OGDCL PAKISTAN:
OIL & GAS DEVELOPMENT
COMPANY LIMITED

NASHPA COMPRESSION PROJECT PHASE-II

ISSUED FOR TENDER

REV	DATE	DESCRIPTION	ORIG	CHKD	LE	QA	PM	LOCAL REPR.	PROJ. MAN
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ENAR

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

TITLE:

SPECIFICATION FOR INSTRUMENTATION INSTALLATION, CALIBRATION AND TESTING

CONTRACT NO.
14-0193

DOCUMENT NO:

0193-IMA-6002– 0

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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 Naspha 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.

This document is intended to specify the basic requirements testing, installation, pre-commissioning and commissioning of instrumentation which deemed necessary for defining minimum requirement at FEED stage and shall not be considered comprehensive and final for procurement.

1.1. Scope

This specification defines the minimum requirements for the installation, calibration and testing of the instrumentation for the safe and efficient functioning for Compression facility to be installed at NASHPA field.

This specification shall be read in conjunction with the "Specification for General & Packaged Instrumentation" Doc No. 0193-IMA-6000 and "Specification for Package Control System" Doc No. 0193-IMA-6001 other relevant project documents.

1.2. 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 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
- Latest revision of referenced International Codes and Standards

Compliance by the manufacturer with the provision of this specification does not relieve him of his responsibility.

1.3. Contractor's Responsibility

The CONTRACTOR responsibility shall include development of all design documentation for instruments, testing, installation, pre-commissioning and commissioning. Reference to this document and other project specifications does not absolve the CONTRACTOR from their responsibility

1.4. Abbreviations

ESD	Emergency Shutdown System
UCP	Unit Control Panels
CCR	Central Control Room
FAT	Factory Acceptance Test
C&E	Cause and Effect Matrix
COMPANY	OGDCL (Oil & Gas Development Company Limited)
Engineering Consultant	ENAR petrotech Servies (Pvt) Ltd.
CONTRACTOR	EPCC/SUPPLIER

2.0 GENERAL

2.1 Codes & Standards

The instrumentation shall confirm with the latest version of standards, codes and statutory regulations listed below:

- Relevant British standard specifications and codes of practice, IEC publications and CENELEC standards.
- Institute of petroleum – Model code of safe practice – electrical.
- International electro-technical commission (IEC).
- Institution of electrical engineer – Regulations for electrical installations, 17th edition.
- ISA practices and standards for instrumentation.
- GPA for analysis of natural gas and similar gaseous mixtures by gas chromatography.
- NFPA 72E automatic fire detectors.
- API RP 551Process Measurement Instrumentation
  NFPA / National electric code.
- BS 5501 Electrical apparatus in potentially explosive atmospheres.
- BS 6121 Cable gland.
- EN 50288–7 Multi-element metallic cables used in analogue and digital communication and control. Sectional specification for instrumentation and control cables.
- CENELEC EN. 500. 18 Flameproof enclosures Ex (d).
- CENELEC EN. 500. 19 Increased safety Ex (e).
- CENELEC EN. 500. 20 Intrinsic safety Ex (i).
- API 14.3 /AGA Report no. 3 for orifice metering of natural gas.
- ISA Standard S5.1
- ISO 5167 Measurement of fluid flow by pressure differential devices
- ANSI B16.36 Orifice Flanges

In general, instruments shall be manufactured, tested and installed to British and European standards and the IEE Regulations for electrical installation. Electrical/ Instrument items to be installed in hazardous area shall be certified from BASEEFA/ CENELEC/IEC/UL/FM

2.2 Personal and Workmanship

2.2.1 General

Only qualified, licensed and suitably experienced tradespersons shall be employed for the performance of the various trade tasks. Electrical work shall be carried out by experienced tradesmen who hold electrical licenses of the appropriate grade. Only experienced Instrument Tube Fitters shall carry out installation of instrument tubing.

All work shall be performed in a neat, tradesman-like manner, to a high degree of workmanship, and in accordance with the best current installation practice.

2.2.2 Hazardous Area Competency

All personnel including supervisors installing, testing and inspecting Ex rated electrical equipment and associated safe area equipment shall have been assessed as being competent to do so in accordance with the relevant Codes & Standards (Clause 2.1).

The Contractor shall provide evidence of competency, training and assessment details for all personnel considered competent to install, test and inspect explosion-protected equipment, for the Company's approval.

