



نگهداشت و افزایش تولید میدان نفتی بینک
سطح الارض و ابنیه تحت الارض

عمومی و مشترک



شماره پیمان:

053 - 073 - 9184

SPECIFICATION FOR FIRE & GAS SYSTEM

نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه
D04	0012	SP	IN	000	PEDCO	GNRAL	BK

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طرح نگهداشت و افزایش تولید 27 مخزن

SPECIFICATION FOR FIRE & GAS SYSTEM

نگهداشت و افزایش تولید میدان نفتی بینک

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Status:

IDC: Inter-Discipline Check
IFC: Issued For Comment
IFA: Issued For Approval
AFD: Approved For Design
AFC: Approved For Construction
AFP: Approved For Purchase
AFQ: Approved For Quotation
IFI: Issued For Information
AB-R: As-Built for CLIENT Review
AB-A: As-Built -Approved



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شماره پیمان:
053 - 073 - 9184

SPECIFICATION FOR FIRE & GAS SYSTEM

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D04	0012	SP	IN	000	PEDCO	GNRAL	BK

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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
EPD/EPC 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

The purpose of this specification is to define the main requirements for the design, manufacturing, testing and documentation of the plant F&G system of Binak oilfield (Compressor station/ Extension of manifold and gas-condensate Pipeline as project work packages). Any deviation from the present specification at any stage of the project shall be subject to CLIENT approval.

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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-E-IN-180 Engineering Standard for Instrument Electrical Power Supply and Distribution Systems
- IPS-E-IN-190 Engineering Standard for Transmission Systems
- IPS-I-IN-100 Inspection Standard for General Instrument Systems
- IPS-G-IN-220 Engineering and Installation Standard for Control Centres
- IPS-G-IN-260 Engineering and Installation Standard for Indicating Lights, Alarms and Protective Systems
- IPS-G-IN-270 General Standard for Instruments of Fire-Fighting and Detection Equipment
- 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-260 Material and Equipment Standard for Alarm and Protective Systems
- IPS-M-IN-290 Material and Equipment Standard for Programmable Logic Controllers (PLC)
- IPS-E-SF-260 Standard for automatic detectors and fire alarm system
- IPS-E-SF-380 Engineering Standard for Fire Protection in Buildings
- IPS-G-SF-310 General Standard for Gas Detectors

3.2 INTERNATIONAL CODES AND STANDARDS

API

- API RP 550 Installation of Refinery Instruments & Control Systems
- API 551 Process measurement Instrumentation
- API 552 Transmission systems
- API 554 Process Instruments and control

BS

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- BS 4683 Electrical apparatus for explosive atmospheres
- BS 5343 Gas detector tubes

- BS 5345 Code of practice for the selection, installation and maintenance of Electrical apparatus for use in potentially explosive atmospheres.
- BS 5420 Specification of degree of protection of enclosures
- BS 5445 Components of automate fire detection system
- BS 5446.1 Fire detection and fire alarm devices for dwellings
- BS 5501 Electrical Equipment for Potentially Explosive Atmospheres
- BS 5760 Reliability of Systems, Equipment and Components
- BS 5839 Fire Detection and Alarm Systems for buildings
- BS 6020 Instruments for the detection of gas parts
- BS 6651 Code of practice for protection of structures against lightning
- BS 6667 Electromagnetic compatibility for industrial process measurement and control equipment
- BS EN 54-1~11 Fire detection and fire alarm systems
- **IEC**
- IEC 60079 Electrical apparatus for explosive gas atmospheres
- IEC 60801-3 Electromagnetic compatibility for industrial-process measurement and control equipment
- IEC 60332 Tests on electric cables under fire condition
- IEC 60529 Degrees of protection provided by enclosures (IP Code)
- IEC 60794 Optical fibre cables
- 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 802.1~6 Local Area Network

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- IEEE C37.90.1 Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
- IEEE C37.90a Standard Relays And Relay Systems Associated With Electric Power Apparatus
- IEEE C63.2 American National Standard for Specifications of Electromagnetic Interference and Field Strength Measuring
- IEEE 488 Digital Interface for Programmable Instrumentation
- IEEE 979 Guide for Substation Fire Protection

ISA

- 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

NFPA

- NFPA 70 National Electrical Codes
- NFPA 72 National Fire Alarm and Signalling Code
- NFPA 72E Standard for Automatic Fire Detectors
- NFPA 72B Standard for the Installation Maintenance and Use of Auxiliary Protective Signalling Systems for Fire Alarm Service
- NFPA 72D Standard for the Installation Maintenance and Use of Proprietary Protective Signalling Systems for Watchman Fire Alarm and Supervisory Service
- NFPA 101 Life Safety Code
- NFPA 325 Fire Hazard Properties of Flammable Liquids, Gases and Volatile Solids
- NFPA 12 Standard on Carbon Dioxide Extinguishing Systems
- NFPA 15 Standard for Water Spray Fixed Systems for Fire Protection
- NFPA 24 Standard for the Installation of Private Fire Service
- NFPA 92A Standard for Smoke-Control Systems Utilizing Barriers and Pressure Differences

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- NFPA 30 Flammable and Combustible Liquids Code
- NFPA 850 Fire Protection for Electric Generating Plants

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

3.3 THE REFERENCE DOCUMENTS

- 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-0003 Specification For ESD 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 Configuration.
- BK- W007S-PEDCO-110-IN-BD-0001 Block Diagram Config. For Control/ESD/F&G Sys. - Extension of Binak B/C Manifold.
- BK-GNRAL-PEDCO-000-SA-SP-0005 Specification For Total Flooding System
- BK-SSGRL-PEDCO-110-IN-DC-0002 Instrument & Control System Design Criteria

3.4 ENVIRONMENTAL DATA

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

4.0 ABBRAVIATIONS

NISOC	:	National Iranian South Oil Company
AFC	:	Approved For Construction
AFD	:	Approved For Design
FGD	:	Flammable Gas Detector
FD	:	Flame Detector
F&G	:	Fire and Gas
FGS	:	Fire and Gas System
HD	:	Heat Detector
SD	:	Smoke Detector
TGD	:	Toxic Gas Detector
CGD	:	Combustible Gas Detection
PA/GA	:	Public Address / General Alarm
MAC	:	Manual Call Point
LEL	:	Lower Explosive Limit
PPM	:	Parts Per Million

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I/O	:	Input / Output
PLC	:	Programmable Logic Controller
CCR	:	Central Control Room
ITR	:	Instrument Technical Room
IPCS	:	Integrated Process Control System
ESD	:	Emergency Shutdown System
HMI	:	Human Machine Interface
EWS	:	Engineering Work Station
OCD	:	Operator Control Desk
OCS	:	Operator Control Station
FFCP	:	Standalone Fire Fighting Control Panel
C&E	:	Cause and Effect



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 BASIC CONDITIONS

6.1 ENVIRONMENTS

The equipment shall be suitable for permanent operation with environmental conditions as described in the project document "Process Basis of Design, BK- GENRL-PEDCO -000-PR-BD-0001"

6.2 TROPICALISATION

All F&G System components shall be tropicalized to eliminate mildew, fungi and other detrimental effects of a tropical environment, dust and moisture proof, fungus-growth proof and resistant to dust and insect attack. Exposed plugs / pins / contacts, including those on circuit boards, shall be gold plated. Printed circuit boards shall be protected by varnish coating.

Air shall be considered corrosive for the presence of saline atmosphere, dust and traces of H₂S. The equipment will be installed in a seismically active area. The equipment also shall be designed to operate during an earthquake.

Packaging shall be suitable for shipment and prolonged storage under tropical conditions to a desert location. VENDOR shall clearly state any special measures required – e.g. power to anti-condensation heaters.

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6.3 INGRESS PROTECTION

Instrument enclosure's "degree of protection" shall be in accordance with IEC 60529. The degree of protection for junction boxes (containing terminals only) shall be IP 65.

Minimum ingress protection for all indoor panels shall be IP 54.

6.4 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.

7.0 ELECTRICAL

7.1 POWER SUPPLIES

7.1.1. External Power Supply (By Others):

F&G system power shall meet NFPA 72. F&G system shall be powered from the 24 VDC uninterrupted power supply which is totally independent and provided by battery for a period of 24 hours back-up (24 hours back up for system normal operating without alarming devices and at the end of this time 5 minutes for activation of all alarming devices). Battery charging shall be automatic, with double battery chargers.

Power distribution shall be configured such that the power supply and distribution for all levels of distribution up to the consumers shall be redundant. During failure of one power supply, the safeguarding system shall not be affected.

External power supply shall be non-grounded power supply. The VENDOR is required to indicate that his system can be powered from electrical grounded power supply as an alternate solution.

The power supply input circuit shall have independent over current protection and transient protection.

The VENDOR shall indicate the maximum allowable mains voltage spikes (amplitude and duration) that the system can withstand without affecting operation.

The VENDOR shall indicate the procedures to be followed and the features of the system, which allow system recovery after power failure.

7.1.2. Internal power supplies (Supplied by FGS VENDOR):

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The VENDOR shall furnish suitable power cables from Mains Distribution Board and a circuit breaker for each incoming mains supply to isolate the supply for maintenance purposes. Failure of one of the incoming power feeders shall not have any effect on normal operation of the F&G System.

They shall generate all required power supply internally used for the F&G System and shall be considered as an integral part of the system.

Power supplies shall be dual or multiple redundant for system modules, field instruments, Intrinsic Safety SIL3 isolators/barriers and other essential equipment. The power supplies shall be sized 40% in excess of the estimated maximum demand including spare I/O ensuring that failure of one unit shall not result in degradation of system performance, and trip of the plant. Each one shall be capable to support the total power requirement of safety modules. Diagnostic facility as LEDs shall be used to check running and fault of power supply. As all modules, power supply shall be replaceable during operation without any trouble on other modules.

The F&G system is required to derive all its internal power requirements, as well as the 24 Vdc required to power the IS isolators (if any) and field devices connected to the I/O cards and modules from the mains supply.

Internal power supplies shall be equipped with fuses.

Each power supply shall be rated such that all loads, including spares, can be simultaneously powered. Diagnostics, signaling and isolation facilities shall be provided to service or replace a faulty power supply unit.

The power packs and power distribution to provide the different voltage levels required within the F&G system shall be part of the system. Power packs and the distribution shall be 100% redundant.

The power supply distribution shall be maintained 'floating' and shall not be referenced to ground. Galvanic isolation shall be provided as required.

Under conditions where the UPS is in 'bypass' it is possible for notches to be superimposed on the power supply wave form. The F&G VENDOR shall ensure that this occurrence does not impair the system performance.

UPS shall be capable of sustaining all components of the system for a period of at least 1.5 hours, in the event of a total power generation failure.

The power consumption of F&G system cabinets as well as the heat dissipation for each cabinet shall be provided. Calculation will take into account spare capacity.

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Diagnostic and signaling facilities shall be provided to identify that a power supply unit requires service or replacement. It shall be possible to isolate, disconnect, remove and replace a faulty power supply unit without loss of operation.

7.1.3. Alternate Voltages

Any voltage level other than that specified as being supplied by the CONTRACTOR, if required for the operation of the F&G System or equipment/instruments driven by the F&G System shall be derived from within the F&G System VENDOR's equipment and shall be the responsibility and scope of supply of the VENDOR.

Where a VENDOR requires a different voltage to that supplied by the CONTRACTOR, then the VENDOR shall provide all necessary equipment, power supplies, AC/DC distribution and protection, fuses, circuit breakers, earth leakage detection and terminals to interface his equipment with the project electrical distribution equipment.

Where DC power supplies are derived from the above AC power supply by the VENDOR, an earth fault monitoring device shall be provided. Earth fault alarm shall be reported to the DCS.

7.1.4. Electrical Power Distribution

All power supplies over 50 volts shall be shrouded and labeled.

