

**Request for Proposal for Supply,  
Erection and Commissioning of Field  
Instrumentation**



**ISRO Propulsion Complex, Mahendragiri  
Indian Space Research Organisation**

## Table of Contents

A.	Scope of Work and Services	3
	1. Introduction	3
	2. Requirement	3
	3. Scope of RFP	6
B.	Instructions to Bidders	21
	1. Submission of Bids	21
	2. Execution Period	21
	3. Prices	22
	4. Payment	22
	5. Validity	22
	6. Quantity Variation	22
	7. Compensation for Delay	23
	8. Delivery Terms	23
	9. Guarantee and Insurance	23
	10. Taxes and Duties	24
	11. Bidder Selection Criteria	24
C.	Terms and Conditions	25
	Annexure - I : Sample Block Diagrams for Measurements, Commands and Detectors	37
	Annexure - II : List of Applicable Codes and Standards	41
	Annexure - III : Specifications of the Field Elements	42
	Annexure - IV : Bill of Quantities	65
	Annexure - V : List of Pressure Transmitters	69
	Annexure - VI : Memorandum of Undertaking	70
	Annexure - VII : Preferred Makes	71

## **A. SCOPE OF WORK AND SERVICES**

### **1. INTRODUCTION**

The main scope of instrumentation system at an engine test facility is divided into four parts namely field instrumentation, control room instrumentation, control system and data acquisition system. The field instrumentation system is mainly categorized into three parts, viz. the measurement system, the command system and the safety system.

This RFP defines the scope of work and basic requirements for augmentation of field instrumentation for the testing of propulsion systems at a test facility at IPRC, Mahendragiri, Tamil Nadu.

### **2. REQUIREMENT**

#### **2.1. DEFINITION**

Instrumentation related to the field instruments which are positioned in the test stand is covered under the broader term 'field instrumentation'. This includes, but is not limited to, the supply & installation of smart field transmitters, safety detectors, explosion-proof junction boxes, solenoid operated valve (SOV) housing cubicles, solenoid operated valves (SOV), pressure switches, smart valve positioners, data cables, cable trays, impulse / pneumatic tubing and structural steel members.

#### **2.2. CONCEPT AND PHILOSOPHY**

The following key points are important to the understanding of the scope of work.

- i. The signals from the test facility are interfaced with front end electronics at Panel Room located approximately 300 m away from the test facility.
- ii. A full-fledged instrumentation system for testing at the engine bay of the SIET already exists.
- iii. The connectivity of main cable trays is already established from the Panel Room to various segments of the test stand.
- iv. Separate explosion proof field junction boxes shall be used for various types of facility measurements and commands.

##### **2.2.1. Facility Measurement System**

- i. Smart field transmitters (HART protocol enabled) are planned for facility pressure (absolute or gauge or differential), facility temperature and some of the facility flow measurements.
- ii. Turbine flow meters with appropriate pre-amplifier units and signal converters are planned for many of facility flow measurements. Armoured FRLS PVC cables of AWG 20 size shall be used for connecting the flow meters to the preamplifier and the preamplifiers to the junction boxes.
- iii. Armoured FRLS PVC cables (single pair or two pair) of AWG 20 size shall be used for connecting the junction boxes to facility field instruments.
- iv. Multicore (32 pair or 48 pair) FRLS PVC cables of AWG 20 size shall be used between field junction boxes to marshalling junction boxes, if any, and between field junction boxes and marshalling junction boxes, if any, to the Panel Room.

- v. For temperature measurements, armoured FRLS PVC two-pair cables shall be laid from the transmitters to the RTD sensors.
- vi. Impulse tubing of the pressure transmitters, in some cases, have to be undertaken. In such cases, the tubing will have to be laid through identified tubing trays and will have to be tested at 1.1 times its maximum allowable working pressure (MAWP) or as dictated by the Department.
- vii. All cables are to be laid in identified cable trays only.

#### **2.2.2. EP valve Command System**

- i. The EP valve command chain is planned with main & redundant coil solenoid operated valves (SOVs) and is operated through independent command chains.
- ii. The SOVs will have an operating pressure normally 8 bar or 60 bar. But in some cases, it may be up to 300 bar.
- iii. The SOVs will be either mounted on the EP valves or will have to be removed from the EP valve body and mounted in the identified weatherproof SOV cubicles.
- iv. 8 or 6 nos. of SOVs shall be mounted in one identified weatherproof SOV cubicles.
- v. A pressure switch shall be mounted after the isolation valve at the pneumatic pressure inlet for all the weatherproof SOV cubicles.
- vi. In cases where the SOV is mounted on the EP valve body itself, two runs of armoured FRLS PVC single pair cables of AWG 18 size shall be laid directly from the identified the junction boxes to the SOV.
- vii. In cases where the SOV is housed inside a cubicle, two runs of armoured FRLS PVC 8 or 6 pair cables of AWG 18 size shall be laid directly from the identified the junction boxes to the SOV cubicle.
- viii. For the SOV command system, multicore (32 pair) FRLS PVC cables of AWG 18 size shall be used between field junction boxes to marshalling junction boxes, if any, and between field junction boxes and marshalling junction boxes, if any, to the Panel Room.
- ix. Armoured FRLS PVC two-pair cables of AWG 20 size shall be used between termination box located on the EP valve and the identified junction boxes for the proximity status switches. The same applies to the pressure switches.
- x. For the proximity status switches, multicore (48 pair) FRLS PVC cables of AWG 20 size shall be used between field junction boxes to marshalling junction boxes, if any, and between field junction boxes and marshalling junction boxes, if any, to the Panel Room.
- xi. Command tubing, in some cases, have to be undertaken. If so, then the same shall be carried out between SOV and EP valve actuator and/or EP valve actuator and command header using 8mm / ½” O.D. seamless stainless-steel tubes. In such cases, the tubing will have to be laid through identified tubing trays and will have to be tested at 1.1 times its maximum allowable working pressure (MAWP) or as directed by the Department.
- xii. All cables are to be laid in identified cable trays only.

#### **2.2.3. Control valve command system**

- i. Control valve shall have a HART-protocol enabled smart valve positioner with an integrated position transmitter.
- ii. Command tubing, in some cases, have to be undertaken. If so, then the same shall be carried out between control valve and the facility command header using ½” O.D. seamless stainless-steel tubes. In such cases, the tubing will have to be laid through

- identified tubing trays and will have to be tested at 1.1 times its maximum allowable working pressure (MAWP) or as dictated by the Department.
- iii. Armoured FRLS PVC two-pair cables of AWG 20 size shall be used between valve positioners and the identified junction boxes.
  - iv. Multicore (32 pair) FRLS PVC cables of AWG 20 size shall be used between field junction boxes to marshalling junction boxes, if any, and between field junction boxes and marshalling junction boxes, if any, to the Panel Room.
  - v. All cables are to be laid in identified cable trays only.

#### 2.2.4. Safety detector system

- i. All safety detectors will be equipped with smart communication protocols and will be operated at 24 V DC.
- ii. Armoured FRLS PVC two-pair cables of AWG 20 size shall be used between detectors and the identified junction boxes.
- iii. Multicore (48 pair) FRLS PVC cables of AWG 20 size shall be used between field junction boxes to marshalling junction boxes, if any, and between field junction boxes and marshalling junction boxes, if any, to the Panel Room.
- iv. All cables are to be laid in identified cable trays only.

### 2.3. INSTRUMENTATION REQUIREMENT

Instrumentation measurement, command and safety requirements are as given below.

Sl. No	Description	Total
<b>Facility Measurements:</b>		
1.	Pressure-based transmitter measurements	150
2.	Temperature transmitter measurements	65
3.	Flow measurements	40
	<b>Sub Total</b>	<b>255</b>
<b>Command System:</b>		
4.	EP valve commands	170
5.	Control valves / Electronic pressure regulators	25
	<b>Sub Total</b>	<b>195</b>
<b>Safety System:</b>		
6.	Safety Detectors	50
	<b>Sub Total</b>	<b>50</b>

### **3. SCOPE OF RFP**

The scope of this RFP includes detailed engineering, procurement, installation and commissioning department site. All field instrumentation and cabling up to Panel Room is the responsibility of the Contractor. Scope of work for field instrumentation system is defined in figures (chain diagrams) given in Annexure I. These figures are only for demarcating the limits of the contractor and department scope and may vary based on Department's discretion.

Some of keywords used in this document are defined as follows.

- i. "Purchaser" shall mean Director, IPRC and any representatives of the Department duly authorized on behalf of President of India for this project.
- ii. "Contractor" shall mean an individual or firm or company whether incorporated or not, chosen by the Purchaser on whom this purchase order is placed for undertaking the works and shall include the legal personnel composing such firm or company, or the successors of such firm or company and the permitted assignee of such individual or firm or company.
- iii. "Purchaser's Site" shall mean locations at Mahendragiri, Tamil Nadu on which work is to be executed by the Contractor, which may be allotted by the Purchaser for the purpose of carrying out the work.
- iv. "Contractor's site or manufacturer's site" shall mean the location at which the control systems as per our requirement are manufactured / integrated.

#### **3.1. DETAILED ENGINEERING**

Input documents to be referred for preparing detailed engineering are:

- i. P&I diagrams
- ii. Equipment layout drawing
- iii. Measurement / Command / Safety chain diagram - Refer Annexure I
- iv. Measurement Plan
- v. Codes & Standards - Refer Annexure II
- vi. Instruments specification sheet - Refer Annexure III

Documents mentioned in i., ii. and iv. will be provided post the finalization of the contract.

The following documents shall be prepared and submitted by the contractor for the approval from the department during detailed engineering.

- i. Instrument / equipment layout diagram
- ii. Instrument / equipment erection diagram (hook up diagrams)
- iii. Instrument / equipment mounting procedure
- iv. Cable and cable tray routing diagram for instrumentation cables
- v. Pneumatic / impulse tube routing diagram (in applicable cases only)
- vi. Field instrument, junction box and Panel Room cable termination diagrams
- vii. Quantity estimation of items under supply of contractor's scope and its specifications sheets duly signed by contractor / OEM datasheets.
- viii. Testing plan
- ix. Quality assurance plan

## **3.2. SUPPLY OF FIELD ELEMENTS**

### **3.2.1. Scope of Contractor Supply**

The following is the list of items to be supplied by the contractor. This is not an exhaustive list. The specifications of these instruments & materials are given in Annexure III. All items supplied by contractor shall meet the specification provided in Annexure III. However, in case of any changes or modifications proposed by contractor / purchaser during detailed engineering review, the contractor shall execute the work as per decisions made by the purchaser. Exact quantity and the list of items required for commissioning the facility will be finalized during detailed engineering.

- Smart Pressure Transmitters.
- Smart Temperature Transmitters.
- Flow preamplifiers for the turbine flow meters.
- Flow signal conditioners and signal converters for turbine flow meters.
- Dual coil solenoid operated valves.
- Smart valve positioners with feedback transmitters.
- Pressure switches.
- PVC cables & CAT6 cables.
- Cable Glands.
- Termination Lugs.
- Explosion-proof Junction Boxes of different sizes.
- Aluminium dummy plugs for the junction boxes.
- Structural materials required for providing structural support for instrumentation related items like cable and tubing trays and their associated trays supports, all types of consumables and accessories for mounting all instruments and instrument supports. All instruments and elements exposed to direct weather conditions shall be provided with canopies which will be considered as a structural material.
- HART modems.
- SS316 tube fittings and exhaust port silencers.
- Necessary concrete required for grouting instrument / field element installation structures.
- Earth strips and earth pit accessories.
- 16 AWG insulated copper earthing cables shall be used for earthing of all the field elements with the earth strip.
- SS Cable Tags with cable number engraved or punched on the top.
- End terminal & identification ferrules.
- Cable harnessing materials.
- Mounting accessories.
- Any other items required for erection and commissioning

All materials furnished shall be new and unused and free of defects. All items supplied by contractor shall meet the specification provided in Annexure III. The specification provides the minimum requirement of the system but it does not relieve the supplier from his responsibilities for completeness of the system concerning the design, the reliability and the safe operation of the supplied equipment. The specification of the items which are not covered will be finalized and approved by the purchaser during detailed engineering phase.

Contractor shall consider all items and accessories for realisation of the system.

### **3.2.2. Free issue materials**

The following is the list of items which will be issued to the contractor by the purchaser. This is an exhaustive list and any omissions from the list in 3.2.1 and 3.2.2 deemed necessary for the installation and commissioning of the systems will be contractor's responsibility.

- Smart Pressure Transmitters not included in the Annexure V.
- Dual coil solenoid operated valves not included in the Annexure IV.
- PVC cables not included in the Annexure IV.
- SOV cubicles.
- Flow meters.

## **3.3. ERECTION AND COMMISSIONING**

### **3.3.1. General instructions**

- i. Erection & commissioning works shall be carried out strictly according to the specifications stipulated in the RFP and as per documents / drawings approved by purchaser during detailed engineering. Also, it shall be carried out under the supervision of the purchaser's representative.
- ii. The contractor shall provide and maintain a formal system for documenting technical clarification from the purchaser.
- iii. Only correctly signed documents which are marked "Approved for Construction" (AFC) shall be used for installation work.
- iv. Only the best trade practices and correct tools shall be used and all works are expected to be completed in a neat and safe manner.
- v. Welding shall be done only by qualified personnel.
- vi. Electrical installation shall only be performed by appropriate qualified trade persons.
- vii. Holes shall be drilled or punched and not burnt out by gas torches or electric arcs.
- viii. Piping and tubing, in any, shall be carried out with the appropriate pipe or tube bending equipment.
- ix. Instrument/equipment shall be mounted using suitable stands / brackets / clamps. As far as possible all instruments shall be mounted on instrument support stands. These shall be installed on floors, RCC columns and walls using approved make anchor fasteners / Hilti bolts and on steel structure by drilling suitable holes and using chromium plated / galvanized bolts and nuts or in exceptional cases by welding. After welding, the slag on weld surface shall be removed and two coat of Red-oxide primer and two coat of



- chlorine-free synthetic enamel paint shall be applied over the surface.
- x. Equipment shall be installed in a neat, workman like manner so that it is level, plumb, square and properly aligned and oriented.
  - xi. Field instruments should not be supported from impulse lines, hand rails and vibrating structures.
  - xii. Instruments shall be located such that it is easy to approach for operation and maintenance. Cover can be removed without obstruction and there should not be any problem in re-glanding the cable later on.
  - xiii. All indicating instruments shall be located such that its scale is conveniently visible to field operator.
  - xiv. Canopy shall be provided for all the instruments, junction boxes and SOV cubicles located in areas exposed to direct weather conditions.
  - xv. All threaded opening of the instruments shall be protected by suitable Aluminium / Chromium plated plugs.
  - xvi. Cable insulation resistance shall be checked before and after laying the cable. If insulation resistance is not within the limits, those cables shall not be used for laying. The contractor should lay new cables, meeting the continuity and insulation resistance requirements, without any cost implication, in case of degradation of electrical properties after laying and termination.
  - xvii. During installation of the signal and control cables and prior to connection up to the instruments, the cables shall be checked for the insulation resistance, continuity and tagging.
  - xviii. The signal and control cables shall be connected to respective terminals, as per the wiring drawings.

### **3.3.2. Tools for erection and commissioning**

The contractor shall bring necessary tools required for erection and commissioning of all the instruments & components and an instrument work shop shall be made ready at the erection site at the location identified by the purchaser.

### **3.3.3. Handling & storage of instruments**

- i. The Contractor shall be responsible for the collection of “free-issue” instrument items, transportation, storage and safe custody of the equipment until the completion of its installation and acceptance by purchaser’s representative. Contractor shall maintain a inventory management system to enable material tracking throughout the installation & commissioning of the facility.
- ii. All instruments shall be visually examined by the contractor on receipt to ensure that they have not been damaged in transit. Instruments shall then be replaced in their original packing and housed in a separate secure, dry, cool storage area provided by the purchaser.
- iii. If any item is damaged by the contractor, new item may be procured and replaced by the contractor with their own cost or the cost of the item will be deducted from the contractor’s bill.

- iv. When unpacking is necessary, care shall be taken to ensure that accessories are not mislaid or mixed.
- v. Instruments shall not be left lying around the construction area.
- vi. All covers and plugs on the instrument connections shall be left in place until connections are used.

#### **3.3.4. Installation Preparation**

- i. Instrument process connections shall be identified before installation.
- ii. Sensitive electronic instruments / components shall be protected during welding, drilling & filing activities.
- iii. Metal filing and metal shaving shall be prevented from falling on the components / ports / connectors.
- iv. Instrument stands and mounting brackets shall be fabricated according to design drawings approved by the department.
- v. Identification tags shall be attached to each field component bearing its tag name in accordance with P&ID drawings / instrument schedules.
- vi. Identification tags shall be painted to all junction boxes and SOV Cubicle. Painting shall be done with yellow background and black lettering.

#### **3.3.5. Scope of Installation**

##### **3.3.5.1. Mounting of pressure-based measurement transmitters**

- i. The absolute, gauge or differential pressure transmitters with appropriate manifolds have to be mounted on a DN 50 MS pipes using clamps. Tag number is to be painted using black color paint on yellow back ground near the transmitter on the pipe.
- ii. A two-valve manifold for absolute or gauge pressure measurement and five-valve manifold with block equalizing and drain valves for differential pressure measurement shall be installed with the transmitter.

##### **3.3.5.2. Cable and cable tray laying for pressure-based measurement transmitters**

- i. Armoured FRLS PVC cables (single pair) of AWG 20 size shall be used for connecting the junction boxes to facility field instruments.
- ii. Multicore (32 pair) FRLS PVC cables of AWG 20 size shall be used between field junction boxes to marshalling junction boxes, if any, and between field junction boxes and marshalling junction boxes, if any, to the Panel Room.
- iii. Cable trays shall be laid between the pressure transmitters and the junction boxes. All cables are to be laid in identified cable trays only.
- iv. Cables shall be terminated to the instrument / junction boxes using suitable SS cable gland.
- v. Refer to 3.3.5.22 for general guidelines for cable laying, 3.3.5.21 for general guidelines cable tray laying and 3.3.5.23 for general guidelines for cable glanding and termination.

### **3.3.5.3. Tubing and tubing tray laying for pressure-based measurement transmitters**

- i. Impulse tubing of the pressure transmitters, in some cases, have to be undertaken. In such cases, the tubing will have to be laid through identified tubing trays and will have to be tested at 1.1 times its maximum allowable working pressure (MAWP) or as dictated by the Department.
- ii. The pressure transmitter manifold valve inlet has to be interface with the adapters on the tapping points on lines / tanks ½” SS tubes with suitable compression fittings.
- iii. Refer to 3.3.5.28 for general guidelines for impulse and pneumatic tubing and 3.3.5.21 for general guidelines tubing tray laying.