All new Ex rated equipment shall have an Initial Detailed Inspection, based on the equipment, installation and environment. The Contractor shall be responsible for providing such inspections for all equipment whether installed by the Contractor or not. The requirements for the installation and inspection of electrical equipment in hazardous areas are referenced in relevant Codes & Standards

3.0 SERVICE CONDITION

3.1 Environmental Conditions

REFER project Design Basis Document No. # 0193-A-1000 for complete Environmental data.

3.2 Hazardous Area

Equipment installed in a hazardous area shall be certified for Class-1, Div.-II, Group C&D or Zone-2 Gas Group II B T 3 unless otherwise detailed on specific data sheets or specifications.

4.0 TOOLS AND TEST EQUIPMENT

The CONTRACTOR shall supply as a minimum the following:

- All installation equipment including but not limited to, tube benders, tube cutters, welding equipment, tube pressure test equipment.
- Each tradesman shall have the exclusive use of a complete set of hand tools as required to complete the scope of work.
- A comprehensive set of test equipment shall be provided for calibration activities. Acceptable evidence of the satisfactory condition of equipment (e.g. up to date test certificates) shall be provided. Test equipment shall be periodically checked for serviceability and currency of calibration dates throughout the testing period. All test equipment shall comply with the relevant Standard & Code. The contractor shall provide, for Company's approval, at least following proposed calibration equipment prior to commencement of work on site.

4.1 Testing And Calibration Equipments

Standard test equipment shall be used for instrument calibration. The test equipment should be duly certified and certification should be available. All instruments shall be calibrated before and after installation at site. Following are the specifications of recommended calibration equipment:

4.2 Portable Electronic Calibrator

Model 1080 Flexi tester or Equivalent

4.3 Measurement

Ranges:	–150mV to + 150mV dc –75V to 75V dc –75mA to + 75mA dc
Output Ranges:	0 to 150mV 0 to 24V dc – 24V DC: 2Wire Loop Supply
Percentage Switch:	0 – 25 – 50 – 75 – 100%

Batteries:	- Rechargeable & Replaceable Battery Cartridge.
Certification:	- CENELEC Zone-I/II, IIB/C, Hazardous Area
Accessories:	- 1. Charger for 220V-240 A/C supply. – 2. Leather Carrying Case.

4.4 Aneroid Precision Pressure Gauges

Ranges:	- 0 –100" Water Column – 0 –850" Water Column – 0 –100 psi –
Compound:	- 760mm Hg – 0 – 15 psi
Accuracy:	- ± 0.066% Full Scale.

4.5 Portable Precision Electronic Pressure Calibration

Type:	
	– Druck Model 601/IS or equivalent.
Display:	
	– LED
Digits:	
	– 4½
Accuracy:	
	– 0.025% Full Scale
Range: I	- 0 – 100 psi
Range: II	- 0 – 500 psi
Range: III	- 0 – 1000 psi
Range: IV	- 0 – 1500 psi
Range: V	- 0 – 100" H2O
Range: VI	- 0 – 850" H2O
Area Classification:	
	– Certified for Zone-I/II, IIB/C Hazardous Area Battery Charger
Power Supply:	
	– 220V A/C 50 Hz.

4.6 Dead Weight Tester

Type:	-	Hydraulic
Range:	-	0 – 3000 psi
Accuracy:	-	± 0.025% Full Scale.
Integral Pressure Source:	-	0 – 3000 psi Hydraulic
Reservoir:	-	With Access for draining and replacement of Hydraulic fluid.
Reservoir Valve:	-	For equalization/return of oil to reservoir on completion of test.
Accessories:	-	Complete set of dead weights.
Ports:	-	1) ½" NPT Pressure Connection for instrument to be calibrated.
-		2) ½" NPT Pressure Connection for standard precision gauges for comparison.
Option:	-	4½" digit LED display.

4.7 Portable Electronic Temperature Calibrator

Portable calibrator must have the option of sink and source 4 – 20mA. Oven for temperature calibration shall be provided.