Electrical power distribution for the system cabinets and other system hardware shall form part of the VENDOR's scope of supply. The minimum requirement for the power distribution shall be as below:

- Redundant power distribution boards with incoming fused isolators and miniature circuit breakers for distribution.
- Redundant feeders to all redundant consuming devices.
- Redundant feeders with selector switches for non-redundant consuming devices.
- Power isolation means at both ends of the power cables

The VENDOR shall be responsible for sizing all power supply units within his scope of supply, and for applying sufficient discrimination in the power distribution system.

Power supply modules shall be installed so as to provide easy access for maintenance purposes. It shall be possible to isolate, disconnect, remove and replace faulty power supplies without interruption to operation. If critical back-up batteries are employed, they shall be easily accessible for maintenance purposes.

The VENDOR shall present to the CONTRACTOR a listing and detailed schematics of the number of electrical feeders, their termination points and respective loads. The VENDOR

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shall provide calculation of the estimated power consumption of the system (volts, amps, watts and heat dissipation). This shall include the basis of the calculation to enable CONTRACTOR to evaluate the impact of any changes.

VENDOR's design deliverables will include a drawing illustrating their complete system power distribution.

7.2 ELECTROMAGNETIC COMPATIBILITY / RADIO FREQUENCY INTERFERENCE (RFI)

The design of the equipment shall be such that it is not adversely affected by electromagnetic interference as defined in IEC 61000. The FGS shall conform to IEC 60801" Electromagnetic Compatibility for Industrial-Process Measurement and Control Equipment".

F&G System shall be immune to signal strength of 10 volts/m with the door open and 15 volts/m with the door closed, over a frequency range of 20MHz through 1 GHz at 1-meter distance.

7.3 ELECTRICAL TRANSIENTS AND ELECTROMAGNETIC INTERFERENCE (EMI)

The F&G System shall be supplied with provision for protection against system error and hardware damage resulting from electrical transients on power or signal. These transients include those generated by switching large electrical loads, by power line fault due to lightning strikes and lightning surges on power or signal cables.

Transient protection shall meet IEC 60801-2 (level 3; 8 kV).

7.4 LIGHTNING PROTECTION

Equipment and cabling in areas which are not protected by either earthed steel structures or dedicated lightning conductors shall be provided with lightning protection.

Equipment located outside protected areas and instruments connected to cables that are routed outside protected areas shall be provided with protective lightning arrestors at both ends of the transmission line.

A lightning arrestor shall consist of a gas tube/varistor/Zener diode combination approved by the CONTRACTOR. Devices with fuses shall not be applied.

Long communication lines shall preferably use fiber optic cabling. If coaxial or twisted pair cabling is applied, galvanic isolation should be used.

7.5 SURGE PROTECTION.

F&G System VENDOR shall ensure that system hardware is suitable to withstand voltage surges.

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8.0 GENERAL CONDITIONS

All F&G System components, as far as mechanical and electrical characteristics and performances are concerned, shall conform to this Specification.

The system shall be designed and manufactured to last the lifetime of the plant (25 years) and shall offer the flexibility of future upgrades and expansion.

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

Any omission in these requirements shall not relieve the VENDOR of this obligation to provide a fully functional and dependable system.

The scope of supply shall include the F&G System facilities.

The F&G VENDOR responsibilities shall include, but not limited to:

- a) Database development for F&G System
- b) F&G System hardware and software configurations
- c) Transfer of data from F&G System to DCS

The DCS VENDOR shall be appointed as the IPCS VENDOR to manage the system interfaces between the DCS and the other systems and equipment VENDOR's that interface to it. CONTRACTOR will retain management of the IPCS contract, and will assist the IPCS VENDOR with his interfaces.

The role of the IPCS VENDOR shall be to:

- a) Coordinate and manage the engineering of the interfaces between the various systems and sub-system VENDORS to meet the IPCS project schedule.
- b) Ensure that all the physical interfaces can communicate with each other through the correct configuration of communication ports and protocols.
- c) Ensure that the DCS database and the other systems' databases are synchronized
- d) Co-ordinate and manage all necessary tests, including FAT and SAT
- e) Arrange for major systems to be brought together for Factory Acceptance Testing.

This shall ensure data compatibility, display conventions, address details and data accuracy.

The F&G SYSTEM VENDOR shall coordinate with the IPCS VENDOR to ensure that the above objectives are met.

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8.1 QUALITY ASSURANCE / QUALITY CONTROL

The VENDOR shall have in effect at all times, a QA/QC program that clearly establishes the authority and responsibility of those responsible for the quality system. Persons performing quality functions shall have sufficient and well defined authority to enforce quality requirements, initiate, identify, recommend and provide solutions to quality problems and verify effectiveness of the corrective action.

A copy of the VENDORS QA/QC program shall be submitted to the CONTRACTOR with its quotation for CONTRACTORS review and concurrence prior to the award. If VENDOR's QA/QC program and facility, where the work is to be performed, is ISO 9001:1994 or ISO9001:2000 (including design) certified, then only a copy of the VENDORS ISO 9001 certificate is required. In addition, if VENDORS facility is ISO certified, CONTRACTORS QA audit requirements will be waived in favor of ISO 9001:1994 or ISO 9001:2000 (including design) registrar audits, unless the CONTRACTORS trend analysis program indicates areas of concern.

The VENDOR shall identify in purchase documents to its SUBVENDORS all applicable QA/QC requirements imposed by the CONTRACTOR, and shall ensure compliance thereto. On request, VENDOR shall provide objective evidence of its QA/QC surveillance of its SUBVENDORS activities.

The VENDOR shall submit certified reports of production tests as soon as the tests are completed satisfactorily.

The CONTRACTOR reserves the right to inspect materials and workmanship at all stages of manufacture and to witness any or all tests. The VENDOR, 30 days after award but prior to the pre-inspection meeting, shall provide the CONTRACTOR with a copy of its Manufacturing and Inspection Plan for review and inclusion of any mandatory CONTRACTOR witness points.

8.2 PROJECT MANAGEMENT AND PLANNING

VENDOR shall appoint a Project Manager who shall take overall responsibility for all aspects of the project. This appointment shall be on an exclusive and dedicated basis for the duration of the project, up to successful completion of the Site Acceptance Tests. The appointment shall be subject to the approval of the CONTRACTOR. The Project Manager shall be the sole contact point for all official correspondence between VENDOR and CONTRACTOR.

VENDOR shall present a fully resourced, planning schedule showing all significant activities from Purchase Order award through to completion of Site Acceptance Test. The chart shall show commercial milestone dates as agreed in the PO, and dates for issue of VENDOR'S documentation in accordance with the VDRS.

The planning schedule should also show dates for receipt of documentation from CONTRACTOR such as I/O Database, field cabling information, P&IDs, Logic Diagrams, Graphic Details, etc.

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8.3 DISCREPANCY AND DEVIATION LIST

Any conflicts and or exceptions to codes and specifications shall be clearly identified to the CONTRACTOR in writing with the bid proposal by the VENDOR. The more onerous and more stringent requirement in such a conflict shall be deemed to apply. All concessions to exceptions and deviations must be individually approved by the CONTRACTOR prior to proceeding with the work.

The VENDOR's proposal shall be considered to be in full compliance with project specifications and international and national standards, with the exception of any formal concession/agreements made by the CONTRACTOR to any exceptions and or deviations highlighted by the VENDOR

VENDOR shall prepare a discrepancy and deviation list against this specification in the bid documents.

The discrepancy and deviation list shall be prepared in a tabulated format, with the discrepancy and deviation listed against each section and sub-section(s) in this specification. Where there are no discrepancies and deviations, this shall be stated against each applicable section/sub-section.

8.4 VENDOR'S SCOPE

The VENDOR shall be responsible for supply of the following, in accordance with the criteria defined within this specification:

- Management of the supply of the systems, including project management, interface management.
- Engineering of the systems.
- Documentation.
- Assistance to the DCS VENDOR for development of the Operator Control Stations, graphics, alarm management, other operator interfaces.
- Stand-alone F&G system for the project.
- All system hardware, including I/O modules, processor units, power supplies, system racks and system cables, as defined by this specification.
- F&G matrix panel, complete with lamp and push buttons dedicated for each zone and buildings

h) (By ESD VENDOR) For monitoring and operator interface One operator work station, common for ESD and F&G along with 32" LED/LCD monitor & keyboard and the operating software which resides the Control Room (CCR) of the Control Building.

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- i) One **operating/engineering** F&G Workstation for **operating/Configuration** along with 32" LED/LCD monitor & keyboard and the operating software which resides in the Engineering Room of the Control Building.
- j) Data management of F&G related field devices in field and building including flammable & toxic gas detectors, flame detectors, smoke & heat detectors, manual alarm call points, beacons and alarm sounder, etc. Detectors inside building (Except those installed in battery room) shall be addressable and be connected to F&G panel as Addressable loop or to Addressable Fire Alarm panel (if any). All hardware parts of system shall be of industrial type. Software licenses shall be valid and authorized.
- k) One industrial laptop computer with the latest technology shall be considered for configuration purposes. All required hardware and software with valid and authorized license shall be included
- l) All DC power supplies for the system cabinets, IS isolators (if any) and field I/O.
- m) Power Distribution for On/Off actuated valves (24V dc).(If any)
- n) System cabinets to house the required hardware, terminals, power supplies, ferrules, panel wiring.
- o) Marshalling cabinets, including IS isolators (if any), terminals, power supplies, ferrules, panel wiring etc.
- p) All interconnection cables between the marshalling cabinets and system cabinets and all system internal power wiring cables. This excludes all fields cabling between the field devices and the marshalling cabinets.
- q) All system interface modem pairs including fiber optic drivers where required.
- r) All necessary software and firmware complete with licenses. This shall include management of the fiber optic backbone and firewall protection for interfaces with 3rd parties (if required).
- s) Interface to DCS information (Redundant Modbus TCP/IP) bus.
- t) System configuration.
- u) Design, verification, FAT and SAT.
- v) Provision of after sales services, including, but not limited to Commissioning, Training, Spare parts and Special Tools.
- w) All F&G system components shall be according to BS54 or have authorized certification e.g. be UL (Underwriters Laboratories) / FM (Factory Mutual) certified.

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- x) All interface cabling and cards (hardwired or serial) for communication with other systems (Fire Water Pump package, HVAC, ESD system, and PCS and FFCP, etc. as shown in detail in Block Diagram Configuration For Control/ESD/F&G System (BK-PPL-PEDCO-320-IN-BD-0001)

8.4.1. Scope Of Supply General Requirements

The F&G Systems shall include, based on the F&G System Sizing Data the following:

IN INSTRUMENT TECHNICAL ROOM(ITR)

F&G System including system and marshaling cabinets is to be stand-alone in Technical Room.

F&G System in ITR will be responsible for all safety Cause & Effect actions of the PLANT.

Additionally, Individual cabinets will be provided to house the F&G Systems.

In ITR, the F&G systems trip and alarm points will be connected into the ESD System by way of fail-safe hardwired discrete dry contacts. In Detail Design stage, it will be determined which signals are to be connected to the ESD System.

One maintenance inhibit station shall be supplied for F&G System in ITR by F&G System VENDOR.

The ability to adjust alarm and trip set-points, initiate bypasses and overrides on the F&G System will be possible from F&G Maintenance/Inhibit Workstations located in ITR which shall be supplied by F&G VENDOR.

IN CENTRALCONTROL ROOM (CCR)

Contained within the Central Control Room will be Common Services Consoles (F&G Matrix Panel) to be located beside an OCD and composed of manual pushbuttons (if any) and lamps.



The F&G System will accept all hardwire input/output from/to the CSCs (Common Service Console) in the CCR.

To configure all aspects of F&G system, one F&G Engineering Workstation shall be supplied for F&G System in Engineering Room by F&G System VENDOR.

The F&G system also gets the hardwired signals from dedicated fire alarm panels for non-process buildings i.e. administration building, warehouse, workshop, Laboratory, etc. These signals will be transferred to The Matrix Panel through the F&G system (If any).