### **3.3.5.4. Mounting of temperature transmitters**

- i. The temperature transmitters have to be mounted on a DN 50 MS pipes using clamps. Tag number is to be painted using black color paint on yellow back ground near the transmitter on the pipe.
- ii. RTD shall be mounted in the process line as per mounting drawing approved by the Department.

### **3.3.5.5. Cable and cable tray laying for temperature transmitters**

- i. Armoured FRLS PVC cables (single pair) of AWG 20 size shall be used for connecting the junction boxes to facility field instruments.
- ii. Armoured FRLS PVC two-pair cables of AWG 20 size shall be laid from the transmitters to the RTD sensors.
- iii. Multicore (32 pair) FRLS PVC cables of AWG 20 size shall be used between field junction boxes to marshalling junction boxes, if any, and between field junction boxes and marshalling junction boxes, if any, to the Panel Room.
- iv. Cable trays shall be laid between the temperature transmitters and the junction boxes and between the temperature transmitters and RTD sensors. All cables are to be laid in identified cable trays only.
- v. Cables shall be terminated to the sensor / instrument / junction boxes using suitable SS cable gland.
- vi. Refer to 3.3.5.22 for general guidelines for cable laying, 3.3.5.21 for general guidelines cable tray laying and 3.3.5.23 for general guidelines for cable glanding and termination.

### **3.3.5.6. Mounting of flow transmitters**

- i. The flow transmitters (remote transmitters) have to be mounted on a DN 50 MS pipes using clamps. Tag number is to be painted using black color paint on yellow back ground near the transmitter on the pipe.
- ii. Appropriate pre-amplifier units and signal converters shall be mounted near the turbine flow meters and signal converters shall be placed in identified junction boxes or at Panel Room.

### **3.3.5.7. Cable and cable tray laying for flow transmitters / preamplifiers**

- i. Armoured FRLS PVC cables (two-pair or as required) of AWG 20 size shall be used for

- connecting the junction boxes to facility field instruments like preamplifiers or flow transmitters and for connecting flow meters to the preamplifiers / flow transmitters.
- ii. Multicore (48 pair) FRLS PVC cables of AWG 20 size shall be used between field junction boxes to marshalling junction boxes, if any, and between field junction boxes and marshalling junction boxes, if any, to the Panel Room.
  - iii. Cable trays shall be laid between the pressure transmitters and the junction boxes. All cables are to be laid in identified cable trays only.
  - vii. Cables shall be terminated to the instrument / preamplifier / junction boxes using suitable SS cable gland.
  - viii. Refer to 3.3.5.22 for general guidelines for cable laying, 3.3.5.21 for general guidelines cable tray laying and 3.3.5.23 for general guidelines for cable glanding and termination.

#### **3.3.5.8. Mounting of heat flux sensors**

- i. Heat flux sensor shall be mounted / pasted as per the approved mounting diagram on steel plates located over two vertical pits to depths of up to 50 metres from the ground level of the test stand. The location can be accessed only with scaffolding structures (vendor's scope) built up from the lowest level of the pits.
- ii. These sensors will have integral mineral insulated extension cables which have to carefully routed through MS channels or angles to the ground level and interfaced to the appropriate instruments.
- iii. Structural steel works involved will be separately billable. Cable laying and cable tray laying involved in this work will not be separately billable but general guidelines will remain same as mentioned in 3.3.5.22, 3.3.5.23 and 3.3.5.21.

#### **3.3.5.9. Mounting of pressure switches**

- i. The pressure switches have to be mounted on a DN 50 MS pipes using clamps. Tag number is to be painted using black color paint on yellow back ground near the transmitter on the pipe.

#### **3.3.5.10. Tubing and tubing tray laying for pressure switches**

- i. Impulse tubing of the pressure switches, in some cases, have to be undertaken. In such cases, the tubing will have to laid through identified tubing trays and will have to be tested at 1.1 times its maximum allowable working pressure (MAWP) or as dictated by the Department.
- ii. Refer to 3.3.5.28 for general guidelines for impulse and pneumatic tubing and 3.3.5.21 for general guidelines tubing tray laying.

#### **3.3.5.11. Cable and cable tray laying for EP valve status switches and pressure switches**

- i. Armoured FRLS PVC cables (two-pair or as required) of AWG 20 size shall be used for connecting the junction boxes on the EP valves for the proximity sensors to the junction boxes or for connecting the junction boxes to the pressure switches.
- ii. Multicore (48 pair) FRLS PVC cables of AWG 20 size shall be used between field junction boxes to marshalling junction boxes, if any, and between field junction boxes and marshalling junction boxes, if any, to the Panel Room.

- iii. Cable trays shall be laid between the field elements and the junction boxes. All cables are to be laid in identified cable trays only.
- iv. Cables shall be terminated to the instrument / preamplifier / junction boxes using suitable SS cable gland.
- v. Refer to 3.3.5.22 for general guidelines for cable laying, 3.3.5.21 for general guidelines cable tray laying and 3.3.5.23 for general guidelines for cable glanding and termination.

#### **3.3.5.12. Mounting of SOV cubicles**

- i. The SOV cubicles (1200 mm (W) x 1300 mm (H) x 350 mm (D), powder coated CRCA) have to be mounted on the fabricated structural supports using proper mounting bolts / screws / accessories.
- ii. Legible tags have to be painted on the SOV cubicles using black color paint on yellow back ground for identification.
- iii. Two miniature junction boxes shall be mounted to or dismantled from the cubicles, if required.
- iv. SS Pneumatic header of size minimum DN25 (for feeding to all solenoid valves in a SOV cubicle) shall be mounted inside the SOV cubicle.
- v. Alteration shall be made to the header as per requirement.
- vi. Stainless steel dummy plugs shall be installed to close all unused ports on the header.

#### **3.3.5.13. Mounting of SOVs in SOV cubicles**

- i. Removal of SOVs from existing location on the EP valve, if required.
- ii. Mounting of SOVs on a plate inside an SOV Cubicle using appropriate bolts / screws / accessories. A maximum of 6 or 8 solenoid valves shall be housed in a single cubicle based on the cubicle selected. A cubicle will have two termination junction boxes and a DN25 pneumatic header with flange.
- iii. The inlet of the SOV has to be interfaced to the header and the outlet of the SOV has to be interfaced to the bulkhead union using 8mm or 1/2" SS tubes and suitable compression fittings. Tubing length in this case will be approximately 200-250 mm only.
- iv. Two sets of 2 core cables shall be laid (2-3 m length) between SOV terminals and SOV cubicle junction box terminals and terminated with appropriate ferrule identification and termination lugs. Cabling is included in the scope of this work.

#### **3.3.5.14. Mounting of SOVs on EP valves**

- i. Mounting or removal of solenoid valves on an EP valve using appropriate bolts / screws / accessories.
- ii. In some cases, the inlet of the SOV has to be interfaced to the header and the outlet of the SOV has to be interfaced to the valve actuator using 8mm or 1/2" SS tubes and suitable compression fittings. Tubing length in this case will be approx. 200-250 mm.

#### **3.3.5.15. Cable and cable tray laying for SOVs and SOV cubicles**

- i. In cases where the SOV is mounted on the EP valve body itself, two runs of armoured FRLS PVC single pair cables of AWG 18 size shall be laid directly from the identified the junction boxes to the SOV.

- ii. In cases where the SOV is housed inside a cubicle, two runs of armoured FRLS PVC 8 or 6 pair cables of AWG 18 size shall be laid directly from the identified the junction boxes to the SOV cubicle.
- iii. For the SOV command system, multicore (32 pair) FRLS PVC cables of AWG 18 size shall be used between field junction boxes to marshalling junction boxes, if any, and between field junction boxes and marshalling junction boxes, if any, to the Panel Room.
- iv. Cable trays shall be laid between the field elements and the junction boxes. All cables are to be laid in identified cable trays only.
- v. Cables shall be terminated to the instrument / preamplifier / junction boxes using suitable SS cable gland.
- vi. Refer to 3.3.5.22 for general guidelines for cable laying, 3.3.5.21 for general guidelines cable tray laying and 3.3.5.23 for general guidelines for cable glanding and termination.

#### **3.3.5.16. Tubing and tubing tray laying for EP valves from SOVs**

- i. Pneumatic tubing of the EP valves, in some cases, have to be undertaken. In such cases, the tubing will have to laid through identified tubing trays and will have to be tested at 1.1 times its maximum allowable working pressure (MAWP) or as dictated by the Department.
- ii. The SOV outlet from the bulkhead union on the SOV cubicle has to be interfaced with the inlet adapter of the actuator of the EP valve using 8 mm or ½” SS tubes with suitable compression fittings.
- iii. Refer to 3.3.5.28 for general guidelines for impulse and pneumatic tubing and 3.3.5.21 for general guidelines tubing tray laying.

#### **3.3.5.17. Mounting of smart valve positioner for control valves**

- i. Removal from an existing valve and mounting of smart valve positioner on a control valve using appropriate bolts / screws / accessories.
- ii. In some cases, the inlet of the positioner has to be interfaced to the header and the outlet has to be interfaced to the valve actuator using 8mm or 1/2” SS tubes and suitable compression fittings. Tubing length in this case will be approximately 200-250 mm only.

#### **3.3.5.18. Cable and cable tray laying for control valve positioners**

- i. Armoured FRLS PVC two-pair cables of AWG 20 size shall be used between valve positioners and the identified junction boxes.
- ii. Multicore (32 pair) FRLS PVC cables of AWG 20 size shall be used between field junction boxes to marshalling junction boxes, if any, and between field junction boxes and marshalling junction boxes, if any, to the Panel Room.
- iii. Cable trays shall be laid between the field elements and the junction boxes. All cables are to be laid in identified cable trays only.
- iv. Cables shall be terminated to the instrument / preamplifier / junction boxes using suitable SS cable gland.
- v. Refer to 3.3.5.22 for general guidelines for cable laying, 3.3.5.21 for general guidelines cable tray laying and 3.3.5.23 for general guidelines for cable glanding and termination.

### **3.3.5.19. Tubing and tubing tray laying for control valves**

- i. Command tubing, in some cases, have to be undertaken. If so, then the same shall be carried out between control valve and the facility command header using ½” O.D. seamless stainless-steel tubes. In such cases, the tubing will have to laid through identified tubing trays and will have to be tested at 1.1 times its maximum allowable working pressure (MAWP) or as dictated by the Department

### **3.3.5.20. Mounting of Junction Boxes**

- i. The explosion proof junction boxes (600 mm (W) x 600 mm (H) x 350 mm (D), LM-6 alloy or any other dimension) have to be mounted on the fabricated structural supports using proper mounting bolts / screws / accessories.
- ii. Legible tags have to be painted on the junction boxes using black color paint on yellow back ground for identification.
- iii. All unused holes shall be plugged with aluminium plugs.
- iv. In general, all instrument cable entries shall be from either sides and multi-core cable entries shall be from bottom.

### **3.3.5.21. Laying and mounting of Cable Trays**

- i. The cable trays of widths 50 mm to 500 mm have to welded or fixed using bolts and nuts on to the supporting structure for laying cables and SS tubes.
- ii. Instrument cabling shall be carried out through trenches / overhead. Main cable ways shall be all ladder trays and local branch ways shall be perforated trays.
- iii. Perforated G.I. trays shall be used from junction boxes to individual instruments.
- iv. Ladder cable tray shall be used between junction boxes and Panel Room.
- v. Suitable cable clamps shall be supplied for binding the cables / tubes at every 2 m for horizontal trays and 0.5 m for vertical trays.
- vi. Structural supports for the cable / tubing trays shall be fabricated as per approved drawings and shall be inspected before erection.
- vii. The cable trays have to be joined by welding and one coat of primer and one coat of good quality enamel / metallic paint have to be applied on all the welded areas.

### **3.3.5.22. Cable laying**

- i. The scope involves laying of multi-core PVC cables (armoured as well as unarmoured) through the specified cable trays.
- ii. The cables have to be harnessed using GI wires of 1.5 mm diameter every meter along the cable tray and tagged with aluminium tags at both the ends.
- iii. Continuity and insulation resistance checks of all cables have to be performed before and after laying.
- iv. Cables shall be carefully cut to the required length, leaving sufficient length for the final connections of the cable to the terminals on either end.
- v. The scope of work consists of laying of multi core cables through cable trays. Supply of cable harnessing materials is in scope of contractor.

- vi. Cable joint is not allowed and cable shall be of continuous length between one termination to the other termination.
- vii. Cables shall be rigidly supported on cable trays, individually or in groups as required using GI wire / SS ties. Distance between the two cable supports shall be less than 1 m.
- viii. Physical protection shall be provided wherever required.
- ix. Each of the cables shall be tagged with cable number punched clearly in metallic tags and tied to the cable at both the ends.
- x. All wires shall be checked for proper identification, continuity and insulation before taking up wiring connections.
- xi. Cables shall be laid as per approved cable scheduling.
- xii. Care should be taken to avoid sharp bending and kinking of conductor, damaging of insulation and stressing the cable beyond the pulling force recommended by the manufacturer.

#### **3.3.5.23. Cable glanding and termination**

- i. The multi-core PVC cables (armoured as well as unarmoured) have to be prepared at both ends for glanding, glanded at both ends, crimped with appropriate termination lugs at both ends and terminated at both ends at terminal blocks / connectors.
- ii. Cables are to be terminated on the junction box / instruments using appropriate size of cable glands with lock nuts and rubber washer with gland hoods. Double compression type cable gland shall be used for armoured and unarmoured cable.
- iii. Proper identification ferrules have to be prepared. All wires shall be checked for proper identification, continuity and insulation before taking up wiring connections.
- iv. Cables shall be terminated as per approved cable scheduling.
- v. Continuity and insulation resistance checks of all cables have to be performed after termination also.
- vi. Cables, earthing wires shall be connected on the field instruments using lugs. Multi strand wires shall be twisted before crimping the lugs before inserting in the screw-less cage clamp type terminals.
- vii. The cable shields have to be prepared, sheathed, crimped and terminated on to the bus bar / terminal strip at both ends.
- viii. While terminating the cable at the devices, a loop involving around half-a-metre extra cable shall be provided.

#### **3.3.5.24. Structural steel fabrication and erection works**

- i. The structural frames are to be fabricated as per approved drawings provided by Department after the site work commences.
- ii. The work involves the fabrication of frames and structures using M.S. pipe (DN 50), M.S. angles (40/50/65 mm), M.S. channels (50/75/100 mm) and flats and anchor fasteners (M8/M12/M16) for cable trays, mounting transmitters, SOV cubicles and junction boxes followed by erection of these structures at the identified location by welding or using anchor fasteners. All the field elements which are placed in areas open



to weather conditions shall be provided with pre-fabricated MS/CRCA canopy for weather protection.

- iii. Edge preparation, welding (pre-fabrication and in-situ welding) and handling of structure.
- iv. After installation of the structure or canopy, two coats of red-oxide primer and two coats of good quality grey color synthetic enamel paint must be applied.
- v. The structural works must be carried out as directed by the purchaser.
- vi. The amount for the structural work is to be quoted on weight (per kg) basis.
- vii. The actual length of the M.S channel / angles will be measured and weight will be calculated using standard tables.

#### **3.3.5.25. Mounting of safety detectors**

- i. The safety detectors have to be mounted on a DN 50 MS pipes using clamps. Tag number is to be painted using black color paint on yellow back ground near the detector on the pipe.

#### **3.3.5.26. Cable and cable tray laying for safety detectors**

- i. Armoured FRLS PVC cables (two pair) of AWG 20 size shall be used for connecting the junction boxes to facility field instruments.
- ii. Multicore (48 pair) FRLS PVC cables of AWG 20 size shall be used between field junction boxes to marshalling junction boxes, if any, and between field junction boxes and marshalling junction boxes, if any, to the Panel Room.
- iii. Cable trays shall be laid between the detectors and the junction. All cables are to be laid in identified cable trays only.
- iv. Cables shall be terminated to the instrument / junction boxes using suitable SS cable gland.
- v. Refer to 3.3.5.22 for general guidelines for cable laying, 3.3.5.21 for general guidelines cable tray laying and 3.3.5.23 for general guidelines for cable glanding and termination.

#### **3.3.5.27. Earth pit and laying of earth strip**

4 nos. of pit of 200 mm diameter and 6-metre depth shall be made and 50 mm diameter and 6-metre length pipe shall be inserted into each pit and all the 4 pits shall be interconnected to form single earth pit as per standard. GI Earth strip of size 25 mm width x 3mm thickness shall be laid in the test stand structure and shall be connected to the earth pit with proper mounting structure. The earth pit resistance shall be less than  $1\Omega$ .

#### **3.3.5.28. Pneumatic / Impulse Tubing Works**

- i. S.S. Tubes shall be cleaned with lint free cloth dipped in acetone / IPA and pulled through the tube using nylon wire until all dirt/dust is removed. As a check for thorough cleaning of tubes, last lint free cloth shall be as clean as new. This is to be done in presence of the department's representative. Outside surface of tube shall also be cleaned by rubbing manually with lint free cloth soaked in acetone. Tubes shall also be cleaned by blowing dust free GN2 before laying.
- ii. Tube bends shall be made with approved and appropriate sizes of tube benders. Bends

shall be of uniform curvature and smooth and shall be free from wrinkles, flattening and kinks. Use of filler material during bending is prohibited. Hot bending is also not permitted.

- iii. At the place of termination/joint, tubes shall be cut square and burrs if any shall be removed by deburring tools without reducing wall thickness of the tube. Tube shall be cut with approved brands of tube cutters only.
- iv. Tubing shall be routed on the cable trays and shall be clamped at the intervals not exceeding 1 m. The tubing shall be run in such a manner to provide maximum protection against physical damage. Tubing runs shall be neatly dressed and grouped together where ever possible.
- v. Tubes shall be identified at both ends by line number/instrument number/equipment number to which it is terminated by SS tags of rectangular shape and shall be tied to the tube securely by SS wire.
- vi. At the joint an offset of around six inches (3 inches on each side of the joint) shall be given on the tube run, so that the fitting will be away from the surface of the tube support having free access for tightening and checking of leaks during test. Joints on adjacent tubes in a bundle shall be staggered suitably to avoid interference.
- vii. To avoid corrosion of SS Tubes, contacts of SS Tubes with CS / MS surfaces should be avoided by installing brass shims / foil in between SS Tubes and CS / MS Surface.
- viii. All the air supply lines shall be pneumatically tested to 1.1 times of the operating pressure by the contractor. The joint should be bubble tight.