Type:	-	Microprocessor Based
Measurement:	-	1. Pt 100 RTD
	-	2. -150mV to + 150mV
	-	3. Thermocouples Type J,K,R,S,T
	-	4. 4-20mA dc current loop
Outputs:	-	1. Standard Pt 100 RTD DIN curve to selected temperature value.
	-	2. -150mV to + 150mV
	-	3. Thermocouples Type J,K,R,S,T
	-	4. 4-20mA dc 2 wire output from 24V DC loop supply.
Accuracy:	-	1. Standard curve for Pt 100 RTD & Thermocouples.
	-	2. ± 0.1% FS for mV, mA inputs & outputs.
Operation:	-	220-240V A/C 50 Hz or Ni-Cd Battery.
Batteries:	-	Rechargeable & replaceable Ni-Cd batteries.
Area Classification:	-	FM/UL certified for use in Class I, Div.2 Group C&D Hazardous Area.

Accessories:
- 1. Charge for 220-240V A/C 50Hz. System.
- 2. Leather Carrying Case.

ROSEMOUNT HART 375 (MINIMUM) Field Communicator

The CONTRACTOR shall submit the detailed Testing and Calibration Procedures to the client for approval.

5.0 STORAGE AND PROTECTION OF MATERIALS AND EQUIPMENT

A suitable weatherproof lockable storage area shall be supplied for the storage of all instrument equipment and materials. In addition clean workshop facilities suitable for the calibration and checking of instrumentation shall also be provided.

During storage and handling all items of instrument equipment and fittings shall be protected in accordance with the recommendations of the Manufacturer.

Precautions shall be taken to prevent mechanical damage during fabrication, storage and transit activities.

6.0 INSTRUMENT CALIBRATION

The object of pre-installation calibration checks is to ensure that each instrument has been supplied in accordance with its specifications, is functionally correct and is in working order.

All instruments shall be checked against the data sheet to ensure that all data listed on the manufacturer's name plate is consistent with that specified on the data sheet. Where the pre-installation test is not specified, or where circumstances prohibit the carrying out of the prescribed test, a test method shall be agreed with the COMPANY.

In general, all tests will simulate as closely as possible design process conditions, by the use of Manometers, Potentiometer, Resistance Bridges, Dead Weight Testers, Test Pressure Gauges, etc., utilizing hydraulic, electric and pneumatic supplies.

No tests shall be carried out on electronic instruments until an adequate warm up period has elapsed.

All instruments shall be subject to a five (5) point calibration check (both increasing and decreasing) prior to installation. The COMPANY shall be advised of any instruments that cannot be calibrated to the relevant specification.

Calibration checks for pressure, differential pressure and temperature instruments shall be carried out in the calibration workshop.

Calibration checks of level instruments and control valves may be carried out in situ.

A standard pre-installation check sheet shall be completed for each instrument. All evidence and records of abortive tests shall be kept in the system work pack.

Flow orifice plates are to be checked for roundness and burrs. The flow orifice diameter and thickness as well as upstream and downstream pipe inside diameters shall be recorded prior to installation of the orifice plate. Orifice plates are scheduled for installation only after flushing and line pressure testing is complete.

Upon completion of tests the instruments shall be drained, the components removed and shipping stops replaced. Draining the instruments of water used in testing is essential as a precaution against freezing.

At the completion of each test a suitable means of indicating the stage reached shall be fixed to each instrument or installation, e.g. a colour coded label as follows:

- Blue Pre-Installation Tested.

7.0 INSTRUMENT INSTALLATION

7.1 Location

All equipment shall be installed in accordance with the relevant project drawings and other documents. The location of equipment and devices which are not dimensioned on the drawings are approximate. It shall be the responsibility of the Instrument CONTRACTOR to establish the exact location of equipment after taking into consideration:

- No obstruction to walkways
- Easy access by operations personnel
- Site maintenance.

Where reasonably possible, locations shall not be such that access would require the use of ladder. If an instrument needs to be accessed during normal operations then it shall be readily accessed from grade or, alternatively, a permanent access platform shall be provided.

7.2 Erection

All steelwork used for mounting instrumentation shall be painted in accordance with the project Specification for Painting and Protective Coatings. This specification also covers the basic requirements for repairs to surface finishes.

Alternatively instrument mountings shall be hot dip galvanized.

All holes shall be drilled. Flame cutting of holes shall not be permitted. All edges shall be de-burred.

No welding shall be allowed to a pressure vessel or any pipe work.

No holes shall be made to structural members without the approval of the project engineering design office.

All supports and bracket shall be full seal welded.

Unless otherwise approved all bolts, screws and nuts shall be zinc plated and isometric hexagon type.

