



NASHPA COMPRESSION PROJECT PHASE-II

RE-ISSUED FOR TENDER

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ENAR Petrotech Services (Pvt.) Limited,
7-B, Sector 7-A, Korangi Industrial Area,
Karachi Pakistan

TITLE:

SPECIFICATION FOR COMPRESSORS PACKAGE CONTROL SYSTEMS

CONTRACT NO.
14-0193

DOCUMENT NO:

0193-IMA-6001-1



OGDCL PAKISTAN
NASHPA COMPRESSION PROJECT(PHASE-II)
SPECIFICATION FOR
COMPRESSOR PACKAGE CONTROL SYSTEM

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1.0 INTRODUCTION

Oil & Gas Development Company (OGDCL) is the leading E&P Company of Pakistan and is “Operator” of the Nashpa Field. Nashpa Field is located in District Karak, KPK. Nashpa is a JV concession with working interest of OGDCL, PPL and GHPL.

OGDCL has decided to install compressor(s) facilities to cater the depleting pressure of reservoir/wells and optimize the production over the Nashpa Field life. The compression facilities shall be installed at Nashpa LPG Plant as a Front End Compression.

The conceptual study was carried out in Phase-I, which concluded that four compressors of same capacities of (each of 35 MMSCFD) with philosophy of 03 operating and 01 standby will be installed at Nashpa Plant as Front End Compressors. Compressors will operate in parallel configuration.

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This document is intended to specify the minimum requirements for a control panel mounted SIL-2 rated PLC based Control Systems which will be supplied pre-installed with each compressor Package.

The CONTRACTOR shall develop a detailed specification with actual model numbers, quantities and manufacturer and make name during detailed engineering based on this document and submit to the client for approval.



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2.0 SCOPE

This Specification covers basic requirements for the selection, application, design, software, configuration, programming, all hardware and software, and installation of Programmable Logic Controllers (PLCS) which need to be supplied for each Compressor Package/Skid Unit with total Four Number Compressor Packages.

This specification shall be read in conjunction with the “Specification for General & Packaged Instrumentation” Doc No. 0193-IMA-6000, “Specification for Instrument Installation” Doc No. 0193-IMA-6002 and other relevant project documents.

2.1 Order of Precedence

In case of any conflict between this specification and its referred documents and the above codes and standards, the CONTRACTOR shall bring the matter to COMPANY’s attention for resolution and approval in writing before proceeding with design, manufacture or purchase. In all cases the more stringent requirement shall apply.

The order of precedence shall be as follows:

- This specification and referred documents
- Referenced International Codes and Standards

Any deviations from the requirements of this specification, its attachments and the referred codes and standards shall be listed as a section in the bid as “List of Exclusion / Deviations”. In the absence of such a statement, full compliance shall be considered.

Compliance by the CONTRACTOR with the provision of this specification does not relieve him of his responsibility to furnish equipment and accessories of a proper design, selection.

2.2 Deviations

COMPANY strongly discourages any deviation to the requirements of any of the listed or attached Data sheets, specifications, recommended vendors, country of origin, codes, standards, regulations, guidance notes, etc. However, if it is inevitable to propose any deviation, same shall be referred to the COMPANY (advising reasons for deviation) during pre-bid stage for a response COMPANY has to submit statement of compliance to the ITB / Tender Document in its bid proposal. In the absence of



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such a statement, it shall be understood that all listed requirements are accepted, without any exception / deviation. Any cost for engineering and materials, subsequently identified shall be wholly borne by the CONTRACTOR and the changes incorporated without slippage to schedule or delivery and without further charge to the COMPANY.

Undue exceptions may also render a bid disqualified as theme of bidding is to have bids of same level for evaluation purposes. Client will not accept any deviations which are buried within the body of the Technical or Financial Proposal and do not appear in the separate list, stated above.