### **3.3.6. Commissioning**

- The electrical power sources to be verified for proper voltage.
- The instrument air supply to be verified for the pressure specified on the design drawings.
- Instrument tags and tubing labels shall be installed in accordance with design drawings.

#### **3.3.6.1. Test Equipment**

The contractor shall bring the test instruments required for checking cable integrity. The accuracy of the multimeter shall be of  $\pm 0.1$  % full scale (FS) and the accuracy of the insulation test equipment shall be of  $\pm 1.0$  % FS. The accuracy of the test instruments will be verified using standard meters available in the department.

#### **3.3.6.2. Tests at site**

The following tests/checks shall be conducted at site on instrumentation items as per relevant drawings / test procedures / commissioning procedures and standards.

##### ***Preliminary checks***

- Checks for physical damage.
- Checks tightness of all connecting terminals.
- Checks cleanliness.
- Checks whether the name plate details of every instrument is accordance to the specification sheets.

### **Commissioning Checks / Tests**

After installation of systems the following field checks shall be carried out.

- Check and log insulation resistance of all wires, completeness of wiring and continuity of wiring of all instrument loops as per the relevant drawings.
- Check completeness, routing of instrument impulse tubing and pneumatic tubing. Check the correctness of tube fitting used and their connection to the respective instruments.
- Pneumatic leak testing of impulse / pneumatic tubing shall be carried out for 1.1.
- Check whether all junction boxes are properly mounted, numbered (i.e. tag no. provided), sealed and is easily accessible from maintenance point of view. All the extra / spare / unused holes shall be plugged, so that junction boxes are sealed shut.
- Check all the instruments for proper installation, tagging, support and sealing. Check for proper routing & dressing of wiring. Ensure the availability of terminal strip numbers, wire numbers, grounding terminals & proper grounding of elements, junction boxes and local panels.

### **3.4. INSPECTION AND QUALITY SURVEILLANCE**

- i. All instrumentation items supplied by the contractor and services covered by this contract shall be subjected to inspection and testing by purchaser's representatives.
- ii. The inspection by the purchaser's representative and issue of inspection certificate thereon shall in no way limit the liabilities and responsibilities of the contractor in meeting the specification and quality requirements specified in the contract.
- iii. The contractor shall supply the material test certificates for the items under the supply of contractor's scope.
- iv. The contractor shall supply and maintain an independent comprehensive database system containing inspection & testing and performance records for each instrument.

### **3.5. DOCUMENTATION**

The lists of documents which have to be provided by the contractor at the different phases specified thereupon are as follows.

#### **3.5.1. Detailed engineering review**

The contractor shall submit the documents specified in detail engineering as in section 3.1.

#### **3.5.2. Erection**

The following documents shall be submitted by the contractor during erection phase.

- Test certificates and inspection reports for the materials /items which are under the scope of contractor
- As built field element layout drawings.
- As built cable layout drawings for instrumentation cables.
- As built tray layout drawings for cable and tubing trays, if any.
- Erection documents for individual sub systems.

### **3.5.3. Commissioning**

At the end of the commissioning 3 copies of the following documents shall be submitted in hard, soft and soft editable format to the Department.

- Certificates of test done during commissioning
- Inspection reports
- Final acceptance reports
- As-built documentations

## B. INSTRUCTIONS TO BIDDERS

### 1. SUBMISSION OF BIDS

The bidder shall quote all the required items as per the design and specification provided in this document.

Quotation shall be submitted on two-bid basis viz., Technical & Commercial bid and Price bid. Quotations that are satisfying our technical specifications and commercial terms & conditions only will be eligible for opening of price bid. The first bid shall contain the technical and commercial aspects and bill of material without the price. **The technical-commercial bid with price information in any form will be summarily rejected.** The second bid shall contain the bill of material with prices as given in the format in Annexure IV.

The bidder is required to submit quotation for the entire works mentioned herein as sealed quotations to Head, Purchase & Stores, IPRC, Mahendragiri acting on behalf of the President of India.

Any incomplete quotations shall be summarily rejected.

The deviation, if any, in the bidder's proposal with respect to this document shall be explicitly mentioned in the schedule of deviations to be provided in the quotation. If the bidder does not mention any deviation, it shall be construed by the Department that the bidder agrees to comply with each and every aspect of this document.

All corrections shall be attested by initials of the bidder with date.

The Department reserves the right to reject any or all quotations in whole or part without assigning reasons thereof.

### 2. EXECUTION PERIOD

The total delivery period, reckoned from the date of award of the purchase order to the date of commissioning and final acceptance of the system, shall be 18 months as detailed below.

Sl. No.	Scope of Work	Period	Responsibility
1.	Detailed Engineering and acceptance by Department.	Within 1 month from the release of Purchase order.	Contractor and Department
2.	Supply of items to site	Within 9 months from the release of Purchase order.	Contractor
3.	Erection and Commissioning at site	Within 18 months from the release of Purchase order.	Contractor

### **3. PRICES**

The bidder shall quote firm and fixed prices valid during the execution of the Contract until commissioning and final acceptance of the systems to the satisfaction of the Department. The prices shall include all taxes and levies levied by any central, state, local or other governmental authority, which the contractor is required to pay in any country as well as in India with reference to fabrication, purchase, transportation up to the delivery point stated in this document. The bidder shall provide the individual item wise break-up prices as given in Annexure IV, only in the second part of their bid.

### **4. PAYMENT**

Payment will be made as per the actual quantity consigned to IPRC Mahendragiri. Milestone payment will be considered as follows.

#### ***For supply portion***

70% of supply price and taxes on 100% of the price shall be released on pro-rata basis within 30 days against receipt and acceptance of item at IPRC, Mahendragiri.

30% of supply price after satisfactory completion of commissioning of all activities against bank guarantee.

#### ***For erection portion***

80% of erection price and taxes on 100% of the price shall be released on pro-rata basis for the completed erection works.

20% of erection price after satisfactory completion of commissioning of all activities against bank guarantee.

The Contractor is required to provide Performance Bank Guarantee (PBG) issued by any nationalized / scheduled / commercialized bank approved by RBI for 3% of the total Contract price valid over a period of 12 months from the date of final acceptance of the system at the site by the Department.

### **5. VALIDITY**

The quoted price should be valid for a period of 6 months from the date of opening of the technical and commercial quotation.

### **6. QUANTITY VARIATION**

The exact quantity and the list of items required for commissioning will be finalized during the course of work and  $\pm 10\%$  variation in the overall purchase order value shall be permitted for any additional supply and erection part of contract that is not be accounted for and for deletions, if any.

## **7. COMPENSATION FOR DELAY**

If the contractor fails to complete execution of the contract or fails to meet delivery specified in the contract or any extension thereof, the Department will recover from the Contractor as Liquidated Damages (LD) a sum of 0.5% of the total contract price for each calendar week of delay or part thereof. The total liquidated damages shall not exceed 10% of the contract price.

## **8. DELIVERY TERMS**

All equipment / materials to be supplied by contractor shall be delivered at IPRC, Mahendragiri. The party shall be responsible for further transportation of items to erection site. Further responsibility of safe handling and storage of all items lies with the vendor. Any damaged item has to be replaced free of cost by the vendor.

## **9. GUARANTEE AND INSURANCE**

- i. The “Defect Liability Period” shall be 12 months from the date of successful completion of commissioning the system. The work shall not be considered as completed until the Department has certified in writing that they have been actually accepted and the Defect liability period shall commence from the date of such certificate.
- ii. The equipment and material supplied by the vendor shall carry a guarantee for a period of 12 months from the date of commissioning, against any material defect, design defect, manufacturing defect and/or failure of equipment to perform, as stipulated.
- iii. In case any defect in the work due to bad materials, and / or bad workmanship develop in the work before the expiry of the period, the Contractor, on notification by the Department, shall rectify or remedy the defects at their own cost and shall make their own arrangements to provide materials, labour, equipment and any other appliances required in this regard.
- iv. The equipment or components repaired or replaced by the Contractor shall be guaranteed for a period of 12 months from the date of repairs or replacement.
- v. The Contractor shall furnish performance guarantee in the form of an unconditional irrevocable bank guarantee to the extent of 10% of the total contract value valid during the defect liability period. If any defect is noticed by the Department during the defect liability period and Contractor fails to rectify or remedy the defects, the Department will have the right to get this done by other agencies and recover the cost incurred, as determined by the Department, which shall be final and binding, by recovery from the amounts due to the Contractor and / or by enforcing bank guarantee.
- vi. The contractor should take all necessary steps including the necessary insurance cover until the system are dispatched & delivered at purchaser’s site.

## **10. TAXES AND DUTIES**

- i. Department will reimburse all taxes and duties at actuals for the materials which are directly consigned to IPRC, Mahendragiri and for the services provided by the Contractor against documentary evidence.
- ii. The statutory deductions on account of Income tax shall be made as per the extant provisions contained in the Indian Income Tax Act, 1961 and tax deducted-at-source certificate will be issued to the Contractor.
- iii. Excise Duty Exemption Certificate will be provided by Department only for those indigenous items consigned to IPRC Mahendragiri against proforma invoice submitted by the Contractor only and not by the sub-contractor.
- iv. Custom Duty Exemption Certificate will be provided by Department for those imported items consigned to IPRC Mahendragiri against proforma invoice submitted by the Contractor/Sub-vendor.

## **11. BIDDER SELECTION CRITERIA**

- i. To ensure the quality of the execution and integrity of the components it is mandatory that bidder must be a qualified agency with experience of executing similar orders of field instrumentation / panel or control room instrumentation within last seven years in any Govt. / PSU / Reputed Corporate Entity / Company (as on bid submission date) as follows.
  - a. One order of value not lesser than ₹ 2 Crores or
  - b. Two orders of cumulative value not lesser than ₹ 3 Crores or
  - c. Three orders of cumulative value not lesser than ₹ 4 CroresThe firm shall submit proof of work order with completion letter for the above job.
- ii. Average annual financial turnover for three out of last six financial years (2017-18, 2018-19, 2019-20, 2020-21, 2021-22, and 2022-23) shall be at least ₹ 3 Crores, copies of balance sheets of last three financial years shall be submitted in support of the requisite financial turnover.
- iii. The bidder must be in profit in three out of past six financial years. Audited balance sheet (2017-18, 2018-19, 2019-20, 2020-21, 2021-22, and 2022-23) to be attached along with the bid to qualify for the job.
- iv. Bidder shall also provide a compliance to the specification of all the supply materials mentioned in the Annexure-IV of this document supported by valid datasheets / catalogues.
- v. A Memorandum of Undertaking, as per the format in Annexure-VI, shall be submitted by the bidder along with the quotation.



## **C. TERMS AND CONDITIONS**

### **1. ENTIRE AGREEMENT**

- a. The contract to be entered into shall convey the final agreement between the Department and the Contractor on the terms and conditions and be a complete and exclusive statement of the terms of the agreement.
- b. In the event of conflicts between general conditions of the contract and the specifications furnished by the Department, the latter will take precedence.

### **2. MODIFICATIONS TO THE CONTRACT**

This contract may be amended or modified only in writing, signed by both parties or their duly authorized agents or representatives, through a change order issued by the Department and accepted by the Contractor, pursuant to the terms stated therein.

### **3. CANCELLATION OF CONTRACT**

- a. The Department will have the right, at any time, to cancel the contract either wholly or in part by giving one month's notice. The Contractor shall undertake to observe the instructions of the Department regarding the winding up of the contract, both on their part and on the part of their subcontractors.
- b. In the case of contract cancellation by the Department without any fault of the Contractor, the Contractor shall immediately take the necessary steps to implement the Department's instructions. The period allowed for implementation shall be fixed by the Department after consultation with the Contractor and, in general, shall not exceed two months.
- c. The Department will, under no circumstances, be liable to pay any sum that, when added to the other sums paid, due, or becoming due to the Contractor under the contract and its amendments, if any, exceeds the contract payment for the work set forth in the contract and its amendments, if any.
- d. The ownership of all materials, parts, and unfinished work paid for by the Department under the provisions of this section shall be vested in or transferred to the Department as soon as they have been paid for.

### **4. CONTRACTOR'S DEFAULT LIABILITY**

- a. The Department shall reserve the right to terminate the work in the following circumstances:
  - i. If the Contractor fails to rectify or replace any defective system / subsystem / equipment within 60 days after the Department gives notice to the Contractor to rectify or replace the said defective system / subsystem / equipment, or if the Contractor delays, suspends, or is unable to complete the system / subsystem / equipment by the mutually agreed-upon date.

- ii. If the contractor commits a breach of any of the terms and conditions of the contract.
- iii. If the Government of India decides to terminate the contract in the public interest.
- b. When the Contractor makes themselves liable for action under the circumstances mentioned above, the Department will have the power to forfeit the bank guarantee of the Contractor, and the Contractor shall have no claim for damages whatsoever on such forfeiture.
- c. The work remaining to be completed at the time of termination of the contract shall be executed through another Contractor. In this case, the expenses incurred in excess of the sums that would have been paid to the original Contractor, had the whole work been executed by them, shall be borne by the original Contractor and recovered from them.

## **5. CHANGES AND MODIFICATIONS TO SPECIFICATIONS AND QUALITATIVE REQUIREMENTS**

- a. The Department shall reserve the right at any time to modify the qualitative requirements, specifications, patents, or drawings related to the work covered by the contract. The Contractor shall inform the Department within 20 days of any objections they have to the required modifications.
- b. The Department may also accept modifications proposed by the Contractor on their initiative or on behalf of subcontractors or as a result of a detailed engineering review.

## **6. SUB-CONTRACTING**

The Contractor shall not assign or subcontract the work or any part of the work without the written approval of the Department. In the event of approval of subcontractors, the detailed specifications and drawings of subcontracted items shall be approved by the Department. All the work carried out by such subcontractors shall also be scrutinized, inspected, and approved by the Department. However, the responsibility for such subcontracted systems shall lie with the Contractor. Any delay in carrying out the work by the subcontractor that affects the overall schedule of the work does not absolve the Contractor from payment of compensation for the delays. All terms and conditions applicable to the Contractor shall also be applicable to subcontractors.

## **7. LANGUAGE AND MEASURES**

All documents pertaining to the Contract including specifications, schedules, notices, correspondence, operating and maintenance instructions, drawings or any other writings shall be written in ENGLISH Language only. The SI units shall be used everywhere. All operating, maintenance and technical manuals, drawings and diagrams in English Language relevant to the systems/components shall be supplied by the Contractor.

## **12. PACKING**

The contractor shall pack all the equipment, materials and its accessories and make the identification names at the top of each pack. Proper packing shall be done to ensure that the items are not damaged during transportation.

## **13. INSURANCE**

The contractor should take all necessary steps including the necessary insurance cover till the system are dispatched & delivered at Department site.

## **8. COMPLIANCE WITH STANDARDS**

All materials supplied or used shall be of new and first quality and manufactured and tested in accordance with the latest editions of the relevant Indian / International standards. Wherever imported components are used, they shall be manufactured in accordance with the relevant standards published in the country of manufacture after allowing for specific aspects under Indian conditions such as tropical climate, etc. Any material or work where no specific standard is applicable shall be fabricated as per the instructions and directions of the Department. All electrical equipment used shall conform to the latest Indian Electricity rules regarding safety, earthing, and other essential provisions specified therein for the installation and operation of electrical parts.

## **9. SECRECY**

The technical information, drawings, specifications, and other related documents forming part of the inquiry or contract are the property of the Department and shall not be used for any other purpose except for the execution of the contract. All rights, including the rights in the event of the grant of a patent and registration of designs, are reserved. The technical information, drawings, specifications, records, and other documents shall not be copied, transcribed, traced, or reproduced in any other form or otherwise in whole and / or duplicated, modified, and / or disclosed to a third party and / or not in any other form whatsoever without the consent in writing, except to the extent required for the execution of work. This technical information, drawings, specifications, records, and other documents shall be returned to the Department with all approved copies and duplicates, if any, immediately after they have been used for the agreed purpose.

## **10. INSPECTION OF WORK**

- a. The Department or any person appointed by it shall have access and the right to inspect the work, or any part thereof, at all times and places during the progress of the work. The inspection and supervision are for the purposes of assuring the Department that the plans and specifications are being properly executed, and while the Department and its representatives will extend to the Contractor all desired assistance in interpreting the plans and specifications, such assistance shall not relieve the Contractor of any

responsibility for the work. Any work that is proved faulty shall be corrected by the Contractor without delay. The fact that faulty work or work that is not in accordance with plans and specifications was not pointed out by the Department will not relieve the Contractor from correcting such work as directed by the Department without additional compensation.

- b. The Department's representatives shall, at all reasonable times, have free access to the works and/or to the workshops, factories, or other places where materials are being prepared or fabricated for the work and also to any place where the materials are lying or from where they are being obtained, and the Contractor shall give every facility to the Department's representatives for inspection and test of the materials and workmanship even to the extent of discontinuing portions of the work temporarily or of uncovering or taking down portions of finished work.
- c. The Department has no obligation to discover defects, patents, or otherwise, and it shall be the sole responsibility of the Contractor. The inspection and clearance for dispatch by the Department's representatives shall not absolve the Contractor's obligations and duties under the terms and conditions herein.

## **11. COORDINATION WITH OTHER CONTRACTORS AND INTERFACING OF THE WORKS**

The Contractor shall extend all cooperation to other Contractors of the Department to perform their works at the site simultaneously. The Contractor shall arrange their activities to ensure smooth and timely execution of the project, minimize interference with the works of other Contractors, and allow other Contractors to use the facilities engaged by them for erection activities. For this purpose, the Contractor shall plan such works and indicate such interfaces in an interface schedule. They shall not be entitled to any extra payment on this account.

## **12. FORCE MAJEURE**

Neither party shall bear responsibility for the complete or partial non-performance of any of his obligations (except for failure to pay any sum which has become due on account of receipt of goods under the provisions of the Contract) if the non-performance results from such force majeure circumstances such as, but not restricted to, flood, fire, earthquake, civil commotion, sabotage, explosion, epidemic, quarantine restriction, strike, lock-out, freight embargo, acts of the Government either in its sovereign or Contractual capacity, hostility, acts of public enemy and other acts of God as well as war or revolution, military operation, blockade, acts or actions of State authorities or any other circumstance beyond the control of the parties that have arisen after the conclusion of the Contract.

In such circumstances, the time stipulated for the performance of an obligation under the Contract may be proportionately extended.

The party, for whom it has become impossible to meet the obligation under this Contract due to force majeure condition, will notify the other party in writing not later than twenty-one days from the date of commencement of the unforeseeable event. Unless otherwise directed by the Department in writing, the contractor shall continue to perform his obligations under the Contract as far as is practical and shall seek all reasonable alternative means for performance not prevented by the force majeure event.

