GAIL INDIA LIMITED

ARC TENDER FOR PROCUREMENT OF METERING SKIDS FOR LAST MILE CONNECTIVITY

VOLUME I OF II (TECHNICAL)
BID DOCUMENT FOR PROCUREMENT OF METERING SKIDS
(BID DOCUMENT NO - 034/LEPL/GAIL/012-R0)
E-TENDER REF: 8000015765
OPEN DOMESTIC COMPETITIVE BIDDING

Lyons Engineering Pvt. Ltd.

PMC:	DOCUMENT INDEX PROCUREMENT OF METERING SKIDS ON ANNUAL RATE CONTRACT BASIS	Doc No. GAIL-ENG-GN-DOC-DL-001 Rev. 0	CLIENT:
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Sr. No.	Description	Document / Drawing No.	Rev. No.
4	List of Vendor for Bought - Out Items	GAIL-STD-GN-DOC-GEN-004	
5	Special Instructions to Bidder	GAIL-STD-GN-DOC-GEN-005	
6	Checklist for Technical Evaluation	GAIL-STD-GN-DOC-GEN-006	
7	Typical FAT Manual / Procedure	GAIL-STD-GN-DOC-GEN-007	
8	Detailed Specification for GPRS GATEWAY/CELLULAR GATEWAY	GAIL-STD-GN-DOC-GEN-008	
9	During FAT (List of Items in the Skid)	GAIL-STD-GN-DOC-GEN-009	
10	Attachment -1 for Flow Computer (FC)	-	

GAIL INDIA LIMITED

SCOPE OF WORK

GAIL-RFP-GN-DOC-SW-001

0	20.01.2020	Issued for RFP	SR	TR	SB	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

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1.0 OVERALL JOB REQUIREMENT:

1.1 This Bid document for Rate contract for procurement of natural gas custody transfer metering skids and Pressure Reduction skids, describes in detail the scope of work, scope of supply and responsibilities of bidder. In this Rate contract, 3 different SOR items (for various types of skids with dry gas filtration) have been envisaged. Metering skids (USM Flow meter, RPD Flow meter & Turbine Flow meter based Metering skids) are envisaged for SOR item nos. 1 to 3.

1.2 For SOR Item No.1, scope of work & supply includes design, engineering, manufacturing, fabrication, procurement of bought out items / components, Testing and inspection, assembly at shop, integration, internal testing, wet flow calibration, packaging, shipping, documentation and Supervision for Installation & commissioning of metering skids consisting of dry gas filtration(1w+1s), 4 stream PRS [2 stream 1w+1s of 100% capacity & 2 stream 1w+1s 10% capacity] and 4 stream metering system with combination of USM with GC and RPD (G-100) meter with Solar Panel, Battery with Charger unit, FCV (in 10% stream) and 3 Nos. LEL Detector along with filed and control room mounted flow computer.

1.3 For SOR Items No.2, Scope of work & supply includes design, engineering, manufacturing, fabrication, procurement of bought out items / components, Testing and inspection, assembly at shop, integration, internal testing, wet flow calibration, packaging, shipping, documentation and Supervision for Installation & commissioning of metering skids consisting of dry gas filter (1w+1s), 2 stream PRS, RPD(G-100) metering and 1 No. LEL Detector along with connection to flow computer for providing the signal.

1.4 For SOR Item No.3, scope of work & supply includes design, engineering, manufacturing, fabrication, procurement of bought out items / components, Testing and inspection, assembly at shop, integration, internal testing, wet flow calibration, packaging, shipping, documentation and Supervision for Installation & commissioning of metering skids consisting of dry gas filtration(1w+1s), 4 stream PRS [2 stream 1w+1s of 100% capacity & 2 stream 1w+1s 10% capacity] and 4 stream metering system with combination of Turbine(G-400) and RPD(G-40/65) of (1w+1s) each with FCV(in 10% stream) and 3 Nos. LEL Detector along with connection to flow computer for providing the signal.

1.5 The requirement of skids shown in typical P&ID, line diagram shall be read in conjunction with the tender specifications. Bidder to supply required skid item/ components as per tender specification, data sheets, typical P&ID and other requirement mentioned in bid document.

The Required Flow capacity, inlet/ outlet size and rating of skid, Size/ G-Rating of meter, skid pressure rating and type of panel/ flow computer in the Metering Skid (Consisting of filtration, Pressure reduction system and Metering system) and PRS skid (Consisting of Filtration and Pressure reduction system with associated valves, pipes and fittings) is as per following Table-A :

TABLE-A

SOR Item No.	Details of Metering / Pressure reduction Skids	Skid Pressure class rating Inlet / Outlet	Flow Meter Size & G-Rating	Type of Panel/ Flow computer *
1.	1.2 MMSCMD capacity USM metering skid with GC, Control panel and FCV, dry gas filtration(1w+1s), 4 stream PRS and 4 stream metering system with combination of USM and 0.072 MMSCMD capacity RPD metering (G-100), 3" with Solar Panel, Battery with Charger unit, FCV and 3 Nos. LEL Detector.	Inlet Pressure: 45 to 92 Kg/cm2, Outlet Pressure: 19 to 49 Kg/cm2 ,	USM & RPD(G-100)	Field and Control room mounted flow computer & Control panel mounted LEL Monitor
2.	0.072 MMSCMD capacity metering skid with dry gas filtration (1w+1s), 2 stream PRS and 2 stream RPD metering System with RPD G-100, 3" and 1 No. LEL Detector along with connection to flow computer for providing the signal.	Inlet Pressure: 25 to 92 Kg/cm2, Outlet Pressure: 15 to 49 Kg/cm2 ,	RPD, G-100,	Field mounted flow computer.
3.	13000 SCMH capacity metering skid with dry gas filtration (1w+1s), 4 stream PRS stream [2 stream 1w+1s of 100% capacity & 2 stream 1w+1s 10% capacity] and 4 stream metering system with combination of turbine (G-400) and RPD (G-40/65) metering system of 1w+1s each, with FCV (in 10% stream) and 3 Nos. LEL Detector along with connection to flow computer for providing the signal.	Inlet Pressure: 50 to 92 kg/cm2, Outlet Pressure: 20 to 49 kg/cm2)	Turbine (G-400) and RPD (G-40/65)	Field mounted flow computer.

Bidder to note the following:

- The design flow capacity of skids indicated above is based on the minimum pressure parameters. Skid inlet size mentioned above is the minimum size of mainline equipment/ nozzle size up to PRS inlet header (including isolation Valves). Whereas Skid outlet size mentioned above is the minimum size of mainline equipment at downstream of PRS, PRS outlet header (including isolation Valves), Flow Meter, FCV, skid outlet valves etc.
- Metering skid shall be supplied with 2 sets (1 working + 1 standby) of solar powered field mounted flow computers with Solar panel, battery with charger. The supplied field mounted flow computers shall be used for Full capacity.
- Metering skid shall be supplied double tier. Bidder shall be envisaged all requirement accordingly.

1.2 Design Capacity of individual skid components :

Design capacity of Pressure reduction and Metering system (1 operating + 1 standby) shall be 100% of Max (rated) capacity of skid mentioned in tender.

In addition to Full Capacity PRS system, dual stream (2-Stream) PRS of 10% capacity is also required.

Separate pipes, valves, drain and vent connection is also required for each stream of lower (10%) capacity PRS system for these SOR items.

Design capacity of Filtration section and requirement of Lower capacity PRS (in addition to full capacity PRS) in the Skids envisaged in this tender shall be as per following Table-B:

TABLE- B

SOR Item No.	Design Flow Capacity of Dry Gas Filtration (for sizing)	Additional Requirement of Lower (10%) capacity of dual/ redundant PRS & Metering (in addition to Full capacity PRS & Metering)
1	125% of 1.2 MMSCMD flow capacity for USM and 125% of 0.072 MMSCMD flow capacity	Additional PRS of Lower (10%) capacity is also required.
2	125% of 0.072 MMSCMD flow capacity	Not required
3	125% of 13000 SCMH flow capacity.	Additional PRS of Lower (10%) capacity is also required.

Description and requirements contained in this specification are concise by necessity and cannot include all the details. However, it is the responsibility of the bidder to execute the job on a turnkey basis in accordance with the specifications and internationally recognized good engineering practices.

Any activity specifically not listed in this document, does not absolve the bidder of their responsibility to include such activities in their scope of work and supply, which otherwise is necessary, to complete instrumentation work for the project. All such activities shall be carried out by the bidder without any cost/ time implication.

1.3 In the event of any conflict between these specifications, related standards and codes, any other attachment to this package, the bidder shall follow the following documents in the order of their priority:

a) Job Specifications, Scope of supply and work.
b) Data Sheets.
c) Typical Piping & Instrumentation Diagram (P&ID).
d) Standard specifications and standards

In case of any conflict in various documents, same shall be referred to GAIL for clarification. **Most stringent one shall apply in case of conflict on various parts of bid documents/ tender**. **In such cases, bidder shall not proceed without getting written approval / clarification from GAIL.**

2.0 SCOPE OF WORK, SUPPLY & RESPONSIBILITY OF BIDDER

Bidder shall be responsible for execution of the skid package on turnkey basis with complete scope of work as listed below but not limited to the following:-

i. Design and Engineering.
ii. Sizing calculation, verification of size to suit technical requirement.
iii. Preparation of documents, drawings and co-ordination for approval of documents by GAIL.
iv. Ordering, Procurement and co-ordination for supply of bought out item.

v. Inspection of bought out items, skid components.
vi. Fabrication, mounting, installation in skid, in-process Inspection, Factory testing and Acceptance.
vii. Transportation, Transit Insurance, loading and unloading of material at GAIL site/ stores.
viii. Supervision for Installation, field calibration/ testing and commissioning of skid.
ix. Compliance of Checklist points during FAT, Site, stores (if any).

x. Rectification of any damage (if any) occurred during transportation/ unloading/ observed on receipt of material at site.

xi. General scope of work, scope of supply and responsibility of bidder as per tender document

Civil work, preparation of skid foundation, cable laying from field to control room is excluded from bidder's scope of work/ bidder's responsibility.

2.1.1 **Design and Engineering:**

(a) GAIL shall provide typical Piping & Instrumentation diagram and process data sheets with this bid package. The bidder shall be responsible to carryout the design and detailed engineering based on the data provided in the bid package and in line with other technical requirements specified elsewhere in the tender document. Scope shall also include sizing and sizing verification for all items including where data is dependent upon detailed engineering, detailing of basic engineering design, preparation of data sheets, coordination drawings for instruments and system oriented items, engineering drawings etc. During detailed Engineering, the general arrangement of skid shall be suitably prepared/ designed to accommodate the skid in the existing plot location of the respective consumer terminal/ site to the extent possible. It is the responsibility of bidder to verify the sizes of each and every skid component and provide details of the same, which shall be supported by the basis of size selection/ sizing calculation.

(b) Single Breakout flanges shall be provided at Inlet and Outlet headers of Filtration, PRS and Metering section so as to join them with other parts as per General Arrangement/ skid configuration. The break out flanges shall be provided at the centerline of Filtration, PRS and Metering section so as to join the same with centerline of other section as per GAD/ requirement at site. The PRS/ Metering sections of lower capacity shall be separated from full capacity PRS/ metering section by flange joint and additional isolation ball valve of required size shall be provided to remove these PRS / Metering for their utilization elsewhere.

(c) Residual Engineering

The bidder shall be responsible for carrying out any residual basic engineering necessary for proceeding with detailed engineering like equipment/ instrument sizing, utility consumption, specifying derived data in process data sheets, type and material selection of instruments/ equipment wherever required.

For Turbine meters, the upstream & downstream meter runs shall be honed and the maximum roughness of meter tube should not exceed 250 RA micro-inch. Turbine meters, shall be wet calibrated (at average operating pressure) as per operating conditions along with supplied flow conditioner/ straightener. Calibration report must mention the details of turbine meter & flow conditioner/ straightener used during calibration.

Meter run and flow conditioner is not required for RPD metering system. However restriction orifice should be considered in the RPM metering.

(d) 2 nos. of GPRS modems shall be supplied for each metering skid and same modem shall be compatible for field and panel mounted flow computers.

Required cable (power supply to Panel, Signal from field instruments, cable required for RTU etc) shall be supplied by the bidder.

Communication with GAIL's RTU/ SCADA system is envisaged to ensure effective and reliable control, management and supervision of the consumers from centralized location. The SCADA system along with

RTUs shall be provided by M/s GAIL. Configuration shall be done such that all the data through various flow computer is available in RTU/SCADA using port available in RTU (Ethernet, RS 232 or 485). Mode of communication with Flow computers shall be decided during detailed engineering and the bidder shall provide required hardware for connectivity through any type of RTU port (Ethernet, RS232 or 485). For this purpose at least one no. of Ethernet port shall be provided in each flow computer, the rest of the ports can be RS 232/ 485 (user selectable). However the bidder shall be responsible for configuring their systems and providing all the necessary details of their systems to the RTU/SCADA vendor. Wiring from Flow computers to a separate terminal in control panel is envisaged for RTU/ SCADA communication. Gas Data and FCV set point is also to be remotely sent to Flow computers through GPRS Modem.

(e) Engineering Drawings & Documents:

i) Bidder Data Requirements attached in (doc. No. GAIL-STD-GN-DOC-GEN-002) indicate the list of drawings and documents required to be supplied by the bidder, as a minimum. Bidder to note that list specifies only the major deliverables. Documents and drawings not listed but necessary for proper engineering, construction, operation and maintenance shall also be prepared by the bidder.

ii) Bidder shall be responsible for preparation of all engineering drawings and documents including those necessary for construction like instrument index, tray layouts, location plans, cable schedules, installation standards, bill of material etc.

iii) Bidder shall also be responsible for providing all drawings and documents for package/ sub package units.

iv) It is expected that bidder utilizes uniform data sheet formats enclosed along with this document, for preparing specifications for various instruments, including those, which are being prepared by package/ sub package vendors. Items for which no format has been attached with the document, bidder may use standard ISA formats. Use of manufacturer standard formats shall be avoided. Duly filled in and signed/ stamped Data sheets of all equipments/ instrument (as per GAIL's Format provided in tender) shall be provided. Only one data sheet per equipments/ instrument shall be submitted by the bidder. In case the Data Sheet of bidder's bought out items has been filled by the respective OEMs/supplier the data sheet has to be countersigned by the bidder.

v) The bidder shall supply all the documents in hard copy and soft form/ magnetic media. This includes all the documentation including those for package units.

(f) The bidder's design and engineering work shall also include review of post-order vendor drawings and documents for all instruments and system oriented items. Following methodology must be followed for drawings and documents being forwarded to GAIL.

i) The Bidder shall thoroughly review and approve vendor drawings for all instruments, equipments including sub-package items, before forwarding to GAIL. Only the original drawings/ documents duly verified, signed and stamped by bidder's authorized and competent representative/ engineer shall be forwarded for approval/ review by GAIL.

ii) The Bidder shall be responsible for all System Engineering documents for the Gas metering systems. This shall include all related documents such Functional design specifications, sizing calculations, pressure drop calculation, mechanical load calculation, stress analysis/ calculation, electrical power requirement calculation etc. and Engineering documents such as power / load calculation, functional loop schematics, instrument details and cable schedule, Power supply distribution schemes etc. These documents shall be reviewed and approved by Bidder based on philosophy specified / agreed for the engineering before forwarding to GAIL.

iii) All multidisciplinary fabrication and construction drawings shall be reviewed and signed by bidder's respective departmental representatives before forwarding to GAIL for review/ approval/ record.

(g) Bidder shall be fully responsible for co-coordinating with all agencies concerned to ensure proper, uniform and smooth engineering. This shall include coordination with:

i) All individual item suppliers for uniformity in engineering and documentation supplied by them including P&ID's, instrument specifications, installation standards etc. and obtaining all requisite drawing and documents for review, record and final documentation.

ii) All instrument item suppliers including suppliers/ manufacturers of various system oriented items.

iii) Bidder's own inter-departmental coordination with departments like instrumentation, mechanical, piping,

electrical, QC, pressure vessel etc. This shall include furnishing all necessary engineering data in the form of drawings & documents and review of drawings & data supplied by other departments.

(h) Bidder shall be responsible for preparation of all As-Built drawing / documents including

i) P&IDs, Foundation details, Layout and GADs

ii) Sizing and load calculation and selection of equipment/ Material

iii) All Datasheets, specifications of instruments

iii) All System documents including hardware and software documentation.

2.1.2 Procurement, Supply, Factory Testing and Acceptance

a) Engineering for procurement shall include preparation of various material requisitions which shall include process data sheets, typical data sheets for instruments, instrument standard specifications, special requirements etc., evaluation of offers received from various manufacturers/ vendors, preparation of Technical Bid Analysis, preparation of purchase requisition and review/ approval of vendor drawings, incorporation of GAIL comments.

b) All Instrument items and Gas metering systems shall be procured from vendor list attached elsewhere in this package. Bidder must desist from procuring any items from vendors not approved by GAIL. Along with the bid, the bidder has to provide the list of items/ equipments with size, Make and Model Number selected form the approved vendor list only. Non-compliance to this may result into rejection of bid.

c) Bidder shall prepare purchase requisitions for all instruments/ systems which shall consist of a consolidated purchase document including all purchase specifications including data sheets, special instructions/ requirements (if any), standard specifications/ purchase specifications, testing requirements, quality requirements etc. All purchase requisitions shall be furnished to GAIL for information/ review/ approval as applicable.

d) Testing & calibration of all instruments and Factory Acceptance Test (FAT), arrangement for final pre-dispatch inspection shall be carried out by the bidder. For any instrument/ equipment, if required, Range/ calibration span, set points, reports etc shall be modified by the bidder during FAT and commissioning as per GAIL's requirement. GAIL/ its representative shall witness testing of any or all items at various stages during manufacture and/or at final stage before shipment at their discretion. Testing shall be carried out as per approved procedures. No instrument shall leave manufacturer's works without successful factory acceptance test. All necessary changes shall be incorporated/ implemented as suggested by GAIL during FAT etc. to meet tender requirement without any cost to GAIL. As build drawing/ final documentation shall be submitted by the bidder, which shall contain all such changes.

2.1.3 Installation, Field Calibration, Testing and Commissioning

a) Installation in the metering skids/ System

i) All the components specified elsewhere shall be installed in the skid and the same shall be witnessed during FAT. For transportation of skid, some of the component / part may be dismantled and sent loose for easy installation at site. Bidder shall carryout installation of all instruments/ components/ equipments in the skid as mentioned in Installation requirement given elsewhere. Installation shall include but not limited to installation of all field instruments, installation skid assemblies explained in this package, installation of junction boxes, interconnection between instruments and junction boxes, fabrication, laying and painting of cable trays, laying of all single pair and multi pair cables inside the skid, JB earthing / grounding, Field Instruments/ signal earthing / Grounding, tagging, ferruling, cable glanding and pair/ core identification of all field cables.

ii) Distribution of power to various instruments in the skid. Separate JB is required for different type of signals and also for power to field instruments.

iii) Installation shall be carried out as per GAIL standards or as recommended in the tender. For special instruments, the installation may be carried out as per vendor/ manufacturer's recommendations however all such installation standards shall be subject to GAIL's review.

b) Bidder shall quote for man day rates as per Scope defined in bid document for installation supervision and commissioning of the complete skid(s). The quoted man-day rates for installation supervision and commissioning shall be valid for **36 months** from the date of delivery of material against placement of individual purchase order under ARC. Bidder shall depute only qualified and competent person for installation supervision / commissioning of skid.

c) Testing & Calibration

Bidder scope of work includes testing of all items and systems including control panel, its accessories, all instruments, equipments, Valves, instrument cables, impulse lines, pneumatic signal tubes and special instruments/ items if any. Bidder shall also carryout testing and calibration of all equipments, instruments / gas metering system as per the requirements specified in section 6.0 of this document and as mentioned elsewhere in the tender document.

d) Commissioning

It is the responsibility of Bidder to co-ordinate and make available the services of vendors/ sub-vendors for gas metering skid/system package, control system, control / solar panel etc. and other special instruments/ equipments like, Gas flow meters, Flow computers, Pressure regulators/ SSV, during FAT, installation at site, testing, startup/ commissioning of the station. The bidder shall provide assistance to GAIL during pre-commissioning/ commissioning without any condition or pre-requisite. Installation of all the loose supplied items, its interconnection etc (except skid erection, construction of earth pit, cable laying, termination of cable, cable tray laying beyond skid) shall be in the scope of bidder. In case of any dispute / conflict arising due to difference in opinion/ interpretation, the interpretation of GAIL/ its representative shall be considered final.

2.1.4 Scope of work - General

The Vendor's scope of work shall also include the following.

a) Inspection and testing of all skid components, sub-assemblies and complete assemblies of all items manufactured at Vendor's works, and other sub-vendor's works in accordance with approved QA/ QC procedure; Shop assembly and hydro-test; Factory Acceptance Test (FAT) for the complete package at VENDOR's works as per approved FAT procedure, Supervision of Installation, start-up and commissioning of the complete package at site; Preparation for shipment, packing and delivery of all packages, equipment and material to site; Preparation and submission of all documents as per requisition with the bid and after award of contract; Preparation and submission of Final Documentation / Completion files as per this specification [Two copy (hard copy and soft copy) of documentation shall be submitted along with the complete system at stores / site for each skid separately].

b) Any work not specifically mentioned but otherwise required, as per statutory rules / codes and standards/ specifications and/or for the completion and operation of equipment to the entire satisfaction of GAIL have to be done by the VENDOR without any additional commercial implications.

i) The scope of work also includes the mechanical and structural detailed design of the skid, procurement of materials, preparation of fabrication drawings, detailing of internals, fabrication, inspection and testing of the piping and structural items at fabrication shop, painting, internal coating if any, preservation, transportation and undertaking Guarantee for the equipment.

ii) The VENDOR shall assume single point responsibility for all aspects of the work. This shall include timely completion, liaison with CONTRACTOR, liaison with VENDOR of specified items, co-ordination of the work, quality and guarantee for the equipment.

iii) Where parts of the package are subcontracted and purchased by the VENDOR, these become part of the VENDOR's package and it is the VENDOR's responsibility to ensure that the complete package complies with the specifications, codes and standards and statutory regulations.

iv) The VENDOR shall be responsible for obtaining necessary approvals, authorization and certification from local Government / Local Statutory bodies, Authorized Inspector and Third Party Inspection Agency as applicable.

v) The equipment shall be suitable for the area classification and site conditions specified. All components/ consumables used shall be new and of current manufacture.

vi) Vendor shall take single point responsibility for the engineering, design, certification, procurement, inspection, testing, supply & performance of the Gas Pressure Reducing and custody Metering System skids along with all instruments, equipment and valves of the skids and control panel/ solar panel based on the data sheets and the specifications furnished and taking into consideration successful operation, safety and the established International standards for the complete skids. As a part of skid design & engineering, the following shall be undertaken/ decided/ furnished by vendor:

- Sizing calculation of filters, flow meters, self-actuated Pressure control valves (Regulator), Safety Shut Off (Slam Shut) valves, Pressure relief valves and Flow control valve. (The sizing calculation for each equipment/ instrument shall be submitted by bidder along-with bid).
- Calculation of Pressure drop across entire skid and also pressure drop across individual components (of metering skid) like filters, flow meters with flow straightener, Self actuated Pressure control valves (Regulator), Safety Shut Off (Slam Shut) valves and Flow control valve. (Overall Pressure drop across entire skid and pressure drop calculation for each component shall be provided by bidder along-with the bid).
- Pressure Set points/ range for Pressure Regulators and slam shut valves.
- Instrument ranges to meet the Process operating and design conditions
- Noise calculations for Regulator / flow control valves. Vendor to provide detailed Noise calculation and standard used and any assumption considered (calculation is to be provided for each PCV along-with the bid).
- Typical instrument data sheets indicate materials for body, internals etc. However, this does not absolve the Vendor of the responsibility for proper selection with respect to the fluid and its operating and design conditions. Proper sizing and selection of the pipe, instruments and equipments and accessories are vendor's responsibility.

2.2 SCOPE OF SUPPLY

2.2.1 SCOPE OF SUPPLY (GENERAL):

In general, the scope of supply shall include (as per P&ID) but not limited to the following as a minimum:

a) Supply of skid mounted Custody transfer Gas metering system package (inclusive of Gas filtration, Pressure

let down skid & Gas metering system) and Pressure Reduction Skid (inclusive of Gas filtration and Pressure

b) let down system) complete in all respect as per Typical P&ID, Process data sheets & as described in Job specification for Gas metering system package.

c) Supply and installation (inside skid) of all applicable field instruments such as Pressure Transmitters, Differential pressure transmitters, pressure gauges, temperature gauge, DPG, Temperature Transmitters &

d) RTDs, Pressure Control valves, Slam shut valves Pressure relief valves, FCV, Flow computer, etc. Supply of Control panel, Flow computers, Gas monitors/ controllers, (installed in control panel), as applicable.

e) The gas custody transfer metering system as a minimum shall consist of all the applicable complete items required for metering skid including Filtration, Pressure reduction system, flow meters, Flow Control Valves, Stream Flow Computers (and its accessories), Printers (if applicable), safety valves / creep relief valves etc. along with skid mounted field instruments/ equipments (such as pressure gauges, Temperature gauges, Pressure & diff. Pressure transmitters, PG, DPGs, Temperature transmitters, temperature elements (RTDs) & thermo wells, limit switches for slam shut valves/ ball valves), batteries(where ever required), Control panel/ Solar panel (with its accessories), complete integrated field instruments, piping and valves (Ball, Globe, plug, check etc), pipe and fittings as shown on the Typical P&ID or specified in the tender specifications/ documents.

The scope of supply includes all instruments/ equipment such as SSV/ Ball valve status indication (in Flow Computers), flow control, other hardware like signal converter, barriers, relays, cables, connecters, power supply, modem etc. to ensure completeness of metering system is in the scope of bidder. Supply/ installation of Cable glands for connecting Field signal/ control cables, power cable is also in the scope of bidder.

f) Field mounted Flow computer, power supply, signal converters/ isolators, power source, hub, GPRS Modem, hardware required to establish various serial link / connectivity with different instruments/ items (like Flow Computers, Laptop, Printers, SCADA/ RTU etc) mentioned elsewhere. For field mounted flow computers, the Flow computers and all other accessories for Metering system shall be installed in field with power supplied through field mounted battery backed Solar panel. For all the metering skids, GPRS Modem (2 Nos.) shall be supplied for Communication with remote station. Additionally provision should exist for communication with GAIL's RTU/ SCADA. Flow computer with inbuilt PID controller for flow control valve is also acceptable. GPRS Modem shall be supplied/ installed with all mounting accessories with signal cable, communication Cable, power cable etc. (all installed in skid/ part thereof, as per good Engineering Practice).

Control panel with receiver instruments & accessories such as, indicating LED lamps, required intrinsic safety barriers, isolators, printers & Metering panel with dual stream Flow computers, Printers and its accessories, Communicator for Field Instruments, signal converters, hub, GPRS Modem, hardware required to establish various serial link / connectivity with different instruments/ items (like Printers, SCADA/ RTU, FC etc) mentioned elsewhere. All hardware and software required for using diagnostic features of supplied instruments like Flow meters, Flow computers etc shall be provided by the bidder.

g) All types of cables for signal, RTD, alarm, control, power, communication, earthing cables (these cable to be used in field, skid and control / solar panel). Supply of all the materials including suitable cable glands for cable termination at both ends is in bidder's scope. Bidder shall also supply suitable power cable (for power supply to/ from panel, power distribution etc.) and also cables required for FC- Modem connectivity. All interconnection to/ from control panel/ solar panel/ wall mounted panel and power source shall be prefabricated type. All cables (including earthing cable), cable trays, earthing strips for grounding/ earthing of skid/ panel and wiring within the skid; (only approved, standard armoured cable shall be supplied). All Interconnecting cables between field Instrument & Junction boxes and from Junction box to metering panel/ control panel to be supplied by the bidder., For (SOR Item No.1) signal and control cables of 200 mtrs.(min.) shall be considered between metering skid and control room and according the same cables shall be provided by bidder.

h) Junction boxes and suitable cable glands (as per the requirement of area classification) for different types of

analog/ digital signals (such as intrinsically safe and non-intrinsically safe 4-20 mA dc), alarm, signal, control, , power, communication etc. should be supplied and mounted/ installed in metering skid. Preferably, all JBs shall be mounted in skid at height of 1 meter from ground/ finished floor level/ skid base frame and accessible / approachable from outside. JBs shall not to be installed inside Skid. Bidder's scope of supply/ work shall include earthing cable/ strips (as applicable) etc. (along with cable tray with supports for installation) in the skid/ JB/ panel, as per the requirements of various instruments.

i) All the software used in the laptop for SOR item No.1, licensed in the name of GAIL (I) Ltd.

i) A structural skid complete with necessary drip pan, walkways, staircase, platforms, gratings, handrails for access for operation and maintenance. Platforms & cross-over(s) / jump-over(s) to be provided for the operation and maintenance of the equipments/ instruments/ JBs installed in the skid. Proper spacing shall be maintained between the equipment(s) for ease of operation & maintenance. The vent & drains shall be properly supported in the skid. All the vents shall be at a height of minimum 3 meters above the working platforms and necessary earthings shall be provided for the same.

k) All pipes, tubing, fittings, valves, gaskets, bolts, nuts, spades, etc., within the skid battery limit. Inlet and Outlet matching flanges and Studs & nuts (for skid interconnection and Inlet & Outlet piping connection), suitable Gaskets shall also be supplied along-with the skid. All impulse piping, pipe fittings and valves, tubing, tube fittings, installation and erection materials such as cable tray and supports, foundation bolts of the skid, gaskets, companion flanges for inlet and outlet of the skid, all type of consumables and accessories for mounting of instruments, instrument supports, tray supports, canopies/ sunshields for all field mounted instruments.

l) Painting of pipes, equipments, instruments, JB, Panel, cabinet, enclosures, shed, platforms, jump-over/ crossovers, as required; in line with the painting specifications attached elsewhere in this document.

m) Galvanized iron/ copper earthing strip and earthing cables for earthing of all instrumentation items including junction boxes etc. to instrument earthing system. (Supply of earthing strip, earthing cable, perforated tray, angle tray, accessories required for cable laying is in bidders scope. For the purpose of supply of these items, distance of 10 meters shall be considered between skid and Earth pit). Making of earth pit and laying of earthing cable/ strips is not in bidder's scope.

m) Mandatory spares and commissioning spares (for each skids separately) as listed elsewhere in this document. Any special tools/ tackles, if required shall also be supplied by bidder.

n) Earth bonding system and earthing boss, Lifting lugs and spreader beam / frame, foundation Anchor bolts for the skid.

o) Copper jumpers for flanges for the skid, Stainless steel nameplate for each part/ section of skid, tagged equipment and component; All Tie-ins with flanged connections shall be in bidder's scope. (All flanges shall be connected through flexible jumpers of Minimum 3 mm thickness copper strips)

All Tie-ins (flanged connections) with metallic gasket, nuts and bolts.

p) Inlet and Outlet matching flanges, expander, Reducer and Studs & nuts shall also be supplied along-with the skid. Equalizing valves for main line Ball valve as mentioned in typical P&ID is required at skid inlet, inlet of filter streams, Inlet of PRS streams and Metering Inlet Ball valves and same is to be supplied.

q) As built drawing/ documentation including Operation and Maintenance manual for all skid components, instruments, equipments etc.

r) All the major items (as applicable) like valves (plug, globe & Ball), pressure control valves, Slam shut valves, flow meters, Flow computers, Flow Control valve, pressure relief valves, Pressure & diff. Pressure transmitters, Temperature instruments etc. shall be supplied from the vendor list attached elsewhere and the offered model of equipments shall have proven track record of successful operation for at least 6 months till bid submission date.

s) In case a single Pilot/ spring is not capable of meeting the pressure set point requirement, additional pilot and/or spring shall be provided along with the Pressure Regulators and Slam shut valves to meet required set point.

t) Status Indications required for Metering inlet Ball valves (mainline) and Slam Shut Valves, as indicated in typical P&ID shall be provided in flow computer and control panel (supplied with skid). Status indication of both SSV shall be available on both the Flow computers. Inlet Pressure and temperature shall be available on the both Flow computers.

u) Suitable Internal or external USB converter shall also be provided with flow computer (for each skid) for connecting it to USB port of Laptop for configuration. Suitable converter / hardware required for Laptops to read/ view FC data directly shall be supplied. (Suitable internal/ external converter shall be provided for Laptop connectivity through USB port).

v) All installation and erection materials such as impulse piping, pipe fittings and valves, tubing, tube fittings, cable tray and supports, foundation bolts of the skid, gaskets, companion flanges for inlet and outlet of the skid, all type of consumables and accessories for mounting of instruments, instrument supports, tray supports, canopies/ sunshields for all field mounted instruments.

w) Bidder shall provide certification that the overall accuracy, performance and repeatability as mentioned in the tender shall be met with the proposed installation-piping configuration (as per proposed P&ID and GAD) of the complete skid. (Vendor shall submit the Calculation for overall system uncertainty including all components of the metering system & calculation of total differential pressure across the skid shall be submitted).

x) The 3.1 Certification is applicable for those outside source Bidder's (whose both manufacturing unit and bidder are outside India) and 3.2 certification is applicable for those Bidders whose manufacturing units are in India.

y) For metering skids supplied with Control room mounted flow computer, if the Skids are sent in dismantled condition, on GAIL's request, integration job, field cabling job (field instrument to JB etc) shall be completed by vendor without any extra implication to GAIL.

2.2.2 Scope of Work & Supply (Project Specific):

Other than the general scope of supply mentioned above, bidder's scope of supply for all Metering skids / PRS skid shall also include following:

a. 2 sets of Solar Panel with its accessories, Battery, charger and 2 sets of Solar powered field mounted Flow computers is required for Metering Skids.

b. **Dry gas Filtration system:** All skids shall consist of dry gas filtration system with one operating and one standby redundancy. Each filtration stream shall be designed for capacity as mentioned elsewhere (Refer **Table-B**) and shall have inlet and Outlet ball valves. The Filtration system with filter shell diameter more than 10" shall be installed with QOEC with davit arm, However the filtration system with shell diameter 10" and below are acceptable with blind covers with davit arm.

c. For Filter Shell diameter of 8" or lower, Dry gas Filtration for natural gas of Vertical configuration is required.

d. **Pressure Reduction system**: Pressure regulators (Monitor and Active) shall be Self actuated pilot operated type and shall be supplied independently for both streams.

Each PRS stream shall have inlet and Outlet ball valves. Suitable bypass arrangement for Inlet ball valve shall be provided as per tender requirement.

LTCS of all material shall be considered at downstream of Pressure regulator including PCV (Active and Monitor).

g) **Metering system:** For SOR Item Nos. 1, Gas metering system comprising of redundant 4 metering streams of USM and RPD flow meters (1 operating + 1 stand by streams philosphy), field mounted Flow computers, Solar panels, and battery (one with each streams) shall be provided for RPD Meter and control room mounted Flow computer for USM Meter with all interface accessories. Each metering stream shall be designed for 100% of max flow capacity as mentioned elsewhere. Each stream of Metering system shall have inlet and Outlet ball valves. Suitable bypass arrangement for Inlet ball valve to be provided as per tender requirement. 3 LEL with control room monitoring. ***2 No. of flow metering signals shall be configured in each flow computer.***

h) **Metering system :** For SOR Item Nos. 2, Gas metering system comprising of redundant 2 metering streams of RPD flow meters (1 operating + 1 stand by streams philosphy), field mounted Flow computers,1 LEL (Local indication in flow computer) Solar panels, and battery (one with each streams) shall be provided for RPD Meter with all interface accessories. The metering stream shall be designed for 100% of max flow capacity as mentioned elsewhere. Each stream of Metering system shall have inlet and Outlet ball valves. Suitable bypass arrangement for Inlet ball valve to be provided as per tender requirement.

i) **Metering system :** For SOR Item Nos. 3, Gas metering system comprising of redundant 4 metering streams of Turbine and RPD flow meters (1 operating + 1 stand by streams philosphy), field mounted Flow computers, Solar panels, and battery (one with each streams) shall be provided with all interface accessories with 19 tube bundle flow conditioner/ straightner with each meter run for turbine flow meter, 2 nos. of field mounted Flow computers (one with each streams), Solar panel, battery shall be provided with all interface accessories. Each metering stream shall be designed for 100% of max flow capacity as mentioned elsewhere. 1 LEL (Local indication in flow computer). Each stream of Metering system shall have inlet and Outlet ball valves. Suitable bypass arrangement for Inlet ball valve to be provided as per tender requirement. ***2 No. of flow metering signals shall be configured in each flow computer.***

j) Each PRS stream in the skid shall have inlet and Outlet ball valves. Suitable bypass arrangement for Inlet ball valve to be provided as per tender requirement. Also PGs to be installed After Monitor and Active Regulator in all streams).

k) Gas filtration system consisting of two (2) stream of dry gas filters (1 operating + 1 standby stream), each designed as tabulated above rated flow capacity of skid(s). Dry gas filtration system shall be used to remove dust particles of atleast 3 micron and to remove condensate if any. Fire case Pressure safety Valves (PSV) shall also be provided on each filter. Filter cover shall have arrangement of Davit arm for ease of maintenance.

l) The maximum permitted velocity through flow meter shall be 20 meter per sec.

m) The Gas Flow Meter shall be certified for custody transfer application by a certifying agency equivalent to Nmi/ PTB/ NPL. For Turbine based skids, Meter run (10 D upstream and 5 D downstream) and Flow straightener is envisaged.

n) Pressure Reduction system consisting of two streams of pilot operated Slam shut valve and Pressure Regulators (1 operating + 1 standby stream) shall be designed. Each stream to contain two regulators (Active, monitor), it means, if one regulator fails the other one will maintain desired output parameters. Under normal conditions, the downstream regulator is considered as active regulator and upstream regulator performs the monitoring function. Active regulator shall be “fail to open” and monitor regulator shall be “fail to close” type. Vendor shall confirm that the noise level for PCV / Regulator (Active & Monitor) is within 85 dBA. In case, noise level is ≥ 85 dBA, Vendor shall provide noise treatment to limit the noise level and include silencers or expanders as required in the scope of supply. Set Point of the PCV Pilots and Slam Shut Valves

shall be adjustable. Vendor shall furnish the adjustable range of the offered pilots and slam shut valves. The design/construction of the Pressure Regulator shall be such that there will be no continuous gas bleeding.

o) Skid mounted field instruments like Pressure & Diff. Pressure gauges, Temperature gauges, Pressure Transmitters, Temperature elements & Thermo wells, limit switches for slam shut valves shall be supplied along-with the skid.

p) The metering stream (flow meter, flow straightener impulse tubing of Pressure transmitter, thermo-well) shall be completely insulated to ensure an even heat transfer throughout the meter run when subjected to ambient environment.

q) The custody transfer equipment at field like transmitters (pressure & temperature) shall be installed in an environmental enclosure to minimize the effects of ambient temperature variations and shall be lockable for prevention of unauthorized data entry.

r) Bidder shall submit the Battery sizing calculation, details of battery (make, model, rating), Product Technical Literature along with offer. The Rating, make and other necessary details in support of selected model for Battery shall also be submitted along with offer. The power consumption of Flow Computer, Modem, PT (low power consumption) and other associated utilities of online system shall be considered for Backup calculation and finalisation of sizing of Battery.

s) Internal / external USB converter shall also be provided with each Flow Computer for assessing/ connecting for configuration through Laptop PC through the USB port of the respective FC.

t) Supply and installation of all tubing, instrument fittings, pipes, pipe fittings, other fittings, valves, gaskets, bolts, nuts, spades, etc, within the skid and its battery limit are in bidder's scope.

u) Supply and installation of all required cables (including earthing cable), cable trays, earthing strips for grounding/ earthing of skid and wiring within the skid. All Interconnecting cables between Skid, Instrument / Junction boxes. Bidder to supply required mounting accessories for Cabling, glanding, tray work etc.

v) Supply and installation of Junction boxes (as per the requirement of hazardous area classification) for power, signal, alarm, instrument and control cables with suitable cable glands (if applicable) are in bidder's scope.

w) Structural skid complete with necessary drip pan, walkways, staircase, platforms, crossover, gratings, handrails for access for operation and maintenance are in bidder's scope. Details of skid assembly, supporting positions, Anchor bolt layout and equipment weights to be provided prior to equipment supply.

x) Lifting lugs and spreader beam / frame, foundation Anchor bolts, copper jumpers for flanges for the skid, Stainless steel nameplate for each tagged equipment and component; All Tie-ins with flanged connections shall be in bidder's scope. Earth bonding system and earthing boss for skid are in bidder's scope. Inlet and Outlet matching flanges and Studs & nuts (for skid interconnection and Inlet & Outlet piping connection), suitable Gaskets shall also be supplied along-with each skid).

Vendor shall take single point responsibility for the engineering, design, certification, procurement, inspection, testing, supply & performance of the Gas Pressure Reducing and custody transfer metering skids along with all instruments, equipment and valves offered/ supplied in the skids based on the data sheets and the specifications furnished, taking into consideration successful operation, safety and established International standards for the complete skids. As a part of skid design & engineering, the following shall be undertaken/ decided/ furnished by bidder:

1) **Calibration of 300# rating RPD flow Meters** considering mentioned overall accuracy/uncertainty. It shall be wet calibrated at 7 different points on average operating pressure. RPD Meter shall be calibrated at flow

rates of 0.025 Qmax, 0.05 Qmax, 0.1 Qmax, 0.25 Qmax, 0.5 Qmax, 0.75 Qmax, and Qmax, subject to minimum flow rate of 1 M3/Hr.

2) Wet calibration of Turbine meter shall be performed at 7 different flow points. Calibration of Turbine Flow Meters shall be done at the following nominal flow rates: 0.025 Qmax, 0.05 Qmax, 0.1 Qmax, 0.25 Qmax, 0.5 Qmax, 0.75 Qmax, and Qmax. as per AGA- 7. (i.e at flow rates of 2.5%, 5%, 10%, 25%, 50%, 75% and 100% of Qmax), subject to minimum flow rate of 5 M3/Hr (or minimum flow rate as per calibration agency/ Laboratory).

The pressure for wet calibration of USM shall be close to the average of minimum and maximum metering Pressure.

3) Based on the approved design and tender requirement, Sizing of pipes, filtration, flow meters, self-actuated Pressure control valves, Safety Shut Off (Slam Shut) valves, Pressure relief valves, Creep relief valve to be submitted by the vendor.

4) Set points for Pressure Regulators (active, monitor) and slam shut valves.

5) Instrument ranges to meet the Process operating and design conditions.

6) Noise calculations for Regulators. Vendor to provide detailed Noise calculation and standard used and assumption considered (if any).

7) All the instruments/ equipment to be procured as per the approved vendor list provided in bid document.

8) Supply of hand held Communicator/ configurator for field transmitters is not envisaged in this project.

9) Charpy impact test on each heat of base material shall be conducted as per A370 for all pressure containing parts such as body, end flanges and welding ends as well as bolting material for pressure containing parts. Unless specified otherwise, the Charpy impact test shall be conducted at 0 deg C. The Charpy impact test specimen shall be taken in the direction of principal grain flow and notched perpendicular to the original surface of plate or forging. The minimum average absorbed energy per set of three specimens shall be 27J with an individual minimum per specimen of 22 J.

10) For Low Temperature Carbon Steel Materials, The impact test temperature shall be as per requirement of Material Standard or minimum design temperature indicated in valve data sheet, whichever is lower. The average absorbed energy value of three full sized specimens shall be 27 J (for materials with Specified Minimum Tensile Strength <100,000 psi)/ 34 J (for materials with Specified Minimum Tensile Strength >100,000 psi). The minimum impact energy value of any one specimen of the three specimens analyzed as above, shall not be less than 22 J (for materials with Specified Minimum Tensile Strength <100,000 psi)/ 26 J (for materials with Specified Minimum Tensile Strength >100,000 psi).

11) When Low Temperature Carbon Steel (LTCS) materials are specified in Valve Data Sheet or offered by Manufacturer, the Charpy V-notch test requirements of applicable material standard shall be complied with. Result of Charpy Test shall be recorded.

12) All Skids inlet of 600# pressure class rating, the skid and its components installed upto PRS shall be designed for 98 Kg/cm2g. Part of skid and its component of 600# class rating shall also be designed for 98 Kg/cm2g.

13) Canopies for all Instruments, etc. are required. Shed/ Enclosure/ fencing/ rain protection for entire skids of smaller sizes. Shed/ Canopy for FC and all other instruments/ transmitters. Requirement of fencing/ enclosure

for complete metering skid with top cover / rain protection.

14) 2-tier arrangement for Skids is acceptable in this project. Lower (10%) capacity PRS streams can be provided above the respective full capacity stream of PRS. **Arrangement shall be finalized during detail engineering**.

15) Apart from the solar powered external maintenance free Battery, Lithium battery pack of 50 Ah is also required to power up FC in case Battery fails to deliver required power to FC / battery voltage goes below 11.2 V. In this case, lithium battery will cater to the requirement of FC power and GPRS Modem will switch off to save power. Alarm shall appear in case of failure of external power supply. GPRS modem shall be powered only through external chargeable battery and will switch off whenever external battery voltage drops below 11.2 V.

16) **Flow computers:** Field mounted flow computers shall have at least 4 no. of ports (for Serial/ TCI/IP interface connection). Out of these 1 no. shall be Ethernet port and balance shall be serial ports (1 no. of USB port shall be provided).

In each of the flow computers, Metering data (PT/TT) of both flow metering streams is required, so as to have redundancy at Flow computer end.

Enclosure of Flow computer shall comply Nema-4X.

For protection from rain and sun, a Suitable Shed / canopy is required for Flow computers.

Working platforms, if required should be provided in the skids at appropriate locations (and shown clearly in the drawing) to facilitate easy access to all parts of the skid and to avoid any operational or maintenance problems.

17) Pressure test points, purge and vent points shall be fitted as indicated in the Installation Schematic drawing attached herewith. When a test point is not provided on an item of equipment, a point shall be provided on the adjacent pipe work. All the ends of drain and vent points shall be plugged. The vent purge valves provided at the inlet and outlet ends shall not be fitted very close to the base level of the skid, which will be very difficult to be operated. A common vent header with flame arrestor along with flapper shall be provided.

The bidder shall use only SS Pressure tubes ½" OD (SS316) or 3/8" OD (SS316)

Bidder shall take care of requirement of Pressure Tubing' & its associated job for connection from the ½ Inch tap off provided from the Pipe to the 2-way valve manifold for Inlet Pressure connection (single stream) & outlet pressure connection (twin stream).

Suitable provision shall be provided by bidder to avoid entrainment of liquids in the gas entering regulator assembly. If required, means for removal should be provided by bidder. Sizing of components should be done considering avoidance of unacceptably low temperatures, which may lead to requirement of preheating.

Skid should have a provision for stream selection wherever specified / mentioned in the specific requirements. Automatic switch over from active stream to the hot standby stream should take place in the event of shut down of the active stream for any abnormal reason.

In metering skid there shall be separate inlet and outlet valve in each stream of Metering section. Each valve shall be designed to seal on both upstream and downstream faces and the space between the faces shall be fitted with vents.

Turbine/ RPD flow meter shall be positioned in such a way that the index can be read conveniently. Suitable means to avoid condensation of water inside index head shall be provided by the bidder. When reading/ viewing the index head, the gas flow direction through the meter shall be from the left to the right.

Technical literature (in English language only), dimensional details of the equipment and system hook up drawing shall be submitted along with the technical bid. The data sheet should be filled up completely and should be enclosed along with the Technical Bid.

Compliance with Technical Specification will be taken for granted by GAIL, if deviations are not specifically

mentioned and accepted by GAIL. Any deviation from the specified technical specification, vendor list, datasheet etc should be highlighted by vendor. However, the acceptance of the same shall be at the sole discretion of GAIL.

As far as possible, all joints shall be Flanged joint only. No threaded joint shall be proposed / considered by the bidder. Stud nuts are to be provided on flange joints. Hole tight / leak tight should not be used on threaded / flange joints in skid.

Flanges, fitting or any other skid component made of cast iron/ ductile iron/ non-ferrous materials (brass or bronze) is not acceptable. Cast iron, ductile iron, non-ferrous materials (brass or bronze) shall not be used in skid/ skid components. All the flanges used in skid shall be raised face. Flanged end connections for station piping (inlet and outlet) of the skid should be in sizes of 4"/ 6"/8" only. All stud bolts and nuts used in CGD networks shall be hot dipped galvanized as per ASTM A 153 or equivalent.

Vendor shall confirm that the Skid is suitable for outdoor installation in tropical climate with the conditions specified in tender. All required cable, conduit and suitable cable gland (ex-proof) required for power, signal, pulse input, RTD shall be supplied / installed by bidder. The Supply & laying of perforated cable tray on supports and accessories required for cable laying and routing lies in the scope of the bidder. All interconnecting signal, power, control cables used in the skid shall be armoured. The signal/control cables shall be individual pair shielded and overall shielded. Vendor shall follow the cable specifications as per control cable standard specifications. Battery shall be installed in ex-proof JB/ enclosure. Certificates for JBs, enclosure shall be provided by bidder.

Bidder shall carry out installation of junction boxes on separate support, JB earthing / grounding, tagging, ferruling, cable glanding & termination, pair/ core identification of all cables.

The Supply & laying of earthing strip and earthing cables (copper) for earthing of instruments, junction boxes etc. to instrument earthing system lies in bidder's scope. Bidder shall supply required earthing strip/ cable for earthing.

(Earth pit shall be provided by GAIL. However Hardware required for interconnection shall be provided by bidder).

Provision for anchoring skid (on foundation) shall be provided by bidder. Supply of suitable anchor bolts (preferably of 16 mm size) also lies in bidder's scope.

Tapping with valve required for PG connection shall be of 3/4". PG shall have 1/2" NPT(M) as process connection.

SSV and CRV shall be designed to operate in the entire range of design (elsewhere mentioned in the tender document). For sizing of skid- PRS downstream components/ skid items/ equipment like Meter, Valves, Pipe etc, delivery pressure (outlet pressure) shall be considered.

The following performance characteristic curves should be furnished:

a) Outlet pressure v/s flow (for various inlet pressures)
b) Inlet pressure v/s flow (for various outlet pressures)

3.0 DESIGN PHILOSOPHY

3.1 GENERAL

3.1.1 This Document together with the attachments covers the minimum requirements for the design and engineering of metering skid complete with all accessories. Bidder shall be responsible for Design, engineering, sizing, selection, manufacture and/ or procurement, of materials, components and equipment necessary for complete package.

3.1.2 This document provides in detail, the minimum qualitative requirements of most of the instruments/ equipments. Where no such requirements are indicated in this document, the bidder shall submit the same for GAIL's approval.

3.1.3 The total uncertainty calculation of the metering system to be submitted as per the design data prior to the fabrication of skid.

3.2 CODES AND STANDARDS

3.2.1 Design and terminology shall comply, as a minimum, with the latest edition prior to the date of bid enquiry of following codes, standard practices and publications:

AGA	American Gas Association, Gas Measurement Committee Report No.3 – Orifice Metering of Natural Gas. Report No.7 - Measurement of Gas by Turbine Meters. Report no 8 – compressibility calculation Report no. 9 – Ultrasound metering of natural gas
ANSI / ASME	American National Standards Institute/ American Society of Mechanical Engineers. B 1.20.1Pipe Threads. B 16.47Steel Pipe Flanges and Flanged Fittings. B 16.20Ring Joint Gaskets and Grooves for Steel Pipe Flanges.
ANSI/FCI	American National Standards Institute/Fluid Controls Institute 70.2Control valve seat leakage classification.
API	American Petroleum Institute
RP 520	Sizing, selection and installation of pressure relieving system in refineries. Part-I- Sizing and selection Part-II- Installation
RP 521	Guide for pressure relieving and depressurizing systems
P 526	flanged steel safety relief valves.
RP 527	Seat tightness of pressure relief valves.
MPMS	Manual of Petroleum Measurement Standards.
RP 551	Process Measurement Instrumentation. Part 1 - Process Control and Instrumentation
RP 552	Transmission Systems
S 1101	Measurement of Petroleum liquid hydrocarbon by Positive Displacement meter.
S 2000	Venting Atmospheric and low pressure storage tank.
S 2534	Measurement of liquid hydrocarbons by turbine meter systems.
S 670	Vibration, Axial-Position and Bearing-Temperature Monitoring Systems.
ASTM	American Society for Tests and Materials.
BS	British Standards
BS-1042	Measurement of fluid flow in closed conduits.
BS-4368	Compression coupling for tubes.
BS-4800	Colours for ready mixed paint.
BS-5308	Part-2 Specification for PVC insulated cables.
BS-6364	Specification for valves for cryogenic service.
BS-7244	Flame Arrestors for general use

OIML R 137 – 1 & 2	RPD Meter
AGA Report No 3 (all parts)	Orifice Meter
AGA Report No 7	Turbine Meter
AGA Report No 9	Ultrasonic Meter (> 6")
AGA Report No 8	Calculation of Compressibility Factor
AGA Report No 8/Report no.10	Calculation of Speed of Sound
ISO 6976	Calculation of calorific value
GC ISO 6142	Standard Gas
DIN-43760	Temperature vs Resistance curves for RTDs.
DIN-19234	Electrical Distance Sensors; DC interface for Distance Sensor and Signal Convertor.
IBR	Indian Boiler Regulations.
IEC	International Electro-technical Commission.
IEC 60079	Electrical Apparatus for Explosive Gas atmosphere
IEC 60085	Thermal Evaluation and Classification of Electrical Insulation
IEC 60332	Test on bunched wires or cables.Part 3 Cat 1
IEC 60331	Fire resistance characteristics of electrical cables
IEC 60529	Classification of degree of protection provided by enclosures.
IEC 60534-2	Industrial Process Control Valves-Flow capacity
IEC 60584-2	Thermocouples - Tolerances
IEC 60584-3	Thermocouples extension and compensating cables, tolerances Identification system.
IEC 60751	Industrial platinum resistance thermometer sensors
IS	Indian Standard
IS-5	Colours for ready mixed paints.
IS-319	Specification for free cutting Brass bars, rods and sections
IS-1239	Mild steel tubes, tubulars and other wrought steel fittings.
IS-1271	Specification of Thermal Evaluation and Classification of Electrical Insulation.
IS-1554-Part I	PVC insulated (heavy duty) electric cables-working voltage up to and including 1100 V.
IS-2074	Ready mixed paints, air drying, red oxide- zinc chrome.
IS-13947	Degree of Protection provided by enclosures for low voltage switch gear and control gear.
IS-2148	Flame proof enclosures for electrical apparatus.
IS-3624	Specification for pressure and vacuum gauges
IS-5831	PVC insulation and sheath of electric cables.
IS-7358	Specifications for Thermocouples
ISA	Instrument Society of America.
S-5.2	Binary logic diagrams for process operations.
S-7.3	Quality standard for instrument air.
S-75.01	Flow equations for sizing control valves.
ISO 5167	Measurement of fluid flow by means of orifice plates, nozzles, venturi tubes inserted in circular cross-section conduits.
NEC	National Electric Code.
NFPA	National Fire Protection Association.
NFPA-496	Purged and pressurised enclosures for electrical equipment.
EN	European Standard
EN334	European standard for pressure regulators upto 100 bar
EN12186	Gas Pressure Regulating Stations for Transmission and distribution
EN14382	Safety systems for Gas distribution

3.2.2 In general, Bidder shall carryout engineering as per IEC/ BIS standards.

Any other standard, if necessary, can also be referred by bidder during the execution of the job, without diluting the basic requirements, however with prior information to Owner/ Owner's Representative. In any case bidder must furnish a list of codes and standards other than those specified in this document, which shall be followed by them during engineering.

3.3. INSTRUMENT DESIGN CRITERIA

3.3.1 The Equipments and instrumentation selected for the metering skids shall be rugged in design and must be well proven in the hydrocarbon industry. Prototype design or equipment of experimental nature or design undergoing testing etc. shall not be selected and supplied. Following criteria must be applied before selecting a particular instrument item: "The instruments as being offered/ supplied should have been operating satisfactorily in hydrocarbon industry like Refinery, Petrochemical and Gas Processing Plant under similar process conditions for at least **4000 hrs**. from the bid due date."

3.3.2 The complete station shall be designed in such a way that the mean gas velocity remains within 20 Meter per second except in Pressure regulating valve / slam shut valve. Velocity in the piping upstream / downstream of Pressure reduction station shall be within 20 Meter per second. Maximum seat velocity of Slam shut valves is limited to 40 meter / second. For sizing of all field Equipments/ instruments, Compressibility factor of 0.98 shall be used.

3.3.3 For FCV operation, instrument air shall not be provided by GAIL. For all metering skids of outlet pressure class rating of 300 # and higher, a Suitable proven two-stage high pressure gas supply trains/ systems shall be supplied/installed by vendor for proper operation of the flow control valves through natural gas. For all metering skids of outlet pressure class rating of 150 #, a proven single–stage high pressure gas supply trains/ systems shall be supplied/ installed by vendor for proper operation of the flow control valves through natural gas. Special care has to be paid for dealing the problem arising from possible condensation due to pressure reduction. A well proven system to be used for this application. I/P converters/ Electro pneumatic positioner, Filter regulators, Actuators, positioners shall be suitable for Natural gas application.

3.3.4 Instrument Requirements for classified area:

a) All electronic/electrical instruments and equipments shall be suitable for area classification as per IEC codes and shall be tested by any recognized authority like BASEEFA, FM, PTB, CMRI etc. and shall be certified by **CCOE.**
b) Certified Intrinsically Safe (IS) equipment as per IEC-60079-11 shall be used, in general, in hazardous area. In case intrinsically safe equipment is not available, flameproof enclosures as per IEC-60079.01 may be considered.
c) Junction boxes and accessories required for flameproof instruments shall also be certified flameproof.
d) All non flameproof panels and cabinets installed in classified area shall be purged as per requirements specified in NFPA-496, as a minimum.
e) Other type of protection as specified in IEC-60079 shall not be used.

3.3.5 **Statutory Approvals**

a) Bidder shall be responsible for obtaining all statutory approvals, as applicable for all instruments, equipments and control systems.

b) In addition, equipments/instruments/systems located in the hazardous area shall be certified by the local statutory authorities for their use in the area of their installation. In general following certification shall be given:

- For all intrinsically safe/ explosion proof/ flameproof equipments/ instruments/ systems or equipments with any other type of protection allowable as per this package which are manufactured abroad and certified by any statutory authority like BASEEFA, FM, UL, PTB, LCIE etc. should also have the approval of Chief Controller of Explosives (CCOE), Nagpur.

- For all flame proof equipments manufactured locally (indigenously), the testing shall be carried out by any of the approved test house like CMRI/ERTL etc. The equipment shall in addition bear the valid approval from Chief Controller of Explosives, Nagpur and a valid BIS license.

- For all intrinsically safe equipment manufactured locally (indigenously), the testing shall be carried out by any of the approved test house like CMRI/ERTL etc. The equipment shall in addition bear the valid approval from Chief Controller of Explosives, Nagpur.

- Custody transfer approval from Nmi/ PTB/ NPL or equivalent body from the country of origin.

- CCOE certificate for the foreign items shall be submitted during detailed engineering, however appropriate approval certificates from the country of origin shall be provided with the bid.

3.3.6 In general, intrinsically safe philosophy shall be followed for all transmitters & PED 97/23/EC compliance shall be included for pressure contained/handling equipments , PCV/SSV/RPD.

3.3.7 Bidder to note that external barriers shall be selected based on entity concept.

Typically barrier selection must be made based on the following:
i) Analog Inputs (4-20 mA): MTL/ P&F KFD series/ Eqv.
ii) Analog Outputs (4-20 mA): MTL/P&F KFD series/ Eqv.
iii) Proximity Inputs: MTL/ P&F KFD series/ Eqv. (Covering the range of at-least 200% of frequency range of the flow meter).

3.3.7 All instruments in the skid shall be certified for IEC Zone 1 Gas Group IIA/IIB, T3.

3.3.8 All the mainline ball valves used in skid package shall be full bore type.

3.3.9 Instruments, which are not available as per their standard design from any reputed manufacturer as intrinsic safe, can be supplied in flameproof design. All such instruments shall be certified flameproof for the area classification and requirements indicated in clause 3.3.4 above.

3.3.10 Flame-proof (explosion proof) junction boxes as applicable shall be certified for IEC-Zone-2, IIA/IIB for all the classified areas for flame proof instruments.

3.3.11 Sizing for Pipe, Valves, Filtration system, Safety valves, Pilot operated self actuating pressure control valve, slam shut valve, flow meter, Flow control valve, power supply, solar panel, control panel, load etc. is bidder's responsibility.

3.3.12 Any change in instrument size or revision in line sizes because of required sizing as per tender requirement shall be carried out by bidder without any financial implications to GAIL.

3.3.13 All line mounted temperature elements shall be Class A type 4 wire RTD type as per IEC 60751.

3.3.14 All the instruments shall be provided with canopies of adequate size to protect instruments from direct rain & sunlight. All such canopies shall be prefabricated type. The custody transfer equipments at field like transmitters (pressure & temperature) shall be installed in environmental enclosure to minimize the effects of ambient temperature variations and shall be lockable for prevention of unauthorized data entry. The size of the cabinet shall be suitable for removing and fixing of transmitters for ease of maintenance. The transmitters shall be fixed in mounting brackets inside the cabinet. The cabinet shall be mounted and fixed in the skid.

3.3.15 All the field switches shall be suitable for Flameproof and weather proof enclosure contacts. The process switch shall be silver plated with contacts rated for rating of 30 V DC, 1 Amp. This requirement shall also be applicable for any other switch contact like push button, selector switches in the intrinsically safe service. The field switches shall be normally closed type and open to alarm. Switch contacts shall be SPDT. For all field switches (except Limit Switches), differential of switch shall be less than 60% of difference between set value & operating value.

3.3.16 Tube Fittings used for the installation of instruments shall be tested as per BS 4368 or equivalent standards.

3.3.17 Bidder shall provide Indications signals like Inlet PT, Inlet TT, Filter DPT-1, Filter DPT-2 and PID control for FCV in all Flow computers (all streams). Bidder shall also provide open/ close Indications for all Slam shut valves (all streams) in all Flow computers (all streams) and control panel (wherever applicable). Same shall be detailed during detailed engineering.

3.4 JUNCTION BOXES AND CABLING PHILOSOPHY

3.4.1 **Cable Routing**

3.4.1.1 Single / multiple pair cables from instrument to junction box shall be through perforated trays. Cable glands shall be provided at instrument end and junction box end. Supply of all required Cables and Cable glands shall be in bidder's scope. However cable laying shall be in the scope of GAIL.

3.4.2 **Junction Box**

3.4.2.1 Separate junction boxes shall be used for the following:
a) 4-20 mA DC signals (IS)
b) Contact signals (Field switches, Limit switches, push buttons etc.)
c) Interlock and shutdown signals (Solenoid valves)
d) Power supply to various instruments
The JBs shall have side entry for Branch cable/ single pair cable and Bottom entry for multi-pair cable entry. No top entry shall be considered.

3.4.2.2 The multi-cable entry for 6-pair JB and 12 pair JB shall be 1" NPT (F) and 1.5" NPT (F) respectively. Each junction box shall be provided with 2 multi-cable entries from the bottom of the junction box with one plugged with weather proof plugs.

3.4.2.3 Junction boxes, cable glands and accessories shall be weather proof in general. Slipper type PVC sleeves shall be used over cable glands for all cable entries in junction boxes to avoid water entry in junction boxes. In case of explosion-proof components used (only for packages), the respective junction boxes, cable glands and accessories shall be certified weatherproof and explosion proof.

3.4.2.4 Only one multi-cable entry shall be used in the junction box. The other cable entry shall be plugged.

3.4.2.5 The junction boxes in the field as well as in local panel shall be provided with sufficient number of terminals to terminate all the pairs of multi-cable (including spare pairs) and shields of individual pairs as applicable.

3.4.2.6 Charge controller for Battery charger shall be supplied in separate Ex-proof enclosure. Battery Enclosure / JB shall be Flame-proof/ Ex-proof as per area classification and same shall be installed 15 meters away from the skid (cable of suitable length shall be supplied by bidder).

3.5 PAINTING REQUIREMENTS

3.5.1 All instrument impulse lines (except SS 316 Tubing) and instrument / equipment structural items shall be painted by the bidder.

3.5.2 The painting/ coating shall be performed in totality for all instrument/ equipment items such as:

a) All line mounting and equipment mounted instruments and all line mounted equipments.
b) All instrument impulse piping (except SS 316 Tubing)
c) All instrument / equipment structural items like M.S. cable trays, instrument / equipment supports and tray supports, instrument stanchion, impulse line supports etc.
d) All surfaces of GI items wherever repair has been carried out shall also undergo painting.
e) All cabinets/panels, base frames which have undergone repair at site shall also be painted.
f) The final coating on external surfaces shall be applied just before handing over the plant or commissioning of the plant.
g) Name of the manufacturer, colour and quality of all types of primers and paints shall be subject to approval of the owner/owner's representative.

3.5.3 Painting of other equipments shall be as per Painting specifications attached elsewhere.

3.6 POWER SUPPLY & POWER SUPPLY DISTRIBUTION

3.6.1 Bidder shall provide Solar power system (solar panel, charger, battery with accessories, installed in skid), wherever applicable for powering the flow computer and transmitters/ instruments. Provision for battery charging through 230 V AC shall also be provided by bidder.

3.6.2 In case, 24 V DC power is required for the instruments installed in panel like modem, barriers, isolators, field instruments, converters relays etc. the same shall be arranged/ provided by the vendor through dual redundant power source / packs/ suitable converter. All these Power source/ packs shall be sized with the safety factor of 2 of the actual load requirement. The power to these components shall be provided through MCB/ fusible Terminal block with provision for electrical isolation.

3.7 OTHER DESIGN CONSIDERATIONS & REQUIREMENTS

3.7.1. Vendor shall submit the complete design and engineering of the metering system including piping as per the guidelines of AGA 7 (including any other AGA recommendation as applicable). The total uncertainty calculation of the metering system shall be as per tender requirement and the same to be submitted as per the design data

3.7.2. prior to the fabrication of skid. Critical components within the custody transfer metering system should be compatible to ensure “Overall System Uncertainty” for this critical fiscal transaction purpose with all components within the metering system must be well proven and compatible in the similar application. The meter tube shall be shim less and shall have smooth internal surface.

3.7.3. The complete skid/ station shall be designed in such a way that the mean gas velocity remains within 20 Meter per second except in Pressure regulating valve / slam shut valve. Velocity in the piping upstream / downstream of Pressure reduction station shall be within 20 Meter per second. Maximum seat velocity of Slam shut valves is limited to 40 meter / second.

3.7.4. The skid shall be complete in all respect, ready for easy/ quick installation and commissioning of equipment with minimum work at site. All field-mounted instruments shall be mounted on the skid and impulse lines properly supported on the skid. Ease of transportation shall be one of the considerations in deciding the size, configuration, layout of skid.

3.7.4. All the main line ball valves shall be full bore ball valves**.** Flow control valve size shall be of the line size and shall be of full port design. The isolating Ball vales Up-steam & Downstream of the meters shall be of the same size as that of Gas flow meter in order to prevent any flow profile distortion. Body size of FCV shall be same as size of PRS outlet size/ inlet line size of FCV and port size shall be maximum available port size (full port FCV shall be selected).

3.7.5. Flow control valve shall be installed with low bleed positioner & I/P converter (or electro pneumatic positioner) for limiting flow to consumer (Since Instrument air is not available at site, line gas is to be taken from pipe line upstream of metering system. Necessary filtration and double stage regulator arrangement (well proven for this specific application) shall be considered to provide the gas supply to Valve Actuator, I/P converter (or electro pneumatic positioner)). The I/P converter, positioner / electro-pneumatic positioner, filter regulator and actuator shall be designed & certified for high pressure natural gas application (instead of air). The positioner required with FCV can be SMART type or conventional. However approval from CCOE for use in hazardous area with approval for Natural gas service is required.

3.7.6. For all the ball valve of size above 2” in the main lines (at upstream of filtration, pressure reduction and metering skids) the equalizing line with double block valves to be provided as per Typical P&ID. Equalizing valves are not required for ball valves up to 2” sizes. In the main lines of the skid all the ball valve (at upstream of filtration, pressure reduction and metering skids) of sizes 6” and above shall have the equalizing line with 2” size valves. All the main line ball valves of sizes 3” and 4” shall have equalizing line with valves of 1” size. In the equalizing lines first valve shall be ball valve and the second valve (of the block valve) shall be Globe/ plug valve.

3.7.7. All the vent / drain lines shall have combination of first valve as Ball valve and second one as Globe/ plug valve. First Valve (Upstream valve) shall be Ball valve (welded type) and the second (Downstream) valve shall be Plug/ Globe valve (flanged). The Inlet side of Ball valve of Drain/ vent lines shall be welded type. All drains valves shall be provided with suitable Blind flange/ Plug. All the drain valves on the main lines shall be of ¾" size for main lines up to 4". All the drain valves on the main lines shall be of 1" size for main lines above 4". All the vent valves shall be of 1" size for main lines up to 6" and vent valves shall be of 2" size for main line sizes above 6". **The second Isolation valves (Globe / plug valves) of all the vent lines shall be of LTCS (Low Temperature Carbon Steel) material.**

3.7.8. Dual isolation valves of minimum ½" size (First one ball valve and second one shall be globe/ plug valve) are required for all the impulse / sensing lines.

3.7.9. For 150# pressure class rating; Floating ball valves are acceptable up-to 8" size and Trunion mounted Ball valves (TMBV) shall be provided for ball valves above 8".

3.7.10. For 300# rating; Floating ball valves are acceptable up-to 4" size and Trunion mounted Ball valves (TMBV) shall be provided for ball valves above 4".

3.7.11. For 600# class; Trunion mounted Ball valves (TMBV) are required for sizes 2" and above.

3.7.12. The equipment/ items of Metering skid shall be properly supported to avoid vibration. Special support as required shall be provided by vendor. All piping shall be rigidly supported. Adequate supports provided for the complete assembly shall be bolted to the skid structure and shall be designed and located with due regards to weight distribution and operational pipe stress.

3.7.13. The gas flow meter and meter tube piping shall be installed in a region of zero stress in the pipeline to minimize strain on the meter. The upstream pipe work shall be carefully aligned to minimize flow disturbances, especially at the upstream flange of the meter.

3.7.14. The design of the 19 tube bundle flow straightner / flow conditioner for turbine meter shall comply with the requirements of AGA 3 & 7. As a minimum, flow straightener shall be of SS-316.

3.7.15. The skid shall be prefabricated and mounted on a steel frame. It shall have inlet flange for inlet side and outlet flange suitable for outlet side. It shall have separate vent connections. Each skid shall be complete in all respect ready for alignment & grouting at site.

3.7.16. Optimize access to instruments and fittings. All equipment shall be orientated to permit servicing without undue dismantling and to have good access and maximum safety.

3.7.17. Pressure let down skid shall be with redundant identical let down streams (1 working and 1 standby) with automatic switchover from failed regulator stream to standby stream. In case of failure of pressure regulation with the working stream the slam shut valve of this stream shall close and the standby stream shall start regulation. Appropriate set points of pressure regulator and slam shut valve of each stream shall be decided by the vendor in order to regulate the downstream pressure so that gas to consumer is always ensured at the contracted pressure.

3.7.18. Slam shut valve & Monitor Regulator valve shall be Fail Close type and Active Regulator shall be fail open type.

3.7.19. The equipment shall be bonded for earth continuity and two external earthing bosses shall be provided, on each skid at diagonally opposite ends, for connection to the plant earth grid.

3.7.20. Lifting lugs and their supporting structure shall be designed for load equal to two times the weight to be lifted (shipping weight). The detailed stress analysis of the skid structure and frames shall be submitted by the vendor.

3.7.21. The tubing and fittings used for impulse piping shall be of 12 mm (1/2") SS 316. Tube fittings shall be flare less compression type of three-piece construction consisting of ferrule, nut and body suitable for use on SS tubes.

Instrument valves and manifolds shall be of SS-316 construction of forged type. The fittings shall be swage-lock type/ design.

3.7.22. The piping materials including valves & flanges shall be supplied as per specifications attached elsewhere in the package and shall be suitable for the process conditions given elsewhere. Skid piping design shall comply to Piping specifications including Inspection and testing requirements attached elsewhere in the bid package.

3.7.23. Gas filters specifications and design requirements including Inspection and testing requirements shall be as per the specifications for Gas filters attached elsewhere in the bid package and shall be suitable for the process conditions given elsewhere**.** The drain pipes shall be installed at the bottom of the inlet chamber (un-filtered gas) with block & bleed arrangements.

3.7.24. All interconnecting instrument cables, earthing cables in skid shall be armored. Only the cables used inside JB/ panel shall be non-armoured insulated cable. All signal and alarm cables shall be individual pair shielded and overall shielded. Vendor shall follow the cable specifications as per signal cable standard specifications.

3.7.25. All field transmitters and I/P converters (or Electro pneumatic positioner) shall be certified weather proof to minimum IP65 and intrinsically safe suitable for hazardous area classification IEC Zone 1, Gr. IIA/ IIB, T3.

3.7.26. All limit switches, Junction boxes, cable glands & accessories shall be certified weather proof to minimum IP55 and Flame proof suitable for hazardous area classification IEC Zone 1, Gr. IIA/ IIB, T3.

3.7.27. All field mounted instrumentation items shall be suitable for continuous working in outdoor installations, considering temperature, humidity etc. as per data given elsewhere in this bid. Ingress protection for all field instruments and enclosures/ junction boxes/ cable glands etc. shall be IP-55/ NEMA 4 as minimum. Instruments mounted on the skid shall be suitable for installation in tropical hot and humid climate considering:

Ambient Temperature: 0 ^{0}C to 50 ^{0}C and Relative Humidity: 95%.

3.7.28. The Vendor shall include isolation valves in Impulse Lines for the pressure regulators, slam shut valves etc. The pressure instruments shall be provided with individual process isolation valves and block and bleed manifolds.

3.7.29. Transmitters shall be microprocessor based **"SMART"** type with HART Protocol. Accuracy of pressure transmitters (PTs/ DPTs used for non-custody transfer application) shall be $\pm$ 0.075% of FSD or better and for Temperature transmitters it shall be ±0.2% FSD or better.

Accuracy of metering pressure transmitters (used for custody transfer application) shall be $\pm$0.04% of FSD or better. All transmitters shall be 2 wire, HART compliant and provided with intrinsic safe integral output meter with digital display. The temperature transmitters shall be Pt 100 RTD sensor type (class A, 4 wire type) with integral head mounted **SMART** transmitter with two wire 4-20 mA DC output, 24 VDC loop powered complete with local output meter (LCD type). The temperature transmitter shall be provided with flanged thermo-well of 316SS material fabricated from drilled bar stock.

3.7.30. Minimum main line size (pipe size) in the metering / filtration / PRS skid shall be 1". Minimum size of Inlet and outlet piping shall be 4" (If as per calculation higher line size is required, the higher size shall be considered). In case the Inlet/ outlet size as per process parameter (as per sizing calculation) is below 4" size, Suitable Expander/ reducer to be provided to match 4" Inlet/ Outlet piping connection because Inlet and Outlet connection to each skid shall be minimum 4". Also matching flanges for end connection of skids shall be provided. Spectacle blinds to be considered at the inlet lines, outlet lines and inlet valve bypass lines of Metering section of skid.

3.7.31. Vendor shall furnish details of foundation required for the gas pressure reducing & metering skid.

3.7.32. In view of the total weight and overall dimensions of the skids, vendor may decide to fabricate and transport the skid in more than one part. In that case, vendor shall ensure that the site job shall only be limited to bolting together these parts at site and no further welding or joining of components together etc. are required. The

responsibility of such jointing together and its proper functioning would rest on the vendor.

3.7.33. The signal from equipment to the GAIL SCADA system will be through analog as well as serial communication (Modbus). Only one SCADA port shall be available for transmission of all signals. Suitable hardware to be provided for signal transmission from various devices/ communication with various devices.

3.7.34. All the field switches shall be suitable for Flameproof and weather proof enclosure contacts. The process switch shall be silver plated with contacts rated for rating of 30 V DC, 1 Amp. This requirement shall also be applicable for any other switch contact like push button, selector switches in the intrinsically safe service. The field switches shall be normally closed type and open to alarm. Switch contacts shall be SPDT. For all field switches (except Limit Switches), differential of switch shall be less than 60% of difference between set value & operating value.

3.7.35. Platforms, ladders, and vessel supports shall be designed in accordance with the AISC Steel Construction Manual.

3.7.36. The following minimum stress analyses shall be conducted as applicable (in addition to basic code calculation requirements) :

a. Complete detailed calculations shall be provided for lug, leg, or ring type vessel supports, when used. These shall include the effects on the vessel shell local to the attachment.

b. Complete design calculations shall be provided for special, large-diameter closures when used.

c. Stresses at saddle supports.

d. External loading on vessel nozzles and structural attachments.

e. Analysis of lifting and tailing lugs and analysis of vessel stress during lifting.

f. Vertical vessels shall be designed and checked for dynamic wind loading when all of the following conditions occur:

- *L is greater than 50*
- *L/D is greater than 15*
- *W/ (LxD^2) is less than 25*

where L= Vessel Total Height (in ft)
D = Average inside diameter of the top third of the vessel (in ft)
W = Vessel empty weight (in lbs)

3.7.35 The size of the cabinet shall be suitable for removing and fixing of transmitters for ease of maintenance. The transmitters shall be fixed in mounting brackets inside the cabinet. The cabinet shall be mounted and fixed in the skid. Suitable shed / rain protection shall be provided for all transmitters, except metering transmitters, for which environmental enclosure is required. Suitable shed / rain protection shall also be provided for field mounted flow computers.

3.7.36 The function of the PID controller or PID loop of Flow computer is to limit / control the flow through metering skid as per local set point or from remote set point received through GPRS MODEM / SCADA.

3.7.37 Turbine flow meter of size 3" and above, shall have Dual (02 Nos) HF pulse. Pulse output shall be used for flow computation. HF pulsar must be provided on the meter body.

However, for all other Turbine flow meters (of smaller size of 2") one (1) HF pulse and one (1) LF pulse output is also acceptable. HF pulsar must be provided on the meter body.

For RPD Meters, meters shall have one (1) HF pulse and one (1) LF pulse output. HF pulsar must be provided on the meter body.

3.7.38 During detail engineering; dimension / lay-out of skid to be furnished for our review and shall be modified to accommodate the skid in the available plot area at respective consumer terminals.

3.7.39 For 1" or below size of regulator, Integral SSV with Monitor Regulator is acceptable (SSV with Monitor Regulator can be Integral). However The Active regulator shall be Independent.

3.7.40 It is desirable that the Layout of the skid is symmetrical across the center line and clear working space (to be

decided during detail engineering) is available between two streams of filtration, PRS, Metering etc. The distance between centre line of pipes of parallel streams shall be approx.1 mtr. Generally smaller skids shall have straight line configuration and bigger skids shall have U-Shape configuration. However, the same to be submitted during detailed engineering and got approved before proceeding for fabrication of skids.

3.7.41 The PRS section and metering section shall have modular configuration (removable type) and shall be interconnected with two flanges (one flange at the inlet and other flange at the outlet) only. The detailed configuration of individual streams of PRS and Metering shall be submitted by bidders during detailed engineering for GAIL's Approval.

3.7.42 Independent metering streams shall have independent streams of Solar Panel, Battery and Charger circuit.

3.7.43 For solar panel powered flow computer based skids, Minimum Size/ rating/ capacity of battery shall be 150 Ah (150 Amp Hour) and shall be installed in Ex-proof and weather proof Enclosure as per area classification mentioned elsewhere in tender specifications. Bidder shall submit sizing calculation and if during sizing, higher size of battery is required, then battery of higher size/ rating shall be offered. In case the above battery cannot be installed in a single Ex-proof enclosure, more than one battery (per stream) each installed in suitable ex-proof enclosure(s) shall be provided.

3.7.44 CRV/ Relief Valve at downstream of PRS shall be sized for 1% of design flow capacity of skid.

3.7.45 The metering stream (Gas Flow meter, up-stream & down stream meter tube, flow conditioner, impulse tubing of Pressure transmitter, thermo-well, shall be completely insulated to ensure an even heat transfer throughout the meter run when subjected to ambient environment.

3.7.46 Signals of Metering PT and Metering TT shall be connected to the respective individual flow computers only; and Analog signals like inlet PTs, inlet TTs and filter DPTs shall be communicating to both flow computers.

3.7.47 The PSVs for each stream of Filter shall be designed for fire case.

3.7.48 In the PRS section sufficient distance shall be kept in between slam Shut valves and Downstream valve of PRS so that the higher capacity PCV can be installed for expansion case.

3.7.49 Pressure Class of Skid up to PRS outlet (including PRS section Outlet main line Ball valve) shall be of Inlet pressure class rating mentioned in the tender. All Metering sections and PRS downstream components (which are installed downstream of PRS), shall be of outlet Class rating mentioned in the tender.

3.7.50 *LTCS material is required for pipe and valves used for vent connection, drain connection and PSV discharge headers in all skids.*

3.7.51 Bidder shall provide certification from TPI appointed by them that the skid being supplied is in accordance to all the relevant standards, AGA report(s) for custody transfer of natural gas. Bidder shall also provide certification that the skid being supplied is complete in all respect in accordance to tender requirement and Material requisition and in case some deficiency, issues related to faulty design & engineering is observed at any stage, same shall be corrected/ resolved without any financial implication to GAIL.

3.7.52 Bidder shall submit all engineering documents, test reports and certificates along with final technical documents in hard copy and soft form. Bidder shall also provide certificate that the engineering documents, manufacturing and test certificates provided by supplier is complete in accordance to data requirement of Material requisition, and tender requirement.

3.8 SOLAR Panel and Battery required for Field mounted Flow computers :

3.8.1 Solar panel, Batteries, Battery charger unit etc. shall be installed in Skid at a distance of 10(ten) Meters from skid/ respective Flow meters. Signal Cables of suitable length to be provided accordingly.

3.8.2 Battery shall cater to requirement of Flow computer, transmitters and other skid components for 30 no-sunny days. Minimum capacity of Solar panel shall be 100 W. For power supply and battery charging sizing of Solar panel shall be based on availability of sun for 6 hours/day. Batteries and charger shall be installed in a Junction

box, which shall be installed on a frame at height of 1 meter from ground (bottom of JB shall be minimum 1.0 meters from platform).

3.8.4 All Instrument, transmitters, converters, barriers, components, shall be powered through SOLAR panel/ battery being supplied. Solar Power System shall be designed considering that no separate supply shall be provided by the client. However provision for battery charging through external power supply (230 Vac) shall also be provided by the bidder. Battery charger (230 Vac to 14 Vdc converter), accessories and suitable cables shall be provided for the same. Same shall be detailed during detail engineering.

For Power supply through Solar power system, Batteries and charger shall be installed in a suitable Junction box, as per area classification, which shall be installed on a frame at height of 1 meter from ground (bottom of JB shall be minimum 1.0 meters from platform).

SOLAR PANEL shall be suitable rating rechargeable battery mentioned above. Certification shall be provided for use of Solar panel in the *Class-I, Div-II, Group C&D.*

Charge Regulator should accept power to charge the re-chargeable battery from either through
a) 230 VAC to 12/14 VDC convertor or
b) Solar panel.

To supply power through Solar panel/ Battery, following types of Suitable Cable along with cable gland shall also be supplied (as minimum).

a) Between JB and Battery,
b) Between Solar panel and Battery
c) Between JB and Flow computers.

Solar panel shall be installed at a height of 2 meters from ground. Mounting arrangement with 360 degree angle rotation and tilting arrangement for Solar panel shall also be supplied by the bidder.

Input and out required for flow computer

Minimum I/O required is as follows:

- Pulse input for LF and HF
- 2 input from RTD Pt 100 (4 wire)
- 2 Analog input for metering PT
- 4 Digital Inputs
- 2 Digital Outputs
- Analog Inputs (skid inlet pressure and temperature)

4.0 PROCESS AND DESIGN DESCRIPTION

4.1. The bidders shall design the skid considering the worst process condition.

- All the Equipments shall be able to withstand maximum/ minimum design Pressure and temperature. Worst case process pressure and temperature with max flow is to be considered for sizing equipment selection, noise calculation.
- All the calculations for the sizing of the valves, meters etc shall be based on the max flow capacity, minimum

pressure and maximum temperature. However design temperature / pressure shall be considered for selection of material, mechanical strength of the equipment.

- The set pressure of Pilots for PCV & SDV shall cover the complete range of inlet & out let condition. For PCV, SDV, if one pilot is not able to cater the complete range then additional pilot / loose springs to be supplied for each skid.
- The PSV / CRV to be designed in such a way that the set pressure can be adjusted within the whole operating and design pressure range/ set points. Separate spring(s) shall be provided, if one spring is not sufficient to meet the requirement.
- Specific Gravity of 0.6 and compressibility factor of 0.98 shall be considered for the purpose of sizing.
- Outlet shall be designed as per condition indicated elsewhere in tender.
- Compressibility factor of 0.98 shall be used for sizing calculation of all equipments/ instruments.
- Minimum and design flow shall be 10% and 100% of maximum flow rate respectively of respective streams of PRS and metering.

4.2. Detailed Process and design conditions is mentioned in following Table-C:

TABLE-C

SOR Item No.	**Details of Metering Skids**	**Inlet & Outlet connection**	**Inlet / Outlet pressure class rating of Skid**	**Operating Pressure Range (in Kg/cm2g)**		*** Spring range of PCV/ SSV/ CRV (in Kg/cm2)**	**Max. DP allowed across skid (in Kg/cm2)**
				Skid Inlet	**Skid outlet**		
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
1.	1.2 MMSCMD capacity USM metering skid with GC, Control panel and FCV, dry gas filtration(1w+1s), 4 stream PRS and 4 stream metering system with combination of USM and 0.072 MMSCMD capacity RPD metering (G-100), 3" with Solar Panel, Battery with Charger unit, FCV and 3 Nos. LEL Detector.	8" x8" (for USM) 4" x4" (for RPD)	600# / 300#	45 to 92	19 to 49	15 to 49	5
2.	0.072 MMSCMD capacity metering skid with dry gas filtration(1w+1s), 2 stream PRS and 2 stream RPD metering System with RPD G-100, 3" and 1 No. LEL Detector along with connection to flow computer for providing the signal.	4" x 4"	600# / 300#	25 to 92	15 to 49	10 to 49	5

3.	13000 SCMH capacity metering skid with dry gas filtration (1w+1s), 4 stream PRS stream [2 stream 1w+1s of 100% capacity & 2 stream 1w+1s 10% capacity] and 4 stream metering system with combination of turbine (G-400) and RPD (G-40/65) metering system of 1w+1s each, with FCV (in 10% stream) and 3 Nos. LEL Detector along with connection to flow computer for providing the signal.	4" x 6"	600# / 300#	50 to 92	20 to 49	15 to 49	5

Outlet pressure provided above in column (f) of above table, shall be used for equipment/ component sizing calculation purpose. (The outlet pressure range is provided for sizing calculation of equipment, pipe and instrument).

Set spring range for CRV, Pilots of regulator (PCV) and SSV shall be supplied as per column (g) of above Table, which can be different from the outlet pressure range, column (f).

Set spring range of PCV/ SSV/ CRV is provided in column (g) for selection and supply of suitable pilots/ spring for SSV/ PCV/ CRV etc.

Bidder to note that the flow capacities as indicated above are based on the minimum pressure parameters however during details engineering actual flow capacities shall be indicated based on the actual process parameters furnished by GAIL.

The quoted skid shall be suitable for Gas compositions mentioned below.

Typical Gas Composition for designing the skid shall be as follows:

Name of Component	Composition 1	Composition 2
C6+	0.05	0.2
N2	0.50	0.2
CO2	0.50	4.00
C2	6.10	7.00
C3	1.10	3.75
IC4	0.20	0.70
NC4	0.30	0.80
IC5	0.02	0.20
NC5	0.01	0.20
C1	Balance	Balance

The Heating value of Natural gas (GCV) shall be 9200 to 9880 Kcal/SCM.
The Metering skids shall be designed considering the severity of tender specification.

5.0 JOB SPECIFICATION

5.1 GENERAL

This document defines the instrument job requirements over and above various Standards attached along with this document.

The selection of type of instruments is Bidder's responsibility. For the instruments where type is already identified in the Typical P&ID / data sheets, the Bidder shall follow the same. However during the detail engineering/ procurement stage if it is found that a different type of instrument is most suited for a particular application then the same shall be referred to GAIL for their review, and if suitable, the changed instrument shall

be supplied by the bidder. Bidder shall also be responsible for selecting and reviewing the type of instrument where specifically indicated in P& ID.

Instrument selection and specifications shall be carried out as per specification, typical instrument data sheets and Standard Specifications in general, as appended by special requirements specified here in.

5.2 JOB SPECIFICATIONS FOR GAS METERING SYSTEM / PRESSURE REDUCTION SYSTEM PACKAGE

Refer Job specification for Gas Metering / Pressure Reduction package (doc. no. GAIL-STD-GN-DOC-JOB-001). The referred job specification together with the Typical P&ID, Process parameters, data sheets, standard specifications attached with the Package, defines the requirement for the design, engineering, manufacture, fabrication & assembly, integration, calibration, factory testing, supply, packaging, shipping and documentation including deliverables, statuary and other special approval, inspection, testing overall skid performance guarantee of Gas custody transfer. If required, then installation supervision, commissioning of skid as per terms & condition of the contract/ tender.

6.0 TESTING AND INSPECTION

6.1 GENERAL

6.1.1 All pressure boundary materials shall have certified material test reports (CMTRs) or certificate of compliance as per the design code. Certifications shall be in accordance to **EN 10204 Type 3.2 for pressure parts and Type 2.2 for other parts**. A system of positive material identification (PMI) shall be implemented for the items mentioned in PMI specification attached elsewhere.

6.1.2 Vendor shall submit the QAP & FAT Manual/ procedure to GAIL for review and approval. A typical GAIL QAP and FAT Manual/ procedure is attached elsewhere.

6.1.3 All materials and equipment shall be factory tested before shipment in the presence of Purchaser's representative. No material shall be transported to site until all required tests have been carried out and equipment is certified as ready for shipment. Acceptance of equipment or the exemption of inspection or tests thereof, shall in no way absolve vendor of the responsibility for delivering equipments meeting the requirements of the specifications.

6.1.4 Vendor shall furnish the following

- Material test certificate, Hydrostatic test certificate, certificates of radiography for all line mounted items/ instruments on the skid.
- Certificates from statutory body for hazardous area approval for all electrical items mounted on the skid.
- Calibration certificates, certificates for custody transfer, certificates for the conformity to the standards to be submitted.
- All other certificates mentioned in individual general specification.

6.1.5 Supplier shall perform the usual standard tests to maintain quality control procedures. These test certificates shall be submitted for review well in advance and before starting inspection by Purchaser. Supplier shall be responsible for testing and complete integration of the system. Detailed procedures of test and inspection shall be submitted by the supplier for review before order and mutually agreed upon.

6.1.6 In their offer, bidder shall include cost towards final inspection/ FAT by GAIL/ third party personnel at vendor's shop. For the final inspection (FAT) at their workshop, bidder shall provide required manpower, TPIA, consumable, tool, tackles equipment and utilities as required. For stage inspection and Final inspection, bidder shall deploy third Party Inspectors. Bidder shall propose to GAIL for GAIL's approval, a minimum of 03 nos. of TPI agencies, from which one shall be approved by GAIL.

6.1.7 Other inspection and testing requirements shall be as per respective Standard specifications of various instrument / equipment, items and recommendation of original equipment manufacturer.

6.1.8 Qualification of the TPI appointed by the Vendor/ supplier and deputed for witnessing at various stages of

Fabrication (like Hydro-test, FAT etc) shall be provided by the supplier well in advance for our review and confirmation. The TPI involved to witness shall have relevant experience. No TPI shall be deployed for our approval and FAT shall not commence without this.

6.1.9 Requirement of SCADA interface with Flow computers:

a. The interface between Flow computer and SCADA shall be through RS 485 or Ethernet (whichever is available with GAIL) for real-time polling.
b. In addition to communication through SCADA, GPRS Modem shall also be used for communication. For both Flow computers provided in the skid, the same shall be multi-dropped and serial interface shall be provided through a single RS-485 for SCADA connectivity.
c. Configuration of registers shall be done as per the attached Register List (doc. No. GAIL-STD-GN-DOC-GEN-004). Register Address shall be same as mentioned in the list. However there shall be provision for modification/ addition/ deletion (in list, number of inputs, address etc) as per site requirement, **which shall be provided by bidder without any financial implication to GAIL**.
d. All the Metering Skid parameters shall be provided to user through Serial Interface and same shall be demonstrated during FAT & also during commissioning of Metering Skid.
e. GC data and FCV Set Point writing facility in both flow computers shall be made available through the above interface and same shall be demonstrated during FAT & also during commissioning of Metering Skid.

6.2 **SKID Inspection** :

The following tests shall be conducted for the skid

a. Hydro testing for the integrated skid / individual pipe spools.
b. Pneumatic Leak test of complete skid at 7 Kg/cm2(g).
c. Skid functional testing considering metering, pressure regulation, limiting and safety characteristics. (Functional testing of Slam shut valves, regulators (PCVs) shall be demonstrated by simulation during FAT).
d. Skid piping material testing and NDT of welds as per piping material specifications. Radiography/ X-ray shall be carried out for all welded joints and vendor shall furnish test certificate for the same. Dye-penetration test certificate shall be provided for joints wherever radiography/ X-ray is not possible.
e. Radiography, X-ray, Charpy impact testing for line mounted instrument items such as Self actuated pressure control, pressure relief valves, slam shut valves, Flow meters and meter runs etc.
f. Testing and inspection requirements for skid piping materials shall be as per specifications attached else where in the bid package.

6.3 Skid Equipment

The following tests shall be conducted:

6.3.1 Requirements of non destructive testing like radiography, magnetic particle test, hardness test, hydro-test, Charpy test for Self actuated control valves, pressure relief valves, slam shut valves, flow meters, flow conditioner and meter runs shall be carried out strictly as per following specification.

a) 100% radiography shall be carried out on all casting. Radiography procedure and area of casting to be radio-graphed shall be as per ANSI B16.34 and acceptance criteria shall be as per ANSI B16.34 Annexure B. Two shots shall be taken for each area to be radiographed, as a minimum.
b) Radiography/ X-ray shall be carried out for all welded joints and vendor shall furnish test certificate for the same. Dye-penetration test certificate shall be provided for joints wherever radiography/ X-ray is not possible.
c) Each flow meter along with meter runs shall be subjected to hydrostatic test with a pressure of 1.5 times the design pressure.
d) Charpy impact test on each heat of base material shall be conducted as per A370 for all pressure containing parts such as body, end flanges and welding ends as well as bolting material for pressure containing parts. Unless specified otherwise, Charpy impact test shall be conducted at 0°C for all skid components provided/ installed at upstream of PRS system/ regulator. Charpy test shall be done at temperature indicated elsewhere for PRS section and downstream of components installed at downstream of PRS section. Charpy

impact test specimen shall be taken in the direction of principal grain flow and notched perpendicular to the original surface of plate or forging. The minimum average absorbed energy per set of three specimens shall be 27J with an individual minimum per specimen of 22 J.

6.3.2 Following tests, checks shall be conducted by bidder:

a) For metering systems, Physical/ dimensional checks and workmanship. Checking of meter tube roughness. Calibration including establishing linearity and repeatability over the entire range. Physical/ dimensional checks and workmanship, Checking of turbine meter tube roughness, flow meter Calibration including establishing linearity and repeatability over the entire range. Wet calibration of Turbine Gas Flow Meter at average metering (operating) pressure shall be performed along with the supplied flow conditioner/ straightener.

b) 7-Point Wet calibration of Turbine Gas Flow Meter at mean operating pressure shall be performed along with the meter run & supplied 19 tube bundle flow conditioner/ flow straightener at average operating pressure indicated elsewhere in the tender document. The minimum flow rate for calibration of Turbine meters shall be 8 ACMH or 2.5% of Meter Maximum (whichever is lower).

c) RPD flow meters shall be air calibrated at average pressure at minimum 7 different points/flow rate.

d) Functional and simulation tests including checking of hardware and software for Flow computers, gas flow meters along with all its sub-systems in fully integrated configuration.

e) All the panels, control panel/ solar panel along with all instruments mounted on it including flow computers, monitors, barriers, isolators, power supplies, Printers, indicators, barriers, isolators, power supplies, Modem, lamps and accessories etc.

e) Review of all certificates and test reports.
In the event the purchaser is unable to witness a test, the test shall anyway be completed by the vendor and documents for the same shall be submitted for scrutiny before shipment.

f) All tests as per Standard specifications attached with this bid document.

Flow meter, meter run, flow computer and accessories shall be offered for pre-dispatch inspection to GAIL and / or GAIL's representatives after confirmation of the above tests. Following tests shall be carried out by vendor at their works and test certificates shall be furnished:

Calibration / test certificates for all instruments. Calibration test reports for flow meters duly signed and certified from the recognized International laboratories / statutory weights and measures authority. Statutory body certificates for instruments. Type test report for enclosure of all electronics/ electrical equipment/ Radiographic / Charpy test certificates for flow meters and meter runs, FCV, valves. Material test certificate for all line mounted instruments. Dimensional test report Certificates for custody transfer application and other certificates mentioned elsewhere and Lab should be certified by ISO : 17025.

g) Wet Calibration of Flow meter may also be carried out at GAIL's meter proving facility, i.e GAIL Hazira.

6.3.4 In addition, vendor shall also refer the inspection & testing requirements of the standard specifications attached with the tender and follow the same.

6.3.5 Vendor shall include in his scope the shop inspection charges including factory acceptance test (FAT) inspection by GAIL's representative at vendor's works.

6.3.6 SLAM SHUT VALVES, PRESSURE REGULATORS, PRESSURE RELIEF VALVES

a. Testing to demonstrate set point accuracy and actuation time for Slam shut valves
b. Calibration certificate for Pressure relief valve set pressure. If required PSV shall be set at desired pressure / set point shall be checked during FAT.
c. Seat tightness test for PCVs, Slam shut valves and pressure relief valves and set point test for PCV (shall be conducted at manufacturer's shop and certificates shall be submitted)

6.3.7 The following certificates are required to be submitted during inspection for review before dispatch of materials :

- Verification of certificates as applicable for the material certificates, NDT reports like radiography/ X-ray/ die-penetration/ MP, etc., statutory certificates (from CCOE) for intrinsic safety and explosion proof, certificates of conformity etc.
- Visual verification for quantity, quality and workmanship.
- Hydro testing and pneumatic testing as applicable.
- Functional and performance testing including calibration, accuracy, repeatability testing.
- Seat leakage tests & hydraulic Pressure test, actuator cycling & fail condition tests for control valves
- Set pressure, reseat pressure & seat leakage for pressure relief valves.
- Calibration report of PT, TT, flow meter with meter run and flow conditioner/ straightener
- Radiographic test for thermo-wells etc.
- Bidder must detail out performance specifications of each item which shall be verified by bidder or bidder appointed agency/ Owner/ PMC during factory testing.
- Inspection and testing requirements as per the respective standard specification shall be referred.
- Bidder shall submit all test records / test results for records to purchaser as bound volume along with the test procedure for each test carried out.
- Acceptable criteria for Radiography and other NDT requirements for all the instruments/ instrument castings shall be inline with those specified in 'valve/ piping specifications' for the similar service. Valve specifications/piping specifications have been attached elsewhere in this package.
- CCOE certificate shall be supplied by the bidder for all instruments installed in hazardous area.
- Custody transfer application certificate for Flow computers and flow meters.

6.3.8 Wherever inspection at manufacturer's shop is waived because of any reason, the bidder shall carry out the inspection at vendor/ sub-vendor's shop and Bidder shall forward these inspection reports for verification by GAIL before dispatch. In no case, items shall be released without proper inspection/ verification.

6.3.9 The inspection and testing shall be carried out as per related specifications, international codes and practices/standards, approved documents and/or any other document attached along-with specifically suggesting extent of testing to be carried out at manufacturer's works.

6.3.10 Items for which 'Witness Inspection' is specifically exempted, manufacturer shall forward the test certificates as desired for review by GAIL.

6.3.11 Testing and inspection for all items shall be carried out as per approved factory testing procedures. The material shall be dispatched only after obtaining written dispatch clearance. For items where no testing is witnessed by the purchaser test certificate shall be forwarded for review before dispatch of such equipment

6.3.12 Contractor must detail out performance specifications of each item which shall be verified by contractor or contractor appointed agency/ Owner/ PMC during factory testing.

6.3.13 Inspection and testing requirements as per the respective standard specification shall be referred.

6.3.14 Contractor shall submit all test records / test results for records to purchaser as bound volume along with the test procedure for each test carried out.

6.3.15 Acceptable criteria for Radiography and other NDT requirements for all the instruments/ instrument castings shall be inline with those specified in 'valve/ piping specifications' for the similar service. Valve specifications/piping specifications have been attached elsewhere in this package.

6.3.16 CCOE / ATEX certificate shall be supplied by the bidder for all instruments, JB, installed/ for use in hazardous area.

6.3.17 Specification of Field Mounted (Solar panel powered) Flow Computer:

The flow computers shall be microprocessor based with digital display, data entry keyboard/ Touchpad and

modular in nature to cater to future GAIL requirements. Flow computer electronics shall be protected from industrial interferences; shock and vibration proof and have low power supply consumption.

For Field mounted flow computers approval for custody transfer applications by laboratory/ institutes authorized by weights and measures authorities such as NMI, PTB, NIST, Measurement Canada or certification for custody transfer from International Standard laboratories/ Institutes/ bodies such as Pigsar, Trans Canada Calibrations(TCC) Canada, Colorado Engineering Experiment Station Inc.(CEESI) USA GOST, South West Research Inc. (SWRI) USA shall be submitted.

The flow computers shall compute and display the instantaneous and totalised flow rate for each stream corrected for pressure and temperature variations. The flow computers receive data through GPRS modem from Gas chromatograph/ SCADA for calculation of compressibility factor as per AGA-8 detail method. The flow computers shall be microprocessor based, with keypad and alphanumeric display with AGA firmware for natural gas flow measurement. The flow computers shall be linked to the GAIL's RTU through GPRS for providing the flow measurements of the individual stream runs and related process variables.

For field mounted Flow computers, the port for Laptop connectivity shall be extended to access flow computer without need of opening JB (housing of Flow computer). Mounting shall be field mounted suitable for IEC Zone 2, Gr. IIA, IIB, temp. class T3 with NEMA 4 type enclosure made of carbon steel along with rain protection canopy.

POWER SUPPLY

Flow computer shall have low power consumption and solar powered with battery back-up suitable for 30 no-sunny days. The system shall be designed for supplying power to skid mounted electronic instruments like PTs, TTs, DPTs & I to Ps. Power consumption/load of all field instruments like transmitters, barriers, ball valve etc shall be considered for calculation of total load for battery sizing. Power sizing calculation shall be signed and stamped by flow computer vendor/manufacturer. Vendor shall submit power consumption sheet along with their bid/offer.
Low power transmitters shall be provided for metering Instruments (transmitters).

INPUT SIGNAL CAPABILITY:

a) Frequency & pulse signals from turbine meter: Min 02 Nos.
b) Pressure & temperature inputs for the calculation of standard flow. In place of Independent Metering PT (Pressure Transmitter) shall be independent and in built/ integral Pressure sensor is not acceptable. In place of Metering TT, signals from RTD shall be directly terminated in Flow Computer.
c) Analog inputs from other field transmitters. Flow computer shall be capable to provide 24VDC power to field transmitters (Loop Power) – Min 04 Nos.
d) Inputs through SCADA/ GPRS Modem/ key pad entry for Flow control/ pre-paid/ nomination value set point.
e) Min 04 Nos of Discrete inputs from SDV/ Ball valves.
f) Other standard inputs available.

INTERFACE CAPABILITY WITH OTHER FOREIGN DEVICES:

Vendor shall provide serial links along with cables and connectors at both ends for all the signals with MODBUS protocol to communicate with SCADA for real time monitoring and control including nomination based control.
Flow computers shall also be interfaced with GAIL's RTU's through GPRS modem to get gas temperature and pressure, energy flow rate and total energy, corrected & uncorrected volumetric flow rate and total flow, last day's cumulative energy and volume, current day's running volumetric total and energy total, volume and energy integrated at 6 a.m., gas composition (mole% of C1, C2, C3, iC4, nC4, iC5, nC5, C6+, N2, CO2), Specific gravity, calorific value (GCV/ NCV) etc. The digital and analog data shall be made available to SCADA and it shall be mapped in the contiguous registers so that data can be fetched/ written in minimum transactions. Provision shall also be kept at flow computer for writing data like gas compositions, calorific value etc. from SCADA.

Vendor shall furnish all details like pin configuration and signal wise MODBUS address mapping list etc. for

smooth interfacing of this communication link with SCADA.

Vendor shall also furnish the details of implemented MODBUS protocol like function codes for read and write, CRC implementation, BCC implementation, register addressing methods / mapping etc. during detail engineering for serial interfaces to SCADA. Vendor shall supply connectors and cable for interfacing with laptop.

KEYBOARD CAPABILITY:

The data entry (Min 8 Line * 20 Character) keyboard shall have the provision to enter the following:

- Pressure and temperature base factor
- Specific gravity and scaling factor
- Mol % or composition of the gas to be metered
- Report headings, frequency and timing of reports
- Selection of parameter to be displayed and on-demand printing of reports
- Linearization of error curve & change of K-factor
- Trending of liver parameters shall be available on display
- It shall be possible to calibrate analog input channel from display
- Alarm indication LED shall be available on display
- Flow set-point to FCV controller through Keypad/ remotely through GPRS modem.
- Other standard features available

The flow computer shall have provision to enter default values of all inputs (including gas chromatograph) low/high alarms for all inputs (including gas chromatograph) and shall be user configurable. The flow computer shall use the default values in case any input goes beyond low/high limit.

OUTPUT CAPABILITY:

- RS232/USB output link for laptop / configurator. (Necessary converter for USB to be provided)
- 4 to 20 mA Output for flow control (PID Output)
- 1 nos. of digital output for valve control – nomination/ pre-paid
- 1 no. of serial port for GPRS communications
- Other standard outputs available. (Galvanic isolation is required for all inputs and outputs)
- 1 no. of additional (Spare) port shall be provided in Flow computer for SCADA communication via RS 422/ 485/ 232 (user selectable). Default shall be RS485.

COMPUTATIONAL CAPABILITY:

a) Volume flow rate at standard, normal or operator specified base conditions (Sm3/hr)
b) Integrated corrected volume in SCM.
c) PID algorithm for Flow control.
d) Energy flow rate and integrated energy (user configurable in kcal, MJ & MMBTU).
e) Linearization of error flow curve and meter factor.
f) Calculation of compressibility factor as per AGA-8 detail method.
g) Previous day's flow / energy (i.e. yesterday's 6.00 A.M total volume / energy to today's 6.00 A.M total volume / energy) & current running total for the day (i.e. volume tantalizer/ integrator value at 6.00 A.M from first day) to be stored in a separate location (register) and these shall be user configurable.
h) Today's accumulated flow/ energy (running total since morning 6.00 A.M to current time) and shall be user configurable.
i) Generation of reports for totalized volume & energy at daily (6 a.m), weekly, fortnightly & monthly intervals, flow rate, pressure, temperature, compressibility factor, alarms etc. shall be user configurable.
j) Flow computer shall have local intelligence for acceptance of nomination/ Pre-paid metering/controlling value from centralized SCADA/ host server. The flow computer then needs to keep track of gas consumed/ delivered to customer and enable control upon reaching set-point. Nomination/ Prepaid metering alarm/output will drive the valve after set-point value has been reached and intimation should be made available to centralized SCADA by flow computer.

All the above data shall be made available locally as well as remotely.

STANDARDS USED:

For the above, applicable standards are:

a) AGA report-7 for Turbine gas flow metering system
b) AGA report-8 for Flow computers for characterization method to determine compressibility factor, super compressibility factor, density etc. (same shall be used in supplied for flow computers).
c) Validation of Flow Computer (Comparing of Flow Computation with standard software) confirming to latest AGA-7 (latest version) / AGA 5 / AGA-8 / GPA 2172 / GPA 2145/ ISO 6976 to be submitted for all the flow Computers separately. Flow calculation verification sheet shall be provided with each mentioned standard and same shall be demonstrated during FAT and also during site acceptance/ commissioning at site.

ENGINEERING UNITS (User Configurable) :

Volume flow rate -Sm3/hr, Mass - kg/hr, Pressure - kg/cm2g, Energy – MMBTU / MCal / MJ/ (user selectable), Temperature - °C, Primarily the unit of measurement for Pressure, Temperature, total energy and Energy flow rates shall be Kg/Cm2g, ^{0}C, MMBTU and MMBTU/hr respectively.

MEMORY TYPE: Non volatile

ACCURACY, A/D AND D/A CONVERTORS:

Calculation accuracy shall be better than or equal to ± 0.05% of full scale including linearity, hysteresis, repeatability and resolution. Accuracy for analogue inputs and outputs shall be 0.1% or better.

SCAN PROCESSING TIME:
a) The interval between computer readings of Process variables shall not exceed 1 sec.
b) The interval between each cycle for computation of instantaneous flow rate and totalized flow shall be less than 1 sec.
c) Algorithm and rounding off error for computation shall be with in ± 0.001% of Computed value

SECURITY: 3-Level password protection should be a standard feature in Flow computer.

DISPLAY CAPABILITY:

The flow computer shall have the capability to display the following parameters: Uncompensated volume flow rate, Compensated volume flow rate, Integrated volume (corrected and not corrected),Density/Specific gravity, Pressure, Temperature, Energy rate & total energy, Complete gas composition, Calculated parameters (compressibility factor etc.), Current accumulation, previous day accumulation, Data entry, Error codes, Selected parameter codes, Alarms (process and systems) including diagnostic message, Engineering units as per selected parameter, Other standard displays available. Custody transfer flow computers shall have audit trail, all the above data shall also be made available by vendor in the serial links to RTU. Calibration of analog input channel should be possible from local display. The display should also have process alarm indication facility for ease of operator use.

DISPLAY TYPE: Alphanumeric LCD display with 8 line 20 character

Enclosure: NEMA-4 carbon steel enclosure with additional rain protection canopy/ shed is required.

DIAGNOSTICS:

Flow computers shall have elaborate and sufficient on-line diagnostics to ascertain accurate and proper functioning of the flow computer. Results of diagnostics/ checking shall be displayed on FC. Facility for easy testing of the accuracy shall be provided. Provision for high and low limit check for each input, sensor break, saturation and alarms shall be provided.

Other features:

GAIL intends to have remote connectivity with each flow computer for the purpose of changing of remote
a) Remote/ Local, Open/ Close operation of FCV through GPRS Modem Communication.

Any Hardware/ software required for configuration of Flow Computer, shall be supplied by the bidder.

7.0 DOCUMENTATION

7.1 Detailed drawings, data and catalogues required from the Vendor are indicated in vendor data requirement sheet. The required number of reproducible and prints should be dispatched to the address mentioned, adhering to the time limits indicated.

7.2 Final drawings from the Vendor shall include dimensional details, weight, mounting details and any other special requirements etc for the skids. All dimensions in general shall be in millimeters.

7.3 Vendor shall furnish all the required software, manuals necessary to test, operate and maintain the system. All the certificates, licensed softwares etc shall be provided in name of GAIL (India) Ltd.

8.0 MISCELLANEOUS

8.1 NAME PLATE IDENTIFICATION

In addition to the instruments and equipment nameplate, the structural skid (each part of skid) shall be supplied with a permanent, weather resistant, stainless steel nameplate affixed to the skid, with the following details, as a minimum:

- Project Title and SOR item number/ location.
- Owner's logo and Owner name
- Equipment name and tag number
- Manufacturer's name and skid serial number, skid capacity
- size, rating, flow capacity of individual component like Filters, PRS (SSV, Regulators), Meter, FCV etc.
- Skid part number and overall dimension data.
- Skid weight data.

Each skid and each part thereof and all the instruments in the skid shall have a Stainless steel nameplate attached firmly to it at a visible place furnishing the following information:

- Tag number of the skid.
- Project Name with location: " GAIL (I) Ltd, ----------(name of site/ station)"
- PO No.-
- Inlet size (in inch) and Outlet Size (in inch) with class rating
- Min/ Normal/ Max. Flow capacity in SM3/Hr. for each of the Filtration, PRS and Metering section
- Tag number of Instruments, JB as per purchaser's data sheets
- Body sizes with class rating in inches and the Valve Cg value or flow meter G-Rating (as applicable)
- Set pressure range and flow capacity of pressure safety valves
- Flow range in SM3/hr (SCMH)/ G-rating for Flow meters
- Rating for all the individual instruments
- Original Manufacturer's name and model number of Filtration, Regulators, Flow meter, FCV etc

All cable should have tag no. at JB/ panel end and Instrument end. All wires terminated inside skid and JB should have identification mark, ferrules etc. (for the termination of supplied cables, Identification Tag no, Ferrule etc. shall be provided by bidder).

9.0 SHIPPING & PACKAGING

- Vendor shall indicate the shipping and packaging methodology for each pieces of skid along with its size, weight and no. of pieces.
- Vendor shall try to fix as many types of equipment/ instruments as possible in skid before shipment.
- If any of the items are shipped loose, then it shall be properly packed inside metallic or wooden cartoon with identification tags painted on it. Loose materials, spares etc for any two skid shall not be mixed in one cartoon/ package. A System of tagging, segregation to be followed for easy identification of parts and due care to be taken to avoid intermixing of some parts of different skids.

The purpose of packaging is to ensure safe delivery of material at site without damage during transit with respect to packaging of skids and its accessories prior to dispatch from the Vendor's Workshop/ factory, the following points shall also be noted:

- Stainless Steel Name plate (of size 12" X 8") bearing all necessary project details and details of skid/ its components should be fixed and provided on each segment/ part of the metering skid
- All the spares, Instruments (including gauges, flow computers, transmitters etc) must be supplied in a lockable box for ease of opening at site for verification at site.
- Metal plates (of size 4" X 3") must be fixed/riveted on each box/package containing spares and other items and the following information must be engraved/ painted on each metal plate – Vendor name (supplier), Purchase Order No., SOR item No. and other relevant PO details must be provided on name plate. Tags (bearing type, size, number of cores, length etc) shall be also provided on all cables being supplied as loose for installation at site.
- Loose items should be properly packed and tagged/ marked for easy identification
- Proper identification mark must be present on the control panels, enclosures, JBs etc., being supplied loose.
- Bubble wrapping as well as transparent sheet (stretchable film) wrapping shall be provided for all loose materials including control panel, spares and loose electronic items. Water proof packaging shall be ensured by vendor.
- Indicative Packing list (indicating identified loose items and its box number) shall be prepared well in advance and same shall be provided during Factory acceptance test (FAT) for our review/ comments.

10.0 PERFORMANCE GUARANTEE

10.1 The VENDOR shall guarantee that all work/ job will be performed in accordance with good and sound engineering and construction practices and within the requirements of this specification. The equipment, accessories and all the materials supplied by the VENDOR shall be free from defects, shall be suitable for the use for which they are intended and shall perform in accordance with the requirements of this specification.

10.2 The VENDOR shall furnish a guarantee for the entire skid package comprising of all of its component/ equipments including instruments, piping, valves, fittings, internals, etc., for a period of 12 months from the date of commissioning or 24 months from the date of receipt at GAIL store/ site, whichever is earlier.

10.3 The VENDOR shall take single point responsibility for the complete skid, including the sub-contractor supplied components, the proprietary equipment and components included in skid package and supplied loose in accordance with this specification.

11.0 INSTALLATION AND COMMISSIONING OF METERING SKID

11.1 The VENDOR shall depute **qualified and experienced** personnel for supervision of installation, field-testing and commissioning of the equipments.

11.2 Refer bidder's scope of supply, Installation and commissioning (doc. No. GAIL-STD-GN-DOC-GEN-001).

11.3 **INSTALLATION REQUIREMENTS**:

- All instruments shall be accessible from grade or a platform for operation and maintenance.

- Bidder shall consider the, "GAIL installation standards "as attached or equivalent for installation of each instrument. In case, any instrument require a special installation or any instrument not provided with installation standard the bidder shall prepare the standard and get it approved from GAIL along with other documents.
- Impulse tube/ pipe of size ½" shall be used as impulse lines. The Impulse pipe/ pipe fittings for instrument installation shall be as per the piping material specifications of respective process lines. Tubing when used between manifold and the instrument shall be, 12mm OD with SS316 material of construction as a minimum. The material selected shall be suitable for the process fluid conditions.
- Instrument in gas service are to be installed only above or at least parallel to the tapping with a slope in the impulse towards the tapping to achieve self-draining condition.
- Pressure Relief valves to be installed in line only after proper flushing of the lines.
- No unions shall be used in impulse lines instead break flanges shall be used.
- Plug/ globe valves in combination with Ball valve shall be used for isolation and vent & drain valves, however combination of Ball valve and plug/ globe valves shall be used for equalizing service. All the vent / drain lines shall have combination of first valve as Ball valve and second one as Globe / plug valve.
- Minimum ½" sized valves shall be used for Instrument isolation.
- Impulse piping is to be suitably painted (except SS 316 tubing)
- Schedule 80 seamless pipe with at least 3000 lb rating fittings should be used as a minimum for impulse piping.
- Tube fitting shall be double ferrule type.
- Based on the installation standards for each type of instrument, bidder shall prepare Bill of materials (BOM) which indicates the requirements of different materials for installation of each instrument. However completeness of BOM is bidder's responsibility.
- Mounting of field instruments (if remote mounted)/ JBs on the stanchion or instrument support shall be at the height of 1.3M from the grade level / finished floor level.
- The installation and erection materials like, cables (signal, control, thermocouple extension and power), cable glands, junction boxes, instrument valves and manifolds, impulse pipe and pipe fittings, pneumatic signal tubes, instrument air line fittings and valves and cable trays required for installation of complete instrumentation shall be as per standard specifications enclosed in this tender. Power supply for different instruments/ equipments having different power/ voltage rating shall be installed in different JBs.

11.4 **LOOP CHECKING AND COMMISSIONING**

11.4.1 Bidder is fully responsible for all work related to loop checking (inside the skid), including cable laying, tray work, dressing, identification, ferruling, calibrations, loop testing.

11.4.2 Bidder shall be responsible for commissioning of each & every equipments installed in the skid. (Functionality, simulation for these equipments shall be demonstrated during FAT).

11.5 Manpower required for supervision for Installation and commissioning of Metering Skid shall be deputed unconditionally on request of GAIL/ GAIL's Representative/ site In-charge.

12.0 BID REQUIREMENTS

Bidders Proposal shall include the following (as minimum):

12.1 Vendor's proposal including sizing calculation, datasheet, catalogues, drawings, etc. shall be in ENGLISH language only.

12.2 It is compulsory that bidder utilizes uniform data sheet formats enclosed along-with this document, for preparing specifications for various instruments / equipments, including those, which are being prepared by package/ sub package vendors. Additional information shall be provided in the given data sheets, if necessary. Items for which no format has been attached with the document, bidder may use standard ISA formats. Use of manufacturer standard formats shall be avoided.