Spring and flat washers shall be provided under all nuts and flat washers under bolt heads where necessary. Other fastenings shall be securely locked.

Each bolt or stud shall be the shortest standard length which will show at least one full thread beyond its nut after assembly.

All concrete foundations will be in accordance with the relevant project specification. Where instrument stands are set on concrete they shall be grouted.

All instruments and supports shall be aligned with surrounding members so as to present a symmetrical and square finished installation.

All instruments and equipment shall be installed in accordance with the Manufacturer's instructions and the project design specifications.

Steel supports and brackets shall be fabricated and installed in accordance with the drawings. Where these are not detailed, purpose made supports shall be fabricated in accordance with the relevant latest standards and Codes.

7.3 Instruments and Instrument Systems

Instrumentation air supply tubing, valves and fittings shall be installed as per relevant installation diagrams and instrument hook ups.

Instrument systems shall be installed strictly in accordance with the Vendor’s instructions. Power supplies shall not be connected until the installation has been inspected and approved by the equipment Vendor.

7.4 Instrument Tubing and Piping

7.4.1 Air Supply Headers

Main air headers shall be installed by piping. The instrumentation scope shall be to connect sub and branch headers to the isolation valves on the main header and sub air headers.

7.4.2 Instrument Tubing

All connections shall be 316 stainless steel of the double ferrule compression type assembled and installed in accordance with the manufacturer's installation instructions.

Isolation valves shall be as shown on the relevant hook up drawings.

All tubing shall be seamless fully annealed, 316 stainless steel with a chromium molybdenum content of not less than 2.6%. Tubing size and wall thickness shall be as shown on the hookup drawings.

All tubing shall be fabricated, supported and assembled in a neat, tidy, workman-like manner. All threads shall be assembled using an approved thread sealing tape.

Instrument tubing shall be fitted to brackets or structural steel with proprietary type clamps such as "Stauff Clamps" (or equivalent).

The support fixing distances for instrument tube shall not exceed the following:

- ¼" OD SS Tube 0.5 meters
- ½" OD SS Tube 1.5 meters.

Tubing shall only be cold bent using suitable tube benders. Bends shall be free of any deformation to the tube wall. All cutting of tubing shall be carried out with suitable tube cutters and de-burred with an appropriate de-burring tool.

Care shall be taken when installing stainless steel tube with dissimilar metals that adequate segregation is maintained at all times to prevent galvanic action. This shall be achieved by the use of insulating nylon cleats.

After completion of installation all holes in gland entries to junction boxes shall be sealed using sealing plugs certified for the appropriate hazardous area.

Instrument trades personnel shall be responsible for installation of instrument tubing. This will be as detailed on relevant hook-up drawings.

7.5 Cable Installation

7.5.1 Cable Installation and Storage

All cable shall be kept on reels or in shipping boxes at the feeding end of the wire pull. Cable drums shall be hoisted by means of a bar through the centre of the drum to provide a two-point lift. A sling wrapped around the drum is not acceptable.

All cable shall be visually inspected for faults prior to and during installation. No cable, which has damaged insulation or jackets, shall be installed.

At intermediate pull boxes sufficient cable to reach equipment shall be pulled out and then fed back into the boxes. Cable at intermediate pull boxes shall be safeguarded against damage and dirt while spread out on the ground by using tarps or plywood panels.

Cables or cable supports shall not be fixed directly or indirectly to plant equipment or process piping.

7.5.2 Cable Lengths

The location of equipment shown on the drawings is indicative only and shall be finalized during detail engineering. Consequently, prior to commencing the pulling and laying of cables, the actual route length shall be checked by the Contractor to ensure sufficient cable is available to meet the requirements, without recourse to jointing of cable.

No cable shall be cut without the Contractor determining the actual length required based on as-built site conditions.

7.5.3 Cable Segregation

Where power cables have to be laid alongside instrument cables they shall be separated by means of a suitable barrier placed vertically between the two types of cable.In general, where metallic barriers are not used to provide segregation, the Contractor shall ensure that the following minimum separation distances between cables of differing services is maintained:

- ELV instrumentation and other power cables: 300mm
-

7.5.4 Cable Spacing

The space between cables shall be maximized within the space available. Where several cables share a common space, i.e. cable ladders, the spacing between cables shall be as equal as possible.

7.5.5 Location of Cable Routes

The major routing of cables shall be as shown on the project drawings. Any deviations required from these routes shall be submitted to the Company and approved prior to installation. The Contractor shall ascertain that adequate space remain for future in the cable ladder and cable tray after installation of cables.