Any certificate issued by the Chamber of Commerce or any other competent authority or organization of the respective country shall be sufficient proof of commencement and cessation of the above circumstances.

In case of failure to carry out complete or partial performance of an obligation for more than sixty days, either party shall reserve the right to terminate the Contract totally or partially. A prior written notice of 30 days to the other party will be given informing of the intention to terminate without any liability. This is exclusive of any reimbursements for the goods received as provided for in the agreement.

### **13. INDEMNITY TO DEPARTMENT AGAINST INFRINGEMENT OF LABOR LAWS**

The Contractor shall indemnify the Department against any action, claim, or proceedings relating to the infringement of all or any of the prevailing labour laws of India like Workmen's Compensation Act 1922, Work Labour (Regulation and Abolition), Central Rules 1971, Employees Liability Act 1928, Industrial Disputes Act 1947, Employees Provident Funds and Miscellaneous Act 1952 as amended from time to time during erection and commissioning at the Department's site.

### **14. PATENT RIGHTS**

The Contractor shall fully indemnify the Department against any action, claim, or proceedings relating to infringements or the use of any patent or any design or any alleged patent or design rights and shall pay any royalty which may be payable in respect of any claims made under or any action brought against the Department. In respect of such matters as aforesaid, the Contractor shall be at liberty, at their own expense, to settle any dispute or to conduct any litigation that may arise therefrom. The Contractor shall not be liable to indemnify the Department for the infringement of the patent or design or any alleged patent or design right which is the direct result of an order passed by the Department.

### **15. ARBITRATION**

Except for matters in respect of which the decision of the Department is final as specified in the Contract, any dispute, disagreement, or question arising out of or relating to or in consequence of the work or fulfilment or the validity of the enforcement thereof, which cannot be settled mutually, shall, within 30 days from the date that either party informs the other in writing that such dispute or disagreement exists, be referred to arbitration. In the

event of any question, dispute or difference arising under these conditions or any conditions contained in Contract (except as to any matter the decision of which is specially provided for by these conditions), the same shall be referred to the sole arbitration of the Director, IPRC or some other person appointed by him. It will be no objection that the arbitrator is a Government servant that he had to deal with matter to which the Contract relates or that in the course of his duties as Government servant he has expressed views on all or any other matters in dispute or difference. The award of the arbitrator shall be final and binding on the parties of this Contract.

If the arbitrator be the Director, IPRC

- i. In the event of his being transferred or vacating his office by resignation or otherwise, it shall be lawful for his successor-in-office either to proceed with reference himself, or to appoint another person as arbitrator, or
- ii. In the event of his being unwilling or unable to act for any reason, it shall be lawful for the Director, IPRC to appoint another person as arbitrator.

If the arbitrator be a person appointed by the Director, IPRC

In the event of his dying, neglecting or refusing to act or resigning or being unable to act, for any reason, it shall be lawful for the Director, IPRC either to proceed with the reference himself or appoint another person as arbitrator in place of the outgoing arbitrator. Subject as aforesaid the Arbitration & Conciliation Act 1996 and the rules thereunder and any statutory modifications thereof for the time being in force shall be deemed to apply to the arbitration proceedings under this Clause. The Arbitrator shall have the power to extend with the consent of the Department and the Contractor the time for making and publishing the award. The venue of arbitration shall be the place as Department in his absolute discretion may determine. Work under the Contract shall, if reasonably possible, continue during arbitration proceedings.

In the event of any dispute or difference relating to the interpretation and application for the provisions of the Contracts, such dispute or difference shall be referred by either party to Arbitration of one of the Arbitrations in the Department of Public Enterprises. The Arbitration Act 1996 shall not be applicable to arbitration under this clause. The award of the Arbitrator shall be binding upon the parties to the dispute provided however any party aggrieved by such award may make a further reference for setting aside or revision of the award to the Law Secretary, Department of Legal Affairs, Ministry of Law & Justice, Govt. of India. The parties to the dispute will share equally, the cost of arbitration as intimated by Arbitrator.

## **16. ASSIGNMENT**

The work shall be binding upon the successors and assignees of the parties hereto. It shall not be assigned in whole or in part by either party without the prior written consent of the other. If the Contractor becomes insolvent or, being a firm or a company whether incorporated or not, is dissolved or goes into bankruptcy or is caused to be wound up except for reconstruction purposes or carries on its business under a receiver, the representatives in

law of the estate of the Contractor or any such receiver, liquidator, or any person in whom the agreement may be vested shall forthwith give notice thereof in writing to the Department and shall remain liable for the successful performance of the Contractor or the successors of their obligations under this Contract under any circumstances.

## **17. JURISDICTION AND APPLICABLE LAW**

The work shall be governed by the laws of India currently in force. The courts of India only shall have jurisdiction to deal with and decide any legal matters or disputes arising out of the work.

## **18. EXECUTION OF WORK**

The specifications of the work are intended to describe and provide for a complete finished system. It is understood and agreed by the Contractor that the work described shall be complete in every detail, even though every item necessarily involved is not particularly mentioned. The Contractor shall be required to provide all labour, materials, and equipment necessary for the completion of the work described and shall not avail themselves of any manifesting unintentional error, omission, or inconsistency that may exist. The Contractor shall carry out and complete the work in every respect in accordance with the Contract and the directions and to the satisfaction of the Department.

## **19. RIGHTS OF THE DEPARTMENT**

### **A. RIGHT TO ILLUSTRATE AND EXPLAIN PLANS**

- i. The various parts of the Contract are intended to be complementary to each other, but if any discrepancies appear or any misunderstanding arises, the explanation of the Department will be final and binding.
- ii. The corrections of any errors or omissions of specifications may be made by the Department when such correction is necessary to bring out clearly the intention indicated by a reasonable interpretation of the specifications as a whole.
- iii. Wherever in the specifications which are a part of the work or which may be furnished to the Contractor for directing the work, the terms and descriptions of various qualities of workmanship, materials, structures, processes, plant, or other features of the work are described in general terms, the meaning of fulfilment of which must depend upon individual judgments, then in all such cases, the question shall be decided by the Department, and said material shall be furnished, said work shall be done, and said structure or feature shall be constructed, furnished, or carried out in full and in accordance with their interpretation of the same and to their full satisfaction and approval, provided such interpretation is not in direct conflict with the specifications or generally accepted good practice.

## **B. RIGHT TO DIRECT WORK**

- i. The Department will have the right to direct the manner in which all work under this Contract shall be done, insofar as it may be necessary to secure the safe and proper progress and the specified quality of the work, and all work shall be done, and all material shall be furnished to the satisfaction and approval of the Department.
- ii. Whenever, in the opinion of the Department, the Contractor has made a marked departure from the schedule of completion laid down in the Contract or when untoward circumstances force departure from the said schedule, the Department, in order to assure compliance with the schedule and the provisions of the work, shall direct the order, pace, and method of doing the work, which shall be adhered to by the Contractor.
- iii. If, in the judgment of the Department, it becomes necessary at any time to accelerate the overall execution of the work, the Contractor, when ordered and directed by the Department, will cease the work at any particular point and transfer their men to such other point or points and execute such portion of their works, as may be required, to enable others to hasten and properly engage and carry on their work, as directed by the Department.
- iv. The work by the Contractor at the site beyond normal working hours (08:45 to 17:15 hr) on working days and any time on holidays (including Saturdays and Sundays) shall be permitted only with the prior approval of the Department. The Department may also direct the Contractor to operate extra shifts over and above normal day shift to ensure the completion of the work on schedule if, in the opinion of the Department, such work is required.

## **20. CONTRACTOR'S FUNCTIONS**

- a. The Contractor shall provide everything necessary for the proper execution of the work according to the intent and meaning of the specifications, whether the same may or may not be particularly shown or described therein, provided that the same can reasonably be inferred therefrom. If the Contractor finds any discrepancy therein, they shall immediately and in writing refer the same to the Department whose decision shall be final and binding on the Contractor.
- b. In the execution of the work, no person other than the Contractor, or their duly appointed representatives, their sub-contractors, and their workmen, shall be allowed to work at the site except by special permission, in writing by the Department.
- c. The Contractor shall proceed with the work to be performed under this Contract and each and every part and detail thereof, in the best and most workmanlike manner by engaging qualified, careful, and efficient workers. The Contractor shall do the several parts thereof at such time and in such order as the Department directs and finish such work in strict conformance with the drawings and/or specifications and any changes, modifications thereof made by the Department.



- d. The Contractor's personnel shall not be permitted to reside inside the Department's premises after the work. The Contractor shall arrange for transportation, accommodation, food, health care, communication, etc., for their personnel.
- e. In respect of observance of local rules, administrative orders, working hours, and the like, the Contractor and their personnel shall cooperate with the Department.

## **21. SUPPLY OF TOOLS AND OTHER MATERIALS**

For the full completion of the work, the party shall, at their own expense, furnish all erection tools, power tools, cables, wiring tools, test instruments, and all associated protective equipment, appliances, materials required to accomplish the work under the contract unless otherwise provided for. Adequacy of such tools shall be subject to the final determination of the Department. The party shall not dispose, transport, or withdraw any tools, equipment, and materials provided by them for the contract without taking prior written approval from the Department. The Department shall have the right to refuse permission for the disposal, transport, or withdrawal of tools, equipment, and material if, in their opinion, the same will adversely affect the efficient completion of the work.

## **22. PROTECTION OF WORK**

- a. The Department will not be responsible or held liable for any damage to person or property consequent upon the use, misuse, or failure of any fabrication tools and equipment used by the Contractor or any of their sub-contractors.
- b. The Contractor shall effectively protect all the works from the action of weather and damages or defacement and shall cover finished parts where required for their thorough protection.
- c. The Contractor shall cover the work with a Contractor's all-risk policy during the currency of the contract.

## **23. SITE PERSONNEL**

The party shall identify a Site Supervisor who shall be personally present to supervise the work under the contract. The Site Supervisor shall have full technical capability and complete administrative and financial powers to expeditiously and efficiently execute the work under the contract. Any written orders or instructions which the Department may give to the party's Site Supervisor shall be deemed to have been given to the party.

## **24. FIRST AID**

The Contractor may have access to the Department's qualified first aid personnel and ambulance in case of accidents, subject to the availability of the same. However, the Contractor shall make his own medical and transport arrangements to take care of his employees in case of an accident. The Contractor shall provide a first aid kit at the work site to meet the requirements of minor injuries.

## **25. REPORTING**

The Contractor must report the following information to the Department by the end of every week during the work at the Department's site.

- Progress achieved
- Expected dates for the completion of individual works
- Any actual or likely delay in the execution of work

## **26. WORKING AND SAFETY REGULATIONS**

The Contractor shall observe all statutory and legal requirements enforced by the Central and State Government applicable to the work as well as any local regulations applying to the site issued by the Department or any other authority. Particular attention is drawn to the following:

- a. In case of an accident, the Department shall be informed in writing forthwith. The Contractor shall strictly follow the regulations laid down by the Factory Inspector, Central and State Government authorities in this regard.
- b. Compliance with all electricity regulations.

## **27. ELECTRICAL SAFETY REGULATIONS**

In no circumstances will the Contractor interfere with fuses and electrical equipment belonging to the Department or other Contractors. Before the Contractor connects any electrical appliance to any plug or socket belonging to another Contractor or Department, he will

- a. Satisfy the Department that the appliances are in good working condition
- b. Inform the Department about the maximum current rating, voltage, and phase of the appliance
- c. Obtain permission from the Department detailing the sockets to which the appliance may be connected

## **28. POWER**

Electricity will be supplied free of cost. The Contractor must provide a power supply distributor with an isolator for taking power for his equipment. The Contractor should obtain Electrical safety clearance from CMG and Safety division of IPRC before starting the work.

## **29. WATER**

Free supply of water will be made available by the Department.

## **30. CLEAN-UP OF WORK SITE**

The party shall not store or place the equipment, materials, or erection equipment on the driveways and streets and shall take care that their work in no way restricts or impedes

traffic or the passage of men and material. All waste materials are to be disposed of safely at the location specified by the Department.

### **31. SAFETY AND RELIABILITY**

Since the systems are highly complex in nature, the philosophy and criteria to be adopted shall be highly safety-and-reliability-oriented for their systematic and proper functioning. The designs of the sub-systems, components, and equipment to be carried out by the Contractor shall specifically address essential safety provisions both in-built and external. Reliability is a prime factor that has to be embedded in the process of realizing the systems. To ensure that the sub-system design, development, selection of equipment, components, material, etc., are in compliance with the standard engineering practices, it is necessary to follow established design codes and standards.

### **32. QUALITY ASSURANCE**

The reliability of instrumentation is a combination of specifications of the equipment / components, serviceability, and maintenance of the same, which are meant to serve and provide effective and timely operation, including trouble-free performance of systems and sub-systems to the intended specifications. The Contractor must look for the quality factors individually attributed to engineering developments, redundancy philosophy adopted, selection of equipment and components, test and acceptance procedures followed, repetitive performance achieved, risk analysis carried out, etc. Each and every module must be manufactured and tested to international Quality Control standards. The test certificates shall be provided to the Department. Quality assurance is a unified approach that attempts to control the quality right from the design stage to the commissioning stage, which includes checking the adequacy of the equipment / components for materials, fabrication, installation and testing.

### **33. PURCHASE OF MATERIALS**

The selection of equipment, components, materials, etc., with appropriate and suitable specifications shall be the responsibility of the Contractor, as the overall performance of the system rests with the Contractor. Accordingly, the selection and purchase tasks shall be handled by the Contractor immediately after the approval of Detailed Engineering documents by the Department. The criteria for the selection of a particular product and the reasoning involved therein shall be submitted to the Department for necessary approval. However, the Department's decision will be final. The Department will provide necessary end-use certificates for obtaining the required license for the import of items if requested by the Contractor. In keeping with the terms of the Contract, the Contractor shall undertake the responsibility for handling, packaging, and transportation involved to the accepted level of any sub-systems / equipment covered by the work in the Contract.

#### **34. EMPLOYMENT OF LABOURERS**

The contractor shall deploy Indian Nationals only for the execution of the work. Only skilled employees with experience in this particular work shall be employed. No person below the age of 18 years shall be employed. The Contractor shall pay to each person wages not less than those specified by the Minimum Wages Act. The employees/labor for carrying out all the site works shall be identified well in advance by the contractor, and necessary approval shall be obtained from the Department for entry permit to the work site.

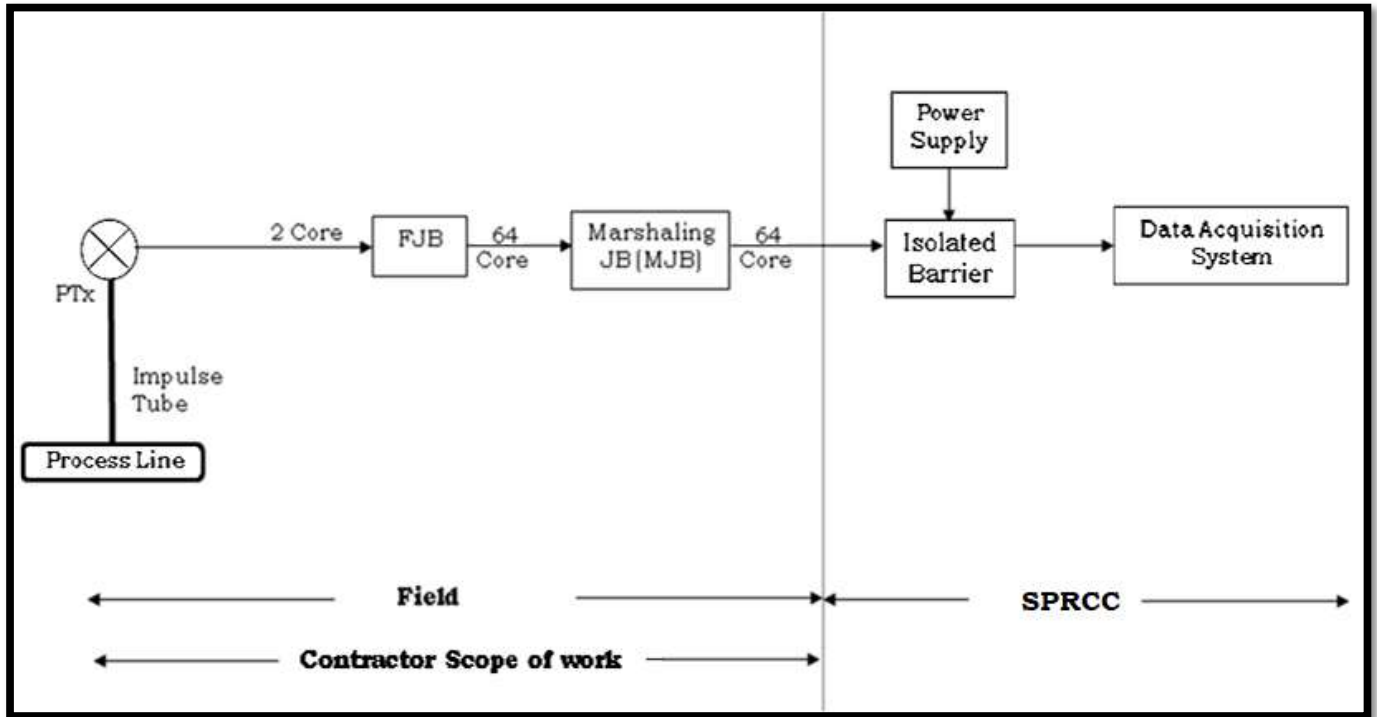
#### **35. GATE PASS**

For Contractor's equipment, tools, materials, etc., which are to be taken out from IPRC, Mahendragiri campus after completion of work, proper entry shall be made at the main gate duly endorsed by CISF. The Department shall issue necessary gate passes for taking out the Contractor's materials, as and when required and after completion of work.