2.3 CONTRACTOR Responsibility

The CONTRACTOR responsibility shall include development of all design documentation for Package Control System, procurement, testing, installation, pre-commissioning and commissioning. Reference to this document and other project specifications does not absolve the CONTRACTOR from their responsibility for supplying suitable Control System. The CONTRACTOR shall develop detailed datasheets; specifications and other relevant details based on this specification and submit to the client for approval during detailed engineering stage.

2.4 Definition

Client / Owner/COMPANY	Oil & Gas Development Company Limited (OGDCL)
Engineering Consultant	ENAR Petrotech Services (Pvt.) Limited.
Vendor / Supplier / Manufacturer / Contractor	EPCC CONTRACTOR
Project	Nashpa Compression Facility Project
PLC	Programmable Logic Controllers
EWS	Engineering Workstation
OWS	Operating Workstation
ESD	Emergency Shutdown System
F&G	Fire & Gas



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2.5 Language and Units of Measurement

The governing language shall be English language.

The units of measurement to be used on this project shall be as listed below:

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- Mass	pounds	(lb)
- Pressure	pounds per square inch gauge	(psig)
- Temperature	degrees fahrenheit	°F
- Mass flow	pounds per hour	(lb/h)
- Liquid flow	barrels per day	(bpd)
	or US gallons per minute	(gpm)
- Vapour flow	million std. cubic feet per day	(MMSCFD)
- Density	pounds per cubic foot	(lb/cu ft.)
- Viscosity	centipoise	(cP)
- Length	mile, feet, inches	(m, ft, in)
- Pipe diameter	inch	(in)
- Time	seconds	(s)
	hours	(h)
	day	(d)



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3.0 SERVICE CONDITIONS

For complete environmental data, refer project Design Basis Document No. # 0193-A-1000.

The CONTRACTOR shall take special note of environmental conditions associated with an installation being situated in Pakistan. It shall be considered that the station control system shall be installed in the extreme conditions of heat, humidity and dust.

- Climate : Desert sand storm
- Temperature : Maximum 55 °C (115 °F)
Minimum -1.1 °C (35 °F)
- Relative Humidity : 10%-17%
- Wind Velocity : 100 mph max
- Daily Rain Fall : 0-50 mm

The equipment proposed for Indoor installation/mounting shall meet the following service conditions:

- Location : Indoor
- Ambient temperature : 2-50 °C
- Control room temperature : 23 °C (average)
- Humidity : 18% to 76%

❖ **System Power Supply:**

- Power Supply Voltage : 220V AC \pm 10%
- Power Supply Frequency : 50 Hz

❖ **Input/Output Control or Signaling Voltage:**

- Digital Input/Output : 24V DC
- Analog Input/Output : 24VDC, 4-20mA



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4.0 STANDARDS AND CODES

The CONTRACTOR shall be responsible for insuring that the Package Control System proposed under this specification is in compliance with the applicable provisions of the latest publication of standards as given in attached document titled as “Engineering Codes, Standards and Recommended Practice”. In addition, following list of standards will also be followed. In the event of conflict, the most stringent requirements shall apply.

IEC – International Electro technical Commission

IEC 61131 “Programmable Controllers”
IEC 801.2,3,4 “Electromagnetic Interference / Susceptibility”

ANSI - American National Standards Institute

ANSI C83.9 “Racks, Panels and Associated Equipment”
ANSI/ISA-S50.1 “Compatibility of Analog Signals for Electronic Industrial
Process Instruments”

NFPA / National Electric Code.

ANSI/NFPA 70 “National Electrical Code”
NFPA 58 “Liquid Petroleum Gas Code”
NFPA 72 “National Fire Alarm and Signaling Code”
NFPA 72E “Automatic fire detectors”
NFPA 75 “Standard for the Protection of Electronic
Computer/Data Processing Equipment.”
ANSI/ISA MC 96.1 “Temperature Measurement Thermocouple”
ANSI/IEEE C37.90.1 “Surge Withstand Capacity Tests – Shall apply only to
equipment with power input(s)”

EIA - Electronic Industry Association

EIA / TIA “Serial Data Communication” RS-232/485
ISA Instrument Society of America
ASTM American Society for Testing and Materials

IEEE – Institute of Electrical & Electronics Engineer

IEEE Std. 730.1 Software Reliability Plans
IEEE Std. 828 Software Configuration Management Plans
IEEE Std. 1042 Software Configuration Management



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ISA – The International Society of Automation

ISAS51.1	Process Instrument Terminology
ISAS71.01	Environmental Conditions for Process Measurement And Control System: Temperature And Humidity
ISAS71.04	Environmental Conditions for Process Measurement And Control System: Airborne Contaminants
NEMA Std. 250	Manufacturing Standards for Enclosures for Industrial Controls and Systems
BS 6346	Cables
BS 6121	Cable Gland



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5.0 GENERAL REQUIREMENTS

PLC based Control Systems as described in this Specification shall be provided by the CONTRACTOR with each Compressor package skid. Total four (4 Nos.) PLC based Control system shall be provided. The system shall be a PLC based process control that includes a comprehensive set of proven algorithms and functional module auxiliaries to provide full control and monitoring capabilities.

The PLC based control system shall have the capabilities for entire control & monitoring needs of the Package skids. This include but not limited to monitoring and controlling of all package and field instrumentation including transmitters, switches, fire and gas detectors/devices, shutdown valves, control valves and related PID with feedback control, various Interlocks/Permissive that have to be implemented. The PLC shall also be certified for use in safety applications up to SIL 2 to handle all shutdown requirements of skid package. Refer to “Specification for General & Package Instrumentation” Doc. No. 0193-IMA-6000, Project Cause & Effect Matrix and other relevant project documents for details.

The package PLC shall have the capability to monitor, control, display, alarm, record and trend all assigned plant inputs and outputs.

The package PLC shall perform package monitoring, process control, execute process and emergency / fire related shutdowns of various levels (ESD-1, 2, 3 & 4) in accordance with the project Cause & effect Matrix and other relevant documents.

The package PLC shall also be responsible to shutdown the compressor on any major upset within the unit, due to fire detection or on command from plant ESD system. The package PLC shall be hardwired interfaced with existing Plant Safety System systems for ESD signals to/from plant Safety system. The Plant existing Safety System is resided in the control room. There shall be at-least following spare hardwired I/Os signals engaged of existing ESD System for interfacing each Compressor PLC;

1. DI Signal (Package Shutdown due to fire to Plant Safety System).
2. DI Signal (Package due to process trip to Plant Safety System).
3. DI Signal (Spare)
4. DO Signal (Shutdown Signal from Plant ESD System).
5. DO Signal (Spare)



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The supplied PLC based control system shall be modular type utilizes latest technology available to date. Only Latest model of PLC controllers, I/O, software etc presently launched will be acceptable.

The package PLC shall be equipped pre-installed and pre-wired in the skid mounted control panel with touch screen HMI/MMI for monitoring and control of each package in field. Control Panel HMI/MMI shall be of 15” weatherproof and suitable for hazardous area.

Control Panel shall be placed under proper Sun Shed to protect Control Panel and touch screen HMI/MMI from direct sunlight.

Each package control panel shall be installed with a Selector Switch with Local & Remote option to operate and monitor compressors from field and also remotely from Control Room.

Also each package control panel shall be provided with installed Led indications light for compressor indications/status e.g. UNIT POWER ON, UNIT RUNNING, UNIT ALARM, UNIT SHUTDOWN and also mounted with manual switches and Push Buttons for local control which include hand switches for SELECTOR SWITCH WITH LOCAL/REMOTE SELECTION, POWER ON/OFF, LOCAL START, LOCAL STOP, LOCAL RESET, EMERGENCY STOP.

The Package PLC shall be designed and configured to achieve the necessary control and process relationships and interlocks defined by the cause and effects and supporting data. The Package PLC control configurations, Events, Alarms and HMI graphics shall be configured as per the plant P&ID's, other project documents and COMPANY instructions.

The system shall comprise of the following items as follows:

- a) Redundant PLC Controllers (SIL 2 certified)
- b) PLC Analog, digital input/output modules
- c) Redundant Ethernet TCP/IP Interface Modules
- d) Redundant Fiber Communication Equipments, switches and cables.
- e) Redundant Power Supply Units
- f) Laptop for configuration of PLC / HMI pre installed with required software.
- g) Engineering and Operating Workstation pre installed with required software (installed in Control Room).



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- h) Licensed Configuration Software for laptop etc.
- i) Control Panel with Touch Screen HMI/MMI (field/Skid mounted)

The PLC control panel shall be suitable for Class-1, Div.-II, and Group C&D or Zone-2 Gas Group IIB T3 environment; therefore Control panels shall be ATEX or Equivalent certified for mentioned Hazardous area and shall be suitable for mentioned service condition.

The enclosure panel shall be Ex 'e' rated with NEMA 4X or IP 66 certification. All the internal components shall be suitable and certified to perform successfully in outdoor ambient temperature. Components Temperature Rating = Ambient (55) + Temperature rise due to heat dissipation. Heat Dissipation values may derate controller performance; therefore each panel shall be installed with Vortex cooler to maintain internal temperature around 35 degreeC. Vortex cooler shall operate on instrument air to be provided by Client at 50 Psig. Installation of Vortex cooler / purging is an addition safeguard and do not relieve panel and components Ex rating requirement mentioned above.

The vortex cooling system shall minimum comprise of the following components;

- Air Filter & Regulator
- Thermostat
- Ducting Kit
- Solenoid Valve

Engineering and Operator Workstation shall reside in the Control Room. The control room is in a safe area away from the main processing facility. The Engineering and Operating workstations shall be common for whole compression facility (i.e. all four compressors shall be monitored & controlled through common Engineering & Operating workstations).

The system shall be designed such that it can display all required process variables and functions on the operator workstations. Graphic displays will mimic the physical equipment on multiple, easily accessible displays. The ability to control process set points and equipment start/stop functions will be provided to the operator at the Operator Workstations.

The package PLC shall communicate with Engineering and Operator workstations for monitoring and controlling in control room over dual redundant Fiber Optic interface.



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Supply, laying, termination of all communication equipment and cables including Ethernet and fiber optic cables and other associated communication equipments for connecting all package PLC's with Engineering and Operator Workstation in Control room shall be in Contractor scope. The tentative approximate distance between compressor skids and control room is 220 meter.

Supply, laying, termination of all hardwired cables along with cable and glands and other accessories for interfacing package PLC with Plant ESD System for shutdown and trip signals shall be in CONTRACTOR scope.

A Shutdown bypass system shall be configured for each of the variables that causes a shutdown sequence to start or for maintenance, calibration, etc. under password protection. Existing ESD/MOS Operator Console shall also be modified to add new compressor signals for shutdown and manual override as per existing plant philosophy and C&E matrix.

Necessary hardware and software modifications will be carried out by the CONTRACTOR in Plant ESD system and HMIs to configure new interlocks, Alarm and shutdown signals due to the addition of compressors in accordance with the project Cause & Effect Matrix drawing.

All supplied equipment shall have EMI/RFI suppression and shall comply with industry regulation on RFI suppression.

CONTRACTOR shall supply all special tools, any hardware or software and test equipment required for installation and startup.



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6.0 TECHNICAL REQUIREMENT

The CONTRACTOR shall provide complete assembled System prewired in skid Control panel with Panel mounted HMI/MMI, communication equipments and switches, Engineering and operator workstations and a laptop with PLC configuration software. The system shall be prewired and ready for field termination. The System shall be supplied for the following requirements as a minimum.

6.1 System Hardware Requirements

- The system shall be designed in a modular scheme. CONTRACTOR shall ensure that it shall be possible to isolate and remove any faulty or malfunctioning module without interrupting proper function of the control system.
- The system shall be based on redundant PLC controllers and certified for IEC 61131 (all parts). PLC controller shall be SIL 2 certified. The system shall employ redundant data bus for communication between controllers and I/O modules.
- Redundancy shall support bumpless transfer between the primary and secondary controllers. Replacement and installation of controller shall be possible without shutting down of the control system.
- The controllers shall be selected such that processor loading does not exceed 60% when all control / monitoring loops and external interfaces are active.
- The controllers and I/O modules shall have LED indications for running, fault, etc for ease of maintenance.
- All modules shall have plastic non-static casing for mechanical protection during storage, installation or removal.
- All controller modules shall have their own independent power supply, battery-backed RAM and watchdog timer for maximum system availability.
- All packaged based instrument I/Os, Statuses, fire & gas detectors and devices shall interface with package PLC for monitoring and control.
- Package PLC shall at-least have 20% spare I/Os.
- CONTRACTOR shall consider I/Os for hardwired interfacing with Plant ESD System for emergency shutdown signals.
- CONTRACTOR shall provide terminal strips to wire hardwired signals to the Plant ESD System for emergency shutdown signals.
- The analog I/O modules shall be selected for 24VDC 4-20mA signal loop powered instruments.
- The digital modules shall be selected for 24VDC input / output dry contacts. However, isolation relays shall be provided between digital I/O modules and end devices.
- I/O modules quantity shall have 5% additional spare capacity after complete utilization for future expansion.



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- Package PLC shall have redundant TCP/IP communication ports and communication switches with fiber ports to communicate with control room housed Engineering and Operator Workstations.
- CONTRACTOR shall be responsible to provide the fiber optic / communication cable required for connecting the package PLC with Engineering and Operator Workstations with all communication cables and connector for interfacing.

6.2 System Software Requirements

- CONTRACTOR shall provide software for complete monitoring and control of the package equipment
- The monitoring software shall utilize different levels of access for process operators / supervisor, and configuration engineers. These levels of access shall be password protected.
- Operator access shall be for plant operator. This level of access shall allow the user to view the process parameters and instrument faceplates. User shall also be allowed to modify process set points and control loop gains.
- Engineering mode shall allow the user to configure process screen graphics, configure new loops or modify existing control strategies in the configuration software. Modification of control strategies and parameters shall be available online.
- The controller programming language shall utilize functional block diagrams as minimum. All programming languages shall be certified for IEC 61131-3.
- The software shall accommodate continuous historian and shall be able to trend all control and monitoring loops in graphical form. The graphical trend shall include graphs for process variable, set point, and PID output where applicable. The software shall also be capable of time scaling all graphical trends for reporting purpose.
- The software shall have complete diagnostic capabilities of the control system. It shall be possible to view the status of all installed hardware and I/O channels, and isolate them if necessary. CPU loading shall also be viewable on the HMI/MMI and remotely on workstations.
- The software shall have auto-tuning feature for adjustment of control loops.
- It shall be possible to change any loop from auto control to manual control. Manual control feature shall allow the operator to force an output to the final control element.
- The system shall be designed such that it can display all required process variables and functions on the operator workstations. Graphic displays will mimic the physical equipment on multiple, easily accessible displays. The ability to control process set points and equipment start/stop functions will be provided to the operator at the Operator Workstations.



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- The system will notify the operator audibly and visually of any abnormal condition in the process. The alarms will be logged on the alarm printer, communicated to the operator by on screen display, and archived in the system for future retrieval. The system will automatically display the actual alarm condition description, time of occurrence, and alarm values on the bottom of the display.
- CONTRACTOR shall provide all required software with lifetime licenses in favor or the Purchaser.
- CONTRACTOR shall keep soft copies of al project documentation (start-up manuals, termination drawings, loop drawings, technical manuals etc) on a separate drive on the engineering and operator workstation for easy access.

6.3 **Power Requirements**

- CONTRACTOR shall provide dual redundant power supplies working on load sharing basis. The power supplies shall be provided with reverse protection diodes for isolation of failed power supply.
- The power supplies should be selected such that one power supply can cater for the power requirement of the complete system and field instrumentation. Each power supply shall be sized to 30% above the maximum power requirement of control system and field instrumentation.
- CONTRACTOR shall provide dual 220VAC power inputs from plant existing UPS. Contractor is responsible for conversion from 220VAC to the required power levels.
- Power wiring shall be such that it shall be possible to isolate any independent module for troubleshooting and diagnostic.

6.4 **Control Panel**

- The control panel shall be of Rittal make, shall be hazardous area classified and enclosure panel shall have minimum NEMA 4X or IP 66 environmental protection.
- The Control panel shall be supplied with pre-installed & pre-wired PLC and touch screen HMI/MMI.
- Control Panel shall be common cabinet for Control system components and marshalling / termination equipment.
- All terminal rows shall be clearly tagged and labeled. Terminal rows and wire ducting shall be segregated for analog signals, digital signals, and power cables.
- Terminals used in the cabinet shall be Weidmuller or equivalent suitable for up to 2.5sqmm cable. All analog terminals shall be knife-out type, whereas digital signal and power terminals shall be fused type with appropriately rated fuse.



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- All the Analog and digital card shall have separate fuse protection. Fuse rating shall be selected according to protection mentioned in specific I/O card specification/datasheets.
- Internal wiring shall be color coded for signal identification. Each termination shall have ferrule or sleeve marked with the relevant tag. All wire tags, terminal numbers and module tags shall match the loop wiring drawings submitted by CONTRACTOR.
- Wire ducting shall have 20% spare capacity for ease of maintenance and future use.
- Control Panel shall be fitted with door operated lights and temperature sensor. The temperature sensor shall be connected to the PLC controller for monitoring and alarm on operator workstation.
- Separate earth copper bars shall be provided on the cabinet bottom for signal ground and cabinet body earth.
- Pocket shall be available inside the cabinet door for A3 sized documents.
- In addition to the above, CONTRACTOR shall provide Engineering laptop with licensed configuration software. The laptop shall be the latest available specification recommended for the software.

6.5 Engineering and Operator Workstations and Console Requirements

- CONTRACTOR shall provide Engineering and Operator Workstations separately which shall be used to control and monitor Compressor station (all four compressors).
- Alarms, reports, Shift reports and Critical parameters reports on operator Request shall be available on these workstations.
- The workstations shall be provided installed with all monitoring and configuration software as mentioned earlier as a minimum.
- All required cables for interconnection with Package control system are in CONTRACTOR scope.
- The Engineering and Operator Workstations shall conform to the below specifications as a minimum:
 - Latest Quad Core Processor E5 or Higher, Minimum 3.60 GHZ / most latest available
 - Windows 10 or latest version compatible with all application Software and drivers with latest version of licensed Antivirus
 - 1 TB Hard disk or better (2 in Each System, One Primary and One Secondary)
 - 2 GB High Performance Graphics Card (supported by display software)
 - 32” HD/LED Dual Monitor
 - 16GB (2 x 8 GB) RAM or better
 - DVD Writer
 - Modem



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- LAN Card (with one spare in addition to utilized capacity)
- Speaker, QWERTY Keyboard & Optical Mouse
- At least 2 USB 2.0 & 1 USB 3.0 ports

In addition to the above, CONTRACTOR shall provide Engineering laptop with licensed configuration software. The laptop shall be the latest available specification recommended for the software.

Engineering and Operator Workstations may be placed on existing console furniture (desktop table) in control room as there is enough space to accommodate new workstations in Control room. However CONTRACTOR shall further confirm the availability of space for workstations during engineering.

6.5 **External Interfaces**

The CONTRACTOR shall provide at least following interfaces:

1. Hardwire interfacing with Plant ESD System (5 Dry contacts, 3 DI & 2 DO).
2. Redundant MODBUS TCP communication Ports for interfacing with Engineering/Operator Workstations for controlling and monitoring purpose.
3. Provision of Ethernet Port (Spare) for any 3rd Party Interface as future provision.
4. Redundant Fiber Optic Communication interface for compressor workstations.