7.5.6 Cable Ladders

The Contractor shall be responsible for the installation of all cable ladders, and supporting brackets, which are required for the installation of cables on the major cable routes and up to the positions of individual items of equipment.

All cable ladder and accessories shall be installed in accordance with the Manufacturer's recommendations.

Cable ladders shall be supported at intervals not exceeding 6.0 metres. If the Manufacturer's instructions require supports at less than 6 metres, the Contractor shall follow the instructions given by the Manufacturer.

The minimum separation between stacked ladders or trays shall be 300mm.

Cable ladder/trays bends, tees and risers shall be of a radius suitable for the bending radius of the largest cable to be installed, and in any case shall not be less than 300mm.

All cable ladder elbows, bends and tees shall be supported at each end. A support shall also be placed at each reducer.

All cable ladder/trays joints shall be made with standard fittings, and in accordance with the Manufacturer's recommendations.

Ladder sections shall be bolted together and connections locked, so that the ladder is electrically continuous and no bolts protrude into the sections, which may damage cables during installation.

Cable ladders shall be bonded electrically to the earth grid and across joints using a minimum of 16mm2 green/yellow PVC covered copper cable.

Cable ladders major run levels and the horizontal dimensions are shown on the drawings. However, the position of the ladders shall be determined also in relation to pipes and other services. Any major alterations required shall be made only with the written approval of the Company. Where it is necessary to cut or weld ladder supports, the exposed metal shall be cleaned and painted

7.5.7 Above Ground Conduit Installation

As a minimum above ground conduit installation shall be made in accordance with the Standards referenced in Section 2, using proprietary sealing chambers and seal filler compound. No sealing compound shall be installed prior to final acceptance of the respective system and wiring. Every conduit shall be sized appropriately for its intended use. Conduit runs shall be neat and securely fastened in accordance with the manufacturer's recommendations. Where installed outdoors, conduit shall be metallic. Conduit where installed indoors shall be non-metallic. Conduit shall be installed so as to avoid all mechanical duct systems and other pipe systems and services. Conduits shall be of minimum size 20 mm and shall be run so as to enable cables to be drawn-in after erection. Conduit is not required on cable bends.

7.5.8 Metallic Conduit

All burrs shall be removed from ends of metallic conduit. Push-in bushes shall be fitted to the ends of conduit runs. The Contractor shall ensure that all conduits are straight, free from rust and scale and any sets shall be made cold in such a manner as not to distort the walls of the conduits.

7.5.9 Non-Metallic Conduit

PVC conduit and fittings shall be in accordance with Standards detailed under section 2.All conduit shall be secured with approved PVC saddles at maximum spacing of 500 mm. Rigid PVC conduit will not be acceptable in the following locations and steel conduit shall be used instead:

- Where exposed to mechanical damage
- where exposed to direct sunlight
- where exposed to temperatures exceeding 60°C.

7.5.10 Cable Laying

Cables shall be handled with all due care. Cable drums shall be rolled only in the direction indicated on the side of the drum. At no time shall a cable be handled in such a way that it takes up a radius less than its permissible installation. Cables shall always be reeled off from the top of the reel. The reel should be turned by hand to prevent stress on the cable. No twists or kinks shall be allowed to occur. Maximum stresses stated by the cable manufacturer shall not be exceeded when laying or pulling any cables. Pulling the cable over the soil shall be avoided in all cases, rollers shall be used wherever possible. Any damage sustained by a cable (including the outer sheath) shall be reported to the Company and remedial action taken before work upon the particular cable proceeds. Notwithstanding any of the above conditions, as a minimum cables shall be laid and

erected in accordance with the Standards listed in Section 2.A loop shall be provided towards each end of a cable for possible future extension. The location of such loops shall be agreed with the Company prior to the commencement of any cable laying activities.

7.5.11 Bending Radii

In general cable bending radii shall be as large as possible, and shall not be less than the Manufacturer's recommendations.