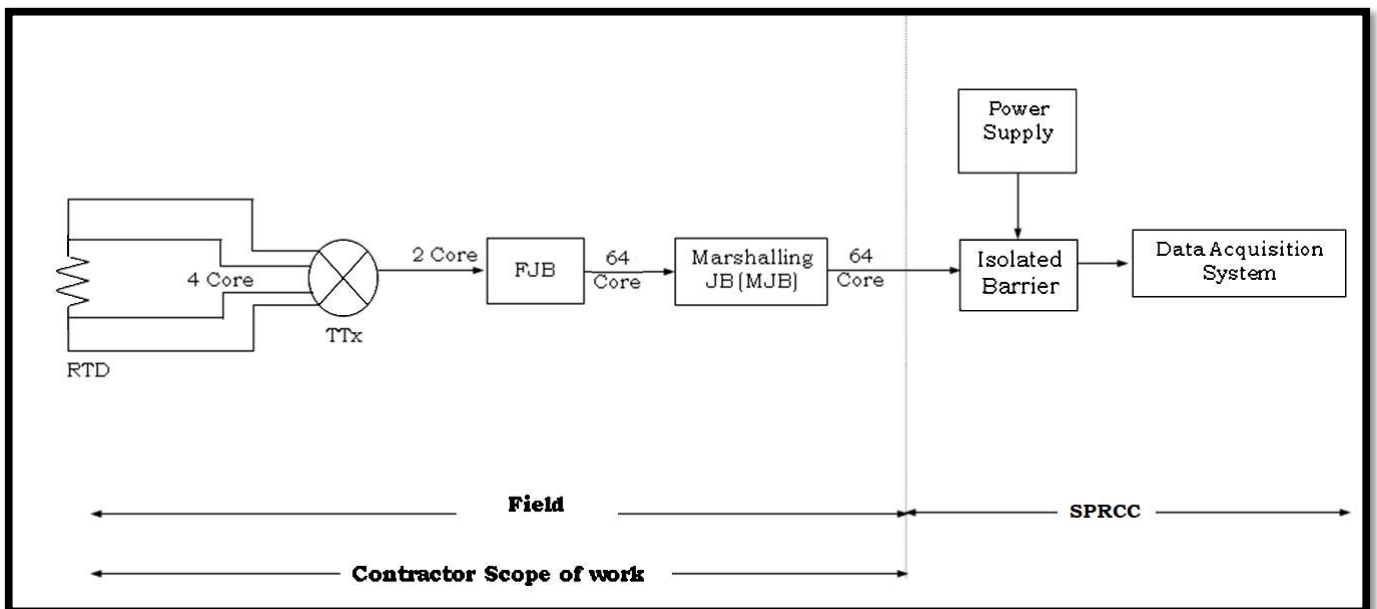
ANNEXURE-I

SAMPLE BLOCK DIAGRAMS FOR MEASUREMENTS, COMMANDS AND DETECTORS

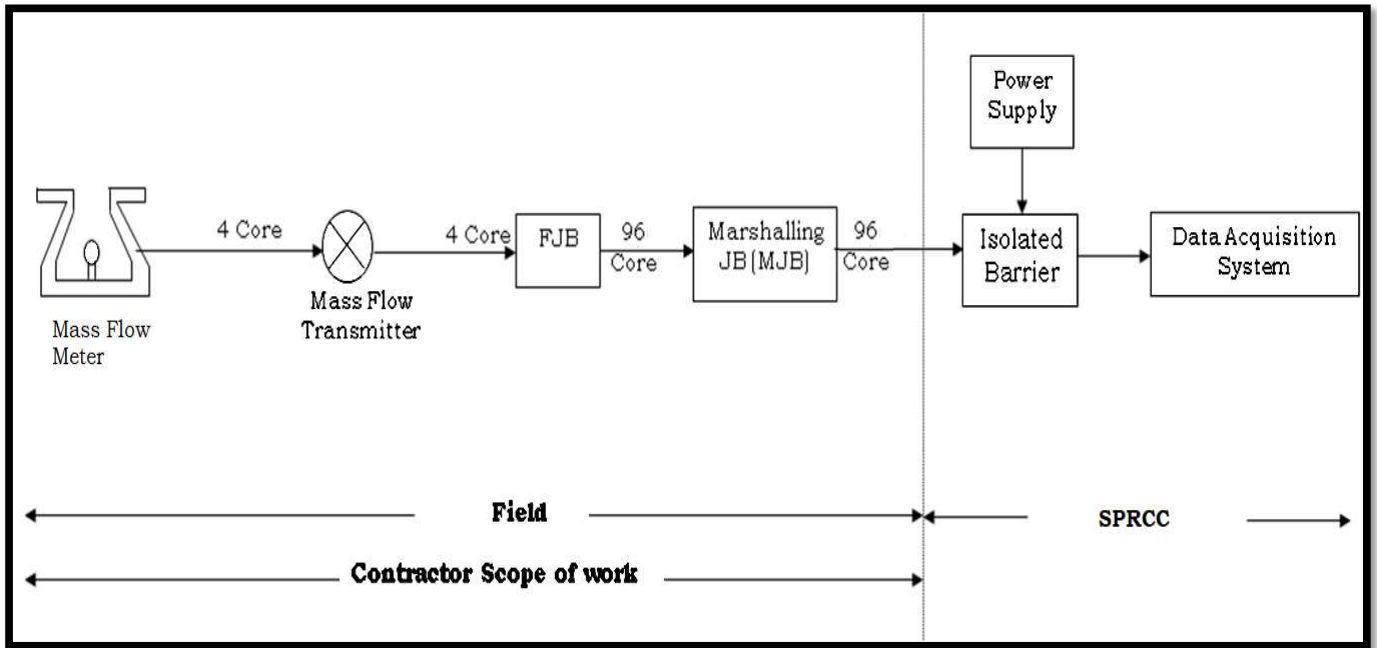
AI.1 Block Diagram of Test Facility Pressure-based Transmitter Measurements



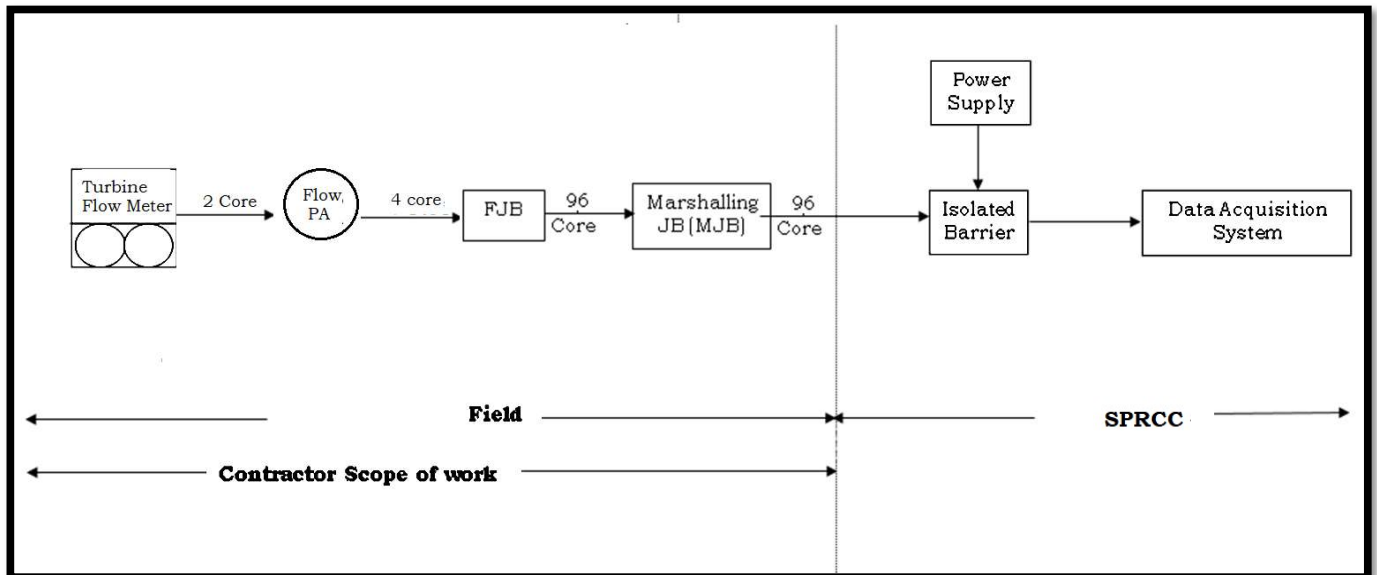
AI.2 Block Diagram of Test Facility Temperature Transmitter Measurements



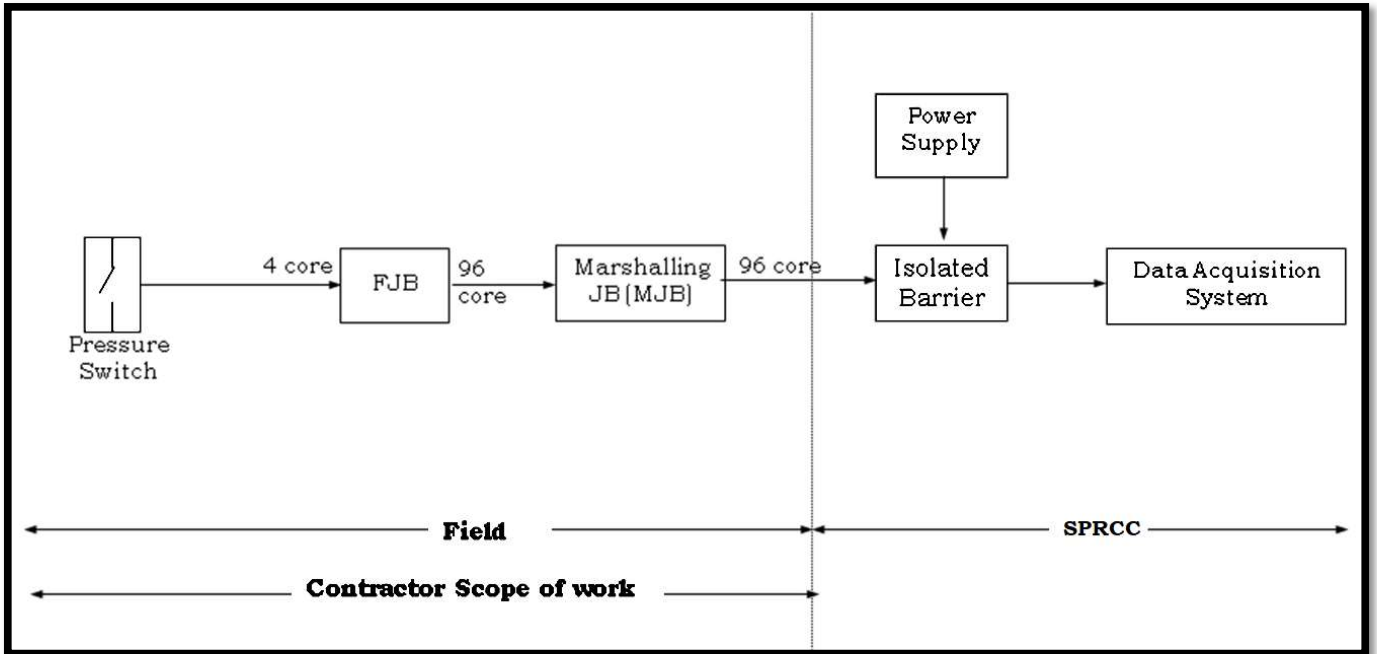
**AI.3 Block Diagram of Test Facility Mass Flow Measurements**



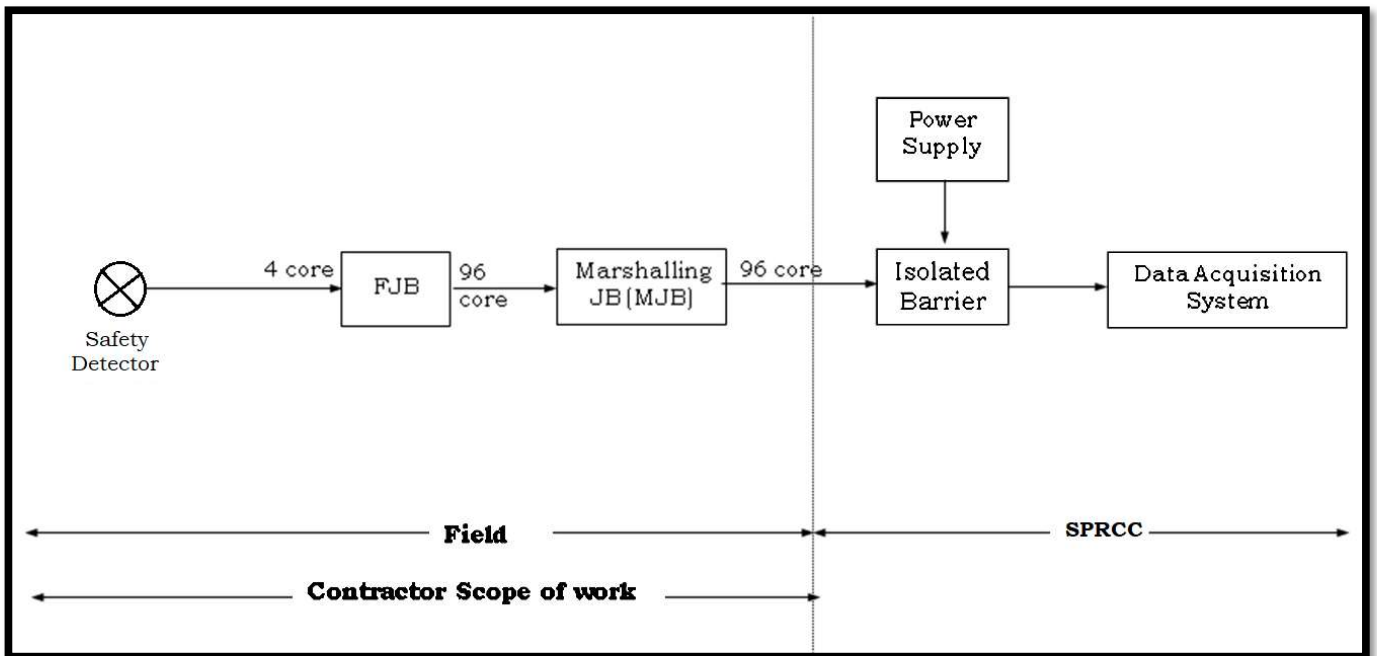
**AI.4 Block Diagram of Test Facility Turbine Flow Measurements**



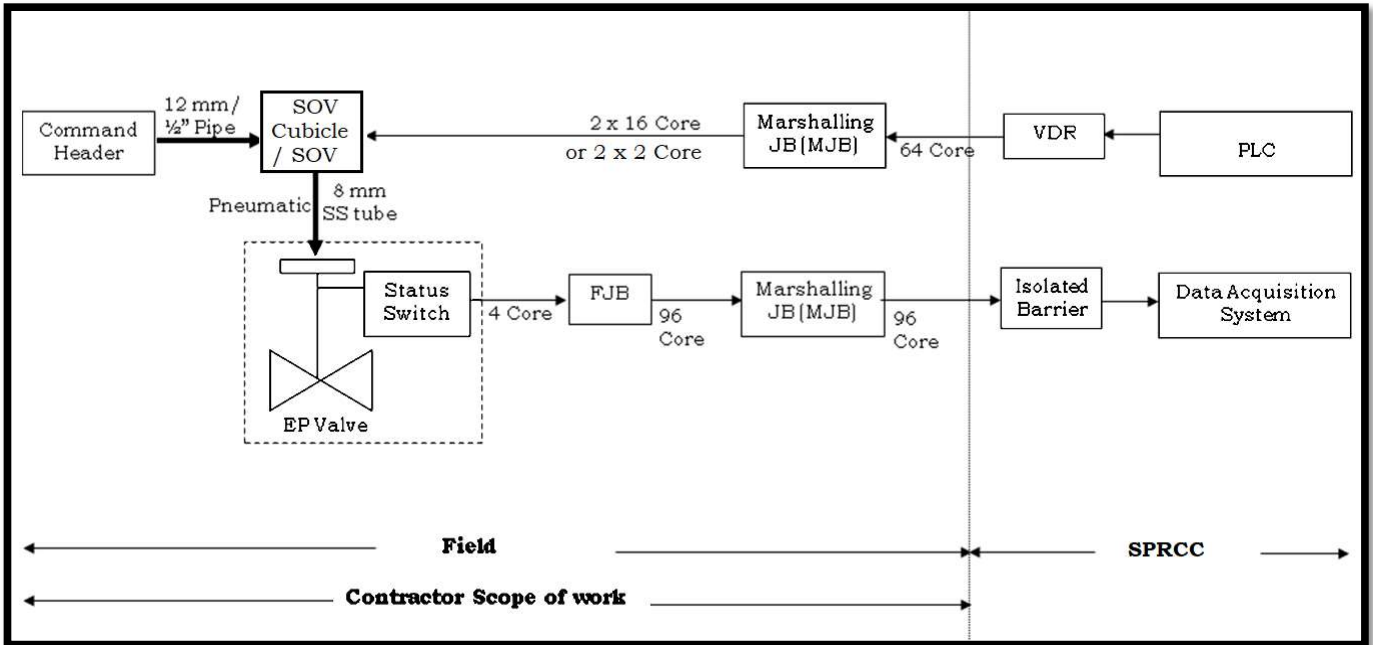
**AI.5 Block Diagram of Test Facility Pressure Switches**



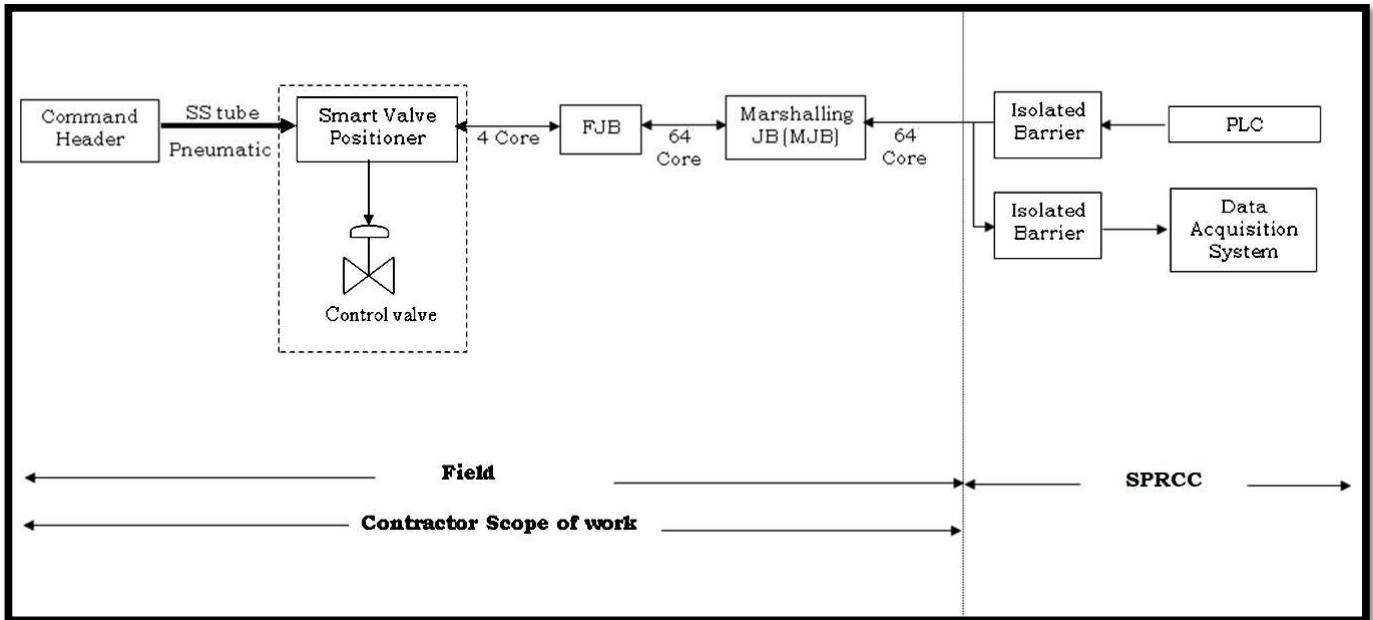
**AI.6 Block Diagram of Test Facility Safety Detectors**



**AI.7 Block Diagram of Test Facility EP Valve Command System**



**AI.8 Block Diagram of Test Facility Control Valve Command System**





## ANNEXURE-II

### LIST OF APPLICABLE CODES AND STANDARDS

ANSI / ISA MC-96.1	:	Temperature Measurement, Thermocouples
API RP-551	:	Process Instrumentation & Control
ASTM A-269	:	Stainless Steel Tubes
IEC 751	:	Industrial platinum resistance thermometer sensors.
IS 2148	:	Flameproof Enclosures for Electrical Apparatus (Second Revision - Amendment-2)
IS 5572, Part-I	:	Hazardous Area Classification for Electrical Installations
IS 5780	:	Intrinsically Safe Electrical Apparatus and Circuits
NFPA 493	:	Intrinsically Safe Apparatus in Div.I Hazardous Location
ANSI B16.5	:	Pipe Flanges and Flanged Fitting
ANSI B16.20	:	Metallic Gasket for Pipe flanges, Ring-joint, Spiral wound and Socketed
ANSI B1.20.1	:	Pipe threads, General purpose (Inch)
ISA S5.1	:	Instrumentation Symbols and Identification
ANSI/ISA-12.12.01-2000	:	Non-incendiary Electrical Equipment for use in Class I and II, Div. 2 Hazardous (classified) locations.