12.3 All units of measurements in vendor's specification sheets shall be same as those in purchaser's data sheets and all material specifications for the various parts in the vendor's specification sheets shall be of the same standard as those in purchaser's data sheets.

12.4 Vendor shall enclose catalogues giving detailed technical specifications, selection guide for

decoding Model no. of offered equipments/ instruments and other information for slam shut valve, self actuated pressure control valves, flow control valve, flow meters, flow computers, pressure relief valve, pressure/ differential pressure transmitter, temperature transmitters, Ball valves, plug valve, globe valves, etc. covered in the bid.

12.5 The Bidder shall submit all the formats including Data sheet, P&ID, Checklists, sizing calculations, noise calculations, Bill of material, Equipment Qualification Certificates, Logistic support certificates etc. duly filled, signed and stamped by the bidder. Make and model nos. must be indicated in all relevant places. These documents must be submitted individually for each SOR item separately.

12.6 Vendor shall submit details of specifically offered make and model of equipment/ instrument along-with the bid. Alternative/ equivalent items is not acceptable and "**Make / equivalent" must not be mentioned for any item.**

12.7 Bidder's proposal shall include SOR wise details for all items of filtration, Gas pressure reducing and metering skids packages. The proposal shall include:

i) Make, Model number and detailed specification along with technical details and catalogue for each applicable item of metering skid like filter, Slam shut valve, self actuated pressure control valve, flow meter, meter tube details, FCV, flow computer, pressure relief valve, pressure/ differential pressure transmitter, Temperature transmitters, Ball valves, plug valves, Globe valves, Check valves etc.

ii) Slam shut valve, self actuated pressure control valve details including type, construction material, CV data/ capacity curves, regulation accuracy, set point spring ranges, details of the valve pilots etc.

iii) P&ID for complete skid to be submitted by bidder based on the typical P&ID (line diagram) and other specifications of the tender.

iv) Detailed Sizing calculations for filtration system, slam shut valves, self actuated pressure control valves (Regulator Valves), Flow control valve, flow meters and pressure relief valves.

v) Calculation for Gas velocities and Pressure drop across complete skid to be submitted by the bidder. It shall include drop across Filtration, slam shut valves, PCV (Regulator), FCV, Flow meter and meter runs and the entire system including all the components, equipments, Instruments. The overall pressure drop across the entire skid shall be minimum.

vi) Vendor to provide Detailed Noise calculations (and standards used and assumptions considered, if any) for self actuated pressure control valves (active and monitor) and Flow control valves.

vii) Bidder shall provide Type approval certificate for quoted gas flow meter, flow computers for custody transfer application along with the bid.

viii) Bidder shall provide Type approval for quoted make and model of Slam shut valve and Regulator (active/ monitor PCV), as per tender specification.

ix) Completely filled Datasheet of all the components/ items of skid with selected make and Model of equipment/ Instrument. Bidder can select and offer any two (2) different make of all major components like valves, filtration, QOEC, Flow meter, Flow control valve,

Regulator, Slam shut valves etc. from the approved vendor list, provided as list of Vendor for Bought - Out Items (doc. No. GAIL-STD-GN-DOC-GEN-004). However all documents including datasheet, sizing calculation, noise calculation, catalogue must be submitted for the both offered makes. If certain documents of any/ all the offered make are not submitted with the bid, the same is likely to be rejected without seeking any clarification. Only those make shall be considered for evaluation, for which complete information and all the relevant documents have been submitted by the bidder.

x) Equipment(s)/ Instrument(s) of any make which is offered by one bidder and acceptable to GAIL shall be accepted for other bidder also. After placement of order, on request of the successful bidder list of other qualified makes for a particular item (for which successful bidder wants to change the vendor) shall be provided.

xi) Weight of each skid/ part thereof must be provided.

xii) Foundation details (suggestive) of the complete skid.

12.7 Vendor shall submit the sizing, rating details & specifications of all the instruments, fittings and piping items, make & model, skid details etc., subsequent to award of contract. The relevant catalogue, technical literature shall also be furnished. GAIL shall review the above and vendor to note that "No post order deviation shall be granted". If during detailed Engineering, it is observed that Make and Model of offered item is not meeting Tender specifications, Vendor shall change the make and/or models of items and specifications to meet the requirement of contract without any price and delivery implications.

12.8 Bidder shall also furnish details mentioned in Technical questionnaire (doc. No. GAIL-STD-GN-DOC-GEN-003).

12.9 VENDOR shall include in the bid, list of specific deviations**,** separately, if any, to this specification and all attachment thereof, otherwise, the quotation will be deemed to be in compliance with the specification requirements and subsequent claims for extra arising out of non-compliance with the specification will not be considered.

13.0 SPARES PHILOSOPHY:

Mandatory spares, commissioning spares and materials required for Erection and commissioning of Metering skid package shall be provided with Metering skid and the price for the same shall be included in the price of skid (There is no separate SOR item for these spares and offer for these spares shall not be provided separately). If the Metering skid consists of Filtration and Pressure reduction/ let down, spares for Filtration and Pressure reduction to be provided. Bidder shall provide all the relevant skid-wise spares for all the SOR items/ all the Skids. Spares for individual skids shall not be clubbed together.

13.1 **Mandatory Spares**: Shall be supplied separately with each skid as per the following list.

i) **For Pressure reduction system (for all SOR items):**

a) Repair kit for each type and size/ Model of Regulator/PCV (Diaphragm, O-rings, soft seat, cone etc) - 02 set
b) Repair kit for each type of pilot (Diaphragm, O-rings etc) - 02 set
c) Repair kit for SDV (Diaphragm, soft seat, O-rings etc.) - 02 set.

ii) **For filtration system (for all SOR items)**

a) Filter Element installed in each Filter - Twice the installed quantity in both the filtration unit. (if in both filtration combined element is 4 than total 08 need to be supplied as mandatory spares).

b) O-Ring for Filters (all type of O-Rings)– 01 set (each set shall consist of all the O-rings / gaskets Installed in both streams of Filters.) [If each Filter stream is having one set of O-ring, then total 2 sets of O-ring shall be supplied]

Bidder to supply all required spares (including soft seat) for supplied SSV, PCV(A) and PCV(M).

13.2 Installed Spares :

i) For All Field JBs :

20 % (minimum 1 No.) of installed quantity of terminals in field JBs shall be installed in excess than the required qty for future expansion.

GAIL INDIA LIMITED

JOB SPECIFICATION
FOR
GAS METERING SKID

GAIL-STD-IN-DOC-JOB-001

0	15.12.2019	Issued for Bid	RKS	UNU	UNU	
Rev	**Date**	**Purpose**	**Prepared By**	**Checked By**	**Approved By**	

CONTENTS

1.0 Introduction

1.1 General

1.2 Scope

This specification together with the P&IDs, Process data sheets, data sheets, standard specifications attached with the Package, defines the requirement for the design, engineering, manufacture, fabrication & assembly, integration, calibration, factory testing, supply, packaging, shipping and documentation including deliverables, installation supervision, commissioning and overall skid performance guarantee of various Gas Metering Skid packages to be installed at various connectivities. Metering packages are to be delivered at locations specified in SCC.

The environmental conditions, Process data, process condition, gas composition and the contractual obligations of the COMPANY shall also be considered for the design.

The VENDOR of the metering System shall provide detailed specifications of all the equipment that form part of the system.

This specification also lists the relevant international industry standards and practices, Local and Company Codes & standards, etc. to whose recommendations and guidelines the design of the Metering system shall be strictly adhered and stringently followed.

The objective of the specification is to provide a system that is:

a) Reliable and Accurate

b) Consistent and Compliant

c) Cost effective

d) Simple to maintain

e) Simple to operate

f) Flexible to accommodate changes in technology, operating requirements and future expansions / upgrades, as required.

g) Safe to operate and maintain

h) Environment friendly

2.0 CODES AND STANDARDS

2.1 The related standards referred to herein and mentioned below shall be of the latest editions prior to the date of the bid:

AGA - American gas association, Gas measurement committee

-AGA Report No. 7 Measurement of gas by Turbine meters

- AGA Report No. 9 Measurement of gas by Multi path Ultrasonic meters

- AGA Report No. 10 Speed of sound in Natural Gas & other Related Hydrocarbon Gases

- AGA Report No. 8 Compressibility and Super-compressibility for Natural Gas and other Hydrocarbon Gases. Transmission Measurement

- AGA Report No. 5 Energy Calculations in Natural gas

- AGA Report No. 3 Orifice Metering of Natural gas and Other hydrocarbon related fluids

ANSI/ASME- / American Society of Mechanical Engineers

B 1.20.1- Pipe Threads

B 16.5 - Steel pipe flanges and flanged fittings

B 31.8 -Gas transmission and distribution piping systems

ANSI/FCI - American National Standards Institute/ Fluid controls Institute

70.2 Control valve seat leakage classification

DIN- 43760 Temperature Vs Resistance curves for RTDs

IEC 801- Electromagnetic compatibility for industrial process measurement and control equipment

IGE/TD/13- Recommendation on transmission and distribution practice for pressure regulating installations for transmission and distribution systems

BS EN-50054-Electrical apparatus for the detection and measurement of combustible gases-General requirements and test methods

BS EN-50057-Performance requirements for Group-II apparatus indicating upto 100% LEL

NEMA 4 & 7-National Electrical Manufacturer's association

International Organization for Standardization (ISO)

Process Measurements Control Functions Instrumentation Representations

Natural Gas - Calculation of Calorific Value, Density and Relative Density.

ISO 12765 Measurement of Fluid Flow in Closed Conduits – Methods using Transit Time Ultrasonic Flow meters

ISO 10723 Natural gas – Performance evaluation for On-line Analytical Systems

ISO 5168 Measurement of Fluid Flow: Estimation of Uncertainty of Ultrasonic Flow meters

ISO 2186 Fluid Flow In Closed Conduits - Connections for Pressure Signal Transmissions Between Primary and Secondary Elements

ISO 6569 Natural Gas - Rapid Analysis by Gas Chromatography

ISO 6976/GPA2145-GPA2172 Natural gas - Calculation of Calorific Value, Density and Relative Density

ISO 6974/6975 –Natural gas-determination of composition with defined uncertainty by gas Chromatography & Natural gas extended analysis-gas chromatographic method.

ISO 170125: Calibration of all primary and secondary instruments

ISO 6142/6143- Traceability of calibration gas for gas chromatograph.

EN 334 European Standard for Gas pressure regulators up to Inlet of 100 bar

EN 14382 European standards for Safety systems

3.0 AREA CLASSIFICATION

The Custody transfer metering skid shall be installed outdoors and shall be suitable for installation in Zone 1 Gas Group IIA / II B Temp Class T3 hazardous area. The electronic equipment installed shall be certified by a recognized certifying authority in the country of origin or by an internationally recognized certifying authority and approved by the local authorities. The electronic equipment shall be suitable for continuous operation in the designated hazardous area. Intrinsically Safe (IS) shall be the preferred mode of protection for all instruments. Only where IS certified instruments are not available flameproof EEx' d ' certified instruments shall be considered. The junction boxes shall be certified as increased safety (EExe). Conduit connection shall not be used. Intrinsic Safety (IS) protection shall be achieved by providing Fused Galvanic Isolators with status indicating LEDs, located in the respective Metering Panels/ cabinets in the control room/ local equipment room in a safe area. The flow computers, Gas Chromatograph controller and electronic receiver instruments shall be installed in air-conditioned control room/ local equipment room, which is a non-hazardous area.

4.0 Environment Protection

All field instruments shall be suitable for reliable and continuous operation under the project environmental conditions specified. The field electronic instruments and junction boxes shall be certified weatherproof to IEC-60529 classification IP 65 as minimum for protection against moisture or dust ingress. The equipment located in field shall be designed to operate continuously in the following conditions.

Ambient air temperature range: 0-65 ^{o}C
Relative humidity range: 95%

The instruments and panels located indoor shall be certified weatherproof to IEC-60529 classification IP 42, minimum. The indoor equipment to be located in air-conditioned environment shall be designed in such a way that it is capable of operating for a minimum period of 48 hours in 30 days (Continuous) without any damage or degradation in the performance, in case of failure of air-conditioning system.

5.1 SELF ACTUATED PRESSURE CONTROL VALVES AND SLAM SHUT VALVES

5.1.1 Set point of the Gas pressure regulators (active//Monitor PCVs) and Slam Shut Valves (SDVs) shall be adjustable. Vendor shall furnish the adjustable range of the Gas pressure regulators and

slam shut valves.

5.1.2 The Gas pressure regulator and slam shut valves shall be provided in redundant pressure regulation stream as primary pressure regulating stream and secondary pressure regulating stream as per P&IDs. It is intended to provide slam shut valves on upstream of self-actuated pressure control valves at gas receiving points for tight shut off at increasing pressure beyond a preset limit, to take care of self-actuated pressure control valves failure. The slam shut valve of primary regulating stream shall close at its set pressure in case of failure of primary operating regulator & monitor and the secondary regulating stream shall come in operation. The automatic switchover shall be achieved with appropriate staggered setting of Pressure regulator and slam shut valves. Vendor shall select the appropriate set points such that the switch-over is smooth without affecting the safety of the system and gas supply to consumers is also not interrupted.

5.1.3 Each pressure regulator / monitor shall be designed for maximum gas flow rate at the minimum inlet arrival pressure. Gas pressure regulators shall be with very high rangeability since high fluctuations in flow demand are expected and also the inlet pressure may vary considerably.

5.1.4 Pressure regulators shall be self-actuated pilot operated with regulation accuracy of better than +/- 2.5% of set point.

5.1.5 The construction of the Regulators shall be such that there will be no continuous gas bleeding.

5.1.6 Leakage class for pressure control valve & slum-shut valve shall be class-VI as per ANSI B16.104

5.1.7 Vendor to note that the noise level for each Regulator valve shall be less than 85dBA at one meter away from the valves. Vendor shall provide noise treatment to limit the noise level and include silencers or expanders as required in their scope of supply. Vendor to provide Noise calculation giving full details and standards used and any assumptions considered in calculation. (This calculation shall be submitted along with the bid)

5.1.8 Slam shut valve shall be self-contained type requiring external control line such that the line pressure acts directly on the diaphragm.

5.1.9 Closing time of slam shut valve shall be less than 2 seconds for all sizes of the valves. Actual closing time of the valve shall be furnished by vendor with the quotation.

5.1.10 Slam shut valves shall be provided with position indicator and shall have separate limit switches for open and close positions. Limit switches shall be with DPDT, snap acting micro switch with contact rating 1 A @ 24 V DC. Limit switch enclosure shall be weather proof to IP 55 and flame proof (Exd) suitable and certified for area classification IEC Zone 1, Gr. IIA, IIB, T3. Cable entry shall be
½" NPT without flying leads.

5.1.11 Resetting of slam shut valves shall be only manual.

5.1.13 Slam shut valve shall have a set point accuracy of ±2.5% over the whole operating range.

5.1.12 Slam shut valves shall be provided with a mechanical indicator to indicate valve open or close position.

5.1.13 Slam shut valve shall have a set point accuracy of ±2.5% over the whole operating range.

5.1.14 Any by-pass valve provided for the slam shut valve shall be spring closing type.

5.1.15 Velocity at pressure regulating valve may increase beyond 20 meter per second however in the downstream pipe it shall be within 20 meter per second. Actual velocity shall be indicated by vendor. Seat velocity at SDV shall not increase beyond 40 meters / second.

5.1.16 Vendor shall furnish the flow rate versus trim lift curve to justify the valve rangeability and valve regulation characteristics.

5.1.17 The PCV & SDV shall be designed in such a way the noise generated by these equipments shall not interfere with the performance of the meter.

5.1.18 The self-actuating Pressure regulating valve shall be designed as per EN334 / Pressure Equipment Directive PED 97/23/EC covering the production quality assurance.

5.1.19 The Slam shut valve shall be designed as per EN14382 and Pressure Equipment Directive PED 97/23/EC covering the production quality assurance.

5.2 TECHNICAL SPECIFICATION FOR FLOW COMPUTER

The system shall be designed in such a way that complete skid (having duly mounted and completely wired Flow computers with Signal selector, Isolating IS barriers & accessories) should be powered through power available in control panel. GPRS enabled GSM Modem shall be used for Communication with remote station in case of non-availability of GAIL RTU.

Internal or external USB converter shall also be provided with each flow computer for connecting it to USB port of Laptop for configuration. Connecting cable from Flow computer to USB Port of laptop shall also be supplied for each skid.

The flow computer shall be certified for custody transfer applications by laboratory / institutes authorized by weights and measures authority of its country of origin such as NMI, PTB, Pigsar or other reputed International Standard laboratories such as Trans Canada Calibrations,(TCC) Canada, Measurement Canada, Colorado Engineering Experiment Station Inc.(CEESI) USA ,

The flow computers shall have an audit trail facility. It should be able to store data for 30 days.

Standard laboratories such as Trans Canada Calibrations, (TCC) Canada, Measurement Canada, Colorado Engineering Experiment Station Inc. (CEESI) USA.

The flow computers shall have an audit trail facility. It should be able to store data for 30 days.

The bidder has to submit the flow chart for Functional Design Specification of the flow computer.

All the configuration software shall be supplied with each skid. The license shall be in the name of “GAIL (India) Limited.

5.2.1 Control Room Mounted Flow computer

The flow computers shall be Microprocessor based, with digital display, data entry keyboard and alphanumeric display with AGA firmware for natural gas flow measurement. Flow computer electronics shall be protected from industrial interferences; shock and vibration proof and have low power supply consumption.

The flow computers shall compute and display the instantaneous and totalized flow rate for each stream corrected for pressure and temperature variations.

The flow computers receive data from the Gas chromatograph for calculation of compressibility factor as per AGA-8 detail method. The flow computers shall be linked to the GAIL's RTU for providing the flow measurements of the individual stream runs and related process variables.

All diagnostics available in Ultra Sonic Meter shall be replicated in Flow Computer also. For evaluation of measurement performance of Ultra Sonic Meter as per Appendix- C clause no 4 of AGA- 9, the Vendor has to select & quote suitable Flow Computer meeting the AGA recommendations.

Mounting shall be Flush panel type. General purpose enclosure.

POWER SUPPLY: 230 V AC ± 10%, 50 Hz ± 3% (UPS) or 24 VDC. The same shall be compatible of available power at control panel mentioned elsewhere.
230 Volts ac, 50 HZ shall be provided at single point in the control panel

INPUT SIGNAL CAPABILITY:

a) Frequency & pulse signals from ultrasonic flow transmitter (meter mounted electronics) and dual HF for meter (panel mounted)

b) 4-20 mA D.C. (2 wire) superimposed with digital signal (HART protocol) from 'SMART' pressure transmitter representing line pressure.

c) 4-20 mA D.C. (2 wire) superimposed with digital signal (HART protocol) from 'SMART' temperature transmitter representing line temperature.

d) RS 485/422 MODBUS from ultrasonic flow meter electronics for meter diagnostics and healthiness parameter.

e) Other standard inputs available.

f) Discrete inputs from ultrasonic meter electronics (if provided in the supplied US Meter)

INTERFACE CAPABILITY WITH OTHER FOREIGN DEVICES:

Vendor shall provide serial links along with cables and connectors at both ends for all the signals with MODBUS protocol. The communication between flow computers and on line GC & SCADA, shall be through serial communication and also through GSM modem in-build or separately installed with the flow computers.

- **WITH GAS CHROMATOGRAPH**

Flow computer shall be interfaced with Gas chromatograph for feeding online gas composition to flow computer through a modbus serial link. Vendor shall be responsible for proper integration of their flow computer with gas chromatograph. Vendor shall provide all necessary hardware, software etc. in vendor's supplied systems and other details required for interfacing of their Flow computers. The flow computer shall calculate the Gross Energy, Net energy, Gross heating value and the Net Heating value of the flowing gas based on the GC data as per GPA 2145 and GPA2172 and ISO6976 (User configurable).

- **WITH RTU (For all flow computers):**

Flow computers shall be interfaced with GAIL's RTU to get gas temperature and pressure, energy flow rate and total energy, corrected & un- corrected volumetric flow rate and total flow, last day's cumulative energy and volume, current day's running volumetric total and energy total, volume and energy integrated at 6 a.m., gas composition (mole%C1, C2, C3, iC4, nC4, iC5, nC5, C6+, N2, CO2, Specific gravity, Calorific value) etc. Contractor to note that SCADA vendors shall provide RS 232 serial link at the RTUs for interfacing of intelligent electronic devises like flow computers. For flow computer interface to RTU, vendor shall accordingly provide RS 232 link (Modicon Modbus ASCII & RTU protocol supporting IEEE single precision floating point no. with user configurable register). The digital and analog data shall be made available to RTU (SCADA) and it shall be mapped in the contiguous registers so that data can be fetched/written in minimum transactions. Provision shall also be kept at flow computer for writing data from RTU like gas compositions, calorific value etc. from RTU.

Vendor shall furnish all details like pin configuration and signal wise MODBUS address mapping list etc. for smooth interfacing of this communication link with RTU (SCADA).

Vendor shall also furnish the details of implemented MODBUS protocol like function codes for read and write, CRC implementation, BCC implementation, register addressing methods/mapping etc. during detail engineering for serial interfaces to SCADA (RTU).

Vendor shall supply 25 meter of interface cable (RS232) between the Flow computers and RTU along with connectors at both ends & necessary converters and other cables accordingly for each flow computer.

KEYBOARD CAPABILITY:

The data entry keyboard shall have the provision to enter the following:

(a) Pressure and temperature base factor, **Atmospheric pressure as per site condition**
(b) Specific gravity and scaling factor
(c) Mol % or composition of the gas to be metered
(d) Report headings, frequency and timing of reports
(e) Selection of parameter to be displayed and on-demand printing of reports
(f) Calorific value(GCV and NCV)
(g) Flow, pressure, temperature and density values and give compensated flow for any external conditions
(h) Linearization of error curve & change of K-factor, meter factor
(i) Other standard features available

The flow computer shall have provision to enter default values of all inputs (inclusive of gas chromatograph) low/high alarms for all inputs (inclusive of gas chromatograph) and shall be user configurable. The flow computer shall use the default values in case any input goes beyond low/high limit.

OUTPUT CAPABILITY:

(a) 4-20 mA compensated volume flow rate, line pressure, line temperature and energy rate (or mass flow rate) (4 Nos.)

(b) Contact alarms output for unit malfunction, process alarm like low pressure etc. (3 nos.).

(c) RS 232/ 485/ 422 (selectable as per user requirement) serial output link for SCADA/RTU/telemetry link for all signals as specified elsewhere. Default serial communication shall be RS485, however, type of serial communication shall be given during detailed engineering

(d) RS232C serial link for owner's PC for reports

(e) Serial port for printers

(f) Ethernet port for interface with LAN connection of GAIL for getting web enabled data of the flow computer.

(g) Other standard outputs available. (Galvanic / Opto- isolation is required for all inputs and outputs)

(h) Additional USB port for connecting laptop (internal or external shall be provided with each flow computer for connecting it to USB port of Laptop for configuration). Connecting cable from Flow computer to USB Port of laptop shall also be supplied for each skid.

(i) Output (4 to 20 mA) for flow control valve.

COMPUTATIONAL CAPABILITY:

(a) Volume flow rate at standard, normal or operator specified base conditions (Sm3/hr). Initially configured at Base pressure :1.033227 kg/cm2 abs, Base temp : 15.556 dec C)
(b) PID algorithm for Flow control.
(c) Integrated corrected volume in SCM
(d) Energy flow rate and integrated energy (user configurable in MCal, MJ & BTU).
(e) Heating value calculation as per ISO-6976/GPA2145-GPA2172 (User configurable). Initially configured as per GPA 2145.
(f) Linearization of error flow curve.
(g) Generation of standard and user defined reports at printer. All reports shall be user configurable.
(h) Calculation of compressibility factor as per AGA-8 detail method.
(i) Previous day's flow / energy (i.e. yesterday's base time total volume / energy to today's base time A.M total volume / energy) & current running total for the day (i.e. volume tantalizer/ integrator value at base time from first day) to be stored in a separate location (register) and these shall be user configurable.
(j) Today's accumulated flow /energy (running total since morning 6.00 A.M to current time) and shall be user configurable.
(k) Generation of reports for totalized volume & energy at daily, weekly, fortnightly & monthly intervals, flow rate, pressure, temperature, compressibility factor, alarms etc. shall be user configurable.
(l) Speed of Sound comparison should be done in the stream flow computer for the speed of sound measured value from the USM and the speed of sound calculation based on the GC component data as per AGA 10. If the difference between the SOS between the actual and the calculated one is more than the permissible limit then the flow computer shall generate an alarm All the above data shall also be made available by vendor in the serial links to RTU.

STANDARDS USED:

For the above, applicable standards are:

(a) AGA report 3, 7 and 9 for flow rate and total flow for meter (as applicable)

(b) AGA-8 characterization method to determine density, compressibility, super compressibility factor etc. for flow computers

(c) AGA Report 5/GPA 2145-GPA2172/ISO6976 for energy rate and integrated energy (should be user selectable as per requirement).

ENGINEERING UNITS (User Configurable):

Volume flow rate -Sm3/hr,
Mass - kg/hr,
Pressure - kg/cm2g,
Energy – Mcal/MMBTU/ MJ (user selectable),
Temperature - °C,
Primarily the unit of measurement for Pressure, Temperature, total energy and Energy flow rates shall be Kg/Cm2g, Deg. C, MCal / MMBTU (user selectable) and Mcal/Hr or MMBTU/hr (User selectable) respectively.

MEMORY TYPE: Non volatile

A/D AND D/A CONVERTORS:

Calculation accuracy shall be better than ± 0.05% of full scale including linearity, hysterisis, repeatability and resolution. Accuracy for analogue inputs to be minimum 0.075% and for analogue outputs accuracy shall be minimum 0.1%.

SCAN PROCESSING TIME:

a) The interval between computer readings of Process variables shall not exceed 1 sec.
b) The interval between each cycle for computation of instantaneous flow rate and totalized flow shall be less than 1 sec.
c) Algorithm and rounding off error for computation shall be with in ± 0.001% of computed value

SECURITY:

The custody transfer equipments at field like PT & TT shall be installed in a environmental enclosure duly locked for prevention of unauthorized data entry and to minimize the effects of ambient temperature variations. The size of the cabinet shall be suitable for removing and fixing of transmitters, ease of maintenance. The transmitters shall be fixed in mounting brackets inside the cabinet. The cabinet shall be mounted and fixed in the skid.

3-Level password protection should be a standard feature in Flow computer.

DISPLAY CAPABILITY:

The flow computer shall have the capability to display the following parameters:

Uncompensated volume flow rate, Compensated volume flow rate, Integrated volume (corrected and not corrected), Mass flow rate, Integrated mass, Density/Specific gravity, Pressure, Temperature, Energy rate & total energy, Complete gas composition, Calculated

parameters (compressibility factor etc.), Current accumulation, previous day accumulation, Data entry, Error codes, Selected parameter codes, Alarms (process and systems) including diagnostic message, Engg. units as per selected parameter, Other standard displays available, and Custody transfer flow computers shall have audit trail, All the above data shall also be made available by vendor in the serial links to RTU.

DISPLAY TYPE: Alphanumeric LCD display

DIAGNOSTICS:

Flow computers shall have elaborate and sufficient on-line diagnostics to ascertain accurate and proper functioning of the flow computer. Results of diagnostics/checking shall be displayed. Facility for easy testing of the accuracy shall be provided. Provision for high and low limit check for each input, sensor break saturation and alarms shall be provided.

Flow Computer Validation Software:
Supplier to provide licensed Software in the name of Client for authenticating the algorithm written in the Flow Computer as per AGA-3, AGA-7, AGA-9(as applicable).

General Remarks:

a) The software for Configuration of flow computer, Audit trail and history retrieval from flow computer shall be supplied by bidder.
b) Master/ Slave configuration should be possible in Flow Computer for Serial communication with GAIL's GC. Sufficient output ports shall be envisaged to establish communication with 2 sets of Flow computers installed at different locations.
c) The Flow computer should reject the GC data during GC calibration / Cal. Check and should use the previous data for calculation.
d) Audit Trail feature should display detailed description, old and new value of parameter changed along with time stamp.
e) The Flow computers should accept GC data through GPRS enabled GSM Modem or SCADA or Serial link (user selectable). Spare port shall be provided in Flow computer for SCADA communication via RS 422/ 485/ 232 (user selectable).
f) Alarm should appear when there is Loss of signal/ HF Pulse from meter. g) Where ever possible, HF pulse shall be used for RPD meters.

5.2.2 Field Mounted (and Solar panel powered) Flow computer:

The flow computers shall be Microprocessor based, with digital display, data entry keyboard. Flow computer electronics shall be protected from industrial interferences; shock and vibration proof and have low power supply consumption.
For Field mounted flow computers approval for custody transfer applications by laboratory / institutes authorized by weights and measures authorities such as NMI, PTB, NIST, Measurement Canada or certification for custody transfer from International Standard laboratories/ Institutes /bodies such as Pigsar, Trans Canada Calibrations (TCC) Canada, Colorado Engineering Experiment Station Inc. (CEESI) USA GOST, South West Research Inc. (SWRI) USA shall be submitted.

The flow computers shall compute and display the instantaneous and totalised flow rate for each stream corrected for pressure and temperature variations. The flow computers receive data through GSM modem from Gas chromatograph/SCADA for calculation of compressibility factor as per AGA-8 detail method. The flow computers shall be microprocessor based, with keypad and alphanumeric display with AGA firmware for natural gas flow measurement. The flow computers shall be linked to the GAIL's RTU

through GSM for providing the flow measurements of the individual stream runs and related process variables.

For field mounted Flow computers, the port for Laptop connectivity shall be extended to access flow computer without need of opening JB (housing of Flow computer).

Mounting shall be field mounted suitable for IEC Zone 2, Gr. IIA, IIB, temp. class T3 with NEMA 4 type enclosure.

POWER SUPPLY: Solar powered with battery back-up suitable for 30 no-sunny days. The system shall be designed for supplying power to skid mounted electronic instruments like PTs, TTs, DPTs & I to Ps.

INPUT SIGNAL CAPABILITY:

a) Frequency & pulse signals from meter.
b) Pressure & temperature inputs for the calculation of standard flow. In place of Independent Metering Transmitters, the Metering PT/ TT can also be in built/ integral.
c) Analog inputs from other field transmitters.
d) Inputs through SCADA/ GSM Modem/ key pad entry for Flow control valve set point.
e) Other standard inputs available.
f) Discrete inputs from SDV.

5.2.2.1 INTERFACE CAPABILITY WITH OTHER FOREIGN DEVICES:

Vendor shall provide serial links along with cables and connectors at both ends for all the signals with MODBUS protocol to communicate with SCADA.

Flow computers shall be interfaced with GAIL's RTU through GPRS enabled GSM modem to get gas temperature and pressure, energy flow rate and total energy, corrected & un-corrected volumetric flow rate and total flow, last day's cumulative energy and volume, current day's running volumetric total and energy total, volume and energy integrated at 6 a.m., gas composition (mole% of C1, C2, C3, iC4, nC4, iC5, nC5, C6+, N2, CO2), Specific gravity, Calorific value (GCV/ NCV) etc. The digital and analog data shall be made available to SCADA and it shall be mapped in the contiguous registers so that data can be fetched/ written in minimum transactions. Provision shall also be kept at flow computer for writing data like gas compositions, calorific value etc. from SCADA.

Vendor shall furnish all details like pin configuration and signal wise MODBUS address mapping list etc. for smooth interfacing of this communication link with SCADA.
Vendor shall also furnish the details of implemented MODBUS protocol like function codes for read and write, CRC implementation, BCC implementation, register addressing methods/mapping etc. during detail engineering for serial interfaces to SCADA.
For SOR-7 and 10 additional provision for feeding GC data to field mounted FC. Vendor shall supply connectors and cable for interfacing with laptop.

5.2.2.2 KEYBOARD CAPABILITY:

The data entry keyboard shall have the provision to enter the following:

- Pressure and temperature base factor
- Specific gravity and scaling factor
- Mol % or composition of the gas to be metered
- Report headings, frequency and timing of reports
- Selection of parameter to be displayed and on-demand printing of reports

- Flow set-point to FCV controller through Keypad/ remotely through GSM modem.
- Linearization of error curve & change of K-factor
- Other standard features available

The flow computer shall have provision to enter default values of all inputs (inclusive of gas chromatograph) low/high alarms for all inputs (inclusive of gas chromatograph) and shall be user configurable. The flow computer shall use the default values in case any input goes beyond low/high limit.

5.2.2.3 OUTPUT CAPABILITY:

- USB output link for laptop / configurator. (Necessary converter for USB to be provided)
- 4 to 20 mA Output for flow control (PID OUTPUT)
- 1 no. of Serial port for GSM communication.
- Other standard outputs available. (Galvanic isolation is required for all inputs and outputs)
- 1 no. of additional (Spare) port shall be provided in Flow computer for SCADA communication via RS 422/ 485/ 232 (user selectable).

5.2.2.4 COMPUTATIONAL CAPABILITY :

(a) Volume flow rate at standard, normal or operator specified base conditions (Sm3/hr) (b) Integrated corrected volume in SCM.
(b) PID algorithm for Flow control.
(c) Energy flow rate and integrated energy (user configurable in kcal, MJ & MMBTU). (e) Linearization of error flow curve and meter factor.
(d) Calculation of compressibility factor as per AGA-8 detail method.
(e) Previous day's flow / energy (i.e. yesterday's 6.00 A.M total volume / energy to today's 6.00 A.M total volume / energy) & current running total for the day (i.e. volume tantalizer/ integrator value at 6.00 A.M from first day) to be stored in a separate location (register) and these shall be user configurable.
(f) Today's accumulated flow /energy (running total since morning 6.00 A.M to current time) and shall be user configurable.
(g) Generation of reports for totalised volume & energy at daily (6 a.m), weekly, fortnightly & monthly intervals, flow rate, pressure, temperature, compressibility factor, alarms etc. shall be user configurable.

All the above data shall also be made available through GPRS enabled GSM modem to SCADA. Flow set point shall be provided through GSM Modem.

5.2.2.5 STANDARDS USED:

For the above, applicable standards are:

(a) AGA report 3/7 for meter
(b) AGA-8 characterization method to determine density, compressibility, super compressibility factor etc. for flow computers
(c) AGA Report 5 / GPA 2145 & GPA 2172 / ISO6976 (user configurable) for energy rate and integrated energy.

5.2.2.6 ENGINEERING UNITS (User Configurable) :

Volume flow rate -Sm3/hr,
Mass - kg/hr,
Pressure - kg/cm2g,
Energy – MMBTU / MCal / MJ/ (user selectable),

Temperature - °C,
Primarily the unit of measurement for Pressure, Temperature, total energy and Energy flow rates shall be Kg/Cm2g, Deg. C, MMBTU and MMBTU/hr respectively.

5.2.2.7 MEMORY TYPE: Non volatile

5.2.2.8 A/D AND D/A CONVERTORS:

Calculation accuracy shall be better than ± 0.05% of full scale including linearity, hysterisis, repeatability and resolution. Accuracy for analogue inputs to be minimum 0.1% and for analogue outputs accuracy shall be minimum 0.1%.

5.2.2.9 SCAN PROCESSING TIME:

a) The interval between computer readings of Process variables shall not exceed 1 sec.
b) The interval between each cycle for computation of instantaneous flow rate and totalized flow shall be less than 1 sec.
c) Algorithm and rounding off error for computation shall be with in ± 0.001% of Computed value

5.2.2.10 SECURITY:

3-Level password protection should be a standard feature in Flow computer.

5.2.2.11 DISPLAY CAPABILITY:

The flow computer shall have the capability to display the following parameters: Uncompensated volume flow rate, Compensated volume flow rate, Integrated volume (corrected and not corrected),Density/Specific gravity, Pressure, Temperature, Energy rate & total energy, Complete gas composition, Calculated parameters (compressibility factor etc.), Current accumulation, previous day accumulation, Data entry, Error codes, Selected parameter codes, Alarms (process and systems) including diagnostic message, Engg. units as per selected parameter, Other standard displays available. Custody transfer flow computers shall have audit trail, All the above data shall also be made available by vendor in the serial links to RTU.

5.2.2.12 DISPLAY TYPE: Alphanumeric LCD display

5.2.2.13 DIAGNOSTICS:

Flow computers shall have elaborate and sufficient on-line diagnostics to ascertain accurate and proper functioning of the flow computer. Results of diagnostics/checking shall be displayed. Facility for easy testing of the accuracy shall be provided. Provision for high and low limit check for each input, sensor break, saturation and alarms shall be provided.

Any Hardware/ software required for configuration of integral transmitters, shall be supplied by the bidder.

5.3 RPD Meter

The PD meter shall be axial flow type gas meter in which the entire gas stream passes through the PD meter rotor. The PD metering of natural gas shall be designed manufactured and tested, as per OIML R6 / R32 / TC8/ SC8 and EN-12480.

Transmitter and other electrical accessories of PD meter shall be suitable for the hazardous area classification. Protection class of enclosure shall be IP65.

Vendor shall furnish the sizing calculations to justify the selection of PD meters considering the flow density/ compressibility of the given composition of the gas. The sizing shall be done at the minimum operating pressure, with compressibility factor of 1.0.

The maximum velocity shall be less than 20 m/sec through the PD meter.

Vendor shall select the proper type and material of wetted parts, bearing for the service conditions indicated.

The pulse generators shall be non-contact type pulse pick up unit. The unit shall be tropicalised hermetically sealed.

PD meter shall have LOCAL INDEX HEAD WITH mechanical/ electronic 8-digit totaliser.

The system shall be immune to RF/FM interferences in that area.

Vendor shall furnish pressure drop figures for each PD meter, at normal operating conditions and at max. flow condition.

While selecting the meter, vendor to ensure that the fluid velocity in the PD meter shall not exceed 20 m/s.

The meters shall be certified by weights and measures approved and internationally traceable laboratory, and Vendor shall furnish the documentary proof in support of the above along with certified calibration curve.

All meters selected shall be of field proven quality with respect to design, material and application. Field mounted instruments shall be capable of working under high ambient Temperature and environmental condition without any degradation in accuracy and repeatability.

The pulse pick-up and transmitters shall comply with the principles of ISO 6551 ‘Cabled transmission of electric and/or electronic pulse data’.

The PD meters should have one LF Pulser and one HF pulses on the meter head and shall be connected to the flow computer.

Certification for Custody transfer And Calibration

Type approval for custody transfer application (for the offered size, type and model of meter) from weights and measures approved laboratories, such as NMI, PTB,MEASUREMENT CANADA, NIST OR other reputed national standard laboratory such as PIGSAR, TRANS CANADA CALIBRATIONS(TCC) CANADA, COLORADO ENGINEERING EXPERIMENT STATION INC.(CEESI) USA ,SOUTH WEST RESEARCH INC. (SWRI) USA shall be submitted.

For each PD meter, bidder to provide calibration certificate duly signed by weights and measures approved laboratories, such as NMI, PTB,MEASUREMENT CANADA, NIST OR other reputed national standard laboratory such as PIGSAR, TRANS CANADA CALIBRATIONS(TCC) CANADA, COLORADO ENGINEERING EXPERIMENT STATION INC.(CEESI) USA ,SOUTH WEST RESEARCH INC. (SWRI) USA , FCRI Palghat India, performed with air at atmoshpheric pressure and ambient temperature at following flow rates : 0.05 Qmax,0.2 Qmax, 0.3Qmax, 0.40 Qmax, 0.5 Qmax 0.70 Qmax, Qmax subject to minimum flow rate of 5 M3/Hr (or minimum flow rate as per calibration agency/ Laboratory).

5.4 FILTRATION SYSTEM

- The filter cover shall be provided with Davit arm for ease of maintenance.
- QOEC with Davit arm is required for Shell/ cover Flange above 10" dia. For Filters with Shell cover / Flange upto 10", Blind Flange with Davit arm is acceptable.
- The design of the filter shall be such that, the liquid/condensate can be drained in pressurized condition.
- All drains and vents shall have one ball valve & one plug valve.
- Fire case PSV of suitable capacity shall be installed in each filter.
- The filtration capacity shall be 3 micron for gas filter.
- Inlet mainline Ball valves (for the filter) shall be provided with equalizing (Block and bleed) arrangements.
- The withstanding capacity of the filter cartridge shall be 2 kg/cm2. However the DP across the filter in operating condition shall not exceed mare than 0.1 kg/cm2.
- The filtration capacity shall be as stated elsewhere in the tender.
- PWHT (Post weld Heat Treatment) shall be as per ASME code requirement.
- The Inlet and Outlet nozzles of individual streams of Filtration system shall be designed considering velocity limit of 20 m/s with rated (max.) flow at operating condition (at minimum operating pressure and max. operating temperature). However the capacity of the filtration system shall be considered as maximum flow possible through selected nozzle (at minimum operating pressure and max. operating temperature) subjected to velocity limit of 20 meters /sec and filtration elements surface area shall be minimum 8 times the cross sectional area of the selected inlet/ outlet nozzles
- The gas filtration system shall be used to remove liquid condensate/dust particles up to 3 micron.

5.5 FIELD TRANSMITTERS (Custody & non-custody type)

- Bidder shall supply all transmitters of SMART type transmitters as per vendor list.

- Accuracy of the pressure transmitters (at the skid inlet, PRS system etc) and differential pressure transmitters shall be ± 0.075% of span or better. This accuracy includes the combined effect of zero stability, linearity, hysteresis and repeatability. Transmitter element material shall be minimum AISI SS 316. Accuracy of the pressure transmitters used for metering (used for flow calculation) shall be ± 0.04% of span or better. For Field mounted (solar panel powered) flow computers, in built/ integral PTs/ TTs also acceptable. The Accuracy of such integral PT and TT shall be minimum 0.075 % and 0.15 % of span respectively.

- All smart transmitters shall have rangeability of 1:100 having integral intrinsic safe local LCD Display. Transmitter with lower rangeability shall not be supplied.

- Static pressure rating for all the transmitters should be of the order of 100 Kg/cm²g for all applications in general. However bidder must ensure that static pressure shall not be less than 1.3 times of maximum operating pressure for ranges above than 1 kg/cm² g.

- The transmitters shall be enabled to HART protocol. (only for transmitters connected to Control room mounted Flow computers / indicators). Transmitters communicating with Field mounted Solar powered Flow computers can be low power. For Solar Powered Field mounted Flow computers, Metering PT can also be in built/ integral (impulse line for Pressure directly connected to Flow computer).

5.6 TEMPERATURE TRANSMITTERS with CLASS'A" 4-wire RTD (PT-100).

- RTD sheath material shall normally be SS 316 as a minimum and RTD shall be Class "A" type with 4 wire system.
- The gauge head of the Temperature elements (RTD's) shall be 80 mm, as a minimum to ensure maintenance ease.
- For temperature transmitters connected to Control room mounted flow computers, the temperature transmitters shall be smart type and shall provide 'HART' output. Temperature Transmitters with dual compartment Housing (for termination and display) shall be supplied for maintenance ease. For interface with field mounted solar powered flow computers, temperature transmitters without HART are also acceptable
- Bidder to note that all thermowells except surface temperature instruments shall be of flanged type only.
- The RTD shall be Class"A" type-4 wire PT-100. The RTD & thermowell shall be designed in such a way that the insertion length inside the pipe shall be more than 60%.

5.7 RECEIVER INSTRUMENTS

- Specification for receiver instruments such as Single loop Controllers and Indicator shall be as per typical data sheet and Standard specification.
- Other than custody transfer transmitters, the indication/ display like Filter DP, pressure & Temperature at Inlet & outlet etc. shall be provided in the control panel.

- Indication for slam-shut valves & Metering Ball valve shall also be provided in Flow computer for all Metering skids and also additionally in Control panel based metering skids

5.8 ISOLATING BARRIERS

In general, intrinsically safe philosophy shall be followed for all transmitters. Bidder to note that external barriers shall be selected based on entity concept.

Typically barrier selection must be made based on the following:

i) Analog Inputs (4-20 mA): Series 5000 of MTL/ P&F KFD series/Eqv.
ii) Analog Outputs (4-20 mA): Series 5000 of MTL/P&F KFD series/Eqv.
iii) Proximity Inputs: MTL/ P&F KFD series/Eqv.(Covering the 200% of entire frequency range of Turbine pulse)

5.9 CABLES

- All cables shall have PVC insulated primary insulation of 85DC PVC as per IS-5831 Type C/ IEC 502. Inner and outer jacket shall be made of extruded flame retardant 90 deg C PVC to IS-5831 Type ST-2 / IEC 502. Oxygen index of PVC shall be over 30% and temperature index shall be over 250 degC.
- All cables shall be fire retardant as per standard IEC 332-3 Part 3 Cat.A. Fire resistance cables whenever specified shall be as per IEC 331 Cat. A.
- Signals cables shall be Type I for single pair and Type IV for multi-pair cables.
- For cable specification, refer enclosed standard specification elsewhere.
- All cables glands shall be of nickel-plated brass and glands shall be double compression type suitable for armoured cables.
- Flame proof glands wherever required shall be supplied with Exd certification.

5.10 JUNCTION BOXES

- Bidder shall supply junction boxes as per the cables selected, wherever required. These shall be of die cast aluminium alloy (LM-6) body and shall be weather proof to IP 55, as a minimum.
- Flame proof junction boxes wherever required shall be supplied with Exd certification. All such boxes shall be weatherproof to IP 55 also.
- Each junction box shall have a minimum of 2 Nos. All spare entries shall be provided with plugs certified Exd for flameproof junction boxes.
- For junction box and cable gland's specification, refer enclosed standard specification elsewhere.
- Cable entry in JB shall be side entry and bottom entry only. In the Junction Boxes, at least 20 % additional spare terminal blocks shall be provided for future.

5.11 INSTRUMENTATION VALVES AND MANIFOLDS

- Bidder shall supply instrument valves (miniature type) and valve manifolds wherever required.
- Body rating shall be as per piping class or better. All valves and manifolds shall be forged type only.
- Valve body and trim material shall be SS 316 unless otherwise specified. Superior trim material shall be selected as required by process conditions. Packing material in general shall be of PTFE.
- For instrument air isolation valves, body material shall be Nickel or cadmium plated carbon steel.
- For instrument valves and manifolds specification, refer enclosed standard specification elsewhere.

5.12 IMPULSE TUBING

- Impulse tubing shall be 1/2" OD x 0.049" thick ASTM A 269 TP 316 stainless steel fully annealed, cold drawn and seamless tubes as a minimum for impulse lines upto 600 # class. Higher thickness according to pressure rating shall be considered for higher pipe classes.
- The hardness of SS tubes shall be Rockwell RB 70-79.
- For tubing and tube fittings specification, refer enclosed standard specification elsewhere.

5.13 TECHNICAL SPECIFICATION FOR ULTRASONIC FLOWMETER

5.13.1 Ultrasonic flow meter shall be multi path type of minimum 4 path & above for natural gas custody transfer flow metering application and the design, construction and operation shall conform to AGA Report 9 (latest version) for multi-path. The meter shall be approved by Nmi/PTB/NPL or equivalent body for custody transfer application.

5.13.2 The principle of operation used shall be simple in design and shall avoid analytical complexity associated with development of information, which is extraneous to the application. The over-all uncertainty (including lab uncertainities) of the supplied system shall be better than 0.3%.

5.13.3 The design used shall provide maximum reliability, maximum on-line performance and minimum maintenance having on-line diagnostic features. Instrument shall be field proven. No prototype instrument shall be supplied. Technique of measurement used shall be interference free. It shall be immune to other impurities in the fluid stream.

5.13.4 Internal surface roughness of 250 Ra or less (smoother) is required for the meter tube (including upstream & down stream straight runs). Meter tube shall be honed for achieving the same and a certificate from TPI shall be submitted to GAIL before flow calibration.

5.13.5 Wet calibration of Ultrasonic meters at operating pressure with natural gas shall be conducted with Upstream & down stream meter runs along with flow profiler.

5.13.6 The Accuracy specified in the tender documents for USM shall be Overall accuracy (inclusive of all lab uncertainty) and it is in percentage of reading. The meter manufacture shall certify that the overall accuracy will be met with the proposed installation-piping configuration (as per proposed P&ID and GAD) of the complete skid.

5.13.7 The flow meter shall be direct path type with minimum 4 path ultrasonic transducers. The transducers shall be energized by the integral electronics to transmit and receive ultrasonic waves. Vendor shall size all the ultrasonic flow meters for the given process conditions as per AGA 9. Sizing shall be done considering maximum flow capacity at minimum inlet operating pressure & gas composition and other process conditions.

5.13.8 The turndown ratio of each flow meter shall be minimum 1:40. Repeatability shall be better than ±0.1% for qt<qi<qmax & ±0.2% for qmin<qi<qt and resolution better than 0.001 m/s. Accordingly vendor shall select the no. of paths (minimum 4 paths or more than 4 path) to meet accuracy requirement and indicate the same in calculations / back-up literature.

5.13.9 The meter shall be provided with pressure tap to measure the static pressure in the meter.

5.13.10 The meter body shall be made of carbon steel as per data sheets (ASTM A 216 GR. WCB or equivalent / better). All flanges shall be weld neck, raised face and shall meet ANSI B 16.5. The ultrasonic metering system shall be provided with full diagnostics and customer user interface.

5.13.11 It shall be possible to replace or relocate transducers without a change in meter performance. After an exchange of transducers and a possible change of the associated software constants, the resulting shift in the meter's performance should not be more than the allowable repeatability of the meter. In addition, the maximum error and the maximum peak-to-peak error as detailed in AGA-9 shall not be exceeded.

5.13.12 The vendor shall comprehensively advise the impact of transducer failure on the performance and accuracy of the USM. Vendor shall confirm that the measurement will not degrade by more than ± 0.05% in case of loss of one path.

5.13.13 The meter design shall have the facility to remove /replace the transducers in situ under line operating condition. Failure or removal of one pair of transducers shall not cause the meter to lose all measurement function. Failure of any path shall generate an alarm identifying the affected path. Also transducers ports shall be designed in a way to reduce the possibility of liquid or solid accumulation.

5.13.14 Area classification shall be IEC Zone-1, Gas Gr. II A & IIB, and Temperature Class T4. All electrical instruments in the field shall be suitable for the specified area classification and certified by a statutory body such as FM, UL, CENELEC, BASEEFA, and PTB etc. The transducers shall be intrinsically safe certified suitable for the specified area classification and weather proof to IP65/NEMA-4 and vendor shall supply necessary isolating barriers between the transducers and preamplifier/transmitter However the transducer/sensor housing can be flameproof (EEx d) certified suitable for the specified area classification instead of intrinsically safe.

5.13.15 Overall pressure drops across the meter assembly including meter runs shall be less than 0.1 Kg/cm2g. Pressure drop calculation across the meter shall be furnished. Ultrasonic meters shall be rated for the maximum design pressure as indicated in the data sheets.

5.13.16 Ultrasonic flow meter spool inside diameter to meet the specified I.D as per AGA. Internal surface roughness shall be as specified elsewhere.

5.13.17 All ultrasonic flow meters shall be supplied with upstream meter run with flow conditioner/ profiler (min.10D before flow profiler, 10 D between flow profiler and US meter) and downstream meter runs (min.5D).

5.13.18 The Meter body length and bore has to be specified by the US Meter Manufacturer. The USM bore and the adjacent upstream pipe along with flanges should have the same inside diameter to within 1% of each other. Vendor has
to provide document to justify the same duly certified by third party internationally recognized certifying agencies

5.13.19 Fixed Dowel pin to be provided in the USM body for proper alignment with the connecting flanges.

5.13.20 External meter body shall be blast cleaned to near white metal as per international standard and primed with inorganic zinc primer (two coats each of
40 micron minimum dry film thickness) and the final coat of epoxy paint of 40- micron dry film thickness.

5.13.21 ELECTRONICS:

5.13.22 Meter electronics shall include all associated transmitters, pre-amplifiers etc.

5.13.23 The transmitter unit shall be microprocessor-based electronics suitable for installation in the field under the ambient condition specified. Meter electronics shall be Weather proof to IP 65/ NEMA 4 and flameproof certified suitable to install in area classification IEC Zone-1, Gas Gr. IIA & IIB, Temp. Class T3 by a statutory body such as FM, UL, CENELEC, BASEEFA, PTB etc.

5.13.24 The electronics unit shall preferably be mounted integral on the meter.

5.13.25 The transmitter shall have extensive diagnostic capability. Self-diagnostic feature should include monitoring the health of the transducers and signal quality.

5.13.26 Meter parameters and factors set into the meter electronics shall be retained in nonvolatile memory and shall be secured with password such that un-authorised changes are prohibited.

5.13.27 Configuration software and firmware shall be provided for each skid. The license shall be in the name of “GAIL India Limited”.

5.13.28 Meter output signals from the meter electronics shall be without flying leads. All the signals from the meter electronics shall be terminated in a junction box (JB) supplied by the meter vendor and shall be mounted on skid. JB shall be weather proof (WP) to IP 65/NEMA 4 and flameproof certified suitable for the specified area classification.

5.13.29 The cable entry sizes between meter electronics and transducers shall be decided by vendor and the WP & flameproof cable glands to be supplied accordingly. Cable entry sizes shall be as per NPT standards.

5.13.30 The maximum velocity shall be less than 20 m/sec through the ultrasonic meter.

5.13.31 Meter electronics shall be capable of multiple output signals as follows:

a) Pulse outputs to flow computers configurable for flow rate signals.
b) RS-485/422 communication port with MODBUS protocol for communicating with the other control system i.e. control room mounted flow computer for meter diagnostics, test and health data.

Vendor shall supply the RS 485/422 cables interconnecting serial link cables which shall be armoured along with suitable connectors and connectors against each tag for communication between flow meter in field and flow computers mounted on metering control panel located at respective control room.

c) The USM shall be connected to the flow computer serially for digital communication and also for frequency pulse signal shall be connected to flow computer for custody transfer flow indication.

d) Facility of any error correction in USM as permitted for custody transfer application shall be provided.

5.13.32 On Line Field Verification :

Speed of Sound comparison should be done in the stream flow computer for the speed of sound measured value from the USM and the speed of sound calculation based on the GC component data as per AGA 10. If the difference between the SOS between the actual and the calculated one is more than the permissible limit then the flow computer shall generate an alarm.

Separately, Licensed software shall be provided in name of GAIL for Speed of Sound calculation (as per AGA 10) as mentioned in Clause No 8 of AGA9.

5.13.33 CERTIFICATION FOR CUSTODY TRANSFER AND CALIBRATION

- Each USM meter shall have calibration certificate, duly signed by approved laboratories of weights and measures authority of country of origin confirming that the meter being calibrated shall work with specified accuracy/ repeatability with the actual gas composition mentioned in the tender documents. Further certificate must mention that the overall accuracy, performance and repeatability as mentioned in the tender shall be met with the proposed installation-piping configuration (as per proposed P&ID and GAD) of the complete skid. (Vendor shall submit the Calculation for overall system uncertainty including all components of the metering system). The Vendor shall furnish the regulations of the certifying authority considered by him for custody transfer applications. If other instruments are also needed to be certified as per the regulations the same shall be complied.
- The flow computer shall be certified for custody transfer applications by laboratory / institutes authorized by weights and measures authority of its country of origin or reputed International Standard laboratories / Institutes like NMI, PTB, Pigsar Trans Canada Calibrations (TCC) Canada, Measurement Canada, Colorado Engineering Experiment Station Inc. (CEESI) USA, South West Research Inc. (SWRI) USA.
- Each meter shall be “zero calibrated” (“dry calibrated”) with nitrogen. Test results shall be furnished. In the dry calibration set up, the gas velocity observed on all the acoustic paths shall be zero. The speed of sound of the individual acoustic path in the dry calibration set up shall not exceed ±0.2% of the mean velocity of all the paths
- Flow calibration shall be performed for at least seven points and error curve shall be obtained. Test medium shall be Natural Gas.
- Flow Verification for at least two points shall be done after adjustment/ incorporation of factors obtained through calibration and the same to be recorded in the calibration report, as per AGA-9.
- Vendor shall carryout performance test and certify the meter in combination with its companion electronics. A recognized test facility with traceable reference measurements shall be used. Flow test data at 7 points(at 2.5%, 5%, 10%, 25%, 50%, 75% and 100% of Qmax) covering the

minimum to the maximum flow rate minimum to the maximum flow rate shall be obtained for ascertaining the meter linearity and repeatability with in the specified limits. The average of minimum and maximum Outlet Pressure of the metering system or 60 Kg/cm2 g whichever is lower shall be considered as operating pressure for wet calibration. **The pressure for wet calibration of USM shall be close to the average of minimum and maximum metering Pressure.**

- The Ultrasonic meters shall be 'flow calibrated' with natural gas and shall have calibration certificate duly signed by laboratories approved by weights and measures authority of its country of origin or recognized international Institutes like NMI, PTB, Pigsar, Trans Canada Calibrations(TCC) Canada, Measurement Canada, Colorado Engineering Experiment Station Inc.(CEESI) USA etc. Accuracy with wet flow calibration shall be demonstrated within ±0.3% for multi path type under flow conditions in the turndown ratio of 1:10. The meter proving system to be used by vendor shall be traceable to international standards and uncertainty of meter proving system shall be furnished. Gas metering system integration, testing, validation and including third party "wet' calibrations (for the ultrasonic meters with its associated upstream / downstream meter runs & flow profiler) should be done in flow labs as detailed above.
- Certification for US meters: The vendor shall provide certification from Calibrating agency/ Laboratory / OEM of Ultrasonic Gas Flow meter confirming that the meter being calibrated shall work with specified accuracy/ repeatability with the actual gas composition mentioned in the tender documents. Further the OEM of Ultrasonic Gas Flow meter shall certify that with the P&ID and GAD of skid being proposed / supplied by the bidder the performance, accuracy, repeatability etc. of the offered Ultrasonic gas flow meter shall be within the mentioned specifications. (Vendor shall submit the Calculation for overall system uncertainty including all components of the metering system)

Calibration report

The results of flow calibration shall be documented in a written report to be supplied to GAIL. For each meter, the report shall include at a minimum the following:

a) Name of Meter Manufacturer
b) Model and Serial No. of Meter
c) Name and Address of the Calibration facility.
d) SPU Firmware revision number
e) Date(s) of calibration
f) Name and Designation/ Title of the person(s) conducting calibration
g) Description of calibration procedure
h) Upstream and Down-stream piping configuration including flow profiler, meter runs.
i) Serial nos. of all piping and flow profiler
j) Diagnostic report of the software configuration parameters at the time of calibration
k) All calibration data including Flow rates, Pressure, Temperature, Velocities, errors and gas composition
l) A statement of uncertainty for the facility with reference to the method used and date of last verification of traceability to the recognized national/ International standard.
m) An Identification of Adjustment method applied and adjustment factors used
n) No. of pages in the calibration document
o) Typed name below signature(s) of all the people who sign the calibration document.

CHECK & PAY CONFIGURATION & PROCEDURE for USM Based Metering Skids:

The following Procedure is applicable for USM based Metering skid having Z Configuration (for Meter Verification through PAY-CHECK configuration). This scheme/ configuration shall be implemented in the Supervisory system being provided by the Bidder.

Stream-1 shall be selected in “PAY” mode and Stream-2 can be selected in “CHECK” mode. Both “PAY” and “CHECK” Flow computers (Stream-1 and 2) shall do fiscal metering separately/ independently and update data in the supervisory computer. In “PAY” Flow computer all fiscal totals get incremented.

In “CHECK” Flow computer only maintenance totals get incremented.

When the User decides to do meter verification and selects the “PAY” and “CHECK” streams at the meter verification window. The stream selected as “CHECK” shall put its Flow computer in “Maintenance mode” automatically by the HMI system and thereby its maintenance mode totals in the Flow computer shall increment, keeping the fiscal totals at the last reading.

Once the streams-1 and 2 are selected in “PAY” and “CHECK” mode respectively and the User clicks on the begin button, a confirmation is required from the user to proceed ahead. Once the user confirms, system prompts to align the Valves according to PAY- CHECK streams configuration. The Valve alignment procedure during meter verification is mentioned below. Once User manually aligns the Valves according to PAY- CHECK streams, reconfirmation is requested from the User that the Valve alignment has been completed. HMI system also verifies the correct valve alignment by checking valve open / close feedbacks.

After User confirmation by clicking Start button, the system captures cumulative UVOL, CVOL, Mass and Energy Totals of “PAY” Flow computers and are stored as Start status. For “CHECK” Flow computer, Maintenance UVOL, CVOL, Mass and Energy Totals are recorded as Start status of “CHECK” Flow computer.

Cumulative Totalisers of “PAY” Flow computer and “CHECK” Flow computer increment till User Clicks on Stop Button. When verification is stopped, the system displays respective Totalisers for the Flow computers as Stop status and also calculates the difference between Stop status and Start Status.
Percentage difference between “PAY” Flow computer Totalisers and “CHECK” Flow computer Maintenance Totalisers are calculated and displayed as accuracy indication of Meter under Test.

After Meter verification has been stopped, User can either press Yes Button to continue with the meter verification or else press NO Button to move ahead in the sequence and then align the valves as per the procedure mentioned below.

After User clicks “RESET” Button, and confirms the “Reset” then the Flow computer status of “CHECK” stream is changed from Check to Offline, resets all other parameters like difference and accuracy readings.

This completes the Meter Verification.

a. Valve Alignment procedure during meter verification:

Correct sequence of Valve operation is as follows when “PAY” stream is to be verified using “CHECK” Stream.

1. Open “PAY” stream Inlet Valve.
2. Open Crossover Valve(s)

3. Ensure closure of "CHECK" Stream Inlet valve
4. Open Outlet valve of "CHECK" Stream
5. Close "PAY" stream Outlet Valve.

b. Valve Re-alignment procedure after completion of meter verification:

1. Close Cross over Valve(s)
2. Open "PAY" stream Outlet Valve
3. Close Outlet valve of "CHECK" Stream

5.14 HYDROCARBON (LEL) DETECTORS –

Not applicable in this tender

Hydrocarbon detectors shall be used to monitor hydrocarbon gas leakages from the equipments (like metering system, filters), valves, piping etc.

The isolated 4-20mA analog output from each detector shall be taken to LEL Monitors (to be mounted on Metering Control Panel for SOR item No1, LEL signal shall be configured in field mounted flow computer for other SOR items.

Construction and performance should be as per BS EN-50054 and 50057.

Basic criteria for deciding location shall be prevailing wind direction and gas densities.

LEL gas detectors (IR Type point detectors) (quantity as per datasheet) on the skid and LEL Gas monitor in the control panel shall be provided as per data sheet and applicable standards / codes. The infra-red type LEL detectors shall be dual beam, dual wavelength type.

LEL detectors/transmitters shall be microprocessor based and shall be immune to RF and EM interference.

LEL detectors shall be immune to catalytic poisons and sunlight

Heated optics shall be provided in the LEL detectors to avoid condensation on the window/mirror in the detectors.

Vendor to indicate drift in the calibration of the LEL detectors.

All LEL detectors/transmitters shall be supplied pre-calibrated by the vendor either with the gas to be sensed or by applying cross sensitivity factors to achieve an installed accuracy of ± 2% LEL at site.

All calibration equipment required for site calibration of the detectors including calibration kit with S/W and special connector, calibration gases (for 6 months use), gas cylinders, self regulating valves, pressure gauges, hose, interconnection tubing, fitting etc., shall be supplied by the vendor.

Any special tool required for the maintenance of the system /detector head shall be supplied by the vendor. The maintenance of any detector head/module

should not necessitate shutdown of total/partial detection system except those that are being maintained.

Lamps in the infra-red detectors shall be replaceable type. Lamp life shall be minimum 5

Infra-red detectors shall be compensated for lamp intensity variation due to dust, variation in humidity etc. All the supplied LEL detectors/transmitters shall be weather proof to NEMA 4 or IP 55.
Vendor to furnish calibration procedure for the LEL detectors/transmitters. Response time of LEL detectors shall be indicated. Time lag caused by splash deflectors/guards and dust filters shall be taken into consideration.

All mounting accessories/plates for mounting the LEL detectors/transmitters shall be supplied by vendor.

One no. Portable purge Hydrocarbon calibrator complete with 20 liter volume bottle of calibration gas of known gas/ air mixture, pressure regulator, adapter cap, flow meter shall be provided. CCOE Certification for cylinder and certification/ report for mixture composition is to be provided by the bidder.

One set of portable gas detector shall be provided complete with its controller, audiovisual alarm and shall be suitable for use in hazardous area.

Battery charger shall be provided for portable calibrator and which shall be chargeable with 230 V AC.

5.15 Control Panels- ONLY FOR SOR ITEM No. 1

- The prefabricated metering control panels shall be supplied and tested with all items/instruments mounted and all wiring installed requiring only connection of field wiring to terminal blocks provided for this purpose and inter-panel wiring in order to commission the panels. Metering control panel shall be free-standing type.

- Vendor shall be responsible for manufacture/supply of all hardware and software necessary to meet the functional requirements including Factory Testing and Acceptance of the system.

- Power supply of 230 V AC ± 10%, 50 Hz ± 3% UPS or 24 VDC or both (as per the availability of power at site) shall be made available by GAIL to vendor at a single point in the Metering control panel being supplied by vendor. Further distribution to all the instruments, accessories in panel and field instruments like GC and Meters at Gas metering skid with all items like MCBs, Bus Bars etc. shall be in vendor's scope. All the equipments by vendor shall be suitable for the specified voltage variation. Vendor has to made provision in the panel for accepting both the 230 VAC as well as 24 VDC by installing rectifier for DC supply and inverter for AC based on suitable load calculation of the entire supplied system.

- Vendor shall furnish power consumption details for control panel, each type of power supply mentioned above.

- Vendor shall be fully responsible for the manufacture in respect of proper design, quality workmanship and operation of all the equipment, accessories, etc. supplied by the vendor for the Metering Control panel.

- It shall be obligatory on the part of vendor to modify and / or replace any hardware and modify the operating, application and diagnostic software free of cost, in case any malfunction is revealed even during on line operation after taking over by the owner within the warranty period.

- Factory Acceptance Test and Calibration of all items shall be carried out by the vendor and fully compliant reports shall be furnished to Owner meeting the complete requirements. Owner can witness any or all items testing in stages during manufacture and/or at final stage before shipment at the discretion of Owner.

- Vendor shall provide Commissioning Spares for the package and shall provide a list of these spares. If however any additional spare is consumed during erection and commissioning the same shall be provided free of cost by the bidder.

- Vendor shall provide hot redundant Power supply in control panel. All the hubs /routers/ switches shall also be redundant.

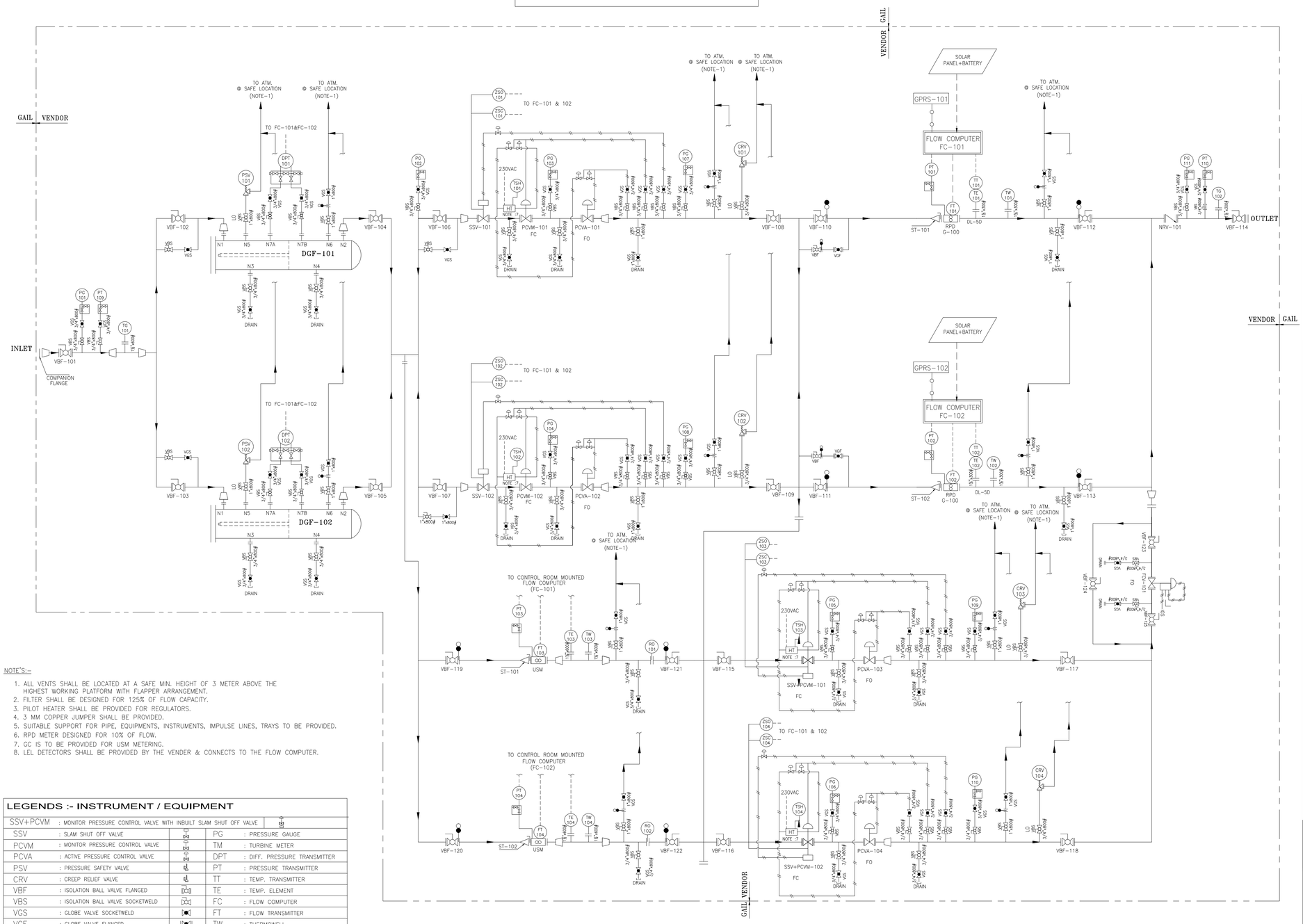
- The control panel shall also have hooter for generation of Audible alarm (system generated alarms, process alarm, Flow computer / GC alarms, operator assigned alarm, Metering supervisory system alarms) and push button shall be provided for Test/ Acknowledge/ accept/ reset of Alarm. Selector switch shall be provide in the panel for selection of operating flow computer (which is in line) for PID control (Flow control) through FCV installed in field. The PID signal for Flow control (through FCV) shall be sent through operating Flow computer.

5.16 Specifications of Laptop – To be provided only with SOR Item No. 1

Following minimum configuration required for offered Laptop:

SL. No.	Part	Specification
1	Processor	8th Gen Quad-Core Intel Core i5-8250U (1.6 GHz base frequency, up to 3.4 GHz with Intel Turbo Boost Technology)
2	Memory Cache	6MB Cache
3	Memory RAM	8GB DDR3 (1333MHz)
4	Hard Disk Drive	1 TB 5400RPM SATA Hard Drive
5	Display	15.6", Fingerprint Reader, Convertible, Full HD Touchscreen, Inking Pen
6	Interface	1 No. Serial port 9 pin D type connector - (USB to Serial convertor)
		3 nos. of USB port
		Network with RJ 45 connector
7	DVD Drive	8X DVD + /-R Drive
9	Accessories	Cell Battery and Charger
		(Laptop Batteries Carry 1 Year Warranty only)
10	Operating System	Windows 10 (Licensed)/Latest

REFER:- SOR ITEM NO. 1



NOTE'S:-

1. ALL VENTS SHALL BE LOCATED AT A SAFE MIN. HEIGHT OF 3 METER ABOVE THE HIGHEST WORKING PLATFORM WITH FLAPPER ARRANGEMENT.
2. FILTER SHALL BE DESIGNED FOR 125% OF FLOW CAPACITY.
3. PILOT HEATER SHALL BE PROVIDED FOR REGULATORS.
4. 3 MM COPPER JUMPER SHALL BE PROVIDED.
5. SUITABLE SUPPORT FOR PIPE, EQUIPMENTS, INSTRUMENTS, IMPULSE LINES, TRAYS TO BE PROVIDED.
6. RPD METER DESIGNED FOR 10% OF FLOW.
7. GC IS TO BE PROVIDED FOR USM METERING.
8. LEL DETECTORS SHALL BE PROVIDED BY THE VENDER & CONNECTS TO THE FLOW COMPUTER.

LEGENDS :- INSTRUMENT / EQUIPMENT			
SSV+PCVM	: MONITOR PRESSURE CONTROL VALVE WITH INBUILT SLAM SHUT OFF VALVE	PG	: PRESSURE GAUGE
SSV	: SLAM SHUT OFF VALVE	TM	: TURBINE METER
PCVM	: MONITOR PRESSURE CONTROL VALVE	DPT	: DIFF. PRESSURE TRANSMITTER
PCVA	: ACTIVE PRESSURE CONTROL VALVE	PT	: PRESSURE TRANSMITTER
PSV	: PRESSURE SAFETY VALVE	TT	: TEMP. TRANSMITTER
CRV	: CREEP RELIEF VALVE	TE	: TEMP. ELEMENT
VBF	: ISOLATION BALL VALVE FLANGED	FC	: FLOW COMPUTER
VBS	: ISOLATION BALL VALVE SOCKETWELD	FT	: FLOW TRANSMITTER
VGS	: GLOBE VALVE SOCKETWELD	TW	: THERMOWELL
VGF	: GLOBE VALVE FLANGED	SS	: SELECTOR SWITCH
DGF	: DRY GAS FILTER	RPD	: ROTARY POSITIVE DISPLACEMENT
NRV	: NON RETURN VALVE/CHECK VALVE		: SPECTACLE BLIND
ST	: CONICAL STRAINER	TG	: TEMP. GAUGE
LO	: LOCK OPEN	FC	: FAIL CLOSE
LC	: LOCK CLOSE	FO	: FAIL OPEN
ZSC	: LIMIT SWITCH CLOSE	HT	: PILOT HEATER
ZSO	: LIMIT SWITCH OPEN		

DESIGN TEMPERATURE :

1) Inlet Design Temperature of the Metering Skid shall be lies in between (−)29 deg C to (+)65 deg C.
2) Outlet Design Temperature of the Metering Skid shall be lies in between (−)45 deg C to (+)65 deg C.

REFERENCE DRAWING

S.NO.	DRAWING/DOCUMENT NAME	DRAWING/DOCUMENT NO.

REV.	DATE	DESCRIPTION	PREP.	CHKD.	APPD.
0	20.12.19	ISSUED FOR BID	DV	UN	UN

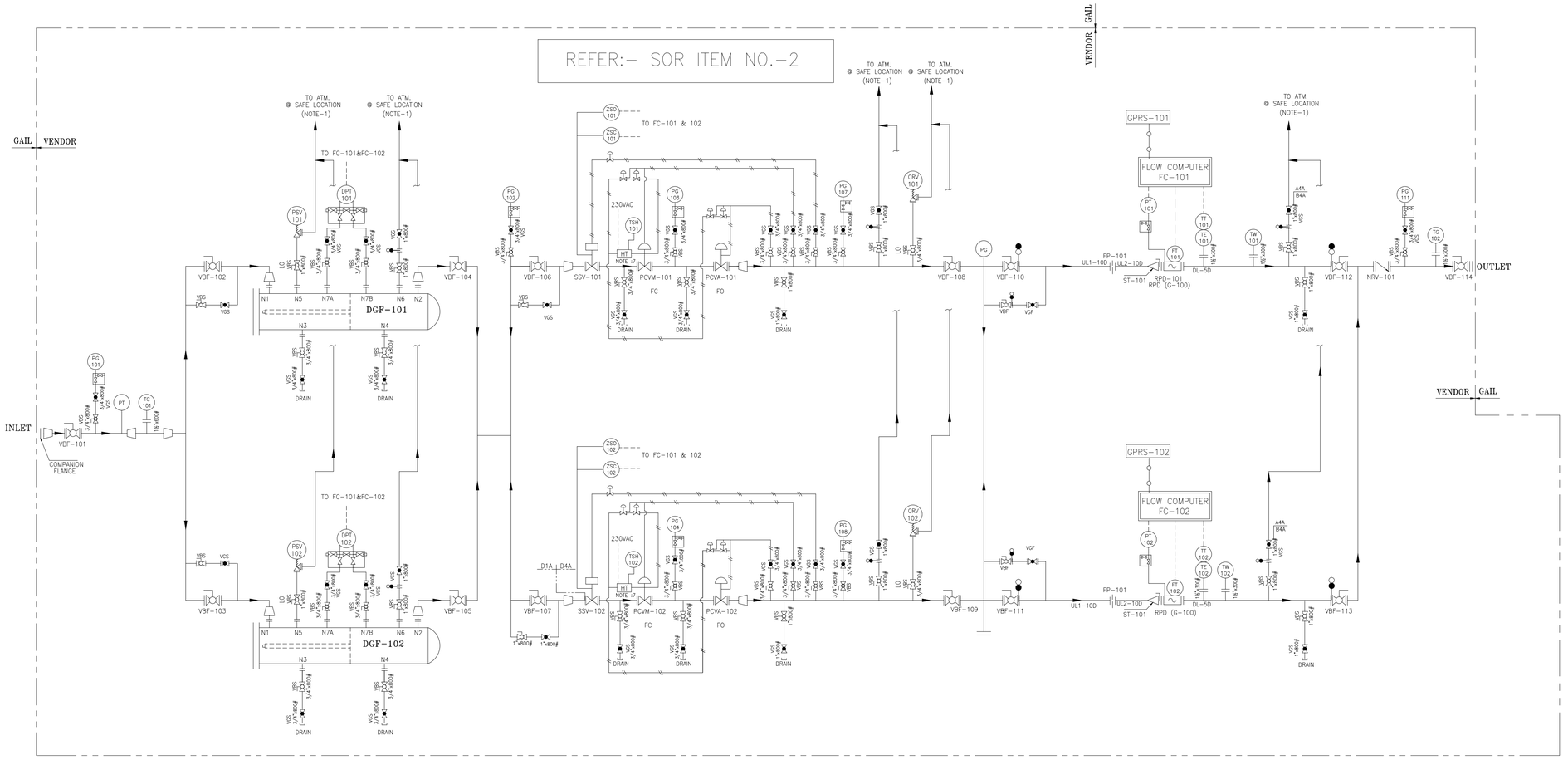
CLIENT: GAIL (INDIA) LIMITED

PMC: LYONS ENGINEERING PVT. LTD. NEW DELHI

PROJECT: ARC TENDER FOR THE SUPPLY OF METERING SKID

SCALE	TITLE:		
AS SHOWN	METERING SKID:-USM AND RPD TYPE TYPICAL P&ID		
SIZE	DRAWING NUMBER	SHEET	REV.
A1	GAIL-STD-PR-DWG-PID-001	1 OF 1	0

REFER:- SOR ITEM NO.-2



LEGENDS :- INSTRUMENT / EQUIPMENT

SSV+PCVM	: MONITOR PRESSURE CONTROL VALVE WITH INBUILT SLAM SHUT OFF VALVE		
SSV	: SLAM SHUT OFF VALVE	PG	: PRESSURE GAUGE
PCVM	: MONITOR PRESSURE CONTROL VALVE	USM	: ULTRASONIC FLOW METER
PCVA	: ACTIVE PRESSURE CONTROL VALVE	DPT	: DIFF. PRESSURE TRANSMITTER
PSV	: PRESSURE SAFETY VALVE	PT	: PRESSURE TRANSMITTER
CRV	: CREEP RELIEF VALVE	TT	: TEMP. TRANSMITTER
VBF	: ISOLATION BALL VALVE FLANGED	TE	: TEMP. ELEMENT
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LC	: LOCK CLOSE	FC	: FAIL CLOSE
ZSC	: LIMIT SWITCH CLOSE	FO	: FAIL OPEN
ZSO	: LIMIT SWITCH OPEN	HT	: PILOT HEATER

NOTE'S:-

1. ALL VENTS SHALL BE LOCATED AT A SAFE MIN. HEIGHT OF 3 METER ABOVE THE HIGHEST WORKING PLATFORM WITH FLAPPER ARRANGEMENT.
2. FILTER SHALL BE DESIGNED FOR 125% OF FLOW CAPACITY.
3. PILOT HEATER SHALL BE PROVIDED FOR REGULATORS.
4. 3 MM COPPER JUMPER SHALL BE PROVIDED.
5. SUITABLE SUPPORT FOR PIPE, EQUIPMENTS, INSTRUMENTS, IMPULSE LINES, TRAYS TO BE PROVIDED.
6. RPD METER DESIGNED FOR 10% OF FLOW.
7. PILOT HEATER
8. LEL DETECTORS SHALL BE PROVIDED BY VENDER & IT CONNECTS TO THE FLOW COMPUTER.

DESIGN TEMPERATURE :

1) Inlet Design Temperature of the Metering Skid shall be lies in between (-)29 deg C to (+)65 deg C.
2) Outlet Design Temperature of the Metering Skid shall be lies in between (-)45 deg C to (+)65 deg C.

REFERENCE DRAWING

S.NO.	DRAWING/DOCUMENT NAME	DRAWING/DOCUMENT NO.

REV.	DATE	DESCRIPTION	PREP.	CHKD.	APPD.
0	24.01.19	ISSUED FOR REVIEW & COMMENT	SK	SR	TR

CLIENT: GAIL (INDIA) LIMITED

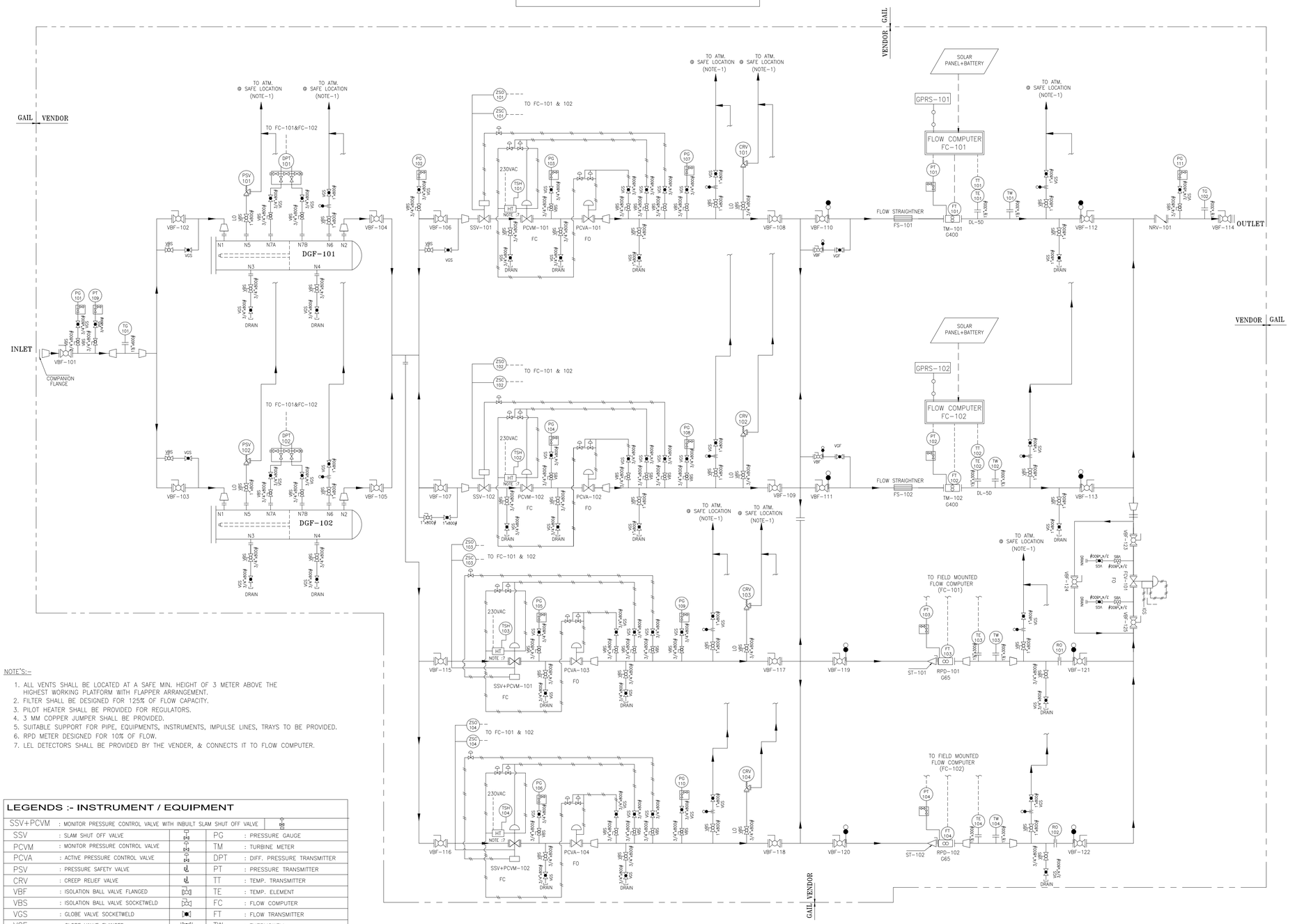
PMC: LYONS ENGINEERING PVT. LTD. NEW DELHI

PROJECT: ARC TENDER FOR THE SUPPLY OF METERING SKID

SCALE	TITLE:
AS SHOWN	TYPICAL METERING SKID P&ID FOR RPD METER.

SIZE	DRAWING NUMBER	SHEET	REV.
A1	GAIL-STD-PR-DWG-PID-002	1 OF 1	0

REFER:– SOR ITEM NO.–3



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7. LEL DETECTORS SHALL BE PROVIDED BY THE VENDER, & CONNECTS IT TO FLOW COMPUTER.

LEGENDS :- INSTRUMENT / EQUIPMENT

SSV+PCVM	: MONITOR PRESSURE CONTROL VALVE WITH INBUILT SLAM SHUT OFF VALVE	PG	: PRESSURE GAUGE
SSV	: SLAM SHUT OFF VALVE	TM	: TURBINE METER
PCVM	: MONITOR PRESSURE CONTROL VALVE	DPT	: DIFF. PRESSURE TRANSMITTER
PCVA	: ACTIVE PRESSURE CONTROL VALVE	PT	: PRESSURE TRANSMITTER
PSV	: PRESSURE SAFETY VALVE	TT	: TEMP. TRANSMITTER
CRV	: CREEP RELIEF VALVE	TE	: TEMP. ELEMENT
VBF	: ISOLATION BALL VALVE FLANGED	FC	: FLOW COMPUTER
VBS	: ISOLATION BALL VALVE SOCKETWELD	FT	: FLOW TRANSMITTER
VGS	: GLOBE VALVE SOCKETWELD	TW	: THERMOWELL
VGF	: GLOBE VALVE FLANGED	SS	: SELECTOR SWITCH
DGF	: DRY GAS FILTER	RPD	: ROTARY POSITIVE DISPLACEMENT
NRV	: NON RETURN VALVE/CHECK VALVE	TG	: TEMP. GAUGE
ST	: CONICAL STRAINER	FO	: FAIL OPEN
LO	: LOCK OPEN	FC	: FAIL CLOSE
LC	: LOCK CLOSE	HT	: PILOT HEATER
ZSC	: LIMIT SWITCH CLOSE	SP	: SPECTACLE BLIND
ZSO	: LIMIT SWITCH OPEN		

DESIGN TEMPERATURE :

1) Inlet Design Temperature of the Metering Skid shall be lies in between (–)29 deg C to (+)65 deg C.
2) Outlet Design Temperature of the Metering Skid shall be lies in between (–)45 deg C to (+)65 deg C.

REFERENCE DRAWING

S.NO.	DRAWING/DOCUMENT NAME	DRAWING/DOCUMENT NO.

REV.	DATE	DESCRIPTION	PREP.	CHKD.	APPD.
0	25.01.20	ISSUED FOR APPROVAL	DV	SR	TR

CLIENT: GAIL (INDIA) LIMITED

PMC: LYONS ENGINEERING PVT. LTD. NEW DELHI

PROJECT: ARC TENDER FOR THE SUPPLY OF METERING SKID

SCALE	TITLE:		
AS SHOWN	METERING SKID:- TURBINE AND RPD TYPE TYPICAL P&ID		
SIZE	DRAWING NUMBER	SHEET	REV.
A1	GAIL-STD-PR-DWG-PID-003	1 OF 1	0

GAIL INDIA LIMITED

STANDARD SPECIFICATION

FOR

ERECTION WORKS

GAIL-STD-IN-DOC-TS-001

0	17.01.2019	Issued for Bid	RKS	UNU	UNU	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

CONTENTS

1.0 GENERAL

1.1 This specification, in general, covers the Scope of work, execution methodology, drawing and document requirements, criterion for handling scrap and excess material, material supply requirements necessary to complete various works defined in this document, and other requirements which are required to be complied during the course of execution of instrumentation works.

1.2 Instrumentation works shall be performed in accordance with this technical specifications and various other drawings and schedules supplied during the execution of work and instructions received from Engineer-in-Charge or his authorized representative(s) from time to time during the execution of this work.

2.0 DEFINITIONS

2.1 Manifolds

2.1.1 For close coupled instruments, wherein the distance of instrument is within 0.6 metre (2 feet) from the instrument tapping, 'Manifold' shall mean complete piping of instruments from first block valve upto the instruments.

2.1.2 For remote mounted instruments, wherein distance of instrument is more than 0.6 metre (2 feet) from primary tapping such as orifice, 'Manifold' shall mean the assembly of nipples, valves and fittings around the instrument to form a block and bleed or bypass manifold or drain manifold as the case may be. These shall be generally according to the installation standards enclosed with tender. Wherever the instruments are installed with built- in manifold (for example 2 valve-3 way manifold) this definition shall not be applicable as the built-in manifold forms part of the instrument.

2.2 First Block Valve

First block valve shall mean the valve/valves those are mounted directly on equipments, columns, vessels, pipes, standpipes etc. and shall be operated to isolate the instrument and interconnected instrument piping from the tap off point.

2.3 Supports

Supports shall mean the MS (mild steel) angles, flats, channels those are generally provided to support the main cable ways, cable ducts, junction boxes, angle trays, perforated trays, instrument impulse tubing/piping, signal tubing, instrument air supply lines etc. at specified intervals to keep all items firmly to protect the installation secured against vibration, warping, bending etc.

2.4 Scrap

2.4.1 Salvageable Scraps

Salvageable scrap shall mean lengths of tubes, pipes, multicables, other cables etc. that can be used one time or other at a later date. This material is recovered from the cut-pieces of tubes, pipes, multicables, cables etc.

2.4.2 Non Salvageable Scrap

Non salvageable scrap shall mean the cut piece lengths of tubes, pipes, multicables, cables etc. and they are from cut pieces of tubes, pipes, multicables, cables etc. that cannot he used at all, at any time.

2.5 Standards

2.5.1 The instrumentation erection, calibration and testing shall be carried out in accordance with various related national, international and Indian Standards in instrumentation hut not limited to the following. The Standards referred herein and mentioned below shall be of the latest edition prior to the date, of the purchaser's enquiry:-

API	**American Petroleum Institute** MPMS - Manual of Petroleum Measuring Standards RP - Recommended Practices
BS-6739	Instrumentation in process control systems: Installation design and practice.
ISA	Instrument Society of America Standards, Recommended Practices, and Technical Reports. RP 7.1 Pneumatic Control Circuit Pressure Test
IS-5	Colours for ready mixed paints and enamels
IS-2074	Ready mixed paint, air drying, red oxide-zinc chrome priming

3.0 SCOPE OF WORK

3.1 Contractor scope of work shall include the following;

a) Complete instrument erection work with details as listed under 'Schedule of quantities' attached elsewhere in the tender document.

b) Supply of all hardware and residual activities not listed specifically in 'Schedule of Quantities' but are necessary to ensure proper execution and completeness of instrumentation work.

c) Supply of all items specifically listed in the 'Schedule of Quantities' with specifications attached else where in the tender document.

d) As-built construction drawings and documents as detailed out in this specification.

e) Arranging all necessary test and calibration equipment as per details provided in this specification.

f) Any other work, not specifically listed, but necessary for the successful completion of instrumentation erection work defined in this specification.

3.2 The various jobs covered under Instrumentation erection work are detailed out in the schedule of quantities. However to ensure proper execution and completeness of works any or all of the following activities, as necessary, shall also form part of the vendor scope of work. The price of all such activities shall be covered in the quoted rates.

3.2.1 Fabrication of pipe nipples as necessary including threading as per installation standards.

3.2.2 Drilling of holes in blind flanges including cutting threads as per installation standards.

3.2.3 Filling of seal pots with filling liquids as per the instructions of Engineer-in-Charge.

3.2.4 Back/seal welding of screwed fittings as required by standards or as per the instruct ions of Engineer-in-charge. This may involve welding of dissimilar materials using appropriate electrodes.

3.2.5 Installation of purging devices for instruments and instrument systems as per installation Standards.

3.2.6 Civil works including the casting of foundation as required for instrument supports where paved surfaces do not exist.

3.2.7 Minor civil works like chipping of pavement, grouting of instrument panels/supports/ stanchions on the pavement, laying of conduits below pavement after chipping and refinishing of pavement as necessary.

3.2.8 Sealing of cables/tube entries into the control room after laying and testing of all cables1 tubes either by filling with sealing compound or by installing Multi-Cable Transit block (MCT) including fixing of MCT frame, routing of cables through cable blocks, tightening of cable blocks.

3.2.9 Degreasing of hand wheels of control valves, stud bolts, nuts of side and bottom flange of control valves, skid bolts and flanges of orifice plates/or other primary elements and degreasing of any other instrument as per manufacturers instructions or as required by Engineer-in-Charge.

3.2.10 Degreasing of impulse lines, valves, instruments and other instrument items in oxygen and chlorine service as per manufacturer's instructions or as required by Engineer-in-Charge.

3.2.11 Rotation of top works of Displacer type level instruments wherever required.

3.2.12 Rotation of control valve bonnet wherever required.

3.2.13 Reversing the action of control valves either by replacement of actuator springs, accessories or positioner wherever required as per manufacturer's instructions.

3.2.14 Minor modification/repairs required to be carried out on the instruments namely, replacement of dial, glass for pressure gauges/temperature gauges or any other similar instrument, replacement of rotameter tubes and level gauge glass; replacement of damaged signal tubes on control valves; tapping of damaged threads on couplings, tees and other fittings; cleaning of nozzles and relays in pneumatic instruments.

3.2.15 Painting of all structural supports for trays, pipes, junction boxes, instruments, ducts as per painting specification or as instructed by Engineer-in-Charge.

3.2.16 Identification of instruments impulse lines/manifold connected with alarm/trip circuit with approved colour of paint.

3.2.17 Punching of tag numbers on items or tag plates wherever required as per instructions of Engineer-in-Charge.

3.2.18 Fabrication and installation of pipe stanchion as per Instrument support standards including casting of concrete pedestal, grouting, welding etc. as necessary.

3.2.19 Drilling holes for providing glands/grommets on panels, shut down cabinets, power supply cabinets, local control panels, pneumatic enclosures, junction boxes etc., wherever required for cables/multi tubes entry.

3.2.20 Grounding of shields of shielded cables to respective instrument earth bus provided in the control room/local panel/thermocouple head etc. as required and instructed by Engineer- in-Charge.

3.2.21 Laying and termination of earth cable at both ends between instrument earth bus provided in control room/local panel to instrument earth pits provided by other contractors unless specified otherwise.

3.2.22 Grounding of one of the thermocouple lead in the head using 10 k (ohm) resistance including of supply of resistance for grounded thermocouples.

3.2.23 Supply of all types of consumables required for the execution of the job without any exception.

3.2.24 Sealing of safety valves with standard lead seals after final setting in the presence of Engineer-in-Charge.

3.2.25 Coordination during installation, pre commissioning and commissioning with mechanical and other sub-contractors for proper installation of line mounted instruments like control valve, orifice assemblies, turbine meters, PD (positive displacement) meters, magnetic flow meters, mass flow meters etc., which involve removal of instruments, disconnection of tubes/cables; reconnection of same for alignment and proper installation.

3.2.26 Coordination during pre-commissioning/commissioning with mechanical and other subcontractor for proper installation of vessels/equipment mounted instruments like level transmitters, level gauges, level switches etc which involves removal of instruments, disconnection of tubes/cables, reconnection of the same for alignment and proper installation etc.

3.2.27 Coordination with control system vendors (Distributed Control System (DCS) / Programmable Logic Controller (PLC) / Analyzer system/Terminal Automation etc). as necessary, during installation, loop checking and commissioning as per instructions of Engineer-in-Charge.

3.2.28 Submission of monthly material appropriation statements for cables, tube, piping material and fittings, indicating the quantity issued and consumed in standard proforma.

3.2.29 Incorporation of all information in owners drawings/document, as per the actual execution of work at site including preparation and submission of as-built drawings.

3.2.30 Start-up and commissioning assistance as required and agreed upon with Engineer-in-Charge.

3.2.31 Submission of final material appropriation statements for all the materials issued by the Owner.

3.2.32 Any other work not specifically mentioned above, but required for the proper execution of the instrumentation erection work.

3.2.33 Where requested by Owner/Engineer-in-Charge or his authorized representatives, all or any of the works detailed above and schedule quantities shall also be performed on package units, local panels/cabinets/gauge board installed by owner or by others.

3.3 Work Excluded

3.3.1 Installation of main panels, cabinets and consoles inside control room unless specified otherwise.

3.3.2 Installation of line mounted instruments like control valves, orifice plates and flanges, variable area flowmeters, magnetic flowmeters, tank level instruments etc.

3.3.3 Installation of safety valves, breather valves, flame arresters, rupture discs.

3.3.4 First block valve for instrument tapping points on piping and equipments.

3.3.5 Insulation of steam traced instrument primary impulse lines.

3.3.6 Painting of impulse lines.

4 EXECUTION METHODOLOGY

4.1 Instrument Impulse lines

4.1.1 All impulse lines shall be installed in the best workman like manner and shall follow installation standards in each case. Where there is no installation standard, the

instruction of the Engineer-in-Charge shall be followed.

4.1.2 Horizontal and vertical lines shall be installed using levels and plumb bobs.

4.1.3 Unless otherwise specified in the drawings, impulse lines shall have a slope of not less than 1 in 12 on the horizontal runs.

4.1.4 All welding shall be carried out as per welding procedures and codes with electrodes approved by Engineer-in-Charge. Only qualified welders approved by Engineer-in-Charge shall carry out welding. Charges for non destructive testing like radiography, dye penetration tests, post weld heat treatment tests and stress relieving shall be worked out on the basis of actual man hours spent towards these works and manhour charges with cost of all materials, test equipments, etc., shall be used. However, any materials like electrode, equipments, testing charges for various tests etc., required for initial qualification of the welder/welders shall be borne by the contractor. Wherever welding of dissimilar materials are envisaged for any process hookup, the contractor's scope includes these welding along with supply of weld materials.

4.1.5 Impulse pipes shall be bent using pipe benders only, hot bending will he totally rejected. Pipes shall be cut using pipe cutting device. Hot cutting will not be allowed.

4.1.6 Piping/tubing for steam tracing shall be installed according to the standards without any pocket so as to avoid formation of the condensate pockets.

4.1.7 All threaded joints shall be jointed with PTFE tape only. No other pipe jointing compound shall be used except on high temperature service where graphited sealing compounds shall be used.

4.1.8 All impulse lines shall be properly supported at regular intervals of 1 metre. Wherever insert plates are not available, supports on concrete structures or on ceilings shall be fixed with a minimum of 10 mm expansion bolts. Angle supports shall be fabricated from 40 mm x 40 mm x 5 mm MS angles, as a minimum.

4.2 PVC Covered/Bare Tube (Copper/SS/Aluminium)

4.2.1 Single copper/SS/Aluminium tubes shall be laid as per standards on perforated steel plate. The width of the trays shall be selected as per the number of tubes laid. Tubes shall be clamped to the trays at every 300 mm using clamps made of galvanized steel/aluminium strips. The practice of flattening tubes for clamping purposes shall not be permitted. In case of PVC covered tubes, any exposed portion at ends and connection shall he neatly taped to appropriate thickness. Open ends shall be covered to prevent ingress of moisture dust, vermin etc. Plugs should be removed only when final connection is made.

4.2.2 Trays shall be properly supported either from any rigid steel structure or concrete member as detailed under trays and supports as detailed in para 4.7.4 of this specification.

4.2.3 All threaded ends of male/female tube connectors shall be installed with PTFE tape only. Identification tag plates/ferrules shall be provided on either side of copper tubing as per tubing/junction box schedules. Identification ferrules shall be single sleeve type with letters and numbers neatly printed.

4.3 Installation of Multitubes And Multicore Cables

4.3.1 Multitube/Multicore cables shall always be installed on ducts/trays and shall be properly clamped. At every vertical drop to junction boxes, they shall be clamped at more frequent intervals (maximum of 300 mm). They shall be connected inside junction boxes strictly

At bends minimum radius shall be maintained as per manufacturer's standard. The angle tray supports shall be fabricated from 40 mm x 40 mm x 5 mm angles, as a minimum.

4.3.2 Identification tags shall be provided on either end of multitube/multicore cables as per tubing/cable schedules. Engraved tag plates or PVC ferrules shall be used for identification of tubes/cables.

4.3.3 All multitubes1Multicore cables shall be cut after the exact site measurements are taken between ends. The tube/cable drums shall be selected before cutting the lengths so as to avoid any wastage.

4.3.4 All multicables and multitubes laid in ducts shall be properly dressed and tied with nylon wires of 3 mm diameter.

4.3.5 In the field, the cables and tubes shall be laid in ducts and trays as per layout drawings. Cables shall also be burried underground or taken in concrete trenches wherever required.

4.3.6 Inside control room all cables shall be laid in concrete trenches or below false flooring. When laid below the false floor the cables shall be properly dressed and tied as per the instructions of Engineer-in-Charge.

In other plant rooms like analyzer room or local control rooms the cables shall be laid in concrete trenches, unless specified otherwise.

4.4 Installation of Instruments

4.4.1 All instruments shall be generally installed on supports as per installation standards. In each case all instruments shall be accessible.

4.4.2 Receiver gauges shall be mounted on instrument supports itself, as far as possible as per tubing hookup standards.

4.4.3 Filter regulators shall be mounted on the instrument support below the instruments or on the control valve yoke, as far as possible.

4.5 Instrument Air Supply

4.5.1 The main instrument air header in each area is laid by other contractor. Air supply from the main air header take off valve to individual instruments shall be through either galvanized steel pipe or PVC covered copper tube or SS tubes.

4.5.2 Individual take off valves shall generally be located on top of the main air header. Unions shall be provided at convenient locations. There shall be one isolation valve at each instrument end. The galvanized pipe shall be supported at a minimum interval of 1.5 metres with 40 mm x 40 mm x 5 mm MS angles. Final connection to the instrument shall he copper/SS tubing as per tubing hookup standards.

4.6 Instrument Steam Tracing

4.6.1 The main steam header in each area is laid by other contractor. From the main steam header take off valve, steam to individual instruments shall be taken through carbon steel pipes supported at regular intervals. Steam tracing around individual instruments shall be by copper tubes in general. After steam tracing, the line is connected to the drain funnel through individual steam trap/condensate return

header/tapping point as the case may be.

4.6.2 Electrical Tracing shall be done by others. Assistance, if required, shall be provided by the contractor as per instructions of Engineer-in-Charge.

4.7 Cables Ducts/Ladder trays/perforated trays/angle trays and supports

4.7.1 Galvanized main cable trays are generally prefabricated ladder type trays and shall be laid as per layout drawing.

4.7.2 Closed ducts and ladder type MS angle type trays are generally fabricated as per the drawings and shall be laid as per layout drawings.

4.7.3 Generally heavy structural supports for cable ducts, ladder trays are provided by other agency. However, in critical areas, where additional supports are required to be provided in the opinion of the site-in-charge the same shall be provided by contractor.

4.7.4 The perforated trays/angle trays shall be properly supported at a regular interval of maximum of 1 metre from insert plates or steel structures. Wherever insert plates are not available supports on concrete structures and ceilings shall be fixed with minimum 10 mm diameter expansion bolts. Angle supports for perforated trays/angle trays shall be fabricated from 40 mm x 40 mm x 5 mm MS angles as a minimum.

4.7.5 All supports shall be cut with hacksaw only. Any work executed by gas cutting for making holes or cutting pieces will be totally rejected. Free ends of angle support shall not have sharp edges and shall be properly rounded off.

4.7.6 Perforated trays/angle trays shall be used for branch cables and tube from main trays. Width of trays shall be selected according to number of tubes and cables. Trays shall be laid generally as per site conditions with the approval of Engineer-in-Charge.

4.7.7 No welding on galvanized trays/angles/perforated trays shall be allowed in general. In specific cases where welding is unavoidable, this shall be carried out as per instructions from Engineer-in-Charge. For welding, if required, following procedure shall be followed as a minimum:

a) Remove galvanization thoroughly from the portion to be welded.

b) After welding, clean the welded portion for any slug and sharp edge.

c) Welded portion shall be painted as per procedure described under para 4.10.

4.7.8 Main cable ducts, fabricated ladder type angle trays, MS perforated trays and their supports shall be painted as per painting specification detailed in para 4.10.

4.8 Laying of Cables

4.8.1 All cables shall be laid in accordance with installation drawings and cable schedules. Before laying, cable/multicable on drums shall be meggered and tested to ascertain the transit damages.

4.8.2 All cable routes shall be carefully measured and cables cut to the required lengths, leaving sufficient amount for the final connection of the cable to the terminals on either end. The various cable lengths cut from the cable reels shall be carefully selected to prevent undue wastage of cables. Sufficient extra length of cable shall be kept at the termination points.

4.8.3 A detailed planning shall be submitted prior to cable laying, giving drum number, cable number, lengths which shall be approved by Engineer-in-Charge.

4.8.4 Cables shall have complete uncut lengths from one termination to the other.

4.8.5 All cables shall be indicated close to their termination point by cable number as per cable schedules/junction boxes schedules. PVC ferrule/tag plate shall be used and these identification tags shall be securely fastened to the cables.

4.8.6 All cores of electrical cables shall be identified by their wire numbers by means of PVC ferrules. Wire numbers shall be as per schedules. All temporary ends of cables shall be protected against dirt and moisture. For this purpose, ends of all PVC insulation cables shall be taped with an approved PVC or rubber insulating tape.

4.8.7 The bending radius of cables shall be maintained as per manufacturer's recommendation. Cables installed above ground shall be run exposed on walls, ceilings, structures and shall run parallel or at right angles with beams, walls or columns.

4.8.8 Cables shall be rigidly supported on structural steel and masonry individually or in groups as required using PVC covered galvanized clips, multiple cable supports or cable trays. If drilling of steel must be resorted to, approval must be obtained and steel must be drilled where the minimum of weakening of the structured wall result. Cable shall be supported at every 500 mm on vertical runs and every 100 mm on horizontal runs.

4.8.9 All special cables and power supply cables will be laid direct to the field without any junction boxes, unless otherwise specified.

4.8.10 While laying cables in ducts/trenches or burying them, care shall be taken to low signal cables like alarm, analyzer cables , special cables from turbine meters compensating cable etc. are separated from other power supply cables.

4.8.11 Each underground cable (either in concrete trenches or buried) shall be provided with identifying tag of lead securely fastened every 30 m of its underground length with at least one tag at each end before the cable leaves/enters the ground.

4.8.12 Directly buried cables shall be laid underground in excavated cable trench wherever specified in layout drawings. Trenches shall have sufficient depth and width to accommodate all cables correctly spaced. Pipe sleeves if required for cross overs other than road like drains etc. shall be provided by contractor as per the instructions of Engineer-in-Charge. Before cables are placed the trench bottom shall be filled with 100 mm layer of sand and levelled. Each layer of cables shall be covered with 150 mm of sand on top and sand shall be lightly pressed. A protective covering of 75 mm thick second class red bricks shall be placed flat on the final layer of sand and cable. The remaining portion of the trench shall be then back filled with soil compacted and levelled. On completion of every group of cable laying and before sand filling, every cable shall be given insulation test in the presence of Engineer-in-Charge. Any cable proved to be defective shall be replaced before the next group of cables are laid. Cable route markers indicating number of cables, depth and direction will be placed enroute, on crossovers/turnings etc. to mark the cable route.

4.8.13 At each road crossings and other places, where cables enter pipe sleeves, adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends after hack filling. After laying, the pipe sleeves shall be sealed using sealing compounds.

4.8.14 At the entry into concrete blocks at road crossings cable loops shall be provided at either ends to prevent any damage to cables. Each cable shall have one tag at each end before the cable enters/leaves conduit pipes.

4.8.15 After laying of all the cables and multitubes, the cable entry to control room shall he suitably filled and sealed so as to achieve a positive seal against the entry of gas/water.

4.8.16 On completion of cable laying in concrete trenches, the trenches shall be filled with sand and precast concrete slabs shall be placed on the trench.

4.9 Earthing

4.9.1 Earthing of junction boxes, local panels/cabinets, analyzers etc as required shall be carried out as per the documents and instruction from Engineer-in-Charge.

4.10 Painting

4.10.1 This part of the specification is applicable to cable ducts, MS cable ways, angle trays, instrument supports/perforated trays, all structural supports for the above items, etc.

4.10.2 The surface to be painted shall be thoroughly cleaned with wire brush, sand paper to remove all scales. After cleaning, the surface is painted with one coat of red oxide zinc chromate primer conforming to IS-2074 and allowed to dry completely.

4.10.3 Primer coated surface is painted with one coat of paint to the colour nearest to the final paint and allowed to dry. The colour number shall be specified from IS-5.

4.10.4 Final second coating shall be with the paint of desired colours and shall be selected from IS-5.

4.10.5 It shall be noted that final second coating on external surfaces not covered by cables, copper tubes etc. shall be applied just before handing over the plant or commissioning of the plant whichever is earlier.

4.10.6 The name of manufacturer, colour and quality of all types of primer paint shall be subject to approval of Engineer-in-Charge.

4.11 Testing

4.11.1 Electrical cables for signal power supply alarms shall be checked for megger values and continuity before final termination and ferruling.

4.11.2 Testing shall be carried out after the Installation of instrument with primary piping complete in all respects and approved by Engineer-in-Charge.

4.11.3 Primary piping shall be tested hydraulically/pneumatically to 1.5 times the operating pressure after isolating the instruments. Flushing of piping shall be carried out as per instructions of Engineer-in-Charge. Lines shall be blown after hydro-testing. All external displacement/float type level instrument level gauges shall also be tested as per instructions of Engineer-in-Charge.

4.11.4 Tubes and air line shall be tested with compressed air to 7 kg/cm2 up to the filter regulator. The downstream side of the filter regulator shall be tested for 1.5 kg/cm2. The lines shall be blown with the instrument air up to the regulator for 15 minutes to remove any traces of oil, dust and moisture. All lines shall be checked with soap solution and bubbler unit for possible leak at joints. After pressurizing, source shall be cut off and rate of fall in pressure shall be less than 1 kPa for every 4.4 metre (1 p.s.i. for each 100 ft) of copper tubing for a test period of 2 minutes as per ISA RP 7-1 'Pneumatic Control Circuit Pressure Test'.

4.11.5 All test results shall be recorded in the approved format.

4.12 Calibration

4.12.1 All instruments shall be calibrated strictly as per manufacturer's instructions prior to installation. The scope of calibration includes all field and control room instruments of all types namely, pneumatic, electronic, electrical etc.

4.12.2 Contractor shall use his own oil free instruments air compressor for calibration purposes.

4.12.3 Conversion from one unit to another for the purposes of calibration is not allowed.

4.12.4 Procedure for calibration of different items are as outlined below. However, the detailed procedure shall be submitted to Engineer-in-Charge for approval before proceeding with calibration.

4.12.5 All pressure and differential pressure transmitters shall be calibrated to the settings as per Instrument data/specification sheets and instruction of Engineer-in-Charge.

4.12.6 All thermocouple receiver instruments shall be calibrated by generating milli volt signals suitable for span and type of thermocouple specified.

4.12.7 Receiver instruments programmed shall be calibrated and aligned using test hook-up as per instructions from manufacturer/Engineer-in-Charge.

4.12.8 All pressure and temperature switches shall be calibrated for 0%, 25%, 5O%, 100% of range. These shall be set finally at the required values indicated on the data sheet.

4.12.9 Filled system instruments shall be calibrated for 0%, 25%, 5O%, 75 % and 100% range using standard thermo-oil.

4.12.10 Pressure transmitters shall be calibrated at 0%, 25 %, 50%, 75 % and 100% and vice versa of range using dead weight tester/hydraulic pumps with master gauges.

4.12.11 DP transmitters shall be calibrated at 0%, 25 %, 50%, 75 % and 100 range using mercury, water column manometers and standard gauges.

4.12.12 Pressure transmitters shall be calibrated with dead weight tester and shall be calibrated with thermo-oil baths at 0% , 25 %, 50%, 75 % and 100% and vice-versa of range.

4.12.13 Rotameter transmitters shall be calibrated by moving pointer to 0%, 25%, 50%, 75%, 100% and vice versa range and monitoring the output at the respective flow range.

4.12.14 The external displacer type of level instruments shall be dry calibrated as per manufacturer's instructions or calibrated by filling the displacer chamber with water for level 0%, 25%, 50%, 75% and 100% and draining the water at 100%, 75%, 50%, 25% and 0% of ranges after applying suitable specific gravity corrections of the process fluid as per data sheets.

4.12.15 The internal displacer/float type level instruments shall be dry calibrated as per manufacturer's instruction or using calibration chamber fabricated out of steel pipes and filling the same with water after applying specific gravity corrections of process fluid as per data sheets.

4.12.16 The level switches (external cage type) shall be set by filling the cage with water to the desired alarm/trip level. While setting the switches, it shall be ensured that the micro switches do not reset for full rated travel of the float.

4.12.17 Tank level indicators shall be calibrated by manually lifting the float at 0%, 25%, 50%, 75 % and 100% and vice versa of ranges.

4.12.18 Control valves and positioners shall be checked for hysteresis and linearity and shall be calibrated for rated strokes. Prior to calibration, valves shall be cleaned externally. The system is than lubricated if required, and stroked few times to

ensure that movement is free from friction. The valve shall then be calibrated for rated stroke and linearity also. Subsequently the valves shall be checked for hysteresis to the accuracy of 1% full scale with positioner and 5% full scale without positioners. Stroke speed has to be evaluated for trip/shutdown valves as per safety requirements identified by Engineer-in- Charge.

4.12.19 All calibration readings shall be recorded in the enclosed format and submitted to Engineer-in-Charge for approval. Where significant deviations from specifications are obtained, the matter shall be brought to the immediate notice of the Engineer-in-Charge for corrective action.

4.12.20 Furnished hereunder is a list of recommended calibration and test equipments required as a minimum for calibration work. The contractor shall clearly state in his offer the complete list of calibration and test equipments along with the range, accuracy and quantity which he proposes to use for this job. Contractor should also ensure that any equipment not listed below but required at the time of calibration shall be made available at his own cost. All test equipments and kits shall be approved by NPL/IDEMI/ERTL authorities and shall have valid calibration report: -

a) Controller test stands	Mfr. Standard
b) Indicator/recorder test stands	Mfr. Standard
c) Squeeze bulb (Flow calibrator) Range : 0 to -10,000 mm H2O	--
d) Dead weight testers (Budenberg or equivalent for ranges up to 350 kg/cm2	+- 0.1%
e) Gauge comparator for pressure gauges Rating : up to 350 kglcm2	+- 0.2%
f) Oil bath for temperature instrument Calibrations Max. Temperature 350 C.	Mfr. Standard
g) Standard mercury in glass thermometers Range : -50 to +50 C, 0 to 100C (NPL certified) 0-250 C.	+-0.25%
h) Standard gauges for Ranges upto 350 kg/cm2	+-0.25%
i) U-tube differential manometers/inclined tube manometer Static Pr. rating: 7 kg/cm2.	+-0.1mm
j) Single leg manometers Scale : -1500 mm water 1500 mm hg. Static Pr. rating : 7 kglcm2	+-0.1mm
k) Decade resistance box	Mfr. Standard
l) Multimeters	+-0.05 mV
m) Potentiometer/Direct digital calibrator (capable of generating and measuring mV)	--
n) Meggers 500V / l000 V	--
o) Air hydro pump/hydraulic pump	--
p) Vacuum pump	--
q) Instrument air compressor with filters and regulators and deoilers.	--

r) Current generator (Instrument checker) --
4-20 mA DC(Yokogawa make or equivalent)
with 24 V DC power source.

4.13 Loop Checking

4.13.1 Loop checking shall be performed after calibration, interconnection and leak testing of signal lines is carried out for all instruments. Loop tests are conducted to check the functional performance of all elements comprising the loop, thereby ensuring proper-interconnections and operations.

4.13.2 Before proceeding for loop checking, the calibration results of individual elements shall be recorded on the proforma and shall be approved by Engineer-in-Charge for correctness of installation, measurements and calibration results.

4.13.3 Loop testing for all control loops shall be generally by simulating process conditions for at least 0%, 25%, 50%, 75% and 100% of full scale inputs. Detailed procedure shall be submitted to Engineer-in-Charge for approval before proceeding with the loop checking.

4.13.4 In case of shutdown systems, field/receiver switches are simulated for abnormality by disconnecting the wires at terminals. Function of all associated systems are checked including performance of solenoid valves, On/Off type control/shutdown valves including proper functioning of limit switches and other accessories. Adjustment of limit switches wherever necessary also form part of checking of loop performance.

4.13.5 Performance of individual loops shall be accepted for an overall accuracy of + 1 .5%, Where deviation is found to exist more than specified limit, contractor shall recalibrate the instruments which shall also form part of loop testing, at no extra cost.

4.13.6 After the loop test is complete, the contractor shall connect back any terminations and connections removed for loop checking.

4.13.7 A loop shall be considered as handed over only after measurements in that particular loop are completed and certified by Engineer-in-Charge, in addition to loop sheets being duly filled in all respects, approved and accepted by Engineer-in-Charge and Client. In case of loops in which certain instruments of the loops are calibrated by other agency, loop checking shall be performed in coordination with the agency involved. If a defect in the calibration of the instruments in contractor's scope is observed, same shall be rectified to the satisfaction **of** the Engineer-in-Charge. However, if defect is detected in the calibration of the instruments in the scope of other agency, same shall be rectified by the agency involved. After the calibration has been rechecked by other agency/agencies, the loop checking would be performed to the satisfaction of Engineer-in-Charge. This is part of the contractor scope of work.

4.13.8 Final certified loop sheets shall be submitted in 4 copies and one transparency to the Engineer-in-Charge.

4.13.9 Whenever the installation of central control system like Distributed Control System/Programmable logic controllers/Terminal automation system etc in control room is carried out by any other agency, contractor scope of work for the loops connected to these system shall include the following : -

a) Laying of all related cables up to the designated panel/cabinets/console, dressing of cables including inside control room, identification of cables and cores/pairs of each cable coordination with control system vendor during glanding and termination.

b) Calibration of all field instruments independently.

c) Providing all assistance to control system vendor during loop checking. This shall include providing signals from the field instruments and checking valve operation with the output provided from control system to enable control system vendor to verify loop performance.
d) Coordination with control system vendor to meet loop checking schedule. It shall be contractor's responsibility to demonstrate/prove measuring signal levels of field instrument output in control room in the respective identified pair in case of any problem.
e) Rectification/recalibration of field instruments if found defective during loop checking.