7.5.12 Cable Clamping

Cables shall be tied to vertical cable ladder or cable tray runs using PVC (UV stabilized) coated stainless steel ties. Where horizontal cable ladder or cable tray is in use, cables shall be tied using PVC (UV stabilized) cable ties. For these purposes, ties shall be 7mm width (minimum). Intermediate, temporary and interior cable ties may be nylon and sized for the application. All cabling run on the cable ladder or tray shall be arranged neatly in parallel runs with no crossing over of cables except at take off points. Cables shall be tied:

- On vertical tray and ladder runs every second rung or every 600mm
- On horizontal runs (with ladder laid horizontally flat) every third rung (900mm)
  On horizontal runs (with ladder turned vertically on its side) every second rung (600mm)
- On slotted angle every 600mm.

The maximum number of cables tied to the cable ladder or cable tray using a single tie shall be five. In no case shall the tie span more than 100mm in width.

7.6 Cable Glanding & Termination

7.6.1 Cable Termination

Cables shall be terminated through a threaded glanded entry or using lock nuts as required by the Company. In general, cable lugs 16mm2 and above will be crimped using a hexagonal die crimping tool. No other type of crimping will be acceptable without prior approval by the Company.

Where cable cores are connected to terminals, an additional core length of approximately 8 cm shall be kept, which shall be worked-off as a "pigtail" adjacent to the terminal blocks. This additional core length is only applicable for conductors of multicore and control cables and cross section of maximum 2.5 mm^2.

Cores of the same cable shall be neatly grouped and tied over the maximum possible length by means of binding cord or strap or, where possible, installed in wiring ducts. Unused cores or pairs shall be insulated and bundled for future use or terminated in spare terminals and connected to earth.

Stranded cores shall be connected with compression type cable lugs or spade-type pins wherever the receiving terminals are not suitable for stranded cores. No more than one core shall be connected to the same terminal unless that terminal has special provision for a larger number of cores.

The inner PVC sheath of instrument cables shall be neatly trimmed and sleeved (30mm length minimum). The drain wire on these cables shall be sleeved and connected to the nominated terminal on the drawings. The screen shall be terminated in accordance with the termination drawing. Each cable and core shall be identified.

7.6.2 Cable Glands

In general, all cables entering into equipment shall do so through suitable compression type cable glands.

Cable glands used for each application shall be the correct size and type for the cable in question in order to achieve a firm and waterproof entry. All cable glands shall be properly sealed to make them waterproof. Mastic or tape used in conjunction with an oversized cable gland shall not be permitted. However, cable gland adaptors may be used where necessary. The Contractor shall be responsible for ensuring the correct entry point for cables into equipment. Where multiple cable entry occurs, the Contractor shall place each cable gland location near its associated terminals, to minimize cable and cable core crossovers. Cables installed in the hazardous area shall be glanded with certified cable glands.

The enclosure protection (IP) rating of the enclosure shall not be compromised by the installation of glands. Fiber washers shall be used where required to maintain the IP rating.

7.6.3 Cable, Cable Core and Terminal Identification

All control cable cores shall be identified with "Grafoplast" (or approved equivalent), black on white cable marking, in accordance with the termination diagrams and cable schedule.

The Contractor shall be responsible for all cable marking. Cables shall be numbered with cable numbers as shown on the drawings.

Cables shall be marked at the entry to all equipment, gland plates and field junction boxes. Tags shall be fixed in accessible positions and orientated for best viewing.

Cable number tags shall comprise carrier strips, markers and 5mm cable ties.

7.6.4 Termination Completeness

The Contractor shall install all cables and cores within cubicles in an orderly and tidy manner. All cores shall be installed in wireways where provided and shall be fastened with cable ties.

If cable ways are not provided the Contractor will be responsible for restraining the cores with cable ties.

7.6.5 Earthing and Bonding

All metal structures are to be bonded to the main electrical earth system. As a minimum, bonding shall be in accordance with the requirements detailed in Section 2 and shall include but not be limited to:

- Field junction box enclosures
- All cable ladder and trays
- All bonding as required in drawings and specifications
- All control room equipment racks and panels including doors.

The contractor shall be responsible for electrically bonding all equipment not solidly welded to the structure.

In general and where provided for, packaged equipment metal frames shall be electrically bonded to the earth grid at two points diametrically opposite to each other.

Where earth bonding connection to steel work is required, the connection shall be completed using M10 bolts screwed into bosses. Such bolts, bosses and steel work shall be of similar materials and avoid galvanic corrosion. The bosses shall be fillet welded to the steel work. The bolt shall be fitted with locking washers.