*Note:* Other standards, norms and recommendations, if required, shall be suggested by the contractor and must receive approval from the purchaser.

### ANNEXURE-III

#### SPECIFICATIONS OF THE FIELD ELEMENTS

##### A. PRESSURE TRANSMITTERS (ABSOLUTE AND GAUGE)

1. Type : Smart Absolute Pressure Transmitter or Smart Gauge Pressure Transmitters for higher ranges if absolute version is not available
2. Measurement Range : As per the list in Annexure-V
3. Service Medium : As per the list in Annexure-V
4. Desirable Turndown Ratio (TD) : 8:1 or lower
5. Output : Two wire 4–20 mA with superimposed digital communication HART protocol.
6. Power Supply : 12 to 30 V DC
7. Local Indication : min 4½ digits LCD – Local Alpha Numeric Digital display in Engineering units
8. Hazardous Area Certification : Both intrinsically safe and explosion proof suitable for use in Hydrogen atmosphere. (CENLEC / CSA / FM / ATEX or any equivalent approval).
9. Safety Integrity Level Standard (SIL) : Safety Instrumented System Certification as per IEC 61508 standard, SIL 2 and above.
10. Zero & Span Adjustments : Zero and Span are to be adjusted from the Handheld HART Communicator.
11. Failure mode alarms : High alarm  $\geq 21.0$  mA  
Low Alarm  $\leq 3.6$  mA
12. Reference Accuracy : within  $\pm 0.075$  % of span
13. Ambient Temperature Effect per 28°C : within  $\pm 0.35$  % span
14. Stability : within  $\pm 0.2$  % of URL for 10 years
15. Power Supply Effect : within  $\pm 0.005$  % of span per volt
16. Over Pressure limit : 1.5 times of URL (Upper range Limit).
17. Nominal Operating Temperature :  $-20^{\circ}$  C to  $60^{\circ}$  C
18. Response time :  $\leq 150$  milliseconds
19. Wetted Material : Refer to the table given below.
20. Fill Fluid : Refer to the table given below.
21. Transient Protection : As per IEEE C62.41, category B – 3kA Crest (8/20 microseconds)  
Applicable standards: IEC61000-4-4, IEC61000-4-5.
22. Drain vent port : Not required.
23. Electrical Connection : ½ " – 14 NPT (F) with SS plug.
24. Transmitter Process connection : ½ " – 14 NPT (F) or suitable for the quoted manifold connection
25. Housing Material : Polyurethane covered aluminium
26. External Grounding screw assembly on transmitter body : Required
27. Mounting Bracket : Stainless Steel Bracket with SS fasteners, bolts, nuts, washers and U-clamps suitable for 2-inch pipe mounting.

28. Calibration : Calibration shall be carried out at room temperature in 5 steps ascending and 5 steps descending. Calibration certificate is to be provided. Calibration shall be traceable to National Standards.
29. Manifold : 2 valve manifolds of the same make to be provided as per Specification given in Annexure-III D.

Sl. No.	Medium	Fill fluid	Diaphragm material	Flange & Adapter Material	O-Ring Material	Special Cleaning	Electrical Housing	Calibration Fluid
1	LOx / LN2 / GHe	Inert Fill	316L SS	316 SS	PTFE	Oxygen cleaning for transmitter in Oxygen service as per relevant oxygen service standard	Certified for EEx ia IIC, T6	GN2
2	GN <sub>2</sub>	Silicone Oil	316L SS	316 SS	PTFE	-		
3	Water	Silicone Oil	316L SS	316 SS	PTFE	-		

**B. PRESSURE TRANSMITTERS (VACUUM)**

1. Type : Smart Absolute Pressure Transmitter or Smart Vacuum Pressure Transmitters
2. Measurement Range : As per the list in Annexure-V
3. Service Medium : As per the list in Annexure-V
4. Maximum Turndown Ratio (TD) : 4:1
5. Output : Two wire 4–20 mA with superimposed digital communication HART protocol.
6. Power Supply : 12 to 30 V DC
7. Local Indication : min 4½ digits LCD – Local Alpha Numeric Digital display in Engineering units
8. Hazardous Area Certification : Both intrinsically safe and explosion proof suitable for use in Hydrogen atmosphere. (CENLEC / CSA / FM / ATEX or any equivalent approval).
9. Safety Integrity Level Standard (SIL) : Safety Instrumented System Certification as per IEC 61508 standard, SIL 2 and above.
10. Zero & Span Adjustments : Zero and Span are to be adjusted from the Handheld HART Communicator.

- |   |  |
|---|--|
| 11. Failure mode alarms                                   | : High alarm $\geq 21.0$ mA<br>: Low Alarm $\leq 3.6$ mA   |
| 12. Reference Accuracy                                    | : within $\pm 0.075$ % of span   |
| 13. Ambient Temperature Effect per 28°C                   | : within $\pm 0.35$ % span   |
| 14. Stability   | : within $\pm 0.2$ % of URL for 10 years   |
| 15. Power Supply Effect                                   | : within $\pm 0.005$ % of Calibrated Span per Volt.  |
| 16. Over Pressure limit                                   | : 1.5 times of URL (Upper range Limit).  |
| 17. Nominal Operating Temperature                         | : $-20^{\circ}$ C to $60^{\circ}$ C  |
| 18. Response time   | : $\leq 300$ milliseconds  |
| 19. Wetted Material                                       | : Refer to the table given below.  |
| 20. Fill Fluid  | : Refer to the table given below.  |
| 21. Transient Protection                                  | : As per IEEE C62.41, category B – 3kA Crest (8/20 microseconds)<br>Applicable standards: IEC61000-4-4, IEC61000-4-5.  |
| 22. Drain vent port                                       | : Not required.  |
| 23. Electrical Connection                                 | : $\frac{1}{2}$ " – 14 NPT (F) with SS plug.   |
| 24. Transmitter Process connection                        | : $\frac{1}{2}$ " – 14 NPT (F) or suitable for the quoted manifold   |
| 25. Housing Material                                      | : Polyurethane covered aluminium   |
| 26. External Grounding screw assembly on transmitter body | : Required   |
| 27. Mounting Bracket                                      | : Stainless Steel Bracket with SS fasteners, bolts, nuts, washers and U-clamps suitable for 2-inch pipe mounting.  |
| 28. Calibration   | : Calibration shall be carried out at room temperature in 5 steps ascending and 5 steps descending. Calibration certificate is to be provided. Calibration shall be traceable to National Standards. |
| 29. Manifold  | : 2 valve manifolds of the same make to be provided as per Specification given in Annexure-III D.  |

Sl. No.	Medium	Fill fluid	Diaphragm material	Flange & Adapter Material	O-Ring Material	Special Cleaning	Electrical Housing	Calibration Fluid
1	LOx / LN2 / GHe	Inert Fill	316L SS	316 SS	PTFE	Oxygen cleaning for transmitter in Oxygen service as per relevant oxygen service standard	Certified for EEx ia IIC, T6	GN2
2	GN <sub>2</sub>	Silicone Oil	316L SS	316 SS	PTFE	-		
3	Water	Silicone Oil	316L SS	316 SS	PTFE	-		

**C. PRESSURE TRANSMITTERS (DIFFERENTIAL)**

1. Type : Smart Differential Pressure Transmitter
2. Measurement Range : As per the list in Annexure-V
3. Service Medium : As per the list in Annexure-V
4. Maximum Turndown Ratio (TD) : 4:1
5. Output : Two wire 4–20 mA with superimposed digital communication HART protocol.
6. Power Supply : 12 to 30 V DC
7. Local Indication : min 4½ digits LCD – Local Alpha Numeric Digital display in Engineering units
8. Hazardous Area Certification : Both intrinsically safe and explosion proof suitable for use in Hydrogen atmosphere. (CENLEC / CSA / FM / ATEX or any equivalent approval).
9. Safety Integrity Level Standard (SIL) : Safety Instrumented System Certification as per IEC 61508 standard, SIL 2 and above.
10. Zero & Span Adjustments : Zero and Span are to be adjusted from the Handheld HART Communicator.
11. Failure mode alarms : High alarm  $\geq 21.0$  mA  
: Low Alarm  $\leq 3.6$  mA

12. Reference Accuracy : within  $\pm 0.05$  % of span
13. Ambient Temperature Effect per 28°C : within  $\pm 0.2$  % span
14. Stability : within  $\pm 0.2$  % of URL for 1 year
15. Power Supply Effect :  $\leq \pm 0.005$  % of span per volt
16. Mounting Position Effect : Zero shifts can be calibrated out
17. Static Pressure effect : Span error: within  $\pm 0.25\%$  of span / 1000 psi
18. Maximum Static pressure : As per the list in Annexure-V
19. Over Pressure limit : 1.25 times of URL (Upper range Limit).
20. Nominal Operating Temperature :  $-20^{\circ}$  C to  $60^{\circ}$  C
21. Response time :  $\leq 300$  milliseconds
22. Wetted Material : Refer to the table given below.
23. Fill Fluid : Refer to the table given below.
24. Transient Protection : As per IEEE C62.41, category B – 3kA Crest (8/20 microseconds)  
Applicable standards: IEC61000-4-4, IEC61000-4-5.
25. Drain vent port : Not required.
26. Electrical Connection :  $\frac{1}{2}$  " – 14 NPT (F) with SS plug.
27. Transmitter Process connection :  $\frac{1}{2}$  " – 14 NPT (F) or suitable for the quoted manifold
28. Housing Material : Polyurethane covered aluminium
29. External Grounding screw assembly on transmitter body : Required
30. Mounting Bracket : Stainless Steel Bracket with SS fasteners, bolts, nuts, washers and U-clamps suitable for 2-inch pipe mounting.
31. Calibration : Calibration shall be carried out at room temperature in 5 steps ascending and 5 steps descending. Calibration certificate is to be provided. Calibration shall be traceable to National Standards.
32. Manifold : 5 valve manifolds of the same make to be provided as per Specification given in Annexure-III D.

Sl. No.	Medium	Fill fluid	Diaphragm material	Flange & Adapter Material	O-Ring Material	Special Cleaning	Electrical Housing	Calibration Fluid
1	LOx / LN2 / GHe	Inert Fill	316L SS	316 SS	PTFE	Oxygen cleaning for transmitter in Oxygen service as per relevant oxygen service standard	Certified for EEx ia IIC, T6	GN2
2	GN <sub>2</sub>	Silicone Oil	316L SS	316 SS	PTFE	-		
3	Water	Silicone Oil	316L SS	316 SS	PTFE	-		

**D. 2-VALVE / 5-VALVE MANIFOLDS**

1. Type : 2 valve (isolation and drain valves) manifold / 5 valve (isolation (2), drain (2) and equaliser (1) valves) manifold
2. Material : 316SS
3. Packing material : PTFE
4. Seat type : Integral
5. Instrument Connection : Suitable for quoted transmitter interface
6. Process connection : ½ inch-14 NPTF
7. Maximum Operating Pressure : 400 bar manifolds for transmitter range up to 250 bar  
: 680 bar manifolds for transmitter range between 250 to 500 bar
8. Operating Temperature : 0 to 100° C
9. Hydro Testing : To be carried out at 1.5 times the maximum operating pressure for all the manifolds and certificate to be provided
10. Material Test certificate : To be provided
11. Mounting Bolts : To be supplied with SS material.
12. Oxygen cleaning : Oxygen cleaning to be carried out for transmitters operating medium is oxygen

## **E. TEMPERATURE TRANSMITTERS**

1. Inputs : a) Pt100 IEC, Pt100 JIS, Pt100 GOST  
b) Pt 500 IEC  
c) Thermocouple N, K  
d) Ohms  
e) Millivolts  
f) Special Ohms and Special mV (Special 16-point sensor characterization)
2. Output Signal : Two-wire, 4-20mA with superimposed digital communication (HART protocol)
3. Power Supply : 12 to 42 V DC
4. Range : a) Pt100 IEC, Pt100 GOST: -200 °C to 850 °C  
b) Pt 500 IEC: -200 °C to 450 °C  
c) Thermocouple N, K: -100 °C to 1300 °C  
d) Ohms: 0-2000 ohms  
e) Millivolts: -50 to 500 mV
5. Digital Accuracy : a) Pt100 IEC, Pt100 GOST:  $\pm 0.20$  °C  
b) Pt 500 IEC:  $\pm 0.20$  °C  
c) Thermocouple N, K:  $\pm 0.60$  °C  
d) Ohms:  $\pm 0.02\%$  or  $\pm 0.20$  ohms  
e) Millivolts:  $\pm 0.02\%$  or  $\pm 50$   $\mu$ V
6. Minimum span :  $\pm 10$  °C for RTDs
7. 4-20 mA output D/A accuracy : 0.03%
8. Indicator : Min. 4 1/2-digit LCD indicator
9. Zero and Span Adjustment : Zero or span capabilities via local adjustment and digital communication.
10. Temperature Limits : -20 to 60°C
11. Loss of Input (Burnout) : Burnout detection is user selectable. Upscale or down scale with critical status message. For RTD or ohm type inputs; broken wire / wires shall be indicated (3.6 or 21 mA)
12. Humidity Limits : 0-95 % RH
13. Turn-on Time : <10 seconds
14. Damping : up to 30 s
15. Power Supply Effect : 0.005 % span per volt
16. EMI Effect : IEC 61236:2002
17. Alarm : Dual, trip levels adjustable over entire range. High or Low action Acknowledge, messaging
18. Hazardous Area Certification : ATEX Explosion proof, Intrinsically Safe
19. Electrical connection : ½" - 14 NPT



20. Enclosure Rating : NEMA 4X, IP67  
 21. Mounting : Bracket which can be installed on a 2" pipe

## **F. PRESSURE SWITCHES**

### **Input:**

1. Set Pressure : 6 / 40 bar absolute (falling)  
 2. Max operating pressure : 10 / 60 bar absolute  
 3. Over Pressure : 2 times max. operating Pressure  
 4. Burst Pressure : 3 times max. operating Pressure  
 5. Wetted Part : Stainless steel suitable for GN2

### **Output:**

1. Electrical output : Potential free contact DPDT  
 2. Switching electrical rating : 24 VDC / 50 mA  
 3. Switch operating mode : Normally open  
 4. Set point accuracy :  $\leq 2\%$  of set pressure  
 5. Dead band :  $\leq 1\%$  of set pressure

### **Environmental:**

1. Construction : Hermetically sealed  
 2. Operating Temperature : -20 °C to +60 °C  
 3. Humidity : 95 % RH

### **Physical:**

1. Electrical connection :  $\frac{1}{2}$ " -14 NPTF  
 2. Process connection :  $\frac{1}{2}$ " -14 NPTF

## **G. SOLENOID OPERATED VALVES**

### **Valve Body**

1. Type : 3-way, 3/2 operation, normally closed  
 2. Body material : SS 316  
 3. Housing : Die cast Aluminium epoxy painted  
 4. Stem : SS 316 / SS304  
 5. Seat : Viton  
 6. End connection : 3/8" NPTF (may vary after detailed engineering)  
 7. Mounting altitude : Any altitude without affecting the valve operation  
 8. Orifice Size : 6 mm (may vary after detailed engineering)

### **Solenoid**

1. Power supply : 24 V / 500 mA (max.)
2. Solenoid coil : Suitable for continuous energization.
3. Protection : EEx.d II C, T6
4. Certification : Should be certified for use in hydrogen environment
5. Enclosure : IP 65
6. Coil insulation : Class H as defined in IS: 1271.
7. Coil pull in voltage : Between 50 to 70% of normal supply voltage.
8. Coil drop out voltage : Between 30% to 50% of nominal supply voltage
9. Coil temperature rise : Not to exceed 70°C.
10. Coil : Dual Coil
11. Response Time : Less than 100 ms
12. Conduit connection : Enclosure shall have 1/2” NPT (F) connection
13. Mode of operation : Direct / Pilot operated.
14. Freewheeling Diode : Two diodes in series to be provided
15. Coil protection : Reverse polarity protection to be provided
16. Exhaust / Vent : To be protected with SS 316 silencers

### **Process condition**

- Fluid : GN<sub>2</sub> / GHe
- Pressure rating : 8 bar / 60 bar
- Service Life : 50,000 cycles
- Operating Temperature : 20°C to 60°C
- Relative humidity : up to 95%

## **H. STRUCTURAL STEEL MATERIALS**

1. Material : Structural steel includes steel sections pipes and plates.
2. Material Governing standard : IS 2062 (GRADE-A)
3. Dimensions governing standard : IS 808 & IS 1161
4. Certifications : ISI Marking

## I. JUNCTION BOXES

### Enclosure

- The equipment shall be suitable for operating in humid & corrosive atmosphere and shall be explosion proof.
- Explosion protection as per EEx.d II C, T6.
- The degree of ingress protection shall be IP66.
- Housing shall be made out of cast aluminium LM6 alloy with neoprene gaskets.
- Accessories like nuts, bolts, washers etc. shall be made of stainless-steel SS- 304.
- Conduit and cable entry shall be on either sides and at the bottom.
- Doors shall be with properly hinged with proper locking arrangement to avoid entry of dust and moisture.
- Operating temperature: 0 to 50°C
- Ambient humidity: 0 to 95 % RH
- Two numbers of earthing bolts for the body earthing.
- Certification: ATEX or equivalent.
- Approximate dimensions of the field junction box size shall be 600 mm (L) x 600 mm (W) x 350 mm (D). Exact dimension will be finalised during detailed engineering.
- Every field junction box shall have a minimum of 4 numbers of 2” or 2 ½” cable entries at the bottom and a minimum of 32 numbers of ½” or 24 numbers of ¾” or 8 numbers of 1” and 1 ½” cable entries on either side. This is a bare minimum requirement and the final numbers shall be arrived at during detailed engineering.
- Approximate dimensions of the miniature junction box size shall be 100 mm (L) x 100 mm (W) x 80 mm (D). Exact dimension will be finalised during detailed engineering. This shall have one number each of ½” and ¾” size cable entries.