However, the termination of field cables, checking of interconnection between instrument/equipments inside control room, ferruling/tagging of interconnecting cables inside control room and performing loop checking with coordination of contractor shall be in the scope of Control system vendor.
It shall be contractor's responsibility to complete all entries in the 'loop Sheet' related to field instrumentation including calibration, installation checks, interconnection of tubing and cabling, hydrotest etc. and get it duly signed by the Engineer-in-charge. All loop sheets duly filled and signed shall be handed over to control system vendor for overall loop checking records.
It shall be control system vendor's responsibility to complete the loop check column in loop sheet after Engineer-in-charge accept the loops and hand over the sheets in 4 copies to client. All field related assistance shall be provided by contractor during all these activities.

5.0 DRAWINGS AND DOCUMENTS TO BE SUPPLIED FOR Execution BY OWNER/ENGINEER-IN-CHARGE

5.1.1 General layout plan for all units, showing all information like position of field instruments junction boxes, indicative routes of cables, main duct/cable trays.
5.1.2 Cable schedules for alarm/signal/shutdown/power supply cables, pneumatic tubes, earthing guide lines etc.
5.1.3 Termination details/drawings for connecting at control room end.
5.1.4 Individual instrument specifications.
5.1.5 Bill of Materials.
5.1.6 Installation standards/hook up.
5.1.7 Manufacturers hand books with instruction for installation and calibration wherever necessary for reference.

6.0 DRAWINGS AND DOCUMENTS TO BE PROVIDED BY CONTRACTOR

6.1 The drawings for materials that are included in their scope of supply namely local control panel, junction boxes local cabinets.
6.2 The detailed engineering drawings wherever such work is assigned.
6.3 Two sets of As-built with originals layout drawings, instrumentation index, standards, bill of materials, cable schedules etc. duly incorporating the changes/modification carried out during the course of execution of works. The drawings/documents shall be provided by the owner for the above purpose.
6.4 Final material appropriation statement for all the free issue materials indicating shortages if any in the proforma duly approved by Engineer-in-Charge.

7.0 MATERIALS SUPPLY

7.1 Materials to Be Supplied By The Owner Free Of Cost

7.1.1 All pipes, tubes and piping materials such as fittings, steam traps, valves, flanges, gaskets, bolts and nuts for flanges necessary for primary piping, air supply and steam tracing.
7.1.2 Tubes, tube fittings, polyethylene tubes and fittings.
7.1.3 All field mounted instruments like pneumatic, electronic and analyzer instruments, pressure gauges, temperature elements, dial thermometers, thermowells, switches and accessories like air filter regulators, receiver pressure gauges, solenoid valves etc.
7.1.4 Pneumatic and electric junction boxes for field mounting.
7.1.5 Single pair/single triad/multi-pair/multi triad shielded cables/Thermocouple extension cables for signal/alarm/temperature signals and any other special cable specifically indicated in 'Schedule of Quantities'
7.1.6 Two core/three core power cable.
7.1.7 All electrical conduits, fittings, cable glands and cable accessories unless otherwise specifically indicated.
7.1.8 Local panels.

7.2 Materials to be supplied by the contractor at his own cost, as part of this specification

7.2.1 The procurement and supply in sequence and at the appropriate time of all materials and consumables except for the materials specifically enlisted under Owner's scope of supply shall be entirely the contractor's responsibility and his rates for execution shall be inclusive for all these items. These are as, but not limited to, the following:-

a) All industrial gases like oxygen, acetylene or inert gases, compressed air and all types of electrodes, brazing rods, flux etc. for welding purpose, with necessary facilities for testing the welded joints.
b) PTFE tape and other pipe jointing compounds for threads and material for sealing of cable entries to control room, local panels, insulation tapes, sealing compounds for flame proof' conduit fittings.
c) Bolts and nuts for supports, U-bolts with nuts, clamps for tubes and pipes, anchor bolts for panels, expansion bolts (pinch anchor/rawl bolts) of various sizes for fixing to concrete structures. Polythene bags for protection of instruments against rain.
d) Paints, primers and solvents.
e) Plastic tags for identifications of tubes/wires at panel junction boxes.
f) All materials for minor civil works like grouting etc.
g) Structural steel, MS Plates, GI plates, flats, pipe etc. required for fabrication or instruments supports and tray supports wherever required.
h) All accessories for electrical wiring like cable lugs, ferrules for identification etc.

7.2.2 Prefabricated main cable ducts and perforated/ladder trays with necessary accessories like tees bends, crosses etc. as specified in Schedule of quantities.
7.2.3 Mounting accessories for the above like bolts, supports etc.
7.2.4 Spool pieces and blinds for testing wherever required.
7.2.5 Any other item not specified, but required for the completion of the job.

Note: The contractor shall submit in sealed cellophane packets samples of all consumables like bolts, nuts, lubricants, ferrules lugs and any other material included in their scope of supply for approval of Engineer-in-Charge which then forms the standards for erection work.

8.0 SCRAP AND EXCESS MATERIAL

8.1 Every month, the contractor shall submit an account for all the materials issued to him by the owner in the standard proforma prescribed for this purposes by the Engineer-in- Charge.

8.2 On completion of the work, the contractor shall submit 'material appropriation' statements for all materials issued by the Owner in the proforma prescribed by the Engineer-in-Charge.

8.3 The following scrap allowances are permissible:

Length below 0.5 metres	Non salvageable	Unaccountable
Steel pipes, SS tubes	2%	0.5%
Length below 2.0 metres		
Single pair, Single triad, two core/three core	2%	0.5%
Length below 20 metres		
Multitube, Multicables	2%	0.5 %

8.4 All excess materials and scrap shall be returned after duly accounting for, to the storage points designated by the Owner. Where materials are to be weighed before return, the contractor shall be responsible for making the necessary arrangements for weighing etc. The contractor shall not use scrap section obtained during the course of construction for fabricating temporary supports or other items without prior permission of the Engineer-in-Charge.

8.5 If the contractor fails to return the surplus material as aforesaid, the owner will charge the contractor for such unreturned material at panel rates, which will be deducted from whatever amount is due to the contractor. In case any material issued by the owner deteriorates during storage by the contractor, new material will be issued to him at panel rates, but the delay in procuring such materials will be at the contractor's account only.

GAIL INDIA LIMITED

STANDARD SPECIFICATION

FOR

INSTRUMENT TUBING

GAIL-STD-IN-DOC-TS-002

0	17.01.2019	Issued for Bid	RKS	UNU	UNU	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

CONTENTS

Abbreviations:

ID	Inner Diameter
OD	Outer Diameter
PVC	Polyvinyl Chloride

1 0 GENERAL

1.1 Scope

1.1.1 This standard specification, together with the data sheets attached herewith, covers the requirements for the design, materials, inspection, testing and shipping of Instrument Tubing which includes the following types: -

a) Stainless steel tubes
b) Copper tubes

1.1.2 The related standards referred to herein and mentioned below shall be of the latest edition prior to the date of purchaser's enquiry;

ASTM	**American Society for Testing and Materials.**
A 269	Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Services.
A632	Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing (Small Diameter) for General Services.
B 251	Specification for general requirements for wrought seamless copper and copper alloy tube.
B 251M	Specification for general requirements for wrought seamless copper and copper alloy tube (Metric)
B 68	Specification for seamless copper tube, bright annealed.
B 68M	Specification for seamless copper tube, bright annealed. (Metric)
E 243	Standard Practice for Electromagnetic (Eddy - Current) Examination of Copper and Copper - Alloy Tubes
EN 10204	Inspection Documents for Metallic Products

1.1.3 In the event of any conflict between this standard specification, job specification/data sheets, statutory regulations, related standards, codes etc. the following order of priority shall govern:

a) Statutory regulations
b) Job specification
c) Standard specification
d) Codes and standards

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to vendor attached with the material requisition.

1.2.2 Whenever a detailed technical offer is required, vendor's quotation shall include the following;

a) Compliance to the specifications.

b) Whenever the requirement of a detailed specification sheet, is specifically indicated, the specification sheet shall provide information regarding size, length, construction, materials etc. of the items. The material specifications and units of measurement for various items in vendor's specification sheets shall be to the same standards as those indicated in purchaser's data sheet.

c) Overall dimensions in mm/inch as per purchaser's specification.

d) Deviations on technical requirements shall not be entertained. In case vendor has any valid technical reason to deviate, they must include a list of deviations item wise, summing up all the deviations from the purchaser's data sheet and other technical specification along with the technical reasons for each of these deviations.

e) Catalogues giving detailed technical specifications; model decoding details and other related information for each item covered in the bid.

1.2.3 All documentation submitted by the vendor including their quotation, catalogues, drawings, installation and maintenance manuals shall be in English language only.

1.3 Drawings and Data

1.3.1 Detailed drawings, data, catalogues and manuals required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of reproducible, prints and soft copies shall be dispatched to the address mentioned adhering to the time limits indicated.

1.3.2 Final documentation consisting of design data by the vendor or after placement of purchase order shall include the following as a minimum;

a) Specification sheet for each type of tube.

b) Copy of test certificates of all tests indicated in clause 4.0 of this specification.

2.0 DESIGN AND CONSTRUCTION

2.1 Stainless Steel Tubes

2.1.1 The tubes shall be 316L Stainless Steel fully annealed, seamless and cold drawn as per ASTM A 269.

2.1.2 The hardness of the tubes shall be limited to HRB 70-79. Equivalent hardness as Rockwell superficial scale (30T/15T) or Vicker's hardness scale shall also be acceptable.

2.1.3 Tubes shall have good surface finish and shall be free from scratches burrs etc. and suitable for bending.

2.1.4 Maximum working pressure shall be as per Annexure - 1 attached with this specification.

2.1.5 Tubes shall preferably be supplied in length of 5 to 6 metres without welding in between. Tube length less than 5 meters shall be rejected.

2.1.6 All tubes in oxygen and chlorine service shall be thoroughly degreased using reagents like trichloro-ethylene or carbon tetrachloride and tube ends shall be plugged after degreasing process in order to avoid entrance of grease or oil particles.

2.2 Copper Tubes

2.2.1 Copper Tubes (PVC Jacketed)

a) The tube shall be soft annealed copper with 6mm OD and a wall thickness of 1.0mm as per ASTM B 68M copper No. C 12200.

b) The tube shall be jacketed with black PVC. The jacket thickness shall be 1.6mm. The PVC jacket shall confirm to ASTM D-1047.
c) The tube ends shall be plugged prior to transportation.
d) The tube shall be continuous length without any brazing in between.
e) The length of single tube shall preferably be 100 metres. However any tube length less than 70 meters shall be rejected unless specifically required otherwise in job specification.
f) Thedimensionaltolerances shallbeasperASTM B251M.

2.2.2 Bare Copper Tubes (For Steam Tracing)

a) The tube shall be soft annealed copper with 3/8" (10mm) OD with wall thickness of 0.049" or 6mm OD with wall thickness of 1.0mm as per ASTM B68, copper No. C12200.
b) The tube ends shall be plugged prior to transportation.
c) The tube shall be continuous length without any brazing in between.
d) The length of single tube shall preferably be 100 metres. However any tube length less than 70 meters shall be rejected unless specifically required otherwise in job specification.
e) The dimensional tolerances shall be as per ASTM B 251.
f) Maximum working pressure shall be 53.0 kg/cm^{2}g at 38°C unless specified otherwise.

3.0 NAME PLATE

3.1 The following information shall be marked on the stainless steel tubes:

a) Name of manufacturer
b) Type and material grade of tube
c) Tube outer diameter and wall thickness.

4 0 INSPECTION AND TESTING

4.1 Unless otherwise specified, purchaser reserves the right to test and inspect all the items at vendor's works, in line with the inspection test plan for instrument tubing.
4.2 Vendor shall submit following test certificates and test reports for purchasers review:

a) Material test certificates as per clause 3. IB of EN 10204.
b) Hydrostatic test for stainless steel tube and bare copper tubes as per clause 4.3 of this specification.
c) Pneumatic test for PVC jacketed copper tubes as per clause 4.4 of this specification.
d) Hardness / tension test for stainless steel tubes as per clause 4.5 of this specification.
e) Ball test for copper tubes as per clause 4.6 of this specification.
f) Eddy current examination of copper tubes as per ASTM E-243
g) Dimensional test report.

4.3 Hydrostatic test

4.3.1 Stainless steel and bare copper tube shall be hydrostatically tested at ambient temperature at test pressures given in Annexure - 1 attached with this specification. During and after the hydraulic test, the tubes shall not show any leaks or rupture.

4.4 Pneumatic test

4.4.1 PVC jacketed copper tubes shall be tested at 7.0 kg/cm^{2}g of dry air. During and after the test, tubes shall not show any leak or rupture.

4.5 Hardness/Tension Test

4.5.1 All mother tubes shall be hardness tested for each heat prior to drawing for proper quality control. The hardness of the drawn tubes shall be checked by Rockwell Hardness Test. Following shall apply;

a) For tubing less than 0.65in (1.65mm) in wall thickness, Rockwell superficial hardness test on 30T / 15T scale or Vicker's scale shall be equivalent to HRB 70 - 79.

b) Hardness test is not required for tubes smaller than l/4in (6.4mm) inside diameter or tubes having a wall thickness thinner than 0.020in (0.51mm). These tubes shall be tension tested in accordance with ASTM A632.

4.6 BalL Test

4.6.1 Ball test shall be carried on all copper tubes to ensure clear opening of the tube. The OD of the ball shall be minimum 1.0mm for 6.0mm OD tube and 2.0mm for 3/8" (10mm) OD tube.

4.7 Witness Inspection

4.7.1 All tubes shall be offered for pre-dispatch inspection for the following, as a minimum;

a) Physical dimensional verification and workmanship.
b) Hardness / tension test for stainless steel tubes.
c) Hydrostatic and pneumatic tests on representative samples.
d) Ball test on copper tubes on representative samples.
e) Eddy current examination of copper tubes on representative samples.
f) Review of all certificates and test reports as indicated in clause 4.2 of this specification.

4.7.2 In the event that the witness inspection is not carried out by purchaser, vendor shall anyway complete the tests and test reports for the same shall be submitted to purchaser for scrutiny.

5.0 SHIPPING

5.1 The tube shall be plugged at both ends to prevent entry of foreign matter.

5.2 The tubes shall be packed carefully so as to avoid damage during transport.

5.3 All tubes in oxygen and chlorine service shall be separately packed along with a certificate indicating 'SUITABLE FOR OXYGEN / CHLORINE SERVICE', as applicable.

6.0 REJECTION

6.1 Vendor shall prepare their offer strictly as per clause 1.2 of this specification and shall attach only those documents and information which is specifically indicated in the material requisition.

6.2 Any offer not conforming to above requirements, shall summarily be rejected.

ANNEXURE - 1

MAXIMUM WORKING PRESSURE AND HYDROSTATIC TEST PRESSURES FOR INSTRUMENT TUBING

Sr. No.	Size of Tube (OD)	Material	Line Pressure Class	Thickness	Maximum Working Pressure	Hydrostatic Test Pressure
1	½″ (12mm)	Stainless Steel	≤ 600#	0.049″ (1.2mm)	102 Kg/cm²g	153 Kg/cm²g
2	½″ (12mm)	Stainless Steel	≥ 900# to ≤ 1500#	0.065″ (1.65mm)	253 Kg/cm²g	383 Kg/cm²g
3	1/4″ (6mm)	Stainless Steel	≤ 600#	1.00 mm	102 Kg/cm²g	153 Kg/cm²g
4	1/4″ (6mm)	Stainless Steel	≥ 900# to ≤ 1500#	0.065″ (1.65mm)	253 Kg/cm²g	383 Kg/cm²g
5	3/8″ (10mm)	Copper	-	0.049″	53 Kg/cm²g	80 Kg/cm²g
6	1/4″ (6mm)	Copper	-	1.00 mm	53 Kg/cm²g	80 Kg/cm²g

GAIL INDIA LIMITED

STANDARD SPECIFICATION

FOR

INSTRUMENTATION WORKS

GAIL-STD-IN-DOC-TS-003

0	18.01.2019	Issued for Bid	RKS	UNU	UNU	
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1 GENERAL

1.1 Scope

1.1.1 This specification together with the attachments covers the design, engineering, supply, factory inspection and testing, field testing and calibration, installation and commissioning of instrumentation and control systems on a turnkey basis for its successful operation.

1.1.2 The detailed scope of work, specific job requirements, design basis, exclusions, deviations, additions etc. are indicated elsewhere in the bid document.

1.1.3 This specification provides only the qualitative specifications of commonly used instruments and systems, but by no means covers the specification of each and every item covered in the bid document. Instruments specification for those items not covered in this specification shall be submitted by the contractor for approval.

1.1.4 Contractor shall be fully responsible for design, material selection, sizing and proper selection of aa the instruments and systems being supplied by them. Any approval or comment on any document or guideline issued to contractor before or after placement of contract or during execution of the contract shall not absolve the contractor of their contractual obligations and responsibility with regards to completeness, proper selection, satisfactory operation and easy maintenance of the unit.

1.1.5 All equipments supplied shall be of field proven quality both with respect to design and materials. Prototype instruments or instruments of an experimental nature shall not be offered or supplied.

In general, all instruments and instrument control systems, like Programmable Logic Controller (PLC), Distributed Control System (DCS), Analyser Systems, Gas Detection Systems, etc. offered by contractor shall have a well proven performance record of operating satisfactorily in the hydrocarbon industry like refinery, petrochemical, gas processing etc. for a minimum of 4000 running hours. No instrument requiring special maintenance or operating facilities shall be offered or supplied as far as possible.

1.1.6 In the event of any conflict between this specifications, data sheets, related standards, codes etc., the contractor shall refer the matter to the purchase/purchaser's representative for clarification and only after obtaining the same should proceed with the manufacture/engineering of the item in question.

1.2 **Bids**

1.2.1 Bidder shall clearly define the operational philosophy suggested by them, in line with requirements specified in the tender specifications. Bidder shall also clearly indicate the provision of control panels, and control systems required for their sub packages offered by them.

1.2.2 Bidder shall provide the following information along with their offer as a minimum:

a) Compliance statement as given in bid document
b) Configuration diagram and details of the offered control systems like Distributed Control System, Programmable Logic Controller, Analyser system, CCTV, Gas Detection System etc.
c) Details of special instruments and control systems if any.

d) List of deviations, if any, from bid package clause number wise with reasons thereof, wherever applicable.

1.2.3 Information like Instrument list and typical specifications if enclosed by bidder in their bid, shall be retained for information only and shall not be referred by bidder as contractual agreement. No implication shall be admissible on the basis of these documents. Contractor shall submit details only after the finalisation of P&ID (Piping and Instrument Diagram).

1.2.4 In addition to mandatory spares and consumable spares indicated elsewhere in the tender document, bidder shall also quote for two years operational spares for all the instruments and control systems including those required for sub packages being offered by them.

1.3 **Applicable national/international standards.**

1.3.1 Design and terminology shall comply, as a minimum, with the latest edition prior to the date of purchaser's enquiry of following codes, standard practices and publications:

AGA American Gas Association, Gas Measurement Committee

- Report No.3 - National Gas Fluid Measurement- Orifice Metering of Natural Gas.
- Report No.7 - Measurement of Gas by Turbine Meters.

ANSI/ASME American National Standards Institute/ American Society of Mechanical Engineers.

B 1.20.1 Pipe Threads.
B 16.47 Steel Pipe Flanges and Flanged Fittings.
B 16.20 Ring Joint Gaskets and Grooves for Steel Pipe Flanges.

ANSI/FCI American National Standards Institute/Fluid Controls Institute

70.2 Control valve seat leakage classification.

API American Petroleum Institute

RP 520	Sizing, selection and installation of pressure relieving system in refineries.
Part-I	- Sizing and selection
Part-II	- Installation
RP 521	Guide for pressure relieving and depressurising systems.
RP 526	Flanged steel safety relief valves.
RP 527	Seat tightness of pressure relief valves.
MPMS	Manual of Petroleum Measurement Standards.
RP 551	Process Measurement Instrumentation.
Part 1 -	Process Control and Instrumentation.
RP 552	Transmission Systems
S 1101	Measurement of Petroleum liquid hydrocarbon by Positive Displacement meter.
S 2000	Venting Atmospheric and low pressure storage tank.
S 2534	Measurement of liquid hydrocarbons by turbine meter systems.

S 670 Vibration, Axial-Position and Bearing-Temperature Monitoring Systems.

ASME American Society of Mechanical Engineers.

- Boiler and Pressure codes (Section I and VIII)
- Unfired Pressure Vessels˜.

ASTM American Society for Tests and Materials.

BS British Standards
BS-1042 Measurement of fluid flow in closed conduits.
BS-4368 Compression coupling for tubes.
BS-4800 Colours for ready mixed paint.
BS-5308Part-2 Specification for PVC insulated cables.
BS-6364 Specification for valves for cryogenic service.
BS-7244 Flame Arrestors for general use

DIN-43760 Temperature vs Resistance curves for RTDs.

DIN-19234 Electrical Distance Sensors; DC interface for Distance Sensor and Signal Convertor.

IBR Indian Boiler Regulations.

IEC International Electrotechnical Commission.

IEC 79	Electrical Apparatus for Explosive Gas atmosphere.
IEC 85	Thermal Evaluation and Classification of Electrical Insulation.
IEC-332	Test on bunched wires or cables.
Part 3	Cat.A
IEC 529	Classification of degree of protection provided by enclosures.
IEC 534-2	Industrial Process Control Valves-Flow capacity.
IEC 584-2	Thermocouples - Tolerances
IEC 60584-3	Thermocouples extension and compensating cables, tolerences and identification system.

IS Indian Standard

IS-5	Colours for ready mixed paints.
IS-319	Specification for free cutting Brass bars, rods and sections
IS-1239	Mild steel tubes, tubulars and other wrought steel fittings.
IS-1271	Specification of Thermal Evaluation and Classification Of Electrical Insulation.
IS-1554-	PVC insulated (heavy duty) electric cables-working Part I voltage upto and including 1100 V.
IS-2074	Ready mixed paints, air drying, red oxide- zinc chrome.
IS-2147	Degree of Protection provided by enclosures for low voltage switch gear and control gear.
IS-2148	Flame proof enclosures for electrical apparatus.

IS-3624 Specification for pressure and vacuum gauges
IS-5831 PVC insulation and sheath of electric cables.
IS-7358 Specifications for Thermocouples

ISA Instrument Society of America.
S-5.2 Binary logic diagrams for process operations.
S-7.3 Quality standard for instrument air.
S-75.01 Flow equations for sizing control valves.

ISO 5167 Measurement of fluid flow by means of orifice plates, nozzles and venturi tubes inserted in circular cross-section conduits.

NACE National Association of Corrosion Engineers - MR-01-75.

NEC National Electric Code.

NFPA National Fire Protection Association.
NFPA-496 Purged and pressurized enclosures for electrical equipment.

OSHA Occupational Safety and Health Authority.

1.4 **Drawing and Data**

1.4.1 Detailed drawings, documents, data and catalogues etc. as required from the Contractor have been indicated separately in the Contractor Data Requisition. The required number of reproducible and prints should be dispatched to the address mentioned, adhering to the time limits indicated.

1.4.2 Bidder shall furnish all documents in A4 Size (210 mm x 297 mm) paper or folded in A4 size unless otherwise specified. All drawings and sketches shall be in multiples of A4 size like A3 (297 mm x 420 mm) or A2 (420 mm x 594 mm) etc., but folded to 'A4' size. Final documentation shall be submitted in bound volumes.

1.4.3 Definitions of Deliverable Documents

1.4.3.1 **Instrument work Specifications**

This document details out the procedures and methodologies adopted by the contractor to carry out complete instrumentation work. The document apart from others, shall include:

a) Agencies involved for carrying out design, detailing, engineering, procurement, installation, loop checking and commissioning of Instrumentation with specific reference to various systems.

b) Scope of work and responsibilities of various agencies involved.

c) Interface requirement and co-ordination between various agencies.

d) Co-ordination between various engineering disciplines viz. Electrical, Mechanical Equipment, Piping, Process/Operations etc.

e) Experience of various agencies in carrying out respective jobs.
f) Inspection & testing requirements and co-ordination procedures for the same.
g)Co-ordination requirements & procedures for co-ordination with outside/statutory authorities.
h) Quality control and assurance procedures to ensure proper quality.

1.4.3.2 **Drawing and Document Schedule**
This document lists out drawings and documents prepared and/or submitted by contractor to owner either during engineering or as a part of final documentation. Following information shall be available in this document:
a) Name and number of each drawing and document listed.
b) The schedule for the document submission, contractor shall follow as per the overall schedule.

1.4.3.3 **Instrument Index**

Instrument Index lists out all instruments those appear on the P&ID without any exception. It is a basic instrument document, which is necessary for the smooth execution of a job and is also a reference document after the completion of job. Instrument Index shall be prepared in Format. In case, any other format is used, it must contain all information as listed in this format.

1.4.3.4 **Sub Vendor List (for Instruments and Accessories)**
Separate sub-vendor list is included elsewhere for instrumentation item. The list provided are for make only and not for model number. It is contractor's responsibility to select correct model number to suit the requirements and has requisite proven track record. It may be possible that make and / or model number of some instruments are identified in licensor's process package or in P&IDs, in such cases licensor process package or P&ID shall be guiding. In case for certain instruments vendor list is not included, suggested vendor list will have to be got approved from the purchaser/purchaser's representative.

1.4.3.5 **Instrument sizing calculations, selection requirements**
Instrument sizing calculations provide information regarding sizing (as per standards specified elsewhere in this document), type, selection and other related information.

1.4.3.6 **Utility Requirements**
This document lists out the following information regarding utilities required by the contractor:
a) List of utilities required i.e. Power (UPS, Non UPS), Instrument air, Cooling water, Steam for tracing, Nitrogen etc.
b) Location and estimated/actual requirement at each location. The requirement shall be listed as minimum/normal/maximum.
c) In case of AC power, the In-rush current with duration and power factor shall also be indicated for each location.

1.4.3.7 **Nozzle Elevation Drawings for Level Instruments**

These drawings represent the nozzle elevation, nozzle sizes and rating, requirement of stand-pipes, type of level instrument etc. for all the vessels, columns, exchangers and tanks.

1.4.3.8 **Purchase Requisition (PR)**

Purchase Requisition contains all information, which form part of material requisition but updated in line with the finally accepted offer of the successful bidder. Typically purchase requisition shall contain

a) Instrumentation specification, detailed instrument data sheets
b) Standard specification, quality assurance requirements
c) Testing (shop and field), inspection and shipping requirements
d) Drawing document requirement
e) Training requirements, if applicable
f) Make and Model number of selected vendor.

1.4.3.9 **Functional Schematics (FS)**

Functional Schematics details out the functionality of all the loops shown on the P&ID including their correlation. The schematic shows all the hardware necessary to configure a loop including their physical location, their interconnection and important software blocks as applicable to make a loop complete. Similar loops may be combined under the same functional schematic.

1.4.3.10 **Logic Diagrams**

Logic diagram is a logic representation of process interlock and shutdown system and details out the functionality, in a schematic form, based on either process cause and effect table shown on the P&ID or in a separate write-up. The schematic shall be prepared based on ISA S5.2 - ˜Binary Logic Diagrams for Process Operations˜ and shall show the physical location of Input/Output devices, their interconnection with functional blocks, bench status of all electrical devices etc. The schematic shall also be supplemented with operational requirements like startup and process bypasses, reset and shut down push buttons, selector switches, status lamp etc.

1.4.3.11 **Instrument Loop drawings**

Each loop shall have a separate Instrument Loop drawing which shall show each component from field device to final receiver including physical location, initiating device, its terminal number, junction box with its terminal number, cable number with pair number/polarity, receiver instrument terminals/cabinet terminals, system functional blocks of loop in simplified manner (without configuration details).

1.4.3.12 **Control Room Layout**

Control room layout drawing shall show the location of control panels, system cabinets, marshalling racks and other auxiliary cabinets, consoles with monitors, hard wired consoles, printers, non-system panels/cabinets including panels/cabinets for packages, LEL panel, fire alarms panels or any other equipment required to be installed in control room. The layout shall be prepared on control room architectural drawing and shall also show layout of

equipment in engineering room/computer room etc.

1.4.3.13 **Analyser Room / Shelter Layout**
Analyser Room / Shelter drawing shall show the location of all analysers, sample handling systems, junction boxes, HVAC system warning panel, CRTs / analyser consoles, if any and any auxiliary rack / panel / cabinet to be located in the analyser room / shelter along with complete dimensions. The drawing shall also show location of light fittings (inside and outside the shelter/room), LEL detector and fire detectors as applicable. A separate drawing with dimensions shall be issued for each analyser room/shelter.

1.4.3.14 **Panel Front Arrangement**
This drawing shall show the arrangement of Panel mounted instruments like indicating instruments, alarm annunciator, indicating lamps, push buttons/switches etc. including their approximate sizes and their mounting locations.

1.4.3.15 **Configuration Diagram**
This drawing is a graphical representation of all major hardware required in a configurable control system which are necessary to meet all the expected functional requirements.

1.4.3.16 **Dynamic Graphic Display Drawings**
These drawings provide a graphic representation of P&ID's arranged in a sequence which when displayed on the CRT, shall provide easy and logical operational views.

1.4.3.17 **Input/Output Assignment**
This document indicates the physical assignment of various I/O modules and their respective channels to various physical inputs and outputs.

1.4.3.18 **Instrument Duct/Tray/Trench Layout**
Instrument duct/ tray layout drawing show the routing of main instrument duct/tray layout in the unit/plant. The drawing shall be prepared on plot-plan and shall show the size, cross-section at various locations, general notes, symbols, reference drawings and the control room entry.

1.4.3.19 **Instrument Location Plans**
Instrument Location Plans shall show the location of instruments, location of tapping points, location of local panels, junction boxes, main cable routes (cable duct / trenches), instrument air distribution scheme etc. These drawings are prepared on equipment layout drawings preferably in 1:50 scale.

1.4.3.20 **Instrument Cable Schedule**
The instrument cable schedule shall show all instrument and power cables required for complete instrumentation. The document shall show, tag number, cable number, type, length and size of cables, type of junction box, identity of local panel, control room panel/cabinet location etc.

2 DESIGN PHILOSOPHY

2.1 Instrumentation shall be complete in every respect and liberal to the extent of providing data on all operations and variables sufficient for the safe, efficient and easy operation, start up and shut down of the plant.

2.2 The design and installation of instruments shall be generally in accordance with ISA/API recommended practices and other applicable standards like BIS, IBR etc. Material specifications and practices shall, in general, conform to appropriate ASTM or equivalent standards. All standards and code of practices referred to herein shall be of the latest edition prior to the date of purchaser's enquiry.

2.3 All instruments and equipments shall be suitable for use in a hot, humid and tropical industrial climate in which corrosive gases and/or chemicals may be present. As a minimum, all instruments and enclosures in field shall be dust proof and weatherproof to IP-66 as per IEC-529/IS-2147 and secure against the ingress of fumes, dampness, insects and vermin. All external surfaces shall be suitably treated to provide protection against corrosive plant atmosphere.

2.4 **Instrument Requirements for classified area:**

2.4.1

a) All electronic/electrical instruments and equipments shall be suitable for area classification as per IEC codes and shall be tested by any recognized authority like BASEEFA, FM, PTB, CMRI etc. and shall be certified by CCE.

b) Certified Intrinsically Safe (IS) equipment as per IEC-79-11 shall be used, in general, in hazardous area. In case intrinsically safe equipment is not available, flameproof enclosures as per IEC-79.01 may be considered.

c) Junction boxes and accessories required for flameproof instruments shall also be certified flameproof.

d) All non flameproof panels and cabinets installed in classified area shall be purged as per requirements specified in NFPA-496, as a minimum.

e) Other type of protection as specified in IEC-79 shall not be used.

2.4.2 **Statutory Approvals**

a) Contractor shall be responsible for obtaining all statutory approvals, as applicable for all instruments and control systems.

b) In addition, equipments/instruments/systems located in the hazardous area shall be certified by the local statutory authorities for their use in the area of their installation. In general following certification shall be given:

- For all intrinsically safe/explosion proof/flameproof equipments/ instruments/systems or equipments with any other type of protection allowable as per this package which are manufactured abroad and certified by any statutory authority like BASEEFA, FM, UL, PTB, LCIE etc. should also have the approval of Chief Controller of Explosives (CCE), Nagpur.

- For all flame proof equipments manufactured locally (indigenously), the testing shall be carried out by any of the approved test house like CMRI/ERTL etc. The equipment shall in addition bear the valid approval from Chief Controller of Explosives, Nagpur and

a valid BIS license.

- For all intrinsically safe equipment manufactured locally (indigenously), the testing shall be carried out by any of the approved test house like CMRI/ERTL etc. The equipment shall in addition bear the valid approval from Chief Controller of Explosives, Nagpur.

c) Approvals other than above shall neither be offered nor these will be acceptable.

2.5 Sizing for control valves and safety valves is contractor's responsibility. In the P&ID and some cases in data sheets, valve sizes are identified.

a) Contractor shall size these valves also. It is contractor's responsibility to supply the items as per approved sizes. For orifice, the sizing shall be carried out by contractor and in case due to these sizing the line sizes need to be increased or decreased the same shall be carried out by the contractor as part of his contract.

b) The type of flow instruments shall be decided by the contractor based on technical specifications and shall be approved by the purchaser/purchaser's representative. In general type as indicated in P&ID/by licensor shall be followed.

2.6 Following units of measurement shall be applicable, unless indicated specifically otherwise;

Flow	Liquid	: m3/h
	Steam	: kg/h
	Gas and Vapour	: Nm3/h
Pressure/Vacuum	Gauge	: kg/cm2g
		: mm of H_2O
	Vacuum	: kg/cm2
		: mm of H_2O
Temperature		: deg C
Level		: %
Analysis		: %
		: ppm
Conductivity		: µS (micro siemens)
Viscosity		: mPa.s (cP)

2.7 Local control loops shall not be provided, unless it is specifically required as per P&ID.

2.8 **Instrument Sizing**

a) Contractor shall be responsible for sizing of all instrument items like control valves, pressure relief valves, desuperheaters, orifice plates, other flow elements etc.

b) The control valve and pressure relief valve sizes as indicated in the P&ID or in data sheets (whenever indicated) is tentative only and need to be resized by contractor after due verification of the process data. Whenever the sizes differ

from those indicated in the tender document, the same should be brought to the purchaser's notice. Contractor, in such cases, shall proceed only after approval from purchaser.

c) In case line sizes are required to be increased or reduced because of valve or flow element sizing, the same shall be taken care of by the contractor.

d) Sizing guidelines as indicated in the tender document shall be followed. In case no guidelines are provided, contractor may use national/international standards /standard practices for sizing.

2.9 Ranges for instruments shall be selected in general, such that in normal process operation the indication is between 40% to 60% of span for linear and 60% to 80% of span for square root inputs.

2.10 Ranges for process switches shall be selected, in general, such that the set point falls preferably in the middle 30% of full adjustable range i.e. the set point shall fall between 35% and 65% of adjustable range.

2.11 All controllers shall have facility for bumpless auto-manual and manual-auto transfer and set point adjustment. Flow, pressure and level controller shall be provided with proportional plus integral action, while temperature controller with proportional plus integral plus derivative action.

2.12 Field mounted direct actuated flow and temperature switches shall not be used. Instead, receiver switch/trip amplifier shall be used along with flow element/temperature element. Whenever specified in job specification, flow and temperature transmitters may be directly connected to control system to achieve switch action.

2.13 **Intrinsically Safe System Requirements**

Following points must be considered while designing an intrinsically safe system:-

a) All intrinsic safety barriers shall be active isolating type only and shall have isolation between input, output and power supply.

b) Barriers must be selected based on entity concept. Cable parameters shall also be considered while matching entity parameters.

c) The signal transfer accuracy of barrier shall be at least equal to or better than the transmitter selected.

d) Each instrument in the hazardous area and the intrinsic barrier shall be certified for intrinsic safety by a statutory authority.

e) Each input and output in a loop shall have separate barrier. No barrier shall be shared between two loops or input/outputs.

f) Any intrinsically safe loop requiring any device to be connected in the hazardous side permanently or temporarily, shall also be intrinsically safe.

g) Configuration tools whenever required for any intrinsically safe item which forms part of the intrinsically safe item shall also be certified intrinsically safe.

h) Universal barrier with programmable capability shall be used for temperature inputs i.e. for thermocouple/RTD inputs.

i) It is desirable to use one make of barrier for entire plant. The series shall be of MTL/ P&F or equivalent reputed makes.

2.14 **Power Supplies and their Distribution**

a) Following power supply voltage levels shall be used, unless otherwise specified:

˜ For Instruments, Control Systems, Analyzers	110 V AC 10%(UPS) 50 Hz 3 Hz
˜ Solenoid Valves, Relays, lamps	110 V DC 10%
˜ Input interrogation voltage	110 V DC 10%
˜ Panel/cabinets lighting	240 V AC 10%

Any voltage level other than 110VAC UPS(including 24 V DC) if required for powering any subsystem, input interrogation, relays and lamps etc same shall be generated by the bidder using dual redundant power packs (110 V AC to 24 V DC converter).

b) All instruments, control systems (PLC and DCS) and analyzer system shall be able to operate at the following power supply specification:
Voltage level : 110 V AC 10%
Frequency : 50 Hz 3 Hz
Switch over time : 5 mili seconds.

c) Power feeders if specifically indicated, shall be supplied to the bidder at only one location. All further distribution within the package shall be taken care of by the bidder.

d) Instrument power circuits shall be individually protected from fault with the help of fuses. Power supply to the individual instrument shall be disconnected with the help of Double Pole Single Throw (DPST) switch and protected with the help of fuses. Miniature circuit breakers (MCB's) may be selected in place of switch fuse unit in case protection is provided for overload protection.

2.14.1 110 V AC UPS

2.14.1.1 Power from UPS shall be distributed to individual consumer with the switch - Fuse/Miniature Circuit Breaker(MCB) of appropriate ratings. Completely isolated feeders with isolating transformer shall be provided for DCS, free issue control room mounted panels/equipments, package items in the field etc.

2.14.1.2 20% feeder or minimum of one number of each feeder shall be provided as spare. UPS shall be sized accordingly.

2.14.1.3 The main isolator shall be DPST type to isolate AC line and neutral. Likewise individual distribution feeders to have isolators of DPST type to isolate line and neutral.

2.14.1.4 In order to obtain proper fuse coordination following point must be taken into consideration.

a) All the feeders for DCS shall feed to separate sets of bus bars (line and neutral).
b) All the sets of feeders shall be fully independent and shall not be joined together at any point.

2.14.1.5 Voltmeter and ammeter in each main power feeder entry point inside the power supply distribution board shall be provided.

2.14.1.6 Automatic sequential start-up facility for power supply in the AC distribution board shall be provided. For power supply distribution drawing, details shall be referred in job specification.

2.14.2 **DC Power Distribution**

2.14.2.1 Main isolators shall be DPST (double pole single throw) type to isolate both lines with HRC fuse on both lines. Like wise individual distribution feeders shall have isolation of DPST type and fuse on both DC lines.

2.14.2.2 Contractor shall provide 20% (minimum quantity at least one) spare power distribution outlet with isolators and fuses for each branch line for all types and quantities used for each category.

2.14.2.3 The charger/rectifier and battery shall be sized to cater for 30% spare feeder as specified above.

2.14.2.4 DC power distribution shall be designed to avoid any common mode failure. Power supply distribution drawing shall be referred form job specifications for details.

2.14.3 **230 V AC Non UPS Power Distribution**

2.14.3.1 Main and individual distribution feeder shall be provided with switch fuse assembly or MCB.

2.14.3.2 The contractor to note that 230V AC non-UPS shall be used for panel lighting, level gauge illumination, analyzer shelter and cabinet lighting etc. Necessary distributions of the same for the items specified above and supply and laying of the power supply cables from the switchgear to the field shall be by the contractor.

2.15 **Alarm Philosophy**

a) Adequate alarms shall be provided to give audible and visual warning of any process and machine malfunction in the package.

b) All trips shall have a pre-trip warning alarm in addition to alarm at the trip condition.

c) All package alarms including pre-trip warning alarms and trip alarms (shutdown alarms) shall be annunciated on the local panel. First out alarm sequence as per F3A as per ISA shall be provided, whenever required.

d) All rotating equipments shall have the status indication provided on the local panel wherever applicable.

e) Wherever printer is provided, all alarms shall be printed as and when they appear, in the sequence of their occurrence.

f) Common pre-warning alarm and common trip alarm contacts for the sub packages shall be provided for remote annunciation. Additional alarm contacts shall be provided when specified.

g) ˜Fail-safe˜ type with normally closed alarm contacts shall be used.

2.16 All line or equipment mounted instruments like control valves, pressure relief valves, thermowells, orifice flanges, level instruments and analyser instruments etc., installed on pipes and vessels under IBR service shall be certified by IBR or their authorized representative.

2.17 Location of process connections shall be from the side or from the top of the process equipment but not from the bottom. This requirement is applicable to both pipes and vessels. The location of lower side connection when necessary shall be high enough inside vessel to prevent plugging due to dirt or other suspended solids. In addition, the connections shall be short, vertical or horizontal and without any pockets.

Material of construction of instruments shall be as per the material selection guide lines, provided with this specification. And any specific requirement of material of construction by purchaser/purchaser's representative during detail engineering shall be complied by contractor without any time/cost implications. In any case vendor to ensure that the selected material is consistent with temperature, pressure, corrosion conditions and other process requirements.

In case where suitable material of construction is not feasible /possible, diaphragm seal shall be considered.

2.18 All process switches shall be provided with sealed micro switch contacts rated for the specified application. Contacts shall be Single Pole Double Throw (SPDT) type unless otherwise specified. Contacts used in intrinsically safe applications shall be gold plated.

2.19 **Instrument Connections**

2.19.1 The connections of instruments installed on vessels, tanks, standpipes and piping shall be as per following Standards, unless otherwise specified in licensor's package.

a) Instrument Connections on Vessels and tanks.
b) Instrument connection on Piping.
c) For clad vessel minimum connection size shall be 3".

2.19.2 Pneumatic instrument connections for signal and air supply shall be 1/4" NPT (F).

2.19.3 Electrical cable entry connection shall be 1/2" NPT (F). Suitable cable gland shall be used.

2.19.4 End connections shall meet the following, unless, otherwise specified;

a) Threaded end connection shall be NPT as per ANSI/ASME B1.20.1.
b) Flanged end connection shall be as per ANSI/ASME B16.5.
c) Flange face finish shall be per paragraphs 6.4.4.1, 6.4.4.2 and 6.4.4.3 of ANSI/ ASME B 16.5. The face finish wherever specified in data sheets shall have serration as follows;

Serrated : 250 to 500 AARH
125 AARH : 125 to 200 AARH
63 AARH : 32 to 63 AARH

d) Grooves of ring type joint flanges shall be octagonal as per ANSI/ASME B 16.20

2.20 Air supply for the instruments at pressure specified elsewhere shall be made available to the contractor at the battery limit of the unit wherever specified in the job specification. Contractor shall be responsible for further distribution within the Unit.

2.21 **Interface with Main Control Room**

2.21.1 Instrument junction boxes shall be provided as an interface with control room(s). Marshalling details for tubing and cabling shall be shown with corresponding junction box termination number allocated against appropriate instrument tag number. A separate drawing shall be furnished for interface wiring and tubing showing all instruments interface details between purchaser-vendor, wherever applicable. In general, the philosophy outlined in para 2.21.2.3 shall be followed.

2.21.2 Signal Interface Philosophy

2.21.2.1 **Direct signals from field to control room**

a) All signals from field to main control room/Satellite Rack Room (SRR) shall be terminated in the junctions boxes located at appropriate locations in the field. Separate junction boxes shall be used for the following type of signals:
- Intrinsically Safe Analog Inputs/Outputs (4-20 mA)
- Non Intrinsically Safe Analog Inputs/Outputs (4-20 mA)
- Intrinsically Safe Thermocouple Inputs
- Intrinsically Safe RTD Inputs
- Intrinsically Safe contact Inputs
- Non Intrinsically Safe contact Inputs.
- Non Intrinsically Safe contact Outputs.

b) All pulsed signals or serial signals shall be routed directly to control room(s) without the use of intermediate junction boxes, in general. In case, where single cable length is a problem, intermediate junction boxes can be used, however in all such case, same junction box shall not share signals from two or more device.

c) Whenever multi drop serial communication is adopted, intermediate junction boxes may be used for multi dropping purpose only.

2.21.2.2 **Signals from contractor's scope to purchaser**

a) Whenever signals are required to be routed for purchaser's use, contractor shall use separate dedicated junction box or terminal strip (in case of control panel/system cabinet) for each type of signal i.e. for 4-20 mA / alarm / contacts/ temperature element etc.

b) In case of serial signals, contractor shall provide a separate dedicated port for purchaser's use.

2.21.3 Intrinsically Safe barriers wherever required shall be provided by contractor as part of the control system to which these input / outputs are connected. Generally locating
barriers in the local panels shall be avoided. If provided, the arrangement shall be made for proper earthing in the local panel.

2.22 **Instrument Cables**

2.22.1 Multicables between junction boxes and main control room (MCR) / or satellite room or

any other control room shall be as per following philosophy:

a) Signals (4-20 mA or switch contact): 6/12 pair individually and over all shielded (screened) and armoured, twisted, 0.5 mm conductor.
b) Thermocouple: 6/12 pair thermocouple extension cable (20 AWG)
c) RTD: 8 Triad 1.5 mm˜ conductor.
d) Solenoid valves (110 V DC): 6/12 Pair shielded, armoured, 1.5 mm˜ conductor.

Higher conductor size shall be selected to limit the voltage drop within the specified limit.

2.22.2 The colour of outer sheath, inner sheath and individual core for each type of cable shall be as mentioned below:

Type of cable	Signal type	Outer sheath	Conductor Insulation +ve	-ve
a) signalIS	blue		blue *	Black *
	Non IS	black	blue *	Black *
b) control/power		black	red	Black
c) alarm IS, Non IS		black	white	Black
d) extension cable	IS	As per IEC 60584-3		

x Triad cable shall have blue, black and brown colour.

2.23 **Junction Boxes**

2.23.1 Junction boxes shall be used for interconnection in the field wherever necessary as per para 2.21.2. Analog signals (4 - 20 mA), switch contacts, temperature elements, LEL detectors, intrinsically safe, non intrinsically safe and low voltage contact signals shall be segregated in the separate junction boxes. Separate junction box shall also be used for signals and contacts connected to PLC, DCS or and other system.

2.23.2 The junction box shall be suitable for the type of signal and type of multi core cables used as indicated in para 2.21.7. Unless otherwise specified, contractor must use the following type of junction boxes:
For all intrinsically safe signals: Weatherproof junction boxes
For all input/output connected: Explosion proof/flameproof
to explosion proof/flameproof junction boxes instruments

2.23.3 The junction boxes shall have cable entries suitable for the multi and single cables used. 20 % addition cable entries must be provided. Unused entries shall be plugged.

2.23.4 The junction boxes shall have terminals suitable for the cable wire size and shall preferably be of Phoenix or equivalent make. All junction boxes used in intrinsically safe service shall be sky blue in colour while those in non-intrinsically safe service shall be painted gray.

2.23.5 The multi cable entry for 6 pair Junction Box (JB) shall be 1" NPTF and for 12 pair / 8 triad junction box, it shall be 1 1/2" NPTF. Each junction box shall be provided with 2 multi cable entries with one plugged with weatherproof, flameproof plug as required. Multi cable entries shall be from the bottom whereas 1 pair/triad from the side.

2.24 **Philosophy of Junction Box and Cabling**

i) Overhead ducts shall be used for routing multi cables in the unit and upto control room unless specified otherwise. This main duct shall be routed over the pipe rack with suitable accessible location.

ii) Contractor shall provide continuous channel for support of the overhead duct and the same shall be suitable for a load considering 100% filling of the duct by cables. However as a good engineering practice duct shall be sized considering 60% occupancy of the duct by cables. For ladder and angle trays contractor shall provide support at a minimum interval of 1.5 m.

iii) In duct 4-20 mA signal cables, alarm cables, thermocouple cables and RTD cables can run together in one compartment. The control and power (110 V DC) shall run in other compartment. The middle compartment shall be kept vacant. It shall be used for plant communication cable where specified.

2.25 Multi Cable Transit

2.25.1 The cable entry into the control room, satellite rack rooms, local control rooms, analyzer rooms/shelters shall be through Multi Cable Transit Blocks (MCT). The MCT's shall be sized, supplied and installed at site by contractor. The required cutout sizes and act frames sizes shall be calculated and shall be coordinated with control room contractor.

2.25.2 The MCT frames shall be of Standard RGB type of Brattberg or Roxtec or equivalent and of Steel construction. The maximum height of frame shall not exceed 600 mm, unless otherwise specified. The MCT frames provided shall be suitable to withstand blast intensity for which blast proof control room has been designed. The MCT shall be supplied complete with insert blocks, spare blocks, stay plates, end packing etc.

2.25.3 Contractor shall size and provide MCT considering 50% spares for each cable size / cable OD. Intrinsically safe cables, low power cables, non-intrinsically safe cables and power cables for instruments (110 V AC or above) shall be suitably separated from the other cables within the MCT frame. Separate MCT frame shall be considered for electrical cables. The MCT shall be installed as per the recommended practice of supplier. No spare space shall be left uncovered in the frame and shall be filled with dummy block of suitable size. In addition to the above, contractor shall also supply 30% spare insert blocks in each cable size/cable OD as loose supply.

2.26 **Repeat Signals from Sub-Package Local Panel**

a) Generally separate JBs shall be used for interfacing signals from sub-package to control room.

b) Where signals as indicated in clause above is less in number and do not justify separate junction boxes, all such signals may be routed via local control panel if supplied by contractor.

c) All such signals shall be terminated on separate terminal strips in the local control panel.

The terminal strips shall be segregated as per para 2.21.2.1(a). The non-intrinsically safe signals shall be provided in certified flame proof junction boxes in local panels.

d) Intrinsically safe barriers for all intrinsically safe signals, wherever required, shall be provided.

2.27 **Requirement for instrument in steam service**

2.27.1 All in-line instruments such as control valve, thermowell, orifice flanges, pressure relief valves, all types of level instruments and any other in-line instrument shall be provided with IBR form III C certificate.

2.27.2 All pressure relieving devices shall be designed in accordance with ASME code for ˜Boilers and Pressure Vessels', API-521 and Indian Boiler Regulations. In case of valves as per IBR, the same shall be to regulation no. 294 with 5% over pressure and regulation no. 295 with 5% blow down and shall be provided with the following certificates.

i) IBR form-IIIC certificate of manufacture and test of boiler mountings and fittings.

ii) Type test certificate from IBR authority as per regulation no. 293 and Appendix-L of IBR for the valve series supplied.

iii) Radiography of all castings shall be as per piping material specification.

2.27.3 The discharge capacity of pressure relief valves as in (a) above shall be calculated as per IBR regulation no. 293 a, b and c.

2.27.4 Detailed requirement of Pressure Relief Valve is given else where in this specification.

2.27.5 Installation item like syphon, condensate chambers, impulse pipe and pipe fittings connected with IBR lines shall have IBR form III C certification.

2.28 All instruments shall have internal terminal block for cable termination. Flying leads are not acceptable.

2.29 Diaphragm seal instruments with capillary shall be used for congealing, and various services, where plugging of element may occur or where suitable material is not available in highly corrosive services. In these cases the flange material shall be in accordance with piping classes. Spacer ring shall be provided along with vent and drawing. Capillary shall be minimum AISI 316 SS with AISI 304 SS armouring. Seal fluid shall be suitable for the temperature.

2.30 Temperature extension of suitable length shall be provided in the impulse line of the instrument installation where process fluid temperature is higher than the maximum withstanding temperature of the instrument.

2.31 The in-line instruments on fully jacketed lines shall also be jacketed.

2.32 Interlock and Shutdown System shall be an independent system with its own dedicated primary element except for flow. In which case common flow element with separate transmitter shall be used. However separate element with trip amplifier shall be used for temperature. In no case the initiating contacts shall be derived from indicators, controllers, recorders, scanners, alarm annunciator or any such instrument.

2.33 The interlock & shutdown system shall be designed fail safe and shall meet the following requirements, as a minimum:-

a) All initiating contacts shall be close under normal conditions and shall open under abnormal conditions.

b) All relays and solenoid valves shall be energised under normal conditions and shall de-energise under abnormal conditions.
c) Emergency shut down switch contacts shall be wired in series with the final actuating device to ensure positive shutdown.
d) If desired, because of operational or maintenance requirements, adequate trip by-pass facilities are to be provided with warning lights to indicate that the trip has been bypassed. Trip bypass alarms shall be provided in local on local panel as well as in remote location. All such by-pass switches shall be key-operated type.

2.34 The interlock & shutdown system shall be designed using electromagnetic relays unless specified otherwise and shall be located locally or remotely as per the operational requirements. The system shall meet the following requirements as a minimum;

a) The electromagnetic relays shall be low power continuously rated type and shall have LED for status indication.
b) The relays shall be plug-in-type and their plug-in-bases shall have screwed terminals for interconnection. Lug type soldered connection shall not be acceptable.
c) Each relay shall have three numbers of 'NO'(normally open) and three number of 'NC'(normally closed) contacts, as a minimum each suitable to drive the connected load. Out of these, one 'NO' and one 'NC' contacts shall not be used.
d) Each shutdown/interlock logic shall be individually protected using separate switch-fuse unit and shall have a lamp for indicating power healthy status.

2.35 Each shutdown circuit and solenoid valve shall be provided with a switch-fuse unit separately. Programmable Logic Controller (PLC) whenever used for interlock and shutdown, shall be located in environmentally controlled remote control room or satellite rack room. This shall meet the following minimum requirements:

a) PLC shall have dual redundant or triple redundant as specified in job specification. Redundancy for I/O's/Power Supply/Communication network shall be provided as per selected configuration.
b) The software shall include the operating system and application program. The application program shall include software for performing functions like interlock and shutdown logic, programming/program modification, documentation etc. Two copies of application program and two set of licensed system software shall be supplied.
c) The system shall be supplied with programming tools and related accessories.
d) No two shutdown circuits shall be shared by same I/O module, unless specified otherwise.
e) For detailed PLC specifications refer standard specification for PLC 6-52-0040/standard specification for DCS 6-52-0055.
f) TUV approval, wherever required shall be specified in the job specification.

2.36 DELETED

2.37 Contractor shall provide four sets of back up configuration in floppy media. The drawings

should be in AutoCAD (latest version) and all documents in electronic media in addition to hard copy/ reproducibles as a part of project requirement.

2.38 Unit rate of all items/modules and hardware shall be indicated by contractor for any future addition/deletion for system related items. This price shall include all engineering charges, installation, software charges etc. related to the effected addition/deletion.

2.39 All necessary furniture required for mounting consoles, printers, CRT's, video copier etc. shall be provided by the contractor.

3 SPARES PHILOSOPHY

3.1 Mandatory Spares

Mandatory spares for instrumentation and control system shall be provided as below unless otherwise specified in the job specification:

a) **10%** spare instruments or minimum one of each range, type and material of construction (except for control valves, pressure relief valves, displacer type instruments, level gauges, flowmeters, analysers and special instruments)

b) 5% or minimum one module for all control systems (DCS/PLC/PG's/ESD etc.)

3.2 2-years operational spares

Unless otherwise specified in the job specifications, all spares for 2 years of operation like gaskets, O-rings, diaphragms etc. as required for all instruments for two years of trouble free operation shall be provided.

3.3 Commissioning spares

Any kind of spares required for start-up & commissioning shall be provided.

3.4 Consumable Spares

Consumable spares for a minimum of one year duration after acceptance and shall include chart paper, printer paper, ink, cartridges, floppies etc required for recorders, printers and hard copier units, unless otherwise specified elsewhere.

4 GENERAL REQUIREMENT OF INSTRUMENTS

4.1 Instrument Concept

4.1.1 Major instrumentation shall be electronic type with final control elements as pneumatic.

4.1.2 **Electronic Instruments**

a) All electronic instruments requiring separate power supply, shall generally operate on 110 V 50 Hz. Instruments operating at 24 V DC shall also be acceptable.

b) Electronic transmitters shall generally be two wire type. These shall have transmission/output signal of 4-20 mA DC and shall be capable of delivering rated current into external load of at least 600 Ÿ when powered with 24 V DC nominal voltage.

c) Smart transmitter when selected, shall be used in analog output mode. Digital integration shall be avoided unless specified otherwise.

d) All receiver instruments shall be microprocessor based and shall operate on voltage input of 0.25 to 1.25 V, 1 to 5 V, or 0 to 10 V DC, in general.

e) The design of electronic instruments shall be in compliance with the electromagnetic compatibility requirements as per IEC - 801.

4.1.3 Pneumatic instruments whenever used shall operate on air supply of 1.4 kg/cm2g and shall have transmission and output signal of 0.2 to 1.0 kg/cm2g.

4.1.4 Instrument air quality shall be as per ISA-S7.3 and free from corrosive, hazardous and toxic contaminants.

4.2 **Panel Board Instruments:**

4.2.1 Panel board instruments shall generally be multibin subminiature 6" x 3", except recorders, which shall preferably be 6" x 6". Instruments like microprocessor based recorders, temperature scanners etc., shall be as per manufacturer standards.

4.2.2 Panel board instruments shall have the following graduations, in general;

Differential pressure: 0 to 10 square root
flow meters
Variable area: 1 to 10 linear
flow meters
Pressure: Direct Reading
Level: 0 to 100 Linear
Temperature: Direct Reading.

Multiplying factors for flow scales shall be specified on manufacturer's name plate.
Recorder charts shall be dual graduated, in general, in 0 to 10 square root and in 0 to 100 linear.

4.2.3 Subminiature recorders shall have 100 mm strip chart with chart speed of 25 mm/h. Microprocessor based recorders shall have strip chart of 250 mm approx. and chart speed of 50 mm/h with a provision to change speed at site.

4.2.4 Annunciators, in general, shall be solid state type with plug in modules, in a cabinet with back lighted engraved windows and integral power supply. Alarm logic module shall be single channel type. In case multi-input alarm module are selected, only one channel shall be used.
Intrinsically safe annunciator circuit, when used, shall have power supply unit in a safe area. Annunciator alarm sequence shall be as per F3A of ISA.
The design of the alarm annunciator system shall be such that transient alarms of less than 330 milliseconds duration shall be automatically rejected.

4.3 **Control Panel**

4.3.1 All control panels shall be supplied in pre-tubed/pre-wired conditioned and shall be completely tested at manufacturer's works prior to despatch.

4.3.2 Control panels shall be free standing type and fabricated preferably from 3 mm thick cold rolled steel sheet. If the same is not available, 4 mm thick hot rolled steel sheet shall be used. Angle iron frame work shall use a minimum section of 50 x 50 x 4 mm angle. The finish shall include sand blasting, grinding, chemical cleaning, surface finishing by suitable filler

and two coats of high grade lacquer with wet sanding between coats. Two coats of paint in panel colour shall be given for non-glossy high stain finish. Panel face final colour can be any of the following shades as per to IS-5:

Opaline green : ISC No.- 275
Light Admiralty Grey : ISC No.- 697
Sky blue : ISC No.- 101

Panel rear surface, frame work and mounting plates shall have a finish colour of pale cream to IS-5 ISC No.-352 or Beige to IS-5 ISC No.-388. A final coat of paint shall be given at site. Equivalent colour shade according to BS/RAL are also acceptable.

4.3.3 Control panel shall be open back with each section of typically 2100 mm high, 1200 mm wide and 800 mm deep, when mounted inside the control room on 100 mm channel base covering wall to wall, else these shall be totally enclosed cubicle type. The panel width may be increased if necessary.

4.3.4 Enclosed cubicle panels shall have removable hinged doors, generally at the side or back for easy maintenance and accessibility of the instruments. Doors shall be double leaved type with handle and shall be provided with lock and key. Adequate illumination shall be provided inside the panel. All light fittings shall be suitable for 230 V, 50 Hz AC.

4.3.5 No process fluid of any kind, except instrument air shall enter the control panel. Also power supply greater than 230 V shall not enter the local panel.

4.3.6 All cable entries to the local panel shall be from panel bottom only using cable glands of adequate size. Cable gland plate thickness shall be a minimum of 3 mm cold rolled cold annealed (CRCA) as a minimum. All unused cable entries must be plugged.

4.3.7 Space heater shall be provided where condensation is expected.

4.3.8 The design of control panel shall incorporate provision for expansion by installing adequate spare capacity. Each panel shall be designed to accommodate the following additional equipment, as a minimum;

a) 20% of panel front/inside mounted instruments including lamps, push buttons, switches, relays etc.
b) 20% additional power feeders each provided with switch fuse assembly.
c) 20% additional spare windows in alarm annunciators.
d) 20% spare cable entry points.

4.3.9 Panel layout shall be designed considering ease of operation. No push button or hand switch shall be located below 600 mm. Instrument Mounting heights, in general, shall be as follows:-

a) Miniature and subminiature instruments (3 rows)	Bottom row	1100 mm
	Middle row	1350 mm
	Top row	1600 mm
b) Annunciators	-	1950 mm
c) Electric push buttons/ Switches, lamps etc.	-	700 mm

4.3.10 The internal panel layout shall be designed considering proper approach for instruments, terminals and other accessories for maintenance, easy removal and online calibration. No instrument, terminals, power distribution box etc shall be mounted on the panel side plates inside the panel.

4.3.11 All lamps, status as well as alarm, shall be provided with lamp test facility. One single

lamp test push button shall be used for each panel.

4.3.12 Colour Scheme

a) Status Lamps

On/Open/Permissive : Green
Off/Close/Emergency : Red

b) Alarms

Normal/Pre-trip alarms : White
Shutdown alarms : Red

c) Push/Pull buttons

On/Open : Green
Off/Close : Red
Emergency shut-down (ESD) : Red
(Push-button with cover/
Mushroom push button)

4.3.13 Panel Piping and Tubing

4.3.13.1 The instrument air header shall be adequately sized with brass packless isolation valves and shall be complete with suitable dual filter-cum-air reducing station.

4.3.13.2 Panel tubing from the bulk head to the panel instruments and instrument air supply to the panel instruments shall be of 6 mm x 1 mm polyethylene tubing.

4.3.13.3 The tubing shall be laid in plastic slotted ducts. Panel air header and tube fittings shall be of brass, suitably protected against corrosion.

4.3.13.4 Shut off valves shall be installed in all branch lines taking off the transmission and output signal. Each tube shall be identified at both the terminating ends.

4.3.14 **Panel Wiring**

4.3.14.1 Open terminals shall generally be avoided. Terminal strips shall be of 'Phoenix/Klippon/Elmex˜ or equivalent type and shall preferably be mounted in an enclosure. Fused terminal may be used wherever necessary.

4.3.14.2 A minimum of 1 mm^2 multi stranded PVC insulated copper conductor shall be used in general. All wiring shall be laid in the PVC troughs. No trough shall be more than 70% full.

4.3.14.3 Wires carrying measurement signals associated with thermocouples, resistance thermometers, pH instruments and other low level signals shall be routed in separate troughs/wire ways and not along with power cables. Power wiring and control wiring shall be separated by not less than 150 mm. The crossing, if unavoidable, shall be as close to right angles as possible.

4.3.14.4 Extension cables/wires shall be used for all thermocouple inputs. These wires shall be routed in separate troughs/wire-ways.

4.3.14.5 All intrinsically safe wires shall be routed in separate wire ways from non-intrinsically safe and power wiring. Intrinsically safe wiring and terminals shall be light blue in colour and shall be separated from non-intrinsically safe terminals atleast by 50 mm.

4.3.14.6 All incoming power feeders shall be terminated on separate terminals suitable for the incoming feeder size. These shall be located at the bottom of the panel and shall be suitably covered for protection against accidental shorting and for human safety.

4.3.14.7 Following design philosophy shall be followed while deciding the internal layout of panels, as a minimum:-

a) Distance between terminal strip and side of the panel upto 50 terminals : 100 mm (min.)+ trough width

b) Distance between two adjacent terminal strips width : 100 mm (min.)+trough

c) Distance between gland plate and bottom of the strip : 300 mm (min.)

d) Distance of terminal strip from instrument/trough/panel top : 100 mm (min.)

4.4 **Local Control Panel**

4.4.1 Local control panel for the package units shall be installed within the battery limit of the package considering operational and maintenance requirements and accessibility. In case of skid mounted packages, panel shall be located away from the skid.
In case local control panel is housed outdoor i.e. not in a local control room, it shall be designed to meet IP-55 requirements. In addition, panel must be provided with a rain cum sun shade canopy/shed.

4.4.2 Local control panel/panels shall be totally enclosed cubicles. Panel sizing shall be carried out based on equipment being installed keeping in view the maintenance clearances and easiness. Although the panel dimensions shall be guided by the actual requirements, typical dimensions of 2100 mm operational (height) x 1200 mm (width) x 1000 mm (depth) shall be kept in mind while finalizing the panel size. In any case, vendor shall not proceed with panel manufacturing before getting prior approval from the purchaser.

4.4.3 Local control panels located in the hazardous area shall be either purged type or flameproof Ex˜d˜ as specified in the job specification. In case pressurized panels are specified the same shall be purged and pressurized as per NFPA-496 requirements to render space within the panel non hazardous. For panels located in IEC Zone 2 hazardous area type Z purging shall be used with a purge fail alarm in main control room. In case, panels are located in Zone-1, the power shall be cut-off on pressurization X-purge requirement of NFPA-496.
An alarm shall be provided on local panel and a contact shall be provided for remote annunciation, whenever the panel pressurization falls below 2.5 mm of H2O. A protective device to protect the panel from over pressure must be provided.

4.4.4 Panel pressurization with start-up panel purging scheme shall be fully automatic however it shall be started manually from a push button. Solenoid valves and differential pressure switch required for panel purging shall be flameproof, however other items like relays, switches/pushbuttons, timers etc. shall be located in a flameproof housing. Other items like valves, restriction orifice plates, dual filter regulators, pressure gauges, variable area flow meters etc required for pressurization, shall also be located in the non-pressurized section of the panel.

4.4.5 It shall be possible to switch off incoming power to panel from panel front. All such power on/off switches shall be flameproof type.
In addition, all those devices and terminals which can not be powered off from on/off switches shall also be located inside flameproof enclosures.

4.4.6 All hinges, screws and other non-painted metallic parts shall be of stainless steel material.

4.4.7 All other requirements as specified in clause 4.3 of this specification shall also be applicable for local control panels.

4.5 **Local Gauge Board**

4.5.1 Local gauge board shall be used to install skid mounted instruments like pressure gauges, temperature gauges, process switch and transmitters.

4.5.2 Location of local gauge boards, when provided, shall be decided to allow easy access at the rear and front for all instruments and accessories for maintenance and operation.

4.5.3 Gauge board shall be constructed from 3 mm cold rolled cold annealed steel sheet with other necessary steel supporting structure and shall be painted sky blue shade No. ISC-101 as per IS-5.

4.5.4 Local gauge board shall be supplied with all instruments installed and completely in tubed/wired condition before shipment.

4.5.5 All pressure gauges shall be provided with block and bleed valves securely fastened. Identification tags shall be securely fastened for easy identification.

4.6 Temperature Instruments

4.6.1 **Thermowells**

a) All temperature elements shall be provided with Thermowells fabricated out of bar stock of minimum SS 304, in general. Other materials like SS 316/SS 316L, SS310, Inconel, Inclloy etc shall be selected based on the process pressure, temperature and service conditions. Thermowell flange material shall be selected as per piping specifications, in general. However for lines where post weld heat treatment is called for in piping specifications, the thermowell flange material shall be selected same as thermowell material.
For proper selection of material of construction ˜Material Selection Guide Line˜ clause 11.0 of this specification shall be referred. Contractor shall be responsible to select proper material based on the process conditions including pressure-temperature, sulphur contents etc.

b) Thermowell design shall be as per standard upto ANSI 600# including for packages/sub-packages. For thermowells above ANSI 600# rating, contractor may use their own proven design(s) recommended by various manufacturers suitable for the specified pressure-temperature conditions. The thermowell design shall ensure no air gap between the tip of the element and thermowell to minimize measurement lag.

c) Contractor shall carry out the vibration analysis of all thermowells as per PTC codes where line velocity exceeds 6 m/s for liquids and 120 m/s for vapours/gases. In case the thermowell design fails vibration analysis, an alternate design may be used by the contractor. All such design along with calculations shall be submitted for purchaser's review.

d) Immersion length of thermowells shall be selected as follows:

Line Size	Immersion length
upto 6"	280 mm
From 8" onwards	320 mm
Vessels / columns	400 mm

This immersion length is based on thermowell nozzle length of 200 mm (between flange face and inner wall of pipe). In special applications, where thermowell nozzle sizes are larger or where temperature is to be measured at any specific location, vendor shall decide the immersion length based on the actual requirements.

e) Any pipe line size less than 4" nominal bore shall be blown to 4" size to install thermowell.

f) For immersion lengths larger than 500 mm, like those in fired heaters, built up thermowell design shall be used. In all such cases, all welded joints shall undergo 100% radiography testing. For joints where radiography is not possible dye penetration test may be carried out.

4.6.2 **Temperature Gauges**

a) Local temperature gauges shall be liquid/vapour/gas filled type in general and shall be manufactured as per relevant SAMA Class. Bimetallic gauges shall be considered if required as per licensor package or specified in job specification. The temperature bulb shall be of SS 316 construction as a minimum.

b) All local temperature gauges shall have 150 mm dial size with adjustable head. The bulb size shall be selected to suit the thermowell.

c) All gauges shall be of heavy duty weatherproof construction.

d) Temperature gauges shall have accuracy of 1% URV (upper range value).

e) Bimetallic temperature and direct filled system gauges shall be avoided where excessive vibrations are encountered, such as compressors. Only filled type with capillary extension shall be used in such applications. Capillary tubing shall be minimum of SS304 with stainless steel flexible armouring, having PVC covering over armour.

f) It shall be possible to adjust gauge stem length by using adjustable gland with union. All such fittings shall be suitable for 1/2" NPTF connection to suit thermowell.

4.6.3 **Temperature Elements**

a) For remote temperature indication/recording/control/switch etc., thermocouples or resistance temperature detector (RTD) shall be used depending on the process requirements. Elements shall be spring loaded, mineral insulated and shall have SS 316 sheath as minimum.

b) The design of thermocouple assemblies shall be as per Standard i.e. Thermocouple/RTD assembly with thermowell and shall allow online replacement of temperature element. The element head shall be screwed-in type and weatherproof to IP-56 as a minimum. For thermocouple assembly, the terminals shall be color coded as per element color code.

c) Thermocouples shall be magnesium oxide (MgO) filled ungrounded type, unless specified otherwise. Thermocouple characteristics shall be as per IEC-584-2/IS-7358.

The type of thermocouple shall be selected based on operating temperature conditions. Following guidelines shall be followed in general unless specified otherwise:-

Copper-Constantan (ISA-Type-T) : (-) 200 to 200 deg C
Chromel-Constantan (ISA-Type-E) : 200 to 600 deg C
Chromel-Alumel (ISA-Type-K) : 600 to 1200 deg C
PlatinumRhodium-Platinum (ISA Type-S) : 1200 to 1600 deg C

d) Thermocouple wire size shall be 18 AWG for single and 20 AWG for double thermocouple for most of the applications, in general. However following guidelines shall be followed for selecting single thermocouple wire size as a minimum.

Type	8 AWG	14 AWG	18 AWG	24 AWG
T	-	> 371deg C	For all other temperatures	-
E	> 871 deg C	> 649 deg C	For all other temperatures	-
K	> 1260 deg C	> 1093 deg C	For all other temperatures	-
S	-	-	-	< 1482 deg C

e) The design of thermocouple assemblies shall be such that replacement on line is possible.

f) RTD (Resistance Temperature Detector) shall be platinum element 3 wire type with 100 Ÿ resistance at 0˜C calibrated as per IEC 751/DIN 43760. RTD shall be used within a temperature range of -200 to 650 deg C.

g) RTD shall generally be selected for applications requiring low temperature measurement with comparatively shorter temperature span requiring accuracies of the order of 0.25% or better.

h) Twin element sensors, if used, shall have two separate cable entries.

i) The special thermocouples such as reactor thermocouples, reactor / vessel skin thermocouples etc shall be designed by contractor based on specifications/details provided elsewhere in the contract document.

j) Heater tube skin thermocouple, where applicable, assembly shall meet the heater design requirements and shall be provided with expansion loops. The sheath material shall be selected based on temperature and sulphur content and shall be as per API recommendation.

4.6.4 **Temperature Transmitter**

a) Unless specified otherwise, temperature transmitters, shall be panel/rack mounted type only and shall be located in control room/satellite rack room. In case, field mounted transmitters are specified, separate field mounted transmitters shall be used, head mounted transmitters shall be avoided.

b) Temperature transmitters shall have a built-in linearising function to produce an output linear to temperature range.

c) Field mounted temperature transmitters shall be smart type with HART protocol having an accuracy of +/- 0.1 % of URV. The other features of smart transmitters

shall be same as those covered under field transmitters.

d) Burn out protection must be provided with temperature transmitters and other temperature input devices. Upscale or downscale protection shall be decided based on the application to ensure failsafe operation.

4.7 **Pressure Instruments**

4.7.1 **Pressure Gauges**

a) Pressure gauge dial shall be white, non rusting plastic with black figures. Pointers shall have external micrometer adjustment for gauge zero adjustment.

b) Pressure gauges shall be weatherproof with dial size of 150 mm and shall have features like screwed bezels, externally adjustable zero, over range protection and blowout discs. Pressure gauge sensing element shall be of SS316 and movement of SS304, as a minimum. The design of pressure gauges shall confirm to IS-3624.

c) Pressure gauges shall have an accuracy of 1% of URV as a minimum. Differential pressures gauges may have an accuracy of 2% of URV.

d) Overrange protector and pulsation dampener, whenever used, shall be of SS304, as a minimum. Pulsation dampeners shall be used for all pulsating services. These shall be floating pin type, externally mounted and externally adjustable.

e) All pressure gauges with maximum operating pressure exceeding 60 kg/cm2g and gauges in toxic service shall be solid front type.

f) Process connection shall normally be 1/2" NPTM bottom, except for diaphragm seal where 1˜" flanged connection shall be used in general.

g) Cases shall normally be cast aluminium alloy or black phenol and weatherproof to IP-55 as per IEC-529/IS-2147. Blow-out discs shall be provided for all gauges.

h) Ranges shall be so specified that the gauge normally operates in the middle third of the scale and shall conform to IS-3624 standard dials, wherever possible.

i) Diaphragm seal pressure gauge with capillary shall be used for congealing and viscous services, i.e where plugging of the element may occur or where suitable material is not available in highly corrosive service. Direct mounted, filled type gauges or mechanical linked gauges (schaffer diaphragm type) shall be avoided for any mild to heavy vibrating service.

j) Receiver pressure gauges for local transmitter output indication shall have 100 mm dial with stainless steel element and 1/4" NPTM instrument connection.

k) Shatterproof glass shall be provided for pressure, receiver or draft gauges.

4.7.2 **Pressure Switches**

a) Pressure switches shall have either diaphragm or bellow type of process element with SS316 material of construction as a minimum. Switch type shall be sealed micro type with contact rating suitable for specific application. Pressure switch design with Reed type switches shall not be selected.

b) Pressure switches shall be blind type with 1/2 NPTF process connection and shall be operative in full specified range. The switch differential shall be selected as per operating conditions, it shall be less than 60% of difference between set value and operating value.

c) Pressure switches shall have repeatability of 0.5% of URV, as a minimum.

d) Receiver pressure switches shall have SS316 bellows as measuring element with 1/4" NPTF connection.

e) Over range protection and pulsation damper requirements and design shall be as per above clause.

f) Requirements, design and selection of diaphragm seal (chemical seal) for pressure switches shall be as per clause 4.7.1(i).

4.8 **Level Instruments**

4.8.1 **Level gauges**

a) All gauge glasses shall be steel armoured reflex or transparent type with body and cover material of forged carbon steel as a minimum and shall have tempered borosilicate glass with asbestos or other suitable gasket. Transparent type of gauges shall be provided with integral illuminators operating at 230 V 50 Hz supply and suitable for electrical area classification specified. All gauge glasses must have a rating equal to or more than the vessel design pressure and temperature.

b) Reflex type shall be used for clean and colourless liquids, for liquid level interface. For low temperature, low boiling point service, large chamber type will be used.

Transparent type will be used on acid, caustic, dirty or viscous, coloured liquids and liquid interface. Transparent type with Mica or Kel-F shields shall be used for treated water, boiler and condensate services, and for corrosive liquids, which will attack glass. Tubular gauge glasses shall not be used, in general.

They may be used for non-hazardous services at ambient temperature and low pressures.

c) Large chamber gauges with frost shields shall be provided for cold services below 0˜C. Heating jacket shall be provided for viscous liquids.

d) All gauges shall have top and bottom chamber connections, unless otherwise specified. In addition each gauge shall be provided with ball check valves and pipe union.

e) The visible range of level gauge shall be selected to cover the complete operating level as well as measuring range of the other level instruments provided for the same purpose. In general, the visible length of the level gauges shall be selected from the following: -

Visible length, mm	Centre to Centre Length, mm
220	470
470	720
720	970
980	1230

In any case, the maximum visibility length shall not exceed 1500 mm for a single gauge. Multiple gauges with overlapping range shall be used for such cases.

f) Gauge glass cocks shall be forged off-set type with an integral ball check and back seating stem. Primary isolation valves are normally required in addition to the gauge

glass cocks, except on vented tanks containing harmless liquids. Where the process fluid tends to foul the cocks internals and create plugging or where leakage is a problem, gauge valve may be eliminated. On low temperature service, with liquids having very high vapour pressure at ambient temperature, safety valve shall be provided at the vent connection of the gauge glass.

g) For level gauging in very viscous liquids, liquids with crystals, sour services and pressure above 600# toxic services, float operated magnetic gauges with 2" flanged end connections shall be used.

h) Bicolor type level gauges shall be used for steam drums.

4.8.2 **Level Transmitter**

a) External displacer type instruments with side-side connections and rotatable head, shall normally be used for level measurement upto 1219 mm. Side-bottom connections are preferred where RJ flanges are required. Internal displacer type of level transmitters shall be avoided unless application necessitates its use.

b) All displacer type of level transmitters shall be of torque tube type with torque tube material of inconel, as a minimum.

c) In general, displacer type instruments shall be used with displacer lengths of 356 mm, 813 mm and 1219 mm. For interface level measurement, displacer type instruments shall only be used.

4.8.3 **Level Switch**

a) Level switches shall generally be external ball float type with flanged head. External displacer type level switches can be considered for lighter fluids where specific gravity is less than 0.5. Internal float/displace type level switches shall only be used if external ball float/displacer type is not possible, like in viscous services and in underground tanks/vessels.

b) Multifloat / displacer level switches shall be avoided in process service.

c) Switch shall be sealed micro type with contact rating suitable for the specific application. Level switches with Reed switch shall not be used.

d) Level switch shall be furnished with SPDT contacts with adjustable differential, unless otherwise specified.

4.8.4 **Tank Level Instruments**

4.8.4.1 a) Mechanical float type gauge shall be used for atmosphere tanks where level measurement accuracy requirement is of the order of 2 mm. Liquid seal chamber shall be used where tank contents are toxic or tank is blanketed.

b) Servo type gauges shall be used for level measurement of pressurized tanks/vessels/spheres requiring remote signal transmission and better level measurement accuracies. Leve/data transmission signal to remote control room shall be digital only. Servo type instruments shall have 6" process connection with 12" diameter still well.

c) The tank side indicator for both types of gauges shall have hoisting facility. All tank level gauges shall have side mounted indicator-counter type for

mechanical float type and solid state digital for servo controlled level gauge.

d) The wetted material like float, displacer, tape, wire etc. shall generally be SS316.

e) The accessories for servo-controlled level gauge shall include calibration chamber and isolation ball valves for pressurised tanks. Isolation ball valve size shall be same as equipment nozzle size.

4.8.4.2 Whenever specified, averaging tank temperature element shall be provided. The temperature elements shall be RTD. Number of temperature elements shall be as per ASTM D 1066. The temperature element shall be connected to corresponding gauge head and shall be intrinsically safe.

4.8.4.3 Radar type tank gauges shall be used for storage tanks handling viscous fluids or as specified in job specification.

4.8.4.4 All tank gauges shall be supplied with power ON-OFF switch mounted at grade level. Separate cable entries shall be provided for signal and power in the gauge head/tank side indicator/ON-OFF switch as applicable.

4.8.4.5 Other Special type of level instruments like radar, ultrasonic, hydrostatic, nucleonic, capacitance, conductivity type shall be used as necessitated by application requirements.

4.8.4.6 For high pressure steam drum application conductivity type (hydrostatic or equivalent) level instrument shall be preferred.

4.8.5 For solid level measurement, type of instrument shall be ultrasonic/radio frequency/ electromechanical/capacitance/nucleonic. The actual type selection shall be carried out based on the provenness of the selected type for the similar type of application.

4.9 **Flow Instruments**

4.9.1 **Orifice Plates**

a) Flow measurement shall normally be carried out using thin square edged concentric orifice plate mounted between a pair of weld neck flanges of minimum 300 # ANSI rating for line size 2" and above. Flange taps shall be used for line sizes upto 14" while D-D/2 taps shall be used for line sizes 16" and above. For line sizes 1-1/2" and below for conical entrance orifices corner taps shall be used. Contractor to check fouling of tapping point with respect to welding of flange. In case of fouling, flange tap shall only be used. The material of the orifice plates shall be normally SS316, as a minimum.

Quadrant edge or quarter circle orifice plates shall be used when lower Reynolds number does not permit the use of squared edge orifices as per codes.

Conical entrance type of orifice plates shall preferably be used for very highly viscous liquids upto throat Reynolds number of 250. These shall be fabricated as per BS 1042 Part 1.

b) Vent and Drain holes shall be provided in orifice plates, wherever necessary.

c) Sizing of orifice plate shall be carried out in accordance with ISO-5167. Other sizing methods like AGA Report No.3, BS-1042, 'Flow measurement-Engineering Handbook' by R.W. Miller shall be used when specified.

d) Orifice plates shall be fabricated in accordance with standard 'Orifice Plates and

Flanges Dimensional Details'.

e) Differential range for orifice meter shall normally be 2500 mm of H_2O dry calibration. Other preferred ranges are 500, 1250, 5000 and 10000 mm of H_2O. However the selected value shall be less than the allowable pressure drop mentioned in the process data sheet.

f) Upstream and downstream straight length shall be provided based on maximum d/D ratio of 0.75, in general. Where it is difficult to meet this requirement, the actual d/D ratio can be considered for reducing the straight length as permitted by the codes. The recommended practice shall be as per API-MPMS, Recommended Practices and AGA Report No.3. Flow straighteners should be considered, where straight runs are difficult to achieve otherwise.

g) Meter taps shall be horizontal for liquids, condensible vapours and steam. The taps shall be on top for gas, non-condensible vapour, or liquids which boil at or below the maximum design ambient temperature at operating pressure. Where piping clearances are a factor, taps may be located upto 45 deg above the horizontal centre line for condensible vapour, liquid and steam. The taps may be located upto 60 deg from vertical for gas and non condensible vapour.

For 45 deg installation both the tapping point nipples are 4" long. For horizontal tappings on liquid condensible vapour and steam service they shall be 4" long for one tapping and 6" long for the other.

h) At least one pair of tapping shall be provided for each orifice flange. Where more than one transmitters are used, separate pair of tappings shall be provided for
each orifice flange for each instrument for installation of each instrument separately.

4.9.2 Variable area flow meters shall be as per ISA-RP 16.1, 16.2,16.3,16.4,16.5 and 16.6 and shall be used for viscous or corrosive services or where rangeability in flow precludes the use of an orifice. Metal tube variable area flow meters shall be used for all process fluids. External devices for indicating or transmitting shall be magnetically coupled to the float or extension.

Glass tube variable area flow meters shall be used for low pressure utility services for local indication and where line size is 1-1/2" or less. Glass tube variable area flow meters shall not be used if outlet line is connected to a line or vessel containing hazardous or toxic fluid unless a check valve is installed at the downstream side of variable area flow meters.

4.9.3 Turbine and positive displacement meters or mass flow meters shall be used for accurate flow integration for custody transfer etc. Whenever PD meter is selected, these shall be double casing type with inner casing of SS 316 as a minimum.
Whenever turbine meter is selected, it shall have SS 316 turbine with tungsten carbide bearings.
Pulser and the transmitter selected shall be compatible and should have a proven combination reference.

4.9.4 For flow measurement in lines less than 2", integral flow transmitters shall be selected.

The integral flow assembly shall be supplied as an integral assembly consisting of upstream and downstream straight pipes, integral orifice of SS 316 (as a minimum) and transmitter installed along with manifold. Material of construction of all elements except for end flanges which shall be as per piping specifications, upstream and downstream pipes shall be honed from inside to achieve smooth surface.
Integral orifice meters, when used, shall be installed with block and bypass valves. Orifice meters with metering runs may also be used for lines less than 2".

4.9.5 Magnetic type flow meters shall be used for electrically conductive slurry or corrosive services and shall be installed with line size bypass, with block and clean out valves, at the lowest point in piping to ensure that meter run is always liquid filled. Grounding rings shall be used whenever required.

4.9.6 Target meters shall be considered for highly viscous hydrocarbon streams such as asphalt, tar, polymers etc.

4.9.7 Vortex meter shall be considered where high rangeability is the prime requirement. Ultrasonic flow measurement shall be considered where non-intrusive flow measuring is required.

4.9.8 Averaging pitot tube shall be considered for low pressure loss, high velocity steam, large diameter lines and air ducts. This shall be installed on 1-1/2" size nozzle for small lines and 3" for large lines or lines with high velocity. The average pitot tube shall be of SS 316 material as a minimum, shall be provided with end support, whenever required. Retraction arrangement with ball valves shall be provided for each average pitot tube installation.

4.9.9 Differential Pressure type flow transmitter shall meet all the requirements specified for field transmitters in this specification.

4.10 Field Transmitters

4.10.1 Field transmitters for flow, pressure, differential pressure and level applications shall be yoke mounted smart type unless specified otherwise. These transmitters shall be certified intrinsically safe, in general, with 2 wire system having 4 - 20 mA DC output with superimposed digital signal having simultaneous analog and digital communication. Communication protocol shall be HART only.

4.10.2 Transmitters shall be provided with external zero adjustment and shall have integral vent/drain.

4.10.3 All transmitters shall be provided with integral intrinsically safe output meter. Intrinsically safe remote output meter shall only be provided, if specified in the P&IDs or in the job specifications. All output meters shall provide digital LCD display.

4.10.4 The transmitter shall be microprocessor based and it shall incorporate a non-volatile memory which shall store complete configuration data of transmitter. All necessary signal conversions, including conversion to produce output with the required protocol shall be carried out in the transmitter electronics.

4.10.5 Transmitter shall also run complete diagnostic routine. In the event of detection of failure, the output shall be driven to predefined value.

4.10.6 Temperature sensors shall be provided to compensate for process temperature and ambient temperature variations.

4.10.7 The transmitter shall be able to assure an accuracy of 0.1% of span for a rangeability

of 1:10, unless otherwise specified in the job specification. The accuracy shall include the combined effect of linearity, hysterisis and repeatability.

4.10.8 The response time of smart transmitters shall commensurate with process. It shall be equal or better than the half of the scan time of control loop specified elsewhere in the bid package.

4.10.9 HART protocol of latest version shall be used and shall be suitable for HART maintenance system with corner stone software or equivalent with the following features as minimum:

a) It shall allow multi masters (two for example, primary and secondary) for configuration, calibration, diagnosis and maintenance. The primary could be control system or host computer and the secondary could be the hand held communicator or a maintenance computer.

b) It shall be capable of implementing universal commands. It must be possible to communicate all the commands of HART maintenance system to field transmitters and smart transmitters shall be selected accordingly.

4.10.10 Unless recommended otherwise by compressor manufacturer, field transmitters used in anti-surge control loop shall be non-smart and flameproof type. The flameproof transmitters shall have their calibration adjustment from out side without any need to remove the cover.

4.10.11 Retrofit type of smart transmitters are not acceptable.

4.10.12 Diaphragm seal element with capillary shall be used for congealing, corrosive and highly viscous services.

4.10.13 **Field communicator**

It shall be possible to perform routine configuration, calibration, display process variable, diagnostics etc. from a hand held portable calibrator which can be connected at any location in the transmitter loop. It shall be possible to perform all the above functions on line. The loop function shall remain unaffected while communication is going on between transmitter and the field communicator. No output interruption should occur.

Field communicator shall meet the following requirements.

a) They shall be battery powered with replaceable and rechargeable batteries. Recharger power supply shall be 230 V AC 10 %, 50 Hz 3 Hz.

b) It shall be possible to connect the communicator at any of the following places for purpose of digital communication:

i) Marshalling cabinet serving the transmitter, in safe area, control room.

ii) Junction box serving the transmitter, in hazardous area, field.

iii) Directly at the transmitter, in hazardous area, field.

Plug in type connections shall be provided with field communicator. Necessary interconnection cable and any other accessories required for connection shall be supplied by vendor.

c) Offered communicator shall be dustproof, certified intrinsically safe and suitable for outdoor location. Carrying case shall be supplied with each communicator.

4.11 Control Valves

4.11.1 Control valves shall normally be globe type, single seated or double seated. Other type

of valve like butterfly, ball, rotary plug, angle or 3 way etc., shall be selected as per service requirements.

4.11.2 Control valve sizing shall be carried out as per ISA S75-01. In general, control valves shall be sized so that the valve opening is as noted below;
At max. flow : less than 90% open
At normal flow : about 75% open
At minimum flow : more than 20% open.

4.11.3 Unless specified otherwise flanged control valves shall be used. Body material, body rating and flange rating, shall be as per piping specifications, as a minimum.

4.11.4 Minimum control valve body size shall be 1" in general. Reduced trims can also be considered. Body size shall be limited to 1", 1-1/2", 2", 3", 4", 6", 8", 10", 12" and 14". Higher sizes may be used wherever necessary.

4.11.5 Trim characteristics shall be equal percentage type unless required otherwise because of process application. Control valve plugs shall be top and bottom guided for double seated valves and heavy top guided for single seated valves. Cage guided valves shall be selected for control valve size of 2" and above, in general.

4.11.6 Anti-cavitation trim shall be selected wherever cavitation is expected in the valve.

4.11.7 Noise from control valve during operation shall be limited to OSHA specified level or better. The maximum allowable noise is 85 dBA SPL (Sound Pressure Level) at 1 meter distance from the valve body. Source treatment for noise shall be preferred by using special trims like anti-noise trims, in case noise exceeds the allowable level. Path treatment may be adopted over and above source treatment, if necessary.

4.11.8 Valve seat leakage shall be as per ANSI/FCI 70.2 and shall be selected with due consideration to meet the requirement. For shutdown valves leakage class VI shall be considered.

4.11.9 Flanged bolted type gland packing boxes shall be used. Packing shall normally be PTFE on liquid and gas service upto 200 deg C. PTFE impregnated asbestos shall be used upto 260 deg C. Graphited asbestos with lubricator, shall be used on steam service and temperature above 260 deg C. Alternate suitable material is also acceptable.

4.11.10 Bellows seal shall be used where it is required to isolate the packing from the process fluid or where no leakage to atmosphere can be tolerated like toxic, explosive and precious fluids.

4.11.11 Material used for trim shall be minimum SS316, with guide bushing of hardened stainless steel like 440 C, 17-4 PH, upto a pressure drop of 10 kg/cm˜. For higher pressure drops or erosive and slurry services and in general for all steam services, flashing services, hard-surfacing of plug seat rings and seating area of inner valve with stellite shall be used.
Special cases may require 17-4 PH seat ring and 440 C solid plugs or other materials like Hastelloy, Durimet, Monel etc.
For temperature above 300˜C stellite facing shall be used for guide posts. Guide bushing shall always be harder by a minimum of 125 Brinnel than the guide post.

4.11.12 Contractor shall carryout cavitation and flashing checks for valves in liquid service and select the valve body and trim accordingly. Whenever the data provided is not adequate to carry out such checks, it shall be contractor's responsibility to evolve such

a data and ascertain the correctness of the valve sizing/selection.

4.11.13 Unless otherwise specified in P&ID, block and bypass valves shall be installed for all control valves upto and including 2" size except for butterfly valves, 3 way valves and control valves in slurry and freezing service. Hand wheel shall be provided for all other sizes and services. No by-pass valve or hand wheel shall be used for shutdown valves.

4.11.14 Valve actuator shall be pneumatic spring opposed diaphragm type, in general. Piston type actuators may be used for very high shut off pressure requirements. Additional equipment necessary to meet fail safe condition shall also be included in case double acting piston type actuator is selected. Wherever double acting piston cylender actuators are used, it shall be provided with complete accessories like volume tank, safety valve, non-return valve and pressure gauges etc. The volume tank shall be designed for minimum of 2 full stroke operation of control valves in addition to backup for control valve operation for a preset time as given in job specification. In either case, actuator shall be able to withstand maximum shut-off pressure with the minimum instrument air pressure specified.

4.11.15 Control valve accessories such as positioner, air filter regulator and solenoid valve shall be properly mounted on the actuator and shall be fully tubed.

4.11.16 Valve positioners wherever used shall be side mounted force balance pneumatic type. For electronic instrumentation, I/P converter shall be used along with pneumatic positioners. Separate I/P convertor and positioner shall be used unless specified otherwise. Separate air filter regulator shall be used for each valve positioner. Smart positioner shall be used where specified in job specification.

4.11.17 The I/P convertor shall be intrinsically safe certified and shall be of electronic feedback type. It shall have an integral junction box with 1/2" NPTF cable entry and be suitable for 2" pipe mounting.

4.11.18 The air filter regulator mesh size shall be suitable for I/P convertor.

4.11.19 Whenever limit switches are specified as inductive proximity type, these shall meet NAMUR (DIN-19234) requirements.

4.11.20 Separate limit switches shall be provided for open and close position, where required.

4.11.21 Solenoid valves, wherever used, shall be universal type and shall be continuous rated type with class F coil insulation as per IEC 85/IS 1271. These shall be of brass body with SS316 trim, as a minimum.

4.11.22 Self actuating regulators for flow, pressure and temperature shall be used as indicated in P&ID.

4.11.23 Whenever fire safe requirement is specified for a shutdown valve, the valve body as well as the actuator shall meet the testing requirements as per API 617 latest revision. In addition to above, air volume tank shall also be provided for a storage of air volume with minimum two full strokes of valves. All valve accessories like solenoid valve, limit switches and volume tank etc shall also be enclosed in a certified fireproof enclosure. The cable used for the actuation of the valve shall also be fire resistant (Fire Survival to IEC 331).

4.11.24 All valves in cryogenic service (i.e. the valves installed in piping classes used for temperature below -29˜C) shall be designed and tested as per BS-6364.

4.11.25 Control valves/shutdown valves requiring certain specified operating timings, shall be tested before despatch for the specified operational time verification. Hook-up

drawings along with the timing calculation shall be submitted by contractor for review.

4.12 Pressure Relief Valves and Rupture Discs

4.12.1 Pressure Relief Valves

4.12.1.1 In case, ASME section I valves are supplied, it shall have the certificate from ASME laboratories.

4.12.1.2 Pressure relief valves shall be full nozzle full lift type except for thermal relief valves.

4.12.1.3 Conventional valves shall be specified for constant back pressure while bellows seal type valves shall be specified for variable back pressure more than 10% of set pressure. Pilot operated pressure relief valves shall be used for special services and where set pressure is closer than 10% of the operating pressure, in general.

4.12.1.4 Lifting lever shall be specified for steam and air service. Open bonnet shall be used for steam service.

4.12.1.5 The percentage accumulation in case of pressure relief valves/safety valves shall be as follows:

a) Steam Service
   - ASME SEC I 3%
   - IBR (Before steam let-down station) 5%
   - IBR (Distribution & utilities) and ASME Section VIII 10%

b) Gas, Vapour or liquid except in (c) & (d) below 10%

c) Liquid for thermal Relief 25%

d) Fire exposure on unfired vessels 21%

4.12.1.6 3/4" x 1" threaded (NPT) modified nozzle type valves with typically 0.38 cm˜ orifice size shall be specified for thermal relief.

4.12.1.7 The body material shall, as a minimum, be as per piping specifications. Nozzle and disc material shall be SS316 as a minimum with machined stainless steel guide and spindle. Whenever semi nozzle designs are unavoidable, body material shall be at least same as nozzle material.

4.12.1.8 The spring material of pressure relief valves shall be as follows unless otherwise necessary because of process conditions;
- 29 deg C to 250 deg C : Zinc/nickel plated carbon steel.
above 250 deg C : Tungsten alloy steel.
below – 29 deg C : Stainless steel 316

4.12.1.9 Flanged connection shall be for standard sizes 1" or larger. Minimum flange rating shall be 150 # ANSI.

4.12.1.10 Where permissible, threaded connections shall be used on sizes 3/4" and below.

4.12.1.11 Pilot operated pressure relief valves shall have remote sense facility for pilot valve. Internal sensing for pilot shall be avoided as far as possible.

4.12.1.12 The pressure relief valves shall be type tested for capacity with 5% blowdown as per ASME sec VIII UG-131 and the actual blowdown of individual valves shall meet the process requirement. Contractor shall furnish the type test certificate for the same.

4.12.1.13 Test gag shall be provided for all pressure relief valves.

4.12.2 **Rupture Disc**

4.12.2.1 Rupture discs shall be reverse buckling type, in general and shall be supplied in pre-torqued holder assembly which shall fit inside the inner diameter of the bolt circle of standard ASME flanges. Disc material shall be compatible with the vessel contents and shall be consistent with the bursting requirements.

4.12.2.2 Following shall be taken care when rupture disc is used upstream of the pressure relief valve:

(a) Derating factor of 0.9 shall be used for capacity sizing.

(b) A tell-tale assembly consisting of pressure switch, pressure gauge and excess flow check valve shall be provided to indicate leakage/rupture downstream of the rupture disc.

4.12.2.3 Manufacturing tolerance of the rupture disc shall be decided by contractor based on operating pressures. However when rupture disc is used in combination with pressure relief valve, zero manufacturing range shall be selected.

4.12.2.4 For each rupture disc four(1+3spare) discs shall be provided.

4.13 Pressure reducing stations & Desuperheaters

4.13.1 The design of the desuperheater shall be based on the capacity and rangeability requirements to meet heat & mass transfer equation. Contractor shall also ensure the following while sizing & designing the system apart from other considerations:

(a) turndown of desuperheaters and coolant

(b) minimum velocity requirements

(c) allowable pressure drop

(d) minimum pipe straight run required, upstream & downstream.

(e) location of temperature sensor at downstream

(f) design of control scheme

4.13.2 The desuperheaters shall be of insertion type design, in general, and shall consists of a coolant injection assembly with sleeve and atomising nozzles inserted perpendicular to the process line. Other types including in line mounted desuperheaters like variable orifice, nozzle etc. shall be used based on process conditions.

4.13.3 Temperature control valve in the coolant line shall be integral to the desuperheater, in general. Whenever separate control valve is necessary, its design, sizing, compatibility and suitability with the desuperheater shall be ensured.

4.13.4 Whenever pressure reduction is also required with desuperheating, integral design of desuperheater with pressure reduction shall be offered unless otherwise specified.

4.13.5 The desuperheater and the pressure reducing control valve's body rating shall be equal to or better than the flange rating as per piping material specification.

4.13.6 The insertion type desuperheater shall be suitable for mounting on 3" size flanged nozzle.

4.13.7 The material of all wetted parts shall be suitable for the process being handled at its operating and design flow, pressure and temperature.

4.13.8 The desuperheater shall be sized to maintain temperature at the outlet of the desuperheater within 5 deg C in general.

4.13.9 All accessories like positioner, air filter regulator shall be firmly mounted on the actuator and shall be fully tubed. Actuator shall be fully tubed. Actuator shall be pneumatic spring opposed diagrapgm type in general.Positioners shall be side mounted force balance type. I/P converters shall be used alongwith pneumatic positioners. Separate air filter regulator shall be used for each valve positioner.

4.14 Tank Safety System

4.14.1 Tank safety system shall be provided as per P&ID and shall be designed considering the safety requirements related to over-pressurisation and excessive vacuum generation in the tank because of normal pump in, pump out conditions, fire conditions, sudden de-pressurisation and condensation/contraction of vessel vapours during sudden atmospheric thermal cooling. The system shall consist of tank blanketing equipment, breather valve, emergency vent and flame arrestors as applicable.

4.14.2 The total system design shall take into consideration the blanketing pressure and the tank design pressure/vacuum. The operating margins should be sufficient for each device to operate independently. Design shall also avoid undesirable operation of breather valve under normal pump in, pump out condition and operation of emergency vent under breather valve operation unless absolute necessary as per process requirements. A minimum gap of 35% should be ensured between set pressure of breather valve and emergency vent for proper operation(considering design of breather valve with 20% overpressure).

4.14.3 The blanketing scheme shall be specially designed considering normal and maximum blanketing flow and shall comprise of self actuated control valve(PCV) assembly designed specially for blanketing application. Conventional PCV or set of PCV's shall not be offered as a replacement to blanketing assembly. For the tanks(or vessels) with higher set pressures alternate scheme of pressure control valve with split range control valve of sufficient size can also be accepted if specified in the P&ID.

The flow capacities of the blanketing systems shall be established as per procedure defined in API-2000. The blanketing system selected should have published regulating characteristics to establish its suitability for the requirements.

Wherever an external pressure sensing is necessary it should be taken directly from tank.

4.14.4 The type of breather valve i.e. close vent or open vent type shall be selected based on the P&ID requirements and shall be sized to consider overpressure and vacuum requirements for which a separate pallet shall be used. The breather valve shall generally be dead weight, soft seated type with teflon diaphragm and shall have self draining body construction. Spring loaded type can be used where dead weight design is not feasible. The selected valve design shall ensure that seating surface is shielded from direct liquid/condensate flow to prevent tendency of pallet sticking. A test connection below pallet shall be provided for breather valve testing. The breather valve selected shall have certified flow capacity as per API-2000.

4.14.5 The emergency vent shall be hinged cover type with weighed pallet and shall open to atmosphere. Services where vapours can not be discharged freely to atmosphere, spring loaded design shall also be acceptable. The selected vent shall have certified

flow capacity as per API-2000.

4.14.6 The type of flame arrestor i.e. detonation/deflagration shall be selected as per actual installations requirements and shall meet the requirements of BS-7244. The flanged type of flame arrestor shall be selected in general. Whenever end of line flame arrestors are selected it shall always be provided with a free vent having SS316 mesh. The sizing of the flame arrestor shall be carried out considering maximum delta pressure drop allowable across the flame arrestor/flame arrestor-vent combined. The flame arrestor shall be certified for the capacity as per API-2000 as well as the gas group classified as per BS-7244.

4.14.7 Where no free vent is provided for the valves/flame arrestors installed at the end of the line, goose neck vent shall be installed to prevent entry of rain water/birds. Mesh shall be provided at the end of the goose neck.

4.15 **Compressor Instrumentation**

4.15.1 Contractor/compressor vendor shall be completely responsible for providing adequate instrumentation for safe and efficient operation of the machine. The commonly used instruments are being detailed out in the following clauses, however this does not absolve the contractor of providing additional instrumentation, if required.

4.15.2 **Anti-surge Control System (ASC)**

4.15.2.1 Contractor/compressor vendor shall be fully responsible for the complete design of anti-surge Control system including selection of type of flow element, controller algorithm, type of explosion protection, type and operating timings of final control element. Vendor shall guarantee the performance of machine with the offered ASC System. Whenever required, ASC system shall be designed in such a way that it is capable of detecting surge well in advance and correct the compressor operating point accordingly so as to avoid surge in order to protect machine from possible damage, to minimise process upsets and to minimise recirculation.

4.15.2.2 ASC System shall typically consist of but not limited to flow element, flow transmitter, differential pressure transmitter, ASC controller, control valve and other accessories as felt necessary by the vendor.

4.15.2.3 Vendor shall supply all hardware and software related to the operation and safety of the compressor. This shall include but not be limited to the following :

a) Design and operation of surge control loop scheme based on offered compressor performance.
b) Supply of all hardware in antisurge control loop including dedicated controller, transmitters, measuring elements, final control element etc.
c) Fast response transmitter and control valve etc. as required.
d) Algorithm required for Anti Surge Controller.

4.15.2.4 Dual redundant link shall be provided to interface ASC system with DCS for all operational data required at DCS.

4.16 Vibration and Axial Displacement Monitoring

4.16.1 Vibration and axial displacement monitoring system shall be based on non-contacting type sensing probe, unless otherwise specified.

4.16.2 Vibration and displacement monitoring system shall be as per API-670. The extent and type of monitoring shall be as defined elsewhere. However, contractor shall furnish any additional requirements for monitoring deemed essential by them with reasons. Two probes at 90 degrees apart for each location shall be provided and connected to same dual channel monitor for vibration monitoring.

4.16.3 The sensing probe shall be accessible for adjustment, repair and replacement without dismantling the machine.

4.16.4 Vibration and displacement monitoring system shall be Bently Nevada 3500 series or equivalent. Monitoring instruments shall be located in control room unless otherwise specified.

4.16.5 System shall provide continuous 4-20 mA DC isolated output for each channel of measurement for remote indication and potential free contacts for alarm/shutdown setting.

4.16.6 Monitors shall be with maximum four(4) channel type and shall meet the following specifications as a minimum:-

a) Each channel shall have two independent alarm levels one for pre trip alarm and one for each trip, settable continuously over measurement range. Two relay contacts for each pre trip alarm and trip alarm per channel shall be provided.

b) Broken sensor failure detection without causing shut down.

c) LED status indication to show health status of the monitor, bypass status and communication status of the monitor.

4.17 Speed Monitoring

4.17.1 Speed monitoring system shall be based on non-contacting type sensing probe, unless otherwise specified.

4.17.2 Speed monitoring system shall be as per API-670. The extent and type of monitoring shall be as defined elsewhere. However, contractor shall furnish any additional requirements for monitoring deemed essential by them with reasons. Two probes at 90 degrees apart for each location shall be provided and connected to same dual channel monitor for vibration monitoring.

4.17.3 The sensing probe shall be accessible for adjustment, repair and replacement without dismantling the machine.

4.17.4 Speed monitoring system shall be Bently Nevada 3500 series or equivalent. Monitoring instruments shall be located in control room unless otherwise specified.

4.17.5 System shall provide continuous 4-20 mA DC isolated output for each channel of measurement for remote indication and potential free contacts for alarm/shutdown setting.

4.17.6 Monitors shall be with dual channel type and shall meet the following specifications as a minimum :-

a) Each channel shall have two independent alarm levels one for pre trip alarm and one for each trip, settable continuously over measurement range. Two relay contacts for each pre trip alarm and trip alarm per channel shall be provided.

b) Broken sensor failure detection without causing shut down.

c) LED status indication to show health status of the monitor, bypass status and communication status of the monitor.

4.18 Bearing and Winding Temperature Monitoring

4.18.1 In general, bearing temperature shall be measured at the points which are under maximum loading.

4.18.2 Sensor shall be three wire RTD element of platinum having 100 Ÿ resistance at 0˜C. Calibration shall be to DIN 43760 standards.

4.18.3 The temperature sensor, cables, terminal heads, junction boxes etc. should be capable of withstanding the mechanical vibration and environment of a rotating machinery atmosphere.

4.18.4 Bearing and Winding temperature shall be monitored by means of a temperature monitor. The temperature monitors shall be located in control room and shall meet following requirements:-

a) Accept RTD inputs (platinum, 100 Ÿ at 0˜C calibrated to DIN 43760 standards).
b) Continuous six channel monitoring with each channel input from one RTD.
c) Each channel shall have two independent alarm levels one for pre-trip alarm and one for trip alarm, settable continuously over measurement range.
d) Broken sensor failure detection without causing shut down.
e) LED status indication to show health status of the monitor, bypass status and communication status of the monitor.
f) Analog output 4-20 mA DC isolated signals shall be provided for each channel for remote indication.

4.18.5 Separate temperature monitors shall be provided for motor winding and bearings temperature monitoring.

4.19 Key Phasor

4.19.1 Key phasor system shall be provided by vendor for performing analysis of vibration signals to determine machine malfunctions. It shall consist of a proximity probe and transmitter, extension cable, mounted etc. and other accessories to make the system complete. Vendor shall provide necessary reference on the shaft to determine one-per-turn occurrence.

4.20 Accumulator of Lube Oil System

4.20.1 If accumulators are used with nitrogen for lube oil dampening at the desired pressure to meet the system requirement the following instrumentation with the accumulator to be provided by vendor:

a) Accumulator shall have charge kit with isolation valves and connection hoses.
b) Standard Nitrogen cylinders available in India are at pressure of 140 kg/cm²g with standard connection sizes. Vendor shall provide the complete regulator system with protection for charging nitrogen from nitrogen cylinder to accumulator at the desired pressure. Regulator shall be suitable for the inlet pressure variation

of 140 to 150 kg/cm2g while charging with suitable inlet connection to match the Nitrogen cylinder connection. Regulator system shall have pressure indicator, regulator, relief valve, needle valve etc. as a minimum. Material of construction shall be stainless steel.

4.20.2 The compressor loading-unloading scheme for reciprocating compressors shall be provided as per the minimum requirements specified in the job specifications. Manual as well as automatic schemes shall be provided per steps as per machine requirement.

4.20.3 Emergency switch shall be provided in the local panel/field. All such switches shall have a protective cover to avoid inadvertent shutdown.

4.20.4 Vendor shall provide the following common alarms in control room:

a) Common machine pre-trip alarms.

b) Common machine trip alarm.

4.20.5 Vibration, axial displacement, speed, temperature monitoring system shall be provided with serial link output for connectivity to plant DCS. The serial link shall also be provided for machine diagnostic software running on separate whenever specified in job specification.

5 CLOSED CIRCUIT TELEVISION (CCTV) SYSTEM (NOT APPLICABLE)

5.1 Functionally CCTV system is required for the surveillance of the plant and equipment as detailed out in job specification.

5.2 All the cameras shall have Pan and Tilt control. The camera viewing angle can be varied between 7˜ to 40˜ and shall have zooming facility.

5.3 The CCTV central unit shall be located in the main control room or satellite rack room as required. Separate monitors shall be suitably located in console area and keyboard, joystick etc shall be located on the hardwired console unless otherwise specified in job specification.

5.4 The minimum enclosure protection degree of the system components shall be in accordance with IEC 529 as follows:

a) Outdoor IP 65

b) Indoor IP 42

c) Panels with open doors IP 20 (live parts shielded)

5.5 Control unit and all peripherals shall be installed in air conditioned main control room. Cameras shall be installed outdoor in the field. Cameras with its accessories shall be housed in explosion proof certified Ex˜d˜ housing suitable for gas grouping of the plant.

5.6 The system shall include all hardware, wiring, cabinets, materials and application software for a fully function system. Components shall be for industrial grade.

5.7 Cameras shall be as a minimum, comply with the following specification:

a) Pick up element : $^{1/2}/_{1/3}$" interlined CCD colour

b) Picture point :512 x 582

c) Sampling system :PAL standard CCIR 625/50 lines per frame

d) Video band width :5 MHz = -3 dB

e) Horizontal resolution :Minimum 450 lines

f) Sensitivity :3 lux for a good picture

(@F= 0.95 and 3200 K)

g) Zoomlens :11-66 mm
h) Controls :Zoom, Focus, lris and external synchronization
i) Signal noise ratio :Approx. 50 dB
j) Gamma :0.5
k) Automatic light level :1:10
Control
l) Temp. range :5 - 80˜C
m) Video output 1 V peak :75 Ÿ unbalanced To peak
n) Camera identification :Yes
o) Automatic gain control facility :Yes
The zoom objective shall be equipped with an automatic diaphragm control, auto focus and spot filter.

5.8 The time lapse Video recorder shall be as below unless mentioned otherwise:

a) Cassette tape :Standard 2 hour1/2" S-yVHS E-120 or E-180
b) Record/play back speed :2, 12, 24 and at least up to 72 hours.
c) Video input/output :1 V peak to peak 75 Ÿ unbalanced.

5.9 Movable cameras shall have an electric control mechanism (pan and tilt) which shall be controllable through a job stick and the same shall located on the hardwired console. The pan and tilt shall comply with the following:

a) Angular travel :Pan 0-335 degrees, Tilt $\pm$ 90 degrees
b) Stops :Externally adjustable
c) Speed (no load) :Pan 6 degrees/second, Tilt 3 degrees/second
d) Loading Suitable for camera and camera housing

5.10 Outdoor cameras and accessories shall be housed in an Ex˜d˜ and ingress protected (IP 65)

5.11 Cameras with its accessories shall be installed on steel structure (mounting poles). Mounting pole/structure shall be 10 metre high (minimum and shall be designed for maximum wind velocity of the plant location. The allowable deflection at the top shall be $\pm$ 5 mm. The mounting pole/structure shall be supported on a concrete foundation. A ladder shall be provided to access the camera at top for the purpose of installation and maintenance of camera and its accessories. The design, supply, fabrication and erection of poles including its support arrangement shall be in contractor's scope. The structural steel shall be epoxy painted to meet the environment.

5.12 a) From a master control panel (keyboard) it shall be possible to select any camera and display the picture at the monitor.
b) Remote control panels/keyboard shall be programmed for the control of selected cameras with the possibility to call up any camera connected to the system.
c) Commands from the control unit are sent via a data transceiver to the control

receiver at the camera side. The control receiver will control the camera lens and pan/till functions.

d) Operator shall be able to control all cameras and pan, tilt and zoom functions manually.

e) The Video recorder shall record the activities at all entrances and at locations where alarms have been alerted. The time lapse video recorder(s) shall be able to record up to 72 hours without reloading.

f) It shall be possible to view pictures of four cameras or three cameras and VCR simultaneously on the screen. Suitable quad unit shall be provided.

5.13 Wiring and connection shall be as below unless specified otherwise:-

a) All the cables (indoor/outdoor), connectors and plugs shall be supplied. The connectors shall be BNC type.

b) Flexible cables shall only be used for flexible connections.

c) Video signals from cameras to the control unit shall be transmitted via coaxial cables.

d) Camera control signals may be transmitted either via twisted pair or via multicore cables.

e) All interconnection cabling between field mounted cameras to control equipment shall be shielded and armoured. Outdoor cabling between control equipment/ monitor / key board and optical fibre cable shall also be shielded and armoured.

f) Materials shall be of proven design for similar application.

5.14 All the outdoor items shall be tropicalized and epoxy painted. All carbon steel bolting shall be hot dip galvanized or Cadmium plated and bi-chromated. Screws, rivets, brackets and stiffeners shall be stainless steel. Colour of the topcoat of panels shall be manufacturer standard.

6 CONTROL ROOM REQUIREMENTS

6.1 The control room required for housing control system and other instrument items shall be designed, constructed totally by contractor. The following shall be considered as minimum for control room.

a) The control room shall be common for all units with respect to consoles, however rack room may be common or segregated as per satellite rack room concept.

b) The control room shall be so designed as to have console area for DCS and hardware consoles fire alarm panel which requires direct operation intervention and rack area sharing atleast one of the wall within the console room to house all racks, cabinets etc.

c) A seperate room shall be provided for EC (Engineering Consoles)/PLC consoles.

d) The rack room and EC/PLC room shall have connectivity with console room.

e) All the room shall have false flooring and false ceiling unless otherwise specified.

f) The control room shall be illuminated adequately with glazed lighting arrangement which shall not cause any glare at viewing area. The lighting arrangement shall be approved by Purchaser/purchaser's representative.

g) The console area and rack area shall be separated by solid partition. Painting and finish of floor and colour of consoles/racks shall be aesthetically matched.

h) The main entry to the control room/console area and equipment entry to rack area shall have door opening 2500 mm (W) X 2700 mm (H) (clear space), double door. Escape route for console / rack room shall be provided.

i) The UPS and other electrical equipments shall be housed in UPS room with seperate cable entry. In general no electrical equipment shall be placed at rack area.

j) In the console area consoles shall be arranged in a arch form or straight. Ergonomic techniques shall be used in design and layout of the consoles based on the
assumption that operators are sealed while using the CRT displays, keyboards HW switches other console equipments. A minimum clearance of 2 meters at the backside wall to console and 3 metres at the front shall be kept.

For arch type console minimum of 2 meters from the tip to the front wall shall be considered on either side.

6.2 For rack room, the layout shall be made considering the following.

a) Clearence between back and front rows from wall shall be 1.5 m (minimum).

b) Clearence between 2 rows shall be equal to 1.4 m or DCS vendor's recommendation whichever is higher.

d) Clearence between all rows from side walls shall be equal to 1.5 m (minimum).

6.3 The console area shall be sized to accommodate consoles for future units to be installed by owner at a later date if specified in job specification. The channel base shall be provided based on base frame details to be provided during detailed engineering. The sizing for rack room shall be made in such a way that 30% spare cabinet space available for future use.

6.4 All consoles, racks, in control room and EC / PLC room shall be bolted on in to channel bases which is grouted to the floor.

6.5 The printers shall be arranged in console area.

6.6 All cabling inside the control room shall be done through trays below false flooring. No cable shall be left on the floor.

6.7 Contractor shall obtain specific approval on control room equipment layout before proceeding for control room engineering.

7 DISTRIBUTED CONTROL SYSTEM

7.1 The Control System (DCS/PLC) shall follow the specifications as per 6-52-0055 Standard Specification for Distributed Control System, the specific requirements given in this specifications and special requirement given under job specification. The standard specification for PLC 6-52-0040 shall also supplement the PLC requirement as applicable. Plant operational requirements shall be as per P&IDs, Process description and any other requirement as defined in Process package.

7.2 The offered control system shall have complete infrastructure base available in India for the purpose of maintenance, spare parts supply, engineering support, expansion etc.

7.3 If at any point of time during execution of job, DCS/PLC system as being supplied is found inadequate, additions/modifications required in software or hardware to meet the requirements, shall be carried out by contractor without any time/cost implications.

7.4 Functionally, the plant monitoring, control etc. shall be done through DCS and the interlock/ shut down is executed through PLC, in general. Inter mixing and interchanging of functionalities are not allowed.

7.5 For the overall plant operational philosophy, number of control systems, their locations, the Process units under each system, the connectivity between other control systems etc. the system configuration and other requirements given in Job Specifications attached elsewhere shall be referred and met with.

7.6 Process unitwise segregation shall be provided for controller/data acquision sub-system, PLC, Marshalling/barrier and termination cabinet, relay rack, electrical instrument
interface cabinet, power distribution.

7.7 In case of bulk power supply used for powering 2 wire transmitters, barriers etc. the dual redundant power supply shall be provided.