The position of all earthing connections shall be visible and easily accessible. Earthing points shall be protected against corrosion and all connections shall be electrically and mechanically effective. Where bolted connections are used, the contact surfaces shall be thoroughly cleaned to ensure a low resistance contact. Oxide resistant grease shall be applied to all bolted connections.

Earthing and bonding conductors shall be single core, stranded, annealed copper conductors, PVC insulated, coloured green and yellow, and shall have minimum size as

shown on drawings. In the absence of drawings, minimum size in accordance with the requirements of the Standards detailed in Section 2 shall be used.

The Subcontractor shall check that a suitable earth connection point is provided on panels, terminal boxes and gland plates before cable glanding is started. When no earth connection is provided, an earth tag shall be installed with the cable gland or a gland continuity plate shall be provided. The tag or plate shall then be effectively earthed.

After glanding, the contractor shall check the continuity of the armouring to ensure that a low impedance path of the cable armour and gland is maintained.

No earthing connections shall be made to fixing bolts serving as mechanical fixings.

Earth wires shall be installed such that disconnection of an earthed item of equipment does not cause the disruption of the safety earthing of another item of equipment.

Earthing cables shall be suitably protected with pipe or kick plates where subject to mechanical damage.

Earthing of instrumentation and measurement systems shall be electrically independent of the power system/equipment frame earthing except at the point of common connection to the main structure.

7.7 Labeling

All labels shall be fixed in accordance with drawings data sheets and installation instructions.

Labels shall be stainless steel plates or UV stabilized plastic plates as specified in the label schedule.

Fixing of plates shall be by a minimum of two stainless steel screw, self-tapping screws or stainless steel rivets. Labels larger than 75mm x 30mm shall have four fixing screws. Self adhesive labels shall not be used for identification tags.

Fixing holes in plastic labels shall be drilled oversize and screws shall not be tightened to the extent that the label cannot move under expansion caused by extremes of temperature

7.8 Post Installation Inspections and Testing

7.8.1 General

All instruments will be subject to a post installation check to ensure the instrument is installed, connected, and identified in accordance with the relevant documentation. A detailed check sheet shall be completed for each instrument.

7.8.2 Pressure Testing Instrument Impulse Tubing

The object of this phase of the testing procedure is to ensure that all instruments piping and tubing is pressure tight to the specified working/testing conditions.

The pressure testing of process impulse lines on a given loop shall be completed before the final loop testing.

The procedure to be adopted for pressure testing shall include the following:

- Cleaning or blowing out all pipes and tubes to remove scale, rust or other foreign materials.
- Proving all joints at the specified test pressures.
- Blowing out all water used after hydraulic testing of process impulse piping.

Testing shall be limited to the tube and fittings downstream of the process isolation valve.

After flushing the line with water the open end shall be blanked off and the line shall be pressurized to 1.5 times the maximum working pressure (corrected for temperature). The line shall then be isolated from the pressure source and the pressure should not fall.

After testing the lines shall be reconnected to the instrument manifold and all manifold valves shall be checked for tight shut off.

Attention is drawn to the fact that various tests are carried out by others on process piping, e.g. hydraulic tests, flushing, etc. During hydraulic tests on the process pipework the instrument must be disconnected to ensure that initial isolations are leak proof. During flushing it must be ensured that all installed instruments are suitably and positively isolated from the process line. Instruments fitted with manifolds must have their bypass valve open.

7.8.3 Leak Testing of Pneumatic Lines

Each instrument air supply line shall be disconnected immediately upstream of, and adjacent to, the individual air filter/regulator and blown out with clean air, until cleared of all foreign materials.

A suitable test gauge shall then be connected to the open end of the line.

Open the isolation valve immediately upstream of the piping to be tested and when the line is pressurized close the valve. The gauge reading shall not fall by more than 10 psig in 10 minutes. If the leakage rate is above 10 psig in 10 minutes the joints shall be checked with soap solution and remade as necessary.

When the leakage rate is below 10 psig in 10 minutes the gauges shall be removed, the line reconnected and the joints not previously proven checked with soap solution

7.8.4 Testing of Instrument Wiring

Test Procedure

All instrument cables shall be subject to insulation resistance testing of a magnitude commiserate with their insulation rating. Cables containing intrinsically safe (IS) circuits shall be tested to a minimum of 500V.