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8.5 FUNCTIONAL DESIGN SPECIFICATION (FDS)

The F&G 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 CONTRACTOR 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
- Document issue dates
- Performance calculations
- Availability/reliability analysis
- System constraints and limitations
- Electrical Load/Heat Release Calculations
- Physical dimensions of the cabinets and console
- Details of the components within the scope of supply
- Details of the Operator Interfaces.

9.0 GENERAL DESIGN REQUIREMENTS

9.1 OPERATING REQUIREMENTS

The Integrated Plant Control System (IPCS) consists of Distributed Control Systems (DCS) and safety systems. The IPCS provides for the control and safeguarding of the PLANT, via an integrated Distributed Control System (DCS) with interfaces to ESD and F&G systems.

All normal operations shall be carried out from the Control Room, DCS and safety systems to be made up of standard hardware and software components which has been proven in service and has demonstrated high reliability in the particular field of application.

The F&G System VENDOR shall offer a cost-effective solution that is fit-for-purpose for the operational and safety needs of the project. The VENDOR shall supply a list of previous projects utilizing the equipment proposed and clients / projects the equipment was utilized on for the CONTRACTOR to review.

The F&G systems shall transmit data to the DCS system via redundant data links.

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9.2 AREA CLASSIFICATION

The IPCS equipment shall be installed and located in normally unmanned Auxiliary Room. It includes, but not limited to the following cabinets for related process units:

- DCS, ESD, F&G cabinets including internal power supply units and distribution, processor units, input/output cards, communication interfaces
- Marshalling cabinets for cross connection between field/MCC equipment and system I/O cards
- Power distribution panels
- Maintenance/Inhibit Workstation for ESD and F&G Systems
- Unit Control Panel for Critical Packages

Auxiliary room shall have air-conditioning units to maintain suitable environmental conditions for the installed equipment and occupation.

Electrical and electronic instrumentation for installation in hazardous area zones shall be certified in accordance with the definitions given in IEC 60079 'Electrical Apparatus for Explosive Gas Atmospheres'.

Explosion proof EEx (d) type shall be used as the prime method of protection.

For any equipment located in Zone1, Intrinsically Safe Protection (EExi) classification shall be applied.

The other allowable alternative methods of hazardous area protection are listed below in order of preference:



- **Intrinsic Safety, type EEx (i)**
- Explosion Proof EEx (d)
- Increased safety, type EEx (e)
- Special protection, type EEx (s)

Where applicable, galvanic isolator protection devices shall be used for intrinsically safe circuits unless where specific field devices require Zener-diode safety barriers according to its' manufacturer advise.

Solenoid valves utilized in hazardous areas shall be the explosion proof EEx (d) type, powered from 24V dc generated by the safety systems.(for deluge system)

9.3 F&G SYSTEM CERTIFICATION

The F&G system including hardware, Engineering Workstation and software shall be implemented via fully automated, secure, high integrity redundant Programmable Logic Controllers (PLC)

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certified to DIN V 19250/0801 AK Class 5/6 or IEC 61508 SIL 3 as a minimum (Except for FACP of buildings, if any).

VENDOR shall provide certificates of conformance to IEC 61508 and DIN V 19250/0801 stating the Safety Integrity Level /AK Class, TUV certifying organization, design and operating restrictions, if any.

9.4 ELECTRICAL CERTIFICATION

All electrical and non-electrical equipment and protective systems, for use in potentially explosive atmosphere shall be according to ATEX 94/9/EC or CENELEC equivalent directive.

9.5 SAFETY INTEGRITY LEVEL (SIL)

The F&G system shall be implemented in Programmable Logic Controllers certified by TUV to SIL 3 as a minimum. (Except for FACP of the buildings, if any).

Generally, the safeguarding systems shall be designed to operate on a Fail-Safe configuration i.e. executive actions shall be activated on failure of loops and/or systems.

All Fail safe and Non-Fail Safe input and output circuits shall be line monitored for integrity. Alarms shall be generated if circuits are faulty.

The F&G system shall employ a fail-safe concept; i.e. the F&G system shall revert to the least hazardous condition upon failure of any module, logic processor, field sensor, actuator or power source. This requirement shall generally be achieved by applying a 'de-energies to trip' design. During normal operation, with the plant in a healthy condition, inputs from sensors, the logic system, and outputs to the final control elements shall be energized. The system will interpret the de-energizing of an input as a trip demand and will de-energies the appropriate outputs to initiate a process shutdown. This design shall also ensure isolation / shutdown on loss of electrical power to the system inputs, outputs or logic.

9.6 CYCLE TIMES

Maximum cycle time for the F&G system systems shall be limited to 300 msec, taking into consideration a spare processing capacity of 50%. This requirement is mandatory and shall apply when all the spares and expansion capability required for the system are utilized.

The cycle time shall be determined based on a change in input, logic processing of all safeguarding logic and output at the I/O module.

To ensure that maximum cycle time is within the above requirement, adequate numbers of CPUs shall be provided during the Bid Stage by F&G System VENDOR, with due consideration for possible expansion.

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Voting logic and the number of analogue inputs will significantly affect the cycle time load, and these shall be considered in detail when assigning applications to a PLC by F&G System VENDOR.

9.7 PROVEN EQUIPMENT CRITERIA

Only equipment of 2 year proven reliability in similar service conditions during bid stage shall be supplied (prototypes shall not be proposed). The VENDOR shall provide the related necessary evidence (reference lists with installation dates and run hours accumulated by date, etc.).

Where the requirements above prevent the application of the latest technology, the VENDOR shall submit a second alternative proposal incorporating the latest technology features for evaluation by the CONTRACTOR. This alternative proposal shall specifically identify the un-proven features and state their advantages. The alternatively proposed system shall have equivalent design features to the system previously proposed.

Variations in the selection of system and system components shall be avoided. This is to reduce engineering, procurement, commissioning, maintenance, training, spares holding and operations costs. The hardware modules shall be inter-operable and interchangeable between all F&G cabinets. Versions of internal operating system software for all F&G system shall be identical.

Where sections of a system are to be delivered in separate intervals, one software version shall be used for all section. Update of all system software shall be agreed with CONTRACTOR. All software licenses and access to manufacturer's support shall be provided.

10.0 F&G SYSTEM REQUIREMENTS

The F&G system specified herein shall form part of the overall Process Safety System for the project. It shall integrate and interface with the ESD and Distributed Control System to form the Integrated Process Control System (IPCS).

The F&G system shall encompass both PLANT areas and PLANT buildings, and shall provide for sequence of Events Recording (SOER) in conjunction with the DCS. The Fire & Gas system shall continuously monitor the PLANT for hazardous conditions such as the presence of flammable and toxic gases, and detect fires via dedicated sensors wired to the inputs of the Programmable Logic Controllers. The PLCs shall then generate actions, as determined by the pre-programmed logic.

Information gathered by the F&G system shall be transferred to the DCS system for display, monitoring, and control. Additional 3rd party Fire Alarm (FA) systems (if any), which are located within the non-process buildings, shall interface directly to the F&G system for status display and monitoring only.

A connection between the DCS and the F&G system shall be provided in ITR.

The VENDOR shall be responsible for provision of the following items of equipment in each system, as a minimum, in accordance with the criteria defined within this specification;

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- All system hardware, including all I/O modules, processor units, power supplies, system racks and system cables, as defined by this specification.
- Engineering Workstations.
- All required DC voltage power supplies for the system cabinets, IS isolators (where applicable) and field I/O.
- System cabinets to house the required hardware.
- Marshalling cabinets, including IS isolators (where applicable), terminals, power supplies, ferrules, cabinet wiring, etc.
- All interconnection cables between the Marshalling cabinets and system cabinets.
- All system software, including all configurations and programmed application logic, specially written programs to enable the system to function and interface to other systems as specified.

F&G systems will be interconnected to the DCS by redundant Modbus TCP/IP communications. On failure of one cable, the systems shall fall back to the remaining cable. On failure of all communication links between the two systems, the F&G systems shall continue to provide all safeguarding functions. VENDOR shall configure the systems to meet this requirement identifying operating procedures required to be put in place in accordance with the TUV guidelines.

10.1 F&G GRAPHIC DISPLAYS

The graphic displays shall show the entire status of the F&G system. The graphics shall be viewed via the DCS operator workstations and the status shown shall include normal, alarm, fault, and inhibit conditions for all field devices.

Additionally, flammable gas detector LEL and toxic gas detector (if any) ppm levels shall be displayed at all times. Detector types shall be indicated by means of colored indications that shall be developed throughout the course of the detailed design phase of the project.

An overview graphic shall also be provided; this will consist of a simplified geographical layout of the plant areas that are to be monitored. Common indications for fire, flammable gas, toxic gas, MAC, and detector fault/inhibit shall be provided in each of the PLANT areas shown on this graphic.

- F&G detector layout graphics,
 - ✓ These shall include the status of individual sensors in the area, or the zone status, together with the status of deluges, and extinguish ant systems. These displays shall include wind speed and direction for open areas of the plant.
- F&G overview displays

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- ✓ These shall be of matrix type, or arranged geographically, and shall show the F&G status for plant areas, or for the whole plant.

- Text displays such as F&G alarm summaries

Generally OCD shall have the capability of displaying any data from all parts of the plant regarding to F&G system.

The F&G system VENDOR shall assist the DCS VENDOR as required for the production of the F&G graphics.

10.2 F&G DISPLAY MATRIX

This panel shall display the status of the F&G detection and protection systems. The F&G display matrix shall be driven by hardwired outputs from the I/O modules, and shall also allow manual remote activation of the Deluge Systems. These shall be hardwired to the inputs of the PLC.

The F&G Matrix panel will be mounted in the Control Room.

It should also display common indications for fault and alarm conditions within the process areas, including, but not limited to:

- Manual Call-point Activated
- Fire
- Flammable Gas
- Toxic Gas (if any)
- Fault/Inhibited Device
- Fire Water Pump Status (if any)
- Fire Pump Manual Start (if any)
- Status of Packaged Units F&G systems
- Activation of Packaged Units F&G Extinguishing agents (Inert Gas)

Detector types shall be indicated by means of colored LEDs. Color codes for the following indications shall be:

Toxic gas (if any)	Blue
Flammable gas	Yellow
Fire	Red
System fault	Red
Fire water pump running lights	Orange
Other alarms	Red

Flammable gas visual alarms should distinguish between High (H) and High High (HH) values by assigning one LED to H and one LED to HH level. Plant common alarms shall be grouped in the

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top left-hand corner to facilitate quick appraisal by operating personnel. Each alarm shall be presented by means of a colored lamp and the corresponding text as appropriate.

The normal situation shall be indicated by extinguished LEDs and lamps on the panel. In the event of an alarm, the relevant LEDs and lamps shall start flashing. After acknowledgement the flashing shall stop and change into steady light, but be reactivated on the recurrence of any alarm condition. Return to the normal situation, after acknowledgement, shall extinguish the LEDs and lamps.

An audible alarm shall be provided on the panel, with an intermittent 2000 cycles/sec tone.

An alarm acknowledges pushbutton shall be provided to silence the audible alarm and stop the flashing visual alarm. Remote alarm silence acceptance shall also be provided from the DCS operator station.

10.3 F&G SYSTEMS

F&G Systems are dedicated to:

- Detect presence of fire and/or gas leak to protect personnel, environment and field equipment.
- Perform the related logic to control firefighting equipment, deluge valves, HVAC shutdown.
- Control and monitor the fire water pumps. (if any)

In case of F&G detection in process areas the F&G functions initiate ESD functions.



Initiation of Manual call Point (MAC) trigger alarms without automatic action.

Fire Fighting Control Panel (FFCP) related to the CO2 package should be linked to F&G system to receive release commands during emergency cases. Package and lighting status will be sent to F&G system through this panel.

10.4 INTERFACES BETWEEN THE SAFETY SYSTEMS

Trip signals between F&G and ESD systems or VENDOR packages shall be performed by hardwire signals.

F&G Systems are part of the IPCS; they communicate with:

- DCS, via redundant Modbus TCP/IP serial communication link, for non-safety actions such as reset and for alarms and monitoring,
- Fire Alarm panels in non-process buildings (if any - redundant Modbus RTU serial link (RS-485).