7.8 Control room ergonomics shall be considered while deciding the various operator/engineering interfaces. Unless otherwise specified all operator/engineering interfaces shall be console type. Only single tier shall be considered unless specifically indicated otherwise in the job specifications.

7.9 CONTROLLER AND DATA ACQUISITION SUB SYSTEM

7.9.1

i) Unless otherwise specified, plant control and data acquisition functionality shall be carried out in the 32 bit microprocessor based controller and data acquisition sub-system. A multidrop controller sub-system shall be utilised with 1:1 redundancy including communication sub-system, I/O modules, power supply modules, processor modules etc. within the sub-system.

ii) The controller shall have the following library of algorithms available as their firmware, as a minimum:

General Manual loader, cascading, alarm high, low, extra high, extra low, rate of change, deviation. Control Algorithms Such as P, PI, Error PID, adaptive gain, ratio control, PID with dead band. Arithmetic Function Like addition/subtraction, multiplication, deviation, absolute value, square root, average, summation, Bias, Ramp.

Linearisation Like square root extraction, flow computation, thermocouple Linearisation and cold junction compensation, RTD Linearisation, Polynomial Dynamic Function Like lead/lag, dead time, timer, feed forward. Limiter function Like low output limiter, high output limiter, alarm limiter, set point Comparison functions Like greater than, less than, greater or equal, less or equal, equal, not equal etc. Selector functions Like low selector, high selector, mean value, auto ranging for dual transmitter, override etc.

Logic functions Like AND, OR, NOR, NOT, XOR. ON/OFF DELAY, FLIP-FLOP, PULSE. Sequence control functions like set block, set ramp rates, open/close values, start/stop, pump/motors etc. ramp on/off, get set, block activate, abort sequence

Miscellaneous Like bumpless transfer between all control modes, direct or
function reverse outputs, anti reset wind up, or any other functions to meet the control system requirements

iii) In addition, the controllers and data acquisition sub system shall have the following

features:

a) Output status on controller failure shall flunk/freeze and shall be engineer configurable.

b) Configuration and tuning shall be from centralised level (operator/Engineer station).

c) Anti reset wind up feature and reverse/ direct selection.

d) Control modes shall be auto, manual, cascade, computer.

e) It shall support various types of input-output signals which are 4 - 20 mA DC - 2 wire and non 2 wire, 1-5 V DC, thermocouple (all types) grounded or ungrounded as per IEC 584-2, RTD Pt 100, 3 wire or 4 wire as per DIN 43760, contact (volt free), BCD, pulse etc. inputs.

4 - 20 mA DC, digital output (volt free contact) or any other output as specified.

All I/O modules shall have galvanised isolation.

f) The memory for configuration shall be resident in controller and data acquisition sub system itself and shall be retentive. In case the memory is volatile, chargeable battery back up shall be provided for retention of configuration for 72 hours in case of loss of power to the sub-system.

g) The online diagnostic message shall be available at centralised and local level.

h) The switch-over time from primary to back up controller and vice-versa shall be of the order of one second. In case of failure of primary controller.

i) The system shall be capable of supporting remote I/O's. However, local I/O configuration shall be used, unless specifically indicated otherwise in job specifications.

j) Cable loop resistance of 80 Ÿ (which is equivalent to 1000 M of loop resistance of 0.5 mm˜ cable) shall be considered as default value for deciding interrogation voltage or transmitter power supply.

7.10 COMMUNICATION SUB SYSTEM

7.10.1 The communication sub system which extends outdoor shall be through redundant fiber optic cables. The optical fibre cables or any other system cables shall be of armored type or shall run in GI (galvanised iron) conduits. Separate duct shall be provided for the data highway and system cables. The redundant cables shall follow separate cable routings.

The fiber optic cables shall be provided with wire armouring. If tape armouring is used, it shall be corrugated steel tape armour with double layers of steel tape armouring.

The fiber optic data highway cable shall have separate cables for redundancy with numbers of fibres per requirement. Additionally 4 nos. spare fibre shall be provided.

7.11 OPERATOR INTERFACE SUB SYSTEM

7.11.1 Operator interface subsystem shall be industrial grade work station based and shall be sourced from Original Equipment Manufacturer (OEM).

7.11.2 The system shall be capable of providing the following logging function as minimum for all tags:

- Alarm History per shift
- event logging
- hourly, weekly, daily log reports
- shutdown reports
- MIS (Management Information System) Reports
- Trip initiated log reports

- rotary equipment running data etc.

The log formats shall be user definable and shall be finalised during detail engineering.

7.11.3 Operator interface sub system shall be an independent function sub-system and shall not depend on any other node/sub-system including engineering interface sub-system under normal operating condition.

7.11.4 Number of graphic pages per console shall be 300 as a minimum.

7.11.5 Minimum two cursor control devices shall be provided on each CRT one keyboard other touch screen or track ball or any other as specified in job/particular specifications. The touch screen provided shall operate only when the finger (or any other device) touching the screen target is withdrawn. It shall not operate on mere touching.

7.11.6 Window operation

a) The operator interface sub system shall have facility to open multi-corridors on the operator console for the wider look of the plant. It shall be possible to operate the plant through any of these windows.

b) The system shall have capability to provide multi-window display without erasing the current display panel by opening up multiple drag and drop rectangle window on the screen. The following type of window display and function shall be provided.

- Alarm Window
- Face plate window
- Trend window
- Process window
- Graphic window
- Menu window

c) The system software shall restrict operator to open more than four windows at a time.

7.11.7 The system shall have capability to configure 600 graphic pages. However contractor shall include preconfigurtation of at least 300 graphic pages unless otherwise specified.

7.11.8 Ergonomic techniques shall be used in the design and layout of the consoles based on the assumption that operates are seated while using the CRT displays, keyboards, hardwired switches and other console equipment. Also, note that there shall be no limitation with respect to specific structural arrangement - semi-circular, horse shoe etc.

7.11.9 Operator consoles shall have non-volatile memory for configuration and storage.

7.11.10 Design of graphic displays shall be as per ANSI/ISA-S5.5 ˜Graphic Symbols for Process Displays˜ and as per drawings provided by Owner/ Owner Representative.

7.11.11 The system status display on each of the consoles shall provide indications for CPU loadings / memory loading, and mass storage devices utilization of each of the subsystems in addition to those specified under 5.3.5 of the Standard Specifications 6-52-0055.

7.11.12 Two audible alarms distinguishable from one another, each having adjustable volume control shall be provided with system. One for selected non-critical alarms and the other for critical alarms. Spare dry contacts shall be wired in parallel with audible alarms.

Both the audible alarms and the respective auxiliary contact outputs shall be silenced/ acknowledged from any of the operator keyboard assigned for the operation of that unit.

7.11.13 The operator console shall have four (4) alarm priorities. One alarm shall be for events, second for non critical alarms, a third for critical alarms and a fourth for system

alarms. Contractor shall state in their proposal if the offered system has dead band fixed or adjustable, on analog input alarms. The operator should be able to mask a or group of alarms. A list of suppressed alarms shall be available to the operator.

7.11.14 One number of engineering keyboard shall be provided for each operator console.

7.11.15 The keyboard security against unauthorized entry with key lock and password shall be provided for each keyboard of separator/engineering consoles.

7.11.16 The following are the maximum no of keystrokes required for accessing a view as per standard display hierarchy:

Type of view	No. of key strokes
Group view	2
Loop view	3
Loop in alarm	2
Graphic View	2

7.11.17 For CRT display the following additional requirements shall be considered.

No. of background colour - 7 (min.)
No. of foreground Color - 7 (min.)
No. of display characters - 80 character x 40 lines
No. of character types - Min - 96 ASCII characters
Character construction - Characters 5x7 dots Pattern 7x8 dots

7.11.18 Number of trends per display shall be minimum 4.

7.11.19 The system shall be provided with a minimum of 32 user definable function keys to call up the preselected display from each operator station.

7.11.20 Assignable trend recorders shall be provided for each console with the following:

No. of points to be recorded :Sixteen (min) user selectable
No. of pens/ recorder : 4 or 6
Recorder side : 6" x 3"
Chart size/ speed : 250 mm adjustable set at 50 mm/h.
Selection of assignable tag shall be from operator console.

7.12 Hardware console

7.12.1

a) The layout of the hardwired console shall match with the operator console layout. Any non- DCS CRT required to be placed along with operator console, should be on the hardwired console and shall match with the operator console ergonomics.

b) The plant communication system console, CCTV keyboard/CRT's etc. shall be installed in the hardwired console.

7.12.2 All Hardwired (HW) items like Push buttons, lamp annunciator etc. shall be of miniature type. The emergency Push buttons shall be of mushroom type unless specified otherwise.

7.12.3 All push buttons/selector switches as indicated/required in trip diagrams(manual reset of trip, manual activation of trip, control room reset for solenoid valves etc., auto start/stop logic for pumps and other packages shall be indicated on hardwired consoles(HWC) layout drawing with appropriate tag nos. And legends.

7.12.4 For all 2 out of 3 voting logics as indicated in the P&ID and other specification. Contractor shall consider one common hardwired alarm annunciation in the HWC and

individual alarm in DCS.

7.12.5 All Hardwired items like push buttons, lamps, annunciator sshall be of miniature type.

7.13 HART MAINTENANCE SYSTEM (NOT APPLICABLE)

7.13.1 HART maintenance system shall be supplied by the contractor for smart instrumentation like transmitters, positioners etc. The system shall be located in the control room and shall have compatible software like Cornerstone Asset Management or equivalent.

7.14 WIRING/ TERMINATION

7.14.1 All interconnection between field and control room shall be from Marshalling racks only. All interconnection between marshalling racks and system cabinets shall be through prefabricated cables with plug-in-connectors at both ends.

7.14.2 In all analog marshalling cabinets provision shall be kept for mounting a hand held communicator for smart transmitter.

7.14.3 All interconnecting cables between cabinets/printer/console etc. shall be armoured or run through conduits to protect from rodents.

7.14.4 All cabinets, panels, racks must be designed to avoid congestion for ease of maintenance. All spare cores of multicables shall be terminated on the marshalling rack next to the assigned cores. No cables/ cores shall be left unterminated in the rack/cabinet. Also no terminal or terminal strips shall be located on the side panels of the rack/cabinet.

7.14.5 Rack layout shall ensure clear and adequate segregation between termination panels, I/O modules and cables in the following:

- Analog (intrinsically safe)
- Analog (non-intrinsically safe)
- Discrete (intrinsically safe)
- Discrete (non-intrinsically safe)
- Power supply cables (voltage wise split)
- mV signals
- Pulse signals
- RTD signals

7.14.6 Not more that four cabinets shall be combined for wiring. For consoles and cabinets, side cover shall be provided individually.

7.14.7 All wiring shall conform to API-RP-550 Part I section 7 and 12. Different signals level cables shall be routed under false flooring with separation distance as recommended by API-RP-550 section-7.

7.14.8 All wiring inside racks, cabinets and back of the panels shall be housed in covered, non flammable plastic raceways arranged to permit easy accessibility to various instruments for maintenance, repair and removal.

All wiring in the race ways shall be properly clamped. Total wiring cross-sectional area including air gap shall not exceed 50% of the raceway cross-sectional area. Rubber/Plastic grommets shall be used for wire entry into individual instruments and entry/exit of wires through raceways. The exposed length of wiring shall be kept minimum.

7.14.9 Separate wiring raceways shall be used for power supply wiring DC and low level signal wiring, and intrinsically safe wiring, Parallel runs and AC and DC wiring closer than 300 mm shall be avoided.

7.14.10 Wiring termination shall be done using self crimping lugs.

7.14.11 No more than two wires shall be terminated on one side of single terminal. Such a practice shall be avoided as far as possible. The use of shorting links for looping shall be avoided.

7.14.12 Cable glands shall be provided for all cable entries to the cabinets/racks/consoles.

7.14.13 Terminal housing shall be strictly sized with considerations for accessibility and maintenance. Following points should be considered.

a) Distance between terminal strip and side of the cabinet parallel to the strip upto terminals shall be equal to 50 mm (min.)
b) Distance between terminal strip and top and bottom of the cabinet shall be equal to 75 mm (min.).
c) Distance between two adjacent terminals shall be equal to 100 mm (min.)
d) Addition distance for each additional terminal shall be equal to 25 mm (min.)
e) Distance between cable gland plate and bottom of the strip shall be equal to 300 mm (min.).

7.14.14 All terminal strips shall be mounted on suitable anodised metallic or plastic stand off.

7.14.15 No spacing is allowed in between wire/cable straight run.

7.14.16 Terminal strips shall be arranged group wise for incoming and outgoing cables separately. 30% spare terminals shall be provided as a minimum.

7.14.17 Cabinet and rack layout shall be made considering proper accessibility and maintenance, 20% spare accessories like relays, switches, barriers, lamps, fuses etc shall be provided completely wired as a minimum.

7.14.18 Terminal blocks for intrinsically safe wiring shall be separate.

7.14.19 Thermocouple extension cables shall be used for thermocouple signals with in control room.

7.14.20 All trip connected ferrules in the marshalling racks shall be of red colour both from the field and to the field.

7.14.21 For internal signals wiring in the cabinets and accessories, flexibles stranded, PVC insulated, twin twisted and shielded Copper conductor shall be used. For signal wiring external to the cabinet, 1.5 mm^2 twin twisted individual shielded, overall shielded with overall drain PVC insulated and armoured cables shall be used.

For power supply (UPS), min. 3 C x 2.5 mm^2 PVC insulated and armoured Copper conductor shall be used.

7.14.22 All terminals shall be mechanical screw clamp type with pressure plates. Terminations shall be done using self insulating crimping lugs. Wire lugs shall be used for all terminations on terminal blocks, where as forked tongue type lugs shall be used for termination on screw terminals such as a relays, alarm annunciators, push buttons, lamps etc. Terminals shall be suitable to accept conductor size as a minimum.

7.14.23 Additional terminals shall be used for looping if necessary. The use of shorting links for looping shall be avoided.

7.14.24 Sockets for all types of power available in the cabinet shall be provided for maintenance work.

7.14.25 Wiring colour code within the cabinet framework and accessory equipment shall be as follows:

Power Supply (line) Red
Power Supply (neutral) Black
Ground Green
Alarm System White
Control and shut down Yellow
Analog signal intrinsically Light Blue
Safe wiring
DC wiring
Red (positive)
Black (negative)
100 metre length of wires shall be supplied as loose spares for each cabinet column/ row used.

7.15 Identification and Marking

a) All electrical termination's and equipment on the cabinet and other accessories shall be identified with appropriate tag, cable marker, etc.
b) All terminals in a terminal strip shall be identified by their individual numbers located integral with the terminal itself.
c) Interconnecting multicables shall be identified by metal tags as indicated in cable schedules.
d) Wiring at terminals shall be identified by the terminal number and termination service at the other end of the wire. Wiring at instruments and accessories like alarm relays, push buttons etc. shall have ferrules indicating tag number, terminal number and the termination service at the other end of the wire.
e) Looping connections shall be identified by termination services at both ends of the wire.
f) Identification markets as mentioned above shall be repeated in contractor drawings. g) Sample identification methods shall be discussed with Owner before finalisation.

7.16 Printers and hard copy unit

7.16.1 Logging/Alarm and Event/Configuration and maintenance Printer

a) Type of Printer shall be Line for logging printers and serial for others. b) Number of character shall be approx. 96 and type shall be ASCII.
c) Printing speed shall be 300 lines per minute for logging printer and min 120 characters/sec. for others.
d) no. of print columns shall be min. 132 character per line. e) Paper width is approx 381 mm.
f) Paper type shall be continuous fan fold. g) Number of copies shall be three.
h) Bi-directional printing feature is required for alarm and event printers and configuration and maintenance printers.
i) Acoustic cover is required for the printers.
j) Paper feed shall preferably be friction feed.

k) Test pattern generation is required.
l) Mounting shall be self contained with integral stand.
m) Noise level while printing at 1 meter distance shall be less than 45 dBA.
n) Identification os alarms and events is required by dual colour for alarm and event printers.

7.16.2 **Hard Copy Unit**

a) The hard-copier unit shall be electrostatic type or thermal type and shall be able to take coloured copies of any CRT screen either from operator console or from engineering console.
b) No CRT screen shall be locked out while taking copy. In case this is available it should not be more than five seconds maximum.
c) The number of channels shall be selected by contractor as per number of CRTs of operator console and engineering console of the system.
d) The hard copier shall be installed on a self contained integral stand.
e) Where there is a possibility of transfer of high voltage to communication sub system from video copier, high voltage protection barriers shall be provided.

8 ANALYSER SYSTEM

8.1 This clause specifies the general requirements of process and flue gas analysers. Application related specific requirements shall be described in job specification

8.1.1 **Process Analysers**

8.1.1.1 System Design

The principle of operation shall be simple in design and shall avoid analytical complexity associated with development of information which is extraneous to the application. In general, system shall consists of probe, sample tube, pressure reduction, sample conditioning, fast loop operation, analyser and vent connection to flare.

8.1.1.2 **Probe:** As recommended by analyser sub-vendor with isolation valve and material suitable for the application.

8.1.1.3 **Sample tube:** sample tube material shall be suitable for process condition with size as recommended by vendor. The samples consisting of condensable vapour shall be with electricity traced sample tube with temperature control.

8.1.1.4 **Sample conditioning system:** Generally sample conditioning system shall be as per API, meeting analysis requirement. The pressure reduction where required shall be provided with a safety valve at its down stream. Variable area flowmeters shall be provided for fast loop. For the stream where solid particles are expected, necessary filters shall be used. Provision for necessary condensate knockoff system shall be provided, if applicable.

8.1.1.5 **Analyser:** The type of analyser shall be as per P&ID and process data sheets attached with the process package. The analysers shall be installed in the analyser shelter/room in general. In case where no analyser shelter exists, the analyser shall be installed in a free standing analyser cabinet. The analyser cabinet shall be provided with a vortex cooler or air conditioning unit suitable for the area classification.

Process stream analysers shall be microprocessor based and their sample handling system shall be designed and fabricated by the analyser vendor only. The analyser vents and drain

shall be routed to process or flare as applicable.

8.1.1.6 **Enclosure:** All the analyser shall be individually certified for area classification and required gas grouping. All electrical component of the analyser system and air conditioner shall be certified for use in IEC Zone-1 area of required gas grouping.

8.1.1.7 **Calibration gas cylinder/consumables**

All calibration cylinders and other necessary items for analyser calibration shall be supplied by the contractor, considering the requirement of start up / commissioning, warranty period plus two years normal operation. The cylinders shall be located outside the shelter/cabinets and contractor shall provide suitable mounting accessories for the same. Cylinders shall be supplied in two sets, one shall be used and the other for storage and filling.

Analysers like pH, Conductivity shall be two wire type and shall be installed outdoor.

8.1.2 Flue Gas Analysers

8.1.2.1 Flue gas monitoring system shall be used for continuous emission of stack and heaters. Typically SO_x, NO_x, O_2, CO and CO_2 analysers are required for stack and heater analysers.

O_2 Analysers :

Zirconia type (unless paramagnetic type required for process condition)

SO_x/NO_x/CO/CO_2 :

Dilution type for SO_x and NO_x and hot tap extraction type for CO/CO_2 with principle to meet the required specification and performance unless otherwise specified in job specification.

8.1.2.2 Probe: Probe shall be provided with necessary filter and material suitable for the temperature and process condition. The dilution shall take place near the probe where dilution type is specified.

8.1.2.3 Sample tubing: Minimum SS for dilution type. Teflon tube electrically heat traced and armoured for extraction type. Automatic temperature control shall be provided for the tubes.

8.1.2.4 Sample conditioning: Pressure reduction, heating/cooling flow meters etc along with other system components as per API and as recommended by vendor. Provision of first loop, condensate knock off shall be provided.

8.1.2.5 Analysers: Analysers shall be electronic microprocessor based with full diognoestic facility. The analysers shall be located in prefabricated shelter.

8.1.2.6 Analyser shelter

i) The flue gas analysers shall be located in a prefabricated analyser shelter. Minimum width of the analyser shall be 3 m. The design and construction of the shelter shall be self supporting type and it shall be capable of housing required analysers, sample handling system and other accessories. All the air conditioner, all electrical component shall be certified flame proof Ex˜d˜ of required gas grouping.

ii) The structure of shelter shall be constructed by suitable size ˜ISMC (150/125)/ISMB(100)˜ welded properly and adequately sized to ensure structural rigidity and to prevent deformation during loading / unloading of the shelter. The floor shall be constructed from anti slip sheet plates strong enough to withstand load of all the equipments and atleast three maintenance personnel.

iii) External side walls and internal side walls shall be adequately strong and galvanized sheet of thickness 18 gauge with 45 mm x 60 mm x 45 mm x 3 mm thick MS U profile.
iv) The shelter roof shall be adequately strong and sealed to prevent entry of rain and jet water.
v) The shelter shall be provided with main door and an emergency door opposite to main door. Both doors shall be opening outwards, provided with safety glass window and automatic spring door closer.
vi) Extension roof provided along the two longer sides shall be hanged at least 1000 mm outside the analyser shelter.
vii) The tag numbers of analysers shall be fixed near the main door. The tag number of each analyser shall be fixed near the respective items. Inlet/outlet pipes, electrical wires inside the junction box and cables shall be identified.
viii) Provision shall be made for keeping all the fast loop devices outside the shelter.
ix) Shelter shall have inside temperature of 24˜C +/- 2% with humidity less than 50% to obtain repeatability and reliability of the analysers.
x) Each shelter shall be provided with two no. LEL detectors.

8.1.2.7 Auto and span control:
Contractor shall provide all hardware and software required for auto zero and span calibration.
8.1.2.8 **Calibration Gas Cylinder/Consumables**
All calibration cylinders and other necessary items for analyser calibration shall be supplied by the contractor, considering the requirement of start up / commissioning warranty period plus two years normal operation. The cylinders shall be located outside the cabinets and contractor shall provide suitable mounting accessories for the same. Cylinders shall be supplied in two sets, one shall be used and the other for storage and filling.
Flue gas analysers for emission monitoring (i.e SO_x, NO_x, CO_2, CO_x, O_2) shall meet the requirements of EPA, USA regulations.

9.0 **Gas Detection System**
9.1 **LEL Detectors**
LEL detectors shall either be infrared type or catalytic combustion type as specified in job specifications. Material of construction shall be SS304. Accuracy shall be +/- 2% URV. LEL detectors shall be 3 wire type. Detectors shall be weather proof to IP 55 and flameproof Ex ˜d˜suitable for indicated area classification. Necessary rain guard and dust shield shall be provided. Cable distance limitation between LEL detectors and control room shall be reviwed for various vendors based on detectors voltage drop and current consumption. Necessary Calibration kit with gases for minimum 2 years operation after warranty period shall be provided. Portable LEL gas detectors (1 no.) Shall be provided. Seperate gases shall be provided for warranty period.
The LEL monitors shall be installed on a panel to be installed in control room. LEL group alarms shall be provided in DCS.
9.2 **H2S Detectors**
H2S detectors shall be electrochemical type. Material of construction shall be SS304. Accuracy shall be +/- 3% URV. H2S detectors shall be 3 wire type. Detectors shall be weather proof to

IP 55 and flame proof Ex˜d˜ suitable for indicated area classification. Necessary rain guard and dust shield shall be provided. Cable distance limitation between H_2S detectors and control room shall be reviwed for various vendors based on voltage drop and current consumption of detectors. Necessary calibration kit with gases for minimum 2 years operation after warranty period shall be provided. Separate gases shall be provided for warranty period. Portable H2S detectors (1 no.) Shall be provided.
The H2S detector system shall be installed on a panel to be installed in control room. H2S group alarms shall be provided in DCS.

10.0 MATERIAL SELECTION GUIDE LINE

The material requirement of instrumentation item shall be governed by service conditions and process requirement. In general, Piping Material Specification (PMS) shall be used as a guide line of selection of material of instrumentation which shall include material, its composition and other requirements. It is contractor˜s responsibility to select the material which is suitable for pressure, temperature, corrossion, errossion etc. For the instrument connected directly in line or through impulse line shall directly be governed by the respective piping class whereas for instrument mounted on equipment, vessel, columns, reactors etc, equivalent piping class shall be derived based on the lines connected to the respective equipment, vessel, column, reactor, etc, nozzle flange rating. In general, the following shall be considered as guidelines.
i) For all instruments in sour service, all materials of construction shall meet the requirements specified in NACE MR 01-75 latest edition. In addition, any other requirements if specified in respective piping class, shall also be complied.
ii) Impulse pipe material shall be as per the corresponding piping class. However, for Impulse tubing, material shall be SS 316, as a minimum. Better material shall be selected wherever required as per PMS and if SS 316 is not suitable.
iii) Valve body material of PMS to be considered for body material of control valve, self actuated pressure control valve, field instrument, body/bonnet of pressure relief valve, cage / chamber of all level instrument, chamber of senior orifice assembly and body of all other instruments.
iv) Trim material of valves as per PMS shall be considered for the wetted parts of all instruments apart from body / bonnet / cage / chamber and flange shall be as per trim material. The thermowell material shall be as per trim material.
For piping class A1A, A6A, A8A, A10A, A14A, A19A, B1A, B6A, B9A, B13A, D1A, E1A, F1A, A5A, B5A, D5A, A3A, A2A, B2A and D2A, SS 316 shall be used as trim material instead of trim material specified in the PMS. However, stelliting shall be provided in steam cases and where dictated by specification. For piping classes A4F, A3F, B4F, A4G, B4G and D4G, monel shall be used for field transmitters, pressure / differential pressure gauges for body / socket / sensor / diaphragm upto the maximum specified temperature of 200˜C. All flanges shall be as per PMS. The torque tube material of displacer instrument shall be inconel as minimum.

11.0 INSPECTION AND TESTING REQUIREMENT

11.1 Requirements of non destructive testing like, radiography, magnetic particle test, hardness test, hydrotest for items such as control valves, safety valves, orifice flange assembly, level gauges etc., shall be carried out strictly as per respective piping class.

For all instruments, welding and testing shall be carried out as per piping specifications.
Post weld heat treatment shall be carried out for all weldings of instrument as required in accordance with the requirements of piping material specifications.
11.2 For items like control valves, shutdown valves, pressure relief valves, desuperheaters etc. radiography procedure and area of casting to be radiographed shall be as per ANSI B16.34 and acceptance criteria shall be as per ANSI B16.34 Annexure B, in general. However areas of casting to be radiographed for type of valves/desuperheaters not covered in ANSI B16.34 shall be in line with ANSI B16.34.
100 % radiography shall be done on the following areas of each item requiring radiography: -
- inlet flange neck
- outlet flange neck
- cast nozzle (in case of safety valves)
- all weld joints

Two shots shall be taken for each area to be radiographed, as a minimum.
11.3 Following test shall be carried out by contractor at his vendor's works and test certificate shall be furnished.
i) Material test certificate including NACE requirements for all instruments.
ii)* Calibration/ test certificates for all instruments including control valves, safety valves.
iii) Seat leakage test for control valves and safety valves.
iv)* Helium leakage test for control valves and pressure relief valves in H_2 service.
v)* Test certificate for safety valve set pressure and reseat pressure.
vi)* Hydrotest certificate for all inline instruments, pipes, tubes, fittings etc.
vii)* Radiography of control valve and pressure relief valves of rating ANSI 600# or above.
viii) Conformity certificate from sub-vendor.
ix) Capacity certificate duly approved by third party.
x) NACE compliance certificate.
All tests prefixed by (*) shall be witnessed by owner/owner representative /third party
The above is minimum requirement. Inspection agency engaged for the job shall detail out inspection and detailed testing procedure for individual items after contract is awarded.

11.4 Functional and simulation tests for all instruments supplied by the contractor shall be carried out at sub-vendor˜s works and witnessed by Purchaser/purchaser's representative˜s representative.

11.5 Refer to the standard specification 6-52-0055 for inspection and testing requirements of DCS and PLC.

11.6 CCTV System

i) All material / equipment / integrated system shall be tested at the manufacturers workshop and witnessed by owner's representative prior to shipment of materials. A prefactory acceptance test shall be carried out prior to the system is available for testing in presence of owner's representative.
ii) After installation completion, field test shall be performed and control function shall be programmed in accordance with the functional requirements. Tests shall include functional tests of all input, output and alarm functions.

11.7 **Analyser System**

Each components and the system shall be tested separately at the vendor's works and the test certificates like material test certificate for all wetted parts and certificates from statutory bodies for use in area classification indicated in data sheet to be provided to owner. After installation of the analyser system at site, demonstration of the tests carried out at vendor's works shall be explained to owner.

11.8 **Speciality Service**

Contractor shall engage speciality services from the sub-suppliers for special instruments and systems. This shall include engagement of qualified engineers and technicians from suppliers for following items for engineering, installation, field testing and commissioning.

- all type of analysers
- all type of compressor instrumentation
- DCS/PLC
- CCTV
- Machine Monitoring system
- FGS

12.0 INSTALLATION MATERIALS

12.1 Contractor shall ensure and supply all erection hardware required for the installation of complete instrumentation which form a part of the package unit. This includes items like cables, cable glands, junction boxes, instrument valves and manifolds, mounting accessories, impulse piping/tubing, pipe/tube fittings, pneumatic signal tubes, air line pipes and fittings, filter regulators, steam/electrical tracing, insulation materials, cable duct and trays, conduits, identification tags, structural material required for instrument supports and trays etc.

12.2 Clause 12.1 above broadly covers the items required for any typical plant, however the contractor shall supply all necessary items to make the installation and commissioning work complete in all respects, irrespective of whether these have been explicitly included in their scope or not.

12.3 Salient features and minimum requirements for some of the main installation materials is being described in the following paragraphs. For items for which no specification have been provided, vendor may follow their own specifications and prevailing international standards.

12.4 **Cables**

12.4.1 All cables shall have PVC insulated primary insulation of 85˜C PVC as per IS-5831 Type C/ IEC 502. Inner and outer jacket shall be made of extruded flame retardant 90˜C PVC to IS-5831 Type ST-2 / IEC 502. Oxygen index of PVC shall be over 30% and temperature index shall be over 250˜C.

12.4.2 All cables shall be fire retardant as per standard IEC 332-3 Part 3 Cat.A. Fire resistance cables whenever specified shall be as per IEC 331 Cat. A.

12.4.3 The insulation grade shall be 600 V/1100 V as a minimum and shall meet insulation resistance, voltage and spark test requirements as per BS-5308 Part-2.

12.4.4 All cables shall be armoured. Armour over inner jacket shall be of galvanised steel wire/flat as per IS-1554 part I / IEC 502.All the cores of single pair or multi pair shall be twisted and numbers of twist shall not be less than 10 per metre.

12.4.5 For signal and control cables, inner jacket colour shall be black. Outer jacket colour shall be light blue for intrinsically safe application and black for others. For thermocouple extension cables the inner and outer jacket colour shall be as per IS-8784.

12.4.6 Maximum DC resistance of the conductor of the completed cable shall not exceed the following: -

a) 12.3 Ÿ/km at 20˜C for cables with 1.5 mm^2 conductor.

b) 39.7 Ÿ/km at 20˜C for cables with 0.5 mm^2 conductor.

12.4.7 The mutual capacitance of the pair or adjacent cores shall not exceed 250 pF/m at a frequency of 1 kHz. The capacitance between any core and screen shall not exceed 400 pF/ m at a frequency of 1 kHz.

12.4.8 L/R ratio of adjacent cores shall not exceed 40 µH / for cables with 1.5 mm^2 conductor and 25 µH / for cables with 0.5 mm^2 conductor.

12.4.9 The drain wire resistance including shield shall not exceed 30 Ÿ/km. Electrostatic noise rejection ratio shall be over 76 dB.

12.4.10 A pair of communication wire shall be provided for multipair/multitriad cables. Each wire shall be 0.5 mm^2 of plain annealed single or multi-strand copper conductor with 0.4 mm thick 85˜C PVC insulation. Insulation shall be green and red colour coded.

12.4.11 Contractor shall ensure a minimum of 20% of quantity of each type of cables supplied as spare including any special cable. And in each multipair cables 20% pairs shall be kept as spare.

12.4.12 Running length of the cable shall be printed at least at every 5 metre interval. For multipair/multitriad cables, a pair identification shall be provided with numbers at interval of not more than 250mm as per vendor's standard.

12.4.13 **Signal Cables**

a) Single pair shielded signal/alarm cables shall be used between field instruments/ switches and junction boxes/local control panels.

b) Multipair individually and overall shielded signal/alarm cables shall be used between junction boxes/local control panels and control room / satellite rack room as the case, in general.

c) The single pair/triad cables shall be 1.5 mm^2 conductor size made of annealed electrolytic copper conductor of 7 strands with each strand of 0.53 mm diameter. Multipair cables with 0.5 mm^2 conductor size shall have 7 strands of annealed electrolytic grade copper conductor with each strand of 0.3 mm diameter. Multi triad cable or multi pair cable with 1.5 mm^2 conductor shall have 7 strand with each strand of 0.53 mm diameter. Colour of core insulation shall be black blue in pair and black, blue and brown in a triad.

d) Shield shall be aluminium backed mylar/polyester tape bonded together with the metallic side down helically applied with either side having 25% overlap and 100% coverage. The minimum shield thickness shall be 0.05 mm in case of single pair/traid and 0.075 mm in case of multipair/triad cable.

e) Drain wire shall be provided for individual pair and overall shield, which shall be 0.5 mm^2 multi stranded bare tinned annealed copper conductor. The drain wire shall be in continuous contact with aluminium side of the shield.

f) All multi pair cables shall have 6 pair/12 pairs only while multitriad cable shall have 6 triads/8 triads only.

12.4.14 **Control Cables**

a) Single pair control cables shall be used between field mounted solenoid valves and junction boxes/local control panels and shall meet the requirements specified in para 12.4.13 above.

b) Multipair control cables shall be used between junction boxes/local control panel and control room mounted devices in general. These cables shall have only overall shielding.

c) These control cables shall have 1.5 mm² conductor size with 7 stranded conductors of annealed electrolytic grade copper, with each strand of 0.53 mm diameter as minimum.

12.4.15 **Thermocouple Extension Cables**

a) Single pair shielded thermocouple extension cables shall be used between thermocouple head and junction boxes transmitters/local control panel mounted instruments.

b) Multipair individually and overall shielded thermocouple extension cables shall be used between junction boxes and control room mounted devices.

c) The type of thermocouple extension cables shall be compatible with thermocouple used. In addition the colour coding of the primary insulation shall be as per IEC 60584-3.

d) The cable shall have 16 AWG and 20 AWG solid conductors for single and multipairs respectively.

e) All thermocouple extension cable shall be matched and calibrated in accordance with IEC-584-2.

f) Shield shall be aluminium backed by mylar/polyester tape bonded together helically applied with the metallic side down with either side having 25% overlap and
100% coverage. Minimum shield thickness shall be 0.05 mm for single pair and 0.075 mm for multipair cable. Drain wire shall be 0.5 mm^2 multistrand bare tinned annealed copper conductor. The drain wire shall be in continuous contact with the aluminium side of the shield.

g) Core inductance shall not exceed 4 mH/km. However for J-type thermocouple inductance could be 8 mH/km.

h) All multi-pair cables shall have 6 pairs/12 pairs only.

i) For units with IEC Gr.IIC hazardous area classification of gas grouping, polyethylene insulated cables with 70EC Polyethylene (PE) as per IS 6474 or equivalent international standard shall be used in general with all other specification same as (a) to (h).

12.4.16 **Power Supply And Other Cables**

a) All power supply cables shall be as per IS-1554 Part I and shall have copper/aluminium conductors depending on conductor size. Minimum conductor size

shall be 2.5 mm5 of copper conductor. For higher sizes, aluminium conductor can be considered. All these cables shall be PVC insulated and armoured.

b) Any other special cable required for instruments shall also be supplied as per requirements. Vendor shall ensure that these cables are armoured type and shall meet all other requirements specified in para 12.4.1 through 12.4.12, as applicable.

c) Refer electrical sec. specification for details.

12.5 **Cable Glands**

a) Contractor shall supply all cable glands required for glanding the above mentioned cables both at field instrument and local control panel side, junction boxes side and at control room side.

b) All cables glands shall be of nickel-plated brass and they shall be double compression type suitable for armoured cables.

c) Flame proof glands wherever required shall be supplied with Ex>d= certification.

12.6 **Junction Boxes**

a) Contractor shall supply junction boxes as per the cables selected, wherever required. These shall be of die cast aluminium alloy (LM-6) body and shall be weather proof to IP 55, as a minimum.

b) These boxes shall have terminals suitable for minimum or 4 mm5 or less cable termination mounted on rails. 20% spare terminals shall be supplied in each junction box.

c) Telephone sockets and plugs shall be provided in junction boxes.

d) Flame proof junction boxes wherever required shall be supplied with Ex>d= certification. All such boxes shall be weatherproof to IP 55 also.

e) Each junction box shall have a minimum of 2 Nos. for 6P/12C and 4 numbers for 12P/24C spare entries. All spare entries shall be provided with plugs certified Ex>d= for flameproof junction boxes.

12.7 **Instrument Valves and Manifolds**

a) Contractor shall supply instrument valves (miniature type) and valve manifolds wherever required.

b) Body rating shall be as per piping class or better. All valves and manifolds shall be forged type only.

c) Valve body and trim material shall be SS 316 unless otherwise specified. Superior trim material shall be selected as required by process conditions. Packing material in general shall be of PTFE.

d) For instrument air isolation valves, body material shall be Nickel or cadmium plated carbon steel.

e) Vendor shall supply a minimum of 20% instrument valves and manifolds as spare.

12.8 **Impulse Piping/Tubing**

12.8.1 **Tubing**

a) Contractor shall supply 1/2" OD x 0.049" thick ASTM A 269 TP 316 stainless steel fully annealed, cold drawn and seamless tubes as a minimum for impulse lines upto600 # class. Higher thickness according to pressure rating shall be considered for higher pipe classes.

b) Monel or any other tubing shall be used where SS316 is not suitable for the service.
c) The hardness of SS tubes shall be Rockwell RB 70-79.
d) Steam tracing shall be 10 mm OD soft annealed copper tubes of electrolytic grade copper with wall thickness of 1 mm as per ASTM B 68M copper no. C 12200.
e) Instrument air distribution shall be with 6 mm soft annealed copper, 1 mm thick PVC coated as per ASTM B 68M copper no. C 12200
f) Vendor shall supply a minimum of 20% of pipe/tubes as spare.

12.8.2 **Piping**

a) All piping shall be 1/2" NB with material and class as per piping class of the pipe on which the instrument is connected. The piping shall also be 3/4" NB, 12" NB as the case may be. In case of vessel / equipment / reactor piping shall be corresponding equivalent piping class.

12.9 **Pipes and Tube Fittings**

12.9.1 **Tube Fittings**

a) Contractor shall supply flareless compression type of tube fitting and of three piece construction with design similar to Swagelok/Parker Hannifen/Ermeto etc.
b) The fitting/ferrule hardness shall be in the range of RB 85-90 so as to ensure a minimum hardness difference of 5 to 10 between tube and fittings. The ferrule shall be of stainless steel material, in general.
c) Socket-weld type forged pipe fittings of suitable material and rating shall be supplied for pipe fittings. The minimum rating shall be 3000 #. Weld neck fittings shall be used where socket weld type are not allowed by piping class.
d) Instrument air brass fittings shall be suitable for use on copper tubes conforming to ASTM B 68/B 68 M hardness not exceeding RB 50. All fitting parts shall be manufactured from Brass as per IS-319 bar stock or equivalent and shall be nickel plated.
e) All threaded fittings shall have NPT threads as per ANSI/ASME B16.11 only.
f) Vendor shall supply a minimum of 20% of each type of pipe/tube fittings as spare.

12.9.2 **Pipe Fittings**

All pipe fittings shall be according to piping material specification as per piping class of the pipe on which instrument is connected. In case of vessel / equipment / reactor, PMS of equivalent piping class shall be considered.

12.10 **Pneumatic Signal Tubes**

a) Contractor shall supply 6 mm OD x 1 mm thick PVC covered fully annealed electrolytic grade copper tubes as per ASTM B68.74A Cu. No.122 (DH) for pneumatic signal tubes.
b) Contractor shall avoid use of intermediate connections and shall estimate single length for each instrument location.
c) Contractor shall supply a minimum of 20% length of these tubes as spares.

12.11 **Instrument Air Lines Fittings and Valves**

a) Seamless galvanised, inside and outside, carbon steel pipes used for instrument air distribution shall be as per IS 1239 J3A pipe class.

b) Galvanised forged screwed carbon steel screwed fittings of 2000 # rating fittings shall be used.

c) Isolation valves on instrument air service shall be packless gland type full bore ball valves.

d) Vendor shall supply a minimum of 20% of air pipe, fittings and valves as spare.

12.12 **Air Filter Regulators**

a) Instrument air filter regulator of suitable size, range and capacity shall be supplied for each pneumatic instrument.

b) The body of the filter shall be anodised aluminium.

c) The filter shall have 25 Fm sintered bronze/ceramic filter element as a minimum and shall be provided with manual drain and 2" nominal size pressure gauge. Other filter size shall be considered based on recommendation of I/P transducer vendor.

d) Contractor shall supply a minimum of 20% of air filter regulators of each size and range as spare.

12.13 **Cable Trays and Cable Ducts**

a) All cables on the main and sub pipe rack shall be laid in cable duct. Cable ducts shall be fabricated as per 'Duct Fabrication Details' standard No. 7-52-0253.

b) All branch cables/tubes shall run on cable trays.

c) These cable trays shall be made out of M.S steel sheets of 2.5 mm thickness unless galvanised mild steel is specified. Ladder trays shall be of mild structural steel and shall be painted with red-oxide primer. 50 mm x 50 mm angle shall be used as a minimum.

d) The width shall be so selected that 50% of tray space is available for future use.

e) Suitable cable clamps shall be supplied for binding the cables/tubes at every 500 mm.

12.14 **Instrument Support/Structural Steel**

a) Contractor shall supply instrument stands, stancheons and other structural steel material required for supporting the cable trays, impulse lines and instruments.

13.0 INSTALLATION

13.1 Contractor shall be responsible for installation of all the items in their scope of supply including supply, fabrication and erection of all installation / erection material. The scope of installation shall include all field instruments and control systems like field instruments, analyser system, gas detector systems, control system equipments i.e DCS, PLC, Hart maintenance system in main control room / satellite rack room / local control room etc, local and remote panels including supply / fabrication / erection / installation of all erection material i.e cables, cable glands, junction boxes, cable ducts, trays, conduits, instrument supports, trenches, instrument road crossing as required to

complete the job in all respect.

13.2 Contractor=s scope shall include installation of CCTV system, wherever required including cameras along with accessories and mounting pole, cabling and control room mounted items including supply and installation of all erection material.

13.3 Supply / fabrication and installation of instrument mounting posts, support stands / frames, fittings, brackets and other consumables for mounting and supporting all instruments, instrument system components and fixing the same.

13.4 Whenever installation is beyond the scope of contractor, purchaser or its authorised representative shall install the instruments as per the drawing / document / details provided by the contractor. However, in such a case it must be ensured that complete installation materials shall be supplied.

13.5 Any panel or instrument, which has been disconnected or removed for transportation shall be replaced or reconnected where necessary.

13.6 Installation of any underground cables shall include excavation, cable segregation, support, back filling with grades of sands, tiling, trench makers etc. In case of underground cables are required to be in RCC trenches, all installation shall be carried out except excavation. Suitable cable markers made of aluminium shall be provided for all underground cabling.

13.7 Installation of aboveground cables includes identification, suitable supports, angle / perforated / ladder tray duct fixing and fire proofing (if required as per job specification).

13.8 Installation of cable tray/ ladder tray, ducts and miscellineous support materials, clips as required for supporting aboveground instrument cable, tube etc.

13.9 Installation of suitable cable clamps / tray on multicore cables just before termination into the junction box or panel such that the weight of cables is not supported by the cable glands.

13.10 Mark off, gland and connect all instrument cables, supply and install markers / ferrules etc for cable identification in accordance with the specification.

13.11 All instruments including direct mounted instruments like thermocouples, thermowells, temperature gauges, pressure gauges, pressure switches etc. shall be installed in such a way that they have good readability and accessibility. Platforms and ladders shall be provided to meet this requirement, if necessary.

13.12 The capillary of all capillary type instruments shall be supported properly and shall be protected against mechanical damage.

13.13 All pressure/differential pressure instruments shall be provided with block and bleed/by-pass, drain/vent valves etc as per the installation standards, and shall have accessibility.

13.14 All primary piping/tubing (impulse lines) shall have a slope of 1 in 12 on the horizontal run.

13.15 All welding shall be carried out as per the relevant codes with proper electrodes. Any testing (non destructive) like D.P. test and radiography on root weld and final weld shall be carried out as per PMS. All consumables shall be part of contractor's scope of supply. Any pre/post weld treatment as required by the relevant codes and piping material specification shall be carried out. All non destructive tests shall be carried out as per piping material specification.

13.16 All threaded joints shall be joined by PTFE tapes only.

13.17 All impulse lines shall be supported at regular intervals.

13.18 Instrument drain/vent connections shall be piped to safe area like oily water sewer or above pipe racks to avoid accumulation of hazardous fluid in the plant atmosphere. For hydrogen and Lethal services like CO etc all vent / drains shall be connected to closed system even it is not shown in the P&IDs.

13.19 Steam tracing wherever required shall be carried out by 10 mm OD x 1 mm thick copper tubes and condensate traps shall be provided to collect all the condensate and shall be piped to the nearest pipe drain funnels.

13.20 All tubes/cables shall be properly laid on cable trays which shall be supported at regular intervals.

13.21 Separate routing or physical separation shall be maintained between signal cables, shut down and power cables.

13.22 Wherever intrinsically safe system cabling is employed, the minimum separation of 150 mm shall be adhered between IS (intrinsically safe) and non IS signal cables.

13.23 The cases of instruments shall be earthed by earthing wire to the nearest earth bus bar for safety reasons.

13.24 Painting of cable trays/ducts, mild steel cable trays, angle trays, instrument supports and all structural supports shall be painted as under: -

a) The surface to be painted shall be thoroughly cleaned with brush sand paper to remove all scales. After cleaning, one coat of red oxide zinc chromate primer shall be given conforming to IS-2074 and allowed to dry. One coat of final when paint shall be applied.
Second and final coats of paint of final colour shall be given before handing over the plant/ commissioning.

b) Instrument impulse lines shall be painted as per painting requirements of main pipe and equivalent pipes in case of vessel / equivalent / reactor.

13.25 For the purpose of installation planning and scheduling shall be made on daily and entire installation period with other disciplines co-ordination shall be done with other EPCC contractors for common area of work.

13.26 Mounting of instrument / junction boxes shall be at a height of 1.3 metre from grade level / finish floor level.

13.27 Temperature extension of suitable length shall be provided in the impulse line of the instrument installation where process fluid temperature is higher than the maximum withstanding temperature of the instrument.

14.0 IMPULSE LINE REQUIREMENTS

14.1 All instrument impulse shall be provided with the following.

i) Piping or tubing or combination of piping and tubing shall be as per requirement of job specification or licensor's requirements.

ii) All instruments shall be provided with isolation, drain and/ or vent valves with vent/drain end duly capped. This isolation valve shall be in addition to the first isolation /root valve provided on the pipe or vessel at instrument take off.

iii) For flow transmitters integral 3 valve manifold shall be provided.

iv) For remote installation of instrument minimum one pair of break flanges shall be provided.

v) For impulse line with viscous / congealing services a tee off with blind flanged shall be provided for cleaning purpose near to first isolation valve.

vi) For diaphragm seal type instruments, spacer ring with vent and drain connection along with vent / drain valve with end capped.

vii) For instrument flushing/purging line additionally check valve, rotameter, DP regulator, restriction orifice with isolation valves shall be provided.

viii) All the valves used for impulse line shall be globe type.

ix) Contractor to study all the installations and meters shall be provided above the tapping for all types of condensable vapour service.

x) Syphon shall be used for steam service.

xi) Extension in the impulse piping / tubing of suitable length may have to be provided for those instrument installations where process fluid temperature is higher than the maximum withstanding temperature of the instrument / diaphragm.

14.2 Piping standard shall be used for all installation where specified in job specification. For rating upto 600 #, the connection to the transmitters shall be with a male connector and tubing 1/2" OD. For rating higher than 600 #, no tubing shall be used. The connection to the transmitters shall be with 1/2" piping with flanges in between. For piping standard, all pipes shall be 1/2" NB unless higher sizes required to meet the requirements, with all fittings suitable for the piping. All the joints shall be welded or flanged as required. For instrument end connection i.e root valve of orifices and other items, level gauges vent and drain connection, seal welding shall be provided. For non-diaphragm seal instruments and instruments where provided with threaded connection, no welding is required at instrument end.

14.3 Tubing standard shall be used upto 600 # only where the same is required as per job specification. For rating above 600 # and hydrogen/lethal service, only piping standard shall be used. The tubing shall be 1/2" OD tube with all fittings suitable for the same. Valves used shall be threaded. At the first isolation / root valve end suitable pipe tag to tubing conversion fittings shall be used. For remote installation suitable unions / couplings shall be used.

14.4 Based on above guideline, contractor shall prepare, develop installation standards and indicate bill of material for each installation.

14.5 Steam, tracing of all instruments shall be considered on steam traced Process lines as per P&ID and other documents. For steam tracing of instruments copper tube & brass fittings shall be used. Tube fittings shall be double ferrule type. For each instruments steam trace bore shall be provided with steam trap duly connected to plant.

14.6 Use of standpipe for level instruments shall be as per job specifications. The representation on the P&IDs for level instrument connections is schematic only.

14.7 Standpipe shall always be taken from the side.

14.8 **Installation of Systems (DCS, PLC, Analysers etc.)**

14.8.1 The system shall be installed by the system vendor who would be responsible for installation and termination of interconnecting cables in the system racks / cabinets.

Refer to standard specification of DCS 6-52-0055 for detailed requirements. All interconnecting cables shall be identified and the individual cores/wires shall be properly identified using ferrules. Direct-cross ferruling method shall be used for identification.

14.8.2 All system communication cables shall be layed in covered GI (galvanized iron) trays away from power cables. Prefabricated cables shall be avoided for interconnection if these are to be routed out side the cabinets. If unavoidable these should be layed in covered GI trays.

14.8.3 All panels/cabinets shall be properly levelled and secured firmly with the base supporting structure. However, the consoles and printer stands need not be secured to base structure.

14.8.4 **Grounding**

a) Each cabinet, console and other equipment supplied as a part of system shall have earthling lugs, which shall be secured to the 'AC mains earthing bus'.

b) All circuit grounds, shields and drain wires shall be connected to the 'system ground' bus, which is isolated from 'AC mains earth'. This bus shall typically be 25 mm wide and 6 mm thick of copper.
The total resistance of system ground shall be less than 5 Ÿ unless otherwise recommended by system manufacturer.

c) Safety barriers, if used, shall be secured to 'Safety ground', which shall have typically ground resistance of less than 1 Ÿ. The bus shall be designed considering a fault level of 0.5 A at 250 V r.m.s. per barrier.

14.8.5 All other installation guidelines as recommended by system manufacturer shall be followed.

15.0 SITE TESTING AND CALIBRATION

15.1 All impulse lines shall be tested hydrostatically at 1.5 times the maximum operating pressure. Ensure that instrument and vessel/piping is isolated during this test.

15.2 Incase of special instruments/items where hydro testing is not permitted due to service conditions, the impulse lines testing shall be carried out by using air or nitrogen.

15.3 All external cage type level instruments shall be tested upto 1.5 times operating pressure by using nitrogen only.

15.4 After pressure testing, all these impulse lines shall be drained and dried with dry air to remove any traces of moisture, oil and dust.

15.5 Instrument airlines shall be duly tested for any leak after pressurizing and isolating the main root valve by soap solution. After isolation, the rate of fall in pressure shall be less than 1 kPa for every 4.4 metre (1 psi for each 100 feet) of copper tubing for a test period of 2 minutes.

15.6 Pneumatic signal tubes shall be flushed and tested with instrument air for any leak at a pressure of 1.5 kg/cm2g. After pressurizing the line, the source of pressure is cut off and rate of fall in pressure shall be less than 1 kPa for every 4.4 metre (1 psi for each 100 feet) of tubing for a period of 2 minutes.

15.7 All instrument cables shall be tested for continuity and insulation. While meggering the

cables for insulation testing, ensure that all instruments and barriers are isolated at both ends.

15.8 All instruments supplied by the vendor shall be calibrated using proper test equipment.

15.9 All instruments shall be calibrated for 0%, 25%, 50%, 75%, 100% and vice versa.

15.10 All temperature gauges shall be calibrated using temperature baths.

15.11 All thermocouple activated instruments shall be calibrated by generating millivolts by a potentiometer.

15.12 All transmitters shall be calibrated as per instrument ranges.

15.13 All displacer type level transmitters shall be calibrated with water or suitable fluids and corrected for specific gravity.

15.14 All alarm and trip switches shall be calibrated over the entire range and finally set and checked for alarm/trip points and reset points as per the alarm/trip set point schedule. After setting, these shall be sealed.

15.15 All control valves, prior to stroke checking, shall be externally cleaned thoroughly. The full stroke of valve shall be checked for opening and closing. Any adjustment required for obtaining full stroke and reducing hysteresis shall be carried out. The hysterisis shall not be more than 1% URV (upper range value) with positioners and 5% URV without positioners.

15.16 Bubble tight shut-off control valves and shut down valves shall be checked for seat leak test and gland leak test.

15.17 Solenoid valve shall be checked functionally for its operation.

15.18 Safety valves and relief valves shall be set/tested by using dry air/nitrogen. Leakage if any shall be removed by proper lapping of seat and disc.

15.19 All electronic/pneumatic receiver instruments shall be calibrated as per the manufacturer's instructions. Controllers shall be aligned properly.

15.20 All special instruments like analyzer shall be checked and calibrated as per manufacturer's instructions. Prior to testing, all analyzer sample lines shall be thoroughly cleaned by carbon tetra chloride or any other cleaning liquid. After cleaning, these lines shall be thoroughly purged with dry nitrogen.

15.21 No oil should be used in oxygen and chlorine service lines.

15.22 The accuracy of overall loop shall be within 1% for electronic and 1.5% for pneumatic loops.

15.23 After performing the calibration of all instruments, the entire loop shall be checked for proper operation.

15.24 The entire shutdown scheme shall be simulated from the process trip switches and the scheme shall be tested for its proper operation prior to start up of the unit.

15.25 If no instrument air is available vendor shall provide necessary nitrogen cylinders to carry out the above activity.

15.26 **Testing of Systems**

15.26.1 All the system functions shall be checked thoroughly for proper functioning. These shall include but not limited to the following tests:

a) Visual and mechanical.
b) Complete system configuration loading.
c) Demonstration of all system functions.

d) Checking of all systems displays.
e) Checking of correct functioning of all keyboards.
f) Demonstration of all system diagnostics.
g) Checking of proper functioning of all printers, hardcopy unit, and printing of all reports.
h) Checking of all disc drives.
i) Complete checking of logic system, loading of user's program and checkout of results.
j) Checking of correct change-over of the back-up/redundant units in case of failure of main units.

15.26.2 The input signals shall be simulated by disconnecting the field wires for all inputs. Wherever control room mounted Transmitters/Converters/Receiver switches are used, the functioning of same shall also be checked.

15.26.3 Requirements of para 15.26 shall be read in conjuction with 6-52-0055.

15.27 **Loop Checking**

15.27.1 Contractor is totally responsible for all work related to loop checking including cable laying, dressing, identification, ferruling, calibrations, loop testing in coordination with Control system vendor.

15.27.2 The procedure outlined in Section 3.4 Part II of 6-52-0055 (testing, installation, commissioning and acceptance of DCS system) shall be followed for loop checking. However the division of scope of work related to loop checking between various sub contractors shall be decided by contractor.

15.27.3 Before proceeding for loop checking the calibration results of individual elements shall be recorded on the contractor supplied proforma which shall be approved by owner for correctness of installation/ measurements and calibration results.

15.27.4 For calibration of special instruments and loop checking and for loop checking of sub vendor packages contractor shall do necessary coordination with sub supplied. The contractor shall carryout the necessary loop checking to the satisfaction of Purchaser/purchaser's representative which shall be part of contractor's scope of work.

a) For special instruments like analysers the contractor shall ensure the presence of supplier's, technical personnel during field testing/ loop checking and during commissioning to assist above activities.
b) Loop testing for all control loops shall be generally by simulating process conditions for at least 0%, 25%, 50%, 75% & 100% full scale inputs. Detailed procedure shall be submitted to Purchaser/purchaser's representative for approval before proceeding with loop checking.
c) In case of shut down systems, field/receiver switches are simulated for abnormality by disconnecting the wires at terminals. Function of all associated systems are
checked including performance of solenoid valves, on/off control/ shut down valves including proper functioning of limit switches and other accessories. Adjustments of limit switch wherever necessary also from part of checking of loop performance.
d) Performance of individual loops shall be accepted for an overall accuracy of $\pm$ 1.0%. Where deviation is found to exist more than specified limit bidden shall re

calibrate the instruments which shall also form part of loop testing at no extra cost, time implications.

e) Contractor shall complete all the entries in the loop sheet related to field instrumentation as well as the control system side with acceptance of loops and hand over the sheets to owner for final acceptance.

16.0 **COMMISSIONING**

16.1 This activity shall be carried out in a systematic manner so as to avoid any accident to plant and operating personnel.

16.2 During the plant start up all the instruments calibration, controller alignment, trip point settings shall be trimmed so as to meet the operation requirements.

16.3 Prior to guarantee run of any unit, the vital instruments as required by vendor have to be recalibrated and the results recorded.

16.4 As built drawings shall be prepared after installation and commissioning is over.

17.0 **TRAINING**

Unless specified otherwise the following shall be provided by contractor for system training for owner.

Contractor shall arrange training for Owner's personnel. Different type of courses shall be offered for operation/ process engineers and operators, instrument maintenance engineers and technician. Contractor shall indicate a detailed proposal for training in the offer. Travel and living expenses of the owner's personnels shall be borne by the Owner. Apart from the hardware and software maintenance training and site training as specified in 6-52-0055, contractor shall also offer operation training basically meant for operating personnel. The various facilities available in the system for operation, actions required during emergencies and identifying the various diagnostic messages shall be main contents of the operation training.

Hardware and Software maintenance training - At system vendor's works.

Operation Training - At system vendor's works

Site Training - Operation and maintenance

18.0 **POST WARRANTY MAINTENANCE FOR SYSTEMS**

18.1 The requirement of post warranty maintenance for all system oriented items shall be as follows;

a) In the event of any malfunction of the system hardware/ system software, experienced service engineer shall be made available at site within 24 hours on the receipt of such information from owner.

b) The contract shall include detailed proposal related to supply of maintenance spares, tools and tackles as required, travel, boarding and lodging of service
engineer to site on short notice.

c) EPCC contractor after completion of warranty shall transfer the contract of system vendor to owner for direct interaction between owner and system vendor.

d) The services under Post Warranty Maintenance Contract including supply of spare parts and services shall broadly encompass the following:

- **Periodic Maintenance**

  Site visits, minimum four-six times in a year, inspection of general healthiness of the system, study and advice on daily maintenance, inspection of hardware and software, if any problem is reported, running of test programmes, on-line servicing and solving reported problems. Checks shall be conducted on running system i.e (a) On-line sub-systems, (b) Power supply checks, (c) CRT, (d) printer, (e)Any Other vendor recommended service. Complete scope of work involved under each category must be outlined by the system vendor.

- **Preventive Maintenance**

  Once in a year, involving complete overhaul of the system, inspection of hardware and software, fault prediction, inspection of power supply quality, environmental and operating condition checks, calibration checks, major repairs/replacements and detailed reporting.

- **Software maintenance**

  Maintain existing software to improve and utilize existing application and improve performance of the system. Minor modification of the software shall also be covered under this scope.

- **Emergency Service**

  Any failure shall be on system suppliers account. The Engineer must report at site within 24 hours of report of failure, with necessary spares. The system must be brought back within 24 hours after reporting at site.

- **Software Updates**

  All future updates on the system hardware/software supplied shall be made available to the owner as and when available. The installation charges as applicable shall be included.

19.0 LIST OF DOCUMENTS ATTACHED

- All necessary documents attached

GAIL INDIA LIMITED

STANDARD SPECIFICATION

FOR

GAS DETECTION SYSTEM (LEL/H2S)

GAIL-STD-IN-DOC-TS-004

0	17.01.2019	Issued for Bid	RKS	UNU	UNU	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

CONTENTS

1.0 GENERAL

1.1 Scope

1.1.1 This specification, together with the data sheets attached herewith, describes the requirements for the design, manufacture, inspection and testing and supply of the complete Gas Detection System including all detectors, monitors, control panel duly wired and any other hardware as necessary, for installation in Hydrocarbon Plant. The risk is from Hydrogen gas and/or Hydrogen sulfide. The intent of this specification is to show the minimum equipment required and establish a level of quality. All the items required for proper operation of the complete system shall be furnished by the vendor, even though not specifically called for in this specification.

1.1.2 The cabling between detectors and the panel shall be supplied and installed by Purchaser. Specification of all such cables shall be furnished by vendor along with the bid.

1.1.3 The related standards referred to herein and mentioned below shall be of the latest editions prior to the date of purchaser's enquiry:-

IEC-79	Electrical Apparatus for Explosive Gas Atmosphere
IEC-529	Classification of degree of protection provided by Enclosures.
IEC-801	Electromagnetic compatibility for Industrial Process Measurement and Control Equipment.
DIN-50049	Document on Material Testing
IS-2147	Degree of protection provided by Enclosures for low voltage switch gears and control gears.
IS-2146	Flame proof Enclosures of Electrical Apparatus
BS EN-50054	Electrical Apparatus for the Detection and Measurement of Combustible Gases - General Requirements and Test Methods.
BS EN-50057	Performance Requirements for Group I1 Apparatus Indicating upto 100% LEL.
API RP-55	American Petroleum Institute Conducting Oil and Gas Producing & Gas Processing Plant Operations Involving Hydrogen sulphide.

1.1.4 In the event of any conflict between this specification, related standards, codes etc. the vendor should refer the matter to the purchaser for clarification and only after obtaining the same, should proceed with the manufacture of the item in question. In case of conflict between standard specification and job specification, the latter shall prevail.

1.2 Bids

1.2.1 Information to be supplied with the Bid:-

i) Specifications and detailed catalogue information for each instrument/accessory.

ii) List of users for system and detectors with details of plants where i

iii) Suggested front view of panel.
iv) Make and model nos. of each type of instrument for each item.
v) Ambient temperature limitations while system is in storage and installation.
vi) Power consumption of total system.
vii) Approximate time between successive sensor calibration.

1.2.2 Vendor shall quote spare parts for two years operation and commissioning along with offer.
1.2.3 Vendor shall also quote unit price for addition/deletion of hydrocarbon/hydrogen sulfide gas detectors, monitors/controllers etc.
1.2.4 Vendor shall also provide man-day rates for site assistance.
1.2.5 Vendor shall indicate clearly in his quotation the deviations, alternates and exceptions, if any, from this specification. Vendor shall provide reasons for these deviations.
1.2.6 All the units of measurement for various items in the vendor's specification sheets shall be the same as those in purchaser's data sheets.
1.2.7 All the material specifications for various parts in the vendor's specification sheets shall be to the same standards as those in purchaser's data sheets.
1.2.8 A copy of the certificate of intrinsic safety for field mounted instruments from statutory bodies like BASEEFA, CENELEC, FM, PTB, CMRI etc. shall be submitted, wherever applicable.

1.3 Drawings and Data

1.3.1 Detailed drawings, data, catalogues and manuals required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of reproducible and prints should be dispatched to the address mentioned, adhering to the time limits indicated.
1.3.2 Vendor shall provide test certificates for all the tests indicated in para 4.0 of this specification. In addition, vendor shall provide the 'Manufacturer's certificate of conformity to purchaser's specifications' as per clause 2.2 of DIN-50049.

2.0 DESIGN AND CONSTRUCTION

2.1 The vendor's scope of supply shall include, but not limited to the following equipment, unless otherwise specified in the data sheets:-
a) Field mounted gas detectors.
b) Monitors/Controllers for gas detectors.
c) Portable purge calibrator(s) for the gas detection system.
d) Portable gas detectors.
e) Gas-detector panel (completely wired) housing the monitors, alarm-annunciator, switches and relays etc. for carrying out the necessary monitoring and shutdown functions.
f) Data logger for logging and report generation.
g) Other items not listed here, but required to make the system operational.

2.2 Gas detection system shall be designed based on fail safe philosophy.
2.3 Functional requirements of the system are defined in the job specifications. Vendor shall provide necessary hardware to achieve these requirements. Output contacts going out of panel shall be potential free SPDT contacts with 110 V dc 0.5 **A** / 230 V ac 5.0 A ratings.
2.4 For shutdown functions, Bypass switch for hydrocarbon gas detection /hydrogen sulfide detection system shall be provided, whenever specified. Red light shall be provided on panel for each Bypass to indicate the bypass mode.
2.5 The design of electronic instruments shall be in compliance with the electromagnetic compatibility requirements as per 'IEC-801'.
Construction and performance of gas detection system shall be in general as per following applicable standards: -

Hydrocarbon: BS EN - 50054 and 50057
Hydrogen sulfide: API **RP** 55

2.7 Gas Sensors (Hydrocarbon)

2.7.1 Type: Poison resistant Catalytic diffusion1 or infra-red type for combustible gas or vapours (Non selective) as per job specifications.
Construction: Flameproof, 316 SS Body with dust cover/weather protection for outdoor location. Sensor element shall be plug in type. Terminal box shall be provided for further cabling. Flying leads are not acceptable. Cable entry shall be 3/4" NPTF. Catalytic type detector shall incorporate a plug-in type sensor and stainless steel flame arrestor.
2.7.3 Range: 0-100% LEL

2.8 Gas Sensors (Hydrogen sulphide)

Gas Monitors/Controllers

2.8.1 Type: Solid state semiconductor/ electrochemical cell.
2.8.2 Construction: Flameproof, 316 SS Body with stainless steel flame arrestor/dust cover/weather protection for outdoor location. Sensor element shall be plug in type. Terminal box shall be provided for further cabling. Flying leads are not acceptable. Cable entry shall be 3/4" NPTF.
2.8.3 Range: 0- 100 ppm

2.9 Gas Monitors/Controllers

2.9.1 Type: Solid state electronic, panel mounted plug in modular construction.
2.9.2 No. of channels: Maximum 16 sensors with common indicating meter. However single loop integrity shall be maintained by one monitoring card per sensor.

2.9.3 Power Supply: As indicated in data sheet. Monitor/controller shall supply power to sensor.
2.9.4 Range and Meter: 0-100 % LEL for Hydrocarbon

Calibration	0- 100 % ppm for Hydrogen sulfide.
2.9.5 Indicator lights: (Separate for each channel)	Power on 30% LEL or 20 ppm - alarm level high 60% LEL or 50 ppm - alarm level very high Malfunction (Malfunction shall include short circuit, line breaking, over range and earth fault)
2.9.6 Other features:	Dual adjustable set points for gas level alarm. SPDT latching type relay contacts shall be provided for following:- a) 30% LEL/20 ppm (each channel) - alarm level high b) 60% LEL/5Oppm (each channel) - alarm level very high c) Malfunction (common) Common reset push button. Calibration/test switch to allow for sensor calibration without alarm outputs.

2.10 Data logger

2.10.1 Data logger shall be supplied complete with a dedicated printer and necessary software to:

a) Store and print out all analog data and alarms.

b) Generate reports like daily alarm report, faulty detector report, on-demand reports etc.

c) Alarm and event printing.

2.10.2 Type: Microprocessor based, rack mounted and modular in construction.

2.10.3 No. of channels: As per detectors indicated in data sheets. Number of inputs to data logger per detector shall be;

a) Analog input corresponding to LEL/H2S level.

b) High and High-High level.

c) Gas monitor / controller fault alarm.

However, the number of inputs per Input module shall not exceed 16.

2.10.4 Scantime	100 mSec. for alarm inputs. 500 mSec. for analogue inputs.
2.10.5 Printer	Serial dot-Matrix printer to print out alarms and reports
2.10.6 Programming Terminal	One number to configure, programme modifications, reconfiguration, add/ delete inputs, compile new reports etc.
2.10.7 Diagnostic alarms	LED indication on each 110 module and process.

2.10.8 Software features	a) Data-acquisition, manipulation and print-out. b) Printing of alarm and events. c) Diagnostic softwares and print-out of diagnostic alarms. d) On-demand reports for high1 high-high1 fault alarms. e) Daily reports for high/ high-high1 fault alarms and Gas concentration levels. f) Faulty detector report.

2.11 Portable Calibrator

2.11.1 Two portable purge calibrators (one for Hydrocarbon and one for H2S) each consisting of a volume bottle containing a known gas/air mixture, a pressure regulator, a flexible hose and adapter cap (to fit the sensing head) shall be supplied to enable calibration of the sensors in the field without dismantling them.

2.11.2 Calibration range for all sensors will be 0-100% LEL/0-100 ppm for Hydrocarbon/ Hydrogen sulfide.

2.11.3 Sufficient quantity of calibration gas shall be supplied to enable calibration of all sensing heads at least twice.

2.12 Portable Gas Detectors

2.12.1 The portable gas detectors shall be supplied complete with its controller, audio-visual alarm and shall be suitable (preferably intrinsically safe) for use in hazardous area specified. Such units shall be certified by BASEEFA, CENELEC, FM, PTB, CMRI etc. These units shall be supplied with rechargeable batteries and 240 V, 50 Hz ac battery charger. Sufficient number of battery charger/number of points per charge shall be provided based on quantity of such portable units. These units shall be supplied complete with its accessories like carrying case, maintenance kit, calibration kit etc.

2.13 Gas Detection Panel

2.13.1 The panel shall be designed to house the following instruments/accessories.

i) Monitors/controllers for Hydrocarbon gas detectors.

ii) Monitors/controllers for Hydrogen sulfide gas detectors.

iii) Alarm annunciator

iv) Semi graphic

v) Relays/logic cards for shutdown/protection system.

vi) Pushbuttons/Switches as required (including lamp test Pushbuttons)

vii) Any other items which are not listed above but essential to make the system operational and to meet requirements specified in job specification.

Hydrogen sulfide gas monitors shall be segregated from Hydrocarbon gas monitors.

The panel shall be provided with 5 % installed spare (minimum one number) for items like monitors/controllers, relays/logic cards etc. Alarm annunciator shall have 10 % spare points.

2.13.2 Panel Construction

2.13.2.1 Panel Enclosure

The panel shall be of free-standing, self-supporting cubicle type, fully enclosed construction and shall be formed out of cold rolled carbon steel plate of minimum thickness 3mm for front sheet and 2 mm for other sides and door. Panel shall be designed to allow for 10 percent expansion for future changes without involving any major modification in the system. When specified, the panel shall be matched with the other panels to be supplied by other vendors.

The plate shall be cut on squaring shear to ensure tight flush joints when butted together. All sharp edges and corners shall be rounded off to protect personnel. The final assembly shall be free of warps, buckles, dents or blemishes. In order to reduce the loading on the panel face, channel or equivalent support shall be run horizontally beneath the instrument cases/shelves to provide rear support. The finalized panel frame work shall be of sufficient strength to allow transportation and lifting by a crane, with all instrumentation installed, without causing bukling or deflection. Each panel section shall have four (4) removable lifting lugs at the top to facilitate handling.

The enclosure shall have access by means of doors on the rear side. Hinges shall be formed in the enclosure to ensure that the doors fit tightly all around. Door latches shall be the flush-mounted, 3 point type with recessed chrome plated handles. An installed clearance will be maintained inside the panels to allow for door opening and access to equipment.

The enclosure and its internal equipment arrangement shall be designed to provide adequate cooling of panel instrumentation by natural convection alone. Louvers shall be provided on the enclosure for air circulation purposes. Panel may be of welded or bolted construction. In case of bolted construction, it must be ensured that bolt-heads don't project out of panel. In addition, all bolted joints must be properly tightened and locked to ensure a sturdy panel construction.

2.13.2.2 Welding

All sheet and structural steel shall be vapour degreased after shearing, cutting, and forming prior to welding. In case of panel with welded construction, welds shall be continuous on the pieces being joined; spot welding is not acceptable.

Proper precautions shall be taken to prevent material warpage during the welding process. All welded surfaces shall be throughly brushed, chipped and ground to provide a clean, smooth surface.

2.13.2.3 Painting

The entire steel structure is to be sandblasted, phosphatized and painted with two coats of sealing primer and surface finish. The final finish shall be three coats of non-glossy

paint, colour as specified in Job Data Sheets. The fabricator shall supply separately one (1) litre of paint, for touch work on installation.

2.13.2.4 Cutouts
Panel cutout sizes, instrument supports and panel reinforcements shall be strictly in accordance with the instrument manufacturer's recommendations. Cutouts shall not be made with flame producing devices.

2.13.2.5 Equipment Mounting
Gas Monitors/Controllers:
The front of panel mounted Gas Monitors/Controllers shall be installed in mating cases or mounting trays as recommended and supplied by the manufacturer for panel mounting. All wiring to these controllers shall be terminated on terminal blocks and/or multi-pin connectors provided as an integral part of the case. Routine calibration adjustments shall be accessible from the front of the panel, without having to remove any wiring or causing loss of the instrument function. In addition, total removal of the instrument and replacement with a spare shall be possible from the front of the panel.

2.13.2.6 Auxiliary Equipment:
All rear of panel equipment (terminal blocks, auxiliary relays or solid state logic cards etc.) shall be physically located off the exterior walls of the panel by means of suitable mounting brackets/plates welded to the wall prior to finishing the painting. Drilling and tapping on side walls of the enclosure for mounting internal equipment is prohibited. The auxiliary equipment shall be located and arranged for easy access for calibration and maintenance.
It shall not be necessary to remove any item in order to gain access to check or remove any other item. All cable runs shall be grouped, routed and secured to provide a neat appearance and prevent interference with the operation and maintenance of auxiliary equipment. Auxiliary relays, if used, shall be plug-in, enclosed type.

2.13.2.7 Electrical Construction
Code Compliance
The installed electrical equipment component parts and associated wiring in the panel shall be in accordance with the practices outlined in the National Electric Code, latest edition, for non-hazardous area.
Panel Wiring:
The vendor shall supply all wire required for panel internal wiring. Interconnecting wires shall be standard copper conductor, with 600 volt rated fire retardant PVC insulation.
Minimum size shall be 1.0 mrn2 except for power wiring which shall be 1.5 rnm2. The size and type of wires shall be confirmed by vendor. Each wire shall be distinctly colour coded or tagged at both ends with full ring type labels, colour coding/tagging corresponding to that used on panel schematic drawings.

The panel shall be designed for field wiring entry from the bottom. Vendor shall provide removable gland plate for this purpose.

2.13.2.8 Terminals

No more than two (2) wires shall be installed on same terminal of any electrical device. Terminal blocks shall be of heavy duty nylon, 600 volt rated and break resistant. Terminal strips shall be spring loaded, screw locked, stacking type with all terminals clearly labelled. Terminal strips shall be mounted on suitable anodized metallic stand off. A minimum of 10 % spare shall be provided.

2.13.2.9 Grounding

A separate signal ground shall be provided for circuit ground of instruments, drain wires of signal cable shields etc. All gas detector circuits shall be grounded as per manufacturer's recommendations and good engineering practice. For signal ground a grounding bus bar 25 mm wide x 6 mm thick of copper material (insulated from panel structure) shall be provided, which shall run the entire panel length near floor level. The bus bar shall be provided with grounding terminals at either end. Terminals shall be compression type suitable for 4/0 AWG copper ground cable.

All instrument cases and housing capable of carrying current shall be grounded to panel structure. The panel structure shall be provided with earthing lugs for eventual connection to electrical safety earth.

2.13.2.10 Power Supply and Distribution

The main power supply feeder to the panel shall be protected by a suitably sized circuit breaker with manual trip lever. The breaker shall be housed in a suitable surface-mount enclosure.

Power distribution to controllers and associated group of auxiliary relay or solid state logic circuits shall be via fused terminals.

2.13.2.11 Lighting

Internal lighting shall be installed within the panel to provide adequate lighting for maintenance of equipment. The location of lighting fixtures must not interfere with doors or other equipment which must be accessible and space shall be maintained for bulb replacement. A control switch in a suitable surface-mount enclosure shall be provided for lighting the inside of the panel near the door.

The power supply shall be protected by a suitably sized fuse. The vendor shall maintain separation in his panel design between the ac circuit wiring and all other dc circuits.

2.13.3 Alarm Annunciator

2.13.3.1 Alarm annunciator shall be provided at top of panel to display group alarms, shutdown alarms etc. as indicated in job specification. In addition following system alarms shall be provided: -
- Malfunction in Hydrocarbon gas detection system.
- Malfunction in Hydrogen sulfide gas detection system.

2.13.3.2 Alarm annunciator shall be solid state electronic type provided with single input type logic module and solid state audio alarm unit. It shall be provided with first out type sequence (ISA F3A) with function test, acknowledge and reset push buttons. Each window shall be of 75 mm x 50 mm size and provided with two lamps. Lamps shall be removable from panel front.

2.13.3.3 No alarm/ shutdown contacts shall be derived from alarm annunciator unit.

2.14 **Interface with Distributed Control System (DCS)**

2.14.1 Unless otherwise specified, isolated hardwired contacts1 analogue signal shall be provided from each monitor1 controller for purchaser's distributed control system. Contact multiplication, if required, shall be carried out using electromagnetic relays.

2.14.2 Whenever serial interfacing is specified in the job specifications, the gas detection system shall provide serial RS232C output with 'MODBUS' protocol.

3.0 NAMEPLATE

Name plates shall be constructed of black laminated plastic plates with engraved lettering and securely fastened with 316 SS screws. One screw hole for each name plate shall be elongated to provide for expansion and contraction of the name plate.

The name plates shall be mounted below the controllers, identifying the location of their respective sensors. If a multi channel controller is used, each sensor shall be tagged on the name plate using the corresponding point number.

Front panel-mounted control switches shall also be tagged. Name plates shall be located directly below the corresponding switch with the size and lettering proportional to the front panel mounting dimensions of the device.

All front panel-mounted instruments shall also be identified with a metal or plastic name plate attached to the rear of the device and easily visible from the rear of the panel.

Tagging for these name plates shall be identical to that used in the panel front. All rear panel auxiliary equipment shall be similarly identified. The tagging for this equipment shall correspond to that used on the applicable schematic diagrams.

4.0 INSPECTION AND TESTING

4.1 Unless otherwise mentioned, purchaser reserves the right to test and inspect the equipment and its workmanship at the vendor's works.

4.2 The panel shall be completely tested at the vendor's shop, prior to shipment. The vendor shall notify to the purchaser one month in advance when the panel will be completed ready for inspection and testing.

Vendor shall submit the following test certificates and test reports for purchaser's review:-

a) Material test certificate with detailed chemical analysis (MIL certificate).
b) Performance test report of the gas detection system.
c) Calibration report of all gas sensors.
d) Certificate from a statutory body for intrinsic safety/flame proof and weather proof enclosures.
e) Manufacturer's certificate of conformity to purchaser's specifications as per clause 2.2 of DIN 50049.
Sufficient time, ample space and necessary assistance shall be provided by the vendor to assure that inspection and witnessing of all testing may be performed to the satisfaction of the purchaser.

4.3 **Witness Inspection**
4.3.1 Testing shall consist of but not limited to, the following:-
1) Checking of all power wiring for continuity.
2) Checking of all control wiring for continuity and polarity.
3) Calibration and testing of all gas sensors. Each sensor/detector shall be tested by activating it with the sample it will be monitoring in order to ensure that the sensor is operational. Shutdown and alarm functions shall be simulated and checked as per the logic.
4) Functional checking of all sensors in conjunction with controllers, data loggers and alarm annunciator.
5) Review of all certificates and test reports as indicated in para 4.2 of this specification.
In the event of not witnessed by purchaser, the tests shall anyway be completed be completed by the vendor and documents for same submitted for scrutiny. Waiver by the purchaser of its right to witness tests and/or final inspection shall in no way relieve the vendor of his warranty.

5.0 SHIPPING
5.1 After initial acceptance of the panel at the vendor's shop by the purchaser, the sensors and all panel components which the vendor considers liable to be damaged during shipment or storage, shall be packaged for separate shipment. If instruments are removed from the panel, they and their connections shall be suitably tagged to ensure simple re-installation at the job site. Each instrument shall be sealed in plastic bags containing moisture absorbing desiccant.
5.2 Spare parts shall be packaged separately and clearly marked as "Spare Parts".

6.0 REJECTION
6.1 Vendor shall make his offer in detail, with respect to every item of the purchaser's specification. Any offer not conforming to this shall be summarily rejected.

GAIL INDIA LIMITED

STANDARD SPECIFICATION

FOR

DIFFERENTIAL PRESSURE GAUGES, VACUUM GAUGES AND PRESSURE GAUGES

GAIL-STD-IN-DOC-TS-005

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CONTENTS

1.0 GENERAL

1.1 Scope

1.1.1 This specification, together with the data sheets attached herewith covers the requirements for the design, materials, nameplate marking, and inspection, testing and shipping of pressure, differential pressure and vacuum gauges.

1.1.2 The related standards referred to herein and mentioned below shall be of the latest editions prior to the date of the purchaser's enquiry:

ANSI/ASME- American National Standards Institution/American Society of Mechanical Engineers.

B 1.20.1	-	Pipe Threads General Purpose (Inch)
B 16.5	-	Pipe Flanges and Flanged Fittings NPS'A through NPS24
B 16.20	-	Metallic Gaskets for Pipe Flanges, Ring Joint, Spiral wound and Jacketed.
EN10204	-	Inspection Documents for Metallic Products
IEC-60529	-	Degree of Protection Provided by Enclosures (IP Code)
IS-13947	-	Specification for Low Voltage Switchgears and Control gears.
IS-3624	-	Specification for Pressure and Vacuum Gauges.

1.1.3 In the event of any conflict between this standard specifications, data sheets, statutory regulations, related standards, codes etc., the following order of priority shall govern:

a) Statutory Regulations
b) Datasheets
c) Standard Specification
d) Codes and Standards

1.1.4 In addition to compliance to purchaser's specifications in totality, vendor's extent of responsibility shall include the following:

a) Purchaser's data sheets specify the type of pressure element. Unless specifically indicated otherwise, alternate type of pressure elements shall also be acceptable provided all the functional and performance requirements specified in the respective data sheets are guaranteed by the vendor.

b) Purchaser's data sheets indicate the minimum acceptable material of construction for pressure element, movement etc. Alternate superior material of construction shall also be acceptable provided vendor assumes complete responsibility for the selected materials for their compatibility with the specified fluid and its operating conditions.

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to vendor attached with the material requisition.

1.2.2 Whenever a detailed technical offer is required, vendor's quotation shall include the following:

a) Compliance to the specifications.

b) Whenever the requirement of a detailed specification sheet for each item is specifically indicated, the specification sheet shall provide information regarding type, construction, materials, range, accuracy, overpressure/vacuum withstand capability etc., of the gauge and its accessories. The material specifications and units of measurement indicated in the specification sheets shall be to the same standards as those in purchaser's data sheet.

c) Proven references for each offered model in line with clause 1.2.3 of this specification whenever specifically indicated in purchaser's specifications.

d) Deviations on technical requirements shall not be entertained. In case vendor has any valid technical reason to deviate, they must include a list of deviations tag number wise, summing up all the deviations from the purchaser's data sheets and other technical specification along with the technical reasons for each of these deviations.

e) Catalogues giving detailed technical specifications, model decoding details and other information for each type of gauges covered in the bid.

1.2.3 All items, as offered, shall be field proven and should have been operating satisfactorily individually for a period of minimum 4000 hours on the bid due date in the process conditions similar to those as specified in the purchaser's data sheet. Items with proto-type design or items not meeting proven ness criteria specified above shall not be offered.

1.2.4 All documentation submitted by the vendor including their quotation, catalogues, drawings, installation, operation and maintenance manuals etc. shall be in English language only.

1.2.5 Vendor shall quote for two years' operational spares for each gauge and its accessories, which shall include movement, pointer, glass cover plate, accessories like over-range protector/pulsation dampener etc. as a minimum.

1.3 Drawing and Data

1.3.1 Detailed drawings, data, catalogues and manuals required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of reproducible, prints and soft copies shall be dispatched to the address mentioned, adhering to the time limits indicated.

1.3.2 Final documentation consisting of design data, installation manual, operation and maintenance manual etc., submitted by the vendor after placement of purchase, order shall include the following, as a minimum:

a) Specification sheet for each gauges, and its accessories.

b) Certified drawings sheets for each gauges and its accessories, which shall provide dimensional details, internal constructional details, end connection details and materials of construction.
c) Copy of type test certificates.
d) Copy of the test certificates for all tests indicated in clause 4.0 of this specification.
e) Installation procedure for each gauge and its accessories.
f) Calibration and maintenance procedures including replacement of internal parts wherever applicable

2.0 DESIGN AND CONSTRUCTION

2.1 Pressure Elements, Gauge Movement and Socket

2.1.1 The pressure element shall be an elastic element like bourdon tube, bellow, diaphragm etc with material as specified in the data sheet.
2.1.2 In case of bourdon type of gauges, the size of the bourdon tube shall not be less than 75% of the nominal diameter of the dial size.
2.1.3 Gauge construction shall ensure no leakage of process fluid from the sensor elements to atmosphere and between the high pressure and low-pressure side (in case of differential pressure gauges) under normal condition.
2.1.4 The gauge socket shall be in one piece and shall also serve as element anchorage in case of bourdon tube type element, which shall be directly connected to the socket, without any capillary or tube in between. For other types of elements, the anchorage may be integral with the socket or connected with the socket using capillary tube with minimum bore of 3 millimetres.
2.1.5 Any joint in the process wetted system including joint between the element and the anchorage/socket shall be welded type only.
2.1.6 Unless specified otherwise, the pressure gauges shall have an over-range protection of at least 130% of maximum working pressure, as a minimum.
2.1.7 Data sheet indicates the minimum requirement of material of construction. Alternate materials as specified in Annexure 1 to this specification shall also be acceptable subject to meeting process conditions.
2.1.8 The gauge movement material shall be of stainless steel unless specified otherwise in the data sheet. It shall be adjustable for calibration without dismantling the sensor unit. The use of 'S' link for calibration of span is not permitted.
2.1.9 Vendor shall ensure that the operating pressure falls in the middle 30% of the full working range i.e. operating pressure shall fall between 35% and 65% of the range offered.
2.1.10 Pressure gauges with range as 0 to 100kg/cm2g and above shall have safety type solid front case.

2.1.11 All gauges in oxygen and chlorine service shall be thoroughly degreased using reagents like trichloro-ethylene or carbon tetrachloride. All connections shall be plugged after degreasing process in order to avoid entrance of grease or oil particles.

2.2 Cases and Dials

2.2.1 Unless specified otherwise, the gauges shall be weather proof to IP 55 as per IEC 60529 / IS 13947, as a minimum.

2.2.2 In general, dial markings and dial colour shall be as per IS 3624. Dials of gauges in oxygen service shall additionally have the word 'OXYGEN' or 'CHLORINE' written in black and 'USE NO OIL' written in red.

2.2.3 The gauge dial shall be made of a suitable metallic materials so that the finished dial shall be capable of withstanding a dry heat of 85°C for 10 hours and immersion in water-at 85°C for 1 hour without cracking, blistering, warping or discoloration of the dial or paint on the dial.

2.2.4 The pointer stops shall be provided at both ends of the scale to restrict the pointer motion beyond 5% above the maximum of scale and less than 5% below the minimum of the scale.

2.2.5 The dial cover shall be made out of shatter proof glass sheet of thickness 1.5 to 3mm for gauges with dial size less than 100mm while minimum 3.0mm for gauges with dial size 100mm or greater.

2.2.6 All gauges shall be provided with a blow out device i.e. blow out disc of aperture not less than 25mm for gauges with dial size 100mm and above, while 20mm for gauges with dial size less than 100mm.

2.2.7 When safety type solid front type gauges are specified, they shall consist of a solid partition isolating the pressure element from the dial. In such gauges the total solid partition disc area shall not be less than 75% of the cross sectional area of the inside of the case surrounding the pressure element.

2.3 Diaphragm Seals

2.3.1 Unless otherwise indicated in purchaser's data sheets, gauges specified with diaphragm seals shall have their diaphragms integral with the gauges.

2.3.2 Whenever diaphragm seal gauges are specified with capillary, the size of the capillary shall be selected to ensure response time of the gauge better than 5 seconds.

2.3.3 The sealing liquid for diaphragm seal gauges shall be an inert liquid, compatible with the process fluid and its temperature. For gauges in oxygen and chlorine service, the sealing liquid shall be fluro lube or equivalent compatible with the specified service.

2.3.4 For diaphragm seal pressure gauges with flanged ends, the diaphragm shall be rated for the maximum allowable pressure of the associated flange.

2.4 End Connection

2.4.1 Unless specified otherwise, the following shall govern;

a) Threaded end connections shall be NPT as per ANSI / ASME B. 1.20.1. b) Flanged end connection shall be as per ANSI / ASME B. 16.5

c) Ring joint flanges shall have octagonal grooves as per ANSI / ASME B16.20.

d) Flange face shall be as per clauses 6.4.4.1, 6.4.4.2 and 6.4.4.3 of ANSI / ASME B16.5. The face finish as specified in the data sheet shall be as follows;

125AARH	:	125 to 250 AARH
63 AARH	:	32 to 63 AARH

2.5 Performance Requirements

2.5.1 Unless otherwise specified, the accuracy which is inclusive of repeatability and hysteresis of pressure gauges / differential pressure gauges shall meet the following performance requirements:

a) Direct pressure gauge : ±1% of full scale
b) Chemical seal type pressure gauge : ±2% of full scale
c) Differential pressure gauges : ±2% of full scale

2.6 Accessories

2.6.1 Gauges shall be supplied with all accessories as specified in the data sheets pre-installed.

2.6.2 For flanged diaphragm seal gauges, spacer ring, isolation valve and plugs shall be provided whenever specified.

2.6.3 Over Range Protector (OPV)

a) Whenever the maximum pressure specified in the data sheet exceeds the over range protection pressure, over range protector shall be supplied.
b) In case of pressure gauges with diaphragm seal, the over-range protector shall be installed between the seal and the gauge.
c) The material of construction of over range protector shall be same as socket material, as a material.

2.6.4 Snubber

a) Whenever the service specified is pulsating type, snubber shall be supplied.
b) The material of construction of snubber shall be same as socket material, as a minimum.

3.0 NAME PLATE

3.1 Each gauge shall have a stainless steel nameplate attached firmly to it at a visible place either by riveting or screwed to the case, furnishing the following information:

a) Tag number as per purchaser's data sheets.
b) Vendor's name
c) Model number and manufacturer's serial number.
d) Range of the instrument.
e) MAWP and maximum vacuum rating of the element.

4.0 NSPECTION AND TESTING

4.1 Unless otherwise specified, purchaser reserves the right to test and inspect all the items at the vendor's works inline with the inspection test plan for pressure, differential pressure and vacuum gauges.

4.2 Vendor shall submit following test certificates and test reports for purchaser's review:

a) Material test report as per EN10204 clause 2.2 for wetted parts like gauge socket and sensing element and as per clause 3.IB for flanges and spacer rings of diaphragm seal type pressure gauges.
b) Type test report for enclosure.
c) Dimensional test report for all gauges.
d) Performance test reports for all gauges including accuracy, repeatability, over pressure and vacuum test (as applicable)
e) Type test reports for shock test and endurance test as per IS-3624 for each type /model.
f) Type test report for influence of temperature for each type/model.

4.3 Witness Inspection

4.3.1 All pressure, differential pressure and vacuum gauges shall be offered for pre dispatch inspection for following as a minimum:

a) Physical dimensions verification and workmanship.
b) Performance test including accuracy and repeatability, on representative samples of each type/model number before and after over-pressure and vacuum test.
c) Over-pressure and vacuum test (as applicable) shall be carried out on representative samples of each type / model number without loss of their elastic characteristics.
d) Review of all certificates and test reports as indicated in clause 4.2 of this specification.

4.3.2 In the event when the witness inspection is not carried out by purchaser, vendor shall anyway complete the tests and the test documents for the same shall be submitted to purchaser for scrutiny.

5.0 SHIPPING

5.1 All threaded and flanged openings shall be suitably protected to prevent entry of foreign material.

5.2 All pressure gauges in oxygen and chlorine service shall be separately packed along with a certificate indicating 'SUITABLE FOR OXYGEN/CHLORINE SERVICE', as applicable.

5.3 Proper care shall be taken in shipping gauges with diaphragm seals to ensure safety of the diaphragm seals, extensions, capillaries, where specified, shall also be suitably protected.

6.0 REJECTION

6.1 Vendor shall prepare their offer strictly as per clause 1.2 of this specification and shall attach only those documents and information which is specifically indicated in the material requisition.

6.2 Any offer not conforming to above requirements, shall be summarily rejected.

ANNEXURE – 1

MATERIAL OF CONSTRUCTION

SL. No.	Item	Specified Material of Construction	Alternate Material of Construction
1.	Sensing Element	SS316	SS316L, SS316Ti
2.	Socket	SS316	SS316L, SS316Ti
		SS304	SS304L, SS316
3.	Case	Cast Aluminium	SS316Ti, SS316L,SS
4.	Capillary	SS	SS304, SS316, SS304L, SS316L, SS316Ti
5.	Diaphragm	SS316	SS316L, SS316Ti
		SS	SS 302, SS 304, SS 304L, SS316, SS316L, SS316Ti

GAIL INDIA LIMITED

STANDARD SPECIFICATION

FOR

SELF ACTUATED CONTROL VALVES/REGULATORS

GAIL-STD-IN-DOC-TS-006

0	18.01.2019	Issued for Bid	RKS	UNU	UNU	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Abbreviations:

AARH	Arithmetic Average Root Height
C_v	Valve Coefficient
NPS	Nominal Pipe Size
NPT	National Pipe Thread

CONTENTS

1.0 GENERAL

1.1 Scope

1.1.1 This standard specification, together with the data sheets attached herewith forms the requirements for the design, materials, nameplate marking, inspection and testing and shipping of self actuated control valves/ regulators.

1.1.2 The related standards referred to herein and mentioned below shall be of the latest edition prior to the date of purchaser's enquiry;

ANSI/ASME American National Standards Institute/American Society of Mechanical Engineers.

B 1.20.1	Pipe Threads General Purpose (Inch)
B 16.5	Pipe Flanges and Flanged Fittings NPS'A through NPS24
B 16.20	Metallic Gaskets for Pipe Flanges, Ring Joint, Spiral wound and Jacketed
B 16.34	Valves Flanged, Threaded and Welding End

ANSI/FCI American National Standards Institute/Fluid Controls Institute
70.2 Control Valve Seat Leakage Classification

EN-10204 Inspection Documents for Metallic Products.

IBR	Indian Boiler Regulations
IEC-60079	Electrical Apparatus for Explosive Gas Atmosphere
IEC-60529	Degree of Protection Provided by Enclosures (IP Code)
ISA	Instrumentation Systems and Automation Society
S75.03	Face to Face Dimensions for Flanged Globe-Style Control Valve Bodies
S75.04	Face to Face Dimension for Flangeless Control Valves
S 75.19	Hydrostatic Testing of Control Valves
IS-13 947	Specifications for Low Voltage Switchgear and Control gear.
IS-2148	ElectricalApparatus forExplosiveGasAtmospheres - Flameproof Enclosures'd'

1.1.3. In the event of any conflict between this standard specification, job specification/data sheets, statutory regulations, related standards, codes etc. the following order of priority shall govern:

a) Statutory Regulations
b) Data Sheets
c) Standard Specification

d) Codes and Standards

1.1.4 In addition to compliance to the purchaser's specification in totality, vendors' extent of responsibility includes the following:

a) Purchaser's data sheets specify the minimum acceptable material for the body and trim of self actuated control valves. Alternate superior material of construction shall also be acceptable provided vendor assumes full responsibility for selected material for their compatibility with the specified fluid and its operating conditions.

b) Sizing and selection of self actuated control valves suitable for the indicated fluid flow rate over the indicated turndown and viscosity with the stated accuracy, including checking for cavitations, flashing and noise and suitable treatment to limit noise within appropriate limits.

c) Self actuated control valve / regulator with suitable capacity and range-ability for the process conditions indicated.

d) It is responsibility of the Vendor to select the correct model nos. for the instruments to suit purchaser's specification. In case the Model No. is required to be changed at a later date to meet the purchaser's specifications, same shall be done by them without any price and delivery implications.

e) Isolation valves for impulse lines shall also be supplied by the Vendor.

f) For Slam Shut Valves Vendor shall supply 2 nos. of limit switches one for open & one for close indication duly mounted on the valve. The same shall be supplied as per the data sheet.

g) For Pressure Control Valves Vendor shall provide one limit switch for status indication duly mounted on the valve. The same shall be supplied as per attached data sheet.

h) Vendor to include the flame proof junction boxes(Two nos.), cable glands etc for terminating cables of Limit switches in Vendor's scope of supply

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to the vendor attached along with the material requisition.

1.2.2 Whenever a detailed technical offer is required, vendor's quotation shall include the following;

a) Compliance to the specifications.

b) A detailed specification sheet for each item which shall provide the information regarding type, size, material of construction of body / trim / diaphragm, capacity at indicated set value etc. The material specification and units of measurement for various items in vendor specification sheets shall be to the same standards as those indicated in purchaser's data sheet.

c) Proven references for each offered model inline with clause 1.2.3 of this specification whenever specifically indicated in the purchaser's specifications.

d) Deviations on technical requirements shall not be entertained. In case vendor has any valid reason to deviate, they must include a list of deviations tag number wise, summing up all the deviations, from the purchaser's data sheets and other technical specifications along with the technical reasons for each of these deviations.

e) Catalogues giving detailed technical specifications, model decoding details and other information for each type of self actuated control valves / regulators covered in the bid.

1.2.3 All items, as offered, shall be field proven and should have been operating satisfactorily individually for a period of minimum 4000 hours on the bid due date in the process conditions similar to those as specified in the purchaser's data sheet. Items with proto-type design or items not meeting proven-ness criteria specified above shall not be offered.

1.2.4 All documentation submitted by the vendor including their quotations, catalogues, drawings, installation, operation and maintenance manuals etc. shall be in English language only.

1.2.5 Vendor shall also quote for the following;

a) One set of extra packing and gaskets for each self actuated control valve / regulator along with each item.

b) Two years operational spares for each self actuated control valve / regulator and its accessories, which shall include plug, seat ring, gasket set, packing set, diaphragm etc, as a minimum.

c) Any special tools needed for maintenance work on self actuated control valves /regulators. Vendor must confirm in their offer if no special tools are needed for maintenance of offered self actuated control valves / regulators.

1.3 Drawings and Data

1.3.1 Detailed drawings, data, catalogues and manuals required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of reproducible, prints and soft copies shall be dispatched to the address mentioned, adhering to the time limits indicated.

1.3.2 Final documentation consisting of design data, installation manual, operation and maintenance manual etc submitted by the vendor after placement of purchase order, shall include the following, as a minimum:

a) Specification sheet for each self actuated control valve / regulator.

b) The Sizing, Noise calculation and Inlet Velocity calculation for each valve, Pressure drop across respective valve.

c) Flow Rate versus Trim Lift Curve to verify the valve range ability and valve regulation characteristics.

d) Dimensional outline with mounting details for each item.

e) Certified drawing for each self actuated control valve / regulator which shall provide;

i) End connection details.

ii) Assembly details and Face-to-face dimensions in mm.

iii) Height of the completely assembled self actuated control valve / regulator
iv) Weight of complete assembly in kilograms.
v) Internal construction details with parts list.
vi) Material of construction.

f) Copy of type test certificates.
g) Copy of test certificates for all the tests indicated in clause 4.0 of this specification.
h) Installation procedures for self-actuated control valves / regulators and its accessories.
i) Calibration and maintenance procedures including replacement of its internal parts wherever applicable.
j) Certificates from statutory body for the supplied limit switch being flame proof and weatherproof.

2.0 DESIGN AND CONSTRUCTION

2.1 General

2.1.1 The type of self actuated control valve / regulator shall be as specified in the purchaser's data sheet, in general. However, when direct actuated self actuated control valve / regulators are specified, pilot operated valves are also acceptable.

2.1.2 The valve shall be designed as per EN334.

2.1.3 For tank blanketing applications, the offered valve design shall be specifically suitable for the said application and shall allow large flow turndown at the specified outlet pressure.

2.1.4 All pressure containing parts of the valve shall be able to withstand shut-off pressure and maximum operating temperature specified in the purchaser's data sheet. Self actuated control valves / regulators for downstream regulation shall be provided with integral relief valves, wherever necessary.

2.1.5 The set pressure of the self actuated control valve / regulator shall be adjustable throughout the spring range externally. A locking mechanism shall be provided to avoid inadvertent set point adjustment. Vendor shall furnish the adjustable range of the offered Pilots and of the springs.

2.1.6 All the wetted parts shall be suitable for the fluid and process conditions specified in the purchaser's data sheets.

2.1.7 All self actuated control valves / regulators in oxygen and chlorine service shall be thoroughly degreased using reagents like trichloro-ethylene or carbon tetrachloride. End connections shall be blinded / plugged after this degreasing process in order to avoid entrance of grease or oil particles.

2.1.8 The construction of the PCVs shall be such that there will be no continuous gas bleeding.

2.2 Body

2.2.1 Unless otherwise specified in the data sheet, self actuated control valves / regulators shall have flanged end connection integral to the valve body.

2.2.2 The valve/regulator body rating shall be equal to or better than the flange rating specified in the data sheet.

2.2.3 The valve/ regulator shall be suitable for installation in horizontal as well as vertical lines.

2.2.4 Flow direction shall be clearly stamped or cast on the valve / regulator body to ensure correct installation.

2.2.5 End Connection

2.2.5.1 Unless otherwise specified, the end connection details shall be as below;

a) Threaded end connections shall be to NPT as per ANSI/ASME B1.20.1.

b) Flanged end connection shall be as per ANSI/ASME B 16.5.

c) Flange face finish shall be as per clauses 6.4.4.1, 6.4.4.2 and 6.4.4.3 of ANSI / ASME B16.5. The face finish as specified in data sheets, shall have serrations as follows:

125AARH	:	125 TO 200 AARH
63AARH	:	32 to 63 AARH

d) Ring type joint flanges shall have octagonal grooves as per ANSI B16.20.

2.2.5.2 Face-to-face dimensions of self actuated control valve / regulators with flanged globe body design shall be in accordance with ISA S-75.03. The allowable error in dimensions shall be + 2mm.

2.2.5.3 Bottom drains shall be plugged or blind flanged. Wherever plug is used, threads shall correspond to ANSI/ ASME B1.20.1.

2.3 Trim

2.3.1 The term 'trim' covers those parts of a body assembly (excluding the body, diaphragm and bottom flange), which are exposed to and in contact with the line medium, consisting of but not limited to the seat ring, plug stem, plug, plug guide, guide bushing and cage.

2.3.2 Guiding

2.3.2.1 The self actuated control valve / regulator guiding shall be as per manufacturer standard. However, for globe body design of self actuated control valves / regulators following shall govern:

a) Single seated valves shall have top guiding.

b) Double seated valves shall have top and bottom guiding and shall be of the pressure-balanced design.

2.3.2.2 Guide bushing shall be of sufficiently hard material to resist side thrust on the plug.

2.3.3 Material of construction

2.3.3.1 Unless specified otherwise, the trim material for all offered self actuated control valves / regulators shall be 316 Stainless Steel.

2.3.3.2 Wherever stelliting of trim has been specified in purchaser's data sheets it stands for stelliting of the complete plug and seat joint, orifice and plug contour unless specified otherwise.

2.3.3.3 Vendor shall use suitable material pairs, proper surface finish, hardness and clearances, for all internal parts wherever possibilities of galling exist.

2.3.3.4 Pressure drop across slam shut valves shall be restricted to 0.3kg/cm2.

2.4 Actuator and Actuating Mechanism

2.4.1 Actuator for self actuated control valves / regulators shall be spring opposed diaphragm type, in general. Piston and cylinder type of actuator shall also be acceptable if it meets all other requirements specified in the purchaser's data sheets.

2.4.2 The line pressure sensing for the self actuated control valve / regulator shall be internal, in general. Where, external sensing line is necessary, the sense line size shall be 1/2", as a minimum.

2.4.3 Actuator casing and diaphragm shall be suitable to withstand shut-off pressure indicated in the data sheet.

2.4.4 All the wetted parts including actuating mechanism, pilot etc shall be suitable for the fluid being handled. Vendor shall clearly come out with alternate material if the materials as indicated herein are not compatible with the specified process fluid.

a) Actuator casing material shall be same as self actuated control valve / regulator body material as a minimum.

b) The pilot internals shall be 316 Stainless Steel, as a minimum.

c) The actuator diaphragm material shall be 316 Stainless Steel for the hydrocarbon applications as a minimum. Other materials shall be acceptable when specifically indicated in purchaser's data sheet.

d) All non-wetted springs shall be corrosion resistant nickel plated. Wetted springs, if any, shall be of 316 Stainless Steel, as a minimum.

2.5 Sizing

2.5.1 Self actuated control valve/regulators shall be sized considering following guidelines:

a) Valve flow capacities in terms of C_v may be calculated using standard ISA sizing formula or vendor standard sizing formula.

b) Unless specified otherwise, the self actuated control valve / regulator droop shall be less than 10% over set point.

c) The flow capacity of the offered valve shall be verified against published flow capacities of the offered model of valve at the specified inlet and outlet pressure conditions.

2.5.2 Noise level for the offered valve / regulator shall be limited to 85dB as measured at a distance of one meter from the valve / regulator. In case noise level is >85 dB, vendor shall provide noise treatment to limit the noise level and include silencers or expanders as required.

2.6 Finish

2.6.1 The body shall be painted as below:

Carbon steel body	-	Light Grey
Alloy steel body	-	Canary Yellow
Stainless steel body	–	Natural

3.0 NAME PLATE

3.1 Each valve/regulator shall have a stainless steel nameplate attached firmly to it at a visible place, furnishing the following details:

a) Valve tag number as per purchaser's datasheets.
b) Manufacturer's serial number, type of valve and model number.
c) Manufacturer's name/trade mark
d) Body and port sizes in inches.
e) Stem travel in millimeters.
f) Type of regulation upstream/downstream

4.0 INSPECTION AND TESTING

4.1 Unless otherwise specified, purchaser reserves the right to test and inspect all the items at the vendor's work in line with the inspection test plan for self-actuated control valves / regulators.

4.2 Vendor shall submit the following test certificates and test reports for purchaser's review:

a) Material test certificate as per clause 3.IB of EN10204 for each valve body, bonnet castings/ forgings and as per clause 2.2 for trim and diaphragm.
b) Certificate of radiography/X-ray for valve body castings of 600# and above and also wherever specifically indicated in purchaser's data sheet. Radiography procedure shall be as per ANSI B16.34 and acceptance shall be as per ANSI B16.34 Annexure B.
c) Hydrostatic test report for all self actuated control valve / regulators as per clause 4.3 of this specification.
d) IBR certificate in from IIIC for all valves covered under IBR certification
e) Functional test reports for each valve as per clause 4.4 of this specification.
f) Type test certificate for droop within 10% or as specified in the data sheets of set point for each type / model of self actuated control valve / regulator.

4.3 Hydrostatic test

4.3.1 Each self actuated control valve / regulator body shall be subjected to hydrostatic test at test pressure equal to 1.5 times the maximum allowable working pressure at ambient temperature in accordance with ANSI B 16.34. For all self actuated control valve / regulator with external sensing the hydrostatic test shall be carried out by connecting the sensing line. All self actuated control valve / regulator bodies covered under IBR shall be tested as per IBR regulation. There shall not be any visible leakage during this test.

4.4 Functional Tests

4.4.1 Seat Leakage / Tightness Test

The seat leakage test shall be carried out using air or nitrogen and shall meet the requirements specified in FCI 70.2 for the indicated seat leakage class.

4.4.2 Set Pressure Test

4.4.2.1 Set pressure shall be checked for self actuated control valve / regulator using water or air as the testing media. The upstream / downstream pressure shall be maintained depending upon the specified regulation. When specifically indicated, the set pressure test shall be carried out at the specified flow conditions. However the Vendor shall stand guarantee for the complete range of pressure and flow conditions as per the Data Sheets attached with the Bid document

4.4.3 Testing to demonstrate actuation time for slam shut valves.

4.5 Witness Inspection

4.5.1 Vendor shall offer all self actuated control valve / regulator for pre-dispatch inspection for the following as a minimum;

a) Physical dimensional verification and workmanship.
b) Hydrostatic test as per clause 4.3 of this specification on representative samples.
c) Functional test as per clause 4.4 of this specification on representative samples.
d) Review of all certificates and test reports as indicated in clause 4.2 of this specification.

4.5.2 In the event when no witness inspection is carried out by purchaser, the tests shall anyway be completed by the vendor and documents for the same shall be submitted to purchaser for scrutiny.

4.5.3 Vendor shall include inspection by consultant / Purchaser's personnel at Vendor's shop. For this inspection labour, consumable, equipment and utilities as required shall be in Vendor's scope.

5.0 SHIPPING

5.1 Self actuated control valve / regulator and its accessories shall be supplied pre-assembled.

5.2 All threaded and flanged openings shall be suitably covered to prevent entry of foreign materials.

5.3 Self actuated control valve / regulator with external lubricator shall be lubricated prior to shipment.

5.4 All self actuated control valves / regulators in oxygen and chlorine service shall be separately packed along with a certificate indicating 'CERTIFIED FOR OXYGEN / CHLORINE SERVICE' as applicable.

6.0 REJECTION

6.1 Vendor shall prepare their offer strictly as per clause 1.2 of this specification and shall attach only those documents which are specifically indicated in the material requisition.

6.2 Any offer not conforming to the above requirements shall be summarily rejected.

GAIL INDIA LIMITED

STANDARD SPECIFICATION

FOR

CONTROL VALVES

GAIL-STD-IN-DOC-TS-007

0	18.01.2019	Issued for Bid	RKS	UNU	UNU	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

CONTENTS

1.0 GENERAL

1.1 Scope

1.1.1 This standard specification, together with the data sheets attached herewith forms the requirements for the design, materials, nameplate marking, testing and shipping of control valves/ regulators.

1.12 The related standards referred to herein and mentioned below shall be of the latest edition prior to the date of purchaser's enquiry;

IEC-79	Electrical Apparatus for Explosive Gas Atmosphere
IEC-529	Degree of protection provided by enclosures.

ANSI/ASME American National Standards Institute/American Society of Mechanical Engineers.

B 1.20.1	Pipe Threads
B 16.5	Steel Pipe Flanges and Flanged Fittings
B 16.20	Ring Joint Gaskets and grooves for steel Pipe Flanges

API American Petroleum Institute

6D:	Pipelines valves (Gate valve, Plug, Ball and check Valves)
609:	Lug and Wafer type, Butterfly valves

EN 61056-1: Specification for performance, design and construction of valve, regulated sealed type

ISA Instrumentation Systems and Automation Society

S75.01	Flow equation for sizing Control Valve
S75.02	Control Valve capacity test procedure
S75.03	Face to Face Dimensions for Flanged Globe-Style Control Valve Bodies
S75.04	Face to Face Dimensions for Flangeless Control Valves

OSHA Occupational Safety and Health Authority

DIN 50049 Document on material testing

IBR Indian Boiler Regulation

IS-2147 Degree of protection provided by enclosures for low Voltage Switch gears and control gears

IS-2148 Flame proof Enclosures of Electrical Apparatus

1.1.3 In the event of any conflict between this specification, data sheets, related standards, codes etc., the vendor should refer the matter to the purchaser for clarifications and only after obtaining the same should proceed with the manufacture of the items in question.

1.1.4 Purchaser's data sheets indicate the valve capacity (in terms of Cv), materials for the body, trim, packing etc. However, this does not absolve the vendor of the responsibility for proper selection with respect to the following:

a) Valve with suitable capacity (in terms of Cv) and rangeability for the flow conditions indicated.
b) Actuator to meet the shut-off differential pressure indicated.
c) Materials for body, trim, packing box and other parts of the valve for the fluid and its operating conditions indicated.
d) Materials used for various parts of all accessories of the control valve like air filter regulators, solenoid valves, limit switches, positioners, pilot relays, volume boosters, locking relays, interconnecting tubing and fittings etc .
e) Checking for cavitation, flashing and noise generated and to provide suitable treatment to limit these within appropriate limits.

1.2 Bids

1.2.1 Vendor's quotation shall include a detailed specification sheet for each control valve which shall provide all the details regarding type, construction materials, capacity etc. and any other valve accessories.

1.2.2 All the units of measurement for various items in vendor's specification sheets shall be to the same standards those in purchaser's data sheets.

1.2.3 All the material specifications for various parts in the vendor's specification sheets shall be to the same standards as those in purchaser's data sheets.

1.2.4 Vendor shall attach a list of control valves tag number wise, summing up all the deviations, if any, from the purchaser's data sheets. Also, vendor should provide reasons for these deviations wherever possible.

1.2.5 Vendor shall enclose catalogues giving detailed technical specifications and other information for each type of control valve covered in the bid.

1.2.6 Vendor's quotation, catalogues, drawings, operating and maintenance manuals shall be in English.

1.2.7 Vendor shall also quote for the following:

a) Two years' operational spares for each control valve and its accessories which shall include plug, seat ring, gasket set, packing set, diaphragm /o-ring set etc. as a minimum.
b) Any special tools needed for maintenance work. c) One extra set of packing for each valve.
d) Line bolting in case of flangeless valves with material as per Table 1.

1.2.8 A copy of the certification of intrinsic safety / flameproof from statutory bodies like BASEEFA, CENELEC, FM, PTB, CMRI etc. shall be submitted.

1.3 Drawing and Data

1.3.1 Detailed drawings, data, catalogues and manuals required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of reproducible and prints should be dispatched to the address mentioned, adhering to the time limits indicated.

1.3.2 After placement of purchase order, vendor shall submit certified drawings and specification sheets for each control valve which shall specially include the following:

a) Face-to-face dimensions of the valve.
b) Height of the completely assembled valve.
c) Dimensions of clearance space required for maintenance work.
d) Weight of the completely assembled valve.
e) Location of external supports for vibration, in case they are required.
f) Any other special mounting requirement.

All dimensions except nominal body and part size shall be given in millimetres.

1.3.3 Vendor shall provide test certificates for all the tests indicated in para 4.0 of this specification. In addition vendor shall provide the 'Manufacturer's certificate of conformity' to purchaser's specifications as per clause 2.2 of DIN 50049.

2.0 DESIGN AND CONSTRUCTION

2.1 Body

2.1.1 Control valves with flanged body only are acceptable

2.1.2 The minimum control valve body size shall be 1".

2.1.3 The valve body rating should be equal to or better than the flange rating specified in the data sheets.

2.1.4 The valve shall be suitable for installation in horizontal or vertical lines.

2.1.5 Flow Direction

2.1.5.1 Unless otherwise mentioned, flow direction shall be as below:-

a) Flow tending to open for single seated valves.
b) Flow entering between the seats for double seated valves.
c) Flow entering at the side and leaving at the bottom for angle valves.

2.1.5.2 Flow direction shall be stamped or cast on the body.

2.1.6 End Connections

2.1.6.1 Unless otherwise mentioned, end connection details shall be as below:-

a) Threaded end connections shall be NPT as per **ANSI/ASME** B **1.20.1**
b) Flanged end connections shall be as per **ANSI/ASME** B 16.5
c) Flanged face finish shall be serrated concentric to paragraphs 6.3.4.1, **6.3.4.2** and 6.3.4.3 of ANSI B 16.5. The face finish as specified in the data sheets shall have cone serrations as follows;

Serrated:	**250** to **500 AARH**
125 AARH:	**125** to **200 AARH**
63 AARH:	**32 to 63 AARH.**

d) Ring type joint flanges shall have octagonal grooves as per **ANSI** B **16.20.**

2.1.6.2 Face-to-face dimensions of globe type control valves shall be in accordance with **ISA S75.03.**

2.1.6.3 Where provided, bottom drains shall be plugged off or blind flanged. Where a plug is used, threads shall correspond to **ANSI/ASME** B **1.20.1 (NPT).** Where a flange is used, its dimensions and rating shall correspond to **ANSI/ASME** B **16.5.**

2.2 Trim

2.2.1 The term 'trim' covers those parts of body assembly (excluding the body, bonnet and bottom flange) which are exposed to and in contact with the line medium consisting of but not limited to the seat ring, valve plug stem, valve plug, valve plug guide, guide bushing and cage.

2.2.2 Guiding

2.2.2.1 Single seated globe and angle type control valves shall have heavy top guiding.

2.2.2.2 Double seated valves shall have top and bottom or cage guiding and shall be of the pressure balanced type.

2.2.2.3 Whenever cage type control valves are specified, double seated control valves can be accepted. But whenever double seated control valves are specified, cage type control valves will not be accepted.

2.2.2.4 Guide bushings shall be of a sufficiently hard material to resist side thrust on the plug.

2.2.3 Design and Materials

2.2.3.1 The plug characteristics shall be as shown in purchaser's data sheets.

2.2.3.2 Wherever stelliting of trim has been specified in purchaser's data sheets, it stands for stelliting of the complete plug, seat joint and orifice, unless otherwise mentioned.

2.2.3.3 Whenever cavitating conditions are expected vendor shall use materials of sufficiently high hardness and consider use of special plug-to-seat passages.

2.2.3.4 Under extreme temperature conditions, vendor shall consider increased clearances at room temperature, seal welding of threaded seat rings etc. Hard facing of trim is preferred at high temperatures. Under very low temperature, material used should have adequate cold impact strength.

2.2.3.5 Vendor shall use suitable material pairs, provide proper surface, finish, hardness and clearances wherever possibilities of galling exist.

2.3 Sizing

2.3.1 The control valve capacities in terms of Cv shown in the purchaser's data sheets have been arrived at using the formulae given in the standard ISA S 75.01-"Control valve sizing equations". In case vendor's sizing formulae differ from those, purchaser should be provided with the same.

2.3.2 In general, control valves shall be sized so that the valve opening is as noted below:

At maximum flow - about 90% open
At normal flow - about 75% open
At minimum flow - about 20% open

2.3.3 Rangeability of valves shall be 30: 1, unless otherwise specified.

2.3.4 Butterfly valves shall be sized assuming a 60" opening at maximum flow, in general. In special cases, wherever required, high performance butterfly valves shall be offered.

2.4 Noise

2.4.1 Vendor shall examine each control valve for noise generation possibilities.

2.4.2 Noise from control valve during operation shall be limited to OSHA specified levels or better. The maximum allowable noise is 90 **dBA** SPL.

2.4.3 If the predicted noise level is found to exceed 90 dBA SPL, control valve should be treated for noise. Source treatment for noise should be resorted to. When unavoidable, other methods should be recommended based on merit.