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7.0 INSPECTION AND TESTING

- Inspection & testing shall be divided into two areas:
 - Factory Acceptance Test (FAT)
 - Site Acceptance Test (SAT)

7.1 Factory Acceptance Test (FAT)

- The system shall be subjected to inspection by OGDCL/Engineering Consultant, or nominated representative, during the course of manufacture, fabrication, assembly, testing and shipment. Inspection shall include verification of the equipment, dimensions, examination of the documentation and checking the preparation for shipment.
- All relevant certified documentation shall be sent to the COMPANY prior to the test. The test will be witnessed only if the documentation is complete and acceptable to COMPANY. No testing shall commence without written approval of Purchaser. The COMPANY reserves the right to witness any aspects of the assembling process. The extent of the COMPANY participation in inspection and testing will be identified prior to the placement of an order.
- The CONTRACTOR shall submit an inspection and testing procedure for review and approval by COMPANY prior to start assembling.

7.2 Site Acceptance Test (SAT)

- The SAT shall include but not be limited to the following:
 - A complete repeat of the FAT.
 - Full loop tests of all input/output to the field equipment.



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8.0 COMMISSIONING

- The CONTRACTOR shall carryout all commissioning works.
- The CONTRACTOR shall be responsible for supplying all necessary testing equipment, tools and the like for successful start-up and commissioning. Allowance shall be made for full testing of all aspects for the control system during commissioning.
- Commissioning of the control system will take place in conjunction with the commissioning of the package skid instrumentation involving the COMPANY's staff who will ultimately take over the operation of plants.



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9.0 DOCUMENTATION

- The CONTRACTOR shall supply documentation in accordance with applicable codes and standards. All additional documentation required by this Specification shall also be provided by the CONTRACTOR. All documents shall be in English language.
- CONTRACTOR's documents shall include the following information as a minimum.
 - a) Operation manuals
 - b) Maintenance manuals
 - c) Full range of Engineer configuration manuals.
 - d) Equipment manuals
 - e) PLC/MMI system Operational Flowchart
 - f) Panel wiring diagrams
 - g) Loop diagrams
 - h) Soft & hard copies of system software configuration
 - i) Soft copy of program for developing graphic screen displays & CPU programming
 - j) I/O Loading schedules
 - k) Skid Control Panel dimensioned layout drawings
 - l) Cable schedule
 - m) System communication details and drawings
 - n) Inspection and certification
 - o) Description of all implemented computational algorithms
 - p) All construction drawings
 - q) Full 'As-built' drawing package
 - r) Commissioning Manual



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10.0 SPARE PARTS

- The CONTRACTOR shall provide as part of the total system package one set of any special instruments/tools that are needed to maintain the control system.
- The CONTRACTOR shall also supply the two year's operation, maintenance and capital spares. Bid price of these spares shall be included in bid price of the control system. A period list of the spares included in the bid price shall be included in the commercial proposal.

11.0 TRAINING

- The CONTRACTOR shall provide the desirable hardware and software training to the satisfaction of COMPANY personnel's to enable maintenance / operation / configuration of the control system after delivery and installation. The extent of the Purchaser training will be identified prior to the placement of an order.

12.0 WARRANTY

- CONTRACTOR shall have final and total responsibility for the design, fabrication, and performance of the control system supplied.
- CONTRACTOR shall provide warranty of each component in favor of OGDCL.PLC Manufacturer/Vendor shall warrants that the equipment manufactured and sold by it will, upon shipment, will be free of defects in workmanship or material. Should any failure to conform to this warranty become apparent during a period of one year after the date of shipment, CONTRACTOR shall, upon prompt written notice from the COMPANY, correct such nonconformity by repair or replacement, F.O.B. factory of the defective part or parts. Correction in the manner provided above shall constitute a fulfillment of all liabilities of CONTRACTOR with respect to the quality of the equipment.