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- F&G matrix panels on OCD for safety command and alarms (Hardwired)
- HVAC for shutdown (Hardwired)
- Inert Gas control panel located in CCR (Hardwired)
- Fire Fighting/ Deluge system (if any - Hardwired)
- Fire Water pump (if any - Hardwired)
- F&G Interfaces to PA/GA System for the purpose of activation of audible alarms (Hardwired - if any)
- Package UCPs such as Gas Turbine (Hardwired)
- Annunciator for acknowledge and lamp test (common with ESD) in CCR

11.0 EQUIPMENT DESIGN AND MANUFACTURING

11.1 SYSTEM ARCHITECTURE

The F&G system shall be based on multiple logic solvers and shall be distributed amongst the F&G system cabinets. The logic solvers shall be interconnected via TUV approved data links for interchange of safeguarding data.



Refer to documents no: **BK-GCS-PEDCO-120-IN-BD-0001** 'Control/ESD/F&G System Block Diagram Configuration' & **BK-W007S-PEDCO-110-IN-DG-0001** 'Block Diagram Configuration for Control/ESD/F&G System - Extension of Binak B/C Manifold, **BK-PPL-PEDCO-320-IN-BD-0001** 'Block Diagram Configuration For Control/ESD/F&G System' for illustration of the plant F&G system.

11.2 RELIABILITY/AVAILABILITY

The systems shall be designed such that failure of a single component shall have a no impact on the operation of the systems. The systems shall contain diagnostic routines to alert the operator of such a component failure.

The F&G system is categorized for a probability of failure on single input demand:

- Less than 1xE-3 (SIL3) for F&G functions

The minimum overall availability of the systems shall be 99.99%. The Mean Time to Repair shall be 4 hours.

VENDOR shall carry out numerical analyses to determine reliability and availability figures in the form of Mean Time between Failure (MTBF) and Mean Time to Repair (MTTR) figures for their systems. This analysis shall also include a breakdown of the possible failure modes and their effects.

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11.3 SYSTEM HARDWARE REQUIREMENTS

11.4 GENERAL

The F&G system shall have the following characteristics:

- Input and output cards shall have galvanic isolation between field equipment and the system.
- Each I/O channel shall be fully isolated and shall operate in parallel.
- All discrete I/O that shall be line monitored.
- I/O cards shall be designed such that short-circuit or a high-voltage on one I/O channel will not induce a fault on any other I/O of the card.
- 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.
- Design of the system shall employ low drain device and circuit design technique to reduce the power requirement to a minimum.
- 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. F&G system shall provide full status information on F&G maintenance/inhibit station in Auxiliary Room plus operator workstation in **CCR**.
- 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.
- All F&G System I/O modules shall be capable of operating during voltage variations up to +/-10% and frequency variations up to +/- 5%.
- To assess the recommendation for spare parts, theoretical failure rate figures of all boards, power supply units etc. in the system shall be provided by F&G System VENDOR.
- Input circuits shall be type-tested for surge/burst withstands capability in accordance with IEC-61000-4-5.



11.5 REDUNDANCY

The logic solver portion of the system shall be implemented in redundant Programmable Logic Controllers (PLC) arranged in a 1oo2D configuration as defined and certified to DIN V 19250/0801 or IEC 61508 as a minimum.

The VENDOR shall design, engineer and configure the systems so that all critical components are redundant and that failure of a single component shall not result in the loss of control, data transfer

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or operator interfaces. The following components, as a minimum, shall have redundancies incorporated:

- a) Logic Solver CPUs (Dual redundant and independent processors).
- b) Data Highway linking PLCs.
- c) Power Supplies.
- d) DCS system interface gateways.
- e) Hot- replaceable Field Input/output modules.
- f) Dual redundant input cards (2 out of 2 voting and via two separate paths to processor).
- g) Dual redundant output cards (2 out of 2 voting and receiving data from CPU's via 2 separate paths).
- h) Critical External system interface units.

Redundant DC Power Supply Units supplied as part of the system shall share the load, with maximum loading of any one DC Power Supply Unit of 50%.

In the event of failure of a component, the redundant unit shall take over from the faulty unit. The faulty unit shall be marked as 'failed', and annunciate on the Operator Workstation in CCR.

Failure of any unit shall annunciate on the DCS operator workstation, and internal diagnostics provided to aid troubleshooting and rectification.

The Highway shall be dual redundant, TUV approved and have the same safety integrity level of the F&G system.

11.6 I/O SIZING ASSIGNMENTS/ REDUNDANCIES

The following considerations shall be taken into account when planning and designing the system:

- VENDOR shall state the number of channels per I/O module card that the system will employ in their bid proposal.
- Where process equipment is redundant or spared, the I/Os of each equipment shall be installed on an individual card, and if possible on individual racks.
- Signals on one process unit to be connected to the same controller
- Signals from one equipment unit to be connected to the same card.
- Redundant channels shall not be on the same card. Rack to rack redundancy is required.
- Spare signals shall be considered for each process unit and for each different signal type

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- I/O signals used for display/monitoring purposes, shall be considered as non-redundant type, while the signals used for control/trip actions shall be considered as dual redundant type.
- Spare I/Os shall be distributed among I/O cards

Redundant CPU and inter-processor communications shall be provided. CPU redundancy shall be designed to ensure continued automatic control in the event of CPU failure. This means that:

CPU redundancy shall be provided based on hot-standby method.

At the same time the backup CPU shall automatically take over all card functions and safeguarding.

Failure of any CPU shall cause an alarm to be generated on the OCD and be logged. For all logic functions, redundant I/O channel configuration shall be provided. Redundant I/O channel configuration shall be understood as 'duplicated I/O cards in separate racks' so that one card can be removed on-line without causing a trip or inadvertently stopping equipment.

11.7 MAIN PROCESSOR MODULES

The main processors shall operate in parallel and as one integrated unit, with each processor controlling one leg of the I/O bus. Processor architecture shall be transparent to the CONTRACTOR.

For F&G system CPU maximum loading shall be 60% in any condition.

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.

Identical operating software and application programs, including fault history residing in each processor memory shall be executed independently. The processors shall also execute a one-out of-two voting or two out of three voting in all data received and transmitted to the I/O modules that control the process. Two faulty processors shall cause PLANT shutdown (to be advised by F&G VENDOR).

A self-checking routine shall be employed in each system to monitor, as a minimum, the repetitive cycle of operations. The state of each critical component shall be continuously monitored. On detection of a fault or abnormal condition, an alarm on DCS side (operator workstation in CCR) shall be generated.



Input signal shall be separated into two or three isolated paths from the input channel of the input module to the voter circuit output.

Logic control shall be supported by the main processor: As a minimum, the processor shall contain the following configurable functions stored in non-volatile memory:

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- 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.
- Boolean: And, Or, Nand, Nor, Xor, Nxor.
- Miscellaneous: Timer, Delay counter, Sequencer, Flip-flop memory.
- Ladder Symbols: NO contact, NC contact, 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 nonvolatile memory.

It must be possible to reprogram the system using simple method. VENDOR shall confirm.

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

All facilities necessary for making modifications to the logic system should be provided on a portable console.

11.8 COMMUNICATIONS

The F&G system shall be interfaced with the DCS to provide operator information, to permit a limited range of operator actions, and for event logging purposes. This shall be achieved via redundant serial communication links (Modbus TCP/IP) to the DCS, fast communications utilizing the following communications protocols in order of preference:

1. MODBUS TCP/IP
2. MODBUS RTU RS 485
3. OPC

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

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References of operational links with DCS systems shall be given with the VENDOR's offer.

The F&G System VENDOR shall provide (during the detail engineering phase) the specification of the F&G 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.

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

Gateway functions shall include, but not limited to the following:-

- Transmittal to DCS of safety systems inputs, outputs, faults and general diagnostic information.
- Transmittal to safety systems of selected DCS outputs including logic resets and device overrides.

Use of a gateway for the above functions shall not degrade the safety integrity of the safety system and its associated certification. Gateway loading shall not exceed 50% of its capacity at any time. To maintain the specified loading requirement an adequate number of gateways shall be provided.

The communication interfaces shall have internal and self-diagnostics that ensure data integrity and operational security. Identification and location of faults and status shall be automatic.

Faults and failures of the communication lines shall not degrade the safety system reliability.

Loss and re-instatement of data communication shall not result in trips or status changes of the communication points. Recovery of communication shall be automatic. The VENDOR shall indicate the type of output (hardwired) that can be made available, to permit (back-up) annunciation of communication failure at the OCS.

Transfer to a back-up communication module or channel shall be automatic without disrupting the system operation.

The VENDOR shall provide the complete reference and datasheet of the proposed communication modules at bid stage.

11.9 SYSTEM DIAGNOSTICS

The F&G system shall have internal diagnostic facilities to continuously monitor the status of the system.

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As a minimum this shall include testing of all input and output circuits, I/O modules, logic processing modules and communications facilities. Testing shall be comprehensive, testing all paths in the system while, where possible, avoiding the addition of significant quantities of auto-test hardware.

Test programs should preferably be in firmware, and the use of application software based test programs should be avoided.

VENDOR shall state the optimum frequency for the automatic self-test routine necessary to maintain the requirements of system availability and reliability. It shall be possible to manually initiate the self-test routines from the equipment cabinet.

The result (healthy/fault) of the self-test shall be reported to the DCS for logging and alarm annunciation.

On receipt of any trip demand, the auto-test routine shall not inhibit the processing and implementation of the logic function required.

Should a fault be detected the system shall automatically adapt to maintain its ability to meet a demand.

No fault condition shall remain undetected.

The VENDORS Functional Design Specification (FDS) shall describe in detail the software and hardware self-testing routines.

Any failures, faults, or predicted failure conditions shall be annunciated to the operator via the workstations and to be transmitted to DCS for display and logging in OCS. Examples of faults shall include, but not be limited to:

- a) Check voting and fault detection circuitry,
- b) Verify all memories,
- c) PLC Faults, including CPUs, racks
- d) Watchdog fault
- e) Internal communication fault
- f) External Communication Fault
- g) Data Highway Faults.
- h) Internal Memory Failures, etc.
- i) Input / Output Module Faults.

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- j) Diagnostic check of operating system and user programs
- k) Provide faults information to the operator.
- l) Reveal all hidden and potential fault occurrence.
- m) Power Supply Faults.
- n) Fan Failure.
- o) Cabinet Common Alarms, etc.
- p) Earth Leakage Fault

The faulty units shall also be highlighted on LEDs located on each module and the fault logged via the system diagnostics. The alarms shall only be cleared after the faults have been rectified. Transient faults shall also be recorded and logged. Once the number of transient faults has exceeded a preset limit, the device shall be marked as faulty.

The DCS systems shall be equipped with remote diagnostic facilities to enable diagnosis of faults from a remote OCS. Fault signals will be transferred to DCS via the existing communication link between DCS and F&G.

Diagnostic alarms shall be accessible by the maintenance/inhibit station and displayed at the system modules.

F&G PLC shall provide a watchdog contact (free-voltage contact) in case of F&G System common fault.

This signal shall be monitored continuously by the DCS.

VENDOR shall describe in detail the system diagnostics (type of diagnostic, scan time...) and which alarm signals are available.

11.10 TIME SYNCHRONIZATION

The DCS shall provide time synchronization signals to all sub-systems that have an internal real-time clock and can accept time synchronization commands from the DCS. The time shall be derived from a Global Positioning System (GPS) receiver signal and be distributed by the DCS to the sub-systems linked to the DCS. Time synchronization shall be performed at a specific time every 24 hours. The DCS shall set the time in the sub-systems via hard wired links to each system.

The time synchronization facility shall enable all sub-systems to display identical times to assist in plant upset investigations.

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The F&G System shall accept time-synchronization signals via the link from the DCS system to synchronise the internal clock to the DCS. The F&G VENDOR is required to liaise with the DCS VENDORS to determine how the time synchronization is to be carried out. The synchronization shall be performed once a day, every day.

11.11 SMART TYPE DEVICES

Field devices will be smart devices with 4~20 mA signal and superimposed HART protocol. Those devices will be connected to HART input/output cards and the relevant HART data will be transmitted directly to the Instrument Asset Management System (AMS) through the I/O cards and the DCS communication network.

HART information of the smart devices of the ESD/FGS/UCP sub-systems will be made available in the PC based Asset Management System (AMS)/Plant Resource Management (PRM) through multiplexors to which the smart devices of the third party systems will be connected. These multiplexors shall be supplied by related sub-system supplier. Communication cards to be installed in AMS workstation for communication with sub-system HART devices must be supplied by the DCS Vendor with necessary software if any.

Vendor is responsible that full database of all purchased smart transmitters (Hart) will be available on his software to communicate with them.

12.0 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.
- Lighting controlled by door switches and manual switch on/off
- A general purpose socket outlet, served by the general platform supply, rated for 230V AC single phase.

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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.

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.

12.1 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

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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.

12.2 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 a 2-component epoxy resin cement near to the equipment on non-removable parts of the cabinet.

13.0 HUMAN MACHINE INTERFACE

The normal operator interface to the F&G system shall be via the F&G operator workstations. The Operators shall have the capability to initiate manual over-rides, inhibits and resets via the F&G Operator Workstations. No output overrides shall be permitted. The entire status of the F&G system shall be viewed on the F&G operator workstations.

The F&G System VENDOR shall assist the DCS VENDOR as required for the production of the F&G graphics and alarm management. The DCS systems shall manage alarms in accordance with internationally recognized guidelines. Details of alarm management shall be contained in project document **BK-GNRL-PEDCO-IN-SP-0002 "Specification For Control System"**.



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13.1 OPERATOR INTERFACE

Operator Interfaces dedicated to F&G System is provided as follows

13.1.1 In CCR

Refer to document BK-GNRL-PEDCO-IN-SP-0002 "Specification For Control System".

One F&G matrix panel, on OCD composed of light indicators, which shall be hardwired from the F&G System I/O modules. These panels shall display the status of the F&G detection, of the **MACs** and of the main firefighting equipment (if any). PB's located below these panels shall allow remote activation of deluge skids of relevant areas.



13.1.2 In Engineering Room

An Engineering station including industrial fan less type PC, Industrial Monitor and keyboard shall be provided in engineering room.

13.1.3 In Field

PB's will be available in the plant as follows:



- **Manual call Points (MAC)** for fire alarms (without automatic shutdown) linked to F&G System
- Manual Release (MR) deluge valves

13.2 OCS DISPLAY REQUIREMENTS

The F&G VDU's on each Operator Control Desk shall provide alarm summaries, plant overview and detailed displays to identify the location of the hazard.

13.2.1 F&G Graphic Displays

Alarm summaries shall list all individual F&G alarms and sensor fault alarms.

A plant overview display shall provide common alarm indications of F&G situations

The main functions are to be displayed as follows:

- Individual F&G alarms,
- Sensor fault alarms,
- Release of extinguishing agent,
- Fire water system status (If any)
- HVAC system status.

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Wind direction and velocity shall be displayed on graphic display. Symbols for gas alarms should distinguish between High and High-High alarms. The analogue value 0 to 100% LFL bar chart of the gas detector input shall only be available on the maintenance station and on the DCS OCS in **CCR**.

13.3 FIRE & GAS ALARM AND WARNING SYSTEM

Common fire and common gas detection signals shall be provided as follows:

- Common for each zone or per group of zone (to be confirmed during detailed engineering) on the F&G alarm panel (if any)
- Common for each zone at CCR matrix panel on OCD.

All individual sensors and event alarms shall be displayed on the Operator Control Stations.

Common alarms shall be initiated by any individual alarm.

The following common alarms, where applicable, shall be provided:



- Flammable gas, High and High-High levels,
- Toxic gas, high and High-High levels, (if any)
- Fire (initiated from heat, UV/IR, smoke detectors),

The audible alarm in the **CCR** shall be part of the DCS alarm handling system. Alarm devices such as horns, beacons, shall be located in strategic areas throughout the plant and occupied buildings to alert PLANT personnel of the hazardous conditions.

13.4 FIRE & GAS MATRIX PANEL

A graphical representation of areas based on fire detection areas shall be provided on this 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.

LED driver card(s) or de-multiplexer(s) may be provided in order to minimize I/O safety wiring.

Connection between de-multiplexer and safety system shall be serial link. The Vendor will select proven and industrial devices which can performed this functionality.

13.5 DELETED

13.6 DATA EXCHANGE

The DCS is master and F&G System communication hardware and software requirements shall meet DCS capabilities.

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13.6.1 F&G System To DCS

The following data shall be transferred to the DCS:

- High and High-High LEL alarms for each gas detector,
- All analogue signal values
- Individual alarms from other detector types,
- Firefighting system status,
- Sensor fault alarms,
- Sensors inhibit status,
- Output status.

13.6.2 Addressable Fire Detection Panels

Addressable Fire detection panels installed in non-process buildings (if any) shall be provided with alarms and resets facilities and only general alarms, per type, will be reported to F&G system

13.6.3 Maintenance And Operational Override Switches



The F&G systems shall be equipped with Maintenance Override Switches (MOS) as described in section **13.9.1**

13.7 INSTRUMENT TECHNICAL ROOM CABINETS

F&G System installed in ITR shall have a maintenance console provided by F&G System VENDOR, attached to indicate fault conditions such as a general system alarm, high temperature, power supply faults, earth faults, etc.

The indicators shall be driven by the local I/O modules, and shall have a local lamp test facility and reset facilities. The alarms shall be repeated to the DCS operator workstations via the F&G System to DCS links.

13.8 MAINTENANCE/INHIBIT WORKSTATIONS

Maintenance to be done by engineering workstation, or laptop provided for the F&G System to be installed in Engineering Room for start-up, commissioning and maintenance purposes.

13.8.1 Maintenance / Inhibit Station

Maintenance override functionalities described in Section 13.9.1 shall be activated from maintenance inhibit station as follows:

13.8.2 General Requirements

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All arrangements shall be taken for easy operator working.

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

- Controls of the inhibits
- Indication of individual inhibit status with alarm sent to the OCS and event log print out so that the inhibited function cannot be left engaged inadvertently
- Display of all process and system alarm with time and date stamping
- The reset of the fire detection loops shall be performed from the maintenance inhibit console operator interface
- Periodical test of field element

The associated communication link with the safety system shall be carefully designed and shall ensure highly secured communication.

A hardware key shall protect the access of maintenance inhibit unauthorized personnel and shall be available upon issue of the work permit only. In addition, several levels of password protection shall also prevent the unauthorized use of these facilities.

Type and characteristics and installation of the F&G maintenance inhibit station (PC) shall be submitted by F&G VENDOR at bid stage and shall be subject to CONTRACTOR approval.

13.9 OVERRIDES

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Master inhibit/override enable key-switch shall be provided at the CSC (**Common Service Console**) panels in accordance with TUV Maintenance Override Procedure "Maintenance Override Procedure" Version 3.0 – 20 October 2000. The purpose of these key-switches is to enable operators to have the capability to initiate manual overrides, trips, and input inhibits via the F&G Maintenance Workstation in AR.

Input inhibits shall be provided for all system inputs with the exception of devices which are provided for status purposes only. When an input inhibit has been applied this will not prevent the true status of the input being read at the DCS operator station, however actuation of input override mechanism shall only prevent the final related output from being tripped.

The F&G system will subsequently report to the DCS displays the status change of these manual overrides, manual trips, or input inhibits.

In the event of a total failure of communications, the DCS operator station will initiate an audible and visual alarm and all input inhibits, output overrides, and manual trips will retain their last position. Input inhibits/output overrides which are in the operated position may then be removed if required by manually returning the inhibit/override enable key-switch to the disable position.

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All input inhibits/output overrides shall be logged by the F&G System and shall be displayed on DCS graphical displays.

Override facilities shall be provided for Maintenance/test override

13.9.1 Maintenance Override Switches (MOS)

A maintenance override switch function shall be provided for all executive action inputs except for:

- Manual Commands
- Voted 2 out of 3 inputs

The following shall be adhered to:

The F&G logic shall provide a hardwired output to illuminate a lamp in the relevant 'Enable' switch to indicate an override function is 'ON' in a particular area.

Maintenance inhibit switches shall be used to inhibit trip initiators in order to enable maintenance or on-line functional testing.

Outputs shall not be overridden or isolated.

Activation of input override shall inhibit the shutdown logic function only, field input status indication and alarm function shall remain in service.

A maintenance override function is not required for two-out-of-three trip initiator configurations. For two-out-of-two trip initiator configurations a maintenance override function shall be provided for each of the initiators. Setting of one maintenance override function shall create a situation such that the configuration temporarily functions as a one-out-of-two system.

13.9.2 F&G Resets

It shall not be possible to reset any output until the input device returns to the "healthy" state or has been overridden.

Smoke detector loops require a reset facility:

- At the F&G maintenance/inhibit station in ITR,
- At the addressable Fire Alarm panels in non-process building, (if any)

Other detectors are self-resetting type.

F&G logic reset commands are provided by the operator from the OCS, via communications link.

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Maintenance override resets are discussed in the previous section.

Hardwired acknowledge, silence and reset push buttons shall be considered on F&G auxiliary Console.

All outputs generated by the F&G processors shall be auto reset – i.e. the output shall return to the non-alarm condition if the initiating device(s) returns to the healthy condition. Where an executive action is generated by the F&G system output the action shall continue until locally reset at the executive device or system, provided that the F&G initiation has returned to healthy.

13.10 SEQUENCE OF EVENTS RECORDING (SOER)

The F&G systems supplied shall have a Sequence of Event Recording facility. Events shall be recorded, time-stamped and stored in internal memory. The events shall then be transferred to the SOER printer, provided by the VENDOR. The systems shall be capable of providing recording to a resolution of equal to the scan time of the CPU.

The signals to be monitored shall not be required to be wired to special SOE Input cards/modules.

The following signals are required, but not limited to:

- Trip alarm.
- Input status (e.g., line break).
- Maintenance override.
- Feedback on maintenance override.
- Input/Output force status.
- The acknowledge/first-up reset/lamp test (for each input).
- Each individual safety system and utility and diagnostic alarms and faults.

The preferred method of SOER recording is by the DCS, via an ESD/FGS to DCS gateway, or similar, with all time stamping by the safety systems.

A common DCS historization server, servicing all DCS gateways shall be installed at the **CCR**, and be provided with common system printers for logging the SOER data.

For both above alternatives the time stamping resolution of 1 msec shall be achieved.



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13.11 INPUTS / OUTPUTS

13.11.1 Input / Output Specification

The Input/Output modules shall interface to the following types of field inputs/outputs. Process safeguarding inputs and outputs, local annunciators and switches which are used in logic are required to be wired to redundant I/O modules, which shall be hot-replaceable.

Analogue Inputs For 'smart/HART' instruments connected to the I/O modules, the capability of connecting a hand held terminal for calibration and maintenance purposes shall be provided.

All inputs and outputs shall be short circuit proof and individually isolated to provide electrical input isolation.

I/O modules shall be provided with indication of the healthy state of the module and the I/O points on it via LED's or other indicating means.

Each I/O module shall have a maximum of 16 channels.

To compensate for possible hardware failure or testing, a software "override function" shall be available to allow "forcing" of the measurement associated with a specific input point (analogue, digital or software) or to 'force' changes to an output (analogue, digital or software).

ANALOGUE INPUT

The flammable Gas Detectors (CGD and IRGD), toxic Gas Detectors (TGD) (if any) and Flame Detectors (FD) shall have integral signal processing to provide three wires 4-20 mA signal inputs to the Logic System.

Smoke detectors (SD), heat detectors (HD) and Manual call Points (MAC) may be connected in 2- wire collective addressing fire loops. Each input channel shall be capable of supporting a minimum of ten (10) detectors in a loop. VENDOR shall indicate the maximum number of detectors that can be connected on an intrinsically safe and non-intrinsically safe fire loop. All inputs are line monitored.

The F&G System shall be able to perform and generate as a minimum the following facilities for each type of detection loops:

- 1 alarm per loops for smoke, flame, heat and MP's detection loop
- 2 alarms thresholds per gas detection loop,
- Detection loop fault (auto-test, beam block, over range...),
- Open and short circuit line monitoring with generation of fault,
- Inhibit facilities for maintenance operation,

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- Detection loop alarm reset.

Non-process center administration buildings, operations center, substations etc. shall have indoor detectors connected to fire Alarm panels with hardwired common alarm inputs from panels to the plant F&G System.

Analog Input	a) 4-20 mA DC with maximum input resistance to be 250 ohms. b) 24 Vdc loop power for the 2 wire transmitters to be furnished by the F&G system. c) 1-5 Vdc input option to be provided, input resistance equal to 500k ohms or greater. d) The negative terminal to be at isolated signal ground level. The inputs shall be capable of sourcing or sinking the current. e) 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. f) Input faults such as open circuit and short circuit are to be detected by the I/O module, or F&G logic solver. g) Analogue signal scan rate: 0.25sec max.
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DIGITAL INPUTS

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

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Digital Input	a) 24 Vdc as input “1” and open circuit (infinite resistance) as “0”. b) Negative terminal to be at isolated ground level. c) Sense voltage (24 Vdc) to field contacts and inputs for proximity switches shall be provided by the F&G systems. d) Inputs shall be individually isolated. e) Inputs shall have ‘de-bounce’ filtering to eliminate spurious effects. f) The input modules/isolators shall include line monitoring function to detect open and short circuits, for non-fail-safe. g) Digital signal scan rate : 100msec max
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DIGITAL OUTPUTS

The F&G Systems shall provide the power supply for the output circuit loads. Output circuits shall be short circuit proof. Short-circuiting of one output shall not affect any other output.

The following output types shall be supported:



- Solenoid valves with coil voltages of 24V DC. The power average consumption will be 1.2 watt for Intrinsically Safe (IS) Solenoid and for **Exd** type solenoid it will be 10 watt (steady state) and less than 36 watts (start-up). Trip outputs to solenoid valves shall not be switched via relay contacts; only solid-state switching shall be used. The profile of DO signal is controlled by pulse (1 to 10 sec) or latch (released by a reset condition) signals.
- Output cards/circuits shall be provided with protection against the switching of inductive loads (i.e. solenoid valve coils) and also current overloads
- Interfacing relays (to motor control center) with coil voltage of 24 V DC and power consumption of 3 Watt. This output shall be energized during normal operation and de-energized during trip or fail safe. (if any)
- If Non-Fail safe devices such as Sirens and Beacons could not be directly driven from digital output cards with line monitoring , Interface SIL3 relays with line break detection facility shall be considered.

Control Room and/or local panel alarm lights, with lamp rating of 24 V DC and power consumption of 3 Watts, or LED's.

All outputs will generally be fail safe except inhibit signal to fire water pumps start command (to be confirmed during detailed engineering).

Full line monitoring output card (open and short circuit detection) shall be used for all high integrity outputs.

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Digital Output	a) All solenoid outputs shall be 24 Vdc. b) Solid state outputs rated at 1 A, at 24Vdc c) Relay outputs, volt-free, fully independent from each other, rated at 2A, at 24 Vdc. d) Selectable as normally open or normally closed, momentary open or momentary closed. e) Maintained to activate relays, alarms, solenoids, or other similar devices. f) Voltage to output contacts shall be provided by an external source within the F&G system. g) Momentary contacts shall have closing time of 200 msec. h) The output modules shall include line monitoring (where applicable) function to detect open and short circuits.
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13.11.2 Conversion Accuracies

The analogue-to-digital conversion (ADC) performed by the I/O module electronics for digital transmission shall meet the minimum requirements as specified below:

Minimum Resolution	16 bits
Linearity	±1 Least Significant Bit (LSB)
Repeatability	±1/2 LSB
Accuracy	< 0.15% of FSR
Common Mode Rejection	-80dB, DC to 60Hz
Normal Mode Rejection	-3db @ 8Hz, -17db @ 60Hz, -23db @ 120Hz

Each analogue input module is required to have its dedicated Analog-to-Digital Converter. VENDOR shall advise maximum resolution possible with its system.

13.11.3 Looped Sensors

Sensors utilized for detection of smoke and heat within non-process buildings shall be of the addressable looped type. Fire Alarm panel VENDOR shall propose solutions for the implementation of smoke and heat detection within buildings, using detectors and control stations that permit the rapid detection, identification and alarm of hazardous situations.

The control stations may have interface with building FA panels via serial data links, using redundant Modbus TCP/IP protocol. FA panel VENDOR may propose alternative protocols, for CONTRACTOR approval, if applicable.

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13.12 SYSTEM CONFIGURATION

13.12.1 General

Programmable systems shall be programmed with languages that comply with IEC 61131-3, in either Functional Block or Ladder logic manner.

Configuration and logic programming of the systems shall be with 'point, click, drag and drop' software, and fill-in-forms for data entry. Programming using text-based languages shall not be acceptable.

The maximum PLC scan time for the configured application logic plus an additional spare capacity shall be 300 milliseconds. With this maximum scan time, each PLC shall have a maximum loading of 60%. The VENDOR shall provide sufficient number of CPUs for the safety system to guarantee 300ms scan time.

The systems shall be capable of implementing and displaying up to 20 alphanumeric characters for tag numbers.

The application logic should have analogue signal processing capabilities. The VENDOR shall detail what capabilities the proposed systems have as standard.

The trip levels shall be implemented in threshold detectors within the application logic and not in external trip amplifiers.

The system logic shall require an Operator Reset (via DCS) following clearance of the trip initiator.

13.13 SYSTEM AND APPLICATION SOFTWARE

All F&G Software packages for programming, configuration and maintenance shall be provided. The latest release of software shall be provided.

Standard programming method shall be used.

Setting of trip alarm levels for analogue inputs, setting of timers and selection of NO/NC configuration for digital I/O shall be done by software configuration, through a maintenance interface.

Application programs should be structured into well-defined functional modules.

Application programs (software) may initially be stored in RAM memory for system testing, commissioning and plant start-up and shall thereafter be stored either in non-volatile EPROM or volatile RAM/flash EPROM memory.

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A software package should be supplied capable of comparing two application software versions and to indicate where the variations have taken place.

13.14 ENGINEERING WORKSTATIONS

The F&G System shall be equipped with an Engineering Workstation, which shall be used to configure all aspects of the system, including all logic, inputs/outputs, and communication modules and links. The Engineering Workstation shall be capable of downloading the system configuration and application logic into the PLCs that have been networked together via the Safety Network. VENDOR shall advise if other arrangements/configurations are envisaged.

The Engineering Workstation shall be a stand-alone unit. It is envisaged that the Engineering Workstations shall be equipped with high resolution Visual Display Units (LCD type) , CPUs, Hard Disk Drives and data back-up storage units (DVD, CD-Writer, keyboard, mouse and communication interfaces with the F&G System.

An additional portable Engineering Workstation (laptop) shall be provided for maintenance and downloading configurations into the PLCs, in the event that the network is not available. This portable unit shall have the same functionality as the main Engineering Workstation.

The Engineering Workstation and the laptop PC shall be of robust, industrial type. These shall be of the highest standard specification available at the time of order, in relation to technology, processor speed, monitor, memory, hard disk size, etc. and shall include the following, as a minimum

- a) Portable carrying case (Laptop).
- b) USB ports USB.2
- c) Video card.
- d) Connection for external parallel devices.
- e) Connection for external serial devices.
- f) 32" LCD Color monitor for desktop unit
- g) QWERTY keyboard (UK/USA character standard)
- h) Pointing device connection and pointing device: Mouse, touch pad or equivalent.
- i) Battery pack/spare battery pack and external battery charger (Laptop)
- j) Power cord
- k) Internal power supply.

The configuration software shall be capable of being utilized in several modes; operator (view only), supervisor (view and inputs/outputs bypass) and engineer (full facilities including configuration). Access to the various levels shall be by key-switch or password protection.

The configuration database / information must be capable of being backed up on to media such as removable magnetic disks or tape, or Recordable CD/DVD. The Engineering Workstation shall be

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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, 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.

13.15 SOFTWARE ENGINEERING TOOLS

13.15.1 General

The VENDOR shall provide all the software engineering tools necessary to build and to modify the configuration of safeguarding systems as well as network communication interfaces. The tools shall be clearly identified and supplied in sufficient quantity.

All software shall be licensed permanently to the CONTRACTOR. If any dongle is required these shall be permanent and time unlimited.

The engineering tools (software) shall include, but not limited to facilities for:

- I/Os assignment,
- Point configuration,
- Safeguarding Logic
- Cross reference list between logic and I/O.

All engineering tools shall be implemented within the maintenance and engineering workstation, which shall be common to all safeguarding modules. If the tools may be implemented in a PC, remote from the CPUs, for down loading into the CPUs at a later time, this provision shall be included.

Each configuration tool shall be connected to printer and mass memory (hard disk) and permanent storage media (DVD, CD-ROM) for saving and downloading configurations and programs.

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All engineering tools must be self-documenting and must issue all required reports, prints, drawings, etc. so that engineering and maintenance staff may control all the configuration and programming.

A software package should be supplied capable of comparing two application software versions and to indicate where the variations have taken place.

13.15.2 Minimum Requirements

The main function of software engineering tools consists in configuring or modifying the configuration of the safeguarding equipment.

It shall provide facilities as follows:

- To download the configuration from disk (CD-ROM, DVD) in subsystems defined above,
- To save the configuration on a streamer, or DVD, CD ROM,
- To modify the configuration from keyboard/mouse.

These modifications must be recorded at the same time on the configuration streamer, or DVD, CD- ROM.

Configuration of each subsystem shall be accomplished at the engineer workstation, using a fill-in-the-blanks or conversational technique. Configuration shall not require more than one VDU display.

Logic sequence configuration shall be possible using ladder logic, function block or high-level language.

13.15.3 System Data Base Configuration

A data base configuration tool shall be provided to create, maintain and document the whole system database (including configuration of communication network and all types of interfaces).

13.16 CABINET AND CABLING

13.16.1 Marshalling Cabinet

The marshalling cabinets 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

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plant without disconnecting wire. Terminal boards drawings shall be given by the Contractor.

- System wiring from the F&G Controller Unit 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 24 V DC power feeders are wired to separate terminal strips, and are used as required.

13.16.2 Cabinet Mechanical Requirements

The cabinets shall have the following characteristics:

- Standard size of cabinet or frames (e.g. DxWxH: 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 CONTRACTOR Approval.
- Modular structure accessible from one or both sides,
- General earth for metallic parts,
- Separated and isolated earth for electronic circuits,
- Fans with filters as required, along with failure detection or natural draught,
- Cable entry from bottom, with supporting bar and gland plate.
- All cables and wires shall be installed in cable duct or on cable tray
- Outside standard color RAL 7035.
- Heater, thermostat and moisture sensor.

13.16.3 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.

The high temperature inside of cabinets shall be detected and one common alarm for all cabinets shall be wired to the F&G system and shown on F&G display matrix.

13.16.3.1 Termination Panels

The termination panels shall meet the following requirements:

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- All terminals shall be screw terminals,
- Analogue termination panels shall have provisions for internal power access from the termination panel and external power access. Wiring options should be configurable via jumpers which can be changed back to other positions without requiring soldering or replacement components and without disturbing the other loops,
- Termination panels shall have provision for redundant power supplies to drive field transmitters and optional binary relays; separate circuits for redundant I/O power supplies shall be available on each termination panel,
- Power wiring to termination panels shall be through parallel wiring to each termination unit (2 feeders by cabinets 24 V DC power supply). Daisy chaining of power wiring is acceptable,
- Input shall be fuse protected.
- A circuit breaker for each power supply is required.
- Partitions shall be included between terminals for different voltage
- All field protections shall be located in the marshalling cabinets,
- All terminals for field cables shall be "knife switch" type terminals.

13.16.3.2 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.

The Cables of F&G system shall be Fire resistant as a minimum.

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

13.16.3.3 Grounding, Lightning 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.

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The conductive part of instrumentation equipment installed in the ER and CCR 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. The impedance of the instrument earth shall be less than 0.5 ohm.

Three separate and independent earthing systems shall be provided as required:

- Chassis (electrical) earth
Bonded to the structure and utilized for electrical safety of metal enclosures and chassis on all instrument and electrical components.
- Instrument (I.S.) earth
Insulated from the structure and other metal work and utilized for I.S. instrument signal screens.
- Instrument (N.I.S.) earth
Insulated from the structure and other metal work and utilized for Non I.S. instrument signal screens.

Screening shall be grounded at the control panel and insulated in the field.

Three separate and independent reference earths shall be provided for electrical earth, instrument IS earth and instrument NIS earth.

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.

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

14.0 FIRE ALARM SYSTEM SPECIFICATION

14.1 Fire Alarm Panel (FAP)

Fire alarm system shall be microprocessor based addressable and conventional fire detection type in accordance to the EN 54, BS 5839 and IPS-G-IN-270. Fire alarm systems,

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whereby specify space and zone identification, or both, is provided by individually identifiable initiating devices, shall be arranged to meet the following minimum criteria:

- Means are provided to ensure that any one fault (e.g., open circuit, short circuit, or ground) occurring in the signaling line circuit will not render any initiating devices in any fire zone inactive.
- All arrangements are made to enable the initial configuration of the system to be restored in the event of failure (e.g., electrical, electronic, information).
- Signaling line circuits shall be capable of supporting 100 percent of the initiating devices connected to them if all are activated simultaneously without any loss of signal.
- A signaling line circuit shall be arranged.
- All activated detectors shall be shown on the display.
- It shall have local LCD display & keypad / pushbuttons for operator interface to view status & alarms of panel & detectors. There shall be adequate security level defining the access level for preventing any unauthorized access.
- It shall be possible to locally isolate any detector or alarming device for maintenance purpose.
- It shall be possible to configure or modify system through the LAPTOP. Normal operation shall not be affected during modification.
- The required software shall comply with the NFPA or any other recommended standard for fire alarm system.
- Shall be capable of performing required logic functions based on C&E matrix.
- All the addressable detectors inside the building such as smoke detector and manual call points shall be connected in a supervised loop. Fault in the loop shall be reported at the panel.
- Activate Acoustic (bells) & Visual (Flashing light) for alarming purpose can be considered.
- FAP will be programmed according to Cause & effect for addressable loop definitions.
- FAP shall be capable to support required addressable loop (loop length of 1000 meter as minimum for each loop).
- FAP will be connected to F&G system (if any) via redundant Modbus RTU serial link (RS-485).
- FAP status (Fault, Power Failure...) will be connected to F&G system (if any) for alarm monitoring.

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14.2 System Integrity

The system shall maintain a high availability figure with a high level of integrity. This shall be achieved by:

- The use of high reliability components.
- The use of hardware redundancy where appropriate.
- Provision of routine and/or automatic testing and diagnostics.
- Simple fault indication and module replacement repairs.

15.0 SPARE CAPACITY

15.1 OPERATOR CONSOLES AND COMMUNICATION SYSTEM

The F&G 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 ex The system shall be capable of being expanded to cater for additional logic solvers, input/output modules and communication interface units through the installation and connection of standard modular components and units.

The system software shall be capable of catering for the additional I/O and configuration requirements as identified above. The system software shall cover allowances to cater for the additional I/O.

The systems supplied under this scope shall be supplied with adequate circuit breakers, interface points, etc to cater for future expansion described above.

The Engineering Workstation shall be capable of handling additional system nodes. VENDOR shall state the expansion limitations of his system. The VENDOR shall also provide details of how future nodes can be made active with no disruption to operations, of existing/working nodes.

VENDOR shall indicate compliance with the stated spare requirements and shall highlight any additional equipment, which has been included to meet these requirements.

VENDOR shall state the capacity of the overall system in terms of I/O handling ability/logical/graphics, etc.

15.1.1 Controller, I/O Modules and Marshalling Cabinet

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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.



Auxiliary Panels

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.

15.1.2 Serial link

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

16.0 DETECTION IN FIELD AREAS

16.1 FIRE DETECTION

Fire detection in field areas shall normally consist of fusible tube or plug assemblies in the immediate vicinity of potential fire sources (liquid release), UV/IR flame detectors in general field areas, and manual call points located outside the fire areas, typically along access roads.

Fire detection by operation of a fusible tube or plug assembly, flame detector, or Manual call point shall generate alarm, and audible and visual alarms in both the Control Room and F&G Matrix.

Activation of fire water pumps shall be limited to loss of pressure in the fire water closed rings, remote start-up from the Control Room by operators, or activation of deluge valve in accordance with NFPA requirements. Local manual starting of the fire water pumps shall also be available via the local Fire Water Pump Control Panel.

16.2 GAS DETECTION

Gas detectors shall be provided in field areas to warn of the presence of flammable and toxic gases. These shall normally be single detectors located adjacent to the likely release point – typically flange gaskets and pump or compressor seals.

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When a more general release is considered possible, area monitoring may be employed. This may be achieved by the use of multiple point detectors or by beam type detectors, where suitable.

Detection of gas by any detector shall generate an alarm. All such alarms shall be visible at the F&G matrix panel located in the Control Room respectively, and shall be displayed and recorded by the Control System.

17.0 DETECTION IN BUILDINGS

17.1 GENERAL

All plant buildings, unless otherwise specified, shall be provided with fire detection. This shall comprise detectors, visible and audible alarms.

Where buildings are normally unmanned, or contain significant amounts of electronic equipment and cabling, then early warning of fire shall be provided via the use of sampling type smoke detection systems or similar equipment. These shall be used in addition to conventional detectors. Such equipment shall be located in the system cabinets, where feasible.

Immediately after a fire sensor is activated, local visual and audible alarms shall operate. These may also be initiated from outside of the building via operation of a **MAC**, and from a remote location, if necessary - e.g. from the Control Room. Alarm acknowledgement, silence and logic reset functions shall be remotely performed from the Control Room operator control console.



17.2 BUILDING GAS DETECTION

Gas detection systems for buildings shall comprise detectors, visual and audible alarms.

Gas detector signals shall have a normal range of 4 to 20 mA DC. The gas monitor or input circuit shall generate an alarm output if the following occurs:

- Detector fault
- Output signal above or below normal range

It shall be possible to test all gas detectors. Detectors shall be suitably located, or test facilities shall be provided.

Building gas detectors shall be suitably certified for the potential gas hazard.

When the building contains gas detectors all gas alarms shall be visible at a single location. When internal releases are possible the location shall be outside of the release area. Gas alarms shall be visible on the F&G matrix panel located in the Control Room, and shall be displayed and recorded by the FGS.

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Audible and visual alarms for gas i.e. horns and beacons, shall have a different tone and color to those for fire. Alarm acknowledgement, silence and logic reset functions shall be remotely performed from the Control Room operator control console.

18.0 GENERAL REQUIREMENTS

F&G system will generally follow the principle of “energize to activate” for systems. Detectors (if contact type) shall be fail-safe type (normally closed), All inputs or outputs, which are not configured to be fail safe shall be line monitored.

18.1 CONNECTION TO FIRE & GAS SYSTEM

All detectors from field and process rooms shall be connected, via marshalling cabinet, to analogue or digital input cards of the F&G systems. The VENDOR shall guarantee the full compatibility and good functionality of the detector with the selected PLC.

19.0 INSPECTION AND TESTING

19.1 GENERAL

Fire and Gas Detectors shall be subject to an integration system test with the Fire and Gas System works. The Fire and Gas Detector VENDOR shall coordinate under supervision of CONTRACTOR with the Fire and Gas System VENDOR for this test.

The F&G devices shall be fully inspected and tested at the VENDOR’s works to ensure satisfactory operation before packing and shipping. A schedule for testing and inspection shall be detailed in the manufacturing quality plan. The tests will be witnessed by the contractor and Client.



The factory inspection shall be performed at the Vendor's facilities. IPS-I-IN-100 shall be respected as minimum by vendor.

It is the responsibility of the Vendor to inform the Contractor at least 20 working days prior to any inspection, and to ensure that all factory inspections are carried out in accordance with this specification and project requirements.

The Vendor shall provide a step by step procedure that will be used during the final testing. This written procedure shall be provided when the Contractor is notified about the final testing date. This procedure shall include the test configuration, identification of test equipment, and calibration methods.

All components of the total system shall be connected and operated during the inspection tests. Each function shall be tested including the power supply switching and the electronic modules with different types of associated detectors. The alarm reports shall be checked.

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The Vendor shall supply all the test equipment necessary for inspection and calibration.

Manufacturer supplied documentation, operating manuals, drawings, etc. should be available for review during the factory inspection.

All tests shall be performed at the Manufacturer workshop and a complete report shall be submitted to the Contractor.

The Inspection report shall include but not limited to the calibration of all equipment per the manufacturer's procedures using suitable test samples that have physical values close to actual operating plant values. Calibration data shall provide proof of compliance with this specification. Calibration data shall be kept for inclusion in the final documentation.

19.2 TEST

The F&G system shall be 100% tested.

Testing shall be in accordance with the Supplier's testing program and procedures, as approved by the Purchaser. The Purchaser will witness all tests.

Testing to be performed shall include, but not limited to, Burn-in testes on all equipment for a minimum of 24 hrs. without failure. Failure of a component of the system shall restart from the beginning. Supplier shall conduct the following tests as part of the delivery of any and all equipment/work/software delivered under this specification.

The supplier shall provide all the resources and materials he intends to use to perform the different tests.

19.3 INSPECTION AND TESTING PROCEDURES



The VENDOR shall submit detailed procedures and test sheets for Contractor and Client approval which cover the Factory Acceptance Testing 8 weeks before FAT. These procedures shall adequately cover both the VENDOR's own equipment/design and that of any sub-vendors.

Where sub-supplied equipment/design is not explicitly covered by the VENDOR's procedures, then this must be covered by documentation provided with the sub-supply. The VENDOR is responsible for the inspection, co-ordination and retention of the documentation.

19.4 INSPECTION AND TESTING DOCUMENTATION

The VENDOR shall maintain up to date documentation at all times reflecting the inspection/testing status of the equipment. The VENDOR will be required to formally submit certain parts of the

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documentation as defined in the CONTRACTOR's order. However, the submitted documentation shall not be regarded as the total requirements.



The **Contractor and Client** will wish to inspect retained documentation such as internal test results, equipment logs and fault correction records. The original signed test procedures and test sheets shall be supplied to the **Contractor and Client** at the completion of the tests.

19.5 TEST REPORTS

For each and every formal test conducted, a test report must be prepared. The report shall document all the test observations, test results, repairs during the test and action items resulting from the test.

The test report shall include but not limited to:

- Purpose of the test
- Test procedure/method
- Changes or deviations from the approved formal test plan with the reason for the differences
- Results of the test with a comparison to the test results expected as per the test plan
- Explicit identification of noncompliance of failed test items
- An action item list that may result from completion of the test
- The results from the test must demonstrate in a convincing manner

20.0 FACTORY ACCEPTANCE TEST

Prior to delivery of any equipment to the site, all the parts of the system including the control panel, control devices, networks and human interfaces shall be totally interconnected and tested in a safe place to demonstrate that the system is capable of performing all specified functions.

The test shall include both specified performance tests for individual hardware and software modules and integrated system to demonstrate that all hardware, standard software and configuration functions correctly under normal and abnormal conditions.

FAT tests shall be carried out at the Supplier's factory at presences of Supplier, Purchaser and CONTRACTOR representatives. Before that the vendor shall issue FAT procedure which must be approved by the CLIENT.

FAT tests shall also be carried out with all equipment powered up and on line at 100%. The tests shall be carried out on all equipment/work/software, including those supplied by "Sub-Suppliers" as well. These tests are subject to approval by the Purchaser.

As a guideline, the FAT shall include but not limited to the followings:

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- Mechanical checks of the equipment for dimensions, finish, welds, connectors, cables, painting, labeling and workmanship.
- Electrical checks including internal wiring, external-cabling make-ups.
- Demonstration of proper functioning of the power failure protection.
- Confirmation of power consumption and heat generation characteristics.
- Demonstration of proper functioning of the system processor.
- I/O system and loops.
- Redundancy check
- Communication
- Comprehensive checks for compliances to this specification and with all standards referenced in this specification
- Exhaustive checking of the software or logic according to design
- Exhaustive checking of the Station Simulation System realized by the Supplier for the needs of the test
- Inspection of individual hardware and software modules and their proper functioning
- All standard system diagnostics provided by Supplier shall be performed including diagnostic software
- Checking of the proposed packing procedure
-

Successful completion of the FAT shall be acknowledged by Purchaser or Purchaser's Representative by the execution of a released certificate. The certificate will only be issued upon successful completion of the FAT.

Purchaser may request to participate in testing on workshop.

The simulation of F & G shall be done with the detectors supplied by Supplier and by simulation device provided by Supplier and completely wired to the F & G prior to start FAT.

21.0 PACKING, MARKING AND SHIPPING

Following completion of all necessary tests and inspections, VENDOR shall prepare the goods in a suitable way for the type of shipment specified by the CONTRACTOR and in accordance with CONTRACTOR specification for Packing, Marking and Shipping. The main shipping mark referred to in the Packing, Marking and Shipping Specification shall be amended to show the PURCHASER, and current project.

In order to facilitate loading, unloading and handling of cargo, VENDOR shall stencil the necessary cautionary symbols with red mark on the proper place on two opposite ends of the packs. If it is acceptable to store the goods in an open area under a Tarpaulin then the goods shall be marked with a red "free from wet" mark.

Pre-shipment Inspection of the packing and marking shall be carried out before any shipment by an approved third party. In case any export licenses and/or other necessary permits, authorization,

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etc., are required by authorities in the exporting country then the VENDOR shall obtain such export licenses, permits, authorizations, etc. prior to shipment at own cost and risk.

Main notes on adequate packing:

- 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.

22.0 SITE ACCEPTANCE TESTING (SAT)

FGS VENDOR shall develop and produce a SAT procedure with full coordination of ESD/DCS VENDORS covering all aspects of the system that have not been tested in the FAT, specific to the site, or included as a punch list item from the FAT. The SAT procedure shall be submitted to the CONTRACTOR for review / approval prior to commencement of SAT.

SAT shall demonstrate that the system is in the same physical and working condition as FAT, i.e. there is no corruption, damage during shipment, etc. Typically, the SAT will include tests of each type of function block and logic configuration.

The SAT shall include, but not limited to all the interfaces to the actual sub-systems, system redundancy, configuration, physical installation and interfaces, data links settings and testing of data transfer from each data point.

During SAT all field devices shall be tested from the field device through to end element.

At the satisfactory conclusion of the SAT (Site Acceptance Test), a final Certificate of Acceptance shall be prepared by the VENDOR. Attached shall be all test records, software backup media, and receipt for documentation and spare parts plus any other pertinent records regarding the VENDOR's delivery. The document becomes a Certificate of Final Site Acceptance, which shall be submitted to the CONTRACTOR for approval.

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23.0 SITE SUPERVISION

When specified in the Purchase Order, the VENDOR shall provide representatives to assist the CONTRACTOR during installation, commissioning and initial start-up for all aspects of the equipment.

24.0 INSTALLATION AND COMMISSIONING

VENDOR shall provide full details for installing, site testing, commissioning and startup of the equipment as specified in the 'CONTRACTOR Documentation Requirements Schedule listed in the Requisition.

The FGS System must allow the integration and independence of process train units considering plant operating and commissioning phasing requirements. In particular the systems shall be designed in such a way that the commissioning of one independent process train, unit or section shall be possible with the other process train, unit or section in full operation in the same time, and the system integration of this phase shall be possible without the need to wait for Plant overhaul.

When specified in the Purchase Order, the VENDOR shall provide representatives to assist the CONTRACTOR during installation, commissioning and initial start-up for all aspects of the package.

25.0 COMMISSIONING

As part of the plant pre-commissioning activities, the F&G shall be fully commissioned. VENDOR shall prepare a commissioning procedure for the CONTRACTOR to review and approve, prior to the start of the VENDOR commissioning activities.

- Commissioning shall include, but is not limited to, the following:
- An audit and inspection of equipment received. A deficiency report shall be written and appropriate
- Action taken to rectify any problems.
- System power up and functionally tested with appropriate test equipment.
- Field instruments shall be powered up and checked out with diagnostic routines.
- Communications shall be established between all components of the system and tested.

Installation of complete cabinets shall be carried out by the CONTRACTOR with assistance from the VENDOR. Installation of loose shipped items in cabinets shall be performed by VENDOR. Installation of field instruments shall be performed by the Installation/Fabrication CONTRACTOR. Any special tools required for installation and commissioning shall be provided by the VENDOR.

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26.0 COMMISSIONING SUPPORT

VENDOR specialist services will be required during commissioning of the equipment. A comprehensive proposal to provide the required specialists for commissioning support shall form part of VENDOR's scope. Proposal shall include details of the skill and the hourly rates offered.

27.0 MAINTENANCE REQUIREMENTS

VENDOR shall provide full details for maintaining the F&G System.

28.0 CALIBRATION

All detectors shall be suitable for easy on site calibration without dismantling of any equipment.

Because of 2-year maintenance requirements, vendor shall furnish required calibration kits for test of all detectors.

Calibration system which shall be provided for the gas detectors includes the following items:

- Standard gas cylinder for each type of gas detected (including Hydrogen).
 - Stainless steel regulator for each gas cylinder
 - Flow meter for each cylinder
 - Cap to allow the injection of calibration gas on the sensor
 - Set of calibration curves for each type of gas for detection on site
 - Calibration system for heat detectors
 - Calibration system for smoke detectors, if applicable
 - Any other special tools that are necessary for calibration should be specified & offered.
- Special tools for F&G equipment calibration shall include but not limited to:
- Smoke & heat detector test kit (which is composed by 2×bottle smoke aerosol dispenser).
 - Gas calibration kit (which is composed by 2×calibration cup and regulator; 1×cylinder filled with 25 PPM Hydrogen sulfide in air; 1×cylinder filled with 50% LEL Methane in air).
 - Flame tester kit (which is composed by 1×set flame tester kit for UV/IR flame detector + battery charger; the flame tester is an explosion proof test lamp in IP 65 enclosure certified).

Consumable calibration and test facilities such as gas cylinders, smoke detector testers, etc...in addition to commissioning stage shall be supplied for one year (adequate for at least 2 stages of tests/calibration). Considering these facilities are subject to expiration, expire date of them shall last at least two years from the date of commissioning.

Validation date certificate for above equipment is necessary.

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29.0 DOCUMENTATION

Documentation shall be provided in accordance with the CONTRACTOR VENDOR Documentation Instructions. Final documentation list shall be issued by FGS VENDOR in coordination with ESD/F&G VENDOR for CONTRACTOR/CONTRACTOR review and approval

VENDOR shall include all software media containing the standard application software, configurations and any additional project specific software supplied under the project. Databases and other data structures created for the project shall also be delivered to the CONTRACTOR in machine readable formats.

All licenses for the software and certification supplied shall be included in the deliverables.

With his bid the FGS VENDOR shall provide a detailed schedule for engineering, production, assembly, testing and shipping of the FGS systems. This shall identify all major milestones, including production of documentation, dates for receipt of critical data from CONTRACTOR, order of long lead items, production of test procedures, integration requirements, FAT and integrated test dates. An indication of proposed manning levels shall also be provided in accordance with the proposed schedule by FGS VENDOR.

Comments made by CONTRACTOR on drawing submittal shall not relieve VENDOR or SUBVENDORS of any responsibility in meeting the requirements of the specifications. Such comments shall not be construed as permission to deviate from requirements of the Purchase Order unless specific and mutual agreement is reached and confirmed in writing.

Revisions to drawing shall be identified with symbols adjacent to the alterations, a brief description in tabulate form of each revision shall be given, and if applicable, the authority and date of the revision shall be listed.

The VENDOR shall provide the following documents:

- A listing of I/O configuration identifying each module, location and tag
- All index of the system's database including tag numbers, descriptions and initial values
- A complete narrative describing the operation as sequence of the logic and control system
- A fault finding/trouble shooting narrative for the complete system, recommended format is an "if-then: condition diagram
- Installation, operation and maintenance/trouble shooting manuals
- Vendor Data Book
- Outline dimensional drawings (with weight indication)
- Engineering documents containing but not limited to:
 - ✓ Troubleshooting/loop diagrams
 - ✓ Assembly and interconnecting wiring diagrams
 - ✓ Interface details between sub-systems

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- ✓ Input/output terminations
- ✓ Power distribution block diagrams
- ✓ I/O module indexes
- ✓ List of instruments and/or system cables (type, reference, tag, length, routing)
- ✓ Cabinet arrangement and dimensional drawings (front, rear, internal view, with racks and card location)
- ✓ Electrical power consumption, instrument air consumption (if any) and heat dissipation data sheets
- ✓ Hardware design specification (with system architecture diagram)
- ✓ Two wire diagrams for all signal points acquired by the system
- ✓ Programming manuals
- ✓ Configuration and software manuals
- ✓ Interlock and safety logic diagrams and sequence diagrams
- ✓ Recommendation for storage (prior and during erection)
- ✓ List of consumables for erection, commissioning and start-up
- ✓ List of spare parts for erection, commissioning and start-up
- ✓ Calculation of overall system availability / reliability including the failure mode and effect analysis
- ✓ Calibration / setting data sheets, calibration curves, calibration procedure for fire & gas detectors
- ✓ List of sub-VENDOR & data sheets
- ✓ Grounding system

VENDOR shall prepare the relative study and detail engineering in accordance with current international standards.

30.0 TRAINING

30.1 TRAINING PHILOSOPHY

VENDOR shall provide formal training both on site and at the VENDOR's facility for nominated personnel.

The course structure and syllabus shall be submitted to the CONTRACTOR for review and approval. The course pre-requisite experience and technical expertise shall be advised to the CONTRACTOR prior to the start of the course.

30.2 TRAINING COURSE DOCUMENTATION

For each trainee who shall attend a training course, a copy of the complete training course, notes, and drawings shall be provided to the trainee eight weeks prior to the commencement of the training course. The copies shall be retained by the trainees on completion of the training course and shall be the property of CONTRACTOR.

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30.3 OPERATOR AND MAINTENANCE TRAINING COURSE

Two separate courses for Operation and maintenance for at least 10 attendees and minimum one week course duration shall be aimed at providing the attendees with familiarization of the main components of the system, train technicians for first line fault diagnosis, and repair by replacement. Operations and maintenance manuals shall be made available to CONTRACTOR prior to this course.

30.4 SYSTEM CONFIGURATION COURSE

The purpose of this course is to enable CONTRACTOR Engineers to be able to modify FGS system configuration. Typical course content shall be:

- Basic System Introduction.
- Application logic construction and debugging.
- Peripherals.
- Engineering Workstation.

The VENDOR shall provide all necessary training aids required for above courses.

31.0 SPARE PARTS AND SPECIAL TOOLS

The Vendor shall provide certain quantities of consumable for the installation, pre-commissioning, commissioning, 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 CONTRACTOR prior to procurement.

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31.1 SPECIAL TOOLS

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

32.0 GUARANTEE AND MAINTENANCE

32.1 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.

32.2 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.

32.3 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.

33.0 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.