2.5 Packing Box, Bonnet and Stem

2.5.1 Packing Box

2.5.1.1 The packing box shall be flange bolted to the bonnet.

2.5.1.2 Generally low friction type packing like braided teflon are preferred wherever operating conditions permit.

2.5.1.3 Every control valve shall have its packing box drilled and tapped to 1/4" (NPT F) as per ANSIIASME B 1.20.1 for connecting external lubricator. When external lubricator is not provided, this hole shall be plugged.

2.5.1.4 An isolating valve shall be provided with all external lubricators. Vendor shall specify the lubricator stick material used in each case.

2.5.2 Bonnet

2.5.2.1 The bonnet shall be flange bolted to the body threaded connections are not permitted.

2.5.2.2 Wherever the operating temperature of the fluid is above 200°C, extension or radiation finned bonnet shall be provided. For temperatures below 0°C extension bonnet should be provided.

2.5.3 Stem

2.5.3.1 The stem surface finish should be fine. Extra fine surface finish shall be provided wherever the packing material is PTFE.

2.6 Actuator

2.6.1 Actuator shall be sized for the shut-off differential pressure indicated in purchaser's data sheets.

2.6.2 Actuator shall be pneumatically operated.

2.6.3 Actuator casing shall be made of pressed steel.

2.6.4 In general, spring opposed diaphragms type actuators are preferred. Only when this type of actuator becomes extremely unwieldy, should a piston and cylinder type of actuator be considered.

2.6.5 Springs shall be corrosion-resistant and cadmium or nickel plated. They shall be of the enclosed type. Their compression should be adjustable.

2.6.6 In general, an actuator operating range of 0.2 to 1.0 kg/cm2 g is preferred.

2.6.7 The actuator casings and diaphragms shall be designed for minimum twice the maximum pneumatic operating pressure of the control valve.

2.6.8 Among piston and cylinder actuators, spring type is preferred. When spring less type is provided, all accessories like pilot valves, booster relays and volume tank should be provided to ensure desired action on air failure.

2.6.9 Valve stem position indicator shall be provided for every control valve. The position indicator scale shall be calibrated from 0 to 100% in steps of 10%.

2.6.10 In general, side-mounted handwheels are preferred. Handwheels shall provide manual control in both opening and closing directions independent of spring action. Wherever specified, actuators may be of special type i.e., gas over oil/hydraulic etc.

2.7 Accessories

2.7.1 Positioners

2.7.1.1 Positioners shall be of the force-balance type and shall be side mounted on the control valve. They shall be direct acting, unless otherwise specified.

2.7.1.2 The positioner shall be provided with an integral by-pass switch whenever the operating range of the actuator is the same as that of the control signal.

2.7.1.3 Every positioner shall have three pressure gauges mounted on it, one each for air supply, control signal and positioner output to actuator.

2.7.1.4 Pneumatic connections shall be ¼" NPT(F) to ANSI/ASME B1.20.1. If they are different, suitable adapters shall be provided.

2.7.1.5 Positioners shall have corrosion resistant linkages and rugged brackets.

2.7.2 Electro-Pneumatic Converter

2.7.2.1 Electro Pneumatic converter shall be of force balance type and shall be yoke mounted.

2.7.2.2 It shall have an integral terminal housing. I/P converter with flying leads shall not be acceptable.

2.7.2.3 Unless otherwise mentioned, it shall be intrinsically safe.

2.7.2.4 Pneumatic connections shall be ¼" NPT(F) to ANSI B 2.2. If they are different, suitable adapters shall be provided.

2.7.2.5 The electrical connections shall be ½" NPT(F).

2.8 FINISH

2.8.1 The body shall be painted as below:

Carbon steel body	-	Light Grey
Alloy steel body	-	Canary yellow
Stainless steel body	-	Natural

2.8.2 The actuator shall be painted as below:

Direct action (open on air failure) valves	-	green
Reverse acting (close on air failure) valves	-	red

2.8.3 All the Pneumatic valve accessories of the valve shall be weatherproof to IP-55 as per IEC-529/IS-2147.

3.0 NAMEPLATE

3.1 Each control valve shall have a SS nameplate attached firmly to it at a visible place, furnishing information:

a) Tag number as per purchaser's data sheet
b) Body and port sizes in inches
c) Stem travel in mm
d) Action on air failure
e) Spring range
f) Air Supply pressure
g) Manufacturer's model number for the valve body, actuator and positioner.

4.0 INSPECTION AND TESTING

4.1 Unless otherwise specified, purchaser reserves the right to test and inspect all the item at the vendor's works.

4.2 Vendor shall submit following test certificates and test reports for purchaser's review:

a) Material test certificate with detailed chemical analysis from the foundry (MIL certificates) for each casting.

b) Certificate of radiography/x-ray for valve castings. 100% Radiography shall be carried out for the following valve castings;

i) Body sizes 18 inches and above.
ii) Body rating ANSI 600 pounds and above.

c) Pneumatic test certificate for all pneumatic actuator at a pressure not less than one and half (1.5) times the actuator design pressure.

d) IBR certificate in form III C for all valves covered under IBR certification.

e) Test certificate for each valve giving detail of hydrostatic tests, calibration/stroke checks, seat leakage tests, valve characteristics, testing of accessories etc.

4.3 Hydrostatic Test

4.3.1 Each control valve body shall be subjected to hydrostatic test at 1.5 times the test pressure as per ANSI rating, all control valve bodies covered under IBR, shall be tested as per IBR regulation. There shall not be any visible leakage during this test.

4.4 Functional Tests

4.4.1 Seat Leakage Test

The test shall meet the requirements specified in ANSI B 16.104.

4.4.2 Lift Characteristics

The test shall be carried out at no load condition and following shall be verified;

a) Stroke Checks.
b) Linearity and Hysterisis

Linearity and Hysterisis shall be better than +- 1.5% of rated lift with positioner and +- 5.0% without positioner.

4.4.3 Certificate from statutory bodies for intrinsic safety/explosion proof and weather proof for positioners, limit switches etc. IBR certification in form III C shall also be furnished wherever applicable.

4.5 Witness Inspection

Vendor shall offer all values for pre-despatch inspection and following tests/checks shall be carried out as a minimum.

a) Physical dimensional checks and workmanship.

b) Hydrostatic test, calibration checks, seat leakage and Actuator pressure tests on representative sample.

c) Review of all certificates and test reports as indicated in para 4.2 of this specification.

In the event of not witnessed by purchaser, the tests shall anyway be completed by the vendor and documents for same submitted for scrutiny.

5.0 SHIPPING

5.1 The control valve and its accessories shall be supplied preassembled and pre-tubed.

5.2 All threaded and flanged openings shall be suitably protected to prevent entry of foreign material.

5.3 Valves with external lubricators shall be lubricated prior to shipment.

6.0 REJECTION

6.1 Vendor shall make his offer in detail, with respect to every item of the purchaser's specifications. Any offer not conforming to this shall be summarily rejected.

GAIL INDIA LIMITED

STANDARD SPECIFICATION

FOR

SIGNAL CABLES

GAIL-STD-IN-DOC-TS-008

0	18.01.2019	Issued for Bid	RKS	UNU	UNU	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Abbreviations	
DC	Direct Current
DGMS	Director General of Mines Safety
FR	Flame Retardant
PE	Polyethylene
PETP	Polyethylene Terethalate
PVC	Polyvinyl Chloride

CONTENTS

1.0 GENERAL

1.1 Scope

1.1.1 This specification, together with the data sheets attached herewith covers the requirements for design, materials, manufacturing, inspection, testing and shipping of signal cables.

1.1.2 Cables shall comply with latest edition of the following standards prior to the date of the purchaser's enquiry.

ASTM D 2843 Standard Test Method for Density of Smoke from the Burning or Decomposition of Plastics.

ASTM D 2863 Test method for measuring the minimum oxygen concentration to support candle like combustion of plastics (oxygen index).

BS-5308 Part1 Specification for Polyethylene insulated cables.

BS-5308 Part2 Specification for PVC insulated cables.

IEC: 540 & 540A Test methods for insulation and sheaths of electric Cables

IEC60584-3 Extension and compensating cables - Tolerances and identification system.

IEC-60331 Testing of Fire Resistant cables.

IEC-60332 Tests on bunched wires and cables

IEC-60092 Electrical Installations of Cables.

IEC – 60754 – Part 1, 2. Test on Gases Evolved during Combustion of materials from Cables

IS-1554 PVC insulated (heavy duty) electric cables-working voltage up to and including 1100 V.

IS-3975 Mild steel wires, formed wires and tapes for armouring of cables.

IS-5831 PVC insulation and sheath of electric cables.

IS-6380 Elastomeric insulation and sheath of electric cables

IS-6474 Polyethelene Insulation and sheath of electric cables

IS-10810 Method of test for cables.

Part 40	Method for testing uniformity of coating on zinc coated articles.
Part 41	Mass of zinc coating on steel armour
Part 58	Oxygen Index test
Part 59	Determination of halogen acid gas evolved during combustion of polymeric material taken from cables
Part 61	Flame Retardant test
Part 62	Flame Retardance test for bunched cables
Part 63	Smoke density of electric cables under fire conditions

1.1.3 In the event of any conflict between this standard specifications, data sheets, statutory regulations, related standards, codes etc., the following order of priority shall govern:

a) Statutory Regulations
b) Data Sheets
c) Standard Specification
d) Codes and Standards.

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to vendor attached with the material requisition.

1.2.2 Whenever a detailed technical offer is required, vendor's quotation shall include the following;

a) Compliance to the specifications.
b) Whenever the requirement of a detailed specification sheet is specifically indicated, the specification sheet shall provide technical details like type dimensions (under armour, over armour and overall diameter), electrical characteristics etc.
c) Deviations on technical requirements shall not be entertained. In case, vendor has any valid technical reason to deviate, they must include a list summing up all the deviations, from the purchaser's data sheets along-with technical reasons for these deviations.
d) Catalogues giving detailed technical specifications and cross sectional dimensional drawings for each type of cable covered in the bid

1.2.3 All documentation submitted by vendor including their quotation, catalogues, drawings and documents etc. shall be in English language only.

1.2.4 Vendor shall also quote for the following:

a) Unit price per metre for each type of cable, which shall be used for any addition or deletion.of the quantity. The quantity indicated against each type of cable may vary by ± 25% at the time of placement of order.

b) Minimum number of eight PVC / rubber end caps shall be supplied with each drum.

1.3 Drawings and Data

1.3.1 Detailed drawings, data and catalogues required from the vendor are indicated by the purchaser in the vendor data requirement sheets. The required number of reproducible, prints and soft copies should be dispatched to the address mentioned, adhering to time limits indicated.

1.3.2 Final documentation consisting of design and constructional data submitted by the vendor after placement of order shall include the following, as a minimum.

a) Specification sheet for each type of cable.
b) Cable details giving electrical characteristics, overall diameter, diameter under armour and diameter over armour.

2.0 DESIGN AND CONSTRUCTION

2.1 Constructional requirements:

2.1.1 Primary insulation for PVC insulated cables, shall be 85°C polyvinyl chloride Type C as per IS 5831. Thickness of primary insulation shall be 0.5 mm as a minimum. For PE insulated cables, primary insulation shall be of 70° C Polyethylene.

2.1.2 Inner sheath colour of signal cables shall be black. Outer sheath colour shall also be black except for cables used in intrinsically safe systems. The outer sheath colour for all such cables used in intrinsically safe application shall be light blue. The thickness of the sheath shall be as per IS 1554 part 1.

2.1.3 Inner and outer sheath of cable shall be flame retardant made of extruded PVC Type ST2 (90°C) as per IS 5831 and shall meet the following requirements:

a) Minimum Oxygen index of PVC shall be 30 at 27 °C ±2°C. b) Temperature index shall be over 250 °C.
c) Inner and Outer sheath shall meet flame retardant requirements for bunched cables as per IS 10810 (Part 62) category AF or IEC 60332 category A.
d) A rip cord shall be provided for inner sheath.

Outer sheath shall be suitable for protecting the cable against rodent and termite attack.

2.1.4 Armour over inner sheath shall be of galvanized steel wire/flat. The dimensions of armour shall be as per IS 1554 (Part 1). Requirement and methods of tests for armour material and uniformity of galvanization shall be as per IS 3975 and IS 10810 (Part 40) respectively.

2.1.5 Each pair/triad shall be shielded. Shield shall be of aluminium backed by mylar / polyester tape bonded together helically applied with metallic side down having 25% overlap on either side and 100% coverage. Minimum shield thickness shall be 0.05 mm. Drain wire shall be 0.5 mm^2 multi-strand bare tinned annealed copper conductor. The

drain wire shall be in continuous contact with aluminium side of the shield.

2.1.6 Overall shield shall be of aluminium backed up by mylar/polyester tape helically applied with the metallic side down with either side having 25% overlap and 100% coverage. Minimum shield thickness shall be 0.075 mm. Drain wire shall be similar to individual pair/triad drain wire and shall be over the overall shield.

2.1.7 The cores of a pair triad shall be twisted with a minimum of 10 twists per metre of cable.

2.1.8 Sequential marking of the length of the cable in meters shall be provided on the outer sheath at every one meter. The embossing /engraving shall be legible and indelible.

2.1.9 Tolerance in overall diameter of cable shall be within ± 2 mm over offered value.

2.1.10 The cables used in installations under the jurisdiction of Director General of Mines and Safety (DGMS) shall meet all requirements of DGMS. The word "Mining Cable" shall be embossed on the cable outer sheath as per IS 1554 (Part 1).

2.1.11 Drum length and length tolerance

2.1.11.1 The length of the cables in each drum (drum length) shall be as specified in the purchaser data sheets .Where no drum length is indicated in the data sheet /material requisition, the following shall be apply:

Drum length for single pair/ single triad cable : 500 metres

Drum length for multi-pair/ multi- triad cable : 1000 metres

2.1.11.2 Actual produced drum length shall not vary by more than ± 5% from the length indicated in purchaser's datasheet or clause 2.1.11.1 of the specification.

2.1.12 Tolerance over the total ordered length for a type of cable shall be as follows;

a) ± 5% for total length less than 5 km.

b) ± 2% for total length more than 5 km.

2.1.13 Specific Requirements for fire resistant cable.

2.1.13.1 The cables shall have circuit integrity as per IEC 60331.

2.1.13.2 Primary insulation shall be heat resisting elastomeric which can withstand temperature up to 90°C such as silicon rubber/mica glass tape/EPR (medium grade) as per IS 6380. Insulation thickness shall be 1.0mm minimum and shall confirm to IEC 60092.

2.1.13.3 A wrapping of tape made of PETP (polyethylene terepthalate)/woven glass shall be provided over core insulation.

2.1.13.4 Individual pair triad shall be shielded. The shield shall be aluminium backed by glass mica/ PETP tape with the metallic side down helically applied with 25% overlap on either side and 100% coverage. Minimum shield thickness shall be as per IEC 60092. Drain wire shall be 0.5mm^2 (7/0.3mm dia). Multi-stranded bare tinned annealed copper conductor. Drain wire shall be in continuous contact with aluminium side of the shield.

2.1.13.5 Inner and outer sheath shall be made of low smoke, heat resistant, oil resistant and flame retardant material with oxygen index over 30, temperature index shall be over 250°C. Acid generation shall be maximum 20% by weight as per IEC 60754.

Smoke density rating not to exceed 60% as per ASTM D 2843.

2.1.13.6 The thickness of the sheath shall be as per IEC 60092. Inner and outer sheath colour shall be orange. A rip cord shall be provided for inner sheath.

2.1.13.7 Armour bedding over inner sheath shall be of special high oxygen index, low smoke halogen free fire resisting compound.

2.2 Electrical Characteristics

2.2.1 Maximum DC resistance of the conductor of the finished cable shall not exceed 12.3 OHM PER km at 20°C for cables with 1.5 mm^2 conductors and 39.7 OHM PER km at 20°C for cables with 0.5 mm^2 conductors.

2.2.2 CAPACITANCE

2.2.2.1 Mutual Capacitance for PVC Insulated cables

The mutual capacitance of between pairs/triads or adjacent cores shall not exceed of 250 pF / metre at a frequency of 1 KHz.

2.2.2.2 Mutual Capacitance for PE Insulated cables

The mutual capacitance between the pairs/triads shall not exceed of 100 pF / metre at a frequency of 1 KHz.

2.2.2.3 Capacitance between any core or screen

The capacitance between any core and screen shall not exceed a maximum of 400 pF / metre at a frequency of 1 KHz.

2.2.3 L/R ratio of adjacent core shall not exceed 40 uH / OHM for cables with 1.5 mm2 conductors and 25 micro h / OHM for cables with 0.5 mm^2 conductors.

2.2.4 The drain wire resistance including shield shall not exceed 30 OHM. I km.

2.2.5 Electrostatic noise rejection ratio of the finished cable shall be over 76 dB.

2.3 Type I (Single pair/Triad shielded).

2.3.1 Each core shall be 1.5 mm^2 made of 7 stranded annealed electrolytic copper conductor. Each strand shall be 0.53 mm dia.

2.3.2 Colour of core insulation shall be black and blue in pair and black, blue and brown in a triad.

2.3.3 All other specifications shall be as per clauses 2.1 and 2.2 of this specification.

2.4 Type-II (Multi-pair / Multi-triad cable with individual pair/triad shield and overall shield)

2.4.1 Conductor sizes shall be 0.5mm^2 made up of 7 strands of annealed electrolytic copper conductor. Each strand shall be of 0.3 mm diameter.

2.4.2 Overall twist of all pair/triads shall be as per vendor's standard.

2.4.3 A pair of communication wire shall be provided for multipair / multitriad cables. Each wire shall be 0.5 mm^2 of plain annealed single or multistrand copper conductor with 0.4 mm thick 85°C PVC insulation. Insulation shall be green and red colour coded.

2.4.4 A pair identification shall be with numbers at interval of not more than 250 mm

2.4.5 All other specifications shall be as per clauses 2.1. and 2.2 of this specification.

2.5 Type-III (Multi-pair / Multi-triad cable with only overall shield)

2.5.1 The cable shall be same as type-II cable, except that the individual pair/triad shall not have shielding.

2.6 **Type-IV** (Multi-pair /Multi-triad cable with individual pair shield and overall shield)

2.6.1 The cable shall be same as Type II, except conductor size shall be 1.5 mm^2 made of 7 stranded annealed electrolytic copper conductor. Each strand shall be of 0.53 mm dia.

2.7 **Type-V** (Multi-pair / Multi-triad cable with overall shield only)

2.7.1 The cable shall be same as type IV except that the individual pair/triad shall not have the shielding.

3.0 NAMEPLATE

3.1 Each cable drum shall be marked with the following information at a visible place;

a) Manufacturer's name
b) Type and size of the cable with cable indicated in material requisition.
c) Length of the cable in meters contained in the drum.
d) Gross weight
e) Drum number
f) Direction of rotation of drum for unwinding by means of an arrow.
g) Purchase order number.

4.0 INSPECTION AND TESTING

4.1 Unless otherwise specified purchaser reserves the right to test and inspect all the items at the vendors work in line with the inspection test plan for signal cables.

4.2 Vendor shall furnish raw material test certificates for conductor, PVC / PE etc to prove the quality and composition of the materials used for manufacturing the cable to the satisfaction of purchaser or their authorized representative during various stages of expediting and inspection.

4.3 Type test, routine test and acceptance tests shall be carried out as per relevant Indian Standard (IS), unless specified otherwise.

4.4 Type Test

4.4.1 Certificates from third party or purchaser's authorized representative for the following shall be furnished by vendor for cables similar to those being offered;

a) Flame retardant test on bunched cables.
b) Electrostatic noise rejection test
c) Fire resistance test

4.4.2 Vendor shall submit the following test certificates and test reports as per IS 10810 for each batch for purchaser's review:

a) Physical tests for insulation and outer sheath as given below as minimum:
i) Tensile strength and elongation at break
ii) Ageing in air oven.

iii) Shrinkage test
iv) Hot deformation
v) Loss of mass in air oven
vi) Heat shock test
vii) Thermal stability

b) Test for armouring wires/strips.
c) Annealing test (for copper)

4.5 Routine Tests

4.5.1 Each of the following tests shall be carried out by vendor during various stages of manufacture on each finished cable drum.

a) Spark test as per BS 5308 Part 2.
b) Conductor resistance
c) High voltage test as per BS 5308 Part 2
d) Armour resistance test (for mining cables).
e) Mutual capacitance and capacitance between any core or screen.
f) Inductance and L/R ratio.

4.6 Acceptance Tests

4.6.1 Following acceptance tests shall be carried out by vendor on representative samples taken from manufactured lot:

a) Finished cable dimensions
b) Conductor resistance
c) Thickness of insulation and sheath.
d) Tensile strength and elongation at break of insulation and sheath.
e) Pair twisting, laying and identification.
f) Shield overlap, drain wire resistance and continuity check.
g) Armour resistance test (for mining cables). h) Uniformity of zinc coating on armour.
i) Insulation resistance (volume resistivity) as per BS 5308 Part 2.
j) High voltage.
k) Test for rodent and termite repulsion.
1) Mutual capacitance and capacitance between any core or screen
m) Inductance and L/R ratio
n) Oxygen and Temperature index as per ASTM D 2863.
o) Flame retardant Test on single cable as per IS 10810 Part 61.
p) Acid Generation test IEC 60754 / IS 10810 Part 59 (for fire resistant cables)
q) Smoke density test ASTM D 2843 / IS 10810 Part 63 (for fire resistant cables)
r) Overall finish and drum length check.

4.7 Witness Inspection

4.7.1 Vendor shall offer all cables for pre-dispatch inspection to purchaser or their

authorized representative and following test/checks shall be carried out as minimum:

a) Acceptance tests as per clause 4.6 on representative samples.
b) Review of all certificates and test reports as indicated in clause 4.0.

4.8 Immediately after completion of electrical tests, the ends of the cable shall be sealed to prevent ingress of moisture with suitable PVC / rubber caps.

4.9 In the event no witness inspection is carried out by purchaser, the tests shall anyway be completed by the vendor and documents for the same shall be submitted to purchaser for scrutiny.

5.0 SHIPPING

5.1 Cables shall be dispatched in wooden drums securely battened, with take off end fully protected against damage.

6.0 REJECTION

6.1 Vendor shall prepare their offer strictly as per clause 1.2 of this specification and shall attach only those documents, which are specifically indicated in the material requisition.

6.2 Any offer not conforming to above requirements, shall be summarily rejected.

GAIL INDIA LIMITED

STANDARD SPECIFICATION

FOR

RTDS/TC/THERMOWELLS

GAIL-STD-IN-DOC-TS-009

0	18.01.2019	Issued for Bid	RKS	UNU	UNU	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Abbreviations:

AARH	Arithmetic Average Root Height
MAWP	Maximum Allowable Working Pressure
NPS	Nominal Pipe Size
NPT	National Pipe Thread
PTC	Performance Test Code
RTD	Resistance Temperature Detector

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1.0 GENERAL

1.1 Scope

1.1.1 This specification, together with the data sheets attached herewith covers the requirements for the design, materials, nameplate marking, inspection, testing and shipping of thermo-couples, RTDs and thermowells.

1.1.2 The related, standards referred to herein and mentioned below shall be of the latest editions prior to the date of the purchaser's enquiry:-

ANSI/ASME American National Standards Institute/American Society of Mechanical Engineers.

B1 .20.1	Pipe Threads General Purpose (Inch)
B16.5	Steel Pipe Flanges and Flanged Fittings NPS % through NPS24
B16.20	Metallic Gaskets for Pipe Flanges, Ring-Joint, Spiral wound and Jacketed.

API American Petroleum Institute

RP 551	Recommended Practice 551 -Process Measurement Instrumentation.

ASME

PTC 19.3	Performance Test Code-Temperature measurement
EN 10204	Inspection Documents For Metallic Products.
IEC -60079	Electrical Apparatus for Explosive Gas Atmosphere
IEC 60529	Degree of Protection Provided by Enclosures. (IP Code)
IEC 60751	Industrial Platinum Resistance Thermometer Sensor.
IEC 60854-2	Thermocouple Tolerances
IS-13947	Specification for Low Voltage Switch gears and Control gears.
IS-2148	Flame proof Enclosures for Electrical Apparatus for Explosive Gas Atmospheres - Flameproof Enclosures 'd'.
IS-7358	Specifications for Thermocouples
ISA	Instrumentation, Systems and Automation Society.
MC 96.1	Thermocouple Tolerances.

1.1.3 In the event of any conflict between this standard specification, job specification, data sheets, statutory regulations, related standards, codes etc. the following order of priority shall govern:

a) Statutory Regulations b) Data Sheets

c) Standard Specification d) Codes and Standards

1.1.4 In addition to compliance to purchaser's specifications, vendor's extent of responsibility shall include the following:

a) Purchaser's data sheets indicate the minimum acceptable material of construction for sensing element, thermowell etc. Alternate superior material of construction shall also be acceptable provided vendor assumes complete responsibility for the selected materials for their compatibility with the specified fluid and its operating conditions.

b) Vendor shall carry out the vibration analysis of thermowell as per ASME PTC 19.3 standard and shall provide suitable design for the thermowells wherever necessary.

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to vendor attached with the material requisition.

1.2.2 Whenever a detailed technical offer is required, vendor's offer shall include the following:

a) Compliance to the specifications.

b) Whenever the requirement of a detailed specification sheet for each tag number is specifically indicated, the specifications sheet shall provide all the details regarding type, construction and material of construction etc. of the temperature gauge and its accessories. The material specifications and units of measurement indicated in the specification sheets shall be to the same standards as those in purchaser's data sheets.

c) Proven references for each offered model in line with clause 1.2.3 of this specification whenever specifically indicated in purchaser's material requisition.

d) Deviations on technical requirements shall not be entertained. In case vendor has any valid technical reason to deviate, they must include a list of temperature gauges tag number wise, summing up all the deviations from the purchaser's data sheets and other technical specifications along with technical reasons for each of these deviations.

e) Catalogues giving detailed technical specifications, model decoding details and other information for each type of temperature gauge covered in the bid.

1.2.3 All items, as offered, shall be field proven and should have been operating satisfactorily individually for a period of minimum 4000 hours on the bid due date in the process conditions similar to those as specified in the purchaser's data sheets. Items with prototype design or items not meeting provenness criteria specified above shall not be offered.

1.2.4 Vendor shall quote for two years' operational spares, which shall include spare

elements, terminal blocks, gaskets etc. as a minimum.

1.2.5 All documentation submitted by the vendor including their quotation, catalogues, drawings, installation, operation and maintenance manuals etc., shall be in English language only.

1.3 Drawings and Data

1.3.1 Detailed drawings, data, catalogues and manuals required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of reproducible, prints and soft copies shall be dispatched to the address mentioned, adhering to the time limits indicated.

1.3.2 Final documentation consisting of data, installation and maintenance manuals etc. submitted by the vendor after placement of purchase order shall include the following as a minimum:

a) Specification sheet for each thermocouple / RTD and its accessories.
b) Certified drawings sheets for each thermocouple / RTD and its accessories, which shall provide dimensional details, internal constructional details, end connection details and material of construction.
c) Copy of type test certificates.
d) Copy of the test certificates for all the tests indicated in clause 4.0 of this specification.
e) Installation procedure for each thermocouple / RTD and its accessories.
f) Calibration and maintenance procedures including replacement of its internal parts wherever applicable.

2.0 DESIGN AND CONSTRUCTION

2.1 Thermocouples

2.1.1 The type of thermocouple shall be as specified in purchasers data sheets. However when the type of thermocouple is not specified in purchaser's data sheet, following shall apply:

Copper-Constantan (ISA-Type-T)	:	(-) 200 to 200°C
Chromel-Constantan(ISA-Type-E)	:	200 to 600°C
Chromel-Alumel (ISA-Type-K)	:	600 to 1200°C Platinum Rhodium-Platinum
(ISA Type-S)	:	600 to 1600°C

2.1.2 The thermocouple element shall be 18 AWG for all thermocouples, unless otherwise specified in purchaser's data sheet.

2.1.3 Thermocouple assemblies shall be furnished with threaded heads.

2.1.4 Unless otherwise specified, the assembly shall confirm to the following standards;

a) The heads shall be weatherproof to IP55 as per IEC-60529/IS-13947.
b) In case of flameproof construction, heads shall be flame proof as per IEC-60079/IS-2148 and weather proof to IP-55 as per IEC-60529/IS-13947.

2.1.5 The heads shall consist of a case, screwed on cover and terminal block. The thermocouple shall be screwed to the terminal block. Separate screw shall be provided on the terminal block for terminating the extension / compensating cables.

There shall be an extra terminal in the terminal block connected to the head for grounding the shield.

2.1.6 The case shall be suitable for mounting terminal blocks for single or duplex type thermocouple element assemblies.

2.1.7 A heat resistant and moisture proof asbestos free gasket shall be fitted between the case and cover. Head support chain (between case and cover) material shall be stainless steel.

2.1.8 The terminals shall be permanently and legibly identified for their polarity. The terminal block shall be permanently and legibly marked with the IEC letter code to designate the type of thermocouple. There shall be an extra terminal connected to the head for grounding.

2.1.9 The thermocouple assemblies shall be spring loaded.

2.1.10 The thermocouple properties and limits of error shall be as per IEC-60584-2.

2.1.11 Thermocouple shall be 316 Stainless Steel-sheathed magnesium oxide insulated, ungrounded type, unless otherwise specified. For beaded type thermocouple, material for sheath shall be SS316, as a minimum.

2.1.12 The design of thermocouple assemblies shall be such that on line replacement is possible.

2.2 Resistance Temperature Detectors

2.2.1 The type of RTD shall be as specified in purchaser's data sheet. In general RTD shall be 4 wire, Class A type with platinum element having 100 ohms resistance at 0°C, selected for temperature range of(-)200 to 650°C.

2.2.2 The element shall be of highly refined material of reference grade and shall have been stress relieved. RTD calibration shall be as per IEC-60751 -2.

2.2.3 The wire shall be wound on a ceramic core and immobilized against strain or damage. The winding shall be of bifilar type. The leads shall be copper up to terminal block.

2.2.4 The element shall be within a metal sheath, in a manner which provides good thermal transfer and protection against moisture. The sheath material shall be 316 Stainless Steel, unless otherwise specified.

2.2.5 The RTD assemblies shall be furnished with threaded heads. The heads shall consist of a case, screwed on cover and terminal block. The RTD shall be screwed to the terminal block. Separate screw shall be provided on the terminal block for terminating the incoming cable. There shall be an extra terminal in the terminal block connected to the head for grounding the shield.

2.2.6 The case shall he suitable for mounting terminal blocks for single or duplex type RTD element assemblies. The connecting terminals shall be properly numbered and shall be permanently and legibly identified.

2.2.7 The RTD assemblies shall be spring loaded.

2.2.8 A heat resistant and moisture proof gasket shall be fitted between the case and cover. The head support chain (between case and cover) shall be of stainless steel.

2.2.9 Unless otherwise specified, the assembly shall confirm to the following standards:

a) The heads shall be weather proof to IP-55 as per IEC-60529/IS-13947.
b) In case of flame proof construction, heads shall be flame proof as per IS-60079/IS-2148 & weather proof to IP-55 as per IEC-60529/IS-13947.

2.3 **Thermowells**

2.3.1 Unless otherwise specified, the thermowell material shall be 304 Stainless Steel, as a minimum. Alternate material as specified in Annexure-I shall also be acceptable subject to meeting process conditions specified in the data sheet.

2.3.2 Thermowells with immersion length up to 500 mm shall be machined out of forged bar-stock. Built-up thermowell with welded wall construction shall be acceptable for immersion length of greater than 500 mm, unless specified otherwise in purchaser's datasheet.

2.3.3 Thermowell flange material and rating shall be as specified in the data sheet.

2.3.4 All thermowell weld joints shall be full penetration weld type only.

2.3.5 Thermowell immersion length shall be as specified in purchaser's data sheet. Where immersion length is not specified in purchaser's data sheet, following shall govern:

Line Size	Immersion length
Up to 6"	280 mm
8" and above	320 mm
Equipments	400 mm

The immersion length of built-up thermowells shall be as per actual requirements.

2.3.6 Unless otherwise specified, the following shall govern:

a) Threaded end connections shall be NPT as per ANSI/ASME B 1.20.1 b) Flanged end connections shall be to ANSI/ASME B 16.5

c) Where ring type joint flanges shall have been specified, groove shall be suitable for octagonal rings as per ANSI/ASME B 16.20.

d) Flange face finish shall be as per clauses 6.4.4.1, 6.4.4.2 and 6.4.4.3 to ANSI/ASME B 16.5. The face finish as specified in the datasheets, shall be as follows:

125AARH : 125to250AARH
63 AARH : 32 to 63 AARH

2.3.7 All the thermowells in oxygen and chlorine service shall be thoroughly degreased using reagents like trichloro-ethylene or carbon tetrachloride.

3.0 NAME PLATE

3.1 Thermocouple / RTD's

3.1.1 Each thermocouple / RTD assembly shall be provided with a stainless steel nameplate attached firmly to it, furnishing the following information:

a) Tag number as per purchaser's data sheets.
b) Thermocouple type as per ISA / RTD element type.
c) Type of protection whether sheathed or beaded
d) Grounded or Ungrounded

3.2 Thermowell

3.2.1 The following information shall be punched on the extension of the thermowell:

a) Tag number as per purchaser's data sheets.
b) Thermowell material as per purchaser's data sheets.
c) Thermowell immersion length 'U'.

3.2.2 The following information shall be punched on the thermowell flange at a visible place:

a) Nominal flange size in inches and rating in pounds.
b) Flange material as per purchaser's data sheets.

4.0 INSPECTION AND TESTING

4.1 Unless otherwise specified, purchaser reserves the right to test and inspect all the items at the vendor's works inline with inspection test plan for thermocouples, RTDs and thermowells.

4.2 Vendor shall submit following test certificates and test reports for purchasers review.

a) Material test certificate as per clause 3. IB of EN 10204 for thermowells and flanges and as per clause 2.2 for thermocouples and RTDs.
b) Dimensional test report.
c) For instruments with rating of 600# and above, certificate of radiography / X-ray for welded joints. Dye penetration test certificate shall be provided for joints where Radiograph / X-ray is not possible.
d) Certificate for concentricity of bore.
e) Hydrostatic test report as per clause 4.3 of this specification.
f) Calibration report for thermocouples / RTD's.
g) IBR test report in form **III** C for Thermowells covered under IBR certification.
h) Certificate from any statutory authority for explosion proof and weatherproof construction of thermocouples / RTD's head as applicable.

4.3 Hydrostatic Test

4.3.1 Each thermowell made of bar stock or built-up type shall be subjected to hydrostatic test for a time period of 20 minutes at the following pressures:

a) Inside of the well at 100 kg / cm^2 upto 600# flange rating and at 200 kg/cm^2 above 600# or up to flange rating whichever is higher
b) Outside of the well as per ANSI flange rating.

During and after the hydrostatic test, the thermowell shall not show any leaks or rupture.

4.4 Witness Inspection

4.4.1 All Thermocouples, RTD's and thermowells shall be offered for pre-dispatch inspection for following as a minimum.

a) Physical dimensional verification and workmanship.
b) Hydrostatic test on thermowells at random.
c) Calibration including establishing accuracy and repeatability over the entire ran

on representative samples of thermocouples / RTD's.

d) Insulation resistance of 100 M ohms shall be measured at random at 500 V DC except for grounded thermocouple.

e) Review of all certificates and test reports as indicated in clause 4.2 of this specification.

4.4.2 In the event when the witness inspection is not carried out by purchaser, the tests shall anyway be completed by the vendor and documents for the same submitted for scrutiny to the purchaser.

5.0 SHIPPING

5.1 Proper care shall be taken in shipping. All items shall be adequately packed to withstand shipping conditions, without damage.

5.2 All thermowells in oxygen and chlorine service shall be separately packed along with a certificate indicating 'CERTIFIED FOR OXYGEN/CHLORINE SERVICE', as applicable.

5.3 All threaded and flanged openings shall be suitably protected to prevent entry of foreign material.

6.0 REJECTION

6.1 Vendor shall prepare their offer strictly as per clause 1.2 of this specification and shall attach only those documents, which are specifically indicated in the material requisition.

6.2 Any offer not conforming to above requirements, shall be summarily rejected.

ANNEXURE – 1

S.No	Item	Specified Material of Construction	Alternate Material of Construction
1	Thermowell	SS 304	SS 304L,SS 316, SS316L, SS 316Ti
		SS 316	SS 316L, SS 316 Ti

GAIL INDIA LIMITED

STANDARD SPECIFICATION

FOR

JUNCTION BOXES AND CABLE GLANDS

GAIL-STD-IN-DOC-TS-010

0	18.01.2019	Issued for Bid	RKS	UNU	UNU	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

CONTENTS

Abbreviations:

NPT	National Pipe Thread
OD	Outer Diamter
Sq.mm	Square millimeter (mm^2)

1.0 GENERAL

1.1 Scope

1.1.1 This standard specification, together with the data sheets attached herewith, covers the requirements for design, materials, nameplate marking, testing and shipping of junction boxes and cable glands which include the following types:

a) Electrical junction boxes
b) Pneumatic j unction boxes
c) Cable glands (whenever specified)

1.1.2 The related standards referred to herein and mentioned below shall be of the latest editions prior to the purchaser's enquiry;

ANSI / ASME	**American National Standards Institute / American Society of Mechanical Engineers.**
	B1.20.1 Pipe Threads, General Purpose (Inch).
EN 10204	Inspection Documents For Metallic Products.
IEC-60079	Electrical Apparatus for Explosive Gas Atmosphere.
IEC-60529	Degrees of Protection Provided by Enclosures. (IP Code)
IS-5	Colours for ready mixed paints and enamels.
IS-13947	Specification for Low Voltage Switchgear and Control gear.
IS-2148	Electrical Apparatus for Explosive Gas Atmospheres - Flame proof Enclosures 'd'.

1.1.3 In the event of any conflict between this specification, data sheets, related standards, codes etc. the following order of priority shall govern:

a) Statutory Regulations
b) Data Sheets
c) Standard Specification
d) Codes and Standards

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to vendor attached along with the material requisition.

1.2.2 Deviation on technical requirements shall not be entertained.

1.2.3 Whenever a detailed technical offer is required, vendor's quotation shall include the following;

a) Compliance to the specifications.
b) Whenever the requirement of a detailed specification sheet for each item is

specifically indicated, the specification sheet shall provide information regarding type, construction material, size and number of cable entries etc. The material specifications and unit of measurement for various parts in vendor's specification sheets shall be to the same standards as those indicated in purchaser's data sheets. Drawing for each type of junction box with dimensional details (in millimetres) showing the terminal, entries arrangement, mounting details etc.

c) Proven references for each offered model in line with clause 1.2.4 of this specification whenever specifically indicated in purchaser's specification.

d) Copy of certificate for approval of flameproof junction boxes, adapter, plug and cable glands from local statutory authority as applicable such as Chief Controller of Explosive (CCE), Nagpur or Director General Mines Safety in India along with:

i) Test certificate from recognized testing house like CMRI/ERTL etc. as per relevant Indian Standard for all Indian manufactured items or items requiring DGMS approval.

ii) Certificate of conformity from agencies like LICE, BASEEFA, PTB, CSA, UL etc. for compliance to ATEX or any recognized standard for items manufactured outside India.

f) Catalogues in English giving detailed technical specifications, model decoding details and other related information for each type of junction box and cable gland covered in the bid.

1.2.4 All items, as offered, shall be field proven and should have been operating satisfactorily individually for a period of minimum 4000 hours on the bid due date in the process conditions similar to those as specified in the purchaser's data sheet. Items with proto-type design or items not meeting provenness criteria specified above shall not be offered.

1.2.5 All documentation submitted by the vendor including their drawings, installation manual etc shall be in English language only.

1.3 Drawings and Data

1.3.1 Detailed drawings, data, catalogues and manuals required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of reproducible, prints and soft copies, shall be sent to the address mentioned, adhering to the time limits indicated.

1.3.2 Final documentation consisting of design data and installation manual submitted by the vendor after placement of purchase order shall include the following, as a minimum;

a) Specification sheet for each junction box and its accessories like cable glands etc.

b) Certified drawing sheets for each junction box and its accessories, which shall provide dimensional details, internal constructional details (general

arrangement details), and material of construction.

c) Copy of type test certificates.

d) Copy of test certificates for all the tests indicated in clause 4.0 of this specification.

e) Installation procedure for junction boxes and its accessories.

2.0 DESIGN AND CONSTRUCTION

2.1 Junction Boxes

2.1.1 Junction boxes shall be either of the following type as specified in data sheets.

b) Weather proof j unction boxes.

b) Weather proof and flameproof junction boxes.

No other type of junction boxes shall be offered / supplied unless specifically indicated otherwise.

2.1.2 Unless otherwise specified, the enclosure shall conform to the following standards:

Weatherproof housing : IP 55 to IEC-60529/IS-13947
Flameproof housing : Flameproof/Ex (d) as per IEC-60O79/IS-2148.

2.1.3 Number of entries and their location shall be as per data sheets. Junction boxes with top entries shall not be offered. The size of cable entries shall be as per the cable sizes indicated in the data sheet.

2.1.4 Multi-pair junction boxes shall be provided with telephone sockets and plugs for connection of hand-powered telephone set.

2.1.5 Electrical Junction Boxes

a) The material of construction of electrical junction boxes shall be die-cast aluminium of minimum 5 mm thick (LM-6 alloy).

b) Weather proof junction box shall have hinged type door with neoprene gasket, which shall be fixed to the box by plated countersunk screws.

c) Flameproof junction box shall have detachable cover, which shall be fixed to the box by means of cadmium plated triangular head/hexagonal head screws.

d) Flameproof junction boxes for signal, alarm and control shall have the following warning engraved/integrally cast on the cover; "Isolate power supply elsewhere before opening"

e) Power junction boxes (junction boxes for power supply cable / distribution) shall have either the warning cast or shall have warning plate with following marking; "Isolate power supply elsewhere before opening". Unless otherwise indicated in the job specification, power junction boxes shall be suitable for incoming armoured power cable up to 150 sq.mm conductor size.

f) Terminals shall be spring loaded, vibration proof, clip-on type, mounted on nickel plated steel rails complete with end cover and clamps for each row.

g) All terminals used in signal, alarm and control junction boxes shall be suitable for accepting minimum 2.5sq.mm copper conductor, in general.

h) Terminal used in power power junction boxes / power supply distribution box shall be suitable for accepting conductor size of 4 Sq. mm to upto 120 sq. mm. Exact requirement shall be specified in job specification. Higher size of terminals shall be provided when indicated. Bus bar terminals shall be provided for conductor size 50 sq. mm and above. Suitable size of lugs shall be provided to suit conductor size specified.

i) Each junction shall have minimum of 30% spare terminal of those actually required to be utilized. Unless higher number of terminals are specified in the purchaser's data sheet, the number of terminals for various types of junction boxes shall be as follows;

24	Nos.	for	6	pair	junction box.
48	Nos.	for	12	pair	junction box
36	Nos	for	6	triad	junction box.
48	Nos.	for	8	triad	junction box.

j) Terminals shall be identified as per the type of input signal indicated in data sheets e.g all terminals for intrinsically safe inputs shall be blue while others shall be grey in colour.

k) Junction boxes shall be provided with external earthing lugs.

l) Sizing shall be done with due consideration for accessibility and maintenance in accordance with the following guidelines;

i) 50 to 60 mm gap between terminals and sides of box parallel to terminal strip for upto 50 terminals and additional 25 mm for each additional 25 terminals.

ii) 100 to 120 mm between two terminal strips for upto 50 terminals and additional 25mm for each additional 25 terminals.

iii) Bottom/top of terminal shall not be less than 100 mm from bottom / top of the junction box.

2.1.6 Pneumatic Junction Boxes

a) Pneumatic junction boxes shall be made of 3 mm thick hot rolled steel. They shall have necessary neoprene gasket between door and body. Door shall be flush with the box and shall be hinged type and provided with wing nuts.

b) Single tube entries shall be suitable for 6 mm O.D copper tube with bulk head fittings. Multi tube bundle entry shall be suitable for the data furnished in data sheets.

2.1.7 Painting

a) Surface shall be prepared for painting. It shall be smooth and devoid of rust and scale.

b) Two coats of lead-free base primer and two final coats of lead free epoxy based paint shall be applied both for interior and exterior surfaces.

c) The colour shall be as specified in data sheets. However, following

philosophy shall be followed, in general:

(i) Light blue for all intrinsically safe junction boxes.

(ii) Light grey for all others

2.2 Cable glands, Plugs and Reducers/Adaptors

2.2.1 Cable glands shall be supplied by vendor whenever specified.

2.2.2 Cable glands shall be double compression type for use with armoured cables. The cable glands shall be of nickel plated brass, as a minimum.

2.2.3 The cable glands shall be weatherproof. Whenever specified they shall also be flameproof and certificate for the specified electrical area classification specified in the data sheets.

2.2.4 Cable glands shall be supplied to suit the cable dimensions indicated along with tolerances in data sheets. Various components like rubber ring, metallic ring, metallic cone and the outer / inner nuts etc. shall be capable of adjusting to the indicated tolerances of cable dimensions.

2.2.5 Reducers / adapters shall be supplied as per details indicated in data sheets. They shall be nickel-plated brass, as a minimum. These shall also be weatherproof and / or flame proof wherever specified and certified for the electrical area classification specified in the data sheets.

2.2.6 Plugs shall be provided wherever specified. They shall be of nickel-plated brass.

2.2.7 Plugs shall be certified flameproof when used with flameproof junction boxes.

3.0 NAME PLATE

3.1 Each junction box shall have an anodized aluminium nameplate permanently fixed to it at a visible place furnishing the following information;

a) Tag number as per purchaser's data sheet.

b) Manufacturer's serial number and model number.

c) Manufacturer's name/trade mark.

d) Stamp of certifying agency with certificate number.

e) Electrical area classification.

4.0 INSPECTION AND TESTING

4.1 Unless otherwise specified, purchaser reserves the right to test and inspect all the items at the vendor's works in line with inspection test plan for junction boxes and cable glands.

4.2 Vendor shall submit following test certificates and test reports for purchaser's review:

a) Material test certificates as per clause 2.2 of EN 10204

b) Pressure test on castings for flameproof junction boxes.

c) Dimensional test report.

d) High voltage and insulation resistance test report.

e) Air leak test report on pneumatic junction boxes.

f) Certificate from statutory body for suitability to install in specified hazardous area.

4.3 Witness Inspection

4.3.1 All junction boxes, cable glands and other accessories shall be offered for pre-dispatch inspection for the following, as a minimum;

a) Physical dimensional verification and workmanship on representative samples.
b) High voltage and Insulation resistance test on representative samples.
c) Air leak test report on representative samples of pneumatic junction boxes.
d) Review of all certificates and test reports as indicated in clause 4.2 of this specification.

4.3.2 In the event when witness inspection is not carried out by purchaser, the tests shall anyway be completed by the vendor and documents for the same shall be submitted for scrutiny of purchaser.

5.0 SHIPPING

5.1 All threaded openings shall be suitably protected to prevent entry of foreign material.

5.2 All threaded components shall be protected with plastic caps to prevent damage of threads.

6.0 REJECTION

6.1 Vendor shall prepare their offer strictly as per clause 1.2 of this specification and shall attach only those documents, which are specifically indicated in the material requisition.

6.2 Any offer not conforming to above requirements, shall be summarily rejected.

GAIL INDIA LIMITED

STANDARD SPECIFICATION

FOR

INSTRUMENT TUBE FITTINGS

GAIL-STD-IN-DOC-TS-011

0	18.01.2019	Issued for Bid	RKS	UNU	UNU	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

CONTENTS

Abbreviations:

NPS	Nominal Pipe Size
NPT	National Pipe Threads

1.0 GENERAL

1.1 Scope

1.1.1 This standard specification, together with the data sheets attached herewith, covers the requirements for the design, materials, inspection, testing and shipping of instrument tube fittings which include the following types:

a) Stainless steel compression fittings (for stainless steel tube)

b) Brass compression fittings (for copper tube)

1.1.2 The related standards referred to herein and mentioned below shall be of the latest editions prior to the date of the purchaser's enquiry: -

ANSI/ASME American National Standards Institute/American Society of Mechanical Engineers

B 1.20.1	Pipe Threads General Purpose (Inch).
B 16.11	Forged Steel Fittings - Socket Welding and Threaded.

BS-4368 Carbon and Stainless Steel Compression Couplings for Tubes.

EN 10204 Inspection Documents For Metallic Products.

IS-319 Specification for free cutting Brass Bars, Rods and Sections.

ISA Instrumentation, Systems and Automation Society.
RP 42.1 Nomenclature for Instrument Tube Fittings.

1.1.3 In the event of any conflict between this standard specification, data sheets, statutory regulations, related standards, codes etc., the following order of priority shall govern:

a) Statutory Regulations

b) Data Sheets

c) Standard Specification

d) Codes and Standards

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to the vendor attached along with the material requisition.

1.2.2 Whenever a detailed technical offer is required, vendor's quotation shall include the following;

a) Compliance to the specifications.

b) Whenever specifically indicated, detailed specification sheet for each item, which shall provide the information regarding type, size, material of construction etc. of the items. The material specifications and units of measurement for various items in vendor's specification sheets shall be to the same standard as those indicated in purchaser's data sheet.

c) Deviations on technical requirements shall not be entertained. In case vendor has any valid technical reason to deviate, they must include a list of deviations item wise, summing up all the deviations from the purchaser's data sheets and other technical specification along with technical reasons for each of these deviations.

d) Catalogues giving detailed technical specifications, model decoding details and other information for each type of instrument tube fitting covered in the bid.

1.2.3 All documentation submitted by vendor including their quotation, catalogues, drawings, installation, operation and maintenance manuals etc., shall be in English language only.

2.0 DESIGN AND CONSTRUCTION

2.1 Stainless Steel Tube Fittings

2.1.1 Nomenclature of all tube fittings shall be as per ISA RP 42.1.

2.1.2 Fittings shall be of flare less compression type having four-piece (for double compression type) construction consisting of two ferrules, nut and body or three piece (compression type) construction consisting of single ferrule, nut and body suitable for use on tubes of specified material for example stainless steel tubes conforming to ASTM A269 TP 316L with hardness in the range of HRB 70 to 79.

2.1.3 All parts of the tube fittings shall be of 316 Stainless Steel unless specified otherwise.

2.1.4 Hardness of the ferrules shall be in the range of HRB 85-90 so as to ensure a hardness difference of the order of 5 to 10 between tube and fittings for better sealing.

2.1.5 Nuts and ferrules of a particular size shall be interchangeable for each type.

2.1.6 Spanner hold shall be metric.

2.1.7 Threaded ends of fittings shall be NPT as per ANSI B 1.20.1.

2.1.8 Specific techniques like silver plating shall be used over threading in order to avoid jamming and galling.

2.1.9 Ferrule finish and fitting finish shall be such that there is no abrasion/galling when the nut is tightened.

2.1.10 All instrument tube fittings in oxygen and chlorine service shall be thoroughly degreased using reagents like trichloro-ethylene or carbon tetrachloride. End connection shall be plugged after degreasing process in order to avoid entrance of grease or oil particles.

2.2 **Copper Tube Fittings**

2.2.1 Nomenclature of all tube fittings shall be as per ISA RP 42.1.

2.2.2 Fittings shall be of flare less compression type and of three-piece construction consisting of ferrule, nut and body suitable for use on copper tubes conforming to ASTM B68 /B68M, hardness not exceeding HRB 50.

2.2.3 All parts shall be manufactured from brass as per IS 319 bar stock and nickel plated.

2.2.4 For better grip, vendor shall maintain hardness difference between tube and ferrule and indicate the same along with the offer.

2.2.5 Threaded ends of fittings shall be NPT as per ANSI B

2.2.6 Spanner hold shall be metric.

3.0 NAMEPLATE

3.1 No separate nameplates are required on the fittings. However, manufacturer's name/trademark should be punched on a visible place on the body of each fitting for easy identification.

4.0 INSPECTION AND TESTING

4.1 Unless otherwise specified, purchaser reserves the right to test and inspect all items at vendor's works, inline with the inspection test plan for instrument tube fittings.

4.2 Vendor shall submit following test certificates and test reports for purchaser's review:

4.2.1 Type test reports for following tests in accordance with BS-4368 Part IV:

a) Hydrostatic proof pressure test.

b) Minimum hydrostatic burst pressure test.

c) Disassembly and reassembly test.

d) Minimum static gas pressure (vacuum) test.

e) Maximum static gas pressure test.

f) Hydraulic impulse and vibration test.

4.2.2 Material test certificates as per clause 3.1 B of EN 10204.

4.2.3 Routine test reports for following tests:

a) Hydrostatic Test

Instrument tube fittings shall be hydrostatically tested at ambient temperature at test pressures given in Annexure 1 of this specification. During and after the hydrostatic test, the tube fittings shall not show any leakage or rupture.

b) Pneumatic pressure test

The fittings shall be tested at 7 kg/cm^{2}g of dry air. There shall not be any visible leakage when immersed in water or coated with a leak detection solution.

c) Disassembly and reassembly test.

d) Hardness verification:

Hardness test shall be carried out on each rod used for machining ferrules. Vendor shall ensure that after machining, the finished ferrules shall meet the required hardness given in the specification.

e) Dimensional test report

4.3 **Witness Inspection**

4.3.1 All fittings shall be offered for pre-dispatch inspection for the following as a minimum:

a) Physical dimensional verification and workmanship on representative samples.

b) Hydrostatic and pneumatic tests as per clause 4.2.3 of this specification on representative samples.

c) Hardness verification as per clause 4.2.3 of this specification.

d) Disassembly and reassembly test on representative samples.

e) Review of all certificates and test reports as indicated in clause 4.2 of this specification.

4.3.2 In the event when no witness inspection is carried out by purchaser, vendor shall anyway complete the tests and test reports for the same shall be submitted to purchaser for scrutiny.

5.0 SHIPPING

5.1 All threads/ends shall be protected with plastic caps to prevent damage/entry of foreign matter.

5.2 All the fittings in oxygen and chlorine service shall be separately packed along with a certificate indicating 'SUITABLE FOR OXYGEN/CHLORINE SERVICE', as applicable.

6.0 REJECTION

6.1 Vendor shall prepare their offer strictly as per clause 1.2 of this specification and shall attach only those documents, which are specifically indicated in the material requisition.

6.2 Any offer not conforming to the above requirements, shall be summarily rejected.

ANNEXURE - 1

HYDROSTATIC TEST PRESSURES

FOR INSTRUMENT TUBE FITTINGS

Sr. No.	Size of Tube Fittings	Material	Line Pressure Class	Hydrostatic Test Pressure
1	6mm and ½"	Stainless Steel	≤ 600#	153 Kg/cm²g
2	6mm and ½"	Stainless Steel	≥ 900# to ≤ 1500#	383 Kg/cm²g
3	¼" and 3/8"	Brass	-	80 Kg/cm²g

GAIL INDIA LIMITED

STANDARD SPECIFICATION

FOR

CONTROL PANEL AND ACCESSORIES

GAIL-STD-IN-DOC-TS-012

0	22.01.2019	Issued for Bid	RKS	UNU	UNU	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

CONTENTS

Abbreviations:

MWP	Maximum Working Pressure
NPT	National Pipe Threads
LED	Light Emitting Diodes

1.0 GENERAL

1.1 Scope

1.1.1 This specification, together with the data sheets covers the requirements for the design, materials, fabrication, wiring, painting, nameplate marking, inspection & testing, shipment and site activities including installation in control room of main control panels and accessories.

1.1.2 The related standards referred to herein and mentioned below shall be of the latest editions prior to the date of the purchaser's enquiry:

ANSI/ASME American National Standards Institute/American Society of Mechanical Engineers.

B 1.20.1	Pipe Threads General Purpose (Inch)
B 16.5	Pipe Flanges and Flanged Fittings NPS1/2 through NPS24
B16.20	Metallic Gaskets for Pipe Flanges, Ring Joint, Spiral wound and Jacketed.

API American Petroleum Institute

MPMS	Manual of Petroleum Measurement Standards
RP 552	Transmission Systems EN 10204

EN 10204 Inspection Documents for Metallic Products

NFPA-496 National Fire Protection Association Purged and Pressurized Enclosure for Electrical Equipment.

IEC-60079 Electrical Apparatus for Explosive Gas Atmosphere.

IEC-60529 Degrees of Protection Provided by Enclosures. (IP Code)

IEC-61000-4 Electromagnetic Compatibility (EMC) Part 4: Testing and Measurement Techniques.

IS-5 Colours for ready mixed paints and enamels.

IS-2062 Steel for General Structural Purposes.

IS-13947 Specifications for Low Voltage Switchgears and Control gears.

IS-2148 Electrical Apparatus for Explosive Gas Atmospheres-Flameproof Enclosures 'd'

1.1.3 In the event of any conflict between this standard specification, data sheets, statutory regulations, related standards, codes etc., the following order of priority shall govern:

a) Statutory regulations
b) Datasheets
c) Standard specification
d) Codes and standards

1.1.4 In addition to compliance to purchaser's specification in totality, vendor's extent of responsibility shall include the following:

a) Vendor shall be responsible for panel front arrangement including proper location and spacing of instruments and accessories like switches, push buttons, lamps, terminal blocks, supporting steel members, wiring raceways etc., from the point of view of accessibility and ease of maintenance based on the indicative drawings/schemes furnished by the purchaser.
b) Vendor shall be responsible for safe custody of the free issue items issued by the purchaser. Any short supply or damage in free issue items shall be reported to the purchaser at the time of receipt. Otherwise the items shall be deemed to have been supplied in good condition.
c) Vendor shall comply with the complete scope of work and supply of items as per the requirements specified in the material requisition.

1.2 **Bids**

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to vendor attached with the material requisition.

1.2.2 Whenever a detailed technical offer is required, vendor's quotation shall include the following:

a) Compliance to the specifications.
b) Whenever specifically indicated, a detailed specification sheet for each item, which shall provide information regarding type, construction, performance specification etc. of items being supplied by vendor. The material specifications and units of measurement of various items in vendor's specification sheets shall be to the same standards as those in purchaser's data sheets.
c) Proven references for each offered type of item/model inline with clause 1.2.3 of this specification.
d) Catalogues giving detailed technical specifications, model decoding details and other related information for each type of item covered in the bid.
e) A copy of approval for flame proof enclosure/intrinsic safety, wherever specified, from local authorities which is Chief Controller of Explosives (CCE), Nagpur or Director

General of Mines Safety (DGMS) in India, for the main control panel and accessories installed in electrically hazardous area along with:

i) Test certificate from recognized test house like CMRI/ERTL etc. for flameproof enclosure/intrinsic safety, as specified in the data sheet, as per relevant standards for all Indian manufactured equipments or for items requiring DGMS approval.

ii) Certificate of conformity from agencies like LCIE, BASEEFA, PTB, CSA, UL etc. for compliance to ATEX directives or other equivalent standards for all equipments manufactured outside India.

f) List of sub-vendors of items which are part of this enquiry but not manufactured by panel vendor. The sub-vendor list shall be subject to approval by purchaser.

g) A production schedule in the form of bar chart indicating various milestones such as completion of design drawings, material procurement, fabrications, assembly etc. and delivery dates along with the present shop load and capacity data.

h) Approximate overall shipping dimensions and weight of each panel and associated equipment.

i) Deviations on technical requirements shall not be entertained. In case vendor has any valid technical reason to deviate, they may include a list of deviations, item wise, summing up all the deviations, from the purchaser's data sheets and other technical specifications along with the technical reasons for each of these deviations.

1.2.3 All items, as offered by the vendor, shall be field proven and should have been operating satisfactorily individually for a period of minimum 4000 hours on the bid due date in the conditions similar to those as specified in the purchaser's data sheets. Items with prototype design or items not meeting provenness criteria specified above shall not be offered.

1.2.4 Vendor's quoted price shall be firm for ± 10% variations in the scope of work pertaining to various accessories supplied by him. However this shall not include any extra panels or equipment.

1.2.5 Vendor's quotation, catalogues, drawings, installation, operation and maintenance manual etc. shall be in English language only.

1.2.6 Vendor shall also quote for the following:

a) Supply of at least one kilogram of paint for final touch up at site.

b) Two years operational spares for each panel and accessories, which shall include lamps, push buttons etc.

c) Any tools and tackles needed for maintenance work. Vendor must certify in their offer in case no special tools are necessary for the offered main control panels.

d) Unit prices for the following items:

i) Each individual item/accessory like relay, timer, push button etc.

ii) Installation and wiring of each item to be supplied by purchaser/vendor.

iii) Dummy panel section-unwired.

iv) Blank semi-graphic section.

v) Unit cut out rates.

1.3 Drawing and Data

1.3.1 Detailed drawings, data, catalogues and manuals required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of prints, soft copies and reproducible shall be despatched to the address mentioned, adhering to the time limits indicated.

1.3.2 Basic engineering drawings required for preparation of bid are attached with the enquiry. After placement of purchase order, purchaser shall provide certified final dimensional drawings and catalogue information for all free issue items supplied by the purchaser.

1.3.3 Final documentation consisting of design data, installation manual, maintenance manual etc. submitted by the vendor after placement of purchase order shall include the following, as a minimum;

a) Specification sheet for control panels, instruments and accessories.

b) Certified drawings for each control panel, which shall provide following details:

i) Control panel front arrangement drawing showing all dimensions including bezel/cut out dimensions.

ii) Loop wiring drawings showing the terminal numbers of each instrument/ accessory used in the wiring.

iii) Ladder drawings and relay wiring drawings showing terminal numbers for interlock/shutdown.

iv) Power supply distribution drawings with terminal numbers, incoming/ outgoing feeder size, fuse and isolator rating etc.

c) Vendor shall provide test certificates for all the tests indicated in Clause 4.0 of this specification.

d) Calibration and maintenance procedure including replacement of instruments and accessories in vendor scope, whenever it is applicable.

2.0 DESIGN AND CONSTRUCTION

2.1 Control panel and accessories shall be designed and fabricated in accordance with the drawings/data sheets enclosed with the Enquiry. Applicable standards and codes shall include relevant sections of API-MPMS, API RP 552.

2.2 The design of the electronic instruments, relays etc. shall be in compliance with electromagnetic compatibility requirements as per IEC 61000-4.

2.3 Construction

2.3.1 Control panels shall generally be 2100 mm high and 1000 mm deep and shall be mounted on 100mm high channel base. Width of the panels shall be 1200 mm in general, however it may vary as per actual requirements.

2.3.2 Control panel shall be fabricated in best workmanship manner with 3mm thick cold rolled steel sheets. Steel sheets for panels, semigraphic and accessories shall be cut on a squaring shear to ensure tight flush joint when butted together. Adjacent panels are bolted together with cadmium plated bolts and nuts. Bolts or screws shall not be exposed on the face of the panel. Welded coupling of panel section is not allowed.

Adjacent panels shall be assembled with face flush. Gaps or cracks shall not be visible from the front of assembled panels.

2.3.3 Where specified vendor to provide one digital clock on the panel front. Clock display shall be seven segments LED with AM/PM or 24-hour mode, which shall be field selectable. Display shall be visible from a distance of 7 metres arc covering an angle of minimum 120°.

2.3.4 All exposed surfaces in plain view shall be perfectly level, smooth and free from any protrusions and tool or clamp marks. All edges including cut outs shall be ground smooth.

2.3.5 Rear of each panel section shall have a steel framework assembled to it for supporting instruments, raceways and other accessories like power distribution boxes etc. Panel stiffners shall be welded to the rear of the panel and shall not interfere with instrument installation. All structural shapes of steel members shall be as per IS-2062.

2.3.6 When specified, panels/cabinets shall be provided with hinged lift off type doors with gaskets and non-lockable flush type door handles. Door switches operated fluorescent lamps shall be provided for all closed panels/cabinets.

2.3.7 All cable entries to the panels and accessories shall be through single compression type cable glands. Removable gland plates shall be provided at the bottom of all panels and accessories for cable entry.

2.3.8 One telephone socket, and 110V 50 Hz/ 230V 50 Hz plug in outlets shall be provided for every three panel sections.

2.3.9 Semigraphic displays shall be screen printed as per approved drawings, on the front of fibre glass or back of transparent acrylic sheet as specified in material requisition and screwed to a steel backplate of indicated thickness. Semigraphic background colour shall be same as that of control panel.

2.3.10 Where specified LEDs shall be provided on the semigraphic section complete with all wiring brought to terminal boxes located on the framework of semigraphic section. A redundant power supply unit with 100% spare capacity for each power supply shall be provided by vendor for LEDs operation.

2.3.11 After completing fabrication of panels and semigraphics, semigraphics shall be erected and bolted to the top of the panel sections. Suitable angles and tees shall be provided between top of panel sections and bottom of semigraphic sections and at the top of semigraphics. Any defect/misalignment of the assembly shall be rectified before first coat of painting.

2.3.12 Lifting eyebolts shall be provided for each panel.

2.3.13 Normal mounting heights on panel of instruments (centre lines of instruments to floor) shall conform to the following, with minor adjustments depending upon instruments selected:

1	**Instruments**	**Bottom Row Middle Row Top Row**	**1100mm 1350mm 1600mm**
2	**Annunciators**	**-**	**1950mm**
3	**Electrical push buttons, Selector switches**	**-**	**700mm**

2.3.14 Panel layout shall be made considering proper accessibility and maintenance.

2.4 Painting

2.4.1 The entire surface of panels and accessories, comprising front, rear and sides shall be treated and painted as follows:

a) All surfaces including structures shall be sand blasted and grinded until they are smooth and free of scale, rust etc.

b) Chemical treatment shall be done to remove rust, oil, entrapped impurities and other foreign materials.

c) If necessary, suitable filler shall be applied to all pits and blemishes on the surfaces.

d) The front surface of the panels shall be painted with three coats of sealing primer and surfacer. The entire surface shall be wet sanded between coats. Two coats of finish paint of high-grade lacquer enamel shall be given at shop.

e) All other surfaces including those of accessories shall be painted with two coats of sealing primer and surfacer and two coats of lacquer enamel finish paint.

f) A final coat of finish paint of high grade lacquer enamel shall be given at site after assembly and filling of front panel butt joints with suitable filler, to present a continuous panel surface.

g) The finish of the final coat shall be of semi-gloss texture to minimise light reflection.

2.4.2 Unless otherwise specified, exterior portion of all panels and closed cabinets shall have a colour of opaline green shade ISC No.275 (RAL 6019) as per IS 5. Panel rear surface, frame works and bulkhead plates/gland plates shall have a finish colour of pale cream shade ISC No.352 (RAL 1015) as per IS 5. Channel base shall be of black colour.

2.5 Electrical System

2.5.1 General Requirements

2.5.1.1 All equipment and wiring in control room shall be of general-purpose type unless otherwise specified.

2.5.1.2 All wiring shall confirm to API-MPMS, RP 552 and shall be as per approved drawings.

2.5.1.3 All wiring shall be housed in covered non flammable plastic raceways which shall be arranged for easy maintenance. Raceways shall have 50% spare capacity. Rubber/plastic gromets shall be used for wire entry into individual instrument cases and for entry/exit of cables through raceways.

2.5.1.4 Wires carrying measurement signals associated with thermocouple, resistance temperature detectors (RTD), pH Instruments and other low-level signals shall be routed in separate wire ways and not along with power cables. Power wiring and control wiring should be separated by not less than 150 mm. If they have to cross, the crossing should be as close to right angle as possible. Parallel runs of AC and DC wiring closer than300mm shall be avoided.

2.5.1.5 All intrinsically safe wiring shall be routed in separate wire ways, separate from non-intrinsically safe and power wiring. The minimum separation shall be 150mm. Intrinsic safe raceways shall be light blue in colour.

2.5.1.6 Intrinsically safe terminals shall be adequately separated from non-intrinsically safe terminals. The minimum separation shall be 50 mm. Intrinsic safe terminals shall be light blue in colour.

2.5.1.7 Panel wiring for signal and controls shall be carried out using 600 V grade, 1.0 mm^2 stranded copper conductors with flame retardant PVC insulation. Power supply wiring between distribution box and individual instruments shall be done using 600 V grade, 1.5 mm" stranded copper conductors with flame retardant PVC insulation. All internal wiring will be supplied by the panel vendor.

2.5.1.8 Interconnection between main panel and other equipments within control room shall be done using unarmoured multicore cables of grade 600V, 1.5 mm^2 stranded copper conductors with flame retardant PVC insulation.

2.5.1.9 Alarm wiring shall be through multicore cables between alarm terminal box and annunciator directly without any intermediate terminals. Raceways on panel to have sufficient space to accommodate such wiring. Vendor to install and wire all annunciators including signal lights, bull's eye lamp, push buttons, audible devices etc.

2.5.1.10 All wiring, external to main panel/racks (except for alarm annunciators), shall terminate in terminal boxes/terminal strips and their quantity and size shall be determined by vendor.

2.5.1.11 All terminals shall be of mechanical screw clamp type with pressure plates. Self-insulating crimping wire lugs shall be used for all terminations on terminal blocks, whereas forked tongue type or lug with eyehole type shall be used for termination on screwed terminals such as on relays, push buttons, lamp etc. Terminals shall be suitable to accept 2.5mm^2 size conductor, as a minimum. Terminal blocks shall be rated for 600V. Separate set of terminals for accepting higher size of incoming power cables shall be provided. At least 20% spare terminals evenly distributed throughout the panels shall be provided.

2.5.1.12 Generally, no more than two wires shall be terminated on a single terminal. Additional terminals shall be used for looping if necessary. Use of shorting links for looping shall be avoided.

2.5.1.13 Terminals housings shall be sized with due consideration to accessibility and maintenance. Following guidelines shall be observed:

a) 50 mm minimum space shall be provided between terminal strips and sides of the box parallel to the strip for up to 50 terminals and an additional 25 mm for each additional 25 terminals.

b) 100 mm minimum space to be provided between adjacent terminal strips for up to 50 terminals and an additional 25 mm for each additional 25 terminals.

c) 75 mm minimum space shall be provided between terminal strip and top or bottom of the box for upto 50 terminals and an additional 25 mm for each additional 50 terminals.

d) The bottom of any terminal strip shall not be lower than 300 mm from the gland plate unit in any cabinet.

2.5.1.14 All terminal strips shall be mounted on suitable anodized metallic or plastic stand off. Terminal strips shall be arranged group wise for incoming and outgoing cables separately.

2.5.1.15 Wire colour code for panel and accessory shall be as follows:

Power supply hot	-	Black
Power supply neutral	-	White
Ground	-	Green
Alarm System	-	Yellow
Control & Shutdown	-	Red
Signal	-	Blue

2.5.2 Power Supplies

2.5.2.1 Main power distribution box shall have copper bus bars suitable for required current rating. Bus bars shall be suitably insulated. Provision of reducing type of lugs is not acceptable. Main power supply box shall be provided with two pole circuit breakers of thermo-magnetic type.

2.5.2.2 Each section of main panel shall have a separate power supply distribution box with two pole toggle switches and glass cartridge fuses. Power supply to individual instruments shall be through DPDT isolation switch and HRC fuse. Vendor may provide two pole circuit breakers of suitable rating for power distribution.

2.5.2.3 Redundant Power supplies shall be installed and it shall be possible to replace the defective one with full load on the control panel.

2.5.2.4 Plug in type eliminator / rectifier etc shall **not** be used for powering Ethernet switches / hubs / converter cards etc.

2.5.3 Grounding

2.5.3.1 Each panel section and accessory equipment in control room shall be provided with an earthing lug and shall be grounded to an earth bus bar to be provided by purchaser. All panel structure, racks, cabinets etc shall be connected to this power ground bus

2.5.3.2 In addition to above, vendor shall also provide a separate instrument circuit ground bus along the panel length.

This shall be electrically isolated from panel structure, equipment, incoming cable armour etc. This ground bus shall be typically 8 mm thick and 37.5 mm wide and of copper. All circuit grounds of electronic instrument, drain wires of alarm signal cables, intrinsic safety barrier insulated bus bar etc shall be connected to this ground bus by insulated copper conductor. Both ends of this bus bar shall have suitable terminals for further connection to ground electrode by purchaser. Creation of multiple grounds in a loop should be avoided.

2.5.4 Identification and Marking

2.5.4.1 All electrical terminals and equipment on the panel and other accessories shall be identified with appropriate tag, cable marker etc.

2.5.4.2 All terminals in a terminal strip shall be identified by their individual numbers located integral with the terminal itself.

2.5.4.3 Interconnecting multicables shall be identified by metal tags as indicated in cable schedules.

2.5.4.4 Wiring at terminals shall be identified by the terminal number and termination services at the other end of the wire. Wiring at instruments and accessories like alarm relays, push buttons etc shall be identified by the item tag number and terminals number and the termination service at the other end of the wire. Ferrule shall be used for this purpose.

2.5.4.5 Identification markers as mentioned above shall be indicated in vendor drawings.

2.5.5 Internal lighting shall be installed within panel using two fluorescent lighting fixtures to provide adequate lighting for maintenance of equipment. The location of lighting fixtures must not interfere with doors and other equipment and shall be accessible for fluorescent tube replacement. Lighting shall be operable through door switch in a suitable surface mount enclosure.

3.0 NAMEPLATE

3.1 Nameplates shall be provided for all front panel instruments and accessories. For sub miniature instruments, nameplate shall be written on the nameplate slip supplied along with the instrument. For other instruments and accessories (push buttons, lamps etc) nameplates with 1.5 mm thick black laminated plastic with white engraved letters shall be provided.

3.2 Front panel nameplates shall be fixed by means of chrome or nickel plated counter sunk screws. These nameplates shall be 25 mm high with 5 mm letter height, and provide information like tag number, service, multiplication factor etc. Rack nameplates to be fixed. by suitable adhesives and shall generally be 15 mm high with 5mm letter height to indicate item tag number.

3.3 Front panel instruments shall also be identified by their tag numbers on nameplates fixed by adhesives on panel back surface.

4.0 INSPECTION AND TESTING

4.1 Unless otherwise specified, purchaser reserves the right to test and inspect all the items at vendor's works during various stages of manufacturing and assembly of the ordered panels inline with inspection test plan for main control panel and accessories.

4.2 Vendor shall submit the following test certificates and test reports for purchaser's review:

a) Certificates for all bought out components.
b) Calibration test reports for all instruments.
c) Dimensional test report.
d) Performance test report including wiring scheme checks, functional check of accessories and all shutdown and interlock logics by simulation.
e) High voltage and insulation resistance reports.
f) Certificate from statutory body for intrinsically safe/flameproof equipment.

4.4 Witness Inspection

4.4.1 Vendor shall offer all control panels for pre-dispatch inspection at their works. It shall be the responsibility of the vendor to furnish all necessary testing devices and sufficient manpower to perform the tests. Following tests/checks shall be carried out, as a minimum:

a) Physical Verification

i) Each panel shall be inspected physically for dimensions, workmanship, compliance to approved drawings including proper identification and name plates for all panel mounted devices. Permissible tolerances for panel and accessories shall be as follows:

Overall length of panel	±5 mm
Panel cut out	±1 mm
Visible front panel elevation	±1 mm
Structural and framework elevation	±1.5 mm

ii) Panel interior and exterior painting shall be checked for shade thickness and adhesion.

iii) Graphic portion of the panel shall be checked as per approved drawings.

iv) All cables and wirings shall be checked for size, colour, insulation and continuity including identification.

b) Functional Testing

i) Functional checks shall be carried out for all shutdown and interlock logics by simulating the conditions. This shall include satisfactory operation of all accessories like switches, lamps, push buttons etc.

ii) Graphic panel function test shall be carried out by simulating the input condition and verification by lighting of corresponding lamp.

c) Any other test required to place the panel and its accessories in operating conditions.

d) Review of all certificates and test reports as indicated in clause 4.2 of this specification.

4.4.2 In the event when the witness inspection is not carried out by purchaser, the tests shall anyway be completed by the vendor and documents for the same shall be submitted to purchaser for scrutiny.

5.0 SHIPPING

5.1 Each panel and accessory shall be suitably packed and protected from damage due to transportation, loading and unloading.

5.2 Each component part requiring identification for proper assembly at site shall be place wise marked.

5.3 Shipping breaks shall be provided as applicable to avoid panel damage during transportation.

6.0 SITE ACTIVITIES

6.1 Vendor shall furnish a detailed activity schedule covering various activities like installation of panel and accessories, laying of cables, wiring, interconnection, testing etc in consultation with engineer-in-charge.

6.2 Vendor shall install all panel and accessories in the control room as per final approved layout drawings.

6.3 Control panel and semi graphic shall be checked for proper alignment and defect, if any, shall be rectified.

6.4 Vendor shall install all panel-mounted instruments, alarm annunciators and other free issue items as per approved drawings.

6.5 Painting, wiring, cabling etc shall be done as per the respective clauses of this specification.

6.6 Functional tests for panel and accessories shall be carried out after actual installation, wiring, interconnection to the satisfaction of the engineer-in-charge.

6.7 Vendor shall assist field contractor for loop checking.

6.8 Vendor shall maintain the control room and workplace neat and clean. Minor civil work, if necessary, shall be carried out by vendor arising due to damage to flooring during panel installation.

6.9 Vendor shall arrange to draw and transport free issue material and is responsible for safe custody of the same.

6.10 Vendor shall prepare and furnish as built drawing for final record.

7.0 REJECTION

7.1 Vendor shall prepare their offer strictly as per clause 1.2 of this specification and shall attach only those documents and information, which are specifically indicated in the material requisition.

7.2 Any offer not conforming to the above requirements, shall be summarily rejected.

7.3 Panels or parts thereof and materials forming part of it which indicate defects, improper fabrication, excessive repairs etc. shall be subject to rejection. They shall also be subject to rejection if such conditions are noticed after acceptance at vendor's works. Vendor shall be liable to make suitable replacement for such items during the guarantee period for the equipment.

GAIL INDIA LIMITED

STANDARD SPECIFICATION

FOR

INSTRUMENT VALVES AND MANIFOLDS

GAIL-STD-IN-DOC-TS-013

0	22.01.2019	Issued for Bid	RKS	UNU	UNU	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

CONTENTS

ABBREVIATIONS:

CWP	Cold Working Pressure
NPT	National Pipe Thread
PTFE	Poly Tetra Fluoro Ethylene

1.0 GENERAL

1.1 Scope

1.1.1 This standard specifications, together with the data sheets attached herewith, covers the requirements for the design, materials, inspection, testing and shipping of instrument valves and manifolds which includes the following types:

a) Miniature instrument valves
b) Instrument valve manifolds
c) Instrument air valves

1.1.2 The related standards referred to herein and mentioned below shall be of the latest edition prior to the date of purchaser's enquiry;

ASME/ANSI American Society of Mechanical Engineers/ American National Standards Institute

B 1.20.1	Pipe threads General Purpose (Inch)
B 16.11	Forged steel fittings-socket welding and threaded.
B 16.9	Factory made Wrought Steel Butt welding fittings.
B16.34	Valves-Flanged, Threaded and welding end

API-598 Valve Inspection and Testing

EN 10204 Inspection Documents for Metallic Products.

MSS Manufacturers Standardization Society of the Valve and Fittings Industry.

SP99 Instrument Valves

1.1.3. In the event of any conflict between this standard specification, job specification/data sheets, statutory regulations, related standards, codes etc. the following order of priority shall govern:

a) Statutory Regulations
b) Data Sheets
c) Standard Specification
d) Codes and Standards

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to vendor attached with the material requisition.

1.2.2 Deviation on technical requirements shall not be entertained. Whenever a

detailed technical offer is required, vendor's quotation shall include the following:

a) Compliance to the specification.

b) Whenever the requirement of a detailed specification sheet for each item is specifically indicated, the specification sheet shall provide information regarding size, type, rating, material of construction and overall dimensions. The material specifications and units of measurement for various parts in the vendor's specification sheets shall be to the same standards as those indicated in purchaser's data sheet.

c) Drawing for each types of instrument valve and manifold with dimensional details.

d) Proven references for each offered model in line with clause 1.2.3 of this specification whenever specifically indicated in the purchaser's specifications.
Catalogues giving detailed technical specifications, model decoding details and other information for each type of item covered in the bid.

1.2.3 All items, as offered, shall be field proven and should have been operating satisfactorily individually for a period of minimum 4000 hours on the bid due date in the process conditions similar to those as specified in the purchaser's data sheet. Items with proto-type design or items not meeting provenness criteria specified above shall not be offered.

1.2.4 All documentation submitted by the vendor including their drawings, installation manuals shall be in English language only.

1.3 Drawings and Data

1.3.1 Detailed drawings, data, catalogue and manuals etc. required from the vendor is indicated by the purchaser in vendor data requirement sheets attached with material requisition. The required number of reproducible, prints and soft copies shall be dispatched to the address mentioned in the material requisition, adhering to the time limits indicated.

1.3.2 Final documentation consisting of design data, installation and maintenance manual etc. submitted by the vendor after the placement of purchase order shall include the following, as a minimum:

a) Specification sheet for type of instrument valve and manifold.

b) Certified dimensional details showing internal constructional details and material of construction.

c) Copy of type test certificates.

d) Copy of test certificates for all the tests indicated in clause 4.0 of this specification.

e) Installation and maintenance procedures.

2.0 DESIGN AND CONSTRUCTION

2.1 The instrument valves shall be of manufacturer proprietary design. However, the minimum requirements specified herein must be complied.

2.2 Qualification tests (hydrostatic proof and burst tests) as per MSS SP-99 shall be

conducted by vendor for each design and size of valve to establish the cold working pressure (CW.P) rating.

2.3 For all valves and manifolds with body material of carbon steel/stainless steel, the valve trim material shall be 316 Stainless Steel, as a minimum. Whenever body material is other than that specified above, trim material should be same as body material as a minimum.

2.4 Unless otherwise specified, the valve packing material for all valves and manifolds shall be PTFE only. The o-ring materials wherever used shall also be of PTFE.

2.5 The finishing and tolerances of parts like stem, piston, stem threading etc. of the offered valves and manifolds shall be properly machined to avoid problems like galling.

2.6 The hand wheel material for all valves and manifolds shall be zinc/nickel plated carbon steel. Any other material, if provided as per standard vendor design, shall also be acceptable.

2.7 Instrument Valves (Miniature)

2.7.1 The instrument valves shall be of globe pattern needle valves forged/ bar stock with inside screwed bonnet, with back-seated blow out proof system.

2.7.2 Body material shall be 316 Stainless Steel unless otherwise specified.

2.7.3 The minimum cold working pressure (CWP) rating of the valve shall be as per Annexure 1 of this specification, unless otherwise specified.

2.7.4 The end connection shall be ^"NPTF to ANSI B 1.20.1, unless otherwise specified.

2.7.5 Flow direction shall be marked on the body.

2.7.6 The valve dimensions shall be as follows:

a) End to end dimensions 76mm (approximately).

b) Height in fully open condition - 135mm maximum. These dimensions are indicative only.

2.8 Valve Manifolds

2.8.1 3-Valve and 5-Valve manifolds:

2.8.1.1 3-Valve manifold

a) 3-Valve manifold shall be designed for direct coupling to differential pressure transmitters having 2 bolt flanges with 54mm (2-1/8") centre-to-centre connections and 41.3mm (1 -5/8") bolt-to-bolt distance.

b) 3-Valve manifold shall contain two main line block valves and an equalizing bypass valve. The valves shall be needle type. They shall use self-aligning 316 Stainless Steel ball seats, unless otherwise specified.

2.8.1.2 5-Valve manifold

a) 5-Valve manifold shall be designed for direct coupling to differential pressure transmitters having 2 bolt flanges with 54mm (2-1/8") centre-to-centre connections and 41.3mm (1-5/8") bolt-to-bolt distance.

b) 5-Valve manifold shall contain two main line block valves and a combination

double block and bleed for the bypass line. The valve shall of needle type or special ball with bleed hole.

2.8.1.3 The flanges shall be integral part of manifold block.
2.8.1.4 The material of construction shall be 316 Stainless Steel, unless otherwise specified.
2.8.1.5 The minimum cold working pressure (CWP) rating of manifolds shall be as per Annexure 1 of this specification, unless otherwise specified.
2.8.1.6 The process connection shall be '/2"NPTF to ANSI B 1.20.1.
2.8.1.7 Wherever the manifolds are specified for stanchion mounting, these shall be supplied along with mounting accessories. The bolts and nuts shall be alloy steel as per ASTM A 193 Gr B7 and ASTM A194 Gr. 2H (Hot dip galvanised or zinc plated) respectively. Other accessories shall be zinc plated.
2.8.2 3 way 2 valve manifold for pressure gauges
2.8.2.1 The manifold shall be designed for use with pressure gauges with block and bleed valves. The manifold body shall be either straight or angle type as specified in the data sheet.
2.8.2.2 The valve shall be a needle type.
2.8.2.3 The body material shall be 316 Stainless Steel, unless otherwise specified.
2.8.2.4 The minimum cold working pressure rating of the manifold shall be as per Annexure 1 of this specification, unless otherwise specified.
2.8.2.5 The manifold shall have the following connections:

a) The inlet connection shall be 3/4" plain ends with a minimum of 100mm nipple extension suitable for socket weld or butt weld as per B 16.11/ Bl 6.9 as specified in the job specifications
b) The gauge connection shall be with union nut and tail piece threaded to 1/2"NPTF.
c) The drain connection shall be ½" NPTF.

2.9 Instrument Air Valves

2.9.1 Instrument Air Isolation Valves (Miniature)

2.9.1.1 The valves shall be full-bore ball type with forged body.
2.9.1.2 Body material shall be 316 Stainless Steel.
2.9.1.3 The minimum cold working pressure rating of instrument air isolation valves shall be as per Annexure 1 of this specification, unless specified otherwise.
2.9.1.4 The end connection shall be ^"NPTF to ANSI B 1.20.1, unless otherwise specified.
2.9.1.5 End to end dimensions shall be 70mm (approximately).

2.9.2 Instrument Air Needle Valves (Miniature)

2.9.2.1 The instrument valves shall be globe pattern-needle valves forged/bar stock with inside screwed bonnet.

2.9.2.2 Body material shall be 316 Stainless Steel.
2.9.2.3 The minimum cold working pressure of Instrument Air Needle valves shall be as per Annexure 1 of this specification, unless otherwise specified.
2.9.2.4 The end connection shall be %" NPTF to ANSI Bl.20.1, unless otherwise specified.
2.9.2.5 Flow direction shall be marked on the body.
2.9.2.6 The valve dimensions shall be as follows:

a) End to end dimensions - 54 mm (approximately).
b) Height in fully open condition - 49 mm maximum. These dimensions are tentative only.

2.10 All instrument valves in oxygen and chloride service shall be thoroughly degreased using reagents like trichloroethylene or carbon tetrachloride. End connection shall be plugged after degreasing process in order to avoid entrance of grease or oil particles.

3.0 NAME PLATE

3.1 Following information shall be punched on the body of each of these items;

a) Material of construction to the same standards as in purchaser's data sheets.
b) Cold working pressure of each item to the same standards as in purchaser's data sheets.
c) Manufacturer's identification and model number.
d) Flow direction (if applicable)
e) Material of construction.

4.0 INSPECTION AND TESTING

4.1 Unless otherwise specified, purchaser reserves the right to test and inspect all the items at vendor's works, inline with the inspection test plan for instrument valve and manifolds.
4.2 Vendor shall submit following test certificates and test reports for purchaser's review:

a) Material test certificates as per clause 3.1B of EN 10204 for body and bonnet and as per clause 2.2 for other parts.
b) Dimensional test report.
c) Pressure test report as per clause 4.3 of this specification.
d) Hydrostatic proof and burst tests as per MSS-SP-99 for each design and size of valve.

4.3 Pressure Test Requirements

4.3.1 Each valve and manifold shall be subjected to hydrostatic pressure test at ambient temperature for both seat and shell leakage at test pressures given in Annexure-1 of this specification. During and after the hydrostatic test

there shall not be any visible leakage.

4.3.2 Pneumatic Test

Each valve and manifold shall be subjected to pneumatic test for both shell and seat leakage at 7.0 kg/cm^{2}g with testing medium as air at ambient temperature. There shall not be any visible leakage when immersed in water or coated with a leak detection solution.

4.4 Witness Inspection

4.4.1 All valves and manifolds shall be offered for pre-dispatch inspection for following, as a minimum:

a) Physical dimensional verification and workmanship.

b) Pressure test as per clause 4.3 of this specification on representative samples.

c) Review of all certificates and test reports as indicated in clause 4.2 of this specification.

4.4.2 In the event, when witness inspection is not carried out by purchaser, the tests shall anyway be completed by the vendor and documents for the same shall be submitted to purchaser for scrutiny.

5.0 SHIPPING

5.1 The threads/ends shall be protected with plastic caps to prevent damage/entry of foreign matter.

5.2 All instrument valves and manifolds in oxygen and chloride service shall be separately packed along with a certificated indicating 'CERTIFIED FOR OXYGEN/CHLORINE SERVICE' as applicable

6.0 REJECTION

6.1 Vendor shall prepare their offer strictly as per clause 1.2 of this specification and shall attach only those documents and information, which is specifically indicated in the material requisition.

6.2 Any offer not conforming to above requirements, shall be summarily rejected.

ANNEXURE -1

HYDROSTATIC TEST PRESSURES FOR INSTRUMENT VALVES AND MANIFOLDS

Sr. No.	Item	Line Pressure Class	Minimum Cold Working Pressure (CWP)	Hydrostatic Test Pressure for	
				Seat Leakage Test	Shell Leakage Test
1	Instrument Valves (Miniature)	≤ 600#	102 kg/cm²g	112 kg/cm²g	153 kg/cm²g
		≥ 900# to ≤ 1500#	253 kg/cm²g	278 kg/cm²g	383 kg/cm²g
2	Instrument Valve Manifold	≤ 600#	102 kg/cm²g	112 kg/cm²g	153 kg/cm²g
		≥ 900# to ≤ 1500#	253 kg/cm²g	278 kg/cm²g	383 kg/cm²g
3	Instrument Air Isolation valves	-	27 kg/cm²g	30 kg/cm²g	41 kg/cm²g
4	Instrument Air Needle Valve	-	27 kg/cm²g	30 kg/cm²g	41 kg/cm²g

GAIL INDIA LIMITED

STANDARD SPECIFICATION

FOR

PRESSURE RELIEF VALVES

GAIL-STD-IN-DOC-TS-014

0	22.01.2019	Issued for Bid	RKS	UNU	UNU	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

CONTENTS

Abbreviations:

AARH	Arithmetic Average Root Height
NPS	Nominal Pipe Size
NPT	National Pipe Thread

1.0 GENERAL

1.1 Scope

1.1.1 This specification, together with the data sheets attached herewith covers the requirements for the design, materials, fabrication, nameplate marking, inspection, testing and shipment of pressure relief valves.

1.1.2 The related standards referred to herein and mentioned below shall be of the latest editions prior to the date of the purchaser's enquiry: -

ANSI/ASME- American National Standards Institute/American Society of Mechanical Engineers.

B 1.20.1	Pipe Threads General Purpose (Inch).
B 16.5	Pipe Flanges and Flanged Fittings NPS 1/2" through NPS 24
B 16.20	Ring Joint Gaskets and Grooves for Steel Pipe Flanges.
B16.34	Valves-Flanged, Threaded and Welding End

ASME American Society of Mechanical Engineers.

Sec-VIII Boiler and Pressure Vessels Code Section VIII 'Pressure Vessels' Sec-I Boiler and Pressure Vessels Code. Section-! 'Power Boilers'

API American Petroleum Institute

API 520 Sizing, Selection and Installation of Pressure Relieving Devices in Refineries.
Part I Sizing & Selection
Part II Installation

API 521 Guide for Pressure Relieving and Depressurizing Systems.

API 526 Flanged Steel Pressure Relief Valves.

API 527 Seat Tightness of Pressure Relief Valves.

EN 10204 Inspection Documents For Metallic Products.

IBR Indian Boiler Regulations

1.1.3 In the event of any conflict between this specification, data sheets, related standards, codes etc., the following order of priority shall govern:

a) Statutory Regulations
b) Data Sheets
c) Standard Specification

d) Codes and Standards

1.1.4 In addition to compliance to purchaser's specifications in totality, vendor's extent of responsibility shall include the following;

a) Purchaser's data sheets indicate the type, size, relieving area etc. of the selected the valve. However, vendor shall be responsible to size and select the proper valve with orifice relieving area meeting the indicated operating conditions.

b) Purchaser's data sheets specify the minimum acceptable materials for body, bonnet, disc, nozzle, spring, bellows etc.. Alternate superior material of construction shall also be acceptable provided vendor assumes complete responsibility for the selected materials for their compatibility with the specified fluid and its operating conditions.

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to vendor attached with the material requisition.

1.2.2 Whenever a detailed technical offer is required, vendor's" quotation shall include the following:

a) Compliance to the specifications.

b) Whenever the requirement of a detailed specification sheet for each item is specifically indicated, the specification sheet shall provide information regarding type, construction materials, relieving area, relieving capacity, orifice letter designation, overpressure, blow down, operating pressure etc. and any other valve accessories. The material specifications and units of measurement for various items in vendor's specification sheets shall be to the same standards as those indicated in purchaser's data sheets.

c) Proven references for each offered model in line with clause 1.2.3 of this specification whenever specifically indicated in purchaser's specifications.

d) Copy of type test certificate for discharge coefficient, flow capacity and actual discharge area as per ASME/IBR

e) Deviations on technical requirements shall not be entertained. In case vendor has any valid technical reason to deviate, they must include a list of deviations tag number wise, summing up all the deviations from the purchaser's data sheets and other technical specification along with the technical reasons for each of these deviations.

f) Catalogues giving detailed technical specifications, model decoding details and other related information for each type of pressure relief valve covered in the bid.

1.2.3 All items, as offered, shall be field proven and should have been operating satisfactorily individually for a period of minimum 4000 hours on the bid due date in the process conditions similar to those as specified in the purchaser's data sheet. Items with proto-type design or items not meeting provenness criteria specified above shall not be offered.

1.2.4 All documentation submitted by the vendor including their quotation,

catalogues, drawings, installation, operation and maintenance manuals etc. shall be in English language only.

1.2.5 Vendor shall also quote for

a) Two years' operational spares for each pressure relief valve and its accessories which shall include nozzle, disc insert, guide pilot etc. as a minimum.

b) Any special tools and tackles needed for maintenance work. Vendor must certify in his offer in case no special tools are necessary.

1.3 Drawing and data

1.3.1 Detailed drawings, data, catalogues and manuals required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of reproducible, prints and soft copies shall be dispatched to the address mentioned, adhering to the time limits indicated.

1.3.2 Final documentation consisting of design data, installation manual, operation and maintenance manual etc. submitted by the vendor after placement of purchase order shall include the following as a minimum :

a) Specification sheet for each pressure relief valve and its accessories

b) Certified drawing sheets for each pressure relief valve and accessories, which shall provide dimensional details, internal construction details, end connection details, weight and material of construction.

c) Copy of type test certificates.

d) Copy of test certificates for all the tests indicated in clause 4.0 of this specification.

e) Installation procedure for Pressure relief valve and its accessories.

f) Calibration and maintenance procedure including replacement of internals wherever applicable.

2.0 DESIGN AND CONSTRUCTION

2.1 Valve Design

2.1.1 The definitions of various terminologies used in purchaser's data sheets are as per clause 1.2 of API RP 520 part I.

2.1.2 Unless specified otherwise, all pressure relief valves shall be full nozzle full lift type and all relief valves in thermal safety application shall be modified nozzle type.

2.1.3 For flanged pressure relief valves, the valve inlet and outlet size, the orifice designation and corresponding relieving area shall be as per API 526

2.1.4 The design of pressure relief valves in steam service under IBR design code shall be governed by Regulation 294 and regulation 295 of IBR. However where design code is specifically indicated as ASME Section-I, the valve design shall meet the pressure relief valve requirements specified in ASME Section I.

2.2 Valve Sizing

2.2.1 Sizing shall be carried out using the formulae mentioned in the following standards whenever the sizing code mentioned in the purchaser's data sheets refers to these

Sizing Code	Standard
API	API RP 520 Part I API RP 521
ASME	Boiler and Pressure vessel code Section VIII 'Pressure Vessels'. Boiler and Pressure vessel code Section-I.- 'Power Boilers'
IBR	Indian Boiler Regulations, paragraph – 293

2.2.2 Discharge Co-efficient

Following discharge coefficient values shall be used for sizing of pressure relief valves;

a) For all valves in gas, vapour or steam service with design code as ASME Sec VIII or ASME Section I discharge co-efficient of 0.975 as per API 520 shall be used.

b) For all valves in steam service covered under IBR design code, discharge co-efficient shall either be selected as per Regulation 293 or as tested and certified by IBR as per Appendix 'L' of IBR.

c) For valves in liquid service, the discharge coefficient of 0.62 shall be used as per API 520. However vendor may use the ASME certified valve coefficients when pressure relief valve with liquid trim design are offered.

2.2.3 For the selected orifice letter designation and inlet and outlet size of the pressure relief valve, relieving area of the valve offered by vendor shall meet those in API-526.

2.2.4 The discharge capacity of the selected pressure relief valves shall be calculated based on certified ASME capacity curves or by using ASME certified discharge coefficient and actual orifice area. Higher valve size shall be selected in case pressure relief valve discharge capacity so computed, is less than the required flow rate.

2.2.5 For pressure relief valve covered under ASME Sec-I design code, the valve design shall conform to ASME Section I requirements with selected area higher of the area calculated as per ASME Section I requirements and that calculated as per regulation 293 of **IBR.**

2.3 Valve Construction

2.3.1 Body

2.3.1.1 Unless otherwise mentioned, end connection details shall be as below: -

a) Threaded end connections shall be to NPT as per ANSI/ASME B 1.20.1.

b) Flanged end connections shall be as per ANSI/ASME B 16.5.

c) Flanged face finish shall be as per clauses 6.4.4.1, 6.4.4.2 and 6.4.4.3 of ANSI/ASME B 16.5.The face finish as specified in the data sheets, shall be as follows;

125AARH	125to200AARH
63 AARH	32 to 63 AARH

2.3.1.2 For flanged valves, inlet and outlet sizes and ratings and centre to flange face dimensions shall be in accordance with API-526. Dimensional tolerance shall be as mentioned therein.

2.3.1.3 Body drain with a plug shall be provided as a standard feature on every pressure relief valve.

2.3.1.4 For the pilot operated pressure relief valves, where vendor's standard model provides only semi nozzle design (i.e. the body is part of the inlet flow path), body material shall be of the same material as that of nozzle specified in purchaser's data sheets, as a minimum.

2.3.2 Trim

2.3.2.1 The term 'trim' covers all the parts of the valves exposed to and in contact with the process fluid except for the body and bonnet assembly i.e. nozzle, disc, disc holder, stem etc.

2.3.2.2 Valves shall be of the full nozzle type of design with the exception as per clause and valves in thermal relief application.

2.3.2.3 Wherever stelliting of disc and nozzle has been specified, it stands for stelliting of the seat joint and the entire disc contour, unless otherwise mentioned.

2.3.2.4 For high temperature application, the materials for the internals shall be selected to avoid galling.

2.3.2.5 Pressure relief valves with design as per ASME Section I, shall have two adjustable rings to adjust valve over-pressure and blow down.

2.3.2.6 Resilient seat, seals or o-rings wherever used shall be suitable for pressure and temperature conditions specified.

2.3.2.7 Gaskets wherever used shall be metallic type. Gaskets with asbestos filler or with asbestos bearing material shall not be used

2.3.3 Bonnet and Spring

2.3.3.1 All valves shall be provided with a cap over the adjusting bolt. Cap shall be of either bolted type or screwed type as specified in the purchaser's data sheets.

2.3.3.2 Lifting lever shall be provided whenever the fluid to be relieved is steam and air or water above 65°C.

2.3.3.3 Valve spring shall be selected such that it can permit an adjustment of ±5% of the set pressure, as a minimum.

2.3.3.4 Carbon steel springs shall be made corrosion resistant through plating/coating as per manufacturer's standard design or as specified in the purchaser's data sheets.

2.3.3.5 The allowable tolerance in set pressures are as below:

a) ±0.14 kg/cm^2 g for set pressure upto and including 5kg/cm^2 g.
b) ±3% for set pressure above 5kg/cm^2 g.

2.3.3.6 Bonnet shall be of the closed type for all process applications in general. Open type bonnet shall be used only for steam and non-hazardous/non-toxic fluids. For all steam applications under design code 1BR or ASME Section-I with open bonnet design, weather protection cover shall be provided.

2.3.4 Pilot Design

2.3.4.1 For pilot operated valves, the pilot design shall be of inherently fail safe.

2.3.4.2 Unless specified otherwise, pilot shall be non-flowing type.

2.3.4.3 All accessories like back flow preventer, pilot filter etc. required for proper operation of pilot operated valves as per indicated service conditions shall be included.

2.3.4.4 Material of construction of pilot shall be same as that of main valve nozzle as a minimum.

2.3.4.5 The o-ring and diaphragm material of pilot shall be suitable for the pressure and temperature conditions specified in the data sheet.

2.4 All pressure relief valves in oxygen and chlorine service shall be thoroughly degreased using reagents like trichloro-ethylene or carbon tetrachloride. End connections shall be blinded / plugged after this degreasing process to avoid images of oil particles.

3.0 NAMEPLATE

3.1 Each pressure relief valve shall have a stainless steel nameplate attached firmly to it at a visible place, furnishing the following information: -

a) Tag number as per purchaser's data sheet.
b) Manufacturer's serial number and/or model number.
c) Manufacturer's name/trade mark.
d) Nominal flange size in inches and rating in pounds for both inlet and outlet.
e) Orifice letter designation.
f) Valve set pressure.
g) Cold bench test set pressure.

3.2 For the above, pressures shall be marked in the same units as those followed in purchaser's data sheets.

4.0 INSPECTION AND TESTING

4.1 Unless otherwise specified, purchaser reserves the right to test and inspect all the items at the vendor's works inline with the inspection test plan for the pressure relief valves.

4.2 Vendor shall submit the following test certificates and test reports for purchaser's review:-

a) Material test certificate as per clause 3.IB of EN10204 for each valve body and bonnet castings/forging, nozzle and as per clause 2.2 for stem, disc etc.

b) Certificate of radiography/X-ray for valve castings as per following requirements;

i) 100% radiography shall be carried out for all valve castings with body rating of 600# and above or wherever specifically indicated for in the material requisition.

ii) Radiography procedure shall be as per ANSI B 16.34 and acceptance criteria shall be as per ANSI B 16.34 Annexure-B. Following area of pressure relief valve shall be radiographed unless specified otherwise.

- Inlet flange neck
- Outlet flange neck
- Nozzle (in case of cast construction)
- Body/bonnet joint neck.

c) Dimensional, hydrostatic and functional test reports for all valves as per clause 4.3 and 4.4 of this specification.

d) IBR certificate in Form III item 11 for all safety valves in steam service with design code as IBR or ASME Section-I.

e) IBR Form III C for all pressure relief valves in steam application.

f) Type test certificate for blow-off and closing down pressure.

4.3 Hydrostatic Test

4.3.1 Each Pressure relief valve body shall undergo hydrostatic test as per outlet flange ANSI rating. However all the safety valves castings covered under IBR shall be tested as per IBR regulations. There shall not be any visible leakage during this test.

4.3.2 For full nozzle type of pressure relief valve, nozzle shall undergo hydrostatic test as per inlet flange ANSI rating. For Semi nozzle design, valve Inlet shall be tested after assembly as per Inlet flange ANSI rating.

4.4 Functional Test

4.4.1 Cold bench set pressure test:

Pressure relief valve shall be tested for opening at specified set pressure. Testing of pressure relief valves shall be with air or nitrogen, testing of thermal relief valves shall be with water.

4.4.2 Seat Leakage test:

a) Whenever the specified set pressure is less than or equal to 420 kg/cm^{2}g, the valve shall meet the seat tightness requirements specified in API RP-527. The maximum permissible leakage rates against various sizes shall be as specified therein. Whenever the specified set pressure exceeds 420 kg/cm^{2}g, the vendor

shall submit the leakage rates of valves for approval by the purchaser. Where bubble tightness has been specified, there shall be no leakage or bubbles of air at the specified percentage of set pressure.

b) Seat leakage test pressure shall be as per API RP 527 for all valves except for valves under IBR or ASME Section-I design code and pilot operated pressure relief valves. For these valves seat leakage shall be carried out at the following pressure;

i) Valves Under IBR or ASME Section-I : 95% of Set Pressure

ii) Pilot operated Pressure relief valves

^{0} Upto 3.5 Kg/cm2G : 90% of set Pressure
° Above 3.5 Kg/cm2G : 95% of Set Pressure

4.5 Witness Inspection

4.5.1 All pressure relief valves shall be offered for pre-dispatch inspection for following as a minimum: -

a) Physical dimensional verification and workmanship.
b) Hydrostatic test as per clause 4.3 of this specification on representative samples.
c) Functional test on representative samples.
d) Review of all certificates and test reports as indicated in clause 4.2 of this specification.

4.5.2 In the event when witness inspection is not carried out by purchaser, the tests shall anyway be completed by the vendor and documents for same shall be submitted for scrutiny.

5.0 SHIPPING

5.1 Valves shall be supplied as a whole, complete with all the accessories like cap, lifting lever, test gag etc.

5.2 All threaded and flanged openings shall be suitably protected to prevent entry of foreign material.

5.3 All pressure relief valves in oxygen and chlorine service shall be separately packed along with a certificate indicating 'CERTIFIED FOR OXYGEN/CHLORINE SERVICE', as applicable.

6.0 REJECTION

6.1 Vendor shall prepare their offer strictly as per clause 1.2 of this specification and shall attach only those documents which are specifically indicated in the material requisition.

6.2 Any offer not conforming to above requirements, shall be summarily rejected.

GAIL INDIA LIMITED

STANDARD SPECIFICATION

FOR

ELECTRONIC/PNEUMATIC INSTRUMENTS

GAIL-STD-IN-DOC-TS-015

0	22.01.2019	Issued for Bid	RKS	UNU	UNU	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Abbreviations:

AARH	Arithmetic Average Root High
CCE	Chief Controller of Explosives
CMRI	Central Mining Research Institute
DGMS	Director General of Mines Safety
ERTL	Electronics Regional Testing Laboratory
FISCO	Fieldbus Intrinsic Safety Concept
HHT	Hand Held Terminal
HART	Highway Addressable Remote Transducer
MR	Material Requisition
NPS	Nominal Pipe Size
NPT	National Pipe Thread
WC	Water Column

CONTENTS

1.0 General

1.1 Scope

1.1.2 This specification, together with the data sheets attached herewith forms the requirements for the design, materials, nameplate marking, inspection, testing and shipping of electronic/pneumatic instruments.

1.1.3 The related standards referred to herein and mentioned below shall be of the latest editions prior to the date of the purchaser's enquiry:-

ANSI/ASME- American National Standards Institute / American Society of Mechanical Engineers.

B 1.20.1	Pipe Threads General Purpose (Inch)
B 16.5	Pipe Flanges and Flanged Fittings NPS½ through NPS24
B 16.20	Metallic Gaskets for Pipe Flanges, Ring Joint, Spiral wound and Jacketed

BS-5760 Reliability of System, Equipments and Components

EN 10204 Inspection Documents For Metallic Products

IEC-60068 Environmental Testing

IEC-60079 Electrical Apparatus for Explosive Gas Atmosphere.

IEC-60529 Classification of Degree of Protection Provided by Enclosures.

IEC-61000-4 Electromagnetic Compatibility for Industrial Process Measurement and Control Equipment.

IEC-61158 Field bus Standard for use in Industrial Control System

IEC-61158-2 Physical layer specification and Service definition for Field bus

IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems

IS-13497 Specification for Low Voltage Switch gears and Control gears.

IS-2148 Flame Proof Enclosures of Electrical Apparatus.

ISA Instrumentation System and Automation Society

S 7.3 Quality Standard for Instrument Air

50.1 Compatibility of Analog Signals for Electronic Industrial Process Instruments.

1.1.3 In the event of any conflict between this standard specification, job specification/data sheets, Statutory regulations, related standards, codes etc. the following order of priority shall govern:

a) Statutory Regulations
b) Data Sheets
c) Standard Specification
d) Codes and standards

1.1.4 In addition to compliance to purchaser's specifications in totality, vendor's extent of responsibility shall include the following:

a) Purchaser's data sheets specify the minimum acceptable material of construction of body, measuring element and accessories. Alternate superior material of construction shall also be acceptable provided vendor assumes complete responsibility for the selected materials for their compatibility with the process fluid and its operating conditions.

b) Selection of suitable sealant liquid for diaphragm seal instruments compatible with the process fluid and its operating temperature.

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to the vendor attached with the material requisition.

1.2.2 Whenever a detailed technical offer is required, vendor's quotation shall include the following:

a) Compliance to the specifications.

b) Whenever specifically indicated, a detailed specification sheet for each item, which shall provide information regarding type, material of construction, performance specification, model number etc. of the offered electronic / pneumatic instruments. The material specification and the units of measurement for various parts in vendor's specification sheets shall be to the same standards as those indicated in purchaser's data sheets.

c) Proven references for each offered model number inline with clause 1.2.3 of this specification.

d) A copy of approval from local statutory authority, as applicable such as Chief Controller of Explosives (CCE), Nagpur or Director General of Mines Safety(DGMS) in India, for the electronic instruments installed in electrically hazardous area along with:

i) Test certificate from recognized test house like CMRI/ERTL etc. for flameproof enclosure/intrinsic safety, as specified in the data sheet, as per relevant standard for all Indian manufactured equipments or for items requiring DGMS approval.

ii) Certificate of conformity from agencies like LCIE, BASEEFA, PTB, CSA, UL etc. for compliance to ATEX directives or other equivalent standards for all equipments manufactured outside India.

e) Deviations on technical requirements shall not be entertained. In case vendor has any valid technical reason, they must include a list of deviations tag number wise, summing up all the deviations from the purchaser's data sheets and other technical specifications along with the technical reasons for each of these deviations.

f) Catalogues giving detailed technical specifications, model decoding details and other related information for each type of electronic/pneumatic instruments covered in the bid.

1.2.3 All items, as offered, shall be field proven and should have been operating satisfactorily individually for a period of minimum 4000 hours on the bid due date in the process conditions similar to those as specified in the purchaser's data sheets. Items with prototype design or items not meeting proveness criteria specified above shall not be offered.

1.2.4 All documentation submitted by the vendor including their quotation, catalogues, drawings, installation, operation and maintenance manuals, etc shall be in English language only.

1.2.5 Vendor shall also quote for the following:

a) Universal hand held configurator / terminal (HHT) for the configuration and maintenance of instruments with HART output.

b) Field bus hand held tester for configuration and maintenance of field bus network.

c) Field bus configurator with hardware and software for configuration and maintenance of field bus instruments.

d) Two-year operational spares for each model of instruments offered in the bid, which shall include sensor, electronic module, local indicator, o-ring/gasket set etc. as a minimum.

e) Special tools and tackles other than those covered under 1.2.5 (a) (b) and (c). Vendor must certify in their offer in case no special tools are necessary for the offered instruments.

1.3 Drawing and Data

1.3.1 Detailed drawings, data, catalogues and manuals required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of reproducible, prints and soft copies should be despatched to the address mentioned, adhering to the time limits indicated.

1.3.2 Final documentation consisting of design data, installation manual, operation and maintenance manual, etc submitted by the vendor after placement of purchase order shall include the following, as a minimum;

a) Specification sheet for each electronic/pneumatic instrument and their accessories.

b) Certified drawing for each instrument, which shall provide dimensional detail, internal construction and part list, material of construction etc.

c) Calculations for integral orifice d) Copy of type test certificates.

e) Copy of the test certificates of all the tests indicated in clause 4.0 of this specification. f) Installation procedure for electronic/pneumatic instrument and its accessories.

g) Calibration and maintenance procedures including replacement of its internal parts.

h) Device descriptor files for configuring the device parameters(Soft Copy)

i) Common File Format files for integrating the device into the system(Soft Copy)

2.0 DESIGN AND CONSTRUCTION

2.1 General Requirements

2.1.1 The type and material of construction of electronic/pneumatic instruments shall be as specified in the purchaser's data sheet.

2.1.2 The range of instruments shall be selected by vendor base on the set range indicated in the purchaser's data sheet. Where no set range is indicated, vendor may select the same as per the following guidelines;

a) The set range shall be 1.1 times the maximum process value or 1.4 times the operating process value whichever is higher rounded to the nearest ten.

b) The set range shall preferably be in the middle third of the selected instrument range.

2.1.3 Except for instruments covered under clause 2.2.3.10 of this specification or specified otherwise in purchaser's data sheets, each instrument shall have an over-range protection of at least 130% of specified range.

2.1.4 Measuring element in vacuum service shall have under range protection down to full vacuum, without undergoing a change in calibration or permanent set.

2.1.5 Unless otherwise specified, diaphragm seal instrument shall meet the following requirements;

a) Instruments shall have its diaphragm seal integral with the instrument and shall be supplied with adaptor flange.

b) When purchaser data sheets specify wafer seal type of instrument, vendor shall include supply of studs, nuts and gasket as per the materials specified in the purchaser's data sheet. Refer Annexure – 1 attached with this specification for stud – bolts, nuts and gasket material requirement.

c) The sealant shall be an inert liquid, compatible with the process fluid and process temperature indicated in the purchaser's data sheets. In general, sealant shall be;

i) DC 704 or equivalent for all diaphragm seal instruments except for oxygen and chlorine.

ii) Flouro-lube or equivalent for all diaphragm seal instruments in oxygen and chlorine.

d) The requirement of spacer ring shall be as specified in purchaser's data sheet. The material of construction of spacer ring shall be 316 Stainless Steel, as a minimum unless otherwise specified in the purchaser's data sheets.

2.1.6 Wherever purchaser data sheet specified integral flow transmitter, vendor shall supply complete assembly consisting of integral orifice, upstream and downstream meter runs with end flanges.

a) Three nos. of integral orifice plates shall be supplied i.e one is installed and two are spares.

b) Unless otherwise specified, material of construction shall be 316 Stainless Steel for integral orifice and meter run with flanges.

2.1.7 The instrument enclosure shall be suitable for the area classification indicated in the purchaser's data sheets. Unless otherwise specified, the enclosure shall meet the following standards;

Weatherproof housing	IP-65 to IEC-60529/IS-13947.
Flameproof housing	Flameproof/ Ex (d) as per IEC-60079/IS-2148.

Flameproof housing shall also be made weatherproof.

2.1.8 Unless otherwise mentioned, end connection details shall be as below:- a) Threaded end connections shall be to NPT as per ANSI/ASME B 1.20.1.

b) Flanged end connections shall be as per ANSI/ASME B 16.5.
c) Grooves of ring-type joint flanges shall be octagonal as per ANSI B16.20.
d) Flanged face finish shall be as per clauses 6.4.4.1, 6.4.4.2, and 6.4.4.3 of ANSI B 16.5. The face finish as specified in the data sheets shall be as follows: -
125 AARH : 125 to 200 AARH
63 AARH : 32 to 63 AARH

2.1.9 All electronic / pneumatic instruments in oxygen and chlorine service shall be thoroughly degreased using reagents like trichloro-ethylene or carbon tetrachloride. End connection shall be blinded / plugged after the degreasing process in order to avoid entrance of grease or oil particles.

2.1.10 Electronic Instruments

2.1.10.1 All instruments shall be of state-of-the-art technology and shall be in compliance with the electromagnetic compatibility requirements specified in IEC-61000-4 standard.
2.1.10.2 Plug-in circuit boards shall be designed and manufactured such that reverse insertion or insertion of the wrong card is prevented.
2.1.10.3 Electronic instruments shall generally operate on nominal voltage of 24 V DC and shall be protected against short circuit and reverse voltage. Transmission and output signal shall generally be 4 to 20 mA DC for analog and smart transmitters. The display of integral output meter shall be in engineering units for pressure, differential pressure and flow and 100% linear for level.
2.1.10.4 Electronic transmitters with two-wire system shall be suitable for delivering rated current to an external loop resistance of at least 600ohm when powered with 24 V DC.
2.1.10.5 Terminals for electrical connections shall be clearly identified, and polarity shall be permanently marked.
2.1.10.6 Peak to peak ripple and total noise level in the analog output signal shall not exceed 0.25% of the maximum signal.
2.1.10.7 Power supply, signal isolation, ripple and noise requirements shall generally be as per ISA-S 50.1.
2.1.10.8 Electrical conduit entries shall have internal NPT ½" threads.

2.1.11 Pneumatic Instruments.

2.1.11.1 All pneumatic connections shall be 1/4" NPT, unless otherwise specified.

2.1.11.2 All threaded connections shall be internal, unless otherwise specified.

2.1.11.3 The process input connections and pneumatic output and air supply connections etc. shall be permanently stamped on the body at a suitable place.

2.1.11.4 Unless otherwise specified, pneumatic instruments shall operate on air supply of 1.4 kg/cm^2g and shall have transmission and output signal of 0.2 to 1.0 kg/cm^2g.

2.1.11.5 Instrument air quality shall be as per ISA-S7.3 and shall be free from all corrosive, hazardous, flammable and toxic contaminants.

2.2 Transmitters

2.2.1 Pneumatic Transmitters

2.2.1.1 Pneumatic blind transmitters shall be of the force-balance type and pneumatic indicating transmitters of the motion balance type.

2.2.1.2 Transmitters shall have an accuracy of 0.5 % of span.

2.2.1.3 Transmitters shall be supplied with external zero and span adjustments.

2.2.2 Electronic Analog Transmitters

2.2.2.1 Electronic transmitters shall be of the two-wire dc current regulating type. They shall be provided with integral output indicator. When specified, field mounted external output meters shall be provided.

2.2.2.2 Electronic analog transmitters shall have an accuracy of ± 0.25 % of span.

2.2.2.3 Transmitters shall be supplied with external zero and span adjustments, Flameproof transmitters shall also have their calibration adjustment from outside, without any need to remove the cover.

2.2.2.4 Unless otherwise specified, the electronic transmitters shall be certified intrinsically safe.

2.2.3 Smart and Field bus based Transmitters

2.2.3.1 Smart and field bus based transmitters shall be two wire microprocessor based type. These shall have a non-volatile memory, storing, complete sensor characterization and configuration data of the transmitter. All necessary signal conversions and output generation with the required protocol shall be carried out in the transmitter electronics. Integral output meter with LCD display shall be provided for all transmitters.

2.2.3.2 Transmitter shall also run complete diagnostic subroutines and shall provide diagnostic alarm messages for sensor as well as transmitter healthiness. Field bus based transmitter in addition shall have facility to detect plugged impulse lines, whenever specifically indicated in purchaser's data sheets. In the event of detection failure, the output shall be driven to a predefined value, which shall be field configurable.

2.2.3.3 The transmitters with field bus connectivity shall have built in control algorithm like proportional, proportional-integral and proportional-integral-differential.

2.2.3.4 Whenever specifically indicated in purchaser's data sheets, the meter electronics shall be provided with in-built lightening and power supply surges. The transient protection shall meet the requirements specified in IEC-61000-4

2.2.3.5 The configurational data of the instruments shall be stored in a non-volatile memory such that this remains unchanged because of power fluctuations or power off condition. In case vendor standard instrument has battery backed RAM, vendor to ensure that battery drain alarm is provided as diagnostic maintenance message.