### Terminal blocks

1	Connections	:	2
2	Rows or levels	:	1
3	Potentials	:	1
4	Connection per level	:	2
5	Connection Type	:	Spring-cage / Tension-clamp / Cage clamp
6	Insulator Material	:	PA or equivalent
7	Contact Material	:	Tinned Copper
8	Conductor Size	:	AWG 28-12

9	Colour	:	Red / Black
10	Cable Entry	:	Front
11	Nominal Current Rating	:	24 A
12	Nominal Voltage Rating	:	800 V
13	Nominal Cross Section	:	2.5 sq. mm.
14	Rated Surge Voltage	:	8 kV
15	Flammability rating according to UL 94	:	V0
16	Degree of pollution	:	3
17	Mounting	:	35 mm DIN rail mountable
18	Compliances	:	IEC 60947-7-1, RoHS

- There shall be two copper bus bars with appropriate isolators mounted inside the junction boxes for the termination of shields of the multi-pair cables.
- Each junction box shall have a minimum of 192 nos. of terminal blocks. Miniature junction boxes shall have a minimum of 8 nos. of terminal blocks. This number shall be finalised in the detailed engineering.

#### **Name plate**

- Aluminium anodized nameplate indicating the tag number of the junction box shall be provided on each local junction box. The particulars of the name plate will be provided by the department during detail engineering. Nameplate shall be fixed by screws / rivets and not pasted.
- The letter shall be engraved in black on white background.
- Certificate numbering date and gas group classification must be indicated on the manufacturer's nameplate.

#### **Mounting**

Each junction box shall have 4 lugs for fixing on wall or fabricated steel support. The lugs shall be offset so that the rear of the unit stays away from the surface by at least 5mm. Two of the holes shall be round and the other two oblong to facilitate correct positioning. All screws, nuts and studs etc. shall be of electro galvanized or zinc passivated type.

#### **Painting**

The enclosure shall be treated & prepared for painting with two coats of epoxy paint (both internal and external) of colour light admiralty grey shade IS 697.

## **J. FRLS PVC CABLES**

### **Cable Construction**

- 2C x AWG18** : One pair of 19/0.25 mm (18 AWG) annealed tinned copper conductor, polyethylene insulated, cores colour coded, melinex taped, mylar backed aluminium taped with a drain of size 7/0.31mm Annealed tinned copper, melinex tapped, PVC sheathed steel round GI wire armoured and overall sheathed with FRLS PVC and Blue in colour.
- 2C x AWG20** : One pair of 7/0.31 mm (20 AWG) annealed tinned copper conductor, polyethylene insulated, cores colour coded, melinex taped, mylar backed aluminium taped with a drain of size 7/0.31mm Annealed tinned copper, melinex tapped, PVC sheathed steel round GI wire armoured and overall sheathed with FRLS PVC and Blue in colour.
- 4C x AWG20** : Two pairs of 7/0.31 mm (20 AWG) annealed tinned copper conductor, polyethylene insulated, cores colour coded, melinex taped, mylar backed aluminium taped with a drain of size 7/0.31mm Annealed tinned copper, melinex tapped, PVC sheathed steel round GI wire armoured and overall sheathed with FRLS PVC and Blue in colour.
- 12C x AWG18** : 6 pairs of 19/0.25 mm (18 AWG) annealed tinned copper conductor, polyethylene insulated, cores colour coded, all the 6 pairs laid up to form a group, melinex taped, mylar backed aluminium taped with a drain wire of size 7/0.31mm Annealed tinned copper, melinex tapped PVC sheathed, steel round GI wire armoured and overall sheathed with FRLS PVC and Blue in colour.
- 16C x AWG18** : 8 pairs of 19/0.25 mm (18 AWG) annealed tinned copper conductor, polyethylene insulated, cores colour coded, all the 8 pairs laid up to form a group, melinex taped, mylar backed aluminium taped with a drain wire of size 7/0.31mm Annealed tinned copper, melinex tapped PVC sheathed, steel round GI wire armoured and overall sheathed with FRLS PVC and Blue in colour.
- 64C x AWG20** : 20 AWG (7/0.31) Annealed tinned copper conductor, insulated with polyethylene, 2 cores twisted to form a pair melinex taped, aluminium mylar tape shielded with 7/0.31 mm Annealed tinned copper drain wire run continuously in contact with aluminium side of the tape, melinex tapped, PVC sheathed, such 32 groups laid up, melinex tapped, overall sheathed with FRLS PVC and Blue in colour.
- 64C x AWG18** : Two pairs of 19/0.25mm (18 AWG) Annealed tinned copper conductor, insulated with polyethylene, 2 cores twisted to form a pair melinex taped, aluminium mylar tape shielded with 19/0.25mm Annealed tinned copper drain wire run continuously in contact with aluminium side of the tape, melinex tapped, PVC sheathed, such 32

groups laid up, melinex tapped, overall sheathed with FRLS PVC and Blue in colour.

**96C x AWG20** : 20 AWG (7/0.31) Annealed tinned high conductivity copper conductor, insulated with polyethylene, 2 cores of Grey and Brown twisted to form a first pair and 2 cores of Yellow and Violet twisted to form a second pair and overall melinex taped, aluminium mylar tape shielded with 7/0.31 mm Annealed tinned copper drain wire run continuously in contact with aluminium side of the tape, melinex tapped, PVC sheathed, such 24 groups laid up, melinex tapped, overall sheathed with FRLS PVC and Blue in colour.

### **Detailed Specifications**

- |   |                                |   |  |
|---|--------------------------------|---|--|
| 1 | Voltage grade                  | : | 300 V  |
| 2 | Operating temperature          | : | 0°C to 60°C  |
| 3 | Conductor                      | : |  |
|   | a) Conductor Material          | : | Annealed Tinned copper as per IS:8130  |
|   | b) Size of the conductor       | : | 20AWG (7/0.31mm)<br>18AWG (19/0.25mm)  |
| 4 | Insulation                     | : |  |
|   | a) Insulation Material         | : | Solid polyethylene type-03 of BS6234   |
|   | b) Insulation Thickness (Nom.) | : | 0.40 mm  |
|   | c) Pair colours                | : | 2C and 64C (32 x 2C)<br>Red and Black (Twisted)<br><br>4C and 96C (24 x 4C)<br>Pair 1: Brown and Grey (Twisted)<br>Pair 2: Yellow and Violet (Twisted)<br><br>12C, 16C<br>Pair 1: Blue and White (Twisted)<br>Pair 2: Orange and White (Twisted),<br>Pair 3: Green and White (Twisted),<br>Pair 4: Brown and White (Twisted),<br>Pair 5: Grey and White (Twisted), |

		Pair 6: Yellow and White (Twisted),
		Pair 7: Violet and White (Twisted)
		Pair 8: Red and White (Twisted)
d) No. of twists/metre	:	30 (Min)
e) Dia. over insulation (Nom.)	:	1.75 mm
5 Screening over group	:	
a) Tapping before and after:	:	Thickness of melinex tape to be 0.025mm (100% screening coverage, min-20% overlap)
b) Screening	:	
i) Screening Material	:	Aluminium mylar tape
ii) Screening Thickness	:	0.044mm
iii) Coverage and overlap	:	100% Coverage and 35% overlap
iv) Drain wire	:	7/0.31mm Annealed tinned copper
6 Inner sheath	:	
a) Inner sheath Material	:	PVC type ST2 of IS:5831 with FRLS properties
b) Inner sheath Thickness (Nom.)	:	0.65 mm
c) Inner sheath Colour	:	Black
7 Outer sheath	:	
a) Outer sheath Material	:	PVC type ST2 of IS:5831 with FRLS properties
b) Outer sheath Thickness (Nom.)	:	2.2 mm (96 & 64 Core) 2.0 mm (16, 12, 4 & 2 Core)
c) Outer sheath Colour	:	Blue
8 Insulation elongation	:	300%
Sheath elongation	:	150%
Insulation T.S	:	100 kg/cm <sup>2</sup>
Sheath T.S	:	125 kg/cm <sup>2</sup>
9 Approx. overall diameter	:	96 Core: 48.0 mm 64 Core (AWG18): 52.0 mm 64 Core (AWG20): 42.0 mm 16 Core: 25.0 mm 12 Core: 22.0 mm

		4 Core: 16.0 mm
		2 Core: 12.0 mm
	Tolerance in overall diameter	: $\pm 5\text{mm}$ (96/64 core cables), $\pm 2\text{ mm}$ (others)
10	Electrical parameters	:
	a) Conductor resistance at 20°C	: 20 AWG: $\leq 35.0\ \Omega/\text{km}$ 18 AWG: $\leq 22.0\ \Omega/\text{km}$
	b) Min. Insulation resistance of finished cable at Room Temperature	: 5000 M $\Omega/\text{km}$
	c) Max. Mutual capacitance at 0.8/1.0 kHz	: 75.00 pF/m
	d) Max. capacitance core to screen at 0.8/1.0 kHz	: 400 pF/m
	e) Max. drain wire resistance (with screen contact)	: 37 $\Omega/\text{km}$
	f) Inductance	: < 650 $\mu\text{H}/\text{km}$
	g) L/R Ratio	: 20 AWG: < 25 $\mu\text{H}/\Omega$ 18 AWG: < 40 $\mu\text{H}/\Omega$
	h) Static noise	: better than 60 dB
	i) Characteristic impedance (typical)	: 20 AWG: 450 $\Omega \pm 15\%$ 18 AWG: 350 $\Omega \pm 15\%$
	j) HV test	: 1 kV for 1 minute for conductor to conductor and conductor to screen.
11	FRLS Tests	:
	a. Min Oxygen Index when tested as per ASTM D2863	: 29%
	b. Min Temperature Index when tested as per ASTM D2863	: 250 °C
	c. Max Smoke Density rating when tested as per ASTM D2843	: 60%
	d. Max Acid gas generation when tested as per IEC 754 (I)	: 20%
	e. Flammability test as per IEEE 383, IEC 332-III category-C and SS424 1475 CLF3	: Shall meet the requirement
12	General	: Cable should be Anti-Rodent and Anti-termite type



13	Cable marking	: a. The cable group number (as applicable) shall be printed on the cable at 0.5m interval. b. The cable type shall be embossed / printed on the outer sheath at 1.0m interval.
14	Length marking	: At every meter on outer sheath
15	Drum lengths	:
	i) Standard Continuous length	: 96 Core & 64 Core: 500 meters 16, 12, 4 & 2 Core: 1000 meters
	ii) Tolerance	: $\pm 5\%$
16	Armouring (Applicable only for Armoured Cables)	:
	a) Material	: Galvanized Steel round wire
	b) Size	: 1.4 mm diameter

### **General Specifications**

1. Wherever PVC is specified virgin PVC should be used.
2. All cables should have 'anti-rodent' type outer sheath and should be immune to termite attack. It is required to have these protections by addition of chemicals to outer sheath.
3. Cable testing as stipulated in the next section shall be conducted and necessary conformity certificate should be supplied by the contractor.
4. Thermal aging test certificate to be provided by contractor for each type of cable.
5. Cable should be manufactured according to the following standards.
  - a. Copper conductor : IS 8130 – 1984
  - b. Poly Ethylene (PE) insulation : BS 6234
  - c. PVC insulation : IS 5831
  - d. FRLS properties : ASTM D2863, IEC 754(I),  
IEC 332-III category-C and  
SS424 1475 CLF3
6. Proper packing material to be used during laying (manufacturing) in order to ensure that the finished sheathed cable cross section is circular with a tolerance of  $\pm 5\%$  of diameter.
7. Cable should have proper laying to maintain circularity and tight packing with outer sheath shall be ensured.
8. Cable drum should withstand transportation and handling.
9. The drums shall be proofed against attack by white ant or termite, conforming to IS:10418:1982.

### Cable Testing

The following tests as per applicable IS/BS standard shall be conducted in the presence of department representative and certificate to be provided.

- a. Conductor resistance test
- b. Cold bend test
- c. Insulation resistance test
- d. High voltage test
- e. Mutual capacitance test
- f. FRLS tests:
  - i. Min Oxygen Index test as per ASTM D2863
  - ii. Min Temperature Index test as per ASTM D2863
  - iii. Max Smoke Density rating test as per ASTM D2843
  - iv. Max Acid gas generation test as per IEC 754 (I)
  - v. Flammability test as per IEEE 383, IEC 332-III and SS424 1475 CLF3

### K. CABLE GLANDS

- |                                |   |   |
|--------------------------------|---|---|
| 1. Type                        | : | Double compression cable gland            |
| 2. Material                    | : | SS  |
| 3. Cable Type                  | : | Unarmoured/armoured                       |
| 4. Entry Type                  | : | NPT                                       |
| 5. Standard                    | : | European EN 50262                         |
| 6. Operating Temperature       | : | -30 °C to 100 °C                          |
| 7. Max. Continuous temperature | : | 70 °C                                     |
| 8. Protection                  | : | IP 68 (up to 5 bar)                       |
| 9. Accessories                 | : | Lock nut, Washer                          |
| 10. Gland Size                 | : | Shall be chosen to meet the size of cable |

Sl. No.	Cable Gland size	Type of Cable	Cable OD (mm)
1.	2 ½ ”	96 core-20AWG	48±5
2.	2“	64 core-20AWG	42±5
3.	2 ½”	64 core-18AWG	52±5
3.	1 ½”	16 core	25±2
4.	1”	12 core	22±2
5.	¾”	4 core	16±2
6.	½”	2 core	12±2

## **L. TERMINAL LUGS**

- |                   |                     |
|-------------------|---------------------|
| 1. Type           | : Crimping          |
| 2. Insulation     | : PVC Insulation    |
| 3. Conductor      | : Tinned Copper     |
| 4. Shape          | : Tubular, U        |
| 5. Conductor Size | : 0.5 to 1.5 sq.mm. |

## **M. SMART VALVE POSITIONERS WITH POSITION FEEDBACK**

### **Functional specifications**

- |  |   |   |
|--|---|---|
| 1. Type                                | : | Microcontroller based Control Valve Positioners suitable for linear actuators.  |
| 2. Input signal                        | : | 4-20mA, 2 wire.   |
| 3. Power                               | : | Supplied by the 4-20 mA loop. No external supply required   |
| 4. Communication protocol              | : | HART Communication Protocol   |
| 5. Protection against Reverse Polarity | : | To be provided  |
| 6. Output                              | : | Range 0-6 bar (0 - 90 psi).   |
| 7. Air capacity                        | : | >13 kg/h at supply pressure of 0 – 6 bar (0 – 90 psi).  |
| 8. Output function                     | : | For single or double acting actuators, air is vented from actuators or actuators are blocked in case of electrical power failure. |
| 9. Shut-off values                     | : | End position 0 % = 0 – 45 %<br>End position 100 % = 55 -100 %   |
| 10. Travel limit                       | : | 3 mm to 130 mm stroke range<br><br>Freely configurable within 0-100% of total travel  |
| 11. Action (signal)                    | : | Direct:<br>Signal 4- 20mA = Position 0- 100%<br>Reverse:<br>Signal 20- 4mA = Position 0- 100%                                     |
| 12. Indication                         | : | Local display should be provided. Option to see the display with the enclosure covered.   |
| 13. Flow Characterization              | : | Linear, Equal Percentage, Quick Opening   |
| 14. Gain                               | : | Through software. Locally adjustable.   |

15. Travel Time : Through software. Locally adjustable.
16. Actual Position Sensing : 4-20 mA position feedback for continuous position monitoring.

**Performance specifications**

1. Resolution (A/D conversion) : > 16000 steps
2. Sample rate : 20 ms
3. Influence of vibration :  $\leq \pm 1\%$  up to 10g and 80 Hz.
4. Tolerance band : 0.3- 10%, adjustable.

**Physical Specifications**

1. Electrical connection :  $\frac{1}{2}$ "-14 NPT
2. Cable entry : 2 cable glands  $\frac{1}{2}$ -14 NPT
3. Pneumatic connection :  $\frac{1}{4}$ "-18 NPT
4. Mounting orientation : Any orientation allowed.

**Certification**

1. Hazardous Location : Explosion proof, class II C Intrinsic safety certification
2. IP rating : IP 65
3. Electro-Magnetic Interference Effect : Designed to comply with EN61000
4. Safe integrity level : SIL 2 according to IEC 61508 or IEC 61511-1 for single acting valve

**Accessories**

1. Air Filter Regulator unit for positioner
2. Pressure gauge block for input and output pressure
3. Mounting brackets and attachment kits for linear actuators

**N. CAT6 ETHERNET CABLE**

1. Length : 300 m / drum
2. Construction : 4 twisted pairs separated by polymer spine
3. Type : Cat 6 PVC cable
4. Conductor Type : 23 AWG Solid bare copper
5. Support : Gigabit Ethernet 1000 Base-T

- |                              |   |
|------------------------------|---|
| 6. Frequency                 | : 1-250 MHz                               |
| 7. Attenuation (IL)          | : 14 dB or better (at 100 MHz)            |
| 8. NEXT                      | : 58.7 dB or better (at 100 MHz)          |
| 9. ELFEXT                    | : 41.2 dB or better (at 100 MHz)          |
| 10. Return Loss              | : 23.1 dB or better (at 100 MHz)          |
| 11. Characteristic Impedance | : 100±15 ohms                             |
| 12. Standards                | : UL, RoHS, TIA/EIA 568-C2, ISO/IEC 11801 |

**O. PREAMPLIFIERS FOR TURBINE FLOW METERS**

- |  |   |
|--|---|
| 1. Magnetic Pickup Input                 | : Input protected for RF<br>Input frequency: 0 to 10 kHz<br>Trigger sensitivity: 4 m V <sub>rms</sub> (minimum from 10Hz to 3kHz) adjustable with a turn control<br>Input impedance: 40 kΩ (nominal)  |
| 2. Input Power                           | : 8-30 V DC, max. 125 mA @ 24 V DC<br>Reverse polarity protected  |
| 3. Pulse Outputs                         | : 0 to 10 V DC square wave  |
| 4. Analog Output Module (Current Output) | : Accuracy (w/o temperature effect): ±0.05% of full-scale<br>Range: 4 to 20 mA.<br>Output suitable for driving floating or grounded loads<br>Minimum loop impedance 500 ohms.<br>Response time: better than 400 ms for 10 to 90 %<br>Zero and span adjustment with a turn control |
| 5. Analog Output Module (Voltage Output) | : Accuracy (w/o temperature effect): ±0.05% of full-scale<br>Range: 0 to 5 Vdc or 0 to 10 Vdc.<br>Impedance less than 10 ohms.<br>Response time: better than 400 ms for 10 to 90 %<br>Zero and span adjustment with a turn control  |
| 6. Operating Temperature                 | : -40 °C to 85 °C   |
| 7. Enclosures                            | : Explosion proof enclosure EEx.d II C, T6<br>IP 65 rated   |

**P. SIGNAL CONVERTERS FOR TURBINE FLOW METERS**

- |         |  |
|---------|--|
| 1. Type | : Two wire frequency to analog converter with loop powered outputs |
|---------|--|

2. Inputs : *High Level Pulse input*  
 Logic 1: 4-30 VDC, Logic 0: 0-1 VDC  
 Input impedance: min. 3 k $\Omega$   
 Frequency range: 0-10 kHz  
 Isolation: Opto-isolated (500 V)  
 Reverse polarity and over voltage protection  
*Magnetic pickup input (optional)*  
 Trigger sensitivity: 30 mVp-p  
 Input impedance: min. 10 k $\Omega$   
 Frequency range: 0-3500 Hz
3. Frequency Ranges : 150 Hz, 300 Hz, 600 Hz, 1200 Hz,  
 2500 Hz, 5000 Hz, 10,000 Hz (DIP switch selectable)
4. Analog Output Module (Current Output) : Type: Two wire, Loop powered  
 Accuracy (w/o temperature effect): +/- 0.1% of span  
 Range: 4 to 20 mA.  
 Compliance Voltage: 10 to 40 V DC  
 Loop Burden: < 10 VDC  
 Linearity: <  $\pm 0.1\%$  Span  
 Reverse Polarity Protected  
 Response time: better than 150 ms  
 Trim Controls: Zero & Span  
 Indicator: Blinks proportionally to the input frequency
5. Operating Temperature : 20  $^{\circ}$ C to 50  $^{\circ}$ C
6. Mounting : 35 mm DIN rail mountable
7. Enclosures : Explosion proof enclosure EEx.d II C, T6  
 IP 65 rated

#### **Q. USB HART MODEMS**

1. Type : HART communication modem
2. Enclosure : High strength ABS plastic
3. Cables & Connectors : Min. 1 m long HART cable with mini-grabber  
 Min. 0.5 m long USB cable with USB type-A/C
4. Interface : Capacitive and transformer coupling with 1500 V DC  
 isolation and series 250 $\Omega$  resistor
5. Compatible Specifications : HART 4, HART 5, HART 6, HART7, wirelessHART,  
 HART physical layer spec HCF\_SPEC-54



- ½” Bulkhead Union (approx. 100 nos.)

**Tee Joint**

- 1” (approx. 30 nos.)
- ½” (approx. 30 nos.)
- 8 mm (approx. 30 nos.)

**Conversion Adapters**

- ¼” BW to 8 mm O.D. COMP. (approx. 210 nos.)
- ¼” NPT(M) to ½” O.D. COMP. (approx. 310 nos.)
- ¼” NPT(M) to 8 mm O.D. COMP. (approx. 310 nos.)
- ½” BW to ½” O.D. COMP. (approx. 560 nos.)
- ½” NPT(M) to 8 mm O.D. COMP. (approx. 50 nos.)
- ½” NPT(M) to ½” O.D. COMP. (approx. 290 nos.)
- ¾” NPT(M) to ½” O.D. COMP. (approx. 110 nos.)
- ¾” NPT(M) to 8 mm O.D. COMP. (approx. 60 nos.)
- 3/8” NPT(M) to 8 mm O.D. COMP. (approx. 120nos.)
- 1” NPT(M) to ½” O.D. COMP. (approx. 90 nos.)
- 1” NPT(M) to 8 mm O.D. COMP. (approx. 20 nos.)



**ANNEXURE-IV**

**BILL OF QUANTITIES**

Sl. No.	Item	Reference	Quantity	Unit of Measure	Unit Price (in ₹)
<b>Supply of Materials</b>					
1.	Supply of Pressure Transmitters (0-30 bar(a))	Annexure III, Part A, D & Annexure V	10	nos.	
2.	Supply of Pressure Transmitters (0-450 bar(a))	Annexure III, Part A, D & Annexure V	10	nos.	
3.	Supply of Differential Pressure Transmitters (0-1 bar)	Annexure III, Part C, D & Annexure V	5	nos.	
4.	Supply of Differential Pressure Transmitters (0-5 bar)	Annexure III, Part C, D & Annexure V	5	nos.	
5.	Supply of Vacuum Pressure Transmitters (0-2 bar(a))	Annexure III, Part B, D & Annexure V	5	nos.	
6.	Supply of Temperature Transmitters	Annexure III, Part E	85	nos.	
7.	Supply of HART modems	Annexure III, Part Q	2	nos.	
8.	Supply of Flow Preamplifier for Flowmeters	Annexure III, Part O	50	nos.	
9.	Supply of Flow Signal Converter for Flowmeters	Annexure III, Part P	30	nos.	
10.	Supply of 8 bar SOVs	Annexure III, Part G	30	nos.	
11.	Supply of 60 bar SOVs	Annexure III, Part G	25	nos.	
12.	Supply of Pressure Switches	Annexure III, Part F	40	nos.	
13.	Supply of Smart Valve Positioners	Annexure III, Part M	30	nos.	
14.	Supply of 2 core AWG 18 PVC cables	Annexure III, Part J	7000	m	
15.	Supply of 2 core AWG 20 PVC cables	Annexure III, Part J	3000	m	
16.	Supply of 4 core AWG 20 PVC cables	Annexure III, Part J	17000	m	
17.	Supply of 12 core AWG 18 PVC cables	Annexure III, Part J	2000	m	
18.	Supply of 16 core AWG 18 PVC cables	Annexure III, Part J	2000	m	
19.	Supply of 64 core AWG 18 PVC cables	Annexure III, Part J	1000	m	
20.	Supply of 64 core AWG 20 PVC cables	Annexure III, Part J	4000	m	
21.	Supply of 96 core AWG 20 PVC cables	Annexure III, Part J	1500	m	
22.	Supply of CAT6 cables	Annexure III, Part N	300	m	
23.	Supply of Cable Glands (1/2")	Annexure III, Part K	1600	nos.	

Sl. No.	Item	Reference	Quantity	Unit of Measure	Unit Price (in ₹)
24.	Supply of Cable Glands (3/4")	Annexure III, Part K	150	nos.	
25.	Supply of Cable Glands (1")	Annexure III, Part K	150	nos.	
26.	Supply of Cable Glands (1 1/2")	Annexure III, Part K	150	nos.	
27.	Supply of Cable Glands (2")	Annexure III, Part K	50	nos.	
28.	Supply of Cable Glands (2 1/2")	Annexure III, Part K	150	nos.	
29.	Supply of Terminal Lugs	Annexure III, Part L	25000	nos.	
30.	Supply of Explosion Proof Junction Boxes	Annexure III, Part I	55	nos.	
31.	Supply of Explosion Proof Junction Boxes (miniature)	Annexure III, Part I	40	nos.	
32.	Supply of Aluminium Plugs (1/2")	Chapter A, Section 3.2.1	1300	nos.	
33.	Supply of Aluminium Plugs (3/4")	Chapter A, Section 3.2.1	200	nos.	
34.	Supply of Aluminium Plugs (1")	Chapter A, Section 3.2.1	50	nos.	
35.	Supply of Aluminium Plugs (1 1/2")	Chapter A, Section 3.2.1	50	nos.	
36.	Supply of Aluminium Plugs (2")	Chapter A, Section 3.2.1	100	nos.	
37.	Supply of Aluminium Plugs (2 1/2")	Chapter A, Section 3.2.1	100	nos.	
38.	Supply of exhaust port silencers (bug screen) (3/8" MNPT)	-	500	nos.	
39.	Supply of exhaust port silencers (bug screen) (1/2" MNPT)	-	200	nos.	
40.	Supply of exhaust port silencers (bug screen) (1/4" MNPT)	-	200	nos.	
41.	Supply of Structural Steel	Annexure III, Part H	20000	kg	
42.	Supply of SS Tube Fittings (for 1/2" OD tubes)	Annexure III, Part R	1650	nos.	
43.	Supply of SS Tube Fittings (for 8 mm OD tubes)	Annexure III, Part R	1000	nos.	
44.	Supply of SS Tube Fittings (for 1" OD tubes)	Annexure III, Part R	75	nos.	
<b>Erection Works</b>					
45.	Mounting of Pressure Transmitters (Absolute Pressure / Differential Pressure)	Chapter A, Section 3.3.5.1	150	nos.	
46.	Mounting of Temperature Transmitters	Chapter A, Section 3.3.5.4	65	nos.	
47.	Mounting of Flow Transmitters / Pre-amplifiers	Chapter A, Section 3.3.5.6	40	nos.	
48.	Mounting of Safety Detectors	Chapter A, Section 3.3.5.25	50	nos.	
49.	Mounting of Smart Valve Positioners for Control Valves	Chapter A, Section 3.3.5.17	30	nos.	

Sl. No.	Item	Reference	Quantity	Unit of Measure	Unit Price (in ₹)
50.	Mounting of SOV Cubicles	Chapter A, Section 3.3.5.12	40	nos.	
51.	Mounting of SOVs in SOV Cubicles / on EP Valves	Chapter A, Section 3.3.5.13 & 3.3.5.14	170	nos.	
52.	Mounting of Pressure Switches	Chapter A, Section 3.3.5.9	40	nos.	
53.	Mounting of Junction Boxes	Chapter A, Section 3.3.5.20	55	nos.	
54.	Laying and mounting of Cable Trays (100 mm perforated)	Chapter A, Section 3.3.5.21	2000	m	
55.	Laying and mounting of Cable Trays (150 mm perforated)	Chapter A, Section 3.3.5.21	1000	m	
56.	Laying and mounting of Cable Trays (300 mm perforated)	Chapter A, Section 3.3.5.21	1000	m	
57.	Laying and mounting of Cable Trays (50 mm perforated)	Chapter A, Section 3.3.5.21	2000	m	
58.	Laying and mounting of Cable Trays (500 mm ladder)	Chapter A, Section 3.3.5.21	1000	m	
59.	Laying of 2 core cables through cable trays	Chapter A, Section 3.3.5.22	18000	m	
60.	Laying of 4 core cables through cable trays	Chapter A, Section 3.3.5.22	17000	m	
61.	Laying of 12 / 16 core cables through cable trays	Chapter A, Section 3.3.5.22	4000	m	
62.	Laying of unarmoured 32 core cables through cable trays	Chapter A, Section 3.3.5.22	3000	m	
63.	Laying of unarmoured 64 core cables through cable trays	Chapter A, Section 3.3.5.22	18000	m	
64.	Laying of unarmoured 96 core cables through cable trays	Chapter A, Section 3.3.5.22	9500	m	
65.	Glanding & Termination (at both ends) for 12 / 16 core cables	Chapter A, Section 3.3.5.23	80	nos.	
66.	Glanding & Termination (at both ends) for 2 core cables	Chapter A, Section 3.3.5.23	420	nos.	
67.	Glanding & Termination (at both ends) for 32 core cables	Chapter A, Section 3.3.5.23	15	nos.	
68.	Glanding & Termination (at both ends) for 4 core cables	Chapter A, Section 3.3.5.23	350	nos.	
69.	Glanding & Termination (at both ends) for 64 core cables	Chapter A, Section 3.3.5.23	70	nos.	
70.	Glanding & Termination (at both ends) for 96 core cables	Chapter A, Section 3.3.5.23	35	nos.	
71.	Tubing works with ferrule fitting termination (at both ends) - 1/2"	Chapter A, Section 3.3.5.28	4200	m	

<b>Sl. No.</b>	<b>Item</b>	<b>Reference</b>	<b>Quantity</b>	<b>Unit of Measure</b>	<b>Unit Price (in ₹)</b>
72.	Tubing works with ferrule fitting termination (at both ends) - 8 mm	Chapter A, Section 3.3.5.28	2600	m	
73.	Structural Work Fabrication and Erection	Chapter A, Section 3.3.5.24	20000	kg	
74.	Mounting of Heat Flux Sensors	Chapter A, Section 3.3.5.8	42	nos.	

**ANNEXURE-V**  
**LIST OF PRESSURE TRANSMITTERS**

Sl. No.	Tag	Medium	Measurement Range
1	IPI-SP001	Isrosene / GN2	0-30 bar(a)
2	IPI-SP002	Isrosene / GN2	
3	IPI-SP003	Isrosene / GN2	
4	IPI-121S	LOx	
5	IPI-123S	LOx	
6	IPI-125S	LOx	
7	IPI-SP101	LOx	
8	IPI-SP701	Isrosene / GN2	
9	IPI-SP702	Isrosene / GN2	
10	IPI-SP601	GHe	
11	IPI-SP105	LOx	0-450 bar(a)
12	IPI-SP106	LOx	
13	IPI-SP107	LOx	
14	IPI-SP703	Isrosene / GN2	
15	IPI-SP704	Isrosene / GN2	
16	IPI-SP705	Isrosene / GN2	
17	IPI-SP706	Isrosene / GN2	
18	IPI-SP602	GHe	
19	IPI-SP603	GHe	
20	IPI-SP604	GHe	
21	ILI-001B	Isrosene / GN2	0-1 bar Static Pressure: 50 bar(a)
22	ILI-004B	Isrosene / GN2	
23	ILI-001A	Isrosene / GN2	
24	IDI-SP001	Isrosene / GN2	
25	IDI-SP101	LOx	
26	ILI-002B	Isrosene / GN2	0-5 bar Static Pressure: 50 bar(a)
27	IDI-SP002	Isrosene / GN2	
28	IDI-SP102	LOx	
29	IDI-SP103	LOx	
30	IDI-SP104	LOx	
31	IVPI-SP001	Isrosene / GN2	0-2 bar(a)
32	IVPI-SP002	Isrosene / GN2	
33	IVPI-SP101	LOx	
34	IVPI-SP102	LOx	
35	IVPI-SP103	LOx	

**ANNEXURE-VI**

**MEMORANDUM OF UNDERTAKING**

I / We hereby submit the quotation for the execution, to the President of India of the work specified in the underwritten memorandum within the time specified in such memorandum at a total price as specified and in all respects in accordance with the specifications, design, drawings and instructions in writing referred to in this document and with such materials as provided for by and in all other respects in accordance with such conditions as are applicable.

Should this tender be accepted in whole or in part, I / We hereby agree to abide by and fulfil all the terms and provisions contained in the tender enquiry documents which have been read by me / read and explained to me so far as applicable or in default thereof to forfeit and pay to the President of India or his successors in office the sum of money mentioned in the said conditions.

I / We agree to execute all the works referred to in the tender enquiry documents upon the terms and conditions contained or referred to therein and to carry out such deviation / variation as may be ordered in excess of original scope at the rates to be determined in accordance with the provision contained in this document.

**Witness**

**Bidder**

**(Signature)**

**(Signature)**

**Name:**

**Name:**

**Designation:**

**Designation:**

**Address:**

**Address:**

**ANNEXURE-VII**

**PREFERRED MAKES**

The items given below shall be exclusively be of the make/s given against them. Decision of any deviation from this will be under the sole discretion of the Department and it shall be binding to the bidder.

<b>Sl. No.</b>	<b>Item</b>	<b>Make/s</b>
1.	Pressure Transmitters and manifolds	<ul style="list-style-type: none"> <li>▪ Rosemount</li> <li>▪ Honeywell</li> </ul>
2.	Temperature Transmitters	<ul style="list-style-type: none"> <li>▪ SMAR</li> <li>▪ Rosemount</li> </ul>
3.	Flow Preamplifiers and Flow Signal Converters	<ul style="list-style-type: none"> <li>▪ Flowmetrics</li> <li>▪ Sensia (Cameron)</li> </ul>
4.	Solenoid Operated Valves	<ul style="list-style-type: none"> <li>▪ Rotex</li> <li>▪ Asco</li> <li>▪ Parker</li> <li>▪ Joyner</li> </ul>
5.	Supply of Pressure Switches	<ul style="list-style-type: none"> <li>▪ Wika</li> <li>▪ Honeywell</li> <li>▪ Omega</li> </ul>
6.	Smart Valve Positioners	<ul style="list-style-type: none"> <li>▪ ABB</li> <li>▪ Siemens</li> </ul>
7.	PVC cables	<ul style="list-style-type: none"> <li>▪ Thermo Cabs</li> <li>▪ Delton Cables</li> <li>▪ Advance Cable</li> <li>▪ Techno Cables</li> </ul>
8.	CAT6 cables	<ul style="list-style-type: none"> <li>▪ Belden</li> <li>▪ AMP</li> <li>▪ D-Link</li> </ul>
9.	Junction Boxes and Cable Glands	<ul style="list-style-type: none"> <li>▪ Baliga Lighting Equipments</li> <li>▪ Flame Proof Equipments</li> <li>▪ FCG Power Industries</li> <li>▪ Ex-Protecta</li> <li>▪ CEAG Flame Proof Control Gears</li> </ul>
10.	Terminal Lugs	<ul style="list-style-type: none"> <li>▪ Phoenix Contacts</li> <li>▪ Wago</li> <li>▪ Weidmuller</li> </ul>
11.	SS Tube Fittings	<ul style="list-style-type: none"> <li>▪ Swagelok</li> <li>▪ Hamlet</li> <li>▪ Parker</li> </ul>