Insulation resistance testing shall be performed between core to core, core to screen, core to armour, core to earth, screen to armour, screen to earth and armour to earth. A continuity check of each core is also required. These tests and correct discharge to earth will be carried out before termination to field devices or equipment racks. Test results will be recorded on the Subcontractor supplied and Contractor Approved cable test sheets.
Following direct current potentials shall be used for insulation tests as minimum:

- For 300/500V Grade Cables 500V Test
- For 600/1000V Grade Cables 1000V Test

The minimum acceptable insulation resistance value will be minimum 50 mega ohm. If insulation resistance test readings are found to be less than specified minimum in any conductor, the entire cable shall be replaced and the new cable tested.

Communication cables and Fiber optical cables shall be tested as per the recommended practices and codes & standards specified in this document.

Power off Tests

a) Immediately after cables are laid and before connection, all thermocouple, electric and electronic instrument wiring shall be checked for polarity, continuity and insulation resistance between conductors and between conductors to earth. These tests must be carried out before final loop tests.

b) Continuity and insulation resistance checks shall be carried out using the proper test equipment to comply with the requirements of part 6 of the IEE Regulations for Electrical Installations or the rules and regulations with which the installation has to comply.

d) Other tests on I.S. circuits (e.g. for loop impedance, inductance, L/R ratio, etc.) shall be carried out.

e) Coaxial cables used for data highways shall be tested using sinewave reflective testing technique.

8.0 LOOP TESTING

8.1.1 General

The object of 'Loop Testing' is to prove that the installed instrumentation functions correctly and is in fit condition for handing over.

The procedure to be adopted in carrying out these tests is mentioned below, but in general the completed instrument loop shall be tested as one system, and where necessary, adjustments shall be made to calibrations. Associated alarms and trips shall be checked during loop testing.

Electronic Loop Testing is a two man operation, one man in the field at the transmitting or controlled instrument and one man in the control room at the controlling instrument. These men must be provided with adequate means of remote communication, i.e. radio contact.

Loop testing shall never be carried out on electronic equipment that has not been allotted an adequate warm up period.

Loop testing will be documented on the relevant test sheets.

On completion of loop testing all controllers shall be left with correct action and PID settings shall be recorded on the test sheet.

8.1.2 Loop Testing Procedure

Inspect the loop, setting air/electrical supplies where appropriate. Check in particular that control valve's air supply pressure is set in accordance with the specification.

For electronic loops check polarities, measure the loop impedance and make the necessary compensating adjustments.

Simulate an output signal from the transmitter equivalent to 0, 50, and 100 percent of the instrument range. Check the response of all other instruments and control valve(s) in the loop. Instrument zero settings and calibration adjustments shall be made as necessary.

Switch the controller to manual operation and by applying the appropriate signals ensure that the control valve or valves stroke correctly, valve positioner gauges shall also be checked during this stage.

Apply an actuating signal to the controller equivalent to 50 percent of the instrument range and adjust the manual regulator output to 50 percent. Adjust the controller set point to 50 percent and by switching the auto/manual transfer switch, check for 'Bumpless' transfer. Using the manufacturer's instructions adjust where necessary until satisfactory 'Bumpless' transfer is achieved.

Check alarm and trip actions by varying the actuating signals and adjust as necessary.
Locally mounted controller or transmitting only loops shall be tested in a similar manner to that specified above omitting transmitter and/or auto/manual checks if necessary.

After each loop is satisfactorily tested the controller shall be switched to manual.

Resistance thermometers shall be removed from their wells and checked for damage. The resistance of each RTD shall be measured at ambient temperature and the resistance and temperature noted.

After testing, RTD's shall be replaced in their thermowells and reconnected. It is important to ensure that the element length matches its associated thermowell.

Analytical and Special Installations shall be checked according to manufacturer's instructions and/or by agreement with the Contractor.

Trips and alarms not previously covered in the loop tests, e.g. initiating devices which stop/start pumps, etc., shall be checked out in conjunction with Contractor.

All systems shall be checked for 'fail safe' operation which will include the checking of 'burn out' features on thermocouple installations.

At the completion of each test a suitable means of indicating the stage reached shall be fixed to each instrument or installation, e.g. a colour coded label as follows:

- Red Pre-commissioned.

9.0 DOCUMENTATION

During the process of the installation work, the contractor shall maintain a set of master drawings on which he shall record as-built details as the installation proceeds. These drawings shall also be used to record all approved changes. The as-built drawings shall include all work completed but not detailed by the "Approved for Construction" drawings.