2.2.3.6 Accuracy of transmitters, smart as well as field bus based, shall be as follows:

a) For transmitter ranges of 760 mm WC and above, the accuracy shall be equal to or better than ±0.075% within a turndown of 1:10 of the offered span.
b) For transmitters with ranges less than 760 mm WC the accuracy shall be equal to or better than ±0.15% within a turndown of 1:10 of the offered span.
c) For all diaphragm seal transmitter with ranges 500 mm WC and above, the accuracy shall be equal to or better than ±0.25% within a turndown of 1:10 of the offered span.
d) For all diaphragm seal transmitter with ranges less than 500 mm WC, the accuracy shall be equal to or better than ±0.5% within a turndown of 1:10 of the offered span.

The accuracy is defined as the combined effect of repeatability, linearity and hysteresis.

2.2.3.7 The stability of the transmitters shall be equal to or better than ±0.1% of span for a period of minimum 6 months, as a minimum.

2.2.3.8 Transmitter shall update the output at least 8 times a second unless otherwise specified.

2.2.3.9 Unless specified otherwise in purchaser's specification, transmitter response time shall be as follows:

a) For transmitter range of 760 mm WC and above, the response time shall be equal to or better than 500 milliseconds.
b) For transmitter range below 760mm WC, the response shall be equal to or better than 1second.

The response time of the transmitter shall be considered as the sum of dead time and 63.2% step response time of the transmitter.

2.2.3.10 Unless specified otherwise, the over-range/static pressure protection of the transmitter shall be as follows;

a) For transmitter range between 1 kg/cm²g and 100kg, the over range/static pressure shall be 130 kg cm²g.
b) For transmitter with ranges of 100 kg/ cm²g and above, the over-range/static pressure shall be 210 kg/cm²g or 130% of maximum range whichever is higher.
c) For transmitter range between 0.5 kg/cm²g to 1.0 kg/ cm²g, the over pressure/static pressure shall be 70kg/cm²g.
d) For transmitters with ranges between 1000mm WC to 5000mm WC, the over-range/static pressure shall be 35kg/cm²g.
e) For transmitter with ranges less than 1000mm WC, over-range/static pressure shall be 1.0kg/cm²g.

2.2.3.11 In the transmitter, the 'WRITE' option shall be protected through password.

2.2.3.12 Temperature transmitters shall meet the following requirements as a minimum:

a) Temperature transmitter shall be universal type and shall be able to accept input from resistance temperature detector (RTD) or thermocouple (T/C) of any type and range.

b) Temperature transmitters shall be freely programmable i.e. element type and range shall be programmable without any change in hardware / software.

b) Temperature transmitters shall be freely programmable i.e. element type and range shall be programmable without any change in hardware / software.
c) Temperature transmitter shall be remote mounted type, in general. Head mounted transmitters shall be supplied when specifically indicated in purchaser's data sheets.
d) The accuracy of the temperature transmitter with RTD element shall be as follows:

- For temperature range above 350ºc, the accuracy shall be equal to or better than ±0.075% of full scale.
- For temperature range with ranges between 350ºc to 150ºc, the accuracy shall be equal to or better than ±0.15% of full scale.
- For temperature range below 150ºc, the accuracy shall be equal to or better than ±0.2% of full scale.

e) The accuracy of temperature transmitter with cold junction compensation for Thermocouple element shall be as follows;

- For temperature above 350°c, accuracy shall be ±0.25% of range.
- For temperature between 150°c to 350°c. accuracy shall be ±0.5% of range.
- For temperature below 150°c, accuracy shall be ±0.75% of range.

2.2.3.13 When HART protocol is specified, the following features must be ensured;
a) It shall allow multi masters (two for example, primary and secondary) for configuration, calibration, diagnostics and maintenance. The primary could be the control system or host computer and the secondary could be the hand-held communicator.
b) It shall be capable of implementing universal commands from either of these locations.

2.2.3.14 In addition to the requirements specified above, field bus based transmitter shall meet the following requirements;
a) All instruments must satisfy the requirements of the field bus registration laboratory with applicable checkmark like foundation field bus, profibus PA, or as specified in the purchaser's data sheets.
b) All instruments shall have two analog input blocks, as a minimum. In addition, when specified the transmitter shall also have PID controller block.

All instruments must be interoperable and shall have valid interoperability test clearance like ITK latest version for foundation field bus or equivalent for profibus PA, as applicable.
c) The field bus instruments shall support peer to peer communication.
d) Field bus instruments as offered shall not be polarity sensitive.
e) The field bus instruments in hazardous area shall be certified as per entity concept or shall be FISCO approved as per the requirements specified in the purchaser's specification.
f) All instruments shall support EDDL or FDT/DTM requirements, as specified in data sheets.
g) Internal Software shall be configured by the vendor including the following information.
   - Serial Number
   - Device Tag
   - Process Description
i) All instruments shall be capable of supporting incremental Device Descriptor (DD) for extra functionality and/or software revisions in Device memory.

2.4 Receivers

2.4.1 Pneumatic/electrical cables shall be such that they permit the instrument internals to be drawn from its normal mounting position without affecting operation. Pneumatic connection points shall seal automatically upon disconnection.

2.4.2 Electronic receivers shall be suitable for standard voltage inputs of 0.25 to 1.25 V, 1 to 5 V, 0 to 10 V dc. Any voltage receiver shall not alter the voltage drop across the conditioning resistor by more than ±0.1% of input range of maximum input voltage.

2.4.3 Recorder pens shall be easily replaceable.

2.4.4 Each recorder shall be supplied with chart-rolls and ink for six months continuous operation.

2.5 Controllers

2.5.1 Automatic control stations including dedicated cascade control stations shall have switches to transfer control from automatic to manual mode and vice-versa. The transfer shall be procedure less and shall not produce any bump in the process under control during such a transfer, the output signal shall not change by more than 1% of span.

2.5.2 Cascade control stations shall have a switch to select local or remote set point.

2.5.3 The control settings of the controller shall be readily adjustable from the front.

2.5.4 Controller action shall be easily reversible.

2.5.5 Pneumatic automatic controller shall be easily removable, without disturbing the manual control mechanism.

2.5.6 Electronic controller shall be easily removable, with the aid of a service station.

2.5.7 Local mounted pneumatic controllers shall be supplied with gauges for air supply pressure and control signal. The gauges shall be integral with the instrument.

2.6 Accessories

2.6.1 Field HART Communicator:

2.6.1.1 It shall be possible to perform routine configuration, calibration, display process variable, diagnostics etc. from a hand held portable communicator, which can be connected at any location in the transmitter loop. It shall be possible to perform all the above functions on- line. The loop function shall remain unaffected while communication is going on between transmitter and the field communicator.

2.6.1.2 There should be no interruption on the output while communicating with the transmitter.

2.6.1.3 Field communicator shall meet the following requirements:

a) Hand Held communicator shall be universal type and shall be compatible with all make and models of HART transmitters, Smart positioners, instruments with all engineering capability like calibration, diagnostics, configuration, inhibition of HART signal, etc.

b) It shall be possible to connect the communicator at any of the following locations for purpose of digital communication;

i) Marshalling cabinet serving the transmitter, in safe area.

ii) Junction box serving the transmitter, in hazardous area.

iii) Directly at the transmitter, in hazardous area. Plug-in type connections shall be provided with field communicator. Necessary interconnection shall be supplied by the vendor.

c) Offered communicator shall be dust-proof, certified intrinsically safe and suitable for outdoor location. Carrying case shall be supplied with each communicator.

d) When specified in data sheets, the software shall also be capable of configuring other makes of transmitters.

e) They shall be battery powered with replaceable and rechargeable batteries.

2.6.2 Field Bus Tester

2.6.2.1 The field bus testers shall be able to determine the ability of the field bus wiring to carry field bus signals. The field bus tester shall be capable of testing both signal and resistance of the field bus. There shall not be any interruption on the output while communicating with the field bus devices.

2.6.2.2 The field bus tester shall meet all the requirements as specified in clause 2.6.3

2.6.3 Field Bus Configurator

The field bus configurator shall be centralized device like personal computer with hardware and software for configuration and maintenance of field bus instrument.

2.6.4 Remote output meter

2.6.4.1 Remote output meter shall be electronic with LCD display. The display shall be in actual engineering units.

2.6.4.2 The indicator electronic shall be able to perform square root extraction for flow measurement.

2.6.4.3 Offered indicators shall be certified intrinsically safe, when used in hazardous area.

2.6.4.4 Power supply shall be loop powered with smart transmitter, unless otherwise specified.

2.6.4.5 Fieldbus based field indicator shall be able to indicate all signals available in the field bus segment, selectively.

2.6. 5 Yoke mounted instruments shall be supplied with mounting bracket, U-bolt and nuts suitable for mounting the instruments on a 50 mm (nominal bore) pipe stanchion (horizontal or vertical).

2.6.6 Air set

Air set, where provided, shall be a combination air filter regulator set with 5-micron filter cartridge. It shall have a 50 mm diameter pressure gauge to indicate the regulated pressure. Each air set shall be supplied with mounting bracket and bolts with nuts for surface mounting.

2.6.7 Battery charger

Battery charger shall be supplied with all necessary accessories and shall operate at 230V ±10%, 50Hz±3Hz, unless otherwise specified.

3.0 NAMEPLATE

3.1 Each flush panel mounted instrument shall have the following information identified in the front:-

a) Tag number as per purchaser's data sheet.

b) Reading coefficient, if any
c) Pen colour, tag number-wise in the case of recorders.

Each flush panel mounted instrument shall have a back nameplate permanently fixed to it at a visible place reporting the following information:

a) Instrument tag number.
b) Manufacturer's serial number or model number. c) Manufacturer's name/trade mark.

3.2 Surface mounted instruments need be provided with only one nameplate. Local mounted instruments shall have a stainless steel nameplate attached firmly to it at a visible place, furnishing the following information:

a) Tag number as per purchaser's data sheets.
b) Manufacturer's serial number and /or model number c) Manufacturer's name/trade mark.
d) Body material.
e) Measuring element material. f) Range of measurement.
g) Area classification in which the equipment can be used, this shall be to the same code as per purchaser's data sheets.

4.0 INSPECTION AND TESTING

4.1 Unless otherwise specified, purchaser reserves the right to test and inspect all the items at the vendor's works in line with the inspection test plan for electronic/pneumatic instruments.

4.2 Vendor shall submit the following test certificates and test reports for purchaser's review: -

a) Material test report as per clause 3.1B of EN 10204 for body, flanges and spacer rings for all transmitters and diaphragm seal transmitters
b) Material test report as per clause 2.2 of EN 10204 for sensing element
c) Hydrostatic test report as per clause 4.3.
d) Functional and calibration report for each instrument including accuracy, linearity, hysteresis and repeatability.
e) Performance test report as per clause 4.4.
f) Response time of smart and fieldbus transmitters
g) Capability of smart and field bus based transmitters to accept multimasters for configuration, calibration, diagnostics and maintenance.
h) Configuration, calibration and diagnostics check through hand held configurator / field bus tester for smart and field bus based instruments.
i) Configuration, calibration and diagnostics check through field bus configurator for field bus based instruments.
j) Interoperability test certificate as per clause 2.2.3.14c) for fieldbus transmitters
k) Certificate from statutory body for intrinsic safety/flameproof enclosures.
l) Functional test report for fieldbus tester.

4.3 Hydrostatic Test

4.3.1 All transmitters shall be hydrostatically tested at static pressure as per clause 2.2.3.10 for a period of minimum 1 minute. After this test the transmitter shall not undergo a permanent set from the original calibration.

4.4 Performance Test

4.4.1 All instruments shall meet the Accuracy performance characteristics stated in clause 2.2.3.6 after the instruments have been subjected to the following over-range conditions: -

a) An air supply pressure of 2kg/cm²g for all pneumatic instruments.

b) Differential pressure transmitters subjected to a differential pressure in either direction equal to the manufacturer's pressure rating of the body.

4.5 Witness Inspection

4.5.1 Vendor shall offer all items for pre-dispatch inspection. Following tests/checks shall be carried out, as a minimum: -

a) Physical dimensional checks and workmanship.

b) Hydrostatic testing as per clause 4.3 of this specification on representative sample.

c) Performance testing as per clause 4.4 of this specification on representative sample.

d) Functional and calibration check on representative samples.

e) Effect of power supply/air supply variation and load driving capability check on representative samples.

f) Response time check on representative samples for smart and fieldbus transmitters

g) Capability of smart and field bus based transmitters to accept multi masters for configuration, calibration, diagnostics and maintenance.

h) Configuration, calibration and diagnostics check through hand held configurator /field bus tester for smart and field bus based instruments.

i) Configuration, calibration and diagnostics check through field bus configurator for field bus based instruments.

j) Review of all certificates and test reports as indicated in clause 4.2 of this specification.

k) Functional checks on fieldbus tester

5.0 SHIPPING

5.1 All threaded and flanged openings shall be suitably protected to prevent entry of foreign material.

5.2 Instruments shall be supplied individually, in sealed plastic bags.

5.3 Proper care shall be taken in shipping instruments with diaphragm seals to ensure safety of the diaphragm seals, extensions, capillaries, where specified shall be suitably protected.

5.4 All pneumatic / electronic instruments in oxygen and chlorine service shall be separately packed along with a certificate indicating 'CERTIFIED FOR OXYGEN / CHLORINE SERVICE', as applicable.

ANNEXURE – 1

STUD–BOLTS AND NUTS MATERIAL REQUIREMENT

Sr. No.	Piping Classes	Nut and Bolt Material
1	A1A, A2A, A5A, A6A, A7A, A8A, A9A, A10A, A11A, A13A, A14A, A15A, A19A, A20A, A32A, A33A, A1K, A6K, A1M, A1N, B1A, B2A, B5A, B6A, B9A, B13A, B18A, B19A, B32A, B1K, B6K, B18K, B1M, B3M, B5M, B1N, B6N, D1A, D2A, D5A, D18A, D1K, D18K, D18P, E1A, E2A, E5A, E5E, F5A	A-193 Gr. B7 A-194 Gr. 2H
2	A16A, B16A	A-193 Gr. B7M A-194 Gr. 2HM
3	A1B, A1D, A4F, A4G, B1B, B1D, B5D, B1E, B3F, B4F, B4G, D1B, D2B, D1D, D2D, D5D, D5E, F2D	A1-193 Gr. B16 A-194 GR. 4
4	A2K, B2K, D2K	A-320 Gr. B8 CL.2 A-194 Gr. 8
5	A4A, A1H, B4A, B1H, D4A, D1H	A-320 Gr. L7 A-194 Gr. 4
6	A3Y	A-307 Gr. B A-563 Gr. B
7	A3A, A3K, A3Y, A4Y, J3A	A-307 Gr. B A-563 Gr. B
8	A1Z, A4Z, A5Y, A5Z, J2A, J5A	A-307 Gr. B (Galv) A-563 Gr. B (Galv)
9	B4K, B5K	A-193 Gr. B8 M C11 A-194 Gr. 8 MA
10	A32Y	A-193 Gr. B (Galv) A-194 Gr. 2H (Galv)
11	B3M, B4K, B5K, B5M	A-453 Gr. 660 CL.A A-453 Gr. 660 CL.A

ANNEXURE – 2

GASKETS MATERIAL REQUIREMENT

Sr. No.	Piping Classes	Gasket Material
1	A1A, A2A, A5A, A6A, A7A, A8A, A9A, A10A, A11A, A13A, A14A, A15A, A19A, A20A, A32A, A33A, A1K, A6K, A1M, A1N, B1A, B2A, B5A, B6A, B9A, B13A, B18A, B19A, B32A, B1K, B6K, B18K, B1M, B3M, B5M, B1N, B6N, D1A, D2A, D5A, D18A, D1K, D18K, D18P, E1A, E2A, E5A, E5E, F5A	A-193 Gr. B7 A-194 Gr. 2H
2	B5M	SP WND SS316H+ GRAFIL + I RING
3	A2K, B2K, D2K	SP WND SS 316+GRAFIL+SS 316 I/O RING
4	B1N	SP WND SS 316L+GRAFIL + I RING
5	B6N	SP WND SS 316L + GRAFIL
6	A1Z, A3Y, A4Y, A4Z, J2A	BUTYL RUBBER
7	E1A, E2A, E5A, F5A	SOFT IRON
8	E5E, F2D	5% CR, 0.5% MO
9	B4K, B5K	SS 316H+GRAFIL+I RING SS 316 O RING
10	A5Z	PTFE JACKETED ASBESTOS
11	A5Y, A8A, A15A, A32Y, A33Y	IS 2712 Gr. A/1
12	B3M	SP WND SS 321+GRAFIL+I RING
13	A1N, A6K, A16A, B16A	SP WND SS 316 + CAF
14	A3A, A3K, A33A, J3A, J5A	IS 2712 Gr. W/3
15	A2A, A20A, A32A	IS 2712 Gr. W/1
16	A5A, B5A, D5A	SP WND SS 316 + CAF + I RING
17	A7A, B1B, B1D, B1E, B1K, B3F, B4F, B4G,B5D, D1B, D1K, D2B, D1D, D2D, D5D, D5E	SP WND SS 316 + GRAFIL + I RING
18	B6K, B1M	SS 316 + GRAFIL

GAIL INDIA LIMITED

STANDARD SPECIFICATION

FOR

TEMPERATURE GAUGES AND THERMOWELLS

GAIL-STD-IN-DOC-TS-016

0	22.01.2019	Issued for Bid	RKS	UNU	UNU	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

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1.0 GENERAL

1.1 Scope

1.1.1 This specification, together with the data sheets attached herewith, covers the requirements for the design, materials, nameplate marking, inspection, testing and shipping of temperature gauges and thermowells.

1.1.2 The related standards referred to herein and mentioned below shall be of the latest editions prior to the date of the purchaser's enquiry: -

ANSI/ASME	**American National Standards Institute/American Society of Mechanical Engineers.**	
	B 1.20.1	Pipe Threads General Purpose (Inch)
	B 16.5	Pipe Flanges and Flanged Fittings NPS1/2 through NPS24
	B 16.20	Metallic Gaskets for Pipe Flanges, Ring Joint, Spiral Wound and Jacketed.
ASME	B 40.200	Thermometers - Bimetallic/ND

EN-10204	Inspection Documents For Metallic Products
IEC-60529	Degree of Protection Provided by Enclosures (IP Code).
IS-13 947	Specification for Low Voltage Switch Gears and Control Gears
SAMA	Scientific Apparatus Maker's Association.

1.1.3 In the event of any conflict between this standard specification, job specification/data sheets, statutory regulations, related standards, codes etc. the following order of priority shall govern:

a) Statutory regulations
b) Data Sheets
c) Standard specification
d) Codes and standards

1.1.4 In addition to compliance to purchaser's specifications, vendor's extent of responsibility shall include the following:

a) Purchaser's data sheets indicate the minimum acceptable material of construction for sensing element, capillary, stem, thermowell etc. Alternate superior material of construction shall also be acceptable provided vendor assumes complete responsibility for the selected materials for their compatibility with the specified fluid and its operating conditions.

b) Vendor shall carryout the vibration analysis of the thermowells as per ASME PTC 19.3 standard and shall provide suitable design for the thermowells wherever necessary.

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to vendor attached with the material requisition.

1.2.2 Whenever a detailed technical offer is required, vendor's quotation shall include the following:

a) Compliance to the specifications.

b) Whenever the requirement of a detailed specification sheet for each tag number is specifically indicated, the specification sheet shall provide all the details regarding type, construction and materials etc. of the temperature gauge and its accessories. The material specifications and units of measurement indicated in the specification sheets shall be to the same standards as those in purchaser's data sheets.

c) Proven references for each offered model in line with clause 1.2.3 of this specification whenever specifically indicated in purchaser's material requisition.

d) Deviations on technical requirements shall not be entertained. In case vendor has any valid technical reason to deviate, they must include a list of temperature gauges tag number wise, summing up all the deviations from the purchaser's data sheets and other technical specifications along with technical reasons for each of these deviations.

e) Catalogues giving detailed technical specifications, model decoding details and other information for each type of temperature gauge covered in the bid.

1.2.3 All items, as offered, shall be field proven and should have been operating satisfactorily individually for a period of minimum 4000 hours on the bid due date in the process conditions similar to those as specified in the purchaser's data sheet. Items with proto-type design or items not meeting proven ness criteria specified above shall not be offered.

1.2.4 All documentation submitted by vendor including their quotation catalogues, drawings, installation, operation and maintenance manuals etc shall be in English language only.

.1.2.5 Vendor shall quote for two years' operational spares for each temperature gauge and its accessories, which shall include movement, pointer, glass cover plate etc. as a minimum.

1.3 Drawing and Data

1.3.1 Detailed drawings, data, catalogues and manuals required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of reproducible, prints and soft copies shall be sent to the address mentioned, adhering to the time limits indicated.

1.3.2 Final documentation consisting of design data, installation manual and maintenance manual submitted by the vendor after placement of purchase order shall include the following as a minimum:

a) Specification sheet for each temperature gauges and thermowell.

b) Certified drawings sheets for each gauge and its accessories, which shall provide dimensional details, internal constructional details, end connection details and material of construction.

c) Copy of type test certificates.

d) Copy of the test certificates for all the tests indicated in clause 4.0 of this specification.

e) Installation procedure for each gauge and its accessories.

f) Calibration and maintenance procedures including replacement of its internal parts wherever applicable.

2.0 DESIGN AND CONSTRUCTION

2.1 Temperature Gauges

2.1.1 Temperature gauges shall be of the separate socket type suitable for well installation. Upon assembly of components, the temperature gauge element shall firmly contact the bottom of the well. The gauge stem shall fit the well so that maximum heat transfer rate results.

2.1.2 Unless otherwise specified in the purchaser's data sheet, the temperature gauges shall be of bimetallic type.

2.1.3 Whenever filled system type temperature gauges are specified, the SAMA Classification indicated in the data sheet shall be referred as follows;

SAMA Class	Filling Fluid
I	Liquid
II	Vapour
III	Gas

Mercury filled type of temperature gauges shall not be offered.

2.1.4 Vendor shall ensure that the operating temperature falls in the middle 30% of the full working range i.e. 30% to 60% of the offered range.

2.1.5 Unless otherwise specified, the temperature gauges shall have an over range protection of at least 130% of specified range or maximum working temperature, whichever is higher.

2.1.6 Data sheets indicate the minimum requirements of material of construction. Alternate material as specified in Annexure-1 to this specification shall also be acceptable.

2.1.7 Whenever temperature gauges are specified with capillary extension for remote installation, the capillary shall be of 304 Stainless Steel protected by stainless steel flexible armour.

2.1.8 The gauge movement material shall be of stainless steel, as a minimum.

2.1.9 Cases and dials

2.1.9.1 Unless specified otherwise, the case of bimetallic type of gauges shall be all angles rotatable type.

2.1.9.2 Unless specified otherwise, the gauges shall be weatherproof to IP55 as per IEC 60529 / IS 13947 as a minimum.

2.1.9.3 The gauge dial shall be made of a suitable metallic material so that the finished dial shall be capable of withstanding a dry heat of 85°C for 10 hours and immersion in water at 85°C for 1 hour without cracking, blistering, warping or discoloration of the dial or paint on the dial.

2.1.9.4 The pointer stops shall be provided at both ends of the scale to restrict the pointer motion beyond 5% above the maximum scale and less than 5% below the minimum of the scale.

2.1.9.5 The dial cover shall be made out of shatter proof glass sheet of thickness of minimum 3.0mm.

2.1.10 Performance Requirements

Unless otherwise specified, the accuracy of temperature gauge shall be ±1% of set range.

2.2 Thermowell

2.2.1 Unless otherwise specified, the thermowell material shall be 304 Stainless

Steel, as a minimum. Alternate material as specified in Annexure-I shall also be acceptable subject to meeting process conditions specified in the data sheet.

2.2.2 Thermowells with immersion length up to 500mm shall be mechanised out of forged bar-stock. Built-up thermowell with welded well construction shall be considered for immersion length of greater than 500mm.

2.2.3 Thermowell flange material and rating shall be as specified in the purchaser's data sheet.

2.2.4 All thermowell weld joints shall be full penetration weld type only.

2.2.5 Thermowell immersion length shall be as specified in purchaser's data sheets. Where immersion length is not specified in the purchaser's data sheet, following shall govern;

Line Size	**Immersion Length**
Upto 6"	280mm
8" and above	320mm
Equipments	400mm

The immersion length for built-up thermowells shall be as per actual requirement specified in the purchaser's data sheets.

2.2.6 Unless otherwise specified, the following shall govern:

a) Threaded end connections shall be NPT as per ANSI/ASME B 1.20.1

b) Flanged end connections shall be to ANSI/ASME B 16.5

c) Where ring type joint flanges shall have been specified, groove shall be suitable for octagonal rings as per ANSI/ASME B 16.20.

d) Flange face finish shall be as per clauses 6.4.4.1, 6.4.4.2 and 6.4.4.3 to ANSI/ASME B 16.5. The face finish as specified in the datasheets, shall be as follows;

125AARH : 125to250AARH

63AARH : 32 to 63 AARH

2.2.7 All thermowells in oxygen and chlorine service shall be thoroughly degreased using reagents like trichloro-ethylene or carbon tetrachloride. All connections shall be plugged after degreasing process in order to avoid entrance of grease or oil particles.

3.0 NAMEPLATE

3.1 Temperature gauge

3.1.1 Each temperature gauge shall have a stainless steel nameplate attached firmly to it at a visible place either by riveting or screwed to the case, furnishing the following information;

a) Tag number as per purchaser's data sheet.
b) Vendor's name.
c) Model number and manufacturer's serial number.
d) Range of the instrument.

3.2 Thermowell

3.2.1 The following information shall be punched on the extension of the thermowell:

a) Tag number as per purchaser's data sheets.
b) Thermowell material as per purchaser's data sheets.
c) Thermowell immersion length 'U'.

3.2.2 The following information shall be punched on the thermowell flange at a visible place:

a) Nominal flange size in inches and rating in pounds.
b) Flange material as per purchaser's data sheets.

4.0 INSPECTION AND TESTING

4.1 Unless otherwise specified, purchaser reserves the right to test and inspect all the items at the vendor's works inline with inspection test plan for temperature gauges and thermowells.

4.2 Vendor shall submit following test certificates and test reports for purchasers review: -

a) Material test certificate as per clause 3.IB of EN10204 for thermowells and as per clause 2.2 for bimetal strip, stem and bulb etc.
b) Certificate of radiography/X-ray for welded joints. Dye penetration test certificate shall be provided for joints where radiograph/X-ray is not possible.
c) Type test report for enclosure class of temperature gauges.
d) Dimensional test report for all temperature gauges.
e) Certificate for concentricity of bore.
f) Hydrostatic test report as per clause 4.3 of this specification.
g) Calibration report for temperature gauges.
h) IBR Certificate Form III C for thermowells covered under IBR certification.

4.3 Hydrostatic Test

4.3.1 Each thermowell made of bar stock or built-up type shall be subjected to hydrostatic test for a time period of 20 minutes at the following pressures:

a) Inside of the well at 100 kg/cm^2 upto 600# flange rating and at 200 kg/cm^2 above 600# or up to flange rating whichever is higher
b) Outside of the well as per ANSI rating of the flange.

There shall not be any visible leakage or rupture during this hydrostatic testing.

4.4 Witness Inspection

4.4.1 All temperature gauges and thermowells shall be offered for pre-dispatch inspection for the following, as a minimum;

a) Physical dimensional verification and workmanship.

b) Hydrostatic test on thermowells at random as per clause 4.3 of this specification.

c) Performance test including accuracy and repeatability over the entire range on the representative samples of each type / model number.

d) Over range protection on samples of each type / model number.

f) Review of all certificates and test reports as indicated in clause 4.2 of this specification.

4.4.2 In the event when the witness inspection is not carried out by purchaser, the tests shall anyway be completed by the vendor and documents for the same shall be submitted for scrutiny to purchaser.

5.0 SHIPPING

5.1 Proper care shall be taken in shipping the temperature gauges, especially for the case glass and extension capillaries, where specified. All items shall be adequately packed to withstand shipping conditions, without damage.

5.2 All threaded and flanged openings shall be suitably protected to prevent entry of foreign material.

5.3 All thermowells in oxygen and chloride service shall be separately packed along with a certificate 'CERTIFIED FOR USE IN OXYGEN / CHLORINE SERVICE', as applicable.

6.0 REJECTION

6.1 Vendor shall prepare their offer strictly as per clause 1.2 of this specification and shall attach only those documents and information which is specifically indicated in the material requisition.

6.2 Any offer not conforming to above requirements, is liable to be rejected.

Sr. No.	Item	Specified Material of Construction	Alternate Material of Construction
1	Thermowell	SS 304	SS 304L, SS--316, SS 316L, SS 316T1
		SS316	SS 316L, SS 316Ti
2	Case	Cast Aluminium	SS

3	Capillary	SS	SS 304, SS 316, SS 304L, SS316L, SS316 Ti
4	Stem	SS316	SS316L, SS316Ti

GAIL INDIA LIMITED

STANDARD SPECIFICATION

FOR

ULTRASONIC METER (USM)

GAIL-STD-IN-DOC-TS-017

0	22.01.2019	Issued for Bid	RKS	UNU	UNU	
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1.0 GENERAL

1.1 This specification covers the general requirements for multi path transit time ultrasonic gas flow meter for the Gail(India)Ltd..

1.2 The ultrasonic meters shall be used to measure gas flow at the metering station. The meter shall be installed in the main pipeline and shall be piggable (OPTIONAL).

1.3 Vendor shall integrate the flow meter and all flow data into the local RTU/PLC and eventually into the SCADA system.

1.4 Vendor shall furnish all labor, material, equipment, transportation, and facilities necessary to perform all work as defined in this specification and the Data Sheets.

1.5 PURCHASER shall mean the Gail(India)Ltd only.

1.6 VENDOR shall mean the original equipment manufacturer.

1.7 VENDOR's scope of work shall include:

i) Design, engineering, sizing, selection, manufacture and/or procurement of materials, components and equipment necessary for complete package;

ii) Inspection and testing of all components, sub-assemblies, and complete assemblies of items manufactured at VENDOR's works, and other sub-vendor's works in accordance with approved QA/QC procedure.

iii) Mechanical and structural detailed design, procurement of materials, preparation of fabrication drawings, detailing of internals, fabrication, inspection and testing of the piping and structural items at fabrication shop, painting, internal coating if any, preservation, transportation and undertaking Guarantee for the equipment.

iv) All accessories and instruments shown in the P&ID/schematic along with the USM assembly, as within the VENDOR's scope.

v) Shop assembly and hydrotest;

vi) Factory Acceptance Test (FAT) for the complete package at VENDOR's works.

vii) Installation supervision for the complete package at site.

viii) Site Acceptance Test (SAT) for the complete package at site.

ix) Preparation for shipment, packing and delivery of all packages, equipment and material to site.

x) Start-up and commissioning assistance at site.

xi) Training of COMPANY's operating and maintenance personnel.

xii) Preparation and submission of all documents as per requisition with the bid, after award of contract, Final Documentation / Completion files as per this specification.

xiii) Any work not specifically mentioned but otherwise required, as per statutory rules / codes and standards / specifications and/or for the completion and operation of

equipment to the entire satisfaction of GAIL have to be done by the VENDOR without any commercial implications.

xiv) The scope of supply also includes the commissioning and start up spares, recommendations for 2 years operational spare parts, special tools and documentation.

1.8 Other General requirements

(i) VENDOR shall include in the bid, list of specific deviations**,** separately, if any, to this specification and all attachment thereof, otherwise, the quotation will be deemed to be in compliance with the specification requirements and subsequent claims for extra arising out of non-compliance with the specification will not be considered.

(ii) The VENDOR shall assume single point responsibility for all aspects of the work. This shall include timely completion, liaison with CONTRACTOR, liaison with VENDOR of specified items, co-ordination of the work, quality and guarantee for the equipment.

(iii) Where parts of the package are subcontracted and purchased by the VENDOR, these become part of the VENDOR's package and it is the VENDOR's responsibility to ensure that the complete package complies with the specifications, codes and standards and statutory regulations.

(iv) The VENDOR shall be responsible for obtaining necessary approvals, authorization and certification from local Government / Local Statutory bodies, Authorized Inspector and Third Party Inspection Agency as applicable.

(v) All components/consumables used shall be new and of current manufacture.

(vi) In the event of any conflict between this specifications, data sheets, related standards codes etc., vendor shall refer the matter to the PURCHASER for clarifications and only after obtaining the clarification shall proceed with the manufacture of the items in question.

(vii) Typical instrument data sheets for Ultrasonic flow meters is attached. However, this does not absolve the Vendor of the responsibility for proper selection with respect to the fluid and its operating and design conditions. Proper sizing and selection of the ultrasonic flow meters, and accessories are vendor's responsibility

(viii) Vendor to note that Ultrasonic flow meters shall be supplied having proven track record of successful operation for at least 4000 hours till bid due date. Details of earlier supplied references shall be furnished as part of the bid.

(ix) Sizing calculations for USM meter and meter runs at maximum flow and minimum pressure shall be provided. All design & performance characteristics shall be given by vendor.

(x) All units of measurements and material specifications in vendor's specification sheets shall be same as those in purchaser's data sheets.

(xi) Vendor shall enclose catalogues giving detailed technical specifications and other information for multi-path ultrasonic flow meter. Vendor's proposal including

catalogues, drawings, operating and maintenance manuals etc., shall be only in ENGLISH language.

(xii) Vendor shall submit the exact sizing details & specifications of USM meter and piping items, make & model, etc., subsequent to award of contract. The relevant catalogue, technical literature shall also be furnished. GAIL shall review the above and vendor to note that "No post order deviation shall be granted". Vendor shall change the make and/or models of items and specifications to meet the requirement of contract without any price and delivery implications

2.0 CODES, STANDARDS AND DOCUMENTS

2.1 Codes and Standards

The following standards shall be considered part of this specification insofar as they give definitions and describe requirements and tests that the VENDOR shall meet. The standards used shall be the latest revision in force, including any addenda, supplements or revisions thereto. If two or more standards conflict, the more stringent standard shall apply.

ANSI/ASME	B 16.5 Pipe Flanges & Flanged Fittings
ANSI/ASME	B 16.20 Metallic Gaskets for Pipe Flanges
	B 1.20.1 Pipe Threads General Purpose (Inch)
	B16.34 Valves Flanged, Threaded and
	Welding End
	Sec-VIII Boiler & Pressure vessel code rules for construction of Pressure vessels
ASTMD-1250	Standard Guide for use of Petroleum Measurement Tables
AGA Report No. 8	Compressibility Factors of Natural Gas and Other Related Hydrocarbon Gases (also API MPMS Chapter 14.2)
AGA Report No. 9 (Latest edition)	Measurement of Gas by Ultrasonic Meters
ANSI C37.90.1	Surge Withstand Capability
ANSI / NFPA 70	National Electrical Code (NEC)
ANSI / NFPA 75	Standard for the Protection of Electronic Computer Data Processing Equipment
ISO 12675	Measurement of Fluid Flow in Closed Conduits - Methods Using Transit-time Ultrasonic Flowmeters
NEMA ICS 1	General Standards for Industrial Control and Systems
ANSI/ISA-12.00.01	Electrical Apparatus for Class I, Zones 0, 1& 2 Hazardous (Classified) locations: General Requirements

IEC 60079	Electrical Apparatus for Explosive Gas Atmospheres
IEC 60529	Degrees of Protection Provided by Enclosures
API MPMS	American Petroleum Institute Manual of Petroleum Measurement standards Chapter 1 Vocabulary Chapter 4 Proving Systems Chapter 5 Metering 11-2-1 Compressibility Factors for Hydrocarbons 11 -2-2 Compressibility Factors for Hydrocarbons
EN 10204	Inspection Documents For Metallic Products
EN 12405	Gas Meters - Gas Volume Electronic Conversion Devices
EN 50014	Electrical Apparatus for potentially explosive atmospheres – General Requirements
EN 50020	Electrical Apparatus for potentially explosive atmospheres – Intrinsic Safety.

2.2 Documents

xxxxxxxxxx	Piping & Instrument Diagram (P&ID)
xxxxxxxxxx	Data Sheet for Ultrasonic Flow Meter

3.0 CONDITIONS OF SERVICE

3.1 The meter shall be suitable for natural gas fluids with gas composition as defined in the Process Data Sheets(PDS).

3.2 The meter assembly and sensors shall be installed in the locations as indicated in the P&IDs.

3.3 The meter assembly and the ultrasonic transmitters and sensors shall be certified for Zone 1 Gas Gr II A & II B, Temp T3 service as defined in the IEC.

3.4 Unless otherwise specified, the enclosure shall meet requirements of IEC 60079. Ingress protection for all field instruments and enclosures/junction boxes/cable glands etc. shall be IP-55/NEMA 4 as minimum Weatherproof

housing shall be IP55 and flameproof housing shall be EX (d) and weatherproof.

3.5 Instruments mounted in the field shall be suitable for installation in tropical hot and humid climate considering environmental conditions:

0º to 48º Celsius operating temperature range
10% to 100% relative humidity, non condensing

3.6 Power supply for the flow meter shall be from the 24 VDC instrument power supply at the site provided as part of the pipeline SCADA/ control system.

4.0 DESIGN CONSIDERATIONS

4.1 Multi path design shall be used to minimize the effects of flow profile variation across the meter tube. Insertion ultrasonic meters shall not be acceptable.

4.2 Multi path design shall include methods to compensate for non-uniform flow conditions such as swirl and uneven velocity profile in the meter body.

4.3 Meter shall be capable of continued operation in a degraded mode(reduced accuracy) with a failure of one of the signal paths. Meter manufacturer shall state the amount of degradation in accuracy with the loss of one or more signal paths.

4.4 Transducer ports on the meter body shall be designed to prevent any possible collection or pooling of liquid and particulate that can impair the operation of the transducers.

4.5 Transducer ports and the transducers in their normal operating position shall not intrude into the main flow path of the meter.

4.6 VENDOR shall allow a minimum straight horizontal runs of 14X pipe diameter upstream and 5X pipe diameter downstream of meter body (or the vendor's requirement if more stringent) to reduce the impact of non uniform flow profile across the meter. Bi-directional meters shall have a minimum of 14X pipe diameter straight piping at both ends of the meter.

4.7 In-line flow conditioners shall be allowed if the meter is not specified to be piggable. Bi-directional meters shall be fitted with flow conditioners on both sides of the meter.

4.8 Meter body shall have a nameplate affixed with the following information: Manufacturer, model number, serial number and date of manufacture Meter size, flange class, total weight, flange design code and material, body design code and material

Maximum operating pressure

Operating temperature range

Maximum and minimum flow

Direction of flow

4.9 Field activities shall be limited to adjustments to parameters or software constants inside the flow meter controller.

4.10 Meter shall be provided with a temperature sensor downstream of the meter body. A normal intrusive thermowell shall be allowed for meters that will not be pigged.

4.11 Piggable meters shall be equipped with surface mounted, non-intrusive temperature sensor. VENDOR shall provide thermal insulation or other means of thermal protection against effects on solar heating on the surface mounted temperature sensor. A second temperature sensor located in a protected section (non-pigged) of piping shall be used for comparison. The use of either temperature measurement for temperature compensation shall be user selectable.

4.12 Ultrasonic/Turbine Gas Custody Transfer Metering System shall be built and integrated only by the original equipment manufacturer of the Ultrasonic Flow Meter, since critical components within the custody transfer metering system should be compatible to ensure "Overall System Uncertainty" for this critical fiscal transaction purpose. All components within the metering system must be well proven and compatible in the similar application.

4.13 The straight length of calibrated pipe forming the upstream and downstream parts of the meter tubes shall be cut from one piece of pipe without any intermediate girth weld. All meter run pipes shall be specially selected for dimensional accuracy and shall be free from all imperfections and corrosion on internal surfaces.

4.14 The calibrated meter runs shall be easily removable and shall be connected to a adjacent piping by means of flanges.

4.15 The gas flow meter and meter tube piping shall be installed in a region of zero stress in the pipeline to minimize strain on the meter. The upstream pipe work shall be carefully aligned to minimize flow disturbances, especially at the upstream flange of the meter.

4.16 As a minimum, flow conditioners shall be 316 stainless steel of a between-flanges. These shall comply with the requirements of AGA 9 for ultrasonic meters. Where flow conditioners are recommended, care must be taken to select flow conditioners that do not generate acoustic noise with harmonic frequencies that may interfere with the USM performance.

4.17 All tubing and fittings used for impulse piping shall be of SS 316. Tube fittings shall be flare less compression type of three-piece construction consisting of ferrule, nut and body suitable for use on SS tubes. Instrument valves and manifolds shall be of SS316 construction of forged type.

4.18 All interconnecting instrument cables in skid and cables to control room shall be armoured. All signal and alarm cables shall be individual pair shielded and overall

shielded. Vendor shall follow the cable specifications as per signal cable standard specifications.

4.19 The pressure instruments shall be provided with individual process isolation valves and block and bleed manifolds.

4.20 Transmitters shall be microprocessor based **"SMART"** type with HART Protocol. Accuracy of transmitters shall be ± 0.075% of FSD or better for PT/DPT and ±0.1% FSD or better for Temperature Transmitters. All transmitter shall be provided with integral output meter with digital display.

4.28 The temperature transmitters shall be Pt 100 RTD sensor type with integral head mounted SMART transmitter with two wire 4-20 mA DC output, 24 VDC loop powered complete with local output meter (LCD type). The temperature transmitter shall be provided with flanged thermowell of 316SS material fabricated from drilled bar stock.

4.29 Hand held configurator shall be provided for remote calibration, remote configuration and remote diagnostics of the transmitters.

4.30 The design used shall provide maximum reliability, maximum on-line performance and minimum maintenance. Instrument shall be field proven. No prototype instrument shall be supplied. Technique of measurement used shall be interference free. It shall be immune to other impurities in the fluid stream

5.0 PERFORMANCE SPECIFICATION

5.1 The accuracy of flow calculations and results shall be compliant with AGA Report No.9.

5.2 The flow meter design shall allow for bi-directional flow measurement without any mechanical or electrical/electronic modifications. Flow in the normal direction shall be indicated as a positive value flow rate and flow in the reverse direction shall be indicated as a negative value.

5.3 The flow meter shall meet the accuracy requirements specified below:

Maximum Error:	+/-0.7% of measured value
Mean Error:	+/-0.5% of measured value
Linearity:	+/-0.2% of measured value
Resolution:	0.001 m/s (0.003 ft/s) Velocity
sampling Interval:	< 1 second
Zero flow reading:	< 12 mm/s (0.04 ft/s) for each path

6.0 FLOWMETER

6.1 The flow-meter shall consist of a flanged spool meter section with factory installed and calibrated ultrasonic transducers It shall comprise of multi-path ultrasonic transducers. The transducers shall be energized by the integral electronics to transmit and receive ultrasonic waves. Vendor shall size all the ultrasonic flow meters for the given process conditions as per AGA 9. Sizing shall be done considering maximum flow capacity at minimum inlet operating pressure &

gas composition and other process conditions.

6.2 The turndown ratio of each flow meter shall be minimum 1:20. The accuracy of the Ultrasonic flow meter shall be ±0.5% or better and repeatability shall be better than ±0.25% of reading and accordingly vendor shall select the no. of paths to meet accuracy requirement and indicate the same in calculations/back-up literature.

6.3 Meter body and flanges shall be designed to the same pressure and flange ratings as the station piping.

6.4 Ultrasonic meters and the meter runs/flow conditioners shall be rated for the maximum design pressure.

6.4 A minimum of one pressure tap of ½" NPT (F) size shall be provided for measurement of the static pressure in the meter.

6.5 The meter body shall be made of carbon steel as per data sheets (ASTM A 216 GR. WCB or equivalent). All flanges shall be weld neck, raised face and shall meet ANSI B 16.5.

6.6 The ultrasonic metering system shall be provided with full diagnostics and customer user interface.

6.7 It shall be possible to replace or relocate transducers in situ under line operating condition without a change in meter performance. Transducer replacement shall not require re-calibration of the meter. After an exchange of transducers and a possible change of the associated software constants, the resulting shift in the meter's performance should not be more than the allowable repeatability of the meter. In addition, the maximum error and the maximum peak-to-peak error as detained in figure 5.2 of AGA-9 shall not be exceeded. The extraction/insertion tool and any other specialized tools, consumable parts required for transducer removal and insertion shall be supplied.

6.7 Each transducer port on the meter body shall be uniquely marked for easy reference.

6.8 The ultrasonic transducers shall operate reliably over entire range of pressure specified on Data Sheet.

6.9 Each ultrasonic transducer shall be individually tested, calibrated and marked with a unique serial number and with the minimum operating pressure.

6.7 Failure or removal of one pair of transducers shall not cause the meter to lose all measurement function. Failure of any path shall generate an alarm identifying the affected path. The vendor shall comprehensively advise the impact of transducer failure on the performance and accuracy of the USM. Vendor shall confirm that the measurement will not degrade by more than ± 0.1% in case of loss of one path.

6.9 Area classification shall be IEC Zone-1, Gas Gr. II A & IIB, and Temperature Class T3. All electrical instruments in the field shall be suitable for the specified area classification and certified by a statutory body such as FM, UL, CENELEC, BASEEFA, and PTB etc. The transducers shall be intrinsically safe certified suitable for the specified area classification and weather proof to IP65/NEMA-4 and vendor shall supply necessary isolating barriers between the transducers and

preamplifier/transmitter However the transducer/sensor housing can be flameproof (EEx d) certified suitable for the specified area classification instead of intrinsically safe.

6.10 Overall pressure drops across the meter assembly including meter runs shall be less than 0.1 Kg/cm2g. Pressure drop calculation across the meter shall be furnished.

6.12 Ultrasonic flow meter spool inside diameter to meet the specified I.D and internal surface roughness shall be as per standard AGA Report no. 9.

7.0 METER ELECTRONICS AND SIGNAL PROCESSING

7.1 Meter assembly shall include a signal processing unit to perform all control of the transducers and perform all calculations and statistical averaging for calculating flow rate.

7.2 Extensive Diagnostic capability shall be provided to allow monitoring of operating parameters of the meter, health of the transducers and signal quality etc. These shall include parameters required to characterize the performance of the meter and confirm its compliance to AGA-9. The diagnostic functions shall be supported by a PC-based engineering/maintenance software tool.

7.3 Signal processing unit shall perform all flow computer functions, including calculations to correct for pressure, temperature and compressibility to provide corrected flow rates and flow totals at standard conditions.
Compressibility calculations shall be based on the latest version of AGA Report No.8 using the detailed characterization method. Gas quality data, shall be input via the station PLC or RTU from live GC data from the nearest online gas chromatograph.

7.4 The signal processing unit shall be equipped with a minimum of two serial communication ports. One port shall be used for connection to the station PLC / RTU or flow computer. The second port shall be used for maintenance and diagnostic support functions.

7.5 The serial port communication channels shall each be configurable for speeds of 1200, 2400, 4800 or 9600 bits per second. The physical interface for each serial port shall support EIA-485 and EIA-232 standards. Each port shall be equipped with optical protection to provide both galvanic isolation and surge suppression.

7.6 The serial ports shall use MODBUS protocol as a MODBUS slave device. It shall support both RTU mode and ASCII mode communications. RTU mode shall be used for communicating with the SCADA/RTU/PLC or the flow computer.

7.7 All operating parameters and flow data shall be accessible via the serial ports. Analog values retrieved via the serial communication port shall be scaled in engineering units. IEEE floating format shall be used. Status information shall be available as either bit packed 16-bit MODBUS holding registers or as single bit MODBUS data. Operational data shall be user configurable to be in metric units or imperial units and shall include the following as a minimum:

Uncorrected and corrected forward direction flow rate
Uncorrected and corrected reverse direction flow rate

Uncorrected and corrected forward direction flow total (non-resettable)
Uncorrected and corrected reverse direction flow total (non-resettable)
Calculated flow velocity for each signal path
Average flow velocity
Static Pressure Temperature
Path status for each signal path (normal, failed, high error/poor signal quality, etc)
Flow direction
Overall meter data quality

7.8 The signal processing unit shall provided maintenance and calibration support features that are accessible from a notebook computer or a handheld terminal. VENDOR shall include any specialized interconnecting cables, the notebook based software or the portable terminal as part of the maintenance to be supplied with the meter.

7.9 Diagnostic functions shall allow the user to monitor and track the overall performance of the meter and the transducers in particular. As a minimum, it shall be possible to view and store the waveforms of the ultrasonic signals for comparison. It shall also be possible to monitor key operating parameters such as the calculated speed of sound and flow velocity, signal strength and noise of each signal path.

7.10 Meter electronics shall include all associated transmitters, pre-amplifiers etc.

7.11 The transmitter unit shall be microprocessor-based electronics suitable for installation in the field under the ambient condition specified. Meter electronics shall be Weather proof to IP 65/ NEMA 4 and flameproof certified suitable to install in area classification IEC Zone-1, Gas Gr. IIA & IIB, Temp. Class T3 by a statutory body such as FM, UL, CENELEC, BASEEFA, PTB etc.

7.12 The electronics unit shall preferably be mounted integral on the meter.

7.13 Meter parameters and factors set into the meter electronics shall be retained in nonvolatile memory and shall be secured with password such that un-authorised changes are prohibited.

7.14 Configuration software and firmware shall be provided.

7.15 Meter output signals from the meter electronics shall be without flying leads. All the signals from the meter electronics shall be terminated in a junction box (JB) supplied by the meter vendor and shall be mounted on skid. JB shall be weather proof (WP) to IP 65/NEMA 4 and flameproof certified suitable for the specified area classification.

7.16 The cable entry sizes between meter electronics and transducers shall be decided by vendor and the WP & flameproof cable glands to be supplied accordingly. Cable entry sizes shall be as per NPT standards.

7.17 Meter electronics shall be capable of multiple output signals as follows:

a) Dual frequency pulse outputs to flow computers configurable for flow rate signals and shall be user selectable to be either same outputs or one signal dedicated to each direction of flow.

b) One configurable 4-20 mA analogue output internally powered and galvanically isolated.

c) Digital discrete outputs for direction of flow, trouble alarm and output data validation.

d) RS-485/422 communication port with MODBUS protocol for communicating with the other control system i.e. control room mounted flow computer for meter diagnostics, test and health data

7.18 Vendor shall supply the RS 485/422 cables interconnecting serial link cables which shall be armoured including connectors against each tag for communication between flow meter in field and flow computers mounted on metering control panel located at respective control room as per the station wise distances between field & control room.

7.19 Meter electronics shall operate on 230 V AC ± 10%, 50 Hz ± 3% UPS or 24 VDC (selectable) and shall be protected from overload and from transients. Low power consumption is desired.

7.20 Speed of Sound comparison should be done in the stream flow computer for the speed of sound measured value from the USM and the speed of sound calculation based on the GC component data.

8.0 INSTALLATION AND COMMISSIONING

8.1 VENDOR shall implement thermal control strategies as required to maintain the temperature of the overall system and particularly the temperature of the meter assembly within the specified range necessary to maintain a performance compliant with AGA-9. As a minimum, the meter tube shall be protected against direct sunlight to prevent differential heating of the meter tube which can affect the meter accuracy.

8.2 VENDOR shall provide a method of ensuring correct alignment of the meter body with the upstream and downstream piping. If the possible misalignment resulting from normal tolerances of the mating flanges exceeds the maximum allowable by the vendor's design, then special mechanical measures shall be provided to correct alignment. Acceptable methods are dowel pins and RTJ flanges.

8.3 VENDOR shall ensure adequate separation between the ultrasonic meter and possible sources of ultrasonic energy such as control valves to avoid interference with the operation of the transducers.

8.4 VENDOR shall provide all necessary signal conversion equipment necessary to interface the flow meter to a flow computer or to a RTU/PLC based MODBUS/flow calculation module.

8.5 VENDOR shall provide on site support by a vendor specialist for the installation and commissioning of the meter assembly.

9.0 TESTING REQUIREMENTS

9.1 General

9.1.1 PURCHASER may visit the plant at any time and witness all testing and quality control procedures that may take place during fabrication and final testing.

9.1.2 The system shall be tested to ensure high reliability and proper operation. Such testing shall be documented and test records furnished to the PURCHASER prior to the commencement of witnessed testing.

9.1.3 Only after all work has been completed and inspected by the VENDOR to verify conformance with the drawings and specifications shall the Purchaser be invited to witness tests. Any discrepancies found as a result of the inspections or tests shall be corrected by the Vendor at no cost to the PURCHASER (including the cost for making the corrections and repeating the tests and / or inspections).

9.1.4 The VENDOR shall supply all calibration, test, and simulation equipment that are required to demonstrate correct operation of the system. Certificates for all the test equipment shall be traceable to National Standards.

9.1.5 Calibration, test, and simulation equipment shall be used at factory testing, pre-commissioning, commissioning and site periodic testing. During the testing and commissioning period the VENDOR shall ensure that all equipment is maintained in calibration.

9.1.6 All calibration, test, and simulation equipment shall be made available for the PURCHASER's use during the testing and commissioning period.

9.2 Factory Acceptance Testing (FAT)

9.2.1 The assembled system shall be factory tested before shipment in compliance with an approved test plan provided by the VENDOR. The test plan shall be submitted to the PURCHASER for approval at least two months prior to the factory acceptance test date.

9.2.2 The factory tests shall include at least the following:

Hydrostatic test to 1.5 times the design pressure of the pipeline. Tests may be conducted with transducers removed if supported by vendor recommendation.

Dimensional tests including, as a minimum, the average internal diameter of the meter, length of each acoustic path between transducer faces and the axial distance between transducer pairs. The results shall be corrected to a meter body temperature of 20 deg C (68 deg F) and reported to the nearest 0.01 mm (0.0001 inch).

Transducer calibration tests to determine the operating parameters for each transducer or transducer pair. Test results for each transducer shall be recorded and supplied with the transducer. Test shall include all operating and spare transducers.

Complete check and verification of the electronics modules. Tests shall include functional tests of communications to diagnostic/engineering PC and to external MODBUS host.

Each meter shall be "zero calibrated" ("dry calibrated") with nitrogen. Test results shall be furnished. In the dry calibration set up, the gas velocity observed on all the acoustic paths shall be zero. The speed of sound of the individual acoustic path

in the dry calibration set up shall not exceed ±0.2% of the mean velocity of all the paths. The acoustic property of the reference gas shall be well known and well documented. The zero flow tests shall confirm compliance with vendor's minimum requirements for accuracy and bias to achieve AGA-9 compliant results under flowing conditions.

Leak test using a known reference gas at the maximum rated pressure of the meter.

Transducer replacement test to demonstrate the ability of the transducer extraction/replacement tool under operating pressure conditions. A zero flow verification test shall be repeated to verify the accuracy and performance of the meter after replacement of one or more transducer pairs.

9.3 Flow Calibration Test

9.3.1 After successful completion of the Factory Acceptance Test, the complete ultrasonic flow meter assembly shall be flow tested at a certified laboratory under actual flowing conditions with actual pipeline quality natural gas.

9.3.2 The Ultrasonic meters shall be 'flow calibrated' with natural gas and shall have calibration certificate duly signed by weights and measures authority such as NMI, PTB or other reputed National Standard laboratory of its country of origin such as Trans Canada Calibrations, (TCC) Canada ,Colorado Engineering Experiment Station Inc.(CEESI) USA ,South West Research Inc. (SWRI) USA. Accuracy with wet flow calibration shall be demonstrated within ±0.3% for multi path type under flow conditions in the turndown ratio of 1:10. The meter proving system to be used by vendor shall be traceable to international standards and uncertainty of meter proving system shall be furnished. Gas metering system integration, testing, validation and including third party "wet' calibrations (only for the ultrasonic meters with its associated upstream / downstream meter runs) should be done in flow labs as detailed above

9.3.3 Vendor shall carryout performance test and certify the meter in combination with its companion electronics. A recognized test facility with traceable reference measurements shall be used. Flow test data at 6 points covering the minimum to the maximum flow rate shall be obtained for ascertaining the meter linearity and repeatability with in the specified limits.

9.3.4 The test facility shall be equipped with high accuracy reference meters that are certified and traceable back to international standards. The accuracy shall be at least 2 times better than the accuracy of the meter being tested.

9.3.5 No special adjustments or changes shall be allowed in the configuration parameters of the meter. All parameters shall be configured exactly the same as during the FAT and for normal operations.

9.3.6 The result of the flow test shall provide a meter bias adjustment factor to allow the user optionally adjust the flow rate and flow total provided by the meter.

9.3.7 The performance of the meter shall meet AGA-9 requirements before applying the meter bias factor.

9.4 Site Acceptance Testing (SAT)

9.4.1 Site Acceptance shall consist of a repeat of the zero flow verification tests after the meter is installed in its final location in the station piping.

9.4.2 A suitable section of piping, including the meter body assembly shall be isolated and pressurized to perform the zero flow test.

9.4.3 Results of the SAT shall be similar to the results from the FAT. Additional inaccuracies may be allowed due to the larger volume of isolated "meter" assembly.

9.4.4 Site acceptance testing will not be considered complete until all training and documentation have been completed to the satisfaction of the PURCHASER.

9.5 Test Documentation Requirements

9.5.1 The VENDOR shall be required to write a comprehensive test procedure and prepare manuals of test record sheets for use at factory testing, site commissioning, and site acceptance. Both the procedures and the test record manuals shall be subject to approval by the PURCHASER, and shall be submitted to the PURCHASER for approval at least two months in advance of any test.

9.5.2 Test record manuals should be presented in such a way as to allow the system test personnel to work through the complete set of tests required and enter all results as the tests proceed, including failures, retest, and calibrations. Software print outs forming part of the tests should also be included in the manuals. Each test sheet in the manual should have a space provided for the VENDOR and the PURCHASER to sign off the sheet.

9.5.3 On completion of the tests (both at the works and at site) the Vendor shall provide two hand written copies of the test to the PURCHASER. The record sheets shall be typed up by the VENDOR, then checked and resigned by the PURCHASER.

9.5.4 Before commencing any test procedures, record manuals and documentation as required by this specification shall be available in a fully updated state. Current test certificates for all calibration equipment shall also be available.

10.0 DOCUMENTATION REQUIREMENTS

11.1 The Vendor shall provide the following documentation in both hardcopy form and electronic form on CD.

Drawing index

Basic data

Design formulae and calculations

Overall accuracy, or uncertainty in measurement

Outline of calibration and verification methods

Copy of test certificate of intrinsic safety/ flameproof from statutory bodies like BASEEFA, FM, PTB, CMRI etc.

Reliability details for all equipment

Equipment lists and data sheets

Equipment details/drawings for all components

Wiring diagrams

System or component installation drawings and details

Factory Acceptance Test Procedures and Results

Site Installation Plan

Site Commissioning Procedures

Site Acceptance Test Procedures and Results

System User and Technical Manuals

Comprehensive operational and maintenance instructions, which will enable personnel to operate and service the equipment without reference to the Vendor or vendor Certification of Custody transfer

11.0 SPARES AND MAINTENANCE TOOLS

12.1 Spare parts shall be as indicated in Specification for Requirements for spares.

12.2 Vendor shall supply extraction / replacement tool and all associated accessories (one no.) for in situ removal /insertion of transducer under line operating condition.

12.3 Software application and utility programs to configure, test and maintain the ultrasonic meter system shall be included. All necessary wiring, interconnecting cables, signal converters required to safely access the meter electronics / signal processing unit shall be included.

GAIL INDIA LIMITED

STANDARD SPECIFICATION

FOR

TURBINE METER

GAIL-STD-IN-DOC-TS-018

0	01.02.2019	Issued for Bid	RKS	UNU	UNU	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Abbreviations:

AARH	Arithmetic Average Root Height
CMRI	Central Mining Research Institute
DGMS	Director General of Mining Safety
ERTL	Electromechanical Regional Testing Laboratory
LCD	Liquid Crystal Display
MPMS	Manual of Petroleum Measurement Standards
NIST	National Institute of Standards
NPS	Nominal Pipe Size
NPT	National Pipe Thread
RAM	Random Access Memory

TABLE OF CONTENTS

1.0 GENERAL

1.1 Scope

1.1.1 This specification, together with the data sheets covers the requirements for the design and consruction, materials, nameplate marking, inspection, testing and shipping of turbine meters and their accessories.

1.1.2 The related standards referred to herein and mentioned below shall be of the latest editions prior to the date of the purchaser's enquiry:

ANSI/ASME	American National Standards Institute/ American Society of Mechanical Engineers
	B 1.20.1 Pipe Threads General Purpose (Inch)
	B 16.5 Pipe Flanges and Flanged Fittings NPSVi throughNPS24
	B 16.20 Metallic Gaskets for Pipe Flanges, Ring Joint, Spiral wound and Jacketed.
	B16.34 Valves Flanged, Threaded and Welding End
ASME Sec-VIII	Boiler & Pressure vessel code rules for construction of Pressure vessels.
ASTMD-1250	Standard Guide for use of Petroleum Measurement Tables
API MPMS 11.2	Manual of Petroleum Measurement Standards
API STD 2540	Table 5 A- Generalized Crude Oils and JP4, Correction of Observed API Gravity at 60 degrees F, Table-6A-Generalized Crude Oils and JP4, Correction of Volume to 60 degrees F against API Gravity at 60 degrees F
API MPMS	American Petroleum Institute Manual of Petroleum Measurement Standards
	Chapter 1 Vocabulary
	Chapter 4 Proving Systems
	Chapter 5 Metering
	11-2-1 Compressibility Factors for Hydrocarbons
	11 -2-2 Compressibility Factors for Hydrocarbons
AGA	American Gas Association
	Report Number.7 Measurement of Gas by Turbine Meters.
	Report Number. 8 Measurement of Gas by Turbine Meters
EN 10204	Inspection Documents For Metallic Products
EN-12261	Gas Meters-turbine gas meters
EN 12405	Gas Meters - Gas Volume Electronic Conversion Devices
EN 50014	Electrical Apparatus for potentially explosive atmospheres – General Requirements
EN 50020	Electrical Apparatus for potentially explosive atmospheres – Intrinsic Safety T
EN 60947-5-6	Pulse generator requirements
IEC 60079	Electrical Apparatus for Explosive Gas Atmospheres
IEC 60529	Degree of Protection Provided by Enclosures. (IP Code)
IEC-605 87	Test Method for evaluating resistance to tracking and erosion of electrical insulating materials used under severe ambient conditions
IEC 61000-4	Electronic compatibility for Industrial Process Measurement and Control Equipment.
IEC 61058	Functional Safety of Electrical/Electronics/Programmable Electronic Safety Related System
IP 252/76	Part-XIII, Section 1, Level A Dual Pulse Security.
IS-13947	Specification for Low Voltage Switch gears and Control gears.
IS-2148	Flame proof Enclosures for Electrical Apparatus for Explosive Gas Atmospheres - Flameproof

Enclosures 'd'.

ISA RP 31.1	Specification, Installation and Calibration of Turbine Flow meters
ISO 2715	Liquid hydrocarbon; volumetric measurement by turbine meter systems
ISO 6551	Cabled transmission of electric and/or electronic pulse data
ISO 6976	Natural Gas -Calculation of Calorific value, density, relative density and wobbe index from composition
ISO 9951	Measurement of gas flow in closed conduits- Turbine meters
OIML R6	General Provisions for gas volume
OIML R32	Rotary Piston gas meters and turbine gas meters.

1.1.3 In the event of any conflict between this specification, data sheets, related standards, codes etc., the following order of priority shall govern:

a) Statutory Regulations

b) Data sheets

c) Standard specifications

d) Codes and standards.

1.1.4 In addition to compliance to purchaser's specification in totality, vendors' extent of responsibility shall include the following;

a) Purchaser's data sheets indicate the materials for body, trim and accessories of the turbine meter. Alternative superior material of construction shall also be acceptable provided for their compatibility vendor assumes the complete responsibility for the selected materials with the process fluid and its operating and design conditions specified in the data sheets. It shall be vendor's responsibility to guarantee the selection of the offered material for the specified operating conditions.

b) Sizing of the turbine flow meter and its accessories like air eliminator and strainer.

c) Coordination and approvals from weights and measures wherever required.

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the special instructions to vendor attached with the material requisition.

1.2.2 Whenever a detailed technical offer is required, vendor's quotation shall include the following:

a) Compliance to specification

b) A detailed specification sheet for each item, which shall provide information, described as under. The material specification and units of measurement for various parts in vendor's specification sheets shall be to the same standards as those indicated in purchaser's data sheets. All the relevant terminology used in purchaser's data sheets and standard specifications are as per ISA RP 31.1.

i) All the details regarding type, construction materials etc. for various parts of the turbine meter and its accessories.

ii) Adjustable operating range

iii) Back pressure requirements, if any.

iv) Maximum pressure loss through the meter, meter runs and its accessories like strainer/filters at maximum flow rate.

v) Cable specification required and the maximum permissible cable length between the meter and its associated receiver instrument.

c) Flow meter sizing calculations for each flow meter.

d) Upstream and downstream straight length requirements for installation.

e) Proven references for each offered model inline with clause 1.2.3 of this specification.

f) A copy of approval for flameproof enclosure/intrinsically safety, wherever specified, from local statutory authority as applicable such as Chief Controller of Explosive (CCE), Nagpur, or Director General of Mines Safety (DGMS) in India along with;

i) Test certificate from recognised house CMRI/ERTL etc. for flameproof enclosure for the specified hazardous protection class as per relevant Indian Standard for all Indian manufactured equipments, and equipments requiring DGMS approval.

ii) Certificate of conformity from agencies like LCIE, BASEEFA, PTB, CSA, UL etc. for compliance to ATEX or equivalent recognised standards for all equipments manufactured outside India.

g) Deviations on technical requirements shall not be entertained. In case vendor has any valid technical reason, they must include a list of deviations tag number wise, summing up all the deviations from the purchaser's data sheets and other technical specifications along with the technical reason for each of the deviation.

h) Catalogues giving detailed technical specifications, model decoding details, drawings, operating and maintenance manuals and other information for each type of turbine meter and its accessories covered in the bid.

1.2.3 All items, as offered, shall be field proven and should have been operating satisfactorily individually for a period of minimum 4000 hours on the bid due date in the process conditions similar to those as specified in the purchaser's data sheets. Items with proto-type design or items not meeting above specified Proven Track Record shall not be offered.

1.2.4 Whenever specified, vendor must furnish tested valves of failure rates, probability of failure detection and test internals for safety integrity level analysis.

1.2.5 All the documents submitted by the vendor including their quotation, catalogues, drawings installation, operating and maintenance manuals etc. shall be in English language only.

1.2.6 Vendor shall also quote for the following:

a) Two years' operational spares for each turbine meter and its accessories covered in the bid, which shall include rotor, rotor bearing, transmitter electronics modules, filter cartridge/strainer basket etc as a minimum.

b) Any special tools needed for maintenance work on the meter and its accessories. In case no special tools are needed for maintenance of offered turbine meter, vendor must certify in their offer.

1.3 Drawings and Data

1.3.1 Detailed drawings, data, catalogues and manuals required from the vendor are indicated by the Purchaser in vendor data requirement sheets. The required number of reproducible, prints and soft copies should be dispatched to the address mentioned, adhering to the time limits indicated.

1.3.2 Final documentation consisting of design data, installation manual, operational and maintenance manual submitted by the vendor after placement of purchase order shall include the

following, as a minimum:

a) Specification sheet for each turbine meter and its accessories.

b) Certified drawings for each turbine meter, air eliminator, meter runs with flow straightner, strainer etc., which shall provide dimensional details, internal construction details, material of construction etc.

c) Meter calibration factor in pulse per unit volume.

d) Installation procedure for each turbine meter, meter runs, meter accessories, pulse transmitters, strainers, air eliminators etc.

e) Calibration and maintenance procedure including replacement of its internal parts wherever applicable.

f) Calibration certificate and performance characteristic curves for the turbine meter similar to that in AGA Report number 7.

g) Graphs of correction factors such as pressure, temperature and viscosity.

h) Weight in kilograms of each turbine meter and its accessories such as air eliminator, strainer, meter run with flow straightners etc.

i) Copy of test certification for all the tests indicated in clause 4.0 of this specification.

2.0 DESIGN AND CONSTRUCTION

2.1 Body

2.1.1 Turbine flow meter shall be inline-mounting type with flow direction clearly marked on the flow meter body to ensure correct installation. Insertion type turbine flow meter shall not be offered unless specifically indicated in the purchaser's data sheets.

2.1.2 Flow meter design shall ensure that the location and/or orientation of installation i.e. mounting in horizontal and vertical line shall not affect the calibration, accuracy and performance of turbine flow meter.

2.1.3 The flow meter shall have an over-range protection of at least 130% of specified range. Suitable protection shall be provided against over speeding.

2.1.4 The meter design shall also ensure protection against damage due to hydraulic shock which may be caused by quick opening / closing of upstream / downstream valves.

2.1.5 The turbine flow meter in gas application shall additionally meet the following requirements, as a minimum;

a) The turbine meter shall be of axial flow type design in which the entire gas stream shall pass through the turbine meter rotor.

b) The turbine flow meter shall be provided with a pressure tap on meter body for pressure measurement.

c) Integral flow conditioner shall be provided at the inlet of the meter body.

d) Unless otherwise specified in the data sheets, the turbine meter in natural gas application shall meet the requirements as specified in AGA report no.7.

2.1.6 End Connection

2.1.6.1 Flow meter shall be of flanged body construction with material of construction as specified in the purchaser's data sheet. In case of welded end connection design, the weld joints shall be of radiography quality.

2.1.6.2 Unless otherwise mentioned, end connection details shall be as below:

a) Threaded end connections shall be to NPT as per ANSI B 1.20.1

b) Flanged end connections shall be as per ANSI B 16.5

c) Grooves of ring type joint flanges shall be octagonal as per ANSI B 16.20.

d) Flange face finish shall be as per clauses 6.4.4.1, 6.4.4.2 and 6.4.4.3 of ANSI/ASME B 16.5. The face finish as specified in the data shall be as follows:

125 AARH : 125 to 200 AARH

63 AARH : 32 to 63 AARH

2.2 Material of construction

2.2.1 The material of construction of turbine meter trim (internals) and body shall be as specified in the respective data sheets.

2.2.2 The turbine meter bearing shall meet the following requirements, as a minimum;

a) Vendor shall select the proper type and material of bearing suitable for the service conditions indicated in the purchaser's data sheet.

b) The bearing shall be of the non-lubricating type for turbine meters in liquid service.

c) For non-lubricating services such as liquid petroleum gas (LPG), gasoline, ethylene etc. the turbine meter bearing shall be of specifically hardened material i.e. tungsten carbide. The bearing dimensions shall be such that a permanent liquid film is maintained by having a longer axis and/or a larger diameter.

2.3 Pick Up

2.3.1. The pulse generator shall be non-contact proximity sensors or non-contact type pulse pickup unit mounted near turbine measuring wheel and reference wheel as applicable.

2.3.2. The pick-up coil of turbine flow meter shall be hermetically sealed, tropicalized and shall be certified intrinsically safe or explosion proof as specified in the purchaser's data sheet.

2.3.3. The design shall permit replacement of pick-up coils without removal of turbine meter from meter run.

2.3.4. Two pick up heads or high frequency pulsers shall be provided in the turbine flow meter for verification of pulse integrity when used in custody transfer, performance metering and leak detection application in product transfer through pipeline.

2.3.5. The pulse pick-up and transmitters shall comply with the principles of ISO 6551 'Cabled transmission of electric and/or electronic pulse data'. At least security level B and the checking facility of type P as defined by ISO 6551 shall be provided.

2.4 Meter Sizing

2.4.1 Calculations and units of measurement used for sizing of turbine flow meter shall be in metric standards only.

2.4.2 Vendor shall size and select the turbine flow meter considering:

a) Operating viscosity incase of liquid service.

b) Density/compressibility of the given composition of gas.

c) Minimum operating pressure, maximum operating temperature and maximum flow rate in case of gas application and maximum flow and maximum operating viscosity

in case of liquid applications.

2.4.3 The meter maximum of the turbine flow meter shall be selected as follows rounding of the result to nearest ten:

a) 1.4 times the normal flow or 1.1 times of maximum flow whichever is higher.

b) 1.4 times the normal flow when maximum flow is not indicated.

2.4.4. Unless specified otherwise, the sizing of meter shall be carried out considering velocity in the turbine meter for gas metering application not exceed 15m/sec at meter maximum.

2.4.5. Meter selection based on meter sizing shall be carried out in such a way that the maximum flow and normal flow indicated in the purchaser's datasheet shall not exceed the 90% and 70% respectively of the published normal metering range of the turbine flow meter. Extended range shall not be referred for the meter selection.

2.5 Performance specifications

2.5.1 Unless otherwise specified in purchaser's data sheet, turbine flow meters shall meet the following requirements:

a) **Gas turbine meter:**

Accuracy inclusive of linearity, repeatability and hysteresis shall be better than ±1% of actual flow rate between 20% of maximum flow rate.

±2% of actual flow rate between minimum flow and 20% of maximum flow rate.

Repeatability shall be better than 0.15% of actual flow rate.

2.6 Meter Electronics

2.6.1 Flow meter electronics shall be microprocessor based and shall include all the associated items like pre-amplifier, converter, transmitter, integrator, integral output meter etc. The indication on the output meter shall be digital with engineering unit.

2.6.2 Vendor shall ensure that the input/output signals and performance characteristics of individual item e.g. pulser, meter electronics, flow computer etc., are compatible with each other.

2.6.3 The meter electronics i.e. converter / transmitter shall provide either pulse output or 4 - 20 mA output as specified in purchaser's data sheet.

2.6.4 When meter electronics is specified for installation in electrically classified area, the transmitter shall be flamepr6of with intrinsically safe pick-up coil. Safety barriers, as required, for the pick-up coil shall be provided by the vendor and shall be part of transmitter enclosure.

2.6.5 Field mounted meter electronics shall have an integral output LCD meter. Local indication of the output meter shall be digital with engineering units.

2.6.6 The configurational data for the meter shall be stored in non-volatile memory or in a battery backed RAM, as applicable, such that the data remains unchanged because of power fluctuations or power off conditions. In case vendor standard meter electronics has batter backed RAM, vendor to ensure that battery drain alarm is available as maintenance alarm.

2.6.7 The meter electronics shall be protected against transient induced by lighting and power supply surges. Transient protection electronic shall preferably be provided in the terminal block. The transient protection shall meet the requirements specified in IEC 60587.

2.6.8 The design of electronic instruments shall be in compliance to the electromagnetic compatibility requirements specified in IEC 61000-4.

2.6.9 Flow meter electronics shall be either integral to flow meter or shall be remote mounted type.

Where remote mounted electronic is offered, a minimum of 10 meters of interconnecting cable shall be

included.

2.6.10 Flow meter electronics i.e. converter / transmitter shall operate on alternating supply voltage as indicated in the purchaser's data sheets. The performance of the flow meter shall not be affected by the following variations in the supply voltage;

Voltage variation of ± 10% of nominal value.

Frequency variation of ± 6% of nominal value.

2.6.11 Purchaser will provide one feeder for power supply at the transmitter when required. Further distribution, if any, shall be taken care of by vendor. Accessories like cable, cable gland, conduits and junction boxes, as required for interconnecting sensor and transmitter etc. shall be supplied by vendor.

2.6.12 Terminal Housing

2.6.12.1 Following shall apply for both integral as well as remote electronics (including meter housing);

a) All connections shall be terminated on the terminals brought out in the terminal housing located on the flow meter body or in meter electronics. Flying leads shall not be provided.

b) All intrinsically safe terminals shall be properly identified and shall be separate from the non-intrinsically safe terminals.

c) Separate cable entry shall be provided in the terminal housing for power and intrinsically safe signals.

d) The transmitter's enclosure, housing the electrical parts, shall be suitable for the area classification indicated in the purchaser's data sheets. Unless otherwise specified, the enclosure shall cdnform to the following standards:

Weatherproof housing - to IP 55 as per IEC 60529/ IS 13947

Flame proof housing - EX (d) as per IEC 60079/ IS 2148

Flameproof housing shall also be made weatherproof.

2.6.12.2 Proper terminal blocks shall be provided in the meter / transmitter unit for the termination of Purchaser's cables. Separate terminal blocks shall be provided for power and signal connections.

2.7 Flow computers

Unless otherwise specified independent flow computer shall be provided for each turbine meter.

Specifications of the flow computers are attached separately.

2.8 Accessories

2.8.1 Unless otherwise specified, end connections for the accessories shall conform to clause 2.1.6.2 of this specification.

2.8.2 Air Eliminator

2.8.2.1. The air eliminator, where specified shall be supplied complete with all accessories such as differential pressure gauge, pressure gauge, safety valve, vent valve, sight flow glasses etc. as applicable.

2.8.2.2. The air eliminator shall be supplied with necessary supporting brackets suitable for floor mounting.

2.8.2.3. The design of air eliminator shall be as per ASME Section VIII.

2.8.3 Strainer

2.8.3.1 Strainer shall be suitably selected by the vendor for service conditions indicated in purchaser's data sheets and also for the type of turbine meter offered.

2.8.3.2 All accessories indicated in clause 2.8.2.1 of this specification shall also be applicable for strainer.

2.8.3.3 The strainer shall have basket of stainless steel material with mesh insert size as recommended by the turbine meter manufacturer. In case of no specific recommendation from turbine meter vendor the strainer shall have the following US standard sieve mesh sizes against the nominal size of the flow meter:

Nominal Size of flow meter (in inches)	Mesh Size (US)
3/8	170
V_2	120
3/4 and 1	45
1 1/2 above	18

2.8.3.4. The design of strainer shall be as per ASME Section VIII.

2.8.4 Flow Straightener

2.8.4.1 In addition to integral flow conditioner provided with gas turbine meters, line type straightening vanes shall also be provided upstream of turbine meter to eliminate swirls and jetting action set by pipe fitting, valves or regulators preceding the meter inlet piping. The straightening vanes shall be constructed in accordance with AGA report 7 and corresponding AGA specifications. The gas turbine meters shall be provided with upstream meter tubes with flow straightners and down stream meter tube as necessary as per AGA 7 report. Type of flow straightner (tube or vane type etc.) shall be as recommended by vendor considering the metering application.

2.8.4.2 The liquid turbine meters shall be provided with meter tubes and flow straightners as necessary, in accordance with ISO 2715. Minimum upstream and down stream meter run lengths shall be 10D and 5D respectively, where D is the inside diameter of the run. The flow straightners shall be designed and fabricated in accordance with ISO 2715. 2.8.4.3 The straightening element shall be made out of a thin walled tube or light gauge metal vane. However, the design shall be rugged enough to resist the forward thrust due to high flows. For tube type flow straighteners, the length to diameter ratio of each tube shall be at least 10: 1. The element shall have smooth leading and trailing edges.

2.9 All turbine flow meters and their accessories in oxygen/ chlorine service shall be thoroughly degreased using reagents like trichloro-ethylene or carbon tetrachloride. End connections shall be blinded/ plugged after this degreasing process in order to avoid entrance of grease or oil particles.

3.0 NAMEPLATE

3.1 Each turbine flow meter and its accessory shall have a stainless steel nameplate attached firmly to it at a visible place, furnishing the following information:

a) Tag number as per purchaser's data sheet.
b) Manufacturers serial number and model number.
c) Manufacturer's name/trade mark.
d) Nominal end connection size and rating in psi.
e) Body and trim material.
f) Calibrated range and units of measurement of flow.
g) Area classification in which the equipment can be used.

h) Hazardous area certification number and marking

i) Standards for body/trim material (e.g. ASTM)

3.2 The flow computer and meter electronics shall have a stainless steel name plate attached firmly to it at a visible place, furnishing the following information;

a) Tag number as per purchaser's data sheet.
b) Manufacturer's serial number and model number.
c) Manufacturer's name/trade mark
d) Calibration range and units of measurement of flow.
e) Area classification in which equipment can be used.
f) Hazardous area certification number and marking.
g) Operating power supply voltage and frequency.
h) Output type and range.

4.0 INSPECTION AND TESTING

4.1 Unless otherwise specified, purchaser reserves the right to test and inspect all items at vendor's works inline with inspection test plan of turbine meters.

4.2 Vendor shall submit following test certificates and test reports for purchaser's review;

a) Material test certificates as per clause 3.IB of EN 10204 for turbine meter and its accessories.
b) Certificate from statutory body for intrinsic safety and flameproof enclosure for meter electronics and flow computer, as applicable.
c) Type test reports for weatherproof enclosure for meter electronics / transmitter and flow computer housing.
d) Certificates of radiography/X-ray for welded joints. Dye penetration test certificate shall be provided for welded joints where radiography/X-ray is not possible.
e) Dimensional test reports for each turbine meter and its accessories.
f) Hydrostatic test report as per clause 4.3 of this specification.
g) Flow calibration report and performance test for each turbine meter over entire range including establishing accuracy, repeatability and calibration factor for each meter as per clause 4.4 of this specification.

4.3 **Hydrostatic Test**

4.3.1 Each turbine meter and its accessories shall be subjected to hydrostatic test at test pressure equal to 1.5 times the maximum working pressure at ambient temperature in accordance with ANSI B 16.34. There shall not be any visible leakage during this test.

4.4 **Meter Calibration**

4.4.1 Each turbine flow meter shall undergo calibration simulating conditions similar to operating condition as far as possible in vendor's works.

4.4.2 The following methodology shall be followed in general:

a) The liquid turbine meter shall be tested at vendor shop using preferably the mechanical displacement meter prover as detailed out in relevant API MPMS. The calibration shall be carried out using water as test medium at at-least five points covering entire range. All the precautions mentioned under clause 5.2 of ISA RP31.1 shall be observed during calibration.
b) The gas turbine meter (in non-custody application) shall be calibrated using air at pressure

below 100 psig using sonic nozzle.

c) When gas turbine meter is used for custody application, each turbine meter shall be calibrated using natural gas as testing media near operating pressure. For liquid turbine meters the calibration shall be carried out using water at at-least six points covering entire range. TJie calibration shall be carried out at any recognised testing laboratory e.g. NIST traceable calibration laboratory of international repute.

d) Calibration for custody metering shall be carried out using job accessories.

4.5 Witness Inspection

4.5.1 All turbine meters and their accessories shall be offered for pre-dispatch inspection at vendor's works for the following as a minimum:

a) Physical/ dimensional verification and workmanship.

b) Hydrostatic test as per clause 4.3 of this specification.

c) Performance testing and meter calibration, including establishing accuracy and repeatability over the entire range, whenever specifically indicated in the job specifications.

d) Review of all certificates and test reports as indicated at clause 4.2 of this specification.

4.5.2 In the event when the witness inspection is not carried out by purchaser, the tests shall anyway be completed by the vendor and documents for the same shall be submitted to the purchaser for scrutiny.

5.0 SHIPPING

5.1 All threaded and flanged openings shall be suitably protected to prevent entry of foreign material.

5.2 The turbine flow meter and accessories shall be packed separately.

6.0 REJECTION

6.1 Vendor shall prepare their offer strictly as per clause 1.2 of this specification and shall attach only those documents, which are specifically indicated in the material requisition.

6.2 Any offer not conforming to the above requirements, shall be summarily rejected.

GAIL INDIA LIMITED

STANDARD SPECIFICATION

FOR

GAS CHROMATOGRAPH

GAIL-STD-IN-DOC-TS-020

0	27.01.2019	Issued for Bid	RKS	UNU	UNU	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

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1.0 SCOPE

9.1 This specification covers the general requirements for the design, supply, testing, shipping, installation, and commissioning of a Process Gas Analyzer systems.

9.2 The VENDOR shall furnish all labor, material, equipment, transportation, and facilities necessary to perform all work as defined in this specification and on the drawings.

9.3 In the event of any conflict between this specification, related standards, codes etc., the vendor should refer the matter to the purchaser for clarification and only after obtain in the same should proceed with the manufacture of the items in question.

9.4 Vendor's extent of responsibility include:

- Complete application engineering so as to achieve the desired analysis within the specified cycle time.
- Proper design of sampling system and chromatograph proper to measure the component of interest to the stated accuracy.
- Selection of the materials for all parts of the chromatograph system and sampling system so as to be compatible with the process stream and the surround atmosphere as per purchaser's specification
- To provide hardware and software for data transmission between chromatograph and purchasers Host computer and SCADA system.
- Startup and commissioning assistance.
- Painting of complete system for protection against saline and tropical atmosphere.
- PURCHASER shall mean the Gas Authority India Limited (GAIL) or their approved Representative.
- VENDOR shall mean the original equipment manufacturer.

2.0 CODES, STANDARDS AND DOCUMENTS

2.1 Codes and Standards

The following codes and standards shall be considered part of this specification in so far as they give definitions and describe requirements and tests that the VENDOR shall meet. The standards used shall be the latest revision in force, including any addenda, supplements or revisions thereto. If two or more standards conflict, the more stringent standard shall apply.

ANSI/ASME	B 16.5 Pipe Flanges & Flanged Fittings
ANSI/ASME	B 16.20 Metallic Gaskets for Pipe Flanges
API 555	Process Analyzers
ASTM D1945	Standard Test Method for Analysis of Natural Gas by Gas Chromatography

ASTM D2650	Standard Test Method for Chemical Composition of Gases by Mass Spectrometry
ASTM D3588	Practice for Calculating Heat Value, Compressibility Factor, and Relative Density (Specific Gravity) of Gaseous Fuels
ISO 6974	Natural Gas - Determination of composition with defined uncertainty by Gas Chromatograph
ISO 6976	Natural Gas - Calculation of Calorific Values, Density and Relative Density, and Wobbe Index from Composition
AGA Report No.8	Compressibility factors of Natural Gas and related Hydrocarbon gases (API MPMS 14.2)
API MOMS 14.5	Calculation of Gross Heating Value, Relative Density and Compressibility factor for Natural Gas Mixtures from Compositional Analysis
IEC 60079	Electrical Apparatus for Explosive Gas Atmospheres
IEC 60529	Degrees of Protection Provided by Enclosures

2.2 DOCUMENTS

xxxxxxxxxxxx	Data Sheet for Gas Chromatograph

3.0 ENVIRONMENTAL CONDITIONS

All equipment shall be capable of continuous operation under the following conditions:

Fluid Temperature	xx°C to xx°C
Air Temperature	xx°C to xx°C
Relative Humidity	10% to 100% condensing

All equipment and fittings shall be suitable for the following design parameters:

Pipeline design pressure	xxxx Barg
Fluid Temperature	xx°C to xx°C
Typical Gas Composition	Refer Bid
Total Sulphur content	24 ppm (wt) max 5 ppm
H2 S	10 ppm (V) max
Typical Sales Gas Specification	
Gas Component	Concentration
H2O	< Kg / MMSCMD

H2S	< ppm by weight
S	< ppm by weight
CO2	< mole %
N2	< mole %
O2	< mole %
Mercury	< g / NM
Heating Value	Kcal / SCM

4.0 BIDS

4.1 Vendor's quotation shall include a detailed specification sheet for each gas chromatograph system which shall contain the following information:-

a) Proposed system configuration diagram covering chromatograph, programmer, communication interface and details of hardwired and serial outputs.

b) All the details regarding type, construction, materials, accessories etc. of the chromatograph, programmer and communication interface.

c) Availability of various applications and communication software.

d) Overall dimensions of major units in millimetres.

e) Interconnection wiring diagram between gas chromatograph, programmer and communication interface showing locations (e.g. field, control room etc.)

f) Any special cabling requirements including shielding and grounding requirements and maximum permissible distances etc.

g) Details of sample conditioning system.

h) Various utility consumptions like electrical power, steam, instrument air, cooling water etc.

i) Air conditioning requirements (heat load, humidity, particulate / chemical filtration etc.)

j) A copy of the certificate of intrinsic safety/flameproof from statutory bodies like BASEEFA,FM, PTB, CMRI etc.

k) Transportation time calculation indicating sample flow rates, recommended length and size of the sampling tube between sample point and sampling system.

l) Specifications of gases and gas cylinders including their purity and composition details.

m) Calculation for various gas cylinders including their bases of composition.

4.2 All the units of measurement for various items in vendor's specification sheets shall be the same as in purchaser's data sheets. All instruments shall be graduated in the same units as used in purchaser's data sheets.

4.3 All the material specifications for various parts in the vendor's specification sheets shall be to the same standards as those in purchaser's data sheets e.g. ASTM, BS etc.

4.4 Vendor shall attach a list of deviations tag number-wise from the purchaser's data sheets. Also, vendor should provide reasons for these deviations, wherever possible.

4.5 Vendor shall enclose catalogues giving detailed technical specifications and other information on hardware and software of chromatograph, communication interface and other accessories covered in the bid.

4.6 Vendor's quotation catalogues, drawings, and maintenance manuals shall be in English.

4.7 Vendor shall also quote for the following :-

a) Any special instrument/tools needed for maintenance work on the chromatograph.

b) Complete calibration kit necessary for a period of six months consisting of certified calibration gas cylinders and accessories for each chromatograph. In case of dual range of a particular component of analysis, separate calibration standards shall be provided.

c) Fuel and carrier gas cylinders and accessories for each chromatograph for a period of 6 months.

d) Two years operational spares for each chromatograph system.

e) Clean air package for each chromatograph with Flame lonisation Detector (FID)/Flame Photometer Detector (FPD).

f) Commissioning spare parts.

g) Start-up and commissioning assistance

5.0 DRAWINGS AND DATA

5.1 Detailed drawing, data, catalogues and manuals required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of reproducibles and prints shall be dispatched to the address mentioned, adhering to the time limits indicated.

5.2 After placement of purchase order, vendor shall submit certified drawings and specification sheets for each chromatograph which shall include the following as a minimum:-

a) Overall dimensions in mm for each sub system and its weight.
b) Detailed interconnection diagram for wiring, process piping and tubing.
c) System wiring diagram including chromatograph, programmer and communication interface.
d) Installation details.
e) Detailed operating and maintenance manuals for each sub system.
f) Cabling details including shielding/grounding requirements.
g) Factory testing and inspection requirement.

5.3 Vendor shall provide certificate for all the tests indicated in para 4.0 of this specification. In addition, vendor shall provide the 'Manufacturer's Certificate of Conformity to Purchaser's Specifications' as per clause 2.2 of DIN-50049.

5.4 The final as-built documentation shall be supplied by the vendor properly bound in A4 size i.e. 216 x 279 mm sheets. All drawings and sketches shall be in multiple of A4 size but shall be folded to this size.

6.0 DESIGN AND CONSTRUCTION REQUIREMENTS

6.1 GENERAL DEFINITIONS

The following components of the gas chromatograph system are defined as below:

a) Chromatograph:- A stand alone, unit architecture based microprocessor controlled instrument consisting of chromatograph proper, sample conditioning system and programmer which is capable of working and generating hardwired and serial outputs without the aid of any external device.

b) Programmer:- A microprocessor based device which is a part of chromatograph and controls the overall functioning of the system and also provides hardwired analogy and serial outputs.

c) Communication Interface:- A high level microprocessor based device that can "talk" to a number of programmers and does the job of data collection, concentration and providing a single serial interface between chromatograph system and purchaser's DCS or host computer system.

6.1.1 Analyzer and accessories shall be purchased from a single supplier as a complete package. The Gas Chromatograph system shall, in general, consist of the following :-

a) Sample conditioning system including sample probe.
b) Chromatograph analyser.
c) Programmer/ Controller.
d) Recording Unit.
e) Gas cylinders for calibration standards, carrier gas and fuel gas.
f) Communication Interface.

6.1.2 The Chromatograph proper, programmer and the sampling system shall be completely assembled, tested and ready for field installation.

6.1.3 Process Stream sampling shall be continuous.

6.1.4 The analyser performance shall be within the specifications when the supply voltage changes by ±10% of the specified value, and supply frequency changes by ±3Hz of specified value .

6.1.5 Unless otherwise specified, materials for all components wetted by the sample shall be 316SS, as a minimum.

6.1.6 All interconnecting wiring shall be colour coded/numbered and terminal blocks clearly identified.

6.1.7 The sampling system, chromatograph etc. shall be supplied pre-mounted on a self-standing panel. The panel shall have grouting holes to anchor bolt it to the ground.

6.1.8 Base frame and mounting stands with suitable clamps shall be provided for the carrier and calibration gas cylinders.

6.1.9 Components of any sub-assembly that requires removal maintenance shall be removable without having to disassemble any other components. Such components include items like stream selector valves, sample inject valves, filters, pressure regulators, plug-in circuit cards and detector cells.

6.1.10 Sampling valves shall be of special design to minimise peak tailing and baseline separation problems.

6.1.11 Sampling valves shall be of special design to minimise peak tailing and baseline separation problems.

6.1.12 On-stream analyzers shall be installed in accordance with process requirements. They shall be housed in enclosures meeting the Electrical Area Classification Class 1 Zone 1

Gas Gr. IIA & IIB Temp T3. All analyzer components located in hazardous areas must meet the electrical classification of that area.

6.1.13 Analyzer shall be selected for high accuracy and repeatability as the primary criteria. Analysis speed and cycle time is secondary for custody transfer purposes.

6.1.14 Analyzer and sample system shall be suitable for outdoor installation in the field. Minimum of IP66 protection shall be provided.

6.1.15 A sunshade and a three-side weather shelter shall be provided to protect the Analyzer and sample system.

6.1.16 Power supply for the gas chromatograph system shall be 24 VDC / 230 Volts ac from the purchasers electrical supply system. VENDOR shall provide the power requirements of the system.

6.2 SAMPLE SYSTEM

6.2.1 Vendor shall provide a fabricated assembly of sample conditioning system having facility to measure sample flow to the chromatograph proper.

6.2.2 Sampling system design should be such that the sample drawn for analysis is truly representative of the process stream. The unit shall be supplied with all equipment necessary to condition each stream for injection into the chromatograph. The system must include, but not limited to, all Regulators, vaporizers, dryers, filters, rotameter, solenoid valves required for proper analysis. All Components of sampling system shall be rated for the mechanical design pressure and temperature conditions indicated in purchaser's data sheet.

6.2.3 Transportation time for the sample from the process tapping point upto the sampling system shall not exceed 30% of the cycle time specified for the chromatograph.

6.2.4 The sampling system shall contain at least one wire mesh strainer of US standard sieve mesh size 100 or finer. Where purchaser's data sheets indicate greater possibilities of plugging, vendor shall provide more filters/separators as required.

6.2.5 Where purchaser's data sheets indicate possibilities of polymer formation on presence of excess polymers, vendor shall offer suitable design features to minimize plugging because of polymer residue.

6.2.6 Wherever the process stream pressure is low, vendor shall provide/ advise the purchaser on use of aspirators or sample pumps. Vendor shall also indicate the utility requirements (e.g water or air) for such devices.

6.2.7 Sampling system shall include provisions for connection of calibration standard.

6.2.8 Sampling system shall include block valves on all process sampling lines.

6.2.9 The sampling system shall provide a high pressure retractable probe with 2" flange process connection (to fit a 2", full bore, ball valve).

6.2.10 Multistream analyser systems shall have a separate sample handling sub-assembly for each stream.

6.2.11 Stream selecting valves shall be located as close as possible to the analyser to minimize connecting tubing length and possibility of cross-contamination of samples.

6.2.12 Stream selecting valves shall have bubble tight shut off and shall be fail closed so as to block the samples from analyser. Multi stream sample system shall consider the use of double block with atmospheric pressure configuration to prevent cross-contamination when vendor's experience for the particular application involved, demands this precaution.

6.2.13 When fast loop is specified, vendor shall provide flowmeters for sample bypass flow. Sample return line to process shall be provided with isolation valve and check valve. In case of multistream gas chromatographs, separate fast loop return lines shall be provided for each stream. Vendor shall indicate the fast loop return pressure and flow rates for each stream in his quotation. Return pressure shall be higher than the pressure of the process destination point specified by purchaser.

6.2.14 When liquid samples are to be analysed, vendor shall provide vaporizer to be installed close to the process tapping point to convert the liquid phase to vapour and transport the sample in vapour phase to the analyser. The sample vaporizer shall consist of heater, regulator, pressure gauges (upstream and downstream) and safety valves all mounted on a plate ready for installation at site.

6.2.15 Where sample handling system requires heat to properly condition the sample, it will be enclosed in a thermally insulated enclosure. Temperature shall be controlled by an accurate control system to ensure proper sample conditioning. Heating shall be with steal coils.

6.2.16 Where the chromatograph has to analyse very high temperature samples e.g. furnace effluent, cooling probes shall be provide by vendor to bring down the temperature of the sample near the tapping point. Cooling media shall be preferably instrument air. Vendor to indicate the pressure and flow rates of instrument air required for this purpose.

6.2.17 The sampling system shall be mounted on a free standing rack and located as near the chromatograph as possible.

6.2.18 When remote calibration or automatic calibration is specified, solenoid valves shall be used for the purpose to be controlled by the programmer or by a remote control device like distributed control system.

6.2.19 Electrical components in the sampling system shall be suitable for the electrical area classification indicated in the purchaser's data sheet.

6.3 ANALYZERS

6.3.1 Gas Chromatograph

6.3.2 The Gas Chromatograph shall distinguish the following components of natural gas:

CO2, N2, C1, C2, C3, iC4, nC4, iC5, nC5, C6+.

6.3.3 The chromatograph chamber shall be maintained at a constant temperature level. When the detector is of the thermal conductivity type, the temperature shall be maintained within ±1° C.

6.3.4 Where multiple temperature controlled zones are involved in a single chromatograph, each zone shall be well insulated so that the temperature of one zone does not affect that of another.

6.3.5 All the temperature controlled zones shall be operated at a temperature well above the maximum ambient temperature. Provision shall be made for manual temperature control.

6.3.6 Base line drift per analysis cycle without auto-zero shall be ± 1 % of auto-zero adjust span or less.

6.3.7 Vendor shall provide a pressure switch to shut off power supply to the detector during loss of carrier gas flow, so as to prevent any damage to the detector.

6.3.8 The Gas Chromatograph shall calculate heating value, specific gravity, calorific value, and Wobbe Index per ISO 6976 for gas at standard conditions of 1. Bara and 15C. The calculated Kcal values shall have an accuracy of 0.1%, exclusive of calibration standard accuracy. Repeatability shall be +/- 0.5 Kcal per1000 Kcal (0.05%).

6.3.9 Analyzer shall be equipped with an automatic calibration facility. The calibration interval shall be programmable.

6.3.10 VENDOR shall supply one certified calibration gas cylinder prior to commissioning. The certificate shall include the exact mole percent of each of the 10 components, the specific gravity, calorific value, and Wobbe Index. All values to be calculated as per ISO 6976 for gas at a pressure of 1.0156 Bara and a temperature of 15.56°C. Calibration gas composition shall be similar to the expected pipeline gas.

6.3.11 The calibration gas cylinder shall be provided complete with individual regulator, pressure gauges, and valve assembly. Gas cylinder shall have a minimum capacity of 2 standard cubic meters. For the factory testing and the pre-commissioning calibration in the field, the typical gas composition shall be used.

6.3.12 Analyzer shall be supplied with carrier gas supplies. Carrier gas shall be purified helium. A minimum of two cylinders shall be supplied.

6.3.13 The carrier gas cylinders shall be provided complete with individual regulators, pressure gauges, and valve assemblies. The valve assembly shall facilitate changing both cylinder and setting of the cylinder regulator without disturbing operation of the gas chromatograph.

6.3.14 Analyzer controller shall provide a minimum of six dry contact alarm outputs. These contacts shall be wired for alarm purposes. The alarm for each contact shall be configurable.

6.3.15 Analyzer shall provide software configuration of the following parameters as a minimum:

- Stream selection and timing
- Baseline correction
- Peak Detection
- Alarm programming

6.4 PROGRAMMER

6.4.1 Programmer shall do the following as a minimum, communicate from Host computer system through the serial interface and locally on the Programmer itself:- properly control the analysis cycle, provide chromatogram outputs to communication interface for chromatogram / bar chart recording, provide hardwired analog outputs for each component of analysis, provide digital output to communication interface device, automatic zero adjustment and calibration of the chromatograph system.

6.4.2 The programmer shall be dedicated to each chromatograph and shall be an integral part of each chromatograph in the field.

6.4.3 The programmer shall be a microprocessor based solid state device.

6.4.4 Battery back-up shall be provided for the volatile memory.

6.4.5 Audio-visual alarms shall be provided for detector temperature deviation and zero off-set.

6.4.6 Maintenance diagnostics to be included in the software to allow rapid trouble-shooting in the event of system malfunction.

6.4.7 On power failure or on communication failure between chromatograph and programmer, the chromatograph shall revert to safe condition (back flush).

6.4.8 Programmer output to host computer / SCADA shall represent the actual concentration of measured component in engineering unit.

6.4.9 It shall be possible to generate either a chromatogram or a bargraph on the Printer.

6.4.10 For obtaining continuous analog outputs, peak-pickers and long term memory circuit boards shall be provided for each component of interest.

6.4.11 All program data cables shall be capable of field modifications without knowledge of higher level programming.

6.4.12 Detector balancing and zero adjustment shall be automatic.

6.4.13 The programmer will be certified by a statutory body for the electrical area classification specified in purchaser's data sheet.

6.5 COMMUNICATION INTERFACE

6.5.1 Analyzer controller shall support configuration and maintenance via an RS232/RS485 interface to a PC-based notebook computer. The VENDOR shall supply a dedicated notebook computer, complete with appropriate software, for configuration and maintenance of the analyzer. The software shall be capable of providing reports and graphics printout of the analysis results on demand.

6.5.2 Analyzer controller shall support two additional communication ports. Each port shall be individually configurable for speed (1200 bps to 9600 bps) and protocol (MODBUS ASCII, MODBUS RTU and other Vendor specific protocol).

6.5.3 The ports shall normally operate in the RTU mode as a slave device over an RS422/RS485 interface to a MODBUS master device such as a SCADA RTU; PLC or DCS based station controller.

6.5.4 Analyzer shall provide all data such as gas composition, specific gravity, calorific value, and Wobbe Index over this interface to the station controller.

6.5.5 Analyzer shall accept configuration parameters over the MODBUS interface from the station controller.

6.6 CARRIER GAS, FUEL GAS AND CALIBRATION GAS CYLINDERS

6.6.1 Each chromatograph shall be furnished with the following compressed gas steel cylinders:

i. Carrier gas dual cylinder and manifold. The carrier gas system shall be a dedicated one to each chromatograph providing automatic switchover to standby cylinder when the first cylinder is exhausted. All the accessories required for this purpose shall be provided by vendor. Number of cylinders supplied by vendor shall be adequate for 3 months continuous operation.

ii. Certified calibration gas. In case of dual range of measurement, separate calibration standard for each range shall be provided. Calibration standard supplied by vendor shall be adequate to last six months.

iii. Fuel gas for FID/FPD detector for three months continuous operation.

6.6.2 Each of the calibration gas and fuel gas cylinders shall be provided with two stage pressure regulator. For carrier gas manifolds, pressure regulator shall be provided on the manifold for each cylinder.

6.6.3 All gas cylinders shall be located near the chromatograph and shall be mounted by vendor on a free standing support.

6.6.4 In case the calibration standard deteriorates with time (e.g. hydrogen sulphide, hydrogen in gas mixtures) then instead of supplying calibration gas, vendor shall provide alternate device for calibration to be approved by purchaser.

7.0 NAMEPLATE

Each chromatograph and its accessory shall have a S.S. nameplate attached to it at a visible place, furnishing the following information as applicable

a) Tag number as per purchaser's data sheets.
b) Manufacturer's Serial No. and/or Model No.
c) Manufacturer's name/trade mark.
d) Range.
e) Area Classification in which the equipment can be used.

8.0 INSPECTION AND TESTING

9.1 GENERAL

8.1.1 Unless otherwise specified, purchaser reserves the right to test and inspect all the chromatographs at the vendor's works. Vendor's quoted price shall be inclusive of this activity. Vendor shall provide facilities to the purchaser's representative for inspection. This include labour, consumable, equipment and utilities required for the purpose. PURCHASER may visit the plant at any time and witness all testing and quality control procedures that may take place during fabrication and final testing.

8.1.2 Vendor shall submit an inspection procedure in advance to be approved by purchaser.

8.1.3 The system shall be tested to ensure high reliability and proper operation. Such testing shall be documented and test records furnished to prior to the commencement of witnessed testing.

8.1.4 PURCHASER shall not be invited to witness tests until all work has been completed and inspected by the VENDOR to verify conformance with the drawings and specifications. Any discrepancies found as a result of the inspections or tests shall be corrected by the VENDOR at no cost to PURCHASER.

8.1.5 The VENDOR shall supply all calibration, test, and simulation equipment required to demonstrate correct operation of the system. Certificates for all the test equipment shall be traceable to National Standards.

8.1.6 Vendor shall submit factory data sheets for each chromatograph at the time of inspection for purchaser's review. These data sheets shall include the following information as a minimum:-

a) Programmer settings
b) All flow rates i.e. column, detector reference, vents, back flush etc.

c) Temperature, pressure and flow rates necessary to check proper operation of the instrument.

d) All settings for detector e.g. voltage and current for thermal conductivity detector.

e) Component attenuator settings (and auto-zero if applicable).

f) Composition of all test samples.

8.1.7 Vendor shall submit the following test certificates and test reports for purchaser's review;

a) Material test certificate for all wetted parts (MIL certificates)

b) Certificates from statutory bodies for use in area classification indicated in data sheet

9.2 WITNESS INSPECTION

Analyzer testing shall include at least the following:

8.2.1 Visual inspection for physical dimension verification, workmanship and conformity with approved drawings and contract documents.

8.2.2 Demonstration of correct operation of all diagnostic and maintenance functions provided by the analyzer. Errors shall be simulated to demonstrate the ability of the analyzer to detect and report errors.

8.2.3 Demonstration that system performance is unaffected by variations in the 24 VDC power supply over the range of 20 V to 30 V.

8.2.4 Demonstration that the system is unaffected by hand-held portable radio equipment or other sources of RF interference at a level of 10 volts / meter from 10 MHz to 500 MHz.

8.2.5 Demonstration of correct functioning of the Analyzer and sample system using gases having compositions similar to those specified in section 3.0.

8.2.6 The entire Analyzers shall undergo an environmental test to verify its performance and stability over an environmental temperature range of xx to xxºC. The test interval shall be a minimum of 24 hours. Within the 24 hours, the environmental test chamber temperature shall cycle completely from xx to xxºC and back to xxºC. The chamber temperature shall be recorded throughout the entire test period at a minimum interval of 15 minutes between readings. Chromatograph results from each analysis cycle shall be captured for comparison against each other and against the original factory test results. Averaging and max/min functions shall also be tested.

8.2.7 Demonstration that all computational calculations, chromatograph reports and graphical printouts function correctly.

8.2.8 Test of the serial communication ports and the support for MODBUS host retrieval of data from the GC controller and down loading of configuration data to the GC.

8.2.9 The following two tests shall be performed and conform to ASTM D1945.

a) **Run Base Line Test**- The chromatograph shall not show unknown area except valve switching.

b) **Repeatability/Production Test**- By standard gas test result compared to standard gas certificate of analysis.

8.2.10 A chromatogram of a standard calibration sample without auto-zero shall be produced. Attenuation may be manual or automatic during generation of this chromatogram, but shall not exceed that used for final calibration. The chromatogram shall give the following details:-

a) Attenuator setting.

b) Chart Speed.

c) Sample inject period.

d) Auto-zero period.

e) Switching points for auxiliary valves.

f) Each peak in the chromatogram shall be labelled and the attenuator setting noted. The chart shall show composition of the standard sample used with elution times of all component listed.

8.2.11 Effect of variation in the power supply, voltage and frequency, to be verified. Analyser must function satisfactorily.

8.2.12 Review of all certificates and test reports as indicated in para 4.1 of this specification In case of not witnessed by purchaser, the tests shall anyway be completed by the vendor and documents for same submitted for scrutiny

9.0 TRAINING

9.1 The VENDOR shall be required to train nominated maintenance and operational personnel in the period prior to system start-up.

9.2 The VENDOR shall propose courses intended to train and familiarize PURCHASER personnel in all aspects of system hardware maintenance and programming.

9.3 The VENDOR shall provide the Vendor's standard maintenance / trouble shooting course. This course should be sufficiently comprehensive allow trouble shooting to electronic component level and should assume a working knowledge of electronics.

9.4 The VENDOR shall provide a course outline, student prerequisites, and training material for each course, at least four weeks prior to the course starting date.

10.0 SPARE PARTS

10.1 The VENDOR shall provide a priced list of all manufacturer recommended spare parts and consumables required to support the system through installation, commissioning, and two years of operation. The list shall be submitted to PURCHASER for approval a minimum of thirty calendar days prior to factory testing.

10.2 The approved spare parts and consumables shall be provided as part the contract and shall be delivered to site along with the equipment.

10.3 The VENDOR may, with PURCHASER written approval, use the spare parts and consumables during the installation and commissioning period.

10.4 The VENDOR shall replace at his expense any parts or consumables used, and ensure that the full complement of parts and consumables are on hand and turned over to PURCHASER at the beginning of the thirty days of regular operations.

10.5 Vendor shall supply one set of spare columns, one cylinder of carrier gas and one cylinder of calibration gas as commissioning spare.

11.0 SHIPPING

11.1 All threaded and flanged openings shall be suitably covered to prevent entry of foreign material.

11.2 Each major part shall be sealed in thick plastic bags.

12.0 REJECTION

12.1 Vendor shall make his offer in detail, with respect to every item of the purchaser's specifications. Any offer not conforming to this shall be summarily rejected.

GAIL INDIA LIMITED

STANDARD SPECIFICATION

FOR

FLOW COMPUTERS

GAIL-STD-IN-DOC-TS-021

0	27.01.2019	Issued for Bid	RKS	UNU	UNU	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

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1.0 SCOPE

1.1 GENERAL SPECIFICATION FOR FLOW COMPUTER

1.2.1 This Specification covers the design, fabrication, programming, testing, delivery, commissioning and startup of flow computers.

1.2.2 VENDOR is required to furnish a complete and tested flow computer System as specified herein. Any omission of details in this specification shall not relieve the VENDOR of his obligation to furnish a system which shall complete and which operates in a satisfactory manner.

1.2 SERVICES INCLUDED

1.2.1 Application and design engineering resulting in a fully integrated system as defined by this specification.

1.2.2 The VENDOR shall be responsible for providing a complete system configuration, including flow computer data base, analog and logic programming, reports, and interfaces to other control systems using the latest proven design of software and firmware.

1.2.3 Complete testing prior to shipment to ensure satisfactory system operation and full compliance with requirements.

1.2.4 Training of the operation and maintenance personnel to a level sufficient to perform operational functions of the flow computer.

1.2.5 Field service to provide startup support, system checking, and troubleshooting.

2.0 DEFINITIONS

2.1 PURCHASER shall mean the Gas Authority India Limited (GAIL) or their approved Representative.

2.2 VENDOR shall mean the original equipment manufacturer.

2.3 Station Controller shall mean the RTU, PLC, DCS or master flow computer that is networked to all flow computers at a metering location and functions as a data concentrator for retrieving and disseminating

2.4 Information and to function as the connecting device to the SCADA or control system.

3.0 CODES AND STANDARDS

The following standards shall be considered part of this specification insofar as they give definitions and describe requirements and tests that the VENDOR shall meet. The standards used shall be the latest revision in force, including any addenda, supplements or revisions thereto. If two or more standards conflict, the more stringent standard shall apply.

AGA Report No 3	Orifice Metering of Natural Gas and other Related Hydrocarbon Fluids.
AGA Report No 7	Measurement of Gas by Turbine Meters
AGA Report No 8	Compressibility Factors of Natural Gas and Related Hydrocarbon Gases. (API MPMS 14.2)
AGA Report No.9	Measurement of gas by Ultrasonic meters
AGA Report No 12	Cryptographic Protection of SCADA Communications.
API MPMS 5.5	Metering - Fidelity and Security of Flow Measurement Pulsed-Data Transmission Systems
API MPMS 12.2	Calculation of Petroleum Quantity Using Dynamic Measurement Methods and Volume Correction Factors
API MPMS 14.3	Natural Gas Fluids Measurement - Concentric Square Edged Orifice Meters
API MPMS 14.5	Calculation of Gross Heating Value, Relative Density and Compressibility Factor for Natural Gas Mixtures from Compositional Analysis (also GPA 2172)
API MPMS 21.1	Flow Measurement Using Electronic Metering Systems - Electronic Gas Measurement
API MPMS 21.2	Flow Measurement Using Electronic Metering Systems - Electronic Liquid Measurement
ANSI/NFPA 70	National Electrical Code (NEC)
ANSI/NFPA 75	Standard for the Protection of Electronic Computer Data Processing Equipment
NEMA ICS 1	General Standards for Industrial Control and Systems
NEMA ICS 2-230	Components for Solid-State Logic Systems
NEMA ICS-6	Enclosures for Industrial Controls and Systems

4.0 CONDITIONS OF SERVICE

4.1 The equipment will be installed in a Control Room where the temperature and humidity is climate controlled, i.e. air-conditioned. However, in the event of failure of the air-conditioner or commercial AC power supply, the system is expected to continue normal operation. Therefore, the system shall be designed for continuous operation under the following conditions.

20° to 50° Celsius operating temperature range
10% to 95% relative humidity, non condensing

4.2 Power supply for the flow computer system shall be 24 VDC from the instrument power supply system at each location. VENDOR shall confirm the 24 VDC system has sufficient capacity and provide additional capacity where required. Flow computer RAM shall be

preserved by Lithium cell back-up when main power is lost. Printers shall be powered from 220VAC 50Hz.

5.0 GENERAL REQUIREMENTS

5.1 SYSTEM ARCHITECTURE

5.3.1 The flow computers shall be individual microprocessor based devices specifically design to Perform flow related calculations. Each flow computer shall be dedicated to a single meter run.

5.3.2 Where a meter station consists of multiple meter runs, each run shall have its own flow computer. All flow computers in a meter station shall be connected to a station controller. The preferred connection is via Ethernet using TCP/IP.

5.3.3 Flow computers shall support system time synchronization from the station controller. The station controller shall be able to update the internal time of day clock of the flow computers to ensure all flow computers are synchronized to each other. The ultimate source of the clock will be the SCADA host computer, or selectable (per GAIL preference).

5.3.4 Field instruments from the meter run shall be directly connected to the flow computer to ensure signal integrity and to prevent tampering.

5.3.5 Measurement data inside the flow computer shall be protected against tampering via any serial port or networked connections.

5.3.6 Configuration and operating parameters shall be protected by either a hardware key lock switch or by multi-level password protection.

5.3.7 Flow computers used in liquid service shall support the operation of a meter prover. The flow computer in conjunction with a prover computer shall be capable of controlling the proving operation, performing all calculations and correction factors and providing the results of the proving operation.

5.3.8 Each flow computer shall have a dedicated printer for the printing of all reports as specified herein. The printer shall be a standard IBM PC compatible printer, capable of printing a minimum of 80 characters per line on an A4 width page utilizing uncompressed print and 132 characters per line using compressed print.

5.3.9 Program code shall be preserved for 10 year unpowered situation.

5.3.10 Shall have sufficient memory to accumulate data for three months of flow data without rollover.

5.2 ANALOG INPUTS

5.2.1 A minimum of 4 analog inputs shall be provided.

5.2.2 Analog inputs shall be 4-20 mA differential input capable of common mode voltage of at least 15 volts.

5.2.3 Inputs shall be configurable to source power to the field device or to accept power. Normal mode will be for the flow computer to source power.

5.2.4 Inputs shall be optically isolated and shall withstand a minimum of 5 kV surges.

5.2.5 A/D accuracy shall be 0.02 percent or better of span (16 mA) over the entire operating range of the flow computer.16-bit A/D is preferred.

5.2.6 All analog signals shall have configurable high and low operational alarm limits. Alarms shall be recorded in the flow computer's alarm event log.

5.2.7 Inputs shall support normal over and under range operation from 3.6 mA to 4.0 mA and from 20 mA to 21 mA.

5.2.8 Input signals below 3.6 mA and above 21 mA shall be treated as instrument loop failure conditions. These shall be treated as alarm states and shall result in entries in the flow computer alarm/event log.

5.2.9 Flow computer shall perform all required conversion from "raw" 4 20 mA values to scaled engineering values.

5.2.10 Both raw and scaled engineering values shall be available for remote access via the station controller or from other external host devices. Scaled engineering values shall be managed as 32-bit IEEE floating point numbers.

5.3 ANALOG OUTPUTS

5.3.1 Analog outputs shall be 4-20 mA and shall be capable of driving a0-650 Ohm load.

5.3.2 Each output shall be individually configurable to different zero and span setting and shall be configurable to provide an output scaled to repeat one of the input signals or one of the calculated results such as the corrected flow rate.

5.3.3 Minimum accuracy shall be 0.1 percent of span.

5.3.4 A minimum of 4 analog outputs shall be provided.

5.4 DIGITAL INPUTS

5.4.1 Inputs shall be optically isolated to 30 Volts RMS and shall withstand a minimum of 5 kV surges.

5.4.2 Each input shall be configurable to source power to the field device or to accept power. Normal mode will be for the flow computer to source power.

5.4.3 Each digital input shall be configurable as an alarm signal such that a change of state will be recorded into the flow computer's alarm log. The alarm states shall be individually definable to be 0 or 1 for input point.

5.4.4 Each point shall either be retrieval as a single bit or as a bit-packed 16-bit register where one register equals 16 digital input points. The use of a 16-bit register to represent one status point shall not be accepted.

5.5 DIGITAL OUTPUTS

5.5.1 Digital outputs shall be voltage free, relay isolated dry contacts.

5.5.2 Each contact shall be rated for a minimum of 1 Amp at 24 VDC.

5.6 PULSE INPUTS

5.6.1 Pulse inputs shall be provided for use with meters output pulses from turbine and PD meters and for use with other frequency devices such as a Solartron or equivalent densitometer.

5.6.2 Inputs shall be capable of handling pulse signals (0-5 kHz range).

5.6.3 Pulse inputs shall be configurable to handle dual output pulse signals from a single turbine meter if specified. The dual pulse signals shall be processed and checked to verify pulse data integrity as per API MPMS 5.5 Level A data security / Institute of Petroleum standard ,IP 252/76, Part XIII, section1. When signals fail these requirements, an alarm shall be generated.

5.6.4 Flow computer logic shall support a configurable low pulse rate cutoff to suppress spurious pulses from meters during no-flow conditions.

5.6.5 During flowing conditions, all pulses shall be counted and used to calculate the flow rate and flow total.

5.6.6 Flow computer shall accept meter K factor (Calibration factor) entered either manually or downloaded from host.

5.7 SMART TRANSMITTER INPUTS

5.7.1 The flow computers shall provide for the direct digital input of signals from smart transmitters in addition to analog 4-20 mA inputs.

5.7.2 The field devices and the flow computer shall communicate using the HART protocol.

5.7.3 The flow computer shall support configuration, diagnostics, and maintenance of each smart transmitter.

5.7.4 Smart Transmitter input scan time shall be less than one second.

5.8 SERIAL COMMUNICATION INTERFACES

5.8.1 Flow computer shall support serial communication to other devices. A minimum of 4 communication ports shall be provided.

5.8.2 Each port shall be configurable to be RS232 or RS 485, multi-drop, asynchronous, at a user selectable data rate of 300 to 38,400 bps.

5.8.3 The ports shall be configurable to be a host device to communicate with slave field devices such as gas chromatographs (to retrieve gas analysis results) or other flow computers or as a slave device to be polled by other host devices such as the station controller, SCADA RTU, PLC; DCS or another flow computer.

5.8.4 The minimum protocol supported shall be MODBUS in RTU (binary) mode and in ASCII mode.

5.8.5 As most of GAIL RTU uses 16 bit-registers, TWO 16 bit registers are used for accommodating one 32-bit floating point parameter. Hence the flow computer should be configured in 16-bit registers so that no-error is encountered in writing.

5.8.6 The interface shall support both read and write status and analog data employing MODBUS function codes 1, 2, 3, 4, 5, 6, 15, and 16.

5.8.7 Gas composition data, specific gravity, and gas heating value shall be transferred from the gas chromatographs and/or Station Controller /or GSM Modem or SCADA to the flow computer.

5.8.8 All real-time flow values, totalized volumes, and averages calculated by the flow computer shall be transferred to the Station Controller.

5.8.9 The Modbus communication protocol and message structure details to be used on the RS 232/ 485 serial communication port (for SCADA) for Field mounted Flow Computer shall be supplied after placement of order.

5.8.10 Bidder / Supplier shall furnish all details like pin configuration and tag number wise MODBUS address mapping list etc. for smooth interfacing of all communication links with RTU (SCADA).

5.8.11 CD or floppy Bidder / Supplier shall provide all necessary hardware, software etc. in vendor's supplied systems and other details required for interfacing of their Flow Computers with Purchaser's RTU (SCADA). In addition to this, the communication software shall be supplied in for testing the communication link.

5.8.12 Bidder / Supplier shall be fully responsible for proper integration of their supplied systems and also integration with purchaser's SCADA (RTU) system at site and vendor shall provide all necessary assistance to purchaser's for establishing all the serial links with SCADA RTU fully functional & Operational.

5.9 DIAGNOSTICS AND ERROR HANDLING

5.9.1 The flow computers shall have a self diagnostic feature and any failure in the computers or deviations beyond high-low limits of all inputs shall be displayed as an alarm and printed, and also as an alarm contact to the Station Controller. The alarms shall be acknowledged and reset by operating personnel. Alarms shall not reset automatically and must be acknowledged before resetting.

5.9.2 In the case where the parameters received are deemed invalid, the flow computer shall alarm the incident and proceed with the last valid value in memory. This shall be true for all inputs such as the gas composition, specific gravity and heating value. Keypad default values shall not be used, unless specified by the Operator.

5.9.3 The memory content of the flow computer shall not be lost in the event of failure or interruption of the power supply. The flow computer shall be provided with internal battery backup.

5.9.4 The flow computer shall have hardwired interfaces to the Station Controller for hardware failure and instantaneous corrected flow rate.

5.10 POWER SUPPLY AND SOLAR PANEL (OPTIONAL) REQUIREMENT

5.10.1 Power supply to Flow computer shall be 24VDC / 48 VDC / 110 VAC / 230VAC (selectable). Optionally It may be powered by online solar panel suitable for mounting in field location in hazardous area.

5.10.2 All the mounting Hardware, connecting cable from Flow Computer to Solar Panel with suitable Glands and necessary accessories required during commissioning shall be in vendor's scope. Commissioning spares required shall be included.

5.10.3 Vendor / Supplier shall submit the Battery sizing calculation, Details of battery & Solar Panel, Product Technical Literature along with offer. The Rating, Make and other necessary details in support of selected model for Battery & Solar panel shall also be submitted along with offer. The power consumption of Flow Computer, GSM modem and other associated utilities of online system shall be considered for Back up calculation and finalization of sizing of battery.

5.11 GSM MODEM REQUIREMENT (OPTIONAL)

5.11.1 GSM Modem shall be provided in the flow computer for remote data configuration, remote data uploading (previous 35 days data) and remote data monitoring. The Gas Chromatograph data shall also be transmitted to the Flow Computer from the RTU through GSM Modem.

a. Dual Band 900/1800 MHz (E47)
b. Input Current
c. 20mA @ 12V Idle
d. 100mA @ 12V Avg. Tx.
e. 560mA @ 12V Peak Tx.
f. Operating Temperature : -25 to 55 Deg. C
g. Input supply voltage : From Battery pack provided along with Flow Computer.
h. Serial RS 232 serial communication cable.
i. Data Rates : 19200 bps.
j. Data SIM Card : Mini SIm plug in /removal.
k. Cellular data Service: Radio Link Protocol / GPRS / Class BB (4+1).
l. Antenna : Unity gain blade Antenna affixed directly to the module.
m. LED indicator to give power and Network status.
n. Suitable for mounting in the Hazardous area as indicated.

5.12 FLOW CONTROL REQUIREMENT

5.12.1 The Flow controller (for all custody transfer stations) shall be implemented in flow computer by software configuration (PID loop configuration). This shall be configured in

such a way that the flow controller controls the flow control valve if the flow exceeds from the set point. This flow rate setting in the flow computer shall be configurable from remote via GSM Modem / SCADA.

5.13 ELECTRICAL TRANSIENTS

5.13.1 The flow computer and peripheral equipment shall be supplied with provisions for protection against system errors and hardware damage resulting from electrical transients on power or signal wiring. These electrical transients include power line faults, lightning strikes, and lightning-induced surges on power or signal cables. The VENDOR shall clearly describe the method used to provide the electrical transient protection.

5.13.2 The flow computer and peripheral equipment shall operate satisfactorily not only independently, but also in conjunction with other equipment, which is placed nearby. This will require that the operation of equipment will not be adversely affected by interference voltages and fields reaching it from external sources, and also will require that equipment will not, in itself, be a source of interference, which might adversely affect the operation of other equipment.

5.13.3 The basic design of equipment, components and assemblies will consider RFI / EMI control. The applications of RFI/EMI control components, such as filtering, shielding, and bonding shall conform to good engineering practice. The unit construction/packaging design shall ensure easy serviceability and also ensure that integrity of RFI/EMI protection features, such as screening, will not be degraded under normal maintenance conditions.

5.13.4 If additional non-vendors standard equipment is required to meet the RFI/EMI requirements, the VENDOR shall so state, and describe additional equipment to be supplied.

6.0 FLOW CALCULATIONS

6.1 GENERAL

6.1.1 All calculation results shall have accuracy better than 0.001 percent.

6.1.2 All equipment shall be configured for base pressure and base temperature conditions of 1.0156 Bara and 15°C respectively.

6.1.3 The flow computer shall utilize the following inputs for real-time measurements:

- Latest gas analysis data, continuously updated direct online from a Gas Chromatograph or via the Station Controller for the calculation of Super compressibility based on AGA8.

- Specific Gravity and Gas Heating Value corrected for moisture content, continuously direct updated from a Gas Chromatograph or via the Station Controller.

- Density / Specific Gravity (frequency signal) from field mounted instrument such as a Solartron densitometer.
- Online measurement parameters such as temperature, static pressure, orifice meter differential pressure, or turbine meter pulse rate/total, continuously updated from each transmitter interfaced to the flow computer
- Metering system constants such as orifice parameters, turbine meter K-factor as input by the Operator
- Moisture Analyzer (to provide water content)

6.2 ORIFICE METER CALCULATIONS

6.2.1 Flow calculations shall be performed in accordance with the latest equations of the American Gas Association (AGA) Report No. 3 (also API MPMS 14.3). Calculation of the uncorrected and corrected volumetric flow, mass flow, and energy shall be on a 500 millisecond cycle time.

6.2.2 Composition shall be renormalized with measured H20 content.

6.2.3 Heating Value calculation shall be done every cycle, or after composition is updated.

6.2.4 The volume flow rate, at standard conditions, shall be accumulated each volume calculation cycle to provide the accumulated volume at standard conditions.

6.2.5 Compressibility calculations shall be performed in accordance with the equations in the AGA Report No. 8 (AGA-8) "Compressibility and Supercompressibility for Natural Gas and Other Hydrocarbon Gases", November 1992 edition. The calculation shall utilize the "Detailed Characterization Method" equation.

6.2.6 Calculation of compressibility shall be done at a 500 millisecond or less, cycle time.

6.2.7 The flow computer shall calculate and store hourly, daily, and weekly flow weighted averages for differential pressure, static pressure, temperature, gas composition, specific gravity, and gas heating value.

6.2.8 Density input value to AGA shall support multiple user selectable options:

- Field-mounted densitometer instrument (frequency signal from device such as Solartron densitometer or equivalent).
- Calculated value using AGA Report No 8 (Detailed method) and gas composition from gas chromatograph results.
- Manual user entry

6.2.9 The temperature being used in calculation shall be corrected to upstream temperature.

6.3 GAS TURBINE METER CALCULATIONS

6.3.1 Flow calculations shall be performed in accordance with the latest equations of the American Gas Association (AGA) Report No. 7.

6.3.2 Composition shall be renormalized with measured H20 content.

6.3.3 Heating Value calculation shall be done every cycle, or after composition is updated.

6.3.4 Calculation of the uncorrected and corrected volumetric flow, mass flow, and energy shall be at a 500 millisecond or less, cycle time.

6.3.5 The volume flow rate, at standard conditions, shall be accumulated each volume calculation cycle to provide the accumulated volume at standard conditions.

6.3.6 Compressibility calculations shall be performed in accordance with the equations in the AGA Report No. 8 (AGA-8) "Compressibility and Supercompressibility for Natural Gas and Other Hydrocarbon Gases", November 1992 edition.

The calculation shall utilize the "Detailed Characterization Method" equation.

6.3.7 Calculation of compressibility shall be done at a 500 millisecond or less, cycle time.

6.3.8 All calculation results shall have accuracy better than 0.001 percent.

6.3.9 All equipment shall be configured for base pressure and base temperature conditions of 1.0156 Bara and 15°C respectively.

6.3.10 The flow computer shall utilize the following inputs for real-time measurements:

- Latest gas analysis data, continuously updated direct online from a Gas Chromatograph or via the Station Controller for the calculation of Supercompressibility based on AGA-8.

- Specific Gravity (as per AGA-8 , detailed method)and Gas Heating Value (calculated as per ISO 6976) continuously updated direct from a Gas Chromatograph or via the Station Controller using Online line parameters such as differential pressure, temperature, static pressure or pulse rate / total, continuously updated from each transmitter interfaced to the flow computer.

- Meter parameters, input by the Operator.

6.3.11 The flow computers shall utilize a multipoint interpolation algorithm or polynomial equation to best match the calibration curve of the individual turbine meter for linearity correction.

6.4 ULTRASONIC GAS METER CALCULATIONS

6.4.1 Depending on the functionality of the ultrasonic meter's signal processing unit, a separate flow computer may or may not be required.

6.4.2 Two interface methods shall be allowed. One is via a pulse signal and the other is via a MODBUS or Ethernet based communication interface.

6.4.3 If a pulse interface is used, the pulse signal from the meter shall be scaled to provide one pulse per unit of measure of the actual (uncorrected) flow. The pulse signal shall be treated by the flow computer as a gas turbine meter and shall use AGA-7 as the equation for converted to standard flow. The total number of pulses will represent the flow total and the pulse rate will be proportional to the flow rate. The VENDOR shall configure the ultrasonic meter to provide a sufficiently high pulse rate to allow the flow computer to derive an accurate flow rate.

6.4.4 If a communications based interface is used, the VENDOR shall carefully choose the data-polling rate to ensure sufficient updates are available for correction from actual flow conditions to standard conditions.

6.5 CORIOLIS MASS METER CALCULATIONS

6.5.1 Most Coriolis mass meters provide a direct mass measurement with no need for any further correction.

6.5.2 The flow computer shall use the mass flow rate and the density measurement data from the Coriolis meter to calculate a volumetric flow rate (if not already available direct from the mass meter) at standard temperature and pressure.

6.5.3 As a minimum, the flow computers shall provide the hourly, daily and weekly data management and archiving functions.

6.5.4 The flow computer shall also manage any compensation that may be identified during proving for variations in the "meter or K-factor" with flow rate. The flow computer shall support a multi-point meter curve for improving the accuracy of the compensated flow rate and flow total.

6.6 LIQUID TURBINE METER CALCULATIONS

6.6.1 Liquid flow calculations shall be based on API MPMS12.2 (Calculation of Petroleum Quantity Using Dynamic Measurement Methods and Volume Correction Factors).

6.6.2 Flow computer shall support a multipoint meter factor curve. A minimum compensation at 10 flow rates shall be provided.

7.0 DATA MANAGEMENT AND USER INTERFACE

7.1 FLOW COMPUTER KEYPAD INPUT

7.1.1 An operator interface, via keypad shall be provided at each flow computer to permit operator manual entry of data required for measurement. It shall be possible as a minimum to key in the following information:

- Default values, in mm of H2O, of differential pressure
- Default values, in bar, of upstream pressure
- Default values, in deg C, of downstream temperature
- Mean diameter of orifice, in mm
- Mean diameter of meter run, in mm
- The isentropic exponent for the gas or ratio of specific heats
- Dynamic viscosity on the gas in Cp.
- Coefficient of linear expansion of the orifice plate
- Low and high alarms limits setting
- Coefficient of linear expansion of the meter tube
- Fpwl
- Default composition
- Default moisture content
- SG
- Base Pressure
- Base Temperature
- Compressibility Factor Zd, Zf.

7.1.2 Access to the flow computer by unauthorized personnel shall be prevented by Security facilities, such as two part security keys and software passwords.

7.1.3 All keypad-entered values shall be logged by the flow computer and printed as an alarm/ event with time stamp.

7.1.4 Any changes to the data within the flow computer, supervisory computer and station computer, whether by authorized personnel or otherwise via keypad, shall be logged by the flow computer or station computer and generated as an event alarm. This function shall not be suppressible.

7.1.5 The keypad shall also serve as the user control for selecting different display and display data on the front panel display.

7.2 FLOW COMPUTER FRONT PANEL DISPLAY

7.2.1 The flow computers shall display on its front panel on demand the following information in engineering units, to five significant figures, with units of measurement displayed. The units shall be user configurable and shall include a minimum of a choice between Imperial units and metric units.

7.2.2 Current Measurement Display

- Gross flow rate (Cubic Meter/day)
- Standard volume flow rate (SCMD)
- Mass flow rate (tonne/hr, tonne/day)
- Energy flow rate (MMKcal/hr, MMKcal/day)
- Differential pressure (mm H20)
- Pressure (bar)
- Temperature (°C)
- Heating value (Kcal/SCM)
- SG
- Mole percentage (mol %) of C1, C2, C3, nC4, iC4, nC5, iC5, C6+, CO2, and N2

7.2.3 Hourly Measurement Display

- Hourly total of the gross flow (mmscmd)
- Hourly total of the standard volume flow (SCM)
- Hourly total of the mass flow (tonne)
- Hourly total of the energy flow (MMKcal)
- Flow formulaic weighted hourly average of the differential pressure (mm H20)
- Flow formulaic weighted hourly average of the pressure (bar)
- Flow formulaic weighted hourly average of the temperature (°C)
- Flow formulaic weighted hourly average of the heating value (Kcal/SCM)
- Flow formulaic weighted hourly average of the SG
- Flow formulaic weighted hourly average of the mole percentage (mol %) of C1, C2, C3, nC4, iC4, nC5, iC5, C6+, CO2, and N2
- Flow weighted hourly average of Fpv
- Flow weighted hourly average of Fww

Hourly measurement values shall be reset at the beginning of each hour.

7.2.4 Daily Measurement Display

- Daily total of the gross flow (CuM)

- Daily total of the standard volume flow (SCM)
- Daily total of the mass flow (tonne)
- Daily total of the energy flow (MMKcal)
- Flow formulaic weighted daily average of the differential pressure (mm H20)
- Flow formulaic weighted daily average of the pressure (bar)
- Flow formulaic weighted daily average of the temperature (°C)
- Flow formulaic weighted daily average of the heating value (Kcal/SCM)
- Flow formulaic weighted daily average of the SG
- Flow formulaic weighted daily average of the mole percentage (mol %) of C1, C2, C3, nC4, iC4, nC5, iC5, C6+, CO2, and N2

Daily measurement values shall be reset at 0600 each day.

7.2.5 Displays shall be selectable by a combination of Function and Cursor key and shall be organized as a series of hierarchical menus to allow logical and easy access to the displays.

7.3 PC-BASED CONFIGURATION AND MAINTENANCE TOOL

7.3.1 The flow computer shall support a PC-based configuration tool.

7.3.2 The software shall run on a standard Windows based PC with either a serial port or an Ethernet TCP/IP port (preferred) connection to the flow computer.

7.3.3 It shall allow the operator to upload and download configuration parameters to/from the flow computer.

7.3.4 It shall also provide an alternative display interface to the flow computer front panel. In this mode, it shall have the same or increased functionality as the front panel display.

7.3.5 The PC shall also enable the operator to convert the output of the flow computer into the PURCHASER specific data format (VENDOR to liaise with the GAIL to incorporate the necessary (software module).

7.4 REPORTS

7.4.1 The flow computer shall calculate and store hourly, daily, and weekly flow totals and flow weighted averages for differential pressure, static pressure, temperature, gas composition, specific gravity, and heating value, etc. as necessary to produce daily and weekly reports.

7.4.2 The flow computer shall be able to generate reports as described Therein and shall have the ability to retain and generate all the specified reports for the Current Gas Day and thirteen Previous Gas Days.

7.4.3 The following types of reports shall be configurable in the flow computer:

- Current Operating Report, on demand at any time
- Hourly Report, automatic on the hour
- Daily Report, automatic at configurable time
- Weekly Report, automatic once per week
- Alarm/Status/Event Report, automatic at time of occurrence
- Configuration Report, on demand at any time
- Maintenance Report, automatically at the start and end of activating the maintenance function.

7.4.4 All reports shall contain the date, time, station identifier, run number, beta ratio, and algorithm identification. Each report shall start on a new page.

7.4.5 The VENDOR shall submit a design for each report for approval by PURCHASER.

7.4.6 Current Operating Report

7.4.6.1 The Current Operating Report shall be printed whenever requested by the meter station operator.

7.4.6.2 The following data shall be included in the Current Operating Report:

- Line data of pipe internal diameter, orifice bore diameter, and beta ratio
- Cumulative total of the standard volume (MSCM), gross volume (103CuM), mass (tonne) and energy (Kcal). Cumulative totals are from the start of the day to the time of report.
- Line condition data of the standard volume flow rate (MMSCMH), mass flow rate (tonne/hr), energy flow rate (Kcal/hr), differential pressure (mm of H2O), pressure (bar), temperature (°C), HHV Gross Heating Value (Kcal/SCM), SG, and mole percentage (mol %) of C1, C2, C3, nC4, iC4, nC5, iC5, C6+, CO2, and N2

Line condition data shall be the engineering values for the current calculation cycle at the time the report is requested.

It shall be possible to use the line data from this report to recalculate the standard volume flow rate, mass flow rate, and energy flow rate to confirm the flow meter calculation accuracy.

7.4.7 Hourly Report

The hourly report shall be printed automatically at the end of every hour. The flow computer shall generate a transaction record comprising calculated values since the previous transaction record. The hourly report shall include:

- Start time, end time, and total of flow time (minutes/sec/hrs/minutes/sec).
- Cumulated total of the standard volume (SCM), gross volume (CuM), mass (tonnes), and energy (Kcal) for the hour.

- Hourly averages of differential pressure (mm of H2O), pressure (bar), temperature (°C), HHV Gross Heating Value (Kcal/SCM), SG, and mole percentage (mol %) of C1, C2, C3, nC4, iC4, nC5, iC5, C6+, CO2, and N2

7.4.7.1 The current transaction record will be reset and a new transaction record started

- Automatically every hour or when
- Alarms of parameters or data that affect the final billing reports occur
- Parameters that affect the final billing reports are changed

7.4.7.2 The transaction record will include a time stamp of the end time of the transaction. Accumulations, averages and flow time will be for the time period from the previous transaction record end time to the current transaction end time.

7.4.8 Daily Billing Report

7.4.8.1 The daily billing report shall be printed automatically at the end of the gas day. The end of gas day is to be set at 0600 hours, but the end of gas day shall be user configurable.

7.4.8.2 The flow computer shall generate a transaction record comprising calculated values since the previous transaction record. The daily report shall include all of the previous gas day's transaction records, including:

- Start time, end time and total of flow time (minutes / sec or hours/minutes/sec).
- Previous day daily total of the standard volume (SCM), gross volume (CuM),mass (tonnes), and energy (Kcal)
- Previous day daily averages of differential pressure (mm of H2O), pressure (bar), temperature (°C), GHV Gross Heating Value (Kcal/SCM), SG, and mole percentage (mol %) of C1, C2, C3, nC4, iC4, nC5, iC5, C6+, CO2, and N2 .

The current transaction record will be saved and a new transaction record started

- Automatically every day or when Alarms of parameters or data that affect the final billing reports occur Parameters that affect the final billing reports are changed

7.4.8.3 The transaction record will include a time stamp of the end time of the transaction, accumulations, averages and flow time will be for the time period from the previous transaction record end time to the current transaction end time.

7.4.9 Weekly Summarized Billing Report

7.4.9.1 The weekly-summarized billing report shall be printed automatically at the end of the gas week. The start/end of gas week shall be user configurable.

7.4.9.2 The weekly-summarized billing report shall be a summary of the previous 7 days billing reports. The report shall include:

- Start time, end time and total of flow time (minutes/seconds or hours/minutes/seconds).
- The daily total of the standard volume (SCF), gross volume (CuM), mass (tonnes), and energy (Kcal).
- Averages of differential pressure (mm of H2O), pressure (bar), temperature (°C), HHV Gross Heating Value (Kcal/SCM), SG, and mole percentage (mol %) of C1, C2, C3, nC4, iC4, nC5, iC5, C6+, CO2, and N2

7.4.9.3 The transaction record will include a time stamp of the end time of the transaction. Accumulations, averages, and flow time will be for the time period from the previous transaction record end time to the current transaction end time.

7.4.10 Flow Computer Alarm/Status/Event Report

7.4.10.1 The Alarm/Status/Event Report event records shall be printed automatically upon occurrence of an alarm, status change, or event. The event record will contain the time and an English description of the alarm, status change, or event based on Tag Names and the condition.

7.4.10.2 The Alarm/Status/Event Report event records shall be stored in memory and an alarm history report for the previous user definable period shall be generated on request.

7.4.10.3 The event records for the previous gas day shall be automatically printed at the end of each gas day.

7.4.10.4 The number of event records to be stored in the memory for the Flow Computer shall be finalized in the Functional Design Specification.

7.4.11 Configuration Report

7.4.11.1 The flow computer shall provide a software configuration report of all configuration parameters related to Flow Measurement. The report shall be generated upon request.

7.4.11.2 This report shall contain but not be limited to:

- Meter Identifier
- Contract Hour
- Atmospheric Pressure
- Base Pressure & Base Temperature Base
- Calibrated Differential
- Pressure Range and Temperature Range

- Calibrated Static Pressure Range
- All calculation correction factors
- Orifice Bore Diameter
- Internal Pipe Diameter

7.5 Automatic Calibration Software

7.5.1 The calibration software (to be enabled using security code) shall allow for the calibration of the following constituent components of the metering facility:

- Differential pressure transmitters
- Pressure Transmitters
- Temperature Transmitters
- Turbine Meters
- Ultrasonic meters

7.5.1 The software shall guide each calibration by an instructive step-by step procedure. Calibration software with the following features shall be provided:

- User editing of computer, field and test equipment data.
- Automatic test equipment certification check
- Viewing and printing of individual calibration test sheets
- Printing of complete set of individual week's test sheets

7.5.1 On completion of the procedure an output form shall be printed giving all details of "as found" values and "as left", in cases where adjustment and changes to instrument report is done a remark column shall be provided where there is no change. The form shall print the current date and signature boxes. The report form sheet format shall be alterable.

8.0 CONSTRUCTION DETAILS

8.1 ENCLOSURE

8.1.1 The flow computers and printers shall be installed in standalone enclosed system cabinets. They shall be NEMA 1 gasketed enclosures for indoor use.

8.1.2 Cabinet construction shall be of minimum 2 mm steel and hot dip galvanized.

8.1.3 Cabinets shall be cleaned, primed, and finish painted in accordance with the VENDORs standard specifications.

8.1.4 Cabinets shall be painted ANSI 61 light gray unless specified otherwise in the data sheets. A minimum of 500 ml of touch-up paint shall be provided.

8.1.5 The cabinet shall accept cable entry from both the top and bottom. A minimum 120 mm plinth shall be provided under the cabinet.

8.1.6 Front and rear doors with keyed locking handles shall be provided.

The front door shall be provided with a gasketed glass window for viewing the flow computers without opening the door.

8.1.7 The cabinet shall be sized to accommodate the system equipment, terminals, safety barriers, and other equipment as required by this contract.

8.1.8 A permanently affixed document pocket shall be provided on the inside of the cabinet door. VENDOR shall place one complete set of approved as-built drawings for the equipment in this pocket.

8.1.9 Each cabinet shall be provided with two grounded 220 VAC duplex receptacles. VENDOR shall connect these receptacles to a designated circuit from the AC distribution panel.

8.1.10 Each cabinet shall be provided with two fluorescent light fixtures, one front and one rear. Both lights shall automatically turn on when either the front or rear door is opened.

8.1.11 Two 24 VDC fans with filters shall be provided in each cabinet.

8.1.12 Each cabinet shall contain a copper ground bus isolated from the cabinet for instrument earth. The VENDOR shall provide a suitable connection from the bus bar to the site instrument ground.

8.1.13 The front and rear doors shall be electrically bonded to the cabinet by a flexible bonding strap. The VENDOR shall provide a suitable connection from the cabinet chassis to the site AC ground.

8.1.14 Where intrinsic safety (IS) barriers are mounted in the cabinet the VENDOR shall provide a suitable connection from the barriers to the site IS ground.

8.1.15 All cabinet hardware shall be stainless steel.

8.1.16 Cabinets shall be provided with an engraved label on front and rear doors. Label shall be laminated plastic, engraved from the rear, white lettering on black background. Minimum size of label shall be 50 mm high with 25 mm high lettering. Label text shall be submitted to PURCHASER for approval.

8.2 EQUIPMENT

8.2.1 All equipment shall be derated 20 percent below Manufacturer specification and meet all requirements of this specification.

8.2.2 Equipment shall be permanently labeled front and back with the tag number shown on the approved drawings.

8.3 TERMINAL BLOCKS

8.3.1 A terminal block shall be provided for every core entering or exiting the cabinet and for each wiring splice. Terminal blocks shall be IDC (Insulation Displacement Contact) type.

8.3.2 Internal wiring and terminal blocks shall be segregated by voltage level and type as follows:

AC power and control

DC power

Status input

Control output

Analog input

Analog output

8.3.3 A barrier shall separate terminal blocks for each type of I/O signal. Terminal blocks for AC power, DC power, and I/O signals shall be separated by a minimum 25 mm space, and preferably should be on separate mounting rails.

8.3.4 Terminal block groups shall be labeled. Each terminal in a group shall be numbered.

8.3.5 Terminal blocks shall be arranged within the cabinet in vertical columns.

8.3.6 Every I/O point shall be wired to terminals, including spare I/O points.

8.3.7 Every terminal (three each for pulse input/output, analog input/output and control output, two each for status input) of each I/O point shall be wired to terminal blocks.

8.3.8 At least 30 percent spare terminals shall be provided for each voltage level/type, spaced equally along the terminals, and 20 percent additional terminals located together. The base for calculating the required number of terminals shall be inclusive of any terminals provided for spare I/O.

8.3.9 The VENDOR's internal wiring shall be restricted to the system side of the terminal blocks. The VENDOR shall connect no more than two wires to any terminal block. The field side of the terminal blocks shall be left completely free of any wires and jumpers.

8.3.10 Fused terminal blocks shall be provided for all devices requiring 24 VDC power. Each device shall have an individual fused terminal block. Daisy chaining of 24 VDC power from device to device shall not be accepted.

8.3.11 Connection of 24 VDC between fused terminal blocks on the supply side shall be made by metallic jumper bar, specifically made for the purpose by the Manufacturer of the terminal blocks.

8.3.12 Terminals for AC and DC power shall be sized to accept 4 mm2 wiring, I/O signal terminals shall be sized to accept 2.5 mm2 wiring.

8.4 WIRING AND WIREWAYS

8.4.1 Covered PVC wireway shall be provided between terminal blocks for wiring. Wireway loading shall not exceed 30 percent fill at any point.

8.4.2 AC power and control wiring shall utilize separate wireway from DC and I/O wiring.

8.4.3 I/O signal wire shall be individually shielded pair; minimum 1.5 mm2 stranded copper with PVC insulation.

8.4.4 DC and AC power wiring shall be minimum 2.0 mm2 stranded copper, 600 volt insulation, type SIS or AWM.

8.4.5 Wire termination shall use terminal block with IDC (Insulation Displacement Contact) technology and shall be performed with the terminal block Manufacturer's purpose made tool. The use of screwdrivers or other devices shall not be permitted.

8.4.6 Heat shrink sleeves with permanently printed wire numbers shall be placed at each end of every wire.

8.4.7 Wiring shall conform to the following color code:

24 VDC power	:	+ve Red -ve Black
I/O signal	:	+ve Black -ve White
Chassis earth	:	Green w/ yellow stripe
Instrument earth	:	Green

9.0 INSPECTION AND TESTING

9.1 GENERAL

PURCHASER may visit the VENDOR's plant at any time and witness all testing and quality control procedures that may take place during fabrication and final testing.

9.2 PRODUCTION AND CONFORMANCE TESTS

9.3.1 The VENDOR shall perform flow computer component and system testing to ensure high reliability and proper operation. The VENDOR shall document all testing and shall deliver such documentation to PURCHASER prior to the commencement of witnessed testing.

9.3.2 The assembled flow computer equipment shall be final tested before shipment in compliance with an approved test plan provided by the VENDOR. The test plan shall be submitted to PURCHASER at least 30 days before starting the final test.

9.3.3 The test shall include at least the following:

a. The VENDOR shall demonstrate the operation of all diagnostic and maintenance tests provided with the flow computer. Errors shall be simulated to demonstrate its capability to detect and report errors.

b. Various external and internal fault conditions shall be introduced during the test to ensure correct, controlled and safe system response. Such faults shall be representative of the system configuration but shall include power failure/restoration, instrument failure, communication path failure (where applicable), and other faults likely to be encountered.

c. Demonstration that each output signal is transmitted to its Output terminal and each signal received at each input terminal is functioning properly.

d. Demonstration that every input and output circuit is properly Interconnected and sequenced and is functioning properly.

e. Demonstration of compliance with environmental and EMI/RFI

f. Prevention requirements stated herein.

9.3 WITNESSED TESTING

9.3.1 PURCHASER shall not be invited to witness tests until all work has been completed and inspected by the VENDOR to verify conformance with the drawings and specifications.

9.3.2 The final inspections and tests shall be conducted on each flow computer assembly in the presence of PURCHASER. .

9.3.3 The flow computer assembly shall be complete with all Components installed. Any discrepancies found as a result of the inspections or tests shall be corrected by the VENDOR at no cost to GAIL.

9.3.4 PURCHASER shall be permitted to inspect the flow computer assemblies for compliance with this specification, the Industry Standards, the Manufacturers Standards and the design drawings.

9.3.5 The factory acceptance test shall include at least the following:

a. Visual inspection for conformity with approved drawings and contract documents.

b. Demonstration of correct operation of all diagnostic and maintenance functions provided by the flow computer. Errors shall be simulated to demonstrate the ability of the flow computer to detect and report errors.

c. Various external and internal fault conditions shall be introduced during the test to ensure correct, controlled, and safe system response. As a minimum, faults shall include power failure/restoration, instrument failure, and communication path failure.

d. Demonstration that system performance is unaffected by variations in the 24 VDC power supply over the range of 20 V to 30 V.

e. Demonstration that the system is unaffected by hand-held portable radio equipment or other sources of RF interference at a level of 10 Volts/meter from 10 MHz to 500 MHz.

f. Demonstration that each output signal is transmitted to its output terminal, and each signal received at an input terminal is functioning properly. (Including spares)

g. Demonstration that each analog input and output signal meet specified accuracy and repeatability at 0, 25, 50, 75 and 100 percent of full scale. (Including spares)

h. Demonstration that all calculations are being performed correctly and as per these specifications.

i. Demonstration that all reports (data processing, calculation, formats and automatic triggers) are functioning correctly and as per specification.

9.4 SITE ACCEPTANCE TESTING (SAT)

9.4.1 The site acceptance test procedure shall be submitted to PURCHASER for approval at least two months in advance of any test. The SAT must be agreed in full prior to commencement of any testing.

9.4.2 In general, the site acceptance test shall follow the same procedure as the factory test except that the I/O signals will not be simulated.

9.4.3 Site acceptance testing will not be considered complete until all training and documentation have been completed to the satisfaction of GAIL

9.5 TEST EQUIPMENT

9.5.1 The VENDOR shall supply all calibration, test, and simulation equipment that are required to demonstrate correct operation of the system. Certificates for all the test equipment shall be traceable to National Standards.

9.5.2 Calibration, test, and simulation equipment shall be used at factory testing, pre-commissioning, commissioning and site periodic testing. During the testing and commissioning period the VENDOR shall ensure that all equipment is maintained in calibration.

9.5.3 All calibration, test, and simulation equipment shall be made available for PURCHASER use during the testing and commissioning period.

9.5.4 At the completion of commissioning all calibration, test, and simulation equipment shall be serviced and re-calibrated as new and handed over in full working order to PURCHASER.

9.6 TEST DOCUMENTATION REQUIREMENTS

9.6.1 The VENDOR shall be required to write a comprehensive test procedure and prepare manuals of test record sheets for use at factory testing, site commissioning, and site acceptance. Both the procedures and the test record manuals shall be subject to approval by PURCHASER, and shall be submitted to PURCHASER for approval at least two months in advance of any test.

9.6.2 Test record manuals should be presented in such a way as to allow the system test personnel to work through the complete set of tests required and enter all results as the tests proceed, including failures, retest, and calibrations. Software print outs forming part of the tests should also be included in the manuals. Each test sheet in the manual should have a space provided for the VENDOR and PURCHASER to sign off the sheet.

9.6.3 On completion of the tests (both at the works and at site) the VENDOR shall provide two hand written copies of the test to PURCHASER. The record sheets shall be typed up by the VENDOR, then checked and re-signed by PURCHASER. Typed manuals shall be available to PURCHASER one week after the test is completed.

9.6.4 Before commencing any test procedures, record manuals and documentation as required by this specification shall be available in a fully updated state. Current test certificates for all calibration equipment shall also be available.

10.0 INSTALLATION AND COMMISSIONING

10.1 A minimum of 30 calendar days prior to commencement of any installation work the

VENDOR shall provide a schedule detailing the date's work will be undertaken at each site for the approval of PURCHASER.

10.2 The VENDOR shall provide a written plan detailing the work to be performed at each site for installation of the system. The Site Installation Plan shall be submitted to PURCHASER for approval a minimum of 30 calendar days prior to the commencement of any work.

10.3 No installation or commissioning work shall be started at any site until the VENDOR has obtained PURCHASER approval of the factory test results and has achieved 'Approved for Construction' status on all related drawings.

10.4 The VENDOR shall be responsible for obtaining all necessary permits and permission to perform the required installation work.

10.5 The VENDOR will re-check the system as soon as it is installed at site. The objective of the site testing is to confirm the system is still fully calibrated and functional after shipment and installation.

11.0 CRATING AND SHIPPING

11.1 Panels shall be properly created and braced to provide protection against damage to structure, flow computer components, or finish during transit and handling. The VENDOR shall advise PURCHASER if closed air-ride van transit is required. The VENDOR shall inspect and approve the loading and bracing to assure that no damage occurs during transit from tipping or shifting.

11.2 The VENDOR shall remove and properly pack all equipment that cannot be properly secured for transit to prevent damage during transit and handling.

12.0 DOCUMENTATION REQUIREMENTS

12.1 The VENDOR shall provide the following documentation in both hardcopy form and electronic on CD. The format of the document files shall be submitted to PURCHASER for pproval a minimum of 30 calendar days prior to shipment.

- Drawing index
- Basic data
- Design formulae and calculations
- Utility consumption data
- Overall accuracy, or uncertainty in measurement
- Outline of calibration and verification methods
- Reliability details for all equipment
- Equipment lists and data sheets
- Equipment details/drawings for all components

- Full software documentation including details of database layout and contents
- Wiring diagrams
- Schematic diagrams
- Terminal schedule
- Calibration and test equipment drawings
- System or component installation drawings and details
- Factory Acceptance Test Procedures
- Site Installation Plan
- Site Commissioning Procedures
- Site Acceptance Test Procedures
- System Technical Manuals
- Comprehensive operational and maintenance details, which will enable personnel to operate and service the equipment without reference to the VENDOR.
- Comprehensive spare parts list and priced quotation for three years operation.

12.2 The VENDOR shall furnish eight final as-built copies of all documentation listed above.

12.3 The VENDOR shall furnish two copies of all application / configuration Software on computer media.

13.0 TRAINING

13.1 The VENDOR shall provide training to nominated maintenance (hardware and software) and operation personnel in the maintenance and use of the flow computer system.

13.2 The VENDOR shall provide a course outline, course prerequisites, and course training material for each training course six weeks prior to the course start date.

13.3 The course training material shall be customized to reflect the options and configuration of PURCHASER's system.

13.4 Only training courses taught by Manufacturer's authorized representative and approved by the original equipment or software manufacturer shall be offered.

13.5 For each course the VENDOR shall provide for training of up to ten people at the VENDOR premises.

13.6 Hardware Training

These courses shall be sufficiently comprehensive to allow trouble shooting to electronic module level and should assume a working knowledge of electronics.

13.7 Software Training

The VENDOR shall provide courses intended to train and familiarize PURCHASER's personnel in all aspects of system programming and software development. At a

minimum the following topics shall be covered:

- Database editing
- System security
- Report generation
- Device configuration
- System backup

13.8 Operator Training

The VENDOR shall provide courses to operations personnel on the following topics as a minimum:

- Measurement displays
- Alarm acknowledgement and silencing
- Reports
- Printing

14.0 START-UP ASSISTANCE AT SITE

15.1 The services of a competent, experienced start-up engineer shall be included to provide technical direction and supervision, conduct tests, and implement required field changes for the placing in service of the flow computers.

15.2 In addition to performing the activities listed in this section, the VENDOR shall provide for up to four weeks services of the start-up engineer to perform work at the sole direction of PURCHASER.

15.3 The start-up engineer shall actively participate in every aspect of system start-up within the limits of any imposed restrictions.

15.4 The start-up engineer assigned has the responsibility of familiarizing himself with the project and shall be previously trained in all applicable hardware and system software by the system Manufacturer's engineer.

15.5 The VENDOR's start-up engineer when on site shall provide all necessary test equipment required for testing, calibrating, and maintaining the equipment other than process transmitters.

15.6 The VENDOR's start-up engineer shall perform the following functions:

- Provide general technical assistance during installation.
- Provide technical assistance to PURCHASER's personnel in the proper method of placing equipment in initial operation.
- Perform semiformal operator training and maintenance guidelines.
- Maintain a record of drawing revisions based on required field changes.

- Make weekly progress reports.
- Prepare the start-up documentation book.
- Perform start-up work coordinated with PURCHASER and other VENDORs, cooperate in matters of mutual support, and participate in meetings, to meet the overall project schedule.
- Perform or assist PURCHASER personnel in performing all necessary calibration.

15.0 SPARE PARTS AND MAINTENANCE TOOLS

15.1 Spare parts shall be as indicated in the Project Specification for 'Requirements for Spares'.

15.2 Application Software and Utility programs to configure test and maintain the flow computer system shall be supplied in 2 sets of CD, included together with a notebook PC (optional) with all necessary wiring, interconnecting cables, signal converters required to safely access the flow computers.

GAIL INDIA LIMITED

STANDARD SPECIFICATION

FOR

ALARM ANNUNCIATOR

GAIL-STD-IN-DOC-TS-022

0	27.01.2019	Issued for Bid	RKS	UNU	UNU	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

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1.0 GENERAL

1.1 This specification outlines the minimum requirements under which the manufacturer shall design, manufacture, test and supply alarm annunciator.

1.2 Order of Precedence
The following order of precedence shall govern in interpretation of various requirement and data:

- This specification
- Codes & standards
- Vendor's standards

2.0 SCOPE OF SUPPLY

2.1 Alarm Annunciator shall be panel mounted type with Industry standard, steel material.

2.2 Alarm Annunciator shall have 8 channel alarm indication, each cell/ alarm window/channel of size around 80 x 60 mm and comprising of one large window. These alarm windows shall be driven be Alarm Cards as per the process requirement. The annunciator shall be constructed by assembling multiple "cells/ windows" together to provide a unit of the shape and size required. The finished cell array is to be housed inside an extruded aluminum "picture frame" surround which gives a flush mounting appearance and allows the annunciator to be mounted in a single cut-out provided in panel.

2.3 The annunciator shall accept 8 nos. of potential free contact inputs. Alarm Status Indication shall be provided using Ultra bright LED illumination. For this purpose, 4 Nos. of yellow coloured LED lamps and 4 Nos. of Red coloured LED lamps, along with Hooter shall be provided. First out alarm features is also required in 4-channel (for 4 alarms). Alarm details/ Nomenclature for display/ indication/ programming the Annunciator shall be provided during detail engineering.

2.4 Power Supply for Annunciator shall be 24V DC as standard.

2.5 Input from the field shall be transmitted through use of Relays to the Terminal Box. Separate power supply required for energising relays.

2.6 Failsafe Mode - All relays shall be configured in their default setting as energized. The relays will de-energise on trip or in the case of a power failure.

2.7 There shall be provided Lamp Test/ Acknowledge/ Reset Push Buttons to test, acknowledge and reset the alarm accordingly.

2.8 Mounting arrangement shall be flush mounting on panel. The indicating LED lamps/ window shall be accessible from front.

2.9 A "power on" LED shall be provided on the Annunciator.

2.10 All inputs from alarm contacts and external pushbuttons shall be opto-coupled.

2.11 Digital Input from field shall be directly terminated in control panel. Provision for the same (by installing required relays, multiplier, isolator, barrier, power requirement etc) shall be provided.

3.0 MANDATORY SPARES

3.1 The annunciator being essential in providing safe operation of the process it is required that the following number of critical spares be provided as follows:-

SL. No.	Item	Quantity
1	Alarm Card	1
2	Relay Card	1
3	Push Button Assembly	1
4	LED Lamp Assembly	2

GAIL INDIA LIMITED

STANDARD SPECIFICATION

FOR

LEVEL GAUGE

GAIL-STD-IN-DOC-TS-023

0	27.01.2019	Issued for Bid	RKS	UNU	UNU	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

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1.0 GENERAL

1.1 This specification outlines the minimum requirements under which the manufacturer shall design, manufacture, test and supply level gauge.

1.2 **Order of Precedence**
The following order of precedence shall govern in interpretation of various requirement and data:

- This specification
- Codes & standards
- Vendor's standards

2.0 NAME PLATE

2.1 Each gauge shall have a stainless steel nameplate attached firmly to it at a visible place either by riveting or screwed to the case, furnishing the following information:

a) Tag number / Identification No. (as per purchaser's data sheets).
b) Vendor's name
c) Model number and manufacturer's serial number.
d) Design pressure, Pressure class rating, Process parameter etc.
e) Process connection size/ rating, Length etc.

3.0 SCOPE OF SUPPLY

3.1 All Level gauge glass shall be steel armoured reflex type with body and cover material of forged carbon steel as a minimum and shall have toughened borosilicate glass with suitable gasket. All gauge glasses must have a rating equal to or more than vessel design pressure and temperature.

3.2 All level gauges shall have top and bottom chamber connections. In addition each gauge shall be provided with ball check valves and pipe union.

3.3 The visible range of level gauge shall be selected to cover the complete operating level as well as measuring range of the other level instruments provided for the same purpose. In general, the visible length of the level gauges shall be selected from the following:-

Visible length	Centre to Centre Length
220	470
470	720
720	970

In any case, the maximum visibility length shall not exceed 1000 mm for a single gauge. If as per sizing/ design of filters, more than one Level gauge is required to meet the tender requirement, same shall be provided.

3.4 Gauge glass cocks shall be forged off-set type with an integral ball check and back seating stem. Primary isolation valves are required in addition to the gauge glass cocks.

3.5 Flanged connection shall be provided at Inlet/ process and drain connection and at all the process connections. Globe/Plug valve shall be used for Isolation of Level gauge and needle valve shall be used for drain valve. Blind Flange shall be provided at drain line.

3.6 **Material**

Level gauge	:	Carbon Steel or Better (to suit process condition).
Fasteners	:	As per standard ASTM A-193 Gr. B7 / A-194 Gr. 2H.
Packing material	:	Grafoil/ PTFE.

3.7 Safety ball check device shall be provided. Gauge Valve shall have Auto-Shut off ball check.

3.8 All the wetted parts shall be suitable for process fluid.

4.0 INSPECTION AND TESTING

4.1 Unless otherwise specified, purchaser reserves the right to test and inspect all the items at the vendor's works.

4.2 Vendor shall submit following test certificates and test reports for purchaser's review:

a) Dimensional test report for all gauges.
b) Hydro-test, radiography, DP test, any other NDT (as applicable)
c) Performance test reports for all gauges including accuracy, repeatability, etc.

GAIL INDIA LIMITED

QUALITY ASSURANCE PLAN

FOR

INSTRUMENTATION EQUIPMENTS

GAIL-STD-IN-DOC-QAP-001

0	04.02.2019	Issued for Bid	RKS	UNU	UNU	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

	Contractor		**QUALITY ASSURANCE PLAN FOR INSTRUMENTATION EQUIPMENTS**	Client	GAIL INDIA LTD , NOIDA (UP)
	Order No. & Date			Project	
	Sub-Contractor	-		Package No,	-
	Order No. & date	-		Package Name	Type –

INSTRUCTIONS FOR FILLING UP:

1. QAP shall be submitted for each equipment separately with break up of assembly / sub-assembly & part/component or for group of equipment having same specification.
2. Use numerical codes as indicated for extent of inspection & tests and submission of test certificates & documents. Additional codes & description for extent of inspection & test may be added as applicable for the plant and equipments.
3. Separate identification number with quantity for equipment shall be indicated wherever equipment having same specifications belonging to different facilities are grouped together.
4. Weight in kilogram must be indicated under column 5 for each item. Estimated weights may be indicated wherever actual weights are not available.

ABBREVIATION USED :

CONTR : CONTRACTOR
MFR : MANUFACTURER

CODES FOR EXTENT OF INSPECTION, TESTS, TEST CERTIFICATES & DOCUMENTS :

Code	Description	Code	Description	Code	Description	Code	Description
1.	Visual	12.	Routine test as per relevant IS other standard	23.	Short time rating	D1.	Approved GA drawing.
2.	Dimensional	13.	Type test as per relevant IS/ other standard	24.	Operational & functional test	D2.	Approved single line/ schematic
3.	Fitment & alignment	14.	Impulse Test	25.	Over speed test	D3.	Test certificates
4.	Physical Test (Sample)	15.	Partial Discharge Test	26.	Flame proof Test	D4.	Approved Bill of materials
5.	Chemical test (Sample)	16.	Heat run risc test/temper	27.	Clearance and creepage distance	D5.	Un-priced P.O. copy
6.	Ultrasonic test	17.	Enclosure protection test	28.	Acceptance test	D6.	Calibration certificates of all measuring instrument and gauges.
7.	Magnetic particle test (MPT)	18.	Calibration	29	Honing Test		
8.	Radiography test	19.	Noise & Vibration	30	Hydrotest/ Shell leak test		
9.	Dye Penetrant test	20.	Test certificate of bought out components	31	Pneumatic Seat leak test		
10.	Measurement of IR value	21.	Tank pressure test	32	Impact test		
a)	Before HV test	22.	Paint shed vibration				
b)	After HV test						
11.	High voltage test/Dielectric test						

Equipment Details							**Inspection & test**													
Sl. No	**Item**	**Identification No.**	**Quantity** No./ M	**Weight** Kg	**Manufacturer's Name and Address**	**Exp date of Insp**	**Raw material and**						**Final inspection & test**						Test certificate & Document to be submitted to GAIL	Acceptance Criteria standards/ IS/BS/ASM E/ Norms and documents	Remark/ Sampling plan
							MFR		**CONTR & TPI**		**GAIL**		**MFR**		**CONTR & TPI**		**GAIL**				
1	2	3	4	5	6	7	8	P/W /R	9	P/W / R	10		11	P/W / R	12	P/W /R	13	P/W /R	14	15	16
1.0	PCV/ SDV	As per P & ID			GAIL approved Vendor		1,2,3,4, 5,8,30, 32	P P P	30, 32	W R	-		1,2,3,5, 8,20,18, 24, 31	P P P	1,2,3,5 8,20, 18,24,31, 30, 32	R R W R	1,2,3, 5,8,20 18,24 30,31,32	R R W R	1,2,3,5,8, 18,20, 24, 30, 31,32 D1, D3, D4,D6	D3,D6, Tech. spec.	100%
2.0	Pressure Gauge / Temper. Gauge	As per P & ID			GAIL approved Vendor		1,2,3, 4, 5,	P P	-		-		1,2,3, 18,20	P P	1,2,3,4, 5,18,20, 24	R R W	1,2,3,4 5,18,20 24	R R R	1,2,3,4,5, 18,20,24,D 3, D6	D3,D6, Tech. spec.	100%

	Contractor		**QUALITY ASSURANCE PLAN FOR INSTRUMENTATION EQUIPMENTS**	Client	GAIL INDIA LTD , NOIDA (UP)
	Order No. & Date			Project	
	Sub-Contractor	-		Package No,	-
	Order No. & date	-		Package Name	Type –

Equipment Details							Inspection & test													
Sl. No	**Item**	**Identification No.**	**Quantity** No./ M	**Weight** Kg	**Manufacturer's Name and Address**	**Exp date of Insp**	**Raw material and**						**Final inspection & test**						Test certificate & Document to be submitted to GAIL	Acceptance Criteria standards/ IS/BS/ASM E/ Norms and documents	Remark/ Sampling plan
							MFR		**CONTR & TPI**		**GAIL**		**MFR**		**CONTR & TPI**		**GAIL**				
1	2	3	4	5	6	7	8	P/W /R	9	P/W / R	10		11	P/W / R	12	P/W /R	13	P/W /R	14	15	16
3.0	Differential Pressure Gauge	As per P & ID			GAIL approved Vendor		1,2,3, 4, 5	P P	-		-		1,2,3,4, 5,18,20, 24	P P P	1,2,3,4, 5'18,20, 24	R R R	1,2,3,4, 5,18,20, 24	R R R	1,2,3,4,5, 18,20,24, D3, D6,	D3,D6, Tech. spec.	100%
4.0	Resistance Temperature Gauge	As per P & ID			GAIL approved Vendor		1,2,3, 4, 5,	P P	-		-		1,2,3,4, 5,18,20 ,24	P P P	1,2,3,4, 5,18,20, 24	R R R	1,2,3, 4 5,18,20 24	R R R	1,2,3,4,5, 18,20,24, D3, D6	D3,D6, Tech. spec.	100%
5.0	Flow Control Valves	As per P & ID			GAIL approved Vendor		1,2,3,4 ,5,8,30 ,32	P P P	30, 32	W R	-		1,2,3,5, 8,20,18 ,24,31	P P P	1,2,3,5, 8,20, 18,24,31, 30,32	R R W R	1,2,3, 5,8,20 18,24, 30,31,32	R R W R	1,2,3,5,8, 18,20,24, 30,31,32 D1,D3, D4,D6	D3,D6, Tech. spec.	100%
6.0	Turbine / PD Flow Meter & Meter run	As per P & ID			GAIL approved Vendor		1,2,3, 4,5,8, 29,30, 32	P P P P	-		-		1,2,3, 18,20,24	P P	1,2,3,4, 5,8,18, 20,24,29, 30,32	R R R R	1,2,3,4, 5,8,18, 20,24,29, 30,32	R R R R	1,2,3,4,5,8, 18,20,24 D3,D6	D3,D6, Tech. spec.	100%
7.0	Flow Computer	As per P & ID			GAIL approved Vendor		1,2,3, 12,18	P P	-		-		1,2,3, 18,24	P P	1,2,3, 18,24	R R	1,2,3, 18,24	R R	1,2,3,18, 24,D1,D2, D3,D4,D6	D3, Tech. spec.	100%

GAIL INDIA LIMITED

QUALITY ASSURANCE PLAN

FOR

MECHANICAL ITEMS

GAIL-STD-ME-DOC-QAP-001

0	05.02.2019	Issued for Bid	RKS	AP	JR	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

	Contractor		**QUALITY ASSURANCE PLAN FOR MECHANICAL ITEMS**	Client	GAIL INDIA LTD, NOIDA (UP)
	Order No. & Date			Project	
	Sub-Contractor	-		Package No,	-
	Order No. & date	-		Package Name	Type –

INSTRUCTIONS FOR FILLING UP:

1. QAP shall be submitted for each equipment separately with break up of assembly / sub-assembly & part/component or for group of equipment having same specification.
2. Use numerical codes as indicated for extent of inspection & tests and submission of test certificates & documents. Additional codes & description for extent of inspection & test may be added as applicable for the plant and equipments.
3. Separate identification number with quantity for equipment shall be indicated wherever equipment having same specifications belonging to different facilities are grouped together.
4. Weight in kilogram must be indicated under column 5 for each item. Estimated weights may be indicated wherever actual weights are not available.

ABBREVIATION USED :

CONTR : CONTRACTOR
MFR : MANUFACTURER
P : PERFORM
R : REVIEW
W : WITNESS

* : CONTR / MFR as applicable
** : Test to be performed if applicable
O : Functional Test includes : (1) Cold bench set pressure test ,(2) Seat leakage Test , (3) Valve Lift test

CODES FOR EXTENT OF INSPECTION, TESTS, TEST CERTIFICATES & DOCUMENTS :

Code Description	Code Description	Code Description	Code Description
1. Visual 2. Dimensional 3. fitment & alignment 4. Physical Test (Sample) 5. Chemical test(Sample) 6. Ultrasonic test 7. Magnetics particle test(MPT) 8. Radiography test 9. Dye Penetrant test 10. Metallographic Test 11. Welder Qualification and weld procedure test 12. Approval of Test and repair procedure test 13. Heat treatment 14. Pressure test 15. Leakage test 16. Balancing 17. Vibration Test	18. Amplitude test 19. Sponge test 20. Dust/ water ingress test 21. Frication factor 22. Adhesion test 23. Performance test / characteristic curve 24. No load and free running test 25. Load and over load test 26. Measurement of speed 27. Acoustical test 28. Geometrical accuracy 29. Repeatability and position accuracy 30. Proving Test 31. Surface preparation 32. Manufacturer's test certificate 33. IBR / other statutory agencies certificate	34. Internal Inspection report by contractor 35. Hardness test 36. Spark test of lining 37. Calibration 38. Safety devise test 39. Ease of maintenance 40. Fire Test (Type test) 41. Chary V-notch test 42. Operational torque Test 43. ENP 44. Painting 45. Anti-static test 46. Hydrostatic double block & bleed test 47. Functional test – O 48. Pneumatic double block & bleed test 49. Verification of Heat No.	D1. Approved GA drawing. D2. Information and other reference drg/ stamped drgs released for mfg. D3. Reference catalogue D4. Bill of materials/ Item No./ Identification D5.Matchmarks detail D6. Line and Layout diagram D7. Approved erection procedure D8. Un-priced sub P.O. with specification and amendment D9. Calibration certificates of all measuring instrument and gauges. D10. X –ray reports.

Equipment Details							**Inspection & test**											
Sl. No	**Item**	**Identification No.**	**Quantity** No./ M	**Weight** Kg	**Manufacturer's Name and Address**	**Expected schedule of Final inspection**	**Raw material and in-process stage inspection**					**Final inspection & test**						**Test certificate & Document to be submitted to GAIL**	**Acceptance Criteria standards/ IS/BS/ASME/ Norms and documents**	**Remark/ Sampling**
							MFR		**CONTR/ TPI**		**GAIL**	**MFR**		**CONTR/ TPI**		**GAIL**				
1	2	3	4	5	6	7	8		9		10	11		12		13		14	15	16
1.0	Pressure Safety Valves	As per P &ID			Sabim		1,2 3,4 5,8	P P P	3,4, 5,8,	R R	-	1,2, 3,14, 15,31, 44,47	P P P P	1,2,3, 14,15, 47	R W* W*	1,2,3, 14,15 47	R R R	1,2,3,4,5,8, 14,15, 31,32,33,34, 44,47	D1, D2, ASME Sec-VIII, ASME Sec. IX, GAIL TS, Appd. Data sheet	100%

	Contractor		**QUALITY ASSURANCE PLAN FOR MECHANICAL ITEMS**	Client	GAIL INDIA LTD, NOIDA (UP)
	Order No. & Date			Project	
	Sub-Contractor	-		Package No,	-
	Order No. & date	-		Package Name	Type –

Equipment Details						Inspection & test														
Sl. No	**Item**	**Identification No.**	**Quantity** No./ M	**Unit Weight** Kg	**Manufacturer's Name and Address**	**Expected schedule of Final inspection**	**Raw material and in-process stage inspection**					**Final inspection & test**						**Test certificate & Document to be submitted to GAIL**	**Acceptance Criteria standards/ IS/BS/ASME/ Norms and documents**	**Remark/ Sampling Plan**
							MFR		**CONTR & TPI**		**GAIL**	**MFR**		**CONTR & TPI**		**GAIL**				
1	2	3	4	5	6	7	8		9		10	11		12		13		14	15	16
2.0	Ball Valves	As per P &ID			GAIL approved vendor		1,2,3, 4,5,6**, 7**,8**, 9**,13, 35,41,	P P P P P	4,5, 6 8,9, 13,35 41, 43	W* R R W* R	-	1,2,3, 14,15, 42,40, 44,45, 46,47, 48	P P P P P P	1,2,3, 14,15, 42,45, 46,47, 48	W* W* W* W* W*	1,2,3,4,5, 6,14,15, 41,42,43, 44,45,46, 47,48	R R R R R	D1,D2,D3,D9, D10, 1,2,3, 4,5,6**,7 **, 8**,9**, 13,14,15,40, 41,42,43,44, 45,46,48	D1, GAIL TS, Appd. Data sheet, API6D, ASME 16.34, API607,BS6755 ,BS5351	100%
3.0	Plug Valves	As per P &ID			GAIL approved vendor		1,2,3,4, 5, 6**, 7**,8**, 9**,35, 41,43	P P P P P	4,5,6, 7,8,9, 35,41, 43	W* R W* R	-	1,2,3, 14,15, 42,44, 47	P P P P	1,2,3, 14,15, 42,47	W* W* W*	1,2,3, 4,5,6, 14,15, 42,47	R R R R	D1, D2,D3, D9,D10, 1,2,3,4,5,6**, 7 **, 8**,9**, 13,14,35,15, 40,41,42,43, 44,45,47,48	D1, GAIL TS, Appd. Data sheet, API6D,	100%
4.0	Check Valves	As per P &ID			GAIL approved vendor		1,2,3,4 5,6**, 7**,8**, 9**,41,	P P P P	4,5,6, 7,8,9 41	W* R R	-	1,2,3 14,15 44	P P P	1,2,3, 14,15,	W* W*	1,2,3, 4,5 14,15,	R R R	D1, D2,D3, D9, D10,1, 2, 3,4,5,6**,7 **, 8**,9**, 13,14,15,41, 44	D1, GAIL TS, Appd. Data sheet, API6D,	100%
5.0	Filter	As per P &ID			GAIL approved vendor		1,2, 4,5,8, 9,11, 12,35	P P P P	4,5, 11,12 35,	W* R R	-	1,2,3, 4,5,8, 9,14, 31,32, 41,44	P P P P P	1,2,3, 8,9, 14, 15 32 ,41	W* R W* R	1,2,3, 4,5,8 9,14, 15, 32	R R R R	1,2,3,4,5, 8,9,11,12,14 ,31,32,34,35 ,44,D9	D1, D2, ASME Sec-VIII, ASME Sec. IX, GAIL TS, Appd. Data sheet	100% All butt weld joints to be Radiography tested.

	Contractor		**QUALITY ASSURANCE PLAN FOR MECHANICAL ITEMS**	Client	GAIL INDIA LTD, NOIDA (UP)
	Order No. & Date			Project	
	Sub-Contractor	-		Package No,	-
	Order No. & date	-		Package Name	Type –

Equipment Details							Inspection & test													
Sl. No	Item	Identification No.	Quantity No./ M	Unit Weight Kg	Manufacturer's Name and Addre	Expected schedule of Final inspection	Raw material and in-process stage inspection						Final inspection & test						Test certificate & Document to be submitted to GAIL	Acceptance Criteria standards/ IS/BS/ASME/ Norms and documents	Remark/ Sampling plan
							MFR		CONTR/ TPI		GAIL		MFR		CONTR/ TPI		GAIL				
1	2	3	4	5	6	7	8		9		10		11		12		13		14	15	16
6.0	Pipes,	-			GAIL Approved vendor		1,2,4,5,41	P P	4,5,41	W* W*	-		1,2,3,4,5,14	P P	1,2,49	W*	1,2,4 5,14, 41,49	R R R	1,2,3,4,5, 14,	ASTM A 106 GrB, API 5L	One sample per heat
7.0	Pipe fitting, Flanges	-			GAIL Approved vendor		1,2,3, 4,5,41	P P	4,5, 41	W* W*	-		1,2,3, 4,5	P P	1,2,3 4,5	W* R	1,2,3, 4,5	R R	1,2,3,4,5, 41,	ANSI B16.5 (flange) ANSI B 16.9 & 16.11 (fittings)	One sample per heat
8.0	Fasteners	-			GAIL Approved vendor		1,2,4, 5	P P	-		-		1,2,3, 4,5	P P	1,2,3, 4,5	R W*	1,2,3,4, 5	R R	1,2,3,4,5,	ASTM A 193 Gr.B7 & ASTM A194 Gr2H	One sample per heat

Remark (If any) : **EN 10204, Type 3.2 certificates shall be provided for bought out items. These shall be inspected by TPI Appointed by Vendor. LEGEND : P : Perform, W : Witness, R : Review, * : The doc shall be validated by MFR's authorized inspection representative, independent of manufacturing department.**	QAP No.	
	Rev.	
For Contractor / Sub-contractor (Stamp & Signature)	For GAIL (Stamp & Signature)	Date

GAIL INDIA LIMITED

DATASHEET

FOR

CONTROL PANEL

GAIL-STD-IN-DOC-DS-001

0	05.02.2019	Issued for Bid	RKS	AP	JR	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Control Panel

UNITS : Gas Flow - MMSCMD, Liquid Flow - m3/hr , Steam Flow – Kg/hr , Pressure - Kg/cm2g , Temperature – Deg C , Level / Length - mm

General	1	Location	Indoor			
	2	Floor	Concrete			
	3	Air conditioning	No			
	4	Control Panels Quantity	*			
	5	Make	*			
	6					
Control Panel Construction	7	Type	Closed cubicle			
	8	No. of panel sections	*			
	9	Lighting	Required for inside panel with door switch			
	10	Ventilation	Required with louvers & fan.			
	11	Special specifications				
	12	Doors	Rear double side hinged doors with flush pull type handles & with locking arrangement. Single front door with glass cover along with handle (for access from front). Doors shall be of 2 mm sheet steel with PU foamed gaskets			
	13	Painting	(a)	The panel surface shall be thoroughly degreased, smoothed, filled and painted with rust resistant primer.		
			(b)	Two coats of paint in panel colour shall be given for non glossy high satin finish		
				(i)	External colour of cabinet	Grey (RAL 7035)
				(ii)	Internal Colour (Semi glossy)	Pale cream (RAL 9001)
				(iii)	Channel Base	Black
			(c)	Panel rear surface, framework and bulk head plates shall have a finish color of pale cream (RAL 9001).		
	14	Name Plates	Front of Panel	Instrument name plates shall be black, laminated plastic with white core		
			Rear of Panel	Name plate shall be provided on the rear of the panel also.		
Dimensions & Material of Construction of Control Panel	15	Panel dimension	800 mm (W) 2100 mm(H) 800 mm(D) (Including channel base)			
	16	Load Bearing Members	Shall be suitable to handle loads of all instruments etc.			
	17	Front plate	3mm thick cold rolled steel			
	18	Side & Top of panels	3mm thick hot rolled steel			
	19	Channel base	100mm x 50mm x 6mm Mild steel			
	20	Frame base	50mm x 50mm x 6mm mild steel			
	21	Gland Plate	6mm thick steel plate (Cable entry is from bottom)			
	22	Accessories	Hooter, Lamps, push buttons etc. as required			
	23					
Power Supply Distribution Boxes	24	Function	Distribute power to individual instruments			
	25	Mounting	Mounted at the panel inside			
	26	Door	Front single door			
	27	Painting	As per panel painting specifications.			
	28	Box dimension	*			
	29	Box plate thickness	3mm hot rolled steel.			
	30	Cable entry	*			
	31	Accessories	600V Grade DPST toggle switches with glass cartridge fuse for individual instruments/consumers.			
	32	Special requirements	Switch fuse unit for incoming feeder.			
	33					
Bulk Power Supply Unit	34	Input	230 VAC, 50 Hz and or 24 Volts DC whichever is available.			
	35	Output	*			
	36	Rating	*			
	37	Quantity	Hot redundant to power the complete system			
	38					
IS Barriers & Isolators	39	MAKE	MTL/P&F/STALL			
	40	(i) QUANTITY	25% MORE THAN THE REQUIREMENT			
		(ii) TYPE	As required *			
	41	**Lamps**	Clustered LED Type shall be provided for increased life			
		(i) Type	Miniature filament			
		(ii) Rating	*			
		(iii) Voltage	*			
		(iv) Make / Model No.	*	*		
		(v) Quantity	As reqd.*			
	42	**Push Buttons**	Push button for LAMP test and Alarm acknowledge & Reset to be			

				provided. Any system alarm or operator assigned alarm in FC, GC and Metering supervisory system to be annunciated through hooter.
		(i)	Type	*
		(ii)	Contacts	*
		(iii)	Contact rating	*
		(iv)	Make	*
		(v)	Color	*
		(vi)	Quantity	*
	43	**Selector switch**		
		(i)	Type	*
		(ii)	Specification	*
		(iii)	Rating	*
		(iv)	Make	*
		(v)	Quantity	*
	44	**Relays**		
		(i)	Type	Plug in relays
		(ii)	Contact Type	Potential free contact
		(iii)	Contact No	3 NO. + 3 NC
		(iv)	Rating	*
		(v)	Make / Model No	*
		(vi)	Quantity	as per reqmt (Refer functional schematics) *

*: Vendor to confirm (VTC)

Note: Suitable arrangement to be made/ provided for installation of Printer, Modem, CPU, Monitor, Keyboard, accessories and other hardware.

GAIL INDIA LIMITED

DATASHEET

FOR

DIFFERENTIAL PRESSURE INSTRUMENTS (TYPICAL)

GAIL-STD-IN-DOC-DS-002

0	05.02.2019	Issued for Bid	RKS	AP	JR	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Differential Pressure Instruments (Typical)

UNITS : Flow Liquid - m3/hr Pressure - Kg/cm2 G Temperature - Deg C Level/Length - mm

General	1	Function	Transmit and Indicate
	2	Type	Electronic, smart with HART protocol
	3	Case	Manufacture standard
	4	Mounting	Yoke (2" NB Pipe mounting)
	5	Electrical area classification	Zone-1, GR IIA/IIB, T3
	6	Enclosure	WP to IP-65
	7	Hazardous area protection	Intrinsically safe (Note 6)
	8	Air Supply	N/A
	9	Power Supply	
	10	Cable Entry	½" NPTF
	11	Accuracy	±0.04% of span with turn down 1:5 (including linearity, hysteresis & repeatability) used for custody transfer applications. Suitable turndown to be selected provided it meets the other conditions.
	12	Make and model no.	*
Transmitter	13	Output	4-20 mA DC (Note-1 & 2)
	14	Transmitter Power supply	24 V DC (Two Wire)
Controller	15	Out put	
	16	A/M Switch	
	17	No of Positions	
	18	Set point Adjustment	
	19	Manual regulator	
	20	Mode	
	21	Chart	
	22	Chart Drive	
	23	Moving parts Material	
	24	Chart Speed	
Measuring Unit	25	Service	Differential Pressure measurement
	26	Element	Silicon resonant/Capacitance type Diaphragm
	27	Body Material	Carbon steel / Aluminium
	28	Element Material	SS 316
	29	Process Connection	½" NPTF
	30	Process connection location	Bottom entry
	31	Diaphragm Seal	N/A
	32	Static Pressure Rating	100 Kg/cm2
Options	33	3/5 -valve manifold with equalizing valve	Required
	34	Intrinsically safe LCD type O/P meter	Required
	35	Mounting Accessories for 2" pipe mounting (Bracket, U Bolts & Nuts suitable)	Required

Tag no.	Range		Zero Elevation In H2O	Zero Suppression In H2O	Design pressure	Max. Temp. °C	Fluid	Service	Remarks
	Span	Set							

Vendor to provide as per EDB, P&ID and other tender Documents

* : Vendor to confirm (VTC), Legend L: Liquid

Notes:

1. Transmitter shall be suitable for external loop resistance of at least 600 ohms when powered with 24 V DC from control room/control panel.
2. Output 4-20 mA shall be superimposed on digital signal with HART Protocol (For CR mounted FC Skids). For low power transmitters, output and power supply shall be different.
3. Digital communication shall be possible with hand held communicator.
4. Integral intrinsic safe output meter (LCD type) shall be provided for all transmitters.
5. Over range protection shall be suitable for maximum pressure or 130% of range, whichever is higher.
6. CCOE approval certificate shall be provided for transmitter.
7. Equipment shall be protected for the case of full pressurization in one side and with no pressure on the other with equalizing valve in closed condition.

GAIL INDIA LIMITED

DATASHEET

FOR

PRESSURE SAFETY VALVE

GAIL-STD-IN-DOC-DS-003

0	05.02.2019	Issued for Bid	RKS	AP	JR	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Pressure Safety Valves					
UNITS : Gas Flow - MMSCMD, Liquid Flow - m3/hr , Steam Flow – Kg/hr , Pressure - Kg/cm2g , Temperature – Deg C , Level / Length - mm					
General	1	Tag No.		*	
	2	Line No./ Size		*	
	3	Vessel Protected		*	
	4	Quantity		1 nos. at Filter for fire case sizing and 1 nos. each at regulator outlet for creep relief	
	5	Safety/ Relief		Safety/ creep Relief	
	6	Vendor		*	
Valve	7	Type		Standard	
	8	Full Nozzle Full Lift Mod. Nozzle		Full Nozzle Full Lift	
	9	Bonnet Type		Closed	
	10	Conv./ Bellows/ Pllot Operated		Conventional	
	11	Inlet Conn. : Size & Rating		*	*
	12	Inlet Conn. : Facing & Finish		RF Serrated	125AARH
	13	Outlet Conn. : Size & Rating		*	*
	14	Outlet Conn. : Facing & Finish		RF Serrated	125AARH
	15	Cap Over Adj. Bolt :		Required	
	16	Screwed / Bolted		Bolted	
	17	Lifting Gear - Type		-	
	18	Test Gag		Required	
Material	19	Body and Bonnet		ASTM A216 Gr. WCB	
	20	Nozzle and Disc		SS 316 or better	
	21	Spring		Cadmium Plated CS	
	22	Bellows		*	
	23	Resilient Seat Seal		*	
Options	24	Spring For different set point range		Required	
	25				
Basis	26	Code		ASME Sec-VIII / API 520	
	27	Basis of Selection			
	28				
Service Conditions	29	Fluid and State		Natural Gas	Gas
	30	Corrosive Constituent/ Corr. Allow.		CO2 (As per SOW/not mentioned then 4%) / 2.0mm	
	31	Required Flow Capacity		*	
	32	Mol. Wt.	Oper S.G.	*	*
	33	Oper. Pressure, kg/cm2(g)		**	
	34	Oper. Temp.°C Rel. Temp.°C		**	
	35	Valve Discharges to		Atm.	
	36	Back Press. Const. Or Variable		Atm.	Constant
	37	Set Pressure, kg/cm2(g)		*	
	38	Cold Bench Test Pressure		*	
	39	% Over Pressure	% Blow Down	20	*
	40	Cp/ Cv	Compressibility Factor	*	1*
	41	Viscosity at Rel. Temp. (cP)		*	
	42	Vess. : Wall Temp.°C	Surf. Area-m2	*	*
Orifice	43	Calculated Area-inch2		*	
	44	Sel. Area-inch2	Orifice Design	*	*
	45	No. of Valves Reqd. for capacity		1 *	
	46	Total Area-inch2		*	
	47	Actual Flow Capacity Nm3/hr		*	
Others	48	Model No.		*	
	49	Radiography		Reqd. (100%)	
	50	IBR Certification		NR	

* : Vendor to confirm (VTC), ** Refer Process data mentioned elsewhere

Notes:

1. (*) Vendor to Furnish / Confirm
2. Vendor shall furnish sizing calculations to support his valve selection.
3. Valves shall be 100% radio-graphed
4. Vendor to consider coefficient of discharge de-rated by a factor of 0.9 as per ASME – VIII
5. For safety valve sizing, furnish certified capacities as per API-520.

GAIL INDIA LIMITED

DATASHEET

FOR

PRESSURE GAUGES

GAIL-STD-IN-DOC-DS-004

0	05.02.2019	Issued for Bid	RKS	AP	JR	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Pressure Gauges (Typical)			
UNITS : Flow: Liquid m3/hr, Gas-Sm3/hr, Steam-Kg/hr, Pressure: Kg/Cm²g, Temperature: Deg C, Level/Length: mm			
1	Type		Direct
2	Mounting		Local
3	Dial size		150 mm (approx)
4	Colour		White with black numerals.
5	Case Material		Die-cast Aluminium
6	Bezel ring		Screwed
7	Window material		Shatterproof Glass
8	Enclosure		Weatherproof to IP-65
9	Pressure Element		Bourdon
10	Element material		SS 316
11	Socket material		SS 316
12	Accuracy		±1% OF FSD
13	Zero adjustment		Micrometer pointer
14	Connection & Connection location		½" NPTM Bottom entry
15	Movement		SS 304
16	Diaphragm seal Type		Not required
17	Wetted parts marl		
18	Process conn size & rating		
19	Facing and finish		
20	Capillary material		
21	Flushing/filling connection		
22	Over range protection		Required
23	Blow out protection		Yes
24	Options		
	a	Snubber	
	b	Gauge saver	
	c	Syphon	
	d	Liquid filled casing	
	e	Solid front	
	f	2 way, 3 valve manifold	Required

Tag No	Range	Operating pressure	Maximum pressure	Maximum Temp ° C	Fluid	Service	Options
Vendor to provide as per EDB, P&ID and other tender documents							

* : Vendor to confirm (VTC)

Notes:

1. Range shall be selected in such a way that operating pressure shall be in middle of one third of range. If maximum pressure is above than range, gauge saver shall be provided. However, if the range is specified in the process data sheets, same shall be followed.
2. Solid front type shall be provided for the gauges above 60 kg/cm² g operating pressure.
3. Over range protection shall be suitable for maximum pressure or 130% of range, whichever is higher.

GAIL INDIA LIMITED

DATASHEET

FOR

PRESSURE INSTRUMENTS

GAIL-STD-IN-DOC-DS-005

0	05.02.2019	Issued for Bid	RKS	AP	JR	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Pressure Instruments (Typical)

UNITS : Flow Liquid - m3/hr Pressure - Kg/cm2 G Temperature - Deg C Level/Length - mm

General	1	Function		Transmit and Indicate
	2	Type		Electronic, smart with HART protocol
	3	Case		Manufacture standard
	4	Mounting		Yoke (2" NB Pipe mounting)
	5	Electrical area classification		IEC Zone-1, GR IIA/IIB, T3
	6	Enclosure		WP to IP-65
	7	Hazardous area protection		Intrinsically safe
	8	Air Supply		N/A
	9	Power Supply		
	10	Cable Entry		½" NPTF (two no.)
	11	Accuracy		±0.075% of calibrated span (±0.04% for custody transfer application) (including linearity, hysteresis & repeatability)
	12	Make and model no.		*
Transmitter	13	Output		4-20 mA DC (Note-2 & 3)
	14	Transmitter Power supply		24 V DC (Two Wire)
Controller	15	Out put		
	16	A/M Switch		
	17	No of Positions		
	18	Set point Adjustment		
	19	Manual regulator		
	20	Mode		
	21	Chart		
	22	Chart Drive		
	23	Moving parts Material		
	24	Chart Speed		
Measuring Unit	25	Service		Pressure measurement
	26	Element		Silicon resonant/Capacitance type Diaphragm
	27	Body Material		Carbon steel / Aluminium
	28	Element Material		SS 316
	29	Process Connection		½" NPTF
	30	Process connection location		Bottom entry
	31	Diaphragm Seal		N/A
	32	Static Pressure Rating		100 Kg/cm2
Options	33	a	3-valve manifold	Required
		b	Integral orifice	
		c	Air filter Regulator	
		d	Intrinsically safe O/P meter (LCD type)	Required
		e	Mounting Accessories (Bracket, U Bolts & Nuts suitable) for 2" pipe mounting	Required

Tag no	Operating Pressure	Maximum Design pressure	Maximum Design Temperature	Range		Fluid	Service	Remarks
				Span	Set			
Refer Process data attached else where								

* : Vendor to confirm (VTC)

Notes:

1. Transmitter shall be suitable for external loop resistance of at least 600 ohms when powered with 24 V DC from Control panel/ Control Room.
2. Output 4-20 mA shall be superimposed on digital signal with HART Protocol (for control room mounted flow computer systems).
3. Digital communication shall be possible with hand held communicator.

4. Integral intrinsic safe output meter (LCD type) shall be provided for all transmitters.
5. Over range protection shall be suitable for maximum pressure or 130% of range, whichever is higher.
6. CCOE approval certificate shall be provided for transmitter.
7. Equipment shall be protected for the case of full pressurization in one side and with no pressure on the other with equalizing valve in closed condition.
8. Set/Calibrated range shall be selected in such a way that range shall cover the operating pressure between 80 to 20 percentage of manufacturer's span range.

GAIL INDIA LIMITED

DATASHEET

FOR

RECEIVER INDICATOR INSTRUMENTS

GAIL-STD-IN-DOC-DS-006

0	05.02.2019	Issued for Bid	RKS	AP	JR	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Receiver Indicator Instruments (Typical)

UNITS : Flow Liquid - m3/hr, Gas– Sm3/hr, Steam – Kg/hr, Pressure - Kg/cm2 G, Temperature - Deg C, Level/Length - mm

General	1	Function	Indication
	2	Type	Microprocessor based
	3	Case	*
	4	Mounting	Flush Panel
	5	Enclosure	General Purpose
	6	Enclosure Class:	
	7	Electrical Area Class:	
	8	Air Supply:	
	9	Power Supply	*
	10	Power for Transmitter	24V DC
	11	Input	4-20mA
	12	Accuracy:	± 0.1%
	13	Repeatability:	± 0.05%
Controller	14	Controller Location	
	15	Output	
	16	Set point Adjustment	
	17	Configuration	
	18	A/M Switch	
	19	Manual Regulator	
	20	Control mode	
Integrator	21	No. of AI (4-20mA)	06 (maximum permitted)
	22	Type of Display	LCD
	23	Unit	Selectable

Tag no	No. of Points		Scale Graduation	Chart Graduation	Multiplying factor	Control Mode	Control Action	Service	Options
	Record	Indicate							
Refer Process data attached else where									

* : Vendor to confirm (VTC)

Notes:

1. Indications shall be bar Graph Indication.
2. Alarm indication shall be provided for malfuction of indicator, power supply failure.
3. LED display of analog values and other parameters shall be provided.
4. Indicator shall have 6 point (maximum) indication scrolling type.

GAIL INDIA LIMITED

DATASHEET

FOR

TEMPERATURE GAUGES

GAIL-STD-IN-DOC-DS-007

0	05.02.2019	Issued for Bid	RKS	AP	JR	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Temperature Gauges (Typical)

UNITS : Flow Liquid - m3/hr, Gas– Sm3/hr, Steam – Kg/hr, Pressure - Kg/cm2 G, Temperature - Deg C, Level/Length - mm

General	1	Type	Bi-Metallic
	2	Well	Required
	3	Mounting	Direct
	4	Dial Size	150 mm (approx)
	5	Colour	White with Black Marking
	6	Case Material	SS 316
	7	Window Material	Glass
	8	Connection Location	All Angle Rotable
	9	Accuracy	±1% of FSD
	10	Enclosure	Weather Proof
	10.1	Enclosure Class	IP65 as per IEC 60529
	11	Zero Adjustment Screw	External Zero Adjustment
Bi-Metal	12	Stem type	Adjustable Union
	12.1	Material	SS 316
	12.2	Size	½ NPT (M)
	13	Stem Diameter	To suit well
	14	Zero Adujstment	
Filled System	15	SAMA Class	
	15.1	Compensation	
	16	Bulb Type	
	16.1	Bulb Material	
	16.2	Bulb Union Threaded to	
	16.3	Bulb Extension Type	
	16.4	Bulb Dia.	
	17	Capillary Material	
	18	Armour Flexible	
	19	Armour Material	
	20	Capillary Length	
	21	Over Range Protection	130% of Range
Thermowell	22	Material	SS316
	23	Construction	Drilled Bar Stock
	24	Process Connection	11/2" Flanged
	25	Gauge Connection	
	26	Thermowell As Per Drawing	
	27	Options	
	27.1	Liquid filled Casing	Required
	27.2		
	27.3		

Tag no.	Range	Temperature		Well Dimension		Flange		Service	Options
		Normal	Maximum	U	T	Material	Rating, Facing, Finish		
**	*	**	**	*	*	*	*	*	
Vendor to provide as per EDB,P&ID and other Tender documents									

* : By Vendor, ** : Refer Process Data mentioned elsewhere

Notes:

1. OPERATING TEMPERAURE SHALL BE WITH IN 40-60% RANGE. RANGE SHALL COVER MINIMUM AND MAXIMUM

GAIL INDIA LIMITED

DATASHEET

FOR

TEMPERATURE TRANSMITTER

GAIL-STD-IN-DOC-DS-008

0	05.02.2019	Issued for Bid	RKS	AP	JR	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

RTD with Temperature Transmitters (Typical)

UNITS : Flow Liquid - m3/hr, Gas– Sm3/hr, Steam – Kg/hr, Pressure - Kg/cm2 G, Temperature - Deg C, Level/Length - mm

1	Function	Transmit and Indication	24	Sheath Material	SS 316
2	Type	Electronic, Smart	25	Nipple & Union Material	Cadmium Plated Carbon Steel
3	Case	Manufacturer Standard	26	Number of wires for TT	4 Wires(for RTD input) and 2 wires for output
4	Mounting	Transmitter Remote Mounted	27	Head Cover Type	Screwed Cap & SS Chain
5	Electrical area Classification	IEC Zone-I, Group II A/II B, T3	28	Head Material	Cast Aluminium
6	Enclosure	Weatherproof	29	Cable entry	½" NPTF
7	Enclosure Class	IP-65 As Per IS-13947	30	Number of Entries	*
8	Intrinsically safe	Yes Required	31	Enclosure Type	Weatherproof to IP-65 As Per IS-13947
9	Power supply	24 VDC	32	Thermowell	Required
10	Cable Entry	½" NPTF (2 no:s)	33	Material	SS 316
11	Accuracy	± 0.15 % of FSD	34	Construction	Drilled Barstock
12	Repeatability	± 0.05% of FSD	35	Process Connection	1 ½' Flanged
13	Transmitter Output	4~20 mA	36	Instrument Connection	½" NPT
14	Transmitter Power Supply	4 V DC (2 wire)	37	Thermowell	*
15	Service	Temperature Measurement	38	Make	
16	Element	4 wire RTD Class A type	39	Model No.	
17	Assembly	*	40		
18	Number of Elements	Single			
19	Calibration	As Per DIN 43760/IEC-60751-2			
20	Element Material	Platinum			
21	Resistance at Zero Degree Centigrade	100 Ohms (PT-100)			
22	Leads	Mineral Insulated			
23	Sheath O.D.	6.0 mm			

Tag no.	Element Length (mm)	Temperature		Well Dimension		Flange		Service	Location	Range Set
		Normal	Maximum	U	T	Material	Rating, Facing, Finish			
Vendor to provide as per EDB,P&ID and other Tender documents										

* : By Vendor

Notes:

1. Calibration Range shall be –30 to 70 deg C for all line mounted temperature instrument.
2. CCOE approval certificate is required for temperature transmitter.
3. LCD type intrinsic safe Integral output meter shall be provided for all temperature transmitters.
4. Output 4- 20 mA DC shall be super imposed on digital signal with HART Protocol(For CR mounted FC Skid).

GAIL INDIA LIMITED

DATASHEET

FOR

DRY GAS FILTER

GAIL-STD-IN-DOC-DS-009

0	05.02.2019	Issued for Bid	RKS	AP	JR	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Dry Gas Filter

UNITS : Gas Flow - SCMD , Liquid Flow - m3/hr , Steam Flow – Kg/hr , Pressure - Kg/cm2g , Temperature – Deg C , Level / Length - mm

General	1	Tag No.				
	2	Line Size & Sch		*	*	
	3	Inlet Size, Class	Out let size, Class	*	*	
	4	Service		Removal of Dust Particles		
	5	Quantity		02 nos. of dry gas filter per skid		
	6	Vendor		*		
Service Conditions	7	Filter Separator Type		Horizontal Cartridge filtration		
	8	Fluid	State	Natural Gas	Gas	
	9	Oper S.G.	Mol. Wt.	**	**	
	10	Cp / Cv	Compress. Factor	*	**	
	11	Flash %	Viscosity cP (Op)	*	**	
	12	Flow Gas - Minimum / Normal / Maximum		**	**	**
	13	Operating Pressure	Operating Temperature	**	**	
	14	Gas Composition (including Liquid Contaminant)		**		
	15	Dust Content		0 - 0.1 mg/dm3		
	16					
Design	17	Design Code	Design Class	ASME SEC.VIII DIV-I	*	
	18	Design Pressure	Design Temperature	**	**	
	19	Corrosion Allowance (For CS parts)	Corrosive/ Toxic Component	2.0 mm	**	
	20	Liquid & Dust Particles / Mesh Size (Micron)	Filtration Efficiency (Liquid & Solid particles larger than 3 microns)	3 Micron	99%	
	21	Pr. Drop Clean (Max)	Pr. Drop – Dirty (Max)	0.10*	0.20*	
	22	Dust Content		0.1 mg/dm3		
	23	MOC of Filter Element	Make	* Fibre Glass media / Polyester to suit Provided gas composition	*	
	24	OD X Length	Nos of Cartridges	*	*	
	25	Element Bursting Pressure	Flow Direction	2.0	Outside to Inside	
	26	Flange Type	Flange Rating & Finish	WNRF	** , Smooth	
	27	Fixing Details	Nuts & Bolts / Studs	*	*	
	28	PSV Size	DPT Size	*	*	
	29	Vent Size	Drain Size	*	*	
	30	Utility Connection requirement	UC Size	Required		
	31	Head Connection		QOEC with Davit arm required (for Shell/ Flange above 10" dia); Blind Flange with Davit Arm, Nuts & Studs / Bolts required (for Shell/ Flange of sizes up to 10")		
	32	Capacity		i) the maximum flow rate (as per process/ design data indicated elsewhere)		
Dimensions	33	Overall Length	Overall Height	*	*	
	34	Shell Dia		*		
	35	Empty Weight (Kg)	Operating Weight (Kg)	*	*	
	36					
Material of Construction	37	Shell	Shell Flange	SA515/ SA 516 Gr. 60/70 / SA 106 Gr B	SA 105	
	38	Nozzle	Nozzle Flange	SA 106 Gr. B	SA 105	
	39	Head	Head Flange	*	SA 105	
	40	Bolts / Studs	Nuts	SA 193 Gr. B7	SA 194 Gr. 2H	
	41	Gaskets	O Ring	CAF, IS:2712 Gr. 0/1	BUNA `N'	
	42	Supports		SA 283 Gr. C/ IS:2062	*	
	43					
Accessories to be Provided	44	QOEC, Davit Details (with make and model)		*		
	45	Companion Flange, Blind , Flange , Gaskets , Bolts / Studs , Nuts for All Nozzles		Yes		
Inspection & Testing	46	Hydrostatic Test	Radiography	@ 150% Design Pressure	Full (100%)	
	47	Dye Penetration Test	Post Weld Heat Treatment	YES	YES	
Others	48	Painting		Suitable for Corrosives Marine Environment		

* : By Vendor, "** : -From process data

Notes:

1. All C S parts weld joints to be stress relieved. Hardness in welds not to exceed 200 BHN.
2. Gas Composition & Quality is as per Process Data Sheet.
3. QOEC with Davit arm for top/end cover opening to be provided as per requirement for shell/flange of 10" and above dia.
4. Filtration area should be minimum 8 times of inlet nozzle area.
5. Fire case PSV of suitable capacity shall be provided on each dry gas filter.
6. Proper support, cross over and platform required for maintenance of filter, PSV, DPT etc.

GAIL INDIA LIMITED

DATASHEET

FOR

INTRINSIC SAFETY BARRIERS

GAIL-STD-IN-DOC-DS-010

0	05.02.2019	Issued for Bid	RKS	AP	JR	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Intrinsic Safety Barrier (Active) (Analog Inputs)		
1	Function	To limit the transfer of energy to hazardous area.
2	Hazardous area (Field)	IEC Zone 1 Gr. IIA & IIB
3	Location of Barriers	Metering Control Panel (Safe Area)
4	Type	Isolating three port for input, output and Power Supply
5	Power Supply source	External Power
6	Nominal Voltage of Operation	24V DC
7	Signal type	4-20mA
8	Cable type	0.5mm² shielded (7 stranded of dia 0.3mm)
9	Cable Resistance	39.7 Ω/Km
10	Cable L/R ratio	25 µH/Ω
11	Cable Capacitance	400 pf/m
12	Maximum fault voltage	250 V (rms)
13	Certifications	Approved certificate from recognised statutory body
14	Suitability	Smart transmitter with HART protocol
15	Mounting accessories	Required (for mounting on panel back)
16	Make	By vendor
17	Model	By vendor

Note:

1. The barrier model no. shall be offered suitable for HART protocol (4-20mA) analog signal with digital superimposition. Isolating barrier shall be with dual 4-20mA output.

Intrinsic Safety Barrier (Active) (Digital Inputs)		
1	Hazardous area (Field)	IEC Zone 1 Gr. IIA & IIB
2	Location of Barriers	Metering Control Panel (Safe Area)
3	Response time	50ms (Maximum)
4	Power Supply source	External Power
5	Nominal Voltage of Operation	24V DC
6	Contact rating	2A @ 24V DC
7	Number of channels	One, fully floating
8	Number of changeover contacts	Two
9	Mounting accessories	Required (for mounting on panel back)
10	Make/Model	To be provided by vendor

Note:

1. Entity parameters of field instruments shall be finalised during detailed engineering. Proper selection of barriers is vendor's responsibility.

Signal Isolators/Distributors		
1	Input	4-20 mA DC (2-wire)
2	Output	4-20 mA DC Isolated (2 nos.)
3	Driving Capacity	750 ohms (min)
4	Isolation	Between Input & Output and between I/O & Power supply
5	Mounting	Panel back (Isolator to be supplied with mounting accessories)
6	Power supply	24V DC
7	Power ON indication	LED on Front Module
8	Transmitter Power supply	24V DC
9	Accuracy	± 0.1 %
10	Make	MTL/P&F
11	Model No.	By Vendor

Note:

1. Isolators shall be completely wired and installed.

GAIL INDIA LIMITED

DATASHEET

FOR

LEL DETECTOTS/ TRANSMITTERS

GAIL-STD-IN-DOC-DS-011

0	07.02.2019	Issued for Bid	RKS	AP	JR	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

LEL DETECTORS/TRANSMITTERS		
1	Type	Infra-red type
2	Gas to be sensed	Hydrocarbon (Note-1)
3	Material of Construction	Metallic body / Casing Including terminal box
4	Protection	Flame proof or Intrinsically safe certificated suitable for mounting in Zone-1, Gas Gr. IIA, IIB Temperature Class T3 as per IEC and weatherproof to NEMA 4 or IP 65. Necessary splash deflector/quard and dust filter shall be provided
5	Range	0 ~ 100 % LEL
6	Immunity to catalytic poisoning	Required
7	Temperature Compensation	Required
8	Output	4-20 mA DC (Linear with LEL Detection)
9	Power Supply	24V DC from monitor in Metering Control Panel. However at IP Stations, 24V DC from RTU panel,
10	Type of wiring	3 wire system
11	Accuracy	± 2 % LEL
12	Response Time	2 seconds (vendor to confirm)
13	Sensor Life	5 Years minimum
14	Self-Diagnostic facility	Required for both detector fault and dirty optics
15	Fail Safety	Required
16	Mounting Accessories	Required for surface Mounting
17	Cable Entry	Proper cable entry with internal terminal block shall be provided. Flying leads are not acceptable. (Note-2)
18	Quantity	Minimum 6 nos.
19	Model Number	i) LEL Detector* ii) Transmitter*

'*" : By Vendor

Notes:

1. Operating Fluid Composition shall be as per process data sheet.
2. If the external junction box is required, the same shall mate directly with Infra-red detector. Junction boxes shall be weatherproof to NEMA 4 or IP65 and Flame proof (If Flame proof LEL Detectors/transmitters are offered) certified suitable for mounting in Zone-1, Gas Gr. IIA, IIB temperature Class T3 as per IEC.

GAIL INDIA LIMITED

DATASHEET

FOR

LEL MONITOR

GAIL-STD-IN-DOC-DS-012

0	07.02.2019	Issued for Bid	RKS	AP	JR	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

LEL MONITOR		
1	Type	Microprocessor based with indicator
2	Mounting	Rack mounting, rack shall be suitable for flush panel mounting on Metering Control Panel.
3	Number of Channels per Module	Single (1 Sensor per Module)
4	Construction	Plug in modular type to allow for removed of individual units without disturbing the system wiring
5	Calibration/Test Switch	Required, which when put in calibration mode inhibits operation of alarm outputs, enable checks for alarm LEDs and reference level, and also permits access to meter fine zero, meet span and alarm level controls.
6	Total Number of Modules	Minimum 6 nos.
7	Alarm Settings (Shall be adjustable over the full range)	1st Alarm set at 20% LEL 2nd Alarm set at 60% LEL
8	Malfunction Alarm	Required for sensor defects, broken contacts, line breakage, shot circuit, earth fault and over range.
9	Alarm Lights	Required
10	Indicator Lights on the module (separate for each channel)	i. Malfunction warning (per channel) ii. Power ON iii. Calibration Mode, test Mode iv. 20% LEL of rising concentration (per channel) v. 60% LEL of rising concentration (per channel)
11	Power Supply	230V AC ± 10%, 50 Hz ± 3% UPS.
12	Alarm Acknowledge, Test, Reset Push buttons	Required
13	Repeatability	± 1% of Full scale
14	Maximum allowable loop resistance	By vendor
15	Make/Model Number	*

'*" : By Vendor

Notes:

1. Removal of an individual module should not disturb the functioning of the other module in the system. Also calibration of individual detectors of each module shall be possible without affecting the operation of the other detectors associated with that module.
2. Vendor shall provide common potential free contacts combining all channels/sensors corresponding to the following parameters with rating 24V DC, 2A.
   a) Common 20% LEL alarm
   b) Common 60% LEL alarm
   c) Common malfunction alarm

   Common alarms shall be wired to the annunciator in the Metering Control Panel.

GAIL INDIA LIMITED

DATASHEET

FOR

RECEIVER CONTROLLER INSTRUMENTS

GAIL-STD-IN-DOC-DS-013

0	07.02.2019	Issued for Bid	RKS	AP	JR	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Receiver Controller Instruments (Typical)

UNITS: Flow Liquid: m*3/hr; Gas: Sm3/hr; Steam: Kg/hr; Pressure: Kg/cm*2 G; Temperature: Deg C; Level/Length: mm

General	1	Function	Control
	2	Type	Microprocessor based
	3	Case	6" x 3"
	4	Mounting	Flush Panel
	5	Enclosure	General Purpose
	6	Enclosure Class	
	7	Elec. Area Class	
	8	Air Supply	
	9	Power Supply	230 V AC, 50Hz
	10	Power for Transmitter	24V DC
	11	Input	4-20mA
	12	Accuracy	± 0.1%
	13	Repeatability	± 0.05%
Controller	14	Controller Location	Integral
	15	Output	4-20mA
	16	Set point Adjustment	Required
	17	Configuration	Required
	18	A/M Switch	2-Position
	19	Manual Regulator	Mfr. Standard
	20	Control mode	PID
Recorder	21	Chart	
	22	Chart Drive	
	23	Chart Rewinding Cycle	
	24	Chart Speed	
Integrator	25	Form	
	26	Number of Digits	
	26.1	With Reset	
	26.2	Without Reset	
Options	29	Serial link to RU/SCADA for monitoring and set point control	Required
	30	In built selector switch for accessing either of two 4-20mA input signals	Required
Control Modes	P	- Proportional	1 – 500%
	IS	- Integral Slow	0.005 rep/min
	IF	- Integral Fast	100 rep/min
	DS	- Derivative Slow	0.2 min
	DF	- Derivative Fast	100 min

Tag No.	No. of Points		Scale Graduation	Scale Graduation	Multiplying factor	Control Mode	Control Action	Service	Options
	Record	Indicate							
**		*	*				PID	**	A, B, Note-9

'*" : By Vendor; ** - Refer Corresponding Transmitter data sheets

Notes:

1. Scan Time shall be 500msec.
2. Continuous indications for set point, controlled variable and process variable shall be provided along with the operating mode.
3. Memory of the controller shall be retentive or volatile with battery backup.
4. Following operational features shall be provided. Reverse/direct selection, anti-reset wind up, fluck, close, open, freeze on controller failure configuration.
5. Self-diagnostic shall be provided with alarm indication.
6. This accuracy is an overall accuracy including input accuracy of controller and total performance of the controller to get the controlled output. Accuracy of Bar graph indication shall be +/- 2%.
7. The controllers are required to be serially interfaced with the RTU. Serial interface Modbus RS 232 shall be available in each of the supplied controllers and the interface shall be established by the vendor with the RTU for process variable, manipulated variable, remote/local signal & actual signal feedback signal to SCADA and set point download signal from SCADA as minimum. Other details of data required will be provided during detailed engineering.

8. RS-485 Serial connector shall be RJ45/DB-25/DB-9 Type.
9. The function of the PID controller is to limit the flow through metering skid as per local set point or from remote set point received through GSM modem / SCADA.

GAIL INDIA LIMITED

DATASHEET

FOR

TURBINE FLOW METERS

GAIL-STD-IN-DOC-DS-014

0	07.02.2019	Issued for Bid	RKS	AP	JR	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Turbine Flow Meters (Typical)					
UNITS: Flow Liquid: m*3/hr; Gas: Sm3/hr; Steam: Kg/hr; Pressure: Kg/cm*2 G; Temperature: Deg C; Level/Length: mm					
General	1	Tag No.		*	
	2	Line No.		*	
	3	Line size & Sch		**	
	4	Service		Custody Transfer of Natural Gas	
	5				
Meter	6	End Connection: size	Rating	*	*
	7	Facing	Finish	RF serrated	125AARH
	8	Pulses /m3		*	
	9	Flow Range		*	
	10	Enclosure		Weather Proof	
	11	Cable Entry		*	
	12	Material – Body		ASTM A216 Gr WCB or better	
	13	End Connection		Flanged	
	14	Rotor		Aluminium	
	15	Bearing		Stainless Steel	
	16	Other Wetted Parts		Stainless Steel	
	17	Linearity/ Repeatability		Note-1	
	18	Output		HF Pulses (dual)	
Options	19	Mechanical/Digital counter		Required	
	20	Dowel Pin		Required	
	21	Pressure tap from body		Required	
	22	Straightening Vanes		Required	
	23	Meter run(Up & down stream)		Required	
	24	Local counter		Required 8 digit Non	
Service	25	Strainer - Mesh Size			
	26	Pressure Tap on Meter Body		Required	
	27	Lubricator with Accessories		Required	
	28	Roughness in side meter run		Not more than 300 micron	
	29	Cold Insulation			
		a)	On Meter (Jacket type)	Required	
		b)	On Meter tube (UP & Down stream)	Required	
		c)	On Thermowell & Impulse tubing	Required	
	30	Fluid & State		Natural Gas	
Design	31	Flow – Min.	Flow – Max.	**	**
	32	Flow – Normal		**	
	33	Pressure – Operating	Pressure – Max.	**	**
	34	Temp – Oper.	Temp – Max.	**	**
	35	Oper. Visc (cP)	Density (Kg/m3)	**	**
	36	System Pressure Drop		**	
	37	Gas – Mol Wt.		**	
General	38	Compressibility Factor		**	
	39	Cp/CV		**	
	40	Area Classification		IEC ZONE 1 GR IIA, IIB T3	
	41	Make & Model No.- Meter		*	
	42	Transmitter		*	
	43	Pre amplifier		*	

Notes:

"*" By Vendor
"**" As per Process Data

1. Linearity shall be within the envelope of +/-0.5% for flow rates between 20% to 100% of the meter maximum (Qmax) & +/- 1% for flow rate between 5% to 20% of meter maximum (Qmax). At normal pressure, repeatability shall be ± 0.1%.
2. The System Pressure drop includes pressure drop across straightener and Turbine meter.
3. Turbine Meters shall be rated for the maximum design pressure as indicated above.
4. The offered meter must be designed as per AGA7 Specifications and Calibration certificate from the agency approved for custody transfer certification from the country of origin shall be supplied.
5. The Turbine Meter shall be high frequency Pulsar type.
6. Velocity through Turbine Meter shall not exceed 20 m/s.
7. Index Head shall have IP-66 enclosure.
8. For size 3" and above, HF Pulsar shall be provided on meter body. For size 2" Pulsar provided on index head is also acceptable.
9. HF Pulsar shall be used during Wet calibration of Meter.

GAIL INDIA LIMITED

DATASHEET

FOR

LEVEL GAUGES

GAIL-STD-IN-DOC-DS-015

0	07.02.2019	Issued for Bid	RKS	AP	JR	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

LEVEL GAUGES			
General	1	Vendor Scope of supply	Gauge glasses and cocks assembled with nipples and unions
	2	Hazardous Area Classification	Zone-1, Gas Group IIA/IIB,T3
	3	Enclosure Protection	Weather-proof to IP-65
	4	Function	Local Indication
Gauge Glasses	5	Type	Reflex Level Gauge
	6	Chamber Connection	
	7	Type	WNRF
	8	Location	Wet Gas Filtration Chamber
	9	Vent and Drain	½" Plugged and Flanged respectively
	10	Rating	As per rating of KOD (300#)
Material	11	Material	Imported Borosilicate
	12	Chamber	ASTM 105
	13	Cover-Plate	CS
	14	Studs	ASTM A 193 Gr.B7
	15	Nuts	ASTM A 194 Gr.2H
	16	Gaskets	Grafoil
Options	17	Mica Shield	
	18	Illuminator	
	19	Heating Jacket	
	20	Calibrated Scale	Yes (Calibrated Scale – SS)
	21	Non Frost Extn	
	22	IBR Certificate	
	23	Pair of isolation valves	
	24	Safety Feature	Ball Check Valve to be provided to prevent leakage in case of breakage
Illuminator	25	Illuminator	
	26	Power Supply	
	27	Area Class	
	28	Enclosure	
	29	Cable entry	
Heating Jacket	30	Heating Jacket	
	31	Connections	
	32	Inlet	
	33	Outlet	
Cocks	34	Cocks	
	35	Type	Offset
Process Connections	36	Type of Connection	
	37	Vessel/ Process Connection	Flanged WNRF
	38	Gauges	¾" NPT(M) with spherical union *
	39	Vent	½" NPT plugged (AISI 316)
	40	Drain	½" NPT Flanged (AISI 316)
Construction Material	41	Material	
		Body	ASTM A105
		Trim	SS316
		Closing	Quick closing type with ball check
		Bonnet Type	Bolted
		Ball Checks	Yes
		Renewable seats	Yes
Process Conditions		Service Conditions	
		Fluid Handled	HC Condensate plus water
		Operating /Design Temperature	**/** deg Centigrade
		Operating /Design Pressure	**/**
		Liquid Density	**
		Measuring Range	*
Certification		Certifications	Calibration, Hazardous area certificate
		Quantity	2 nos. per wet gas filter

'*" : By Vendor; ** - As per Process Data

Notes:

1. Offered Instruments shall be suitable for corrosive constituents CO2- As per Scope of Work
2. Make and Model No's. to be furnished by bidder for Gail's Approval
3. '*' Vendor to furnish/Confirm
4. Vendor to suggest visible length.
5. Hydro test pressure 1.5 times the design pressure.

GAIL INDIA LIMITED

DATASHEET

FOR

FLOW CONTROL VALVES

GAIL-STD-IN-DOC-DS-016

0	07.02.2019	Issued for Bid	RKS	AP	JR	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

FLOW CONTROL VALVES

UNITS : Gas Flow - MMSCMD, Liquid Flow - m3/hr , Steam Flow – Kg/hr , Pressure - Kg/cm2g , Temperature – Deg C , Level / Length - mm

General	1	Tag No.					
	2	Inlet Line No.			Skid Mounted		
	3	Outlet Line No.			Skid Mounted		
	4	Service			Natural Gas		
	5	Line Size	Sch.		*	*	
	6	Inlet Line I.D.	Outlet Line I.D.				
Body	7	Type of Body			Globe		
	8	Body Size	Port Size		Same or higher than meter size	Full port	
	9	Guiding	No of Ports		*	*	
	10	End Conn : Flgd. Size & Rating			*	*	
	11	Facing & Finish			RF 125 AARRH	RF 125 AARRH	
	12	Body Material			ASTM A216 Gr WCB		
	13	Bonnet Type			Plain		
	14	Packing Material			Teflon		
	15	Lubricator	Isolation Valve				
	16	Trim Form			Equal Percentage		
	17	Trim Matl.Plug/Disc/Ball/Seat			SS 316 Stellited		
	18	Other Wetted Parts			SS 316		
	19	Soft Seating	Material				
	20	ANSI Leakage Class			Class IV		
Actuator	21	Type			Spring &Diaphragm		
	22	Close At	Open At		*	*	
	23	Failure Position			FO		
	24	Hand wheel Position			Yes (Side Mounted)		
Positioner	25	NG Supply Pressure			*		
	26	Input	Output		0.2 - 1.0 kg/cm2		
	27	Bypass	Gauge		Note - 1	Three	
Options	28	Solenoid Valve					
	29	I/P Converter (Suitable for NG)			Required		
	30	Filter With Gauge			Required , Two Sets		
	31	Limit Switch/ Proximity Switch					
Service Conditions	32	Fluid	State		Natural Gas	Gas	
	33	Flow Liquid Min	Normal	Max			
	34	Flow Gas - Min	Normal	Max	10% of capacity	75% of capacity	100% of capacity
	35	Flow Water Min.	Normal	Max			
	36	Inlet Pr. Min.	Normal	Max	PDS	PDS	PDS
	37	MAX. D.P@Min. normal & max. Flow.			*	*	**
	38	Delta Pr. Shut Off			*		
	39	Temp. ° C Oper.	Maximum		PDS	65	
	40	Oper. S.G.	Mol. Weight		*	*	
	41	CP/ CV	Compressibility Factor		**	**	
	42	Flash %	Visc. (CP)		**	**	
	43	Deg. of Superheat % Solids					
	44	Vapour Pr.	Critical Pressure				
	45	% Opening Min/Nor/Max.			*	*	*
	46						
Valve Data	47	Cv. Min.	Cv. Max.		**	**	
	48	Cv. Nor.	Selected Cv		**	**	
	49	Predicted Sound Level DBA			< 85 dBA		
	50	Inlet Velocity m/sec			*		
Model Nos.	51	Valve	Actuator		*	*	
	52	Positioner/I/toPconverter	Solenoid Valve		*	*	
	53	High Pressure gas supply trains					
	54	100% Radiography			Required		

'*" : By Vendor; ** - As per Process Data

Notes:

1. By Pass is required if Input is equal to Output
2. Natural Gas Contains CO2 : As per composition given in scope of work.
3. Permissible Maximum Diff Pressure across the flow control valve is 0.3 kg/cm2.
4. Size of FCV shall be same as Meter size/PRS Outlet size(whichever is higher). FCV shall be full port and shall be provided with low bleedpositioner.

GAIL INDIA LIMITED

DATASHEET

FOR

ROTARY POSITIVE DISPLACEMENT (RPD) FLOW METERS

GAIL-STD-IN-DOC-DS-017

0	07.02.2019	Issued for Bid	RKS	AP	JR	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Rotary Positive Displacement (RPD) Flow Meters (Typical)			
UNITS: Flow Liquid: m*3/hr; Gas: Sm3/hr; Steam: Kg/hr; Pressure: Kg/cm*2 G; Temperature: Deg C; Level/Length: mm			
General	1	Tag No.	*
	2	Line No.	*
	3	Line size & Sch	**
	4	Service (Fluid)	Custody Transfer of Natural Gas
	5	Application Standard	OIML/EEC/EN standard
	6	G Size	G25/ G40/G65/G100 *
Meter	7	End Connection	2" /3" /4" Flanged, ANSI 125#/300#
	8	Max. Flow Rate	*
	9	Accuracy (including lab uncertainity)	+/-2% in the range Qmin to 0.2 Qmax +/- 1% in the range 0.2 Qmax to Qmax
	10	Rangebility	100:1 in 1% Accuracy range 160;1 in 2% Accuracy range
	11	Intrinsic Safety	Required
	12	Temperature Range	-20 Deg C to +50 Deg C
	13	Max. Working Pressure (bar)	18.0 Bar Abs for 150#/ 49.0 Bar Abs for 300#
	14	Pressure Tapping	Inbuilt; to be provided.
	15	Thermo-well	Inbuilt; to be provided.
Service	16	Lubrication provision	Required while meterin service.
	17	Facing & Finish	RF serrated/ 125AARH.
	18	Flow Direction	To be marked on body.
	19	Pulse output	Atleast 1No. LF and 1 No. HF (in the meter body).
	20	Pulses /m3	*
	21	Enclosure protection	Weather Proof, IP65
	22	Material - Body	Corrosion resistant Aluminum/ Steel
	23	Rotor	Aluminum/ Steel
	24	Bearing	Stainless Steel
	25	Other Wetted Parts	Stainless Steel /suitable for the service
	26	Oper. Visc (cP)/Density (Kg/m3)	**
	27	System Pressure Drop	**
	28	Gas - Mol Wt.	**
Index Important	29	Compressibility Factor	**
	30	Cp/CV	**
	31	Area Classification	IEC ZONE 1 GR IIA, IIB T3
	32	Volume Totalizer	Mechanical OR Digital Counter
	33	Max Index Reading	8 digit index NON RESETABLE (999999.99)
	34	Unit	M3
	35	Transmitter	1 LF and 1 HF Transmitter
	36	Manufacturer Calibration Certificate	To be Supplied along with each meter
	37	Warranty Certificate	To be Supplied along with each meter
	38	Operation And Maintenance Manual	To be Supplied along with each meter
	39	Make offered	*
	40	Model Offered	*

Notes:

"*" By Vendor
"**" As per Process Data

1. Meter shall be rated for the maximum design pressure as indicated above.
2. The offered meter must be designed as per OIML Specifications (OIML – R6/R32/TC8/SC8) and EN Standard EN-12480.
3. The RPD Meter shall have 2 nos. of pulse/ frequency output for flow computer interface (1LF and 1HF).
4. Velocity through the RPD Meter restricted to 20 m/s. rating shall be same as upstream pipe rating. Bidder to provide suitable adapter if required to meet the above mentioned end connection requirement.
5. Type approval for custody transfer application from weights and measures approved laboratories, such as NMI, PTB, Measurement CANADA, NIST or other reputed national standard laboratory such as PIGSAR, TRANS CANADA Calibrations (TCC) CANADA, COLORADO Engineering experiment station INC.(CEESI) USA ,SOUTH WEST RESEARCH INC. (SWRI) USA shall be submitted.
6. Lubricator pump with lubricant for first fill to be supplied by bidder.
7. Bidder to provide suitable adapter if required to meet the above mentioned end connection requirement.

8. For each RPD meter, Bidder to provide calibration certificate performed with air at atmoshpheric pressure and ambient temperature at following flow rates: 0.01 Qmax, 0.05 Qmax, 0.10 Qmax, 0.25 Qmax, 0.50 Qmax, 0.75 Qmax, 1.0 Qmax.
9. Meter casing shall be tamper proof & corrosion resistant aluminium or steel suitable for outdoor installation.
10. Meter internal shall be non corrosive, tested for low noise, friction less, endurable for 20 years life and external tamper proof.
11. Meter internal shall be non corrosive, tested for low noise, friction less, endurable for 20 years life and external tamper proof.
12. Minimum 10D upstream with flow straightener & 5D downstream shall be provided with meter.
13. Necessary restricted orifice suitable for the respective RPD shall be provided by the bidder.
14. Bidder to include the supply of required length of spool piece with the meters if required.
15. Lubricator pump with lubricant for first fill to be supplied by bidder.
16. Make of RPD shall be as per vendor list attached with bid documents.
17. Vendor shall submit documents as per "vendor data requirements" enclosed.
18. The selected meter shall be suitable for custody transfer.
19. Meter casing shall be tamper proof & corrosion resistant aluminium or steel suitable for outdoor installation.
20. Meter shall be rated for the maximum design pressure as indicated above.
21. RPD meter shall be calibrated by NABL approved Lab.
22. No plastic components shall be used in RPD flow meter.
23. Inbuilt Pressure tap, Thermowell & lubrication provision (while meter is in service) to be provided

GAIL INDIA LIMITED

DATASHEET

FOR

SELF ACTUATING PRESSURE CONTROL VALVE

GAIL-STD-IN-DOC-DS-018

0	07.02.2019	Issued for Bid	RKS	AP	JR	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Pilot operated Self-Actuated Pressure Control Valves								
UNITS: Flow Liquid: m*3/hr; Gas: Sm3/hr; Steam: Kg/hr; Pressure: Kg/cm²g; Temperature: Deg C; Level/Length: mm								
General	1	Tag No.			**			
	2	Inlet Line No.			**			
	3	Outlet Line No.			**			
	4	Line size & Thickness			**			
	5	Service			Downstream pressure regulation			
	6							
Body	7	Type of regulator			Self-Actuated Pilot operated			
	8	Body Size	Port Size		*	*		
	9	End Connection: Flanged. Size & Rating			* and **			
	10	Facing & Finish			RF serrated / 125 AARRH			
	11	Body Material			ASTM A216 Gr WCB or better			
	12	Diaphragm Material			*			
	13	Trim, plug Material			*/SS316 or better			
	14	Other Wetted Parts			SS316 or better			
	15	Leakage Class			CLASS- VI as per ANSI/FCI 70.2			
	16	Impulse Connection			External			
	17	Valve Set Point			**			
	18	Regulation accuracy			2.5% of the set point **(Note 2)**			
	19							
Options	20	Failure position			Open/close **(Note 3)**			
	21	Limit Switch						
	22	Radiography			Required			
	23	Charpy V-Notch Test			Required			
	24	Impulse tubing/ fittings			Required			
	25	Pressure indicator			In the sensing line required			
	26	Installation			Horizontal			
Service	27	Fluid	State		**			
	28	Flow Gas	Nor.	*Max.*	**	**	**	
	29	Inlet Pressure			**			
	30	Pressure Drop at Various Flow rates.			(Note 4)			
	31	Shut Off Pressure			**			
	32	Temp. Oper.	Max.		**	**		
	33	Oper. S. G.	Mol. Wt.		**	**		
	34	Cp / Cv	Compress. Factor		**	**		
Valve	35	Kg or Cg Min.	Kg or Cg Max.		*	*		
	36	Kg or Cg Nor.	Selected Kg or Cg		*	*		
	37	Predicted Sound Level (d BA)			* **(Note 7)**			
	38	Inlet Velocity m/s.			Less than 20 meter / second			
	39							
Model	40	Valve			*			
	41	Pilot			*			
	42							
	43	Quantity			*			

Notes:

"*" By Vendor
"**" As per Process Data

1. Set Point of the regulator shall be adjustable. Vendor shall furnish the adjustable range of the pilot.
2. Accuracy of the pressure regulation shall be better than or equal to 2.5 % of the set pressure for the entire inlet pressure and flow range.
3. Active Pressure regulator valves shall be fail open type. Monitor valves shall be fail close type.
4. Pressure drop across the valve shall be selected by the vendor considering the Maximum Pressure drop permitted across the skid, given set points (staggered set point of the two regulators and the slam shut valves) and the given inlet / outlet pressure conditions.
5. Regulator shall be sized to deliver the maximum flow at minimum pressure condition and the minimum flow at the maximum pressure condition.
6. The Inlet pressure variation is possible for all the flow rates and the PCV to be sized accordingly.
7. In case valve noise level for the worst case of the given process conditions exceeds 85 d BA (flange to flange of the valve) vendor shall provide and include the noise treatment with silencer/ expander.
8. The Pilot shall be supplied suitable for the set point of complete output pressure range. Preferably one pilot shall cater the complete range, however if it is not feasible then additional springs to be provided to cater the complete range.

GAIL INDIA LIMITED

DATASHEET

FOR

SLAM SHUT VALVE

GAIL-STD-IN-DOC-DS-019

0	07.02.2019	Issued for Bid	RKS	AP	JR	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Slam Shut Valves(Typical)							
UNITS: Flow Liquid: m*3/hr; Gas: Sm3/hr; Steam: Kg/hr; Pressure: Kg/cm²g; Temperature: Deg C; Level/Length: mm							
General	1	Tag No.			**		
	2	Inlet Line No.			**		
	3	Outlet Line No.			**		
	4	Line size & Thickness			**		
	5	Service			Downstream pressure regulation		
	6						
Body	7	Type of Valve			Slam Shut		
	8	Body Size	Port Size		*	*	
	9	End Connection: Flanged. Size & Rating			* and **		
	10	Facing & Finish			RF serrated / 125 AARRH		
	11	Body Material			ASTM A216 Gr WCB or better		
	12	Closing time			Less then 2 secs		
	13	Trim, plug Material			*/SS316 or better		
	14	Other Wetted Parts			SS316 or better		
	15	Leakage Class			CLASS- VI as per ANSI/FCI 70.2		
	16	Less then 2 secs			2.5 % of set point		
	17						
Options	18	Pilot operated			yes		
	19	Manual Reset			Required		
	20	Failure position			Close		
	21	Limit Switch			2 Nos. (Open/ Close)		
	22	Valve Position indicator (local)			Required		
	23	Radiography			Required		
	24	Charpy V-Notch			Required		
	25	Impulse tubing/ fittings			Required		
	26	Pressure indicator			In the sensing line required		
	27	Installation			Horizontal body		
	28						
Service Conditions	29	Fluid	State		Natural Gas	GAS	
	30	Flow Gas- Min.	Nor.	Max.		**	**
	31	Inlet Pressure			**		
	32	Pressure Drop at Various Flow rates.			**		
	33	Shut Off Pressure			**		
	34	Temp. Oper.	Max.		**	**	
	35	Oper. S. G.	Mol. Wt.			**	
	36	Cp / Cv	Compress. Factor		**	**	
	37						
Valve Data	38	Kg or Cg Min.	Kg or Cg Max.		*	*	
	39		Kg or Cg Selected			*	
	40	Predicted Sound Level (d BA)			Less then 85 dBA		
	41	Inlet Velocity (meters/second)			*		
	42	Valve set point	Adjustable spring range		*	*	
	43						
Model Nos.	44	Valve			*		
	45	Pilot			*		
	46						
	47						

Notes:

"*" By Vendor
"**" As per Process Data

1. The Pilot shall be supplied suitable for the set point of complete output pressure range. Preferably one pilot shall cater the complete range, however if it is not feasible then additional springs to be provided to cater the complete range.
2. Pressure drop across the Slam Shut Valve shall be decided on the basis of total pressure drop permitted across the complete skid, flow rate and the velocity limit.
3. Maximum permitted seat velocity is 40 meter / sec.

GAIL INDIA LIMITED

DATASHEET

FOR

ULTRASONIC METER

GAIL-STD-IN-DOC-DS-020

0	07.02.2019	Issued for Bid	RKS	AP	JR	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

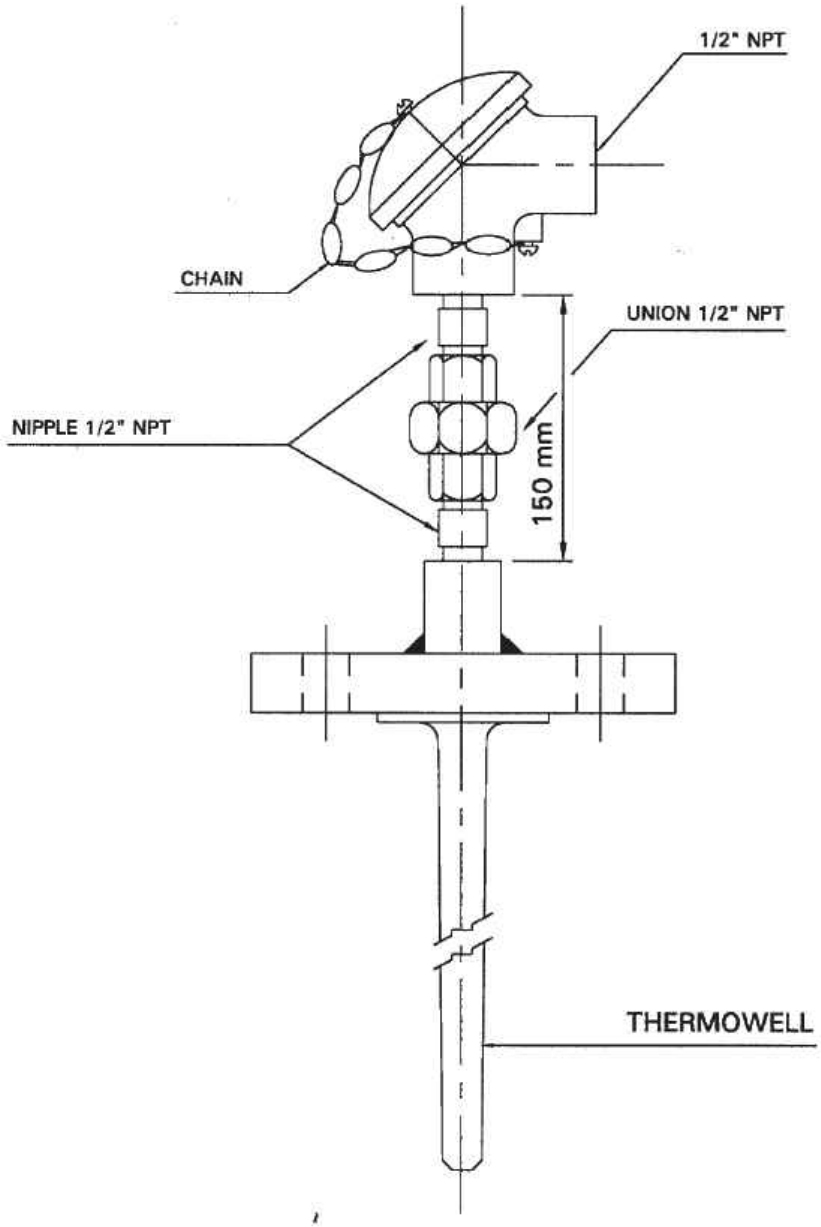
Ultrasonic Flow Meter (Typical)					
UNITS: Flow/ Liquid/ Gas: MMSCMD, Steam: Kg/hr; Pressure; Kg/cm2g; Temperature: °C					
General	1	Tag No.		*	
	2	Line No.		*	
	3	Line Size &Thk./Sch.		*	
	4	Service		Custody Transfer	
	5	Type		MULTIPATH (Minimum 4 path)	
	6				
Meter	7	End Conn.:-Size & Rating		*/ #300	
	8	Facing & Finish		Flanged/ 125 AARH	
	9	Pulses / m3		*	
	10	Flow Range		**	
	11	Enclosure		Weather Proof	
	12	Cable Entry		*	
	13	Material - Body		As per pipe specs *	
	14	Material - End Connection		Flanged, As per Pipe Spec *	
	15	Bi-directional /Unidirectional		unidirectional	
	16	Radiography/Charpy test		Required	
	17	Overall uncertainty (including lab)		±0.3% of Reading (for Qt<Qi<Qmax)	
	18	Repeatability		±0.1% for qt<qi<qmax&±0.2% for qmin<qi<qt	
Pre-amplifier	19	Type - 2 wire / 3 wire		*	
	20	Pre - amplifier location		Meter Mounted	
	21	Power Supply	Cable Entry	From Transmitter	*
	22	Enclosure		WP to IP65/NEMA-4	
	23	Intrinsically Safe| Ex-proof		Flame Proof	
	24				
Transmitter	25	Power Supply	Cable Entry	*	*
	26	Output		Frequency& RS422/485	
	27	Enclosure		WP to IP65/NEMA-4	
	28	Intrinsically Safe| Ex-proof		Flame Proof	
	29	Mounting		Meter Mounted	
Options	30	**Meter runs (Up & Down stream)**		Required	
	31	**Flow Conditioner/ Profiler**		Required	
	32	**Retractable probes**		Required	
	33	**Press. Tap on Meter Body**		Required:- ½" NPT	
	34	**Cold insulation**			
		a)	**On Meter (Jacket type)**	Required	
		b)	**On Meter tube (Up & down stream)**	Required	
		c)	**Thermowell&Impulse tubing**	Required	
Service	38	Fluid & State		**	
	39	Flow – Min.	Max.	**	
	40	Flow - Normal		**	
	41	Pressure - Oper.	Max.	**	
	42	Temp. °C - Min	Oper.¦ Design	**	
	43	Oper. S.G. ¦ Oper.	Oper. Visc. mPa/s(cP)		
	44	System Pressure Drop		**	
	45	Compressibility factor		**	
	46	Gas Density kg/m3	Mol.Wt.		
	47	CP/CV		**	
	48	Total Sulphur| H2S		As per composition in SOW, if not mentioned then assume 4 ppm	
General	49	Area Classification-IEC		ZONE-1,GR.IIA & IIB, T3	
	50	Make & Model No. - Meter		*	
	51		- Transmitter	*	
	52		- Pre-amplifier	*	
	53	Piggable / Non-Piggable		Non-Piggable	

Notes:

"*" By Vendor
"**" As per Process Data

1. Vendor to confirm the meter size. Also furnish sizing calculation for the given process conditions.
2. Vendor to submit certificate, confirming the model suitable for Custody Transfer from the certifying body, mentioned elsewhere.
3. Number of paths to be confirmed by vendor confirming to the performance specifications.
4. Maximum permitted velocity through USM is 20 meters / sec.

5. A qualified flow conditioner and upstream and downstream pipe runs shall be supplied by the meter manufacturer and shall be used during wetcalibration(7 point calibration before adjustment, 2 point verification after adjustment in USM electronics).
6. Straight meter run of 10 ND(Nominal pipe diameter) between upstream of the flow conditioner, 10 ND between flow conditioner and the meterand 5ND downstream of meter shall be supplied by the meter manufacturer and used during wet calibration.

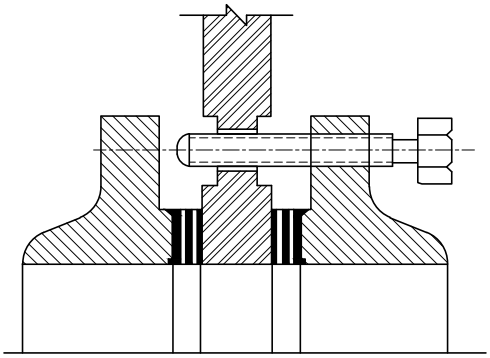


NOTE - IN THE CASE OF DUPLEX THERMOCOUPLE/RTD, TWO INDEPENDENT CABLE ENTRIES SHALL BE PROVIDED.

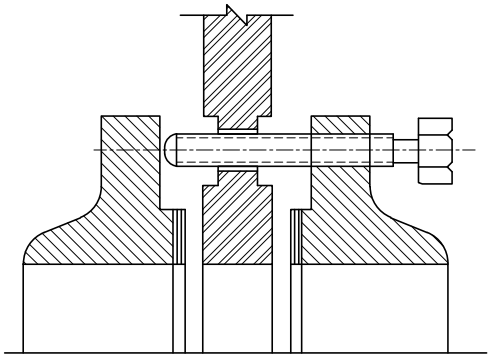
REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED
0	14.03.19	ISSUED FOR TENDER	D.V	U.N	S.B

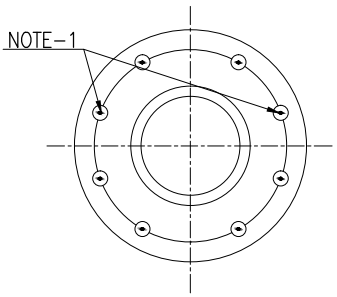
LYONS ENGINEERING PVT. LTD. NEW DELHI	STANDARD JACK SCREW FOR SPECTACLE BLIND (150#, 300#, 600#)	DRAWING NO. GAIL–STD–ME–DOC–TS–001 1 OF 1

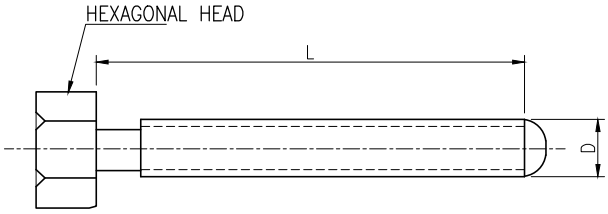
IN OPERATING POSITION



IN JACKING POSITION







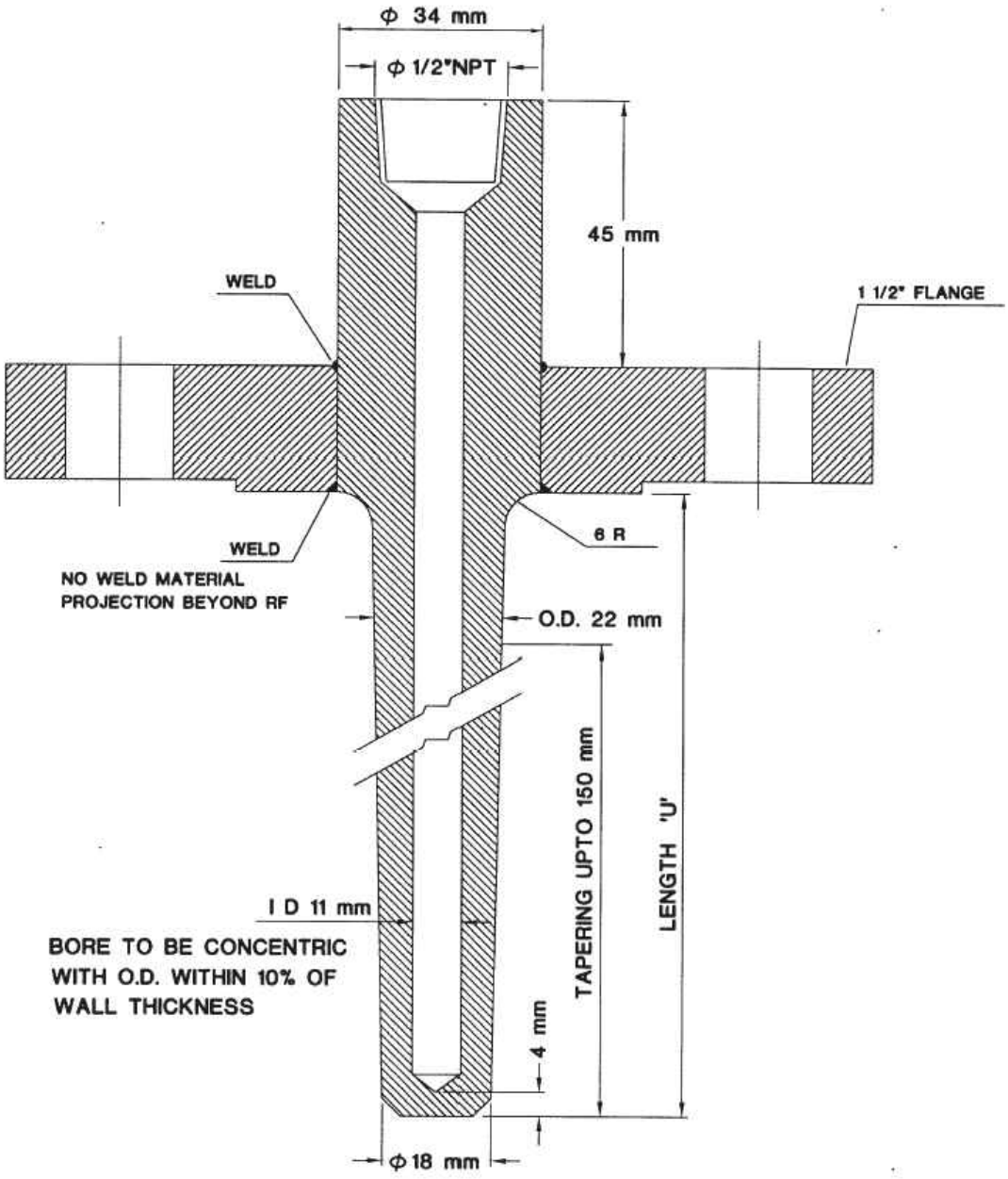
NOS.	150# RF		300# RF		600# RF	
	L	D	L	D	L	D
3"	–	–	–	–	4	3/4
4"	–	–	–	–	4 1/2	3/4
6"	3 1/2	3/4	4	3/4	4 3/4	3/4
8"	3 3/4	3/4	4 1/2	3/4	5 3/4	3/4
10"	3 3/4	3/4	4 3/4	3/4	6	3/4
12"	4	3/4	5 1/4	3/4	6 1/2	3/4
14"	4 1/2	3/4	5 1/4	3/4	6 3/4	3/4
16"	4 1/2	3/4	5 1/2	3/4	7 1/2	3/4
18"	4 3/4	3/4	6 1/1	3/4	8	3/4
20"	5 3/4	3/4	6 3/4	3/4	8 1/2	3/4
24"	5 3/4	3/4	7 1/4	3/4	8 1/2	3/4
26"	5 3/4	3/4	7 1/4	3/4	10	3/4
28"	5 3/4	3/4	7 1/2	3/4	10	3/4
30"	6 1/2	3/4	8	3/4	10 3/4	3/4

NOTES:–

1. DRILLED & TAPPED AT FIELD FOR TWO JACK SCREWS AT 180° APART SUCH THAT SPECTACLE BLIND CAN BE HANDED WITHOUT INTERFERENCE WITH OTHER LINE OR EQUIPMENT.
2. THESE JACK SCREW DIMENSIONS ARE FORE RF FLANGES TO ASME E:6.5 FOR SIZES UPTO 24" AND ASME E:16.47 A/B FOR SIZES ABOVE 24"
3. JACK SCREW MATERIAL SHALL BE ALLOY STEEL

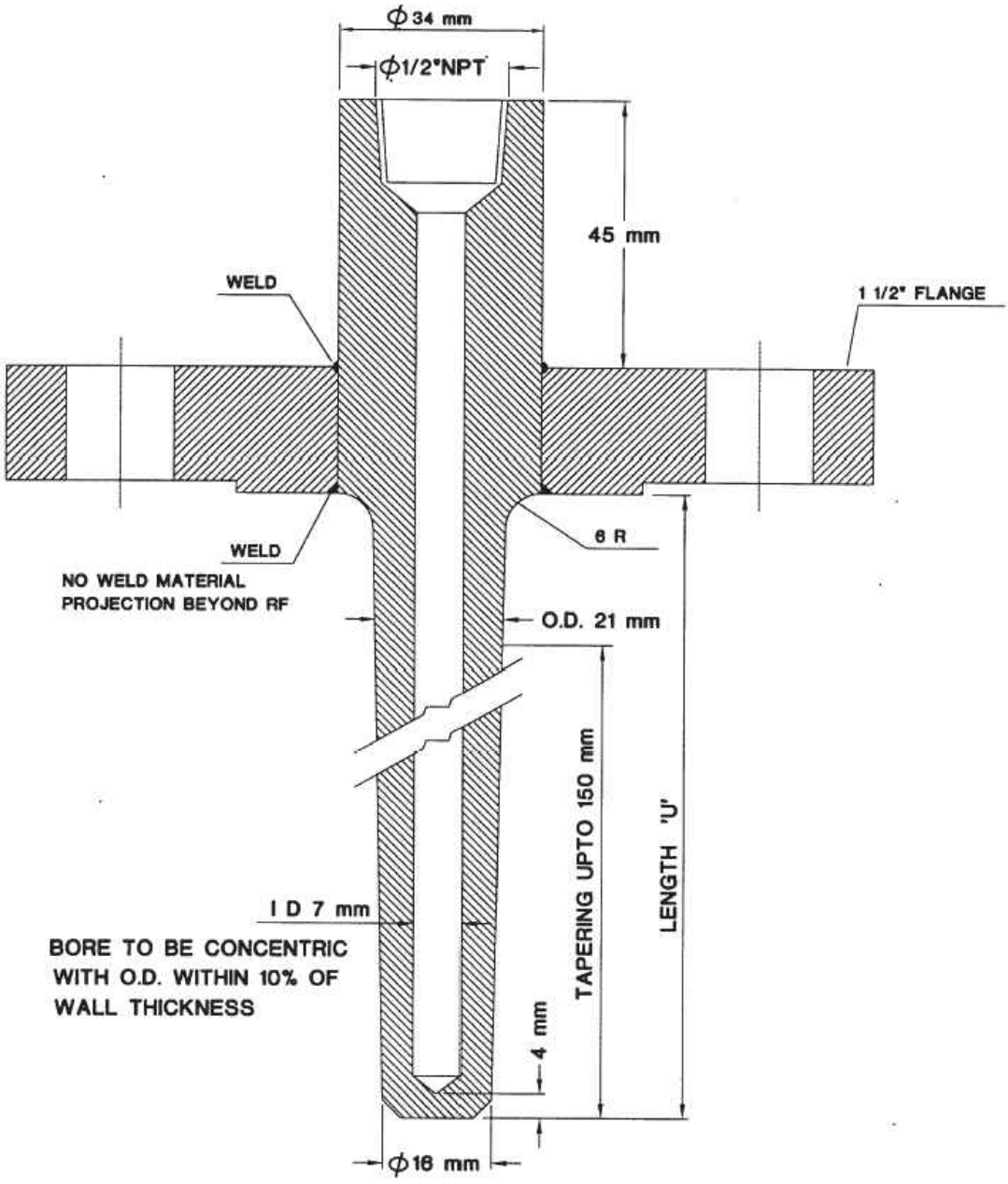
REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED
0	14.03.19	ISSUED FOR TENDER	D.V	U.N	S.B

LYONS ENGINEERING PVT. LTD. NEW DELHI	STANDARD THERMOWELL DRAWINGS	DRAWING NO. GAIL–STD–IN–DWG–TP–002 1 OF 1



NOTES - THIS STANDARD IS APPLICABLE
1) FOR TEMPERATURE GAUGES AND BEADED THERMOCOUPLES.
2) UPTO 600# ANSI OR EQUIVALENT RATINGS

REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED
0	14.03.19	ISSUED FOR TENDER	D.V	U.N	S.B

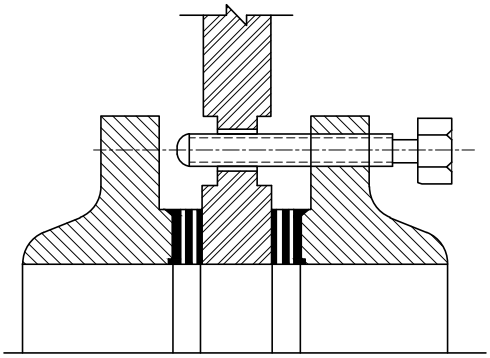


NOTES - THIS STANDARD IS APPLICABLE
1) FOR RTDs AND MINERAL INSULATED THERMOCOUPLES.
2) UPTO 600 # ANSI OR EQUIVALENT RATINGS

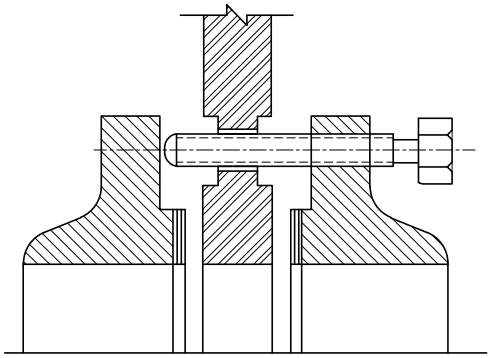
REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED
0	14.03.19	ISSUED FOR TENDER	D.V	U.N	S.B

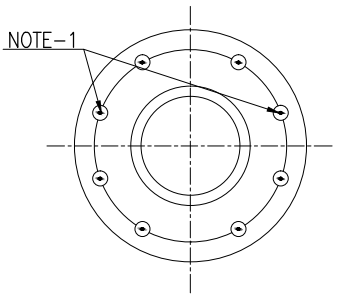
LYONS ENGINEERING PVT. LTD. NEW DELHI	STANDARD JACK SCREW FOR SPACER AND BLIND (150#, 300#, 600#)	DRAWING NO. GAIL–STD–ME–DOC–TS–002 1 OF 1

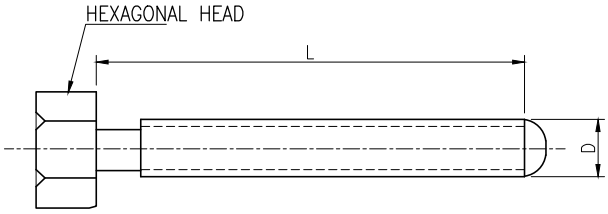
IN OPERATING POSITION



IN JACKING POSITION







NOS.	150# RF		300# RF		600# RF	
	L	D	L	D	L	D
3"	–	–	–	–	4	3/4
4"	–	–	–	–	4 1/2	3/4
6"	3 1/2	3/4	4	3/4	4 3/4	3/4
8"	3 3/4	3/4	4 1/2	3/4	5 3/4	3/4
10"	3 3/4	3/4	4 3/4	3/4	6	3/4
12"	4	3/4	5 1/4	3/4	6 1/2	3/4
14"	4 1/2	3/4	5 1/4	3/4	6 3/4	3/4
16"	4 1/2	3/4	5 1/2	3/4	7 1/2	3/4
18"	4 3/4	3/4	6 1/1	3/4	8	3/4
20"	5 3/4	3/4	6 3/4	3/4	8 1/2	3/4
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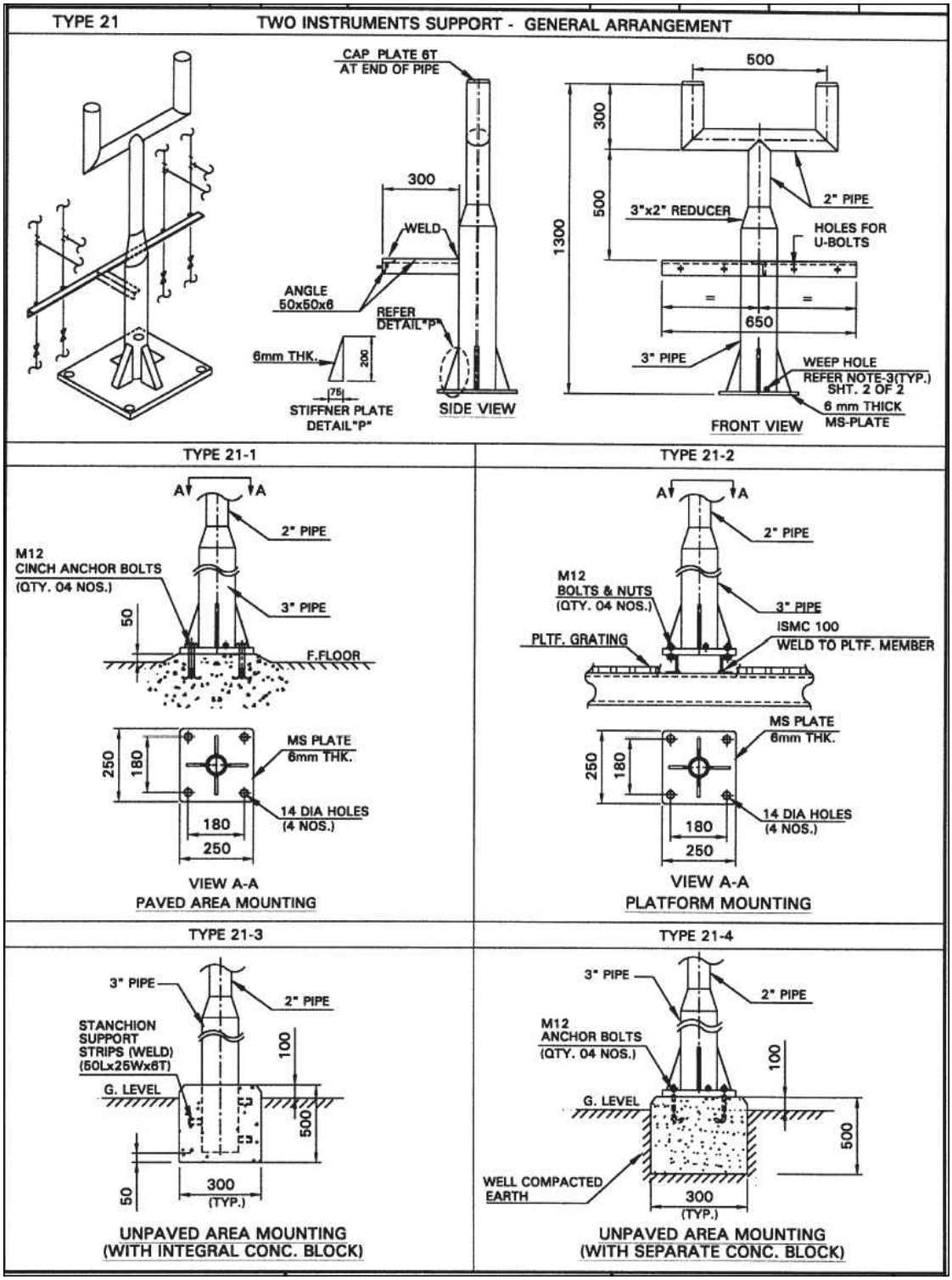
26"	5 3/4	3/4	7 1/4	3/4	10	3/4
28"	5 3/4	3/4	7 1/2	3/4	10	3/4
30"	6 1/2	3/4	8	3/4	10 3/4	3/4

NOTES:–

1. DRILLED & TAPPED AT FIELD FOR TWO JACK SCREWS AT 180° APART SUCH THAT SPECTACLE BLIND CAN BE HANDED WITHOUT INTERFERENCE WITH OTHER LINE OR EQUIPMENT.
2. THESE JACK SCREW DIMENSIONS ARE FORE RF FLANGES TO ASME E:6.5 FOR SIZES UPTO 24" AND ASME E:16.47 A/B FOR SIZES ABOVE 24"
3. JACK SCREW MATERIAL SHALL BE ALLOY STEEL

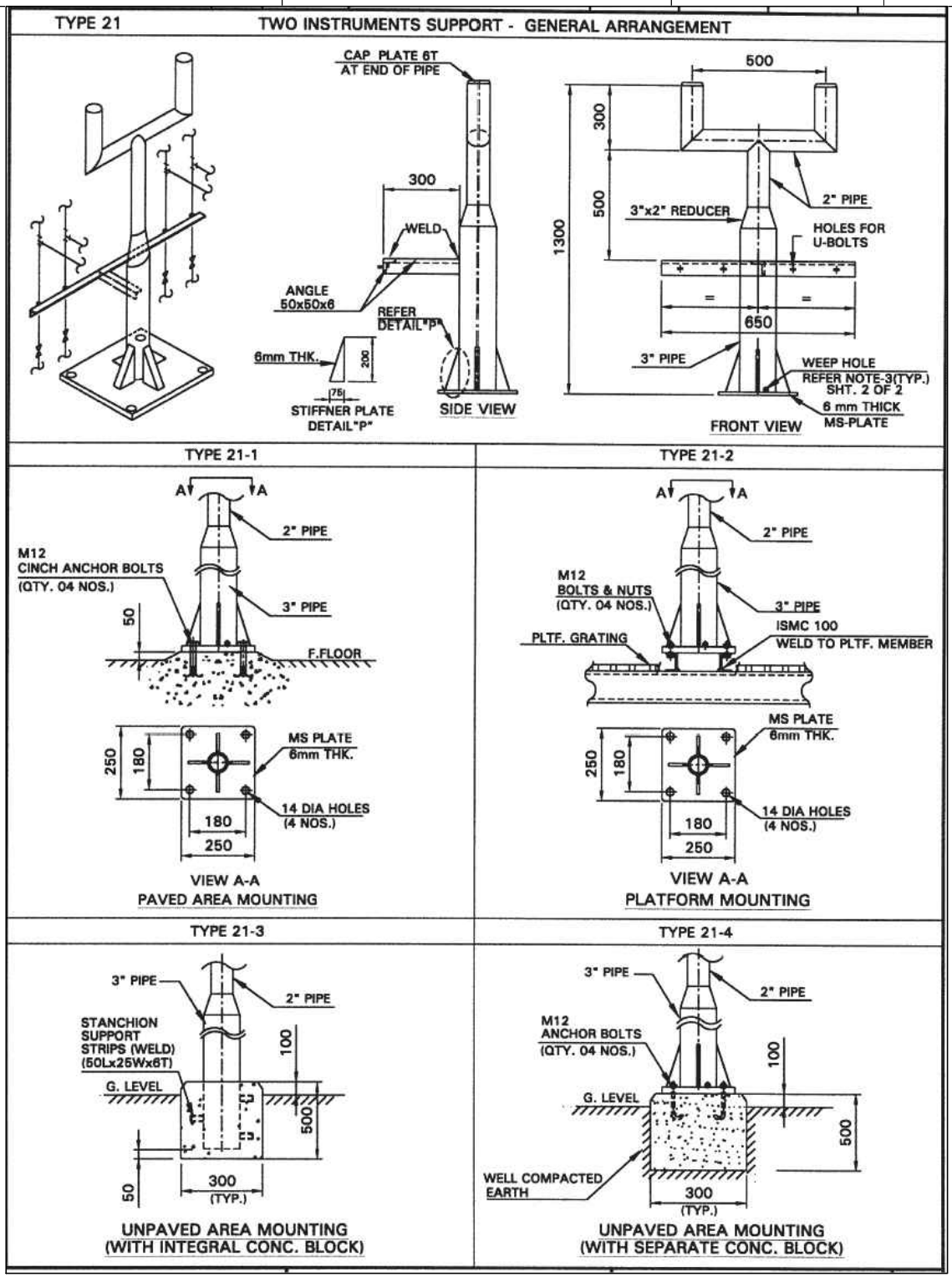
0	14.03.19	ISSUED FOR TENDER	D.V		U.N		S.B	
REV.NO.	DATE	SUBJECT OF REVISION	BY		CHECKED		APPROVED	



INSTRUMENT SUPPORT (TWO INSTRUMENT)

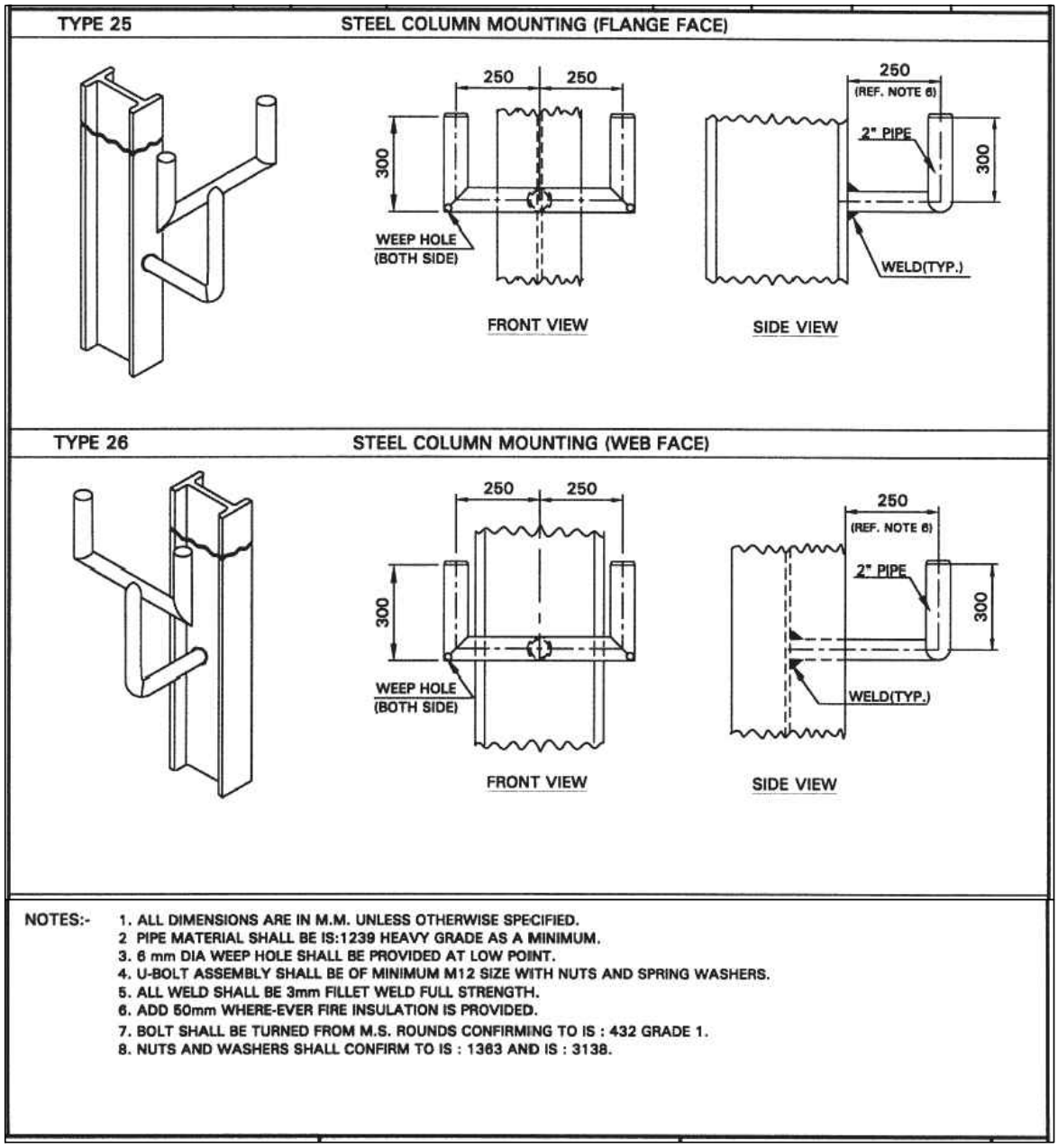
REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED
0	14.03.19	ISSUED FOR TENDER	D.V	U.N	S.B

LYONS ENGINEERING PVT. LTD. NEW DELHI	STANDARD TWO INSTRUMENT SUPPORT DRAWINGS	DRAWING NO. GAIL–STD–IN–DWG–TP–003 1 OF 1



INSTRUMENT SUPPORT (TWO INSTRUMENT)

REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED
0	14.03.19	ISSUED FOR TENDER	D.V	U.N	S.B



NOTES:-

1. ALL DIMENSIONS ARE IN M.M. UNLESS OTHERWISE SPECIFIED.
2. PIPE MATERIAL SHALL BE IS:1239 HEAVY GRADE AS A MINIMUM.
3. 6 mm DIA WEEP HOLE SHALL BE PROVIDED AT LOW POINT.
4. U-BOLT ASSEMBLY SHALL BE OF MINIMUM M12 SIZE WITH NUTS AND SPRING WASHERS.
5. ALL WELD SHALL BE 3mm FILLET WELD FULL STRENGTH.
6. ADD 50mm WHERE-EVER FIRE INSULATION IS PROVIDED.
7. BOLT SHALL BE TURNED FROM M.S. ROUNDS CONFIRMING TO IS : 432 GRADE 1.
8. NUTS AND WASHERS SHALL CONFIRM TO IS : 1363 AND IS : 3138.

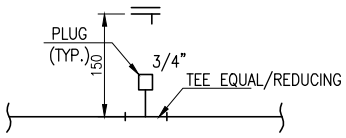
INSTRUMENT SUPPORT (TWO INSTRUMENT)

REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED
0	14.03.19	ISSUED FOR TENDER	D.V	U.N	S.B

LYONS ENGINEERING PVT. LTD. NEW DELHI	STANDARD VENTS & DRAIN ON LINES (ON LINES 1-1/2" & BELOW)	DRAWING NO. GAIL-STD-ME-DOC-TS-003 1 OF 1

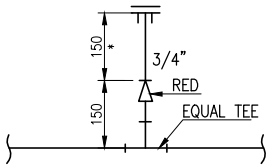
TYPE

VC1
VF1
VP1



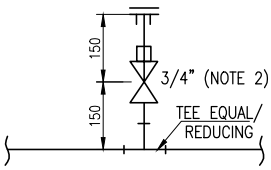
ON LINE 3/4"-1 1/2"

VC2
VF2
VP2



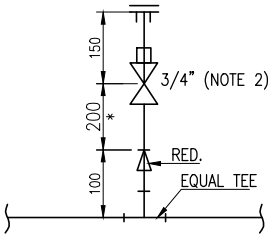
ON LINE 1"-1 1/2"

VC3
VF3
VP3



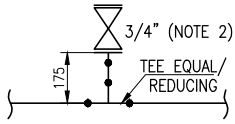
ON LINE 3/4"-1 1/2"

VC4
VF4
VP4



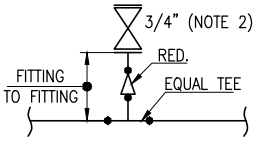
ON LINE 1"-1 1/2"

VF5
VP5

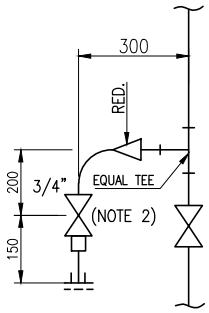


ON LINE 3/4"-1 1/2"

VF6
VP6

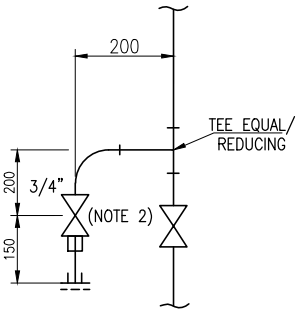


VENT ON LINE 1"-1 1/2"



ON LINE 1"-1 1/2"

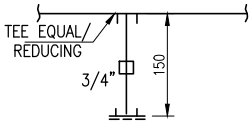
DC7
DF7
DP7



ON LINE 3/4"-1 1/2"

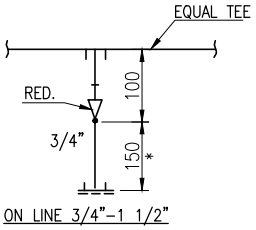
DC8
DF8
DP8

TYPE



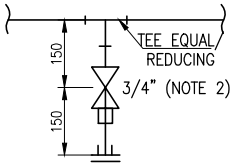
DC1
DF1
DP1

ON LINE 3/4"-1 1/2"



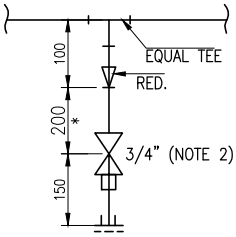
DC2
DF2
DP2

ON LINE 3/4"-1 1/2"



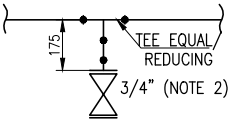
DC3
DF3
DP3

ON LINE 3/4"-1 1/2"



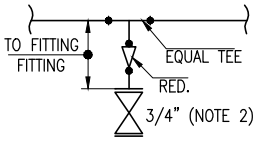
DC4
DF4
DP4

ON LINE 1"-1 1/2"



DC5
DF5

ON LINE 3/4"-1 1/2"



DC6
DF6

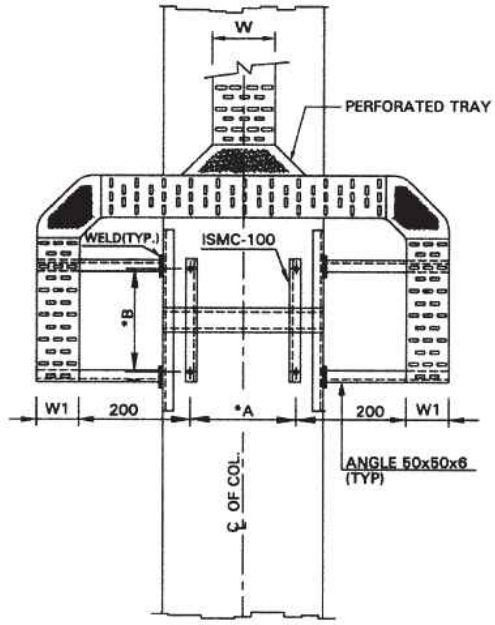
VENT ON LINE 1"-1 1/2"

NOTES:-

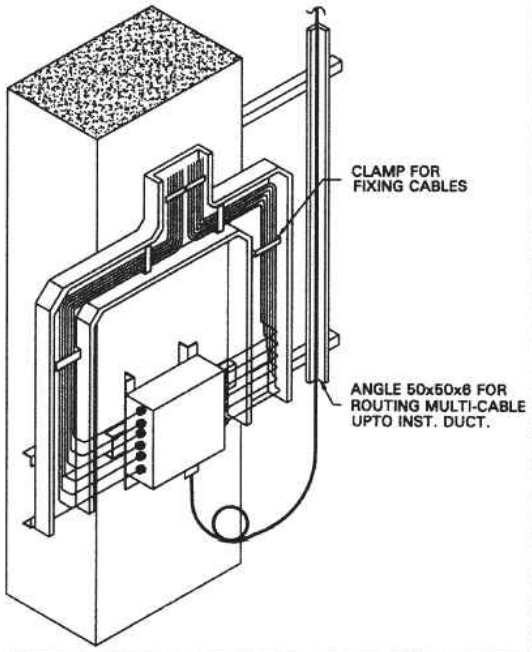
1. DIMENSIONS INDICATED ARE ARE VALID FOR 50mm(MAX) INSULATION FOR HIGHER INSULATION THICKNESS INCREASE DIMENSIONS AS REQUIRED DIMENSIONS MARKED '*' ARE MAXIMUM AND MAY BE REDUCED TO SUIT.
2. VALVES TO BE PROVIDED SHALL BE SIMILAR TO LINE ISOLATION VALVE (GATE BALL OR PLUG VALVE ETC. WITH FLGD. S.W. OR SCR'D) UNLESS OTHERWISE SPECIFIED IN PMS, BRANCH-OFFS LIKE TEES(EQUAL OR REDUCING)/HALF COUPLINGS S.W. OR SCR'D)/SOCKOLETS/ WELDOLETS AND ENC CONNECTIONS LIKE CAP/PLLG/FLANGE & BLIND BLIND FLANGE SHALL BE AS PER PIPING MATERIAL SPECIFICATION.
3. LEGEND : V=VENT; D = DRAIN; C = CAP; F = FLANGE; RED. = REDUCER, COUPLING OR SWAGE; P = PLUG.
4. PLUGGED END OF VALVE OR FITTING SHALL EE THREADED

REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED
0	14.03.19	ISSUED FOR TENDER	D.V	U.N	S.B

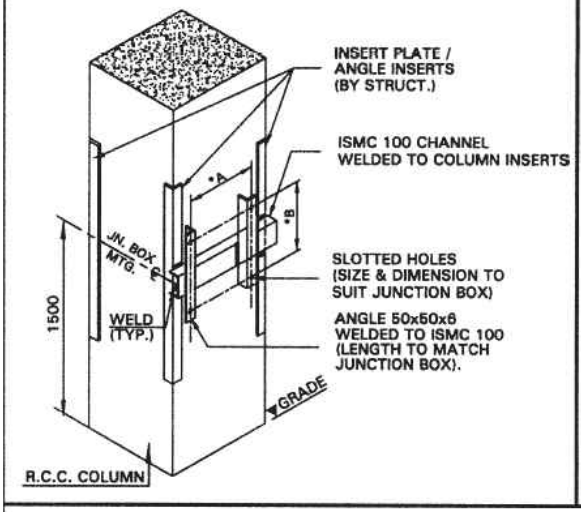
TRAY ARRANGEMENT FOR JUNCTION BOXES



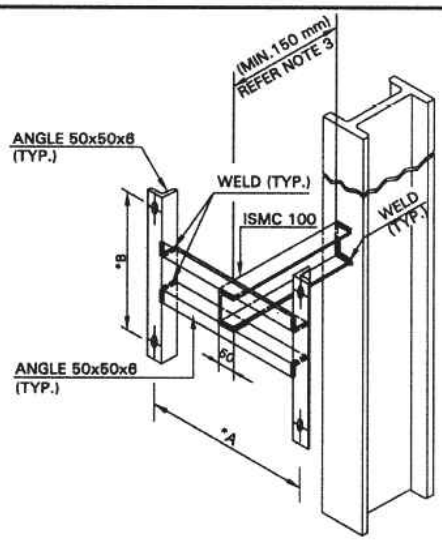
CABLE ROUTING FOR JUNCTION BOXES.



JN. BOX MOUNTING FRAME (R.C.C. COLUMN)



JN. BOX MOUNTING FRAME (STEEL COLUMN)



* DIMENSION `A and B' TO SUIT JUNCTION BOX.

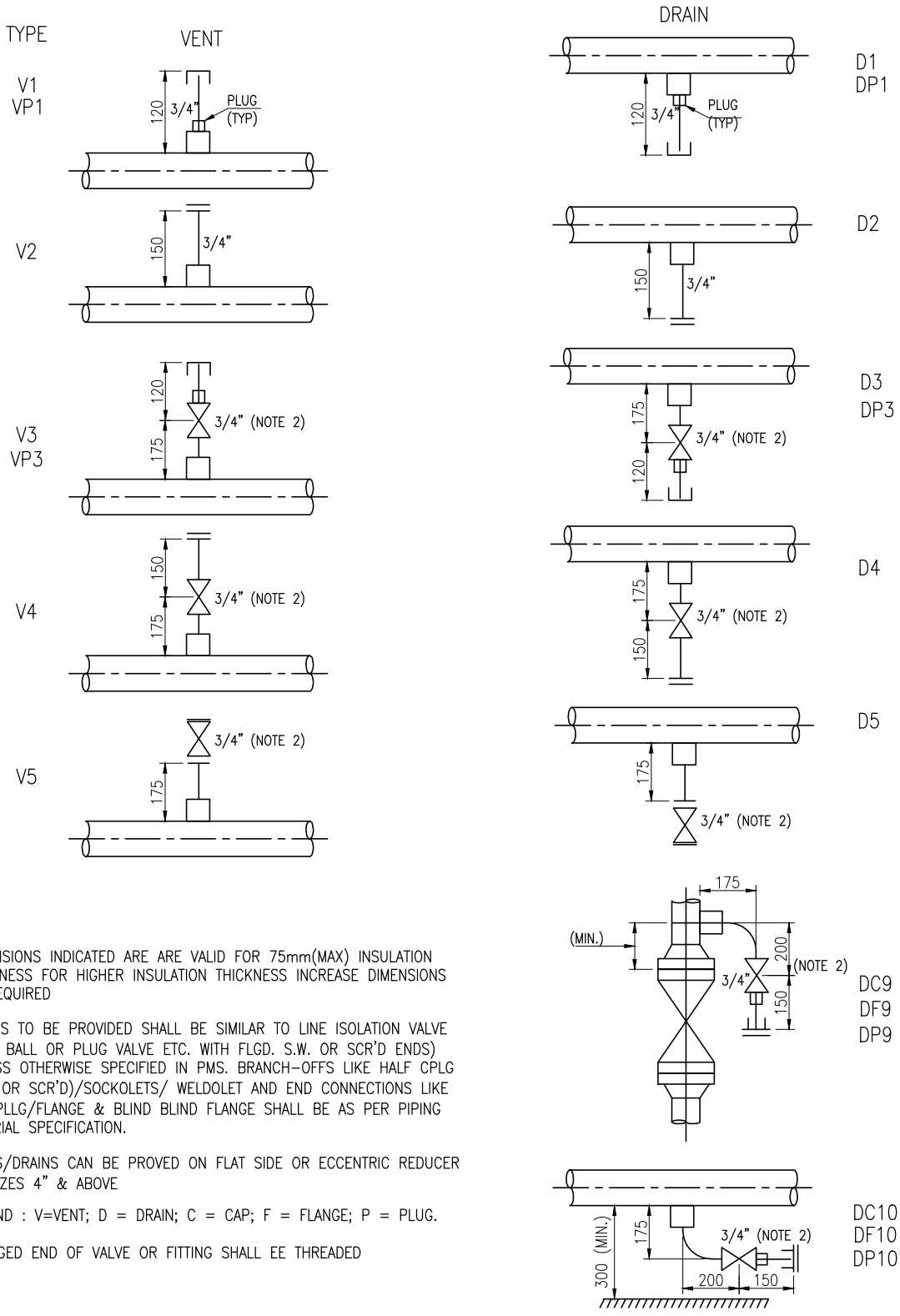
NOTE: 1. ALL DIMENSIONS ARE IN mm.
2. CLAMP MULTICABLE ON ANGLE WITH 25mm WIDE PVC COVERED ALLUMINIUM STRIP.
3. ADD 50 mm WHERE-EVER FIRE INSULATION IS PROVIDED.

TRAY WIDTH

JN. BOX	W	W1
12 PAIR	300	150
8 TRIAD	300	150
6 PAIR	150	100
6 TRIAD	150	100

REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED
0	14.03.19	ISSUED FOR TENDER	D.V	U.N	S.B

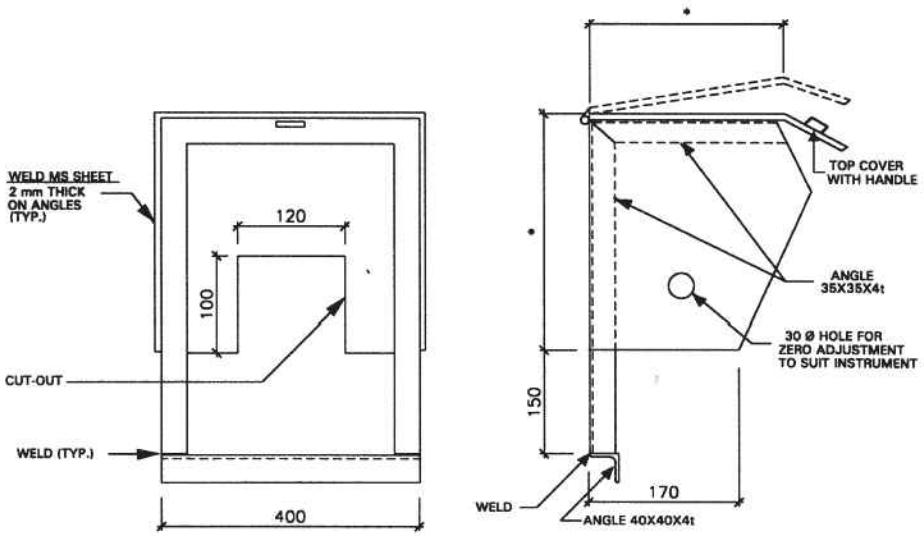
LYONS ENGINEERING PVT. LTD. NEW DELHI	STANDARD VENTS & DRAIN ON LINES (ON LINES 2" & ABOVE)	DRAWING NO. GAIL-STD-ME-DOC-TS-004 1 OF 1

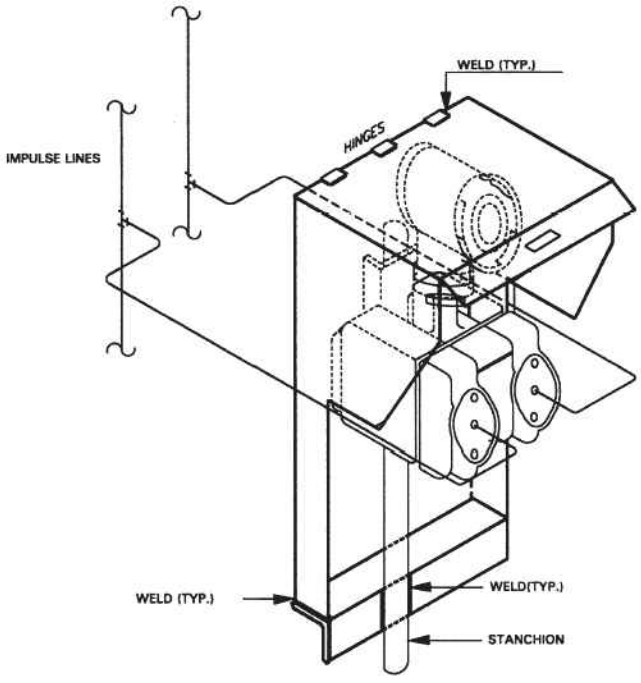


NOTES:-

1. DIMENSIONS INDICATED ARE ARE VALID FOR 75mm(MAX) INSULATION THICKNESS FOR HIGHER INSULATION THICKNESS INCREASE DIMENSIONS AS REQUIRED
2. VALVES TO BE PROVIDED SHALL BE SIMILAR TO LINE ISOLATION VALVE (GATE BALL OR PLUG VALVE ETC. WITH FLGD. S.W. OR SCR'D ENDS) UNLESS OTHERWISE SPECIFIED IN PMS. BRANCH-OFFS LIKE HALF CPLG (S.W. OR SCR'D)/SOCKOLETS/ WELDOLET AND END CONNECTIONS LIKE CAP/PLLG/FLANGE & BLIND BLIND FLANGE SHALL BE AS PER PIPING MATERIAL SPECIFICATION.
3. VENTS/DRAINS CAN BE PROVED ON FLAT SIDE OR ECCENTRIC REDUCER ON SIZES 4" & ABOVE
4. LEGEND : V=VENT; D = DRAIN; C = CAP; F = FLANGE; P = PLUG.
5. PLUGGED END OF VALVE OR FITTING SHALL EE THREADED

REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED
0	14.03.19	ISSUED FOR TENDER	D.V	U.N	S.B





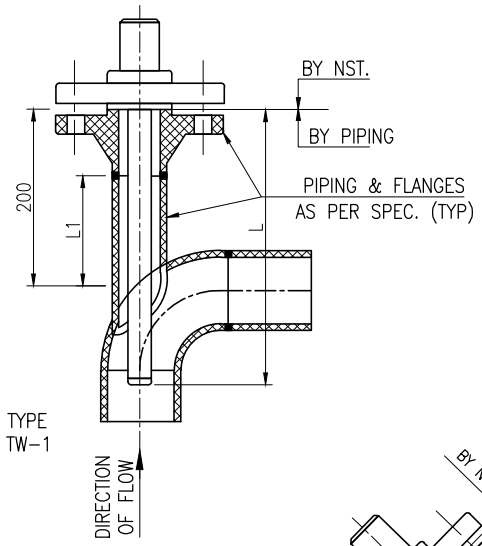
NOTES :

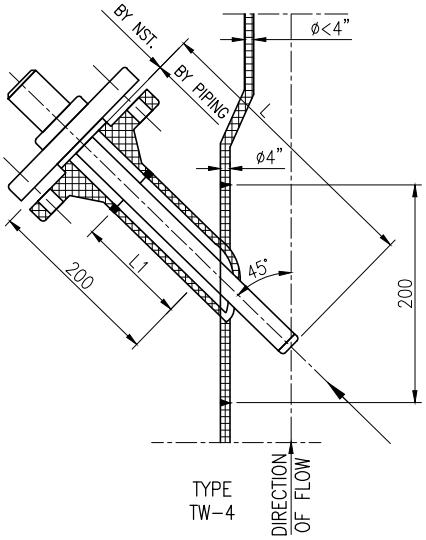
1. ALL DIMENSIONS ARE IN mm
2. * - TO SUIT INSTRUMENT DIMENSIONS
3. HINGES SHALL BE OF STAINLESS STEEL.
4. A MINIMUM OF TWO COATS PAINTING SHALL BE CARRIED OUT AFTER A MINIMUM OF ONE COAT OF RED OXIDE ZINC CHROMATE PRIMER. THE COLOUR OF THE PAINT SHALL BE AS PER IS-5.

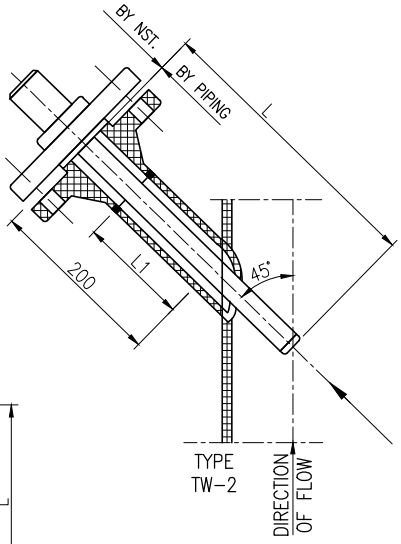
CANOPY FOR INSTRUMENTS

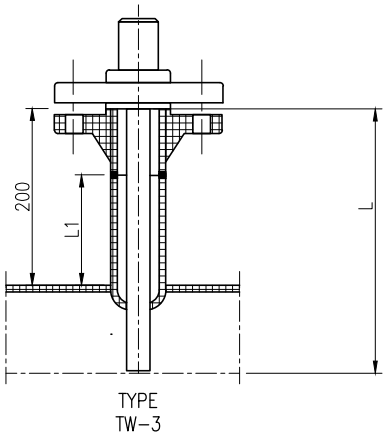
REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED
0	14.03.19	ISSUED FOR TENDER	D.V	U.N	S.B

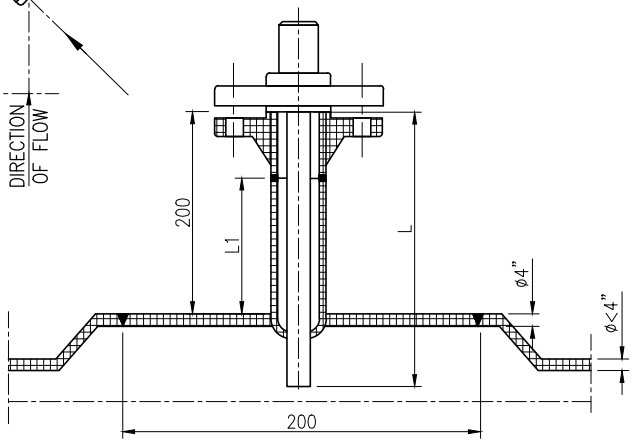
LYONS ENGINEERING PVT. LTD. NEW DELHI	STANDARD WELLS INSTALLATION 1-1/2" DIA TAPS	DRAWING NO. GAIL-STD-ME-DOC-TS-005 1 OF 2











NOTES:-

1. BOLTS, NUTS AND GASKETS BY PIPING.
2. MIN. CLEARANCE FOR REMOVAL L+350.
3. L1 – DIMENSIONS ARE CALCULATED FOR WN. R.F. FLANGE ONLY.
4. IN CASE ANY DEVIANT ON IS REQUIRED FOR INSTALLING T.W. TAPS FROM THIS STANDARD INST. DEPIT. TO BE CONSULTED

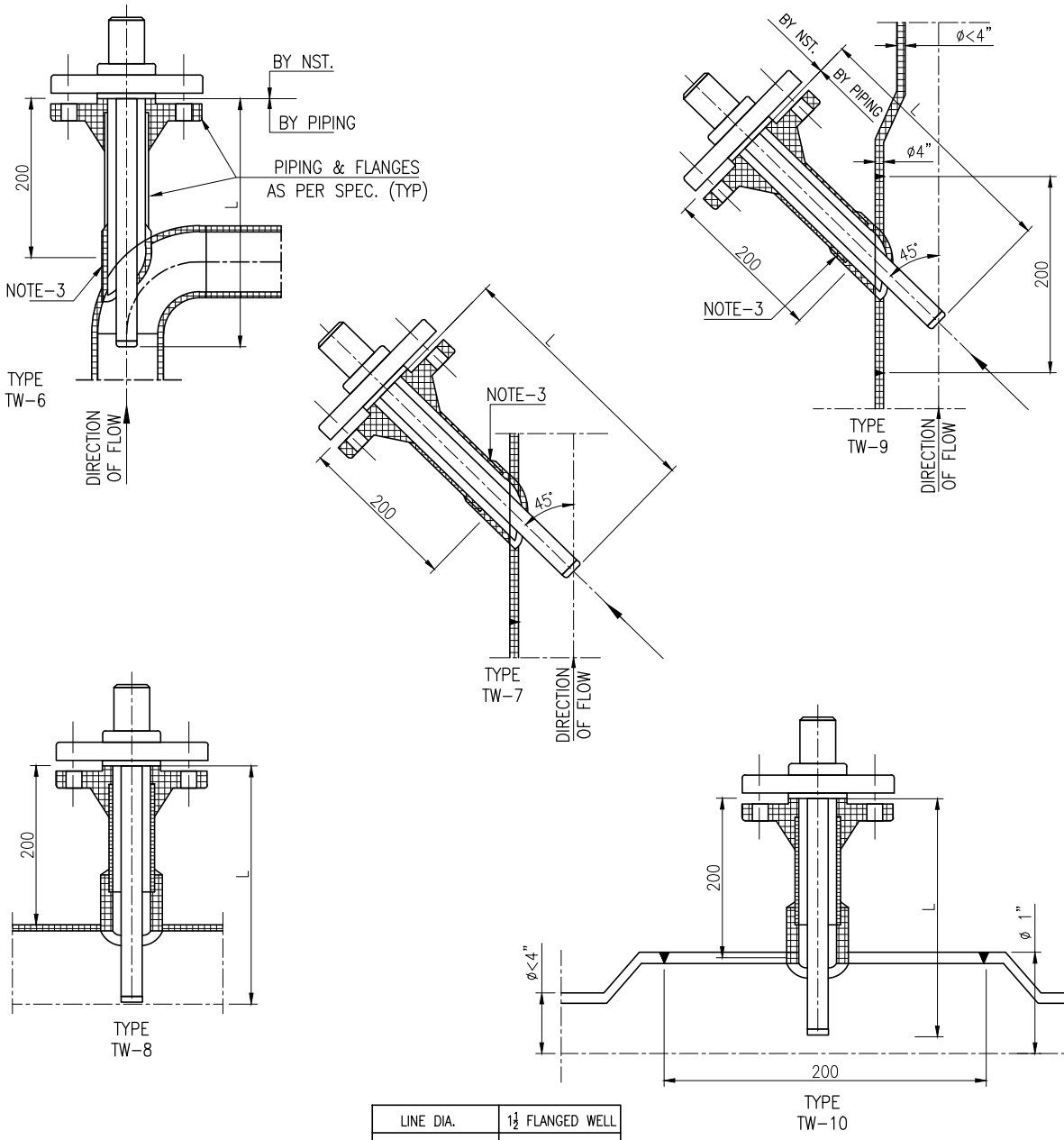
LINE DIA.	1½ FLANGED WELL
4"	280
8"	300
8"	300
10"	340
12"	350
14"	350
16"	280
18"	450
20" AND FLANGED	500
VESSELS	AS REQUIRED

LINE ø	L1				
	150 #	300 #	600 #	900 #	1500 #
4"	138	132	124	111	111

TYPE TW-1 : ELBOW LINE 4" ø OR LARGER
TYPE TW-2 : VERTICAL LINE 4" ø OR LARGER
TYPE TW-3 : HORIZONTAL LINE 4" ø OR LARGER
TYPE TW-4 : VERTICAL LINE DA LESS THAN 4"
TYPE TW-5 HORIZONTAL LINE DA LESS THAN 4"

REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED
0	14.03.19	ISSUED FOR TENDER	D.V	U.N	S.B

LYONS ENGINEERING PVT. LTD. NEW DELHI	STANDARD WELLS INSTALLATION 1-1/2" DIA TAPS	DRAWING NO. GAIL-STD-ME-DOC-TS-005 2 OF 2



LINE DIA.	1½ FLANGED WELL
4"	280
8"	300
8"	300
10"	350
12"	350
14"	350
16"	400
18"	400
20" AND FLANGED	500
VESSELS	AS REQUIRED

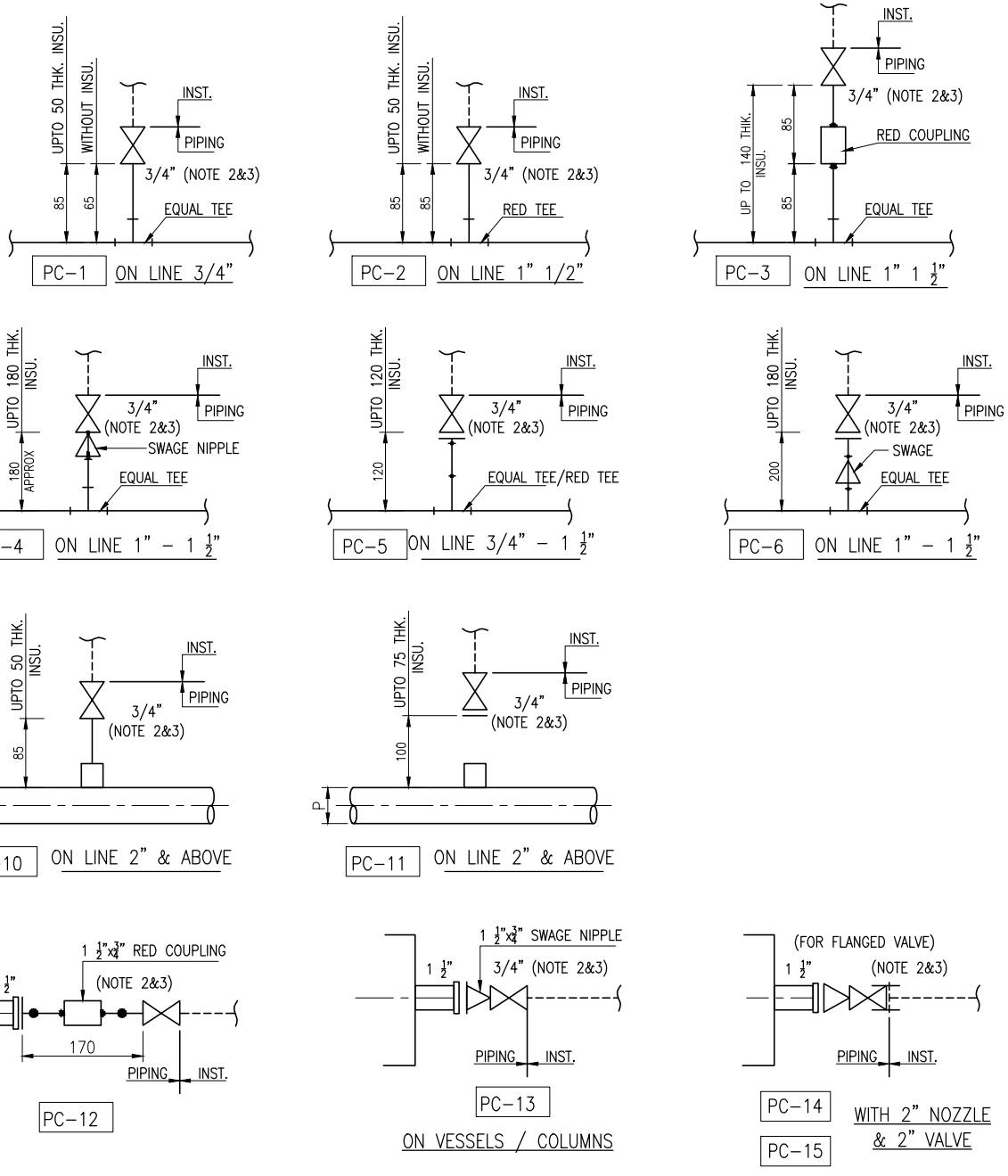
NOTES:-

1. BOLTS, NUTS AND GASKETS BY PIPING.
2. MIN. CLEARANCE FOR REMOVAL L+350.
3. COUPLING TO BE SPECIAL LENGTH.

TYPE TW-6 : ELBOW LINE 4" ø OR LARGER
TYPE TW-7 : VERTICAL LINE 4" ø OR LARGER
TYPE TW-8 : HORIZONTAL LINE 4" ø OR LARGER
TYPE TW-9 : VERTICAL LINE DA LESS THAN 4"
TYPE TW-10 : HORIZONTAL LINE DA LESS THAN 4"

REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED
0	14.03.19	ISSUED FOR TENDER	D.V	U.N	S.B

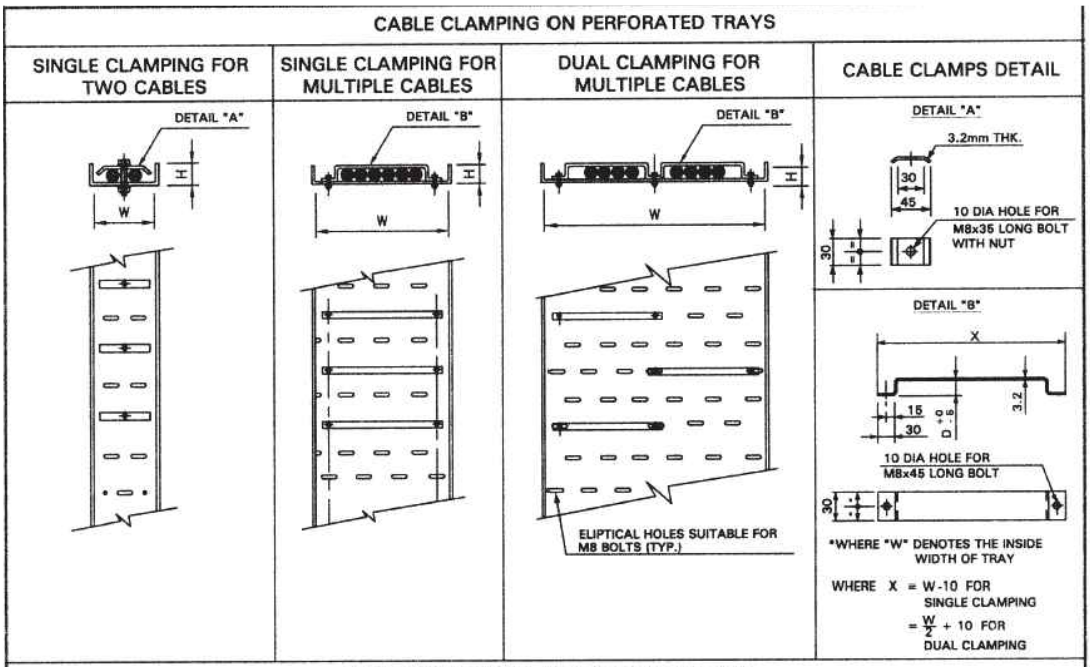
LYONS ENGINEERING PVT. LTD. NEW DELHI	STANDARD PRESSURE TAPPINGS – PG, PT, PI, PA, PC etc	DRAWING NO. GAIL–STD–ME–DOC–TS–006 1 OF 1



NOTES:–

1. DIMENSIONS INDICATED ARE MINIMUM WHICH ALSO COVER INSULATION TO THE EXTEND SHOWN ABOVE IN CASE OF HIGHER THICKNESS OF INSULATION THAN INDICATED THE REFERENCE SHALL BE ADDED IN THE DIMENSIONS SHOWN ABOVE.
2. PRESSURE TAPPING SHALL BE PROVIDED WITH VALVE SIMILAR TO LINE ISOLATION VALVE (GATE. BALL OR PLUG VALVE ETC,. WITH FLGD, S.W. OR SCR'D ENDS) UNLESS OTHERWISE SPECIFIED IN PMS, TEE (EQUAL OR REDUCING)/HALF COUPLING (S.W. OR SCR'D)/ST JB IN/SOCKOLET/WELDOLET SHALL BE AS PER PIPING MATERIAL SPECS.
3. IN CASE CF FLGD VALVES BOLTING & GASKET ON BOTH SIDES OF VALVE SHALL BE IN PIPING SCOPE.
4. IN CASE D = TAPPING PROVIDED OTHER THAN INDICATED IN THIS STD FOR LAYOUT REASONS DETAILED DIMENSIONS WILL BE CALLED DL.

REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED
0	14.03.19	ISSUED FOR TENDER	D.V	U.N	S.B



NOTES :-

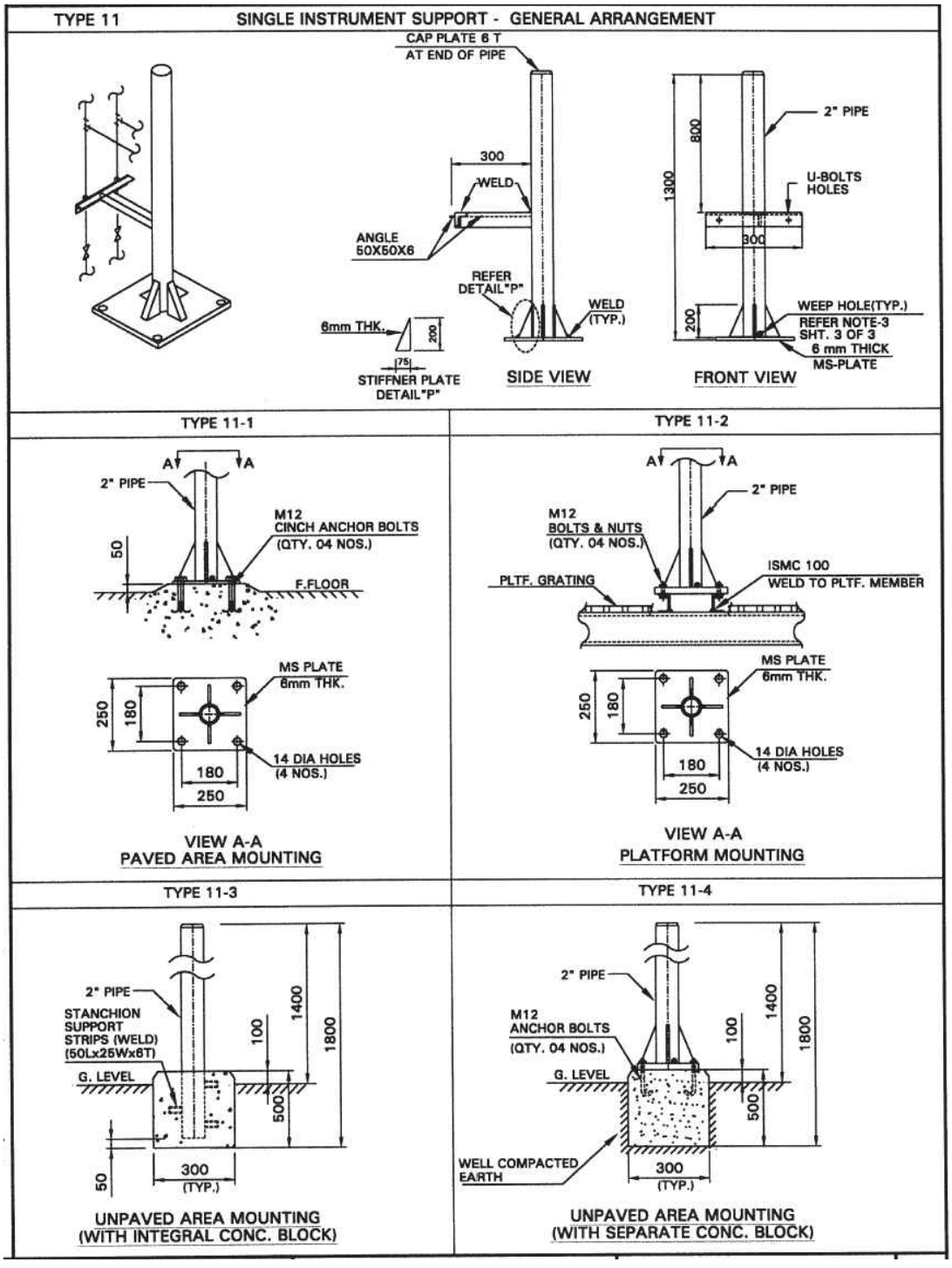
1. ALL DIMENSIONS ARE IN mm.
2. PERFORATED TRAYS SHALL BE SUPPORTED AT EVERY 1000 mm (TYP.) INTERVAL FOR HORIZONTAL AS WELL AS VERTICAL RUNS USING MINIMUM ANGLE SIZE AS 40x40x5 OR CONTINOUS CHANNEL SUPPORT MC50
3. CLAMPING OF CABLES ON PERFORATED TRAYS SHALL BE AT EVERY 500 mm ON VERTICAL RUNS AND EVERY 1000 mm ON HORIZONTAL RUNS.
4. PERFORATED TRAYS SHALL BE SUPPLIED WITH CLAMPS, BOLTS / NUTS AND WASHERS OF GALVANISED MILD STEEL.
5. GALVANISING SHALL BE AS PER IS 4759 (66 µm / 460 g / m2)

CAPACITY OF PERFORATED TRAYS

TRAY WIDTH (W)	FLANGE HEIGHT (H)	NO. OF CABLES		
		1 PAIR/ 1 TRIAD	6 PAIR/ 6 TRIAD	12 PAIR/ 8TRIAD
60	20	2	1	1
100	30	4	2	1
150	30	6	4	3
200	30	10	6	4
300	30	15	8	6

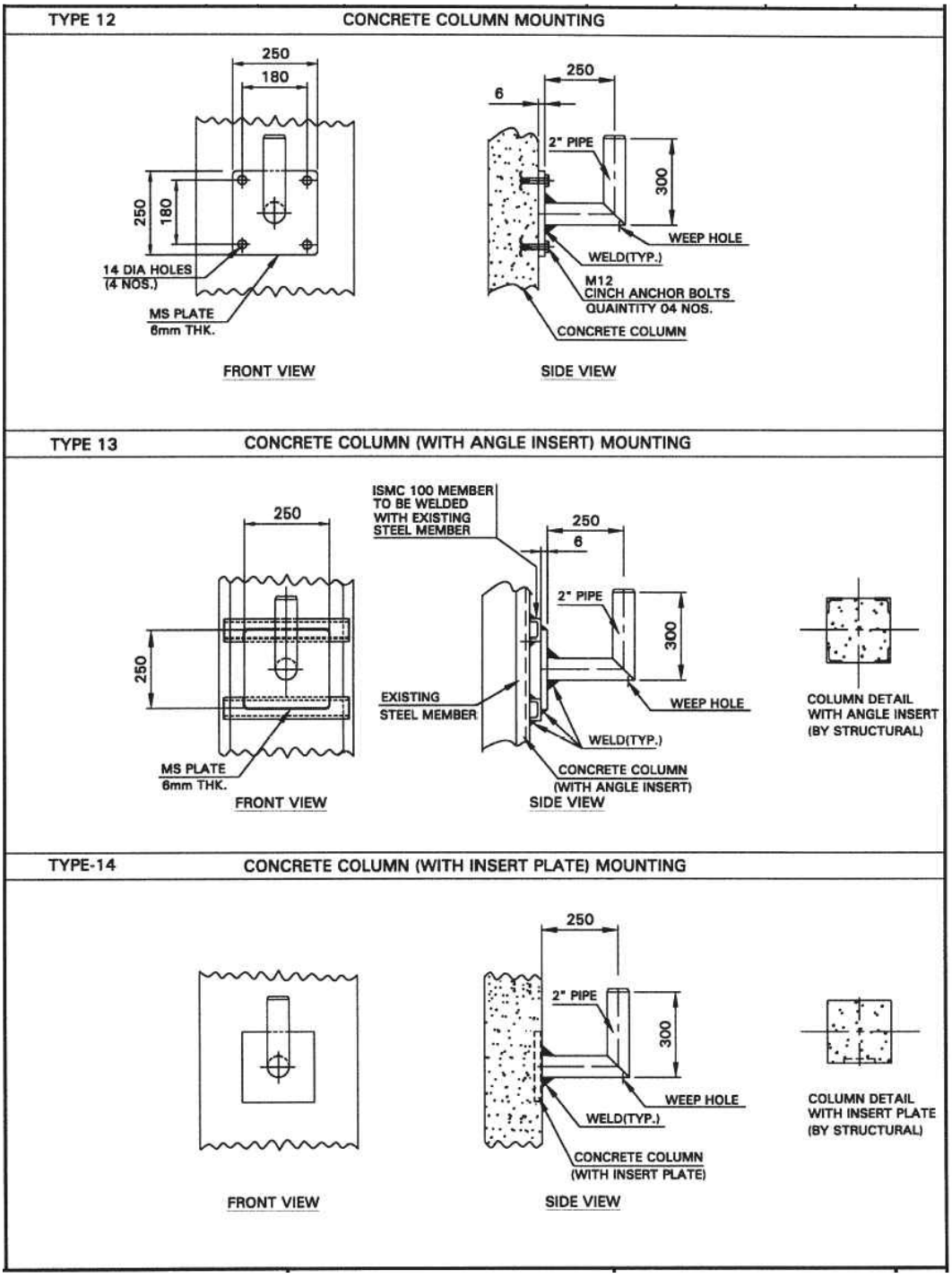
TRAY SUPPORTS AND CABLE CLAMPING DETAIL

REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED
0	14.03.19	ISSUED FOR TENDER	D.V	U.N	S.B



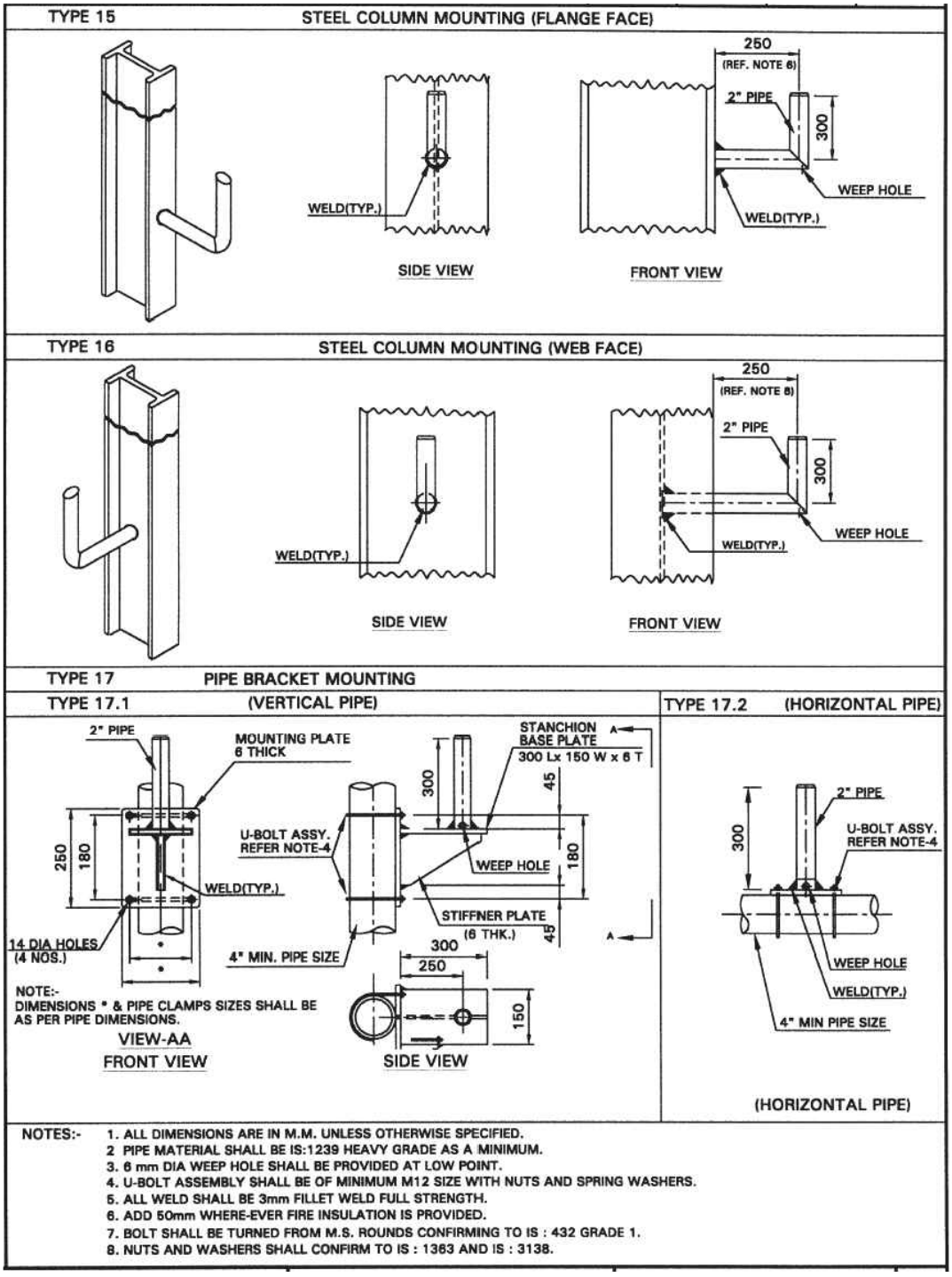
INSTRUMENTS SUPPORT (SINGLE INSTRUMENT)

0	14.03.19	ISSUED FOR TENDER	D.V		U.N		S.B	
REV.NO.	DATE	SUBJECT OF REVISION	BY		CHECKED		APPROVED	



INSTRUMENTS SUPPORT (SINGLE INSTRUMENT)

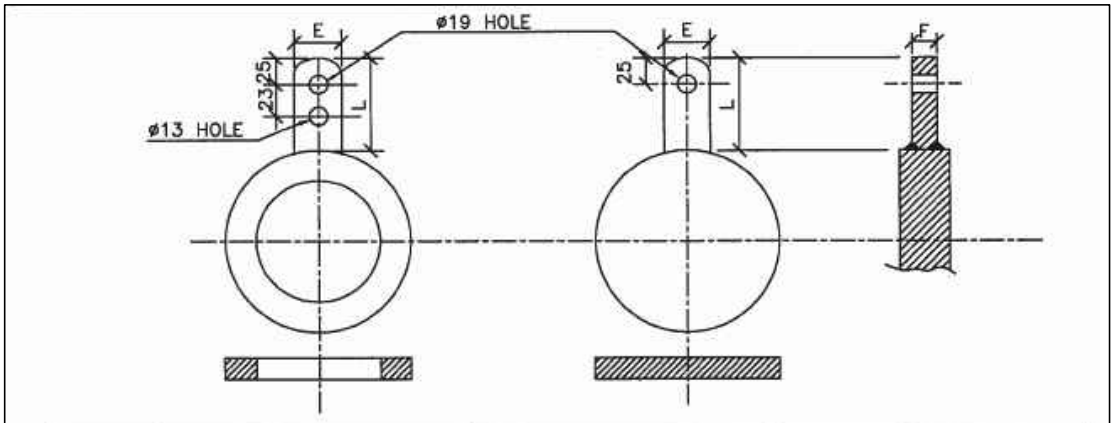
REV.NO.	DATE	SUBJECT OF REVISION	BY		CHECKED		APPROVED	
0	14.03.19	ISSUED FOR TENDER	D.V		U.N		S.B	



INSTRUMENTS SUPPORT (SINGLE INSTRUMENT)

REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED
0	14.03.19	ISSUED FOR TENDER	D.V	U.N	S.B

LYONS ENGINEERING PVT. LTD. NEW DELHI	STANDARD DIMN. FOR HANDLE PROJECTIONS FOR SPACERS AND BLINDS	DRAWING NO. GAIL–STD–ME–DOC–TS–007 1 OF 1



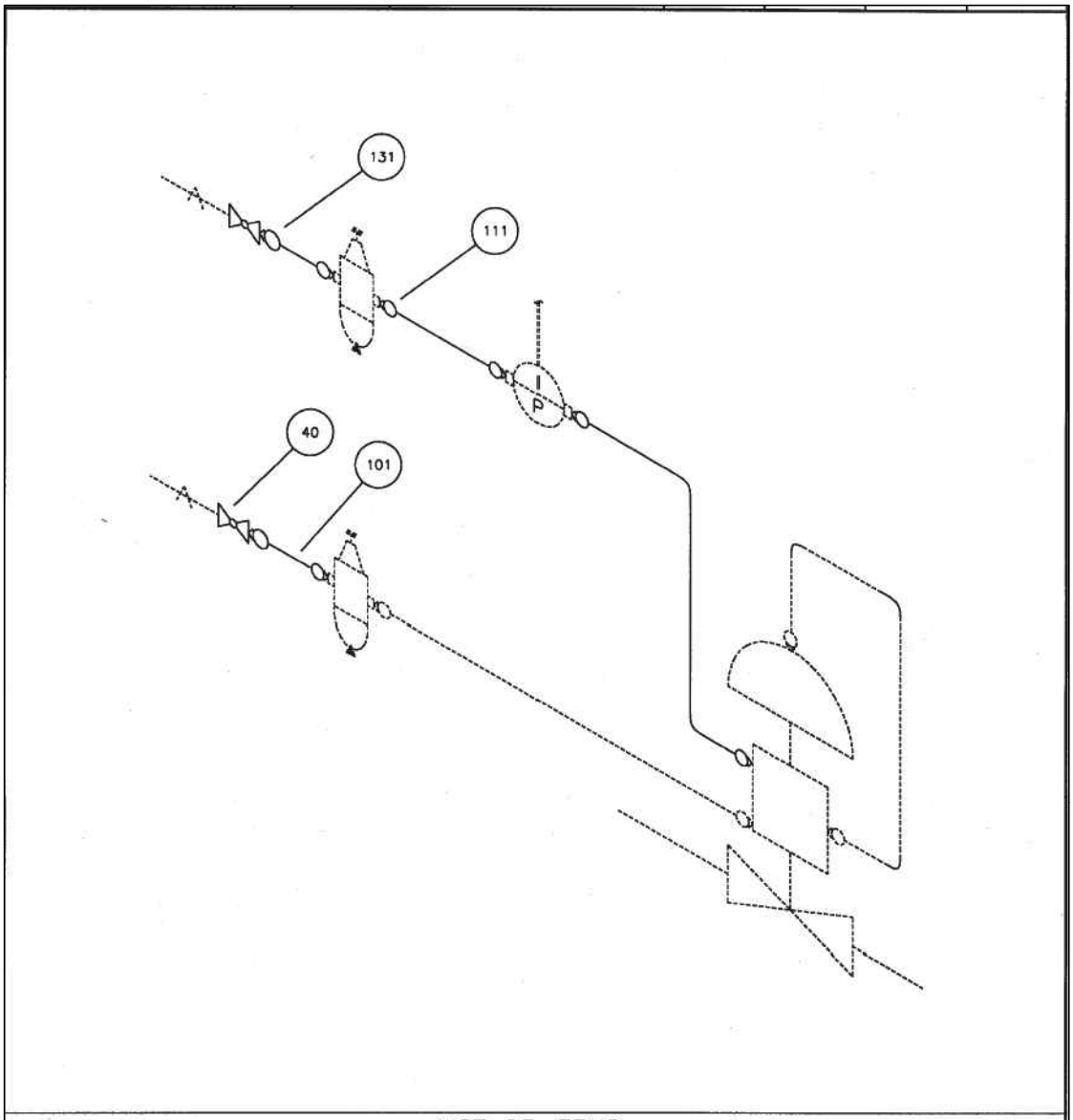
PIPE SIZE INCH	150# FF			300# FF			600# FF		
	E	F	L	E	F	L	E	F	L
1/2"	25	3	100	25	6	100	25	6	110
3/4"	25	3	100	25	6	100	25	6	110
1"	25	3	100	25	6	100	25	6	110
1 1/2"	25	6	100	25	6	100	25	6	110
2"	25	6	100	25	6	100	25	6	110
2 1/2"	25	6	100	25	6	110	25	6	110
3"	40	6	105	40	6	110	40	8	110
4"	40	6	105	40	6	110	40	8	110
6"	40	6	105	40	6	110	40	8	115
8"	40	6	105	40	8	110	40	10	125
10"	40	8	105	40	10	110	40	10	125
12"	40	8	110	40	10	120	40	15	125
14"	40	10	120	40	15	120	40	15	145
16"	40	10	120	40	15	130	40	20	140
18"	40	10	120	40	20	130	40	20	140
20"	40	14	120	40	20	140	40	25	140
24"	50	16	120	50	20	140	50	25	145

NOTES:–

1. ALL DIMENSION ARE IN MILLIMETERS
2. ALL OTHER DIMENSION SHALL BE AS PER ASME B16.48
3. MATERIAL SHALL BE AS PER MR.
4. THE HANDLE MAY BE INTEGRAL OR ATTACHED TO THE LINE BLANK/SPACER BY WELDING. IN CASE OF ATTACHMENT OF HANDLE BY WELDING, HEAT TREATMENT AND WELDING SHALL BE IN ACCORDANCE WITH ASME B31.3

REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED
0	14.03.19	ISSUED FOR TENDER	D.V	U.N	S.B

LYONS ENGINEERING PVT. LTD. NEW DELHI	STANDARD TUBING CONTROL VALVE WITH POSITIONER AND I/P CONVERTER	DRAWING NO. GAIL-STD-IN-DWG-TP-008 1 OF 1



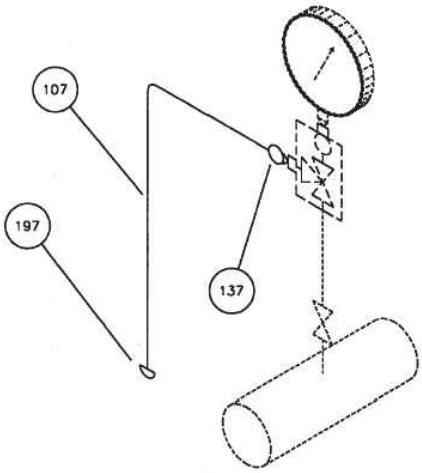
LIST OF ITEMS

CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT	CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT
40	BALL VALVE	1/2"	TH	2	Nø	101	TUBE	6 mm	OD	A/R	m
						111	MALE CONNECTOR	1/4" X 6 mm	TH X OD	6	Nø
						131	MALE CONNECTOR	1/2" X 6 mm	TH X OD	2	Nø

TUBING HOOKUP CONTROL VALVE WITH POSITIONER AND I/P CONVERTER

REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED
0	14.03.19	ISSUED FOR TENDER	D.V	U.N	S.B

LYONS ENGINEERING PVT. LTD. NEW DELHI	STANDARD PRESSURE GAUGE WITH 3 WAY MANIFOLD	DRAWING NO. GAIL–STD–IN–DWG–TP–009 1 OF 1



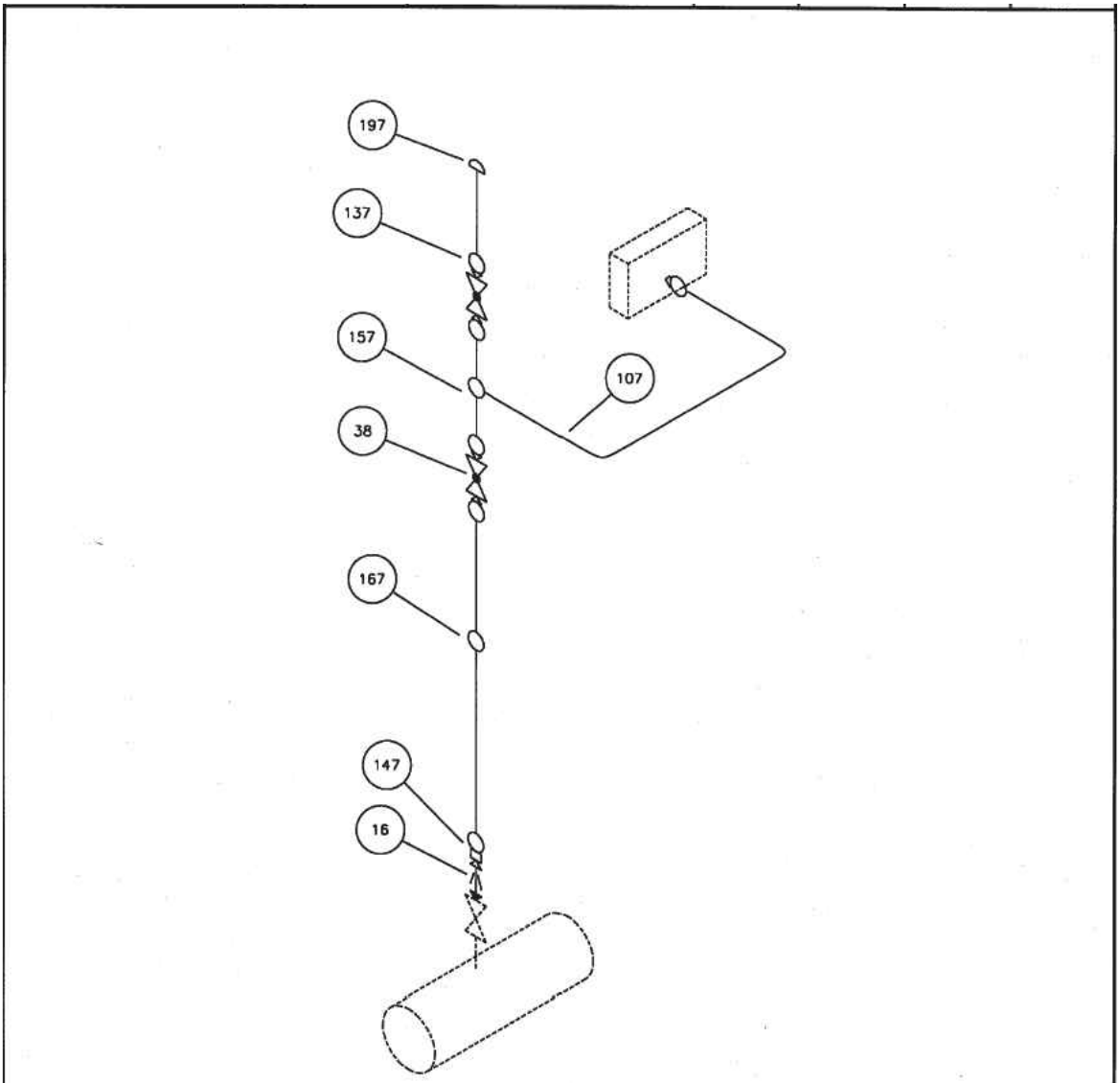
LIST OF ITEMS

CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT	CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT
						107	TUBE	1/2"	OD	A/R	m
						137	MALE CONNECTOR	1/2" X 1/2"	TH X OD	1	Nø
						197	TUBING CAP	1/2"	OD	1	Nø

PRESSURE GAUGE WITH 3 WAY MANIFOLD

REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED
0	14.03.19	ISSUED FOR TENDER	D.V	U.N	S.B

LYONS ENGINEERING PVT. LTD. NEW DELHI	STANDARD PRESSURE INSTRUMENT GAS SERVICE METER (ABOVE METER)	DRAWING NO. GAIL-STD-IN-DWG-TP-010 1 OF 1



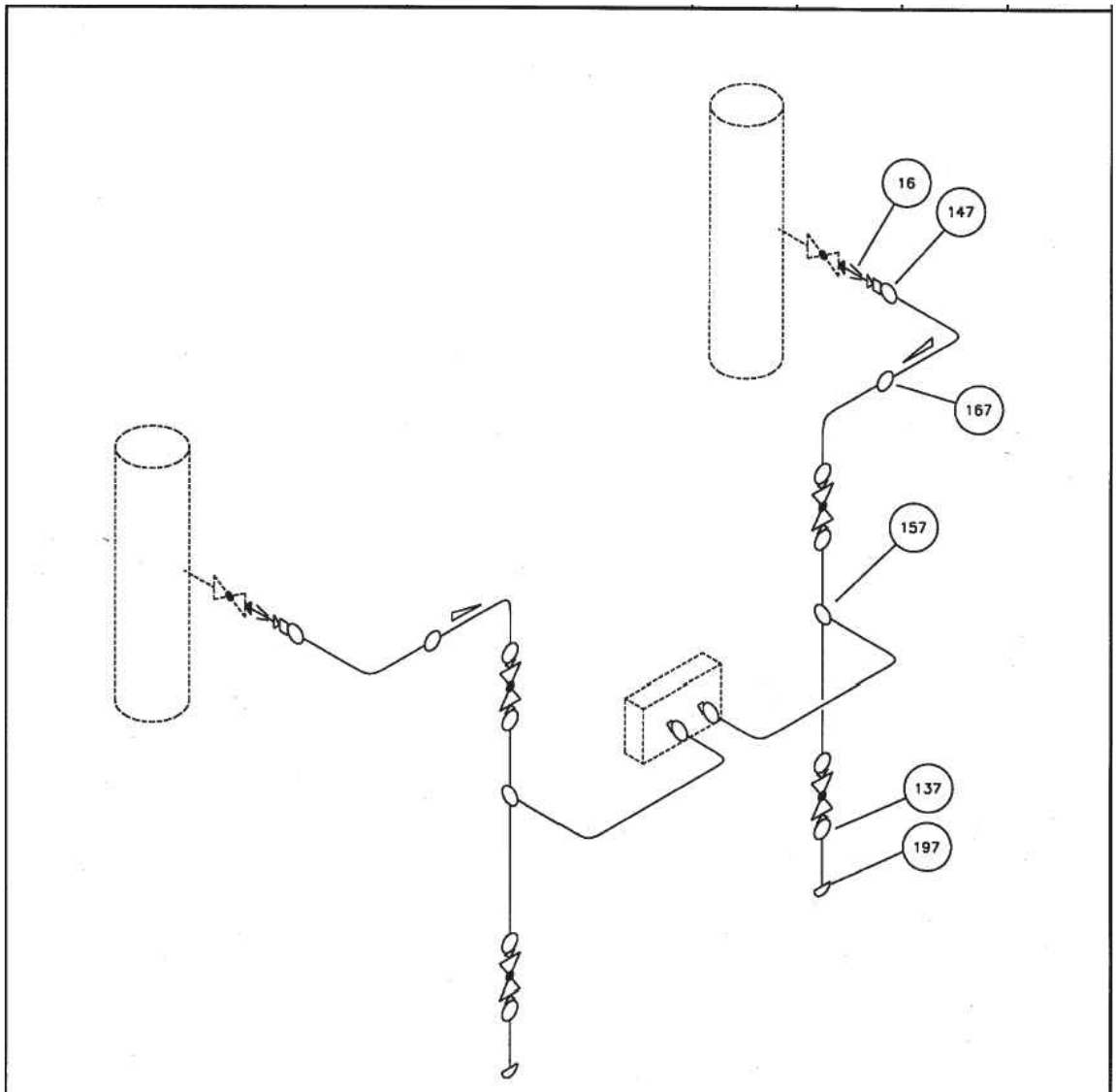
LIST OF ITEMS

CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT	CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT
16	SWAGE NIPPLE	3/4" X 1/2"	PL X TH	1	Nø	107	TUBE	1/2"	OD	A/R	m
38	GLOBE VALVE	1/2"	TH	2	Nø	137	MALE CONNECTOR	1/2" X 1/2"	TH X OD	5	Nø
						147	FEMALE CONNECTOR	1/2" X 1/2"	TH X OD	1	Nø
						157	UNION TEE	1/2"	OD	1	Nø
						167	TUBE UNION	1/2"	OD	1	Nø
						197	TUBING CAP	1/2"	OD	1	Nø

PRESSURE INSTRUMENT GAS SERVICE METER
(ABOVE METER)

REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED
0	14.03.19	ISSUED FOR TENDER	D.V	U.N	S.B

LYONS ENGINEERING PVT. LTD. NEW DELHI	STANDARD DIFFERENTIAL PRESSURE INSTRUMENT DP TYPE (METER BELOW)	DRAWING NO. GAIL–STD–IN–DWG–TP–011 1 OF 1



LIST OF ITEMS

CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT	CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT
16	SWAGE NIPPLE	3/4" X 1/2"	PL X TH	2	Nø	107	TUBE	1/2"	OD	A/R	m
38	GLOBE VALVE	1/2"	TH	4	Nø	137	MALE CONNECTOR	1/2" X 1/2"	TH X OD	10	Nø
						147	FEMALE CONNECTOR	1/2" X 1/2"	TH X OD	2	Nø
						157	UNION TEE	1/2"	OD	2	Nø
						167	TUBE UNION	1/2"	OD	2	Nø
						197	TUBING CAP	1/2"	OD	2	Nø

DIFFERENTIAL PRESSURE INSTRUMENT DP TYPE
(METER BELOW)

REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED
0	14.03.19	ISSUED FOR TENDER	D.V	U.N	S.B

ENGINEERING STANDARD

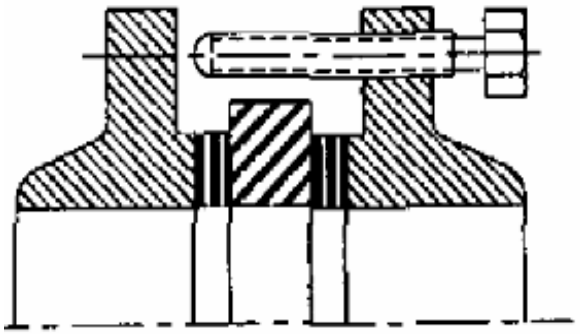
GAIL INDIA LIMITED

JACK SCREW FOR SPECTACLE BLIND (150#, 300#, 600# RF)

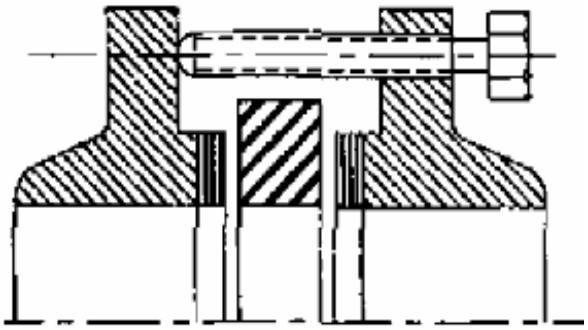
GAIL-STD-ME-DOC-TS-001

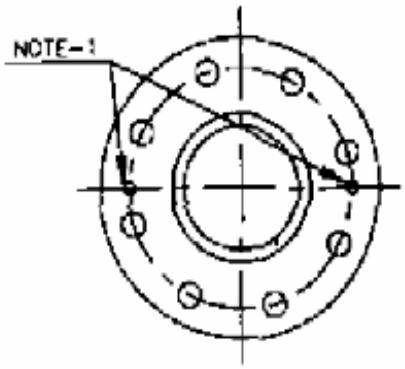
0	12.01.19	Issued For Tender	AP	JR	SB

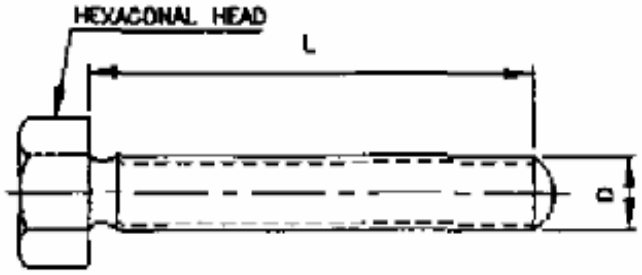
IN OPERATING POSITION



IN JACKING POSITION







NOM. #	150# RF		300# RF		600# RF	
	L	D	L	D	L	D
3"	-	-	-	-	4	3/4
4"	-	-	-	-	4 1/2	3/4
6"	3 1/4	3/4	4	3/4	4 3/4	3/4
8"	3 3/4	3/4	4 1/2	3/4	5 3/4	3/4
10"	3 3/4	3/4	4 3/4	3/4	6	3/4
12"	4	3/4	5 1/4	3/4	6 1/2	3/4
14"	4 1/2	3/4	5 3/4	3/4	6 3/4	3/4
16"	4 1/2	3/4	6 1/2	3/4	7 1/2	3/4
18"	4 3/4	3/4	6 1/2	3/4	8	3/4
20"	4 3/4	3/4	6 3/4	3/4	8 1/2	3/4
24"	5 3/4	3/4	7 1/4	3/4	9 1/2	3/4
26"	5 3/4	3/4	7 1/4	3/4	10	3/4
28"	5 3/4	3/4	7 1/2	3/4	10	3/4
30"	6 1/2	3/4	8	3/4	10 3/4	3/4

NOTES

1. DRILLED & TAPPED AT FIELD FOR TWO JACK SCREWS AT 180° APART SUCH THAT SPACER OR BLIND CAN BE HANDLED WITHOUT INTERFERENCE WITH OTHER LINES OR EQUIPMENT.
2. THESE JACK SCREW DIMENSIONS ARE FOR RF FLANGES TO ASME B16.5 FOR SIZES UPTO 24" AND ASME B16.47A/B FOR SIZES ABOVE 24"
3. JACK SCREW MATERIAL SHALL BE ALLOY STEEL

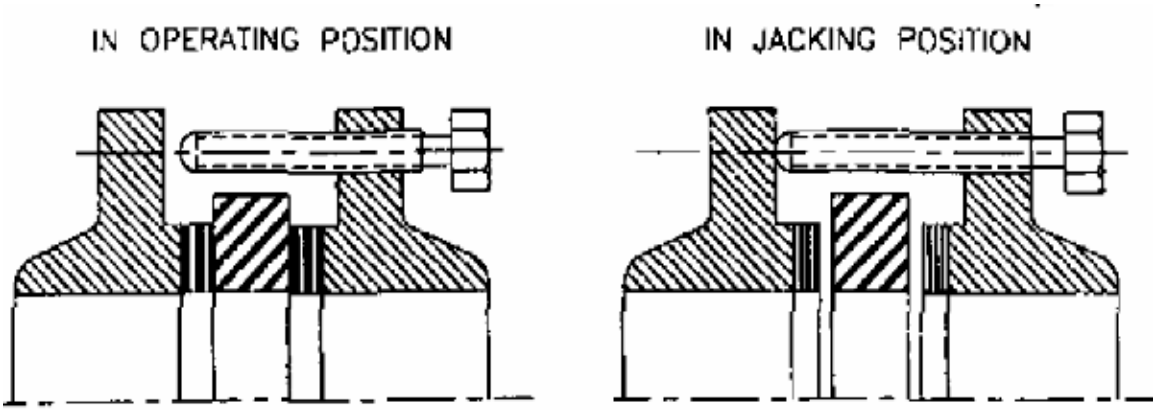
ENGINEERING STANDARD

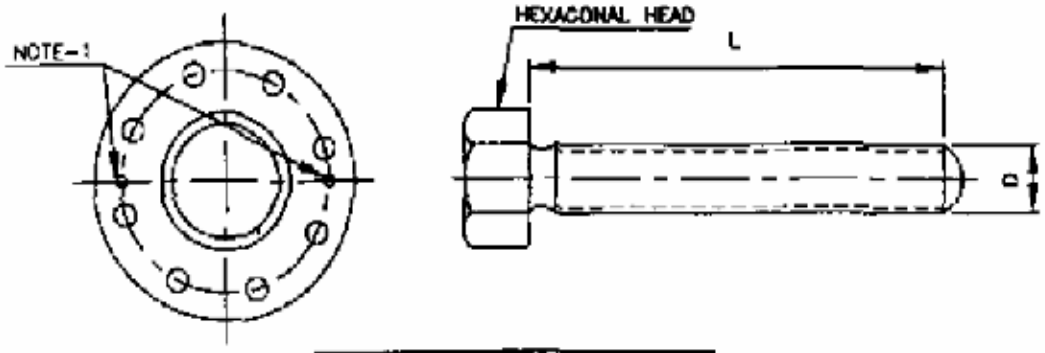
GAIL INDIA LIMITED

JACK SCREW FOR SPACERS AND BLINDS (150#, 300#, 600# RF)

GAIL-STD-ME-DOC-TS-002

0	12.01.19	Issued For Tender	AP	JR	SB





NOM. #	150# RF		300# RF		600# RF	
	L	D	L	D	L	D
3"	-	-	-	-	4	3/4
4"	-	-	-	-	4 1/2	3/4
6"	5 1/4	3/4	4	3/4	4 3/4	3/4
8"	5 3/4	3/4	4 1/2	3/4	5 3/4	3/4
10"	5 3/4	3/4	4 3/4	3/4	6	3/4
12"	6	3/4	5 1/4	3/4	6 1/2	3/4
14"	6 1/2	3/4	5 3/4	3/4	6 3/4	3/4
16"	6 1/2	3/4	6 1/2	3/4	7 1/2	3/4
18"	6 3/4	3/4	6 1/2	3/4	8	3/4
20"	6 3/4	3/4	6 3/4	3/4	8 1/2	3/4
24"	7 3/4	3/4	7 1/2	3/4	9 1/2	3/4
26"	8 3/4	3/4	7 1/4	3/4	10	3/4
28"	8 3/4	3/4	7 1/2	3/4	10	3/4
30"	8 1/2	3/4	8	3/4	10 3/4	3/4

NOTES

1. DRILLED & TAPPED AT FIELD FOR TWO JACK SCREWS AT 180° APART SUCH THAT SPACER OR BLIND CAN BE HANDLED WITHOUT INTERFERENCE WITH OTHER LINES OR EQUIPMENT.
2. THESE JACK SCREW DIMENSIONS ARE FOR RF FLANGES TO ASME B16.5 FOR SIZES UPTO 24" AND ASME B16.47A/B FOR SIZES ABOVE 24"
3. JACK SCREW MATERIAL SHALL BE ALLOY STEEL

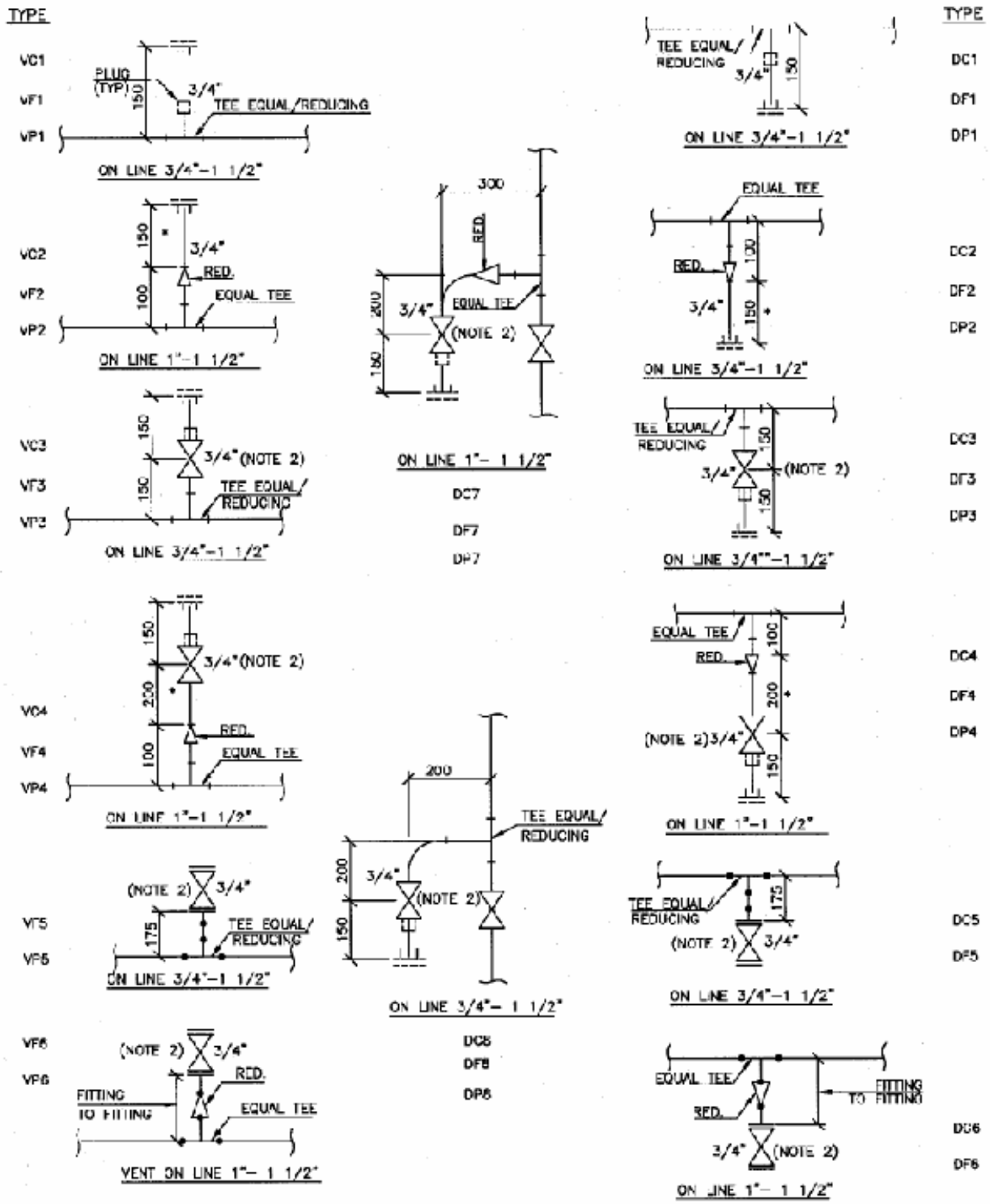
ENGINEERING STANDARD

GAIL INDIA LIMITED

VENTS AND DRAINS ON LINES (ON LINES 1-1/2” & BELOW)

GAIL-STD-ME-DOC-TS-003

0	12.01.19	Issued For Tender	AP	JR	SB



NOTES :

1. DIMENSIONS INDICATED ARE VALID FOR 50mm(MAX) INSULATION. FOR HIGHER INSULATION THICKNESS, INCREASE DIMENSIONS AS REQUIRED. DIMENSIONS MARKED '*' ARE MAXIMUM AND MAY BE REDUCED TO SUIT.
2. VALVES TO BE PROVIDED SHALL BE SIMILAR TO LINE ISOLATION VALVE (GATE, BALL OR PLUG VALVE ETC., WITH FLGD, S.W. OR SCR'D ENDS) UNLESS OTHERWISE SPECIFIED IN PMS, BRANCH–OFFS LIKE TEES(EQUAL OR REDUCING)/HALF COUPLINGS S.W. OR SCR'D)/SOCKOLETