for all equipment) and system loading.
- Test routines
- Repetition of the test made in Supplier’s staging area before shipment and SAT certificates filling.
- Loop check and functional test assistance.
- Preparation of a master copy for all documents of the supplies, which later will be used to prepare the “as built” documentation.

9.3 SYSTEM COMMISSIONING & START-UP

- After S.A.T., during commissioning, the Vendor will be available for configuration assistance, allowing COMPANY to modify on line the configuration of the system.
- Commissioning services will consist in:

- Loop check activity troubleshooting and assistance including configuration changes and display upgrading/modification.
- Preparation of a master copy for all the documents included in the scope of supply, which will be later, used to prepare the “AS BUILT” documentation.
- The on line configuration of the system may not be modified until successful completion of the acceptance test. If configuration changes are deemed necessary these should be agreed with the vendor.

10.0 MECHANICAL COMPLETION

Prior to Vendor's representative coming at site, the CLIENT shall prepare the Auxiliary and Control room with all facilities for system installation and testing.

The Vendor will provide the following services:

Check out that all facility requirements needed for the system are available (electrical power supply, environment conditions, suitable room, cable runs and trays, etc.), supervision of system unloading made by others, checking of installation and system interconnecting performed by Installation Contractor.

10.1 PRE-COMMISSIONING AND COMMISSIONING

Pre-commissioning period covers the:

The Supplier shall include the necessary manpower in order to provide the following services:

- Interface for all problems concerning the system
- Check out that all facilities needed for the system are available (electrical power supply, air conditioning, suitable room, cable runs and trays, grounding etc.)
- Supervision of system internal cables installation
- “Power on” of the electrical power supply (for all equipment) and system loading.
- Repetition of the test made in Supplier’s staging area before shipment and SAT certificates filling.
- Loop check and functional test assistance.
- Preparation of a master copy for all documents of the supplies, which later will be used to prepare the “as built” documentation.

Commissioning period covers the:

- Loop check activity troubleshooting and assistance including configuration changes and display upgrading/modification.

- Functional test

The responsibility of the Vendor includes the troubleshooting of malfunctions and problems detected in the system, and the management of a master for all Vendor's documentation that will later be used to make the "as built" documentation.

The Vendor shall provide any special purpose tools required for ESD system checks before energizing, system initialization, configuration, and start-up and post start-up verification.

11.0 DOCUMENTATION

The Vendor shall supply the following documents on Electronic & paper Copies:

- Technical description of the system and of each component. These approved specifications will be the basis for construction and final system design.
- Block diagram of the system with all cabinets and peripherals along with the interconnecting cables.
- Overall dimensional drawing of “each equipment” (cabinet, panel, etc.) along with the requirements for equipment erection and installation.
- Layout of the different racks with indication or electronic cards location and schedule items.
- Cable list for all cables supplied by the Vendor for wiring the cabinet and system equipment, with tag, length, type reference and routing of each cable.
- Internal cable drawings, which indicate blocks or connector wiring arrangement.
- Single line diagram of electrical supply for all devices of the system with indication for starts up and normal intensity.
- Grounding scheme of the different parts of the system to the central grounding point and indication of resistance grounding leg.
- Trouble shooting drawings.
- The vendor shall provide the cabling data. The cabling data include: cabinets number, card number, channel (number, rack number, terminals number, multiplexer number, connector, cable, IS barrier, etc.)
- Wiring drawings for the input/output terminal blocks or plugs.
- Functional specifications of every function detailing how they are performed through the system's resources. Approval of these documents. is the basis of the work, and has to be performed in the early stage of the job.
- All documentation, which permits the user to understand the software algorithms for the ESD PLC.
- Logic Diagram
- Reference manuals for all software packages.
- Listing, or print out of the configuration for:

  - PLC data bases,

- Computer, Network and PLC gateways,
- Parameters loaded in the different input/output cards,
- All test software used to test the communication with other equipment and/or for inspection,
- Any Specific software.

- User and maintenance manuals for all equipment including configuration tools.
- Acceptance test procedures.
- SPIR (Spare Part List and Interchangeability Record)
- Reports and certificates:

  Copies of the Manufacturer test reports or certificates shall be available during the acceptance tests, including original manufacturer certificate. Inspection and acceptance test reports shall be supplied.

- Any drawing (not listed above), which may be needed for correct installation, start-up and maintenance of the System.
- All paper copy shall be supply A4 size. All drawing electronics files shall be supply on AutoCAD DWG format. All table document electronic files shall be supply on Microsoft excel format. All text document electronic files shall be supply on Microsoft word format.

12.0 SPARE PARTS AND SPECIAL TOOLS

The Vendor shall provide certain quantities of consumable for the installation, pre-commissioning, commissioning, and start-up and up to the end of the guarantee period.

The quantities shall be estimated by Vendor and shall be based upon the Vendor's experience. The following two periods shall be taken into account:

- Pre-commissioning and commissioning period where the consumption of consumable is greater
- Normal use of the System

The VENDOR shall provide lists of recommended spare parts, which shall include the original part numbers with prices for commissioning, start-up and two years operation. All spare parts shall be identified individually.

Spare parts for commissioning and start-up; a qualified and complete list based on PROJECT SPARE PART SUPPLY PROCEDURE (Doc. No. E&D-QC-SP-1).

Spare parts for two years operation; a qualified and complete list based on PROJECT SPARE PART SUPPLY PROCEDURE (Doc. No. E&D-QC-SP-1).

The VENDOR shall be able to provide spares back up and support for the plant life of at least 20

years.

SPIR form shall be approved by CLIENT prior to procurement.

12.1 SPECIAL TOOLS

Special Tools (as option / if any; to be recommended by Vendor)

13.0 GUARANTEE AND MAINTENANCE

13.1 GUARANTEE

The Vendor shall guarantee the satisfactory performance of the system in accordance with project material requisition. This guarantee shall be performed through a letter of acceptance. In addition, The Vendor shall guarantee the availability of all spare parts and replacement parts that are required by any equipment item supplied for 10 years of operational period.

13.1.1 Maintenance during guarantee

The guarantee period shall be eighteen (18) months from the date of delivery or twelve (12) months from the installation date of each equipment/packages at site. For the reason that the process units and facilities might be executed by different temporal schedule, SAT may be carried out unit by unit, consequently the period guarantee of the relevant hardware and software will be started after completion of each respected unit and facility.

During the guarantee period, the Supplier shall provide onsite service personnel, at request, for maintenance, fault detection, repair and/or replacement within 48 hours. The Supplier may utilize the recommended/start up spare parts supplied, to maintain the system. The Supplier shall replace all such spare parts used at no cost and in duly time.

13.1.1. Maintenance after guarantee

The Supplier’s proposal shall include details of all standard maintenance agreements available from the vendor that are suitable for the systems (hardware, firmware and software). The CLIENT shall be under no obligation to select all or some of the agreements detailed and shall be free to negotiate a unique maintenance agreement with the Supplier.

14.0 PACKING, SHIPPING AND STORAGE

The Supplier shall provide adequate packing to prevent contamination, mechanical damage, or deterioration of the items supplied, including spare parts, as defined in the following requirements:

- Items not immediately packaged after manufacturing shall be suitably protected from contamination.

- At the time of shipment, the equipment shall be clean inside and out and covered with a plastic membrane protecting from water, or any other suitable means not harmful to equipment.
- All items shall be adequately boxed, crated, or otherwise protected to prevent loss, damage or pilferage in transit.
- Each box shall contain a detailed packing list in addition to the normally attached external list.
- Large and heavy equipment shall have the weight, center of gravity, and lifting points
- Marked on the exterior covering.

- Supplier shall furnish complete site preparation, shipping, and handling instructions to the Handles.

15.0 SHOCK AND VIBRATION CONSIDERATIONS

In construction, integration, arrangement, and installation of control system panels, The vendor shall meet all considerations related to Noise and Vibration according to IPS-G-SF-900, and use adequate isolation solution for the damping any shock and vibration by any internal/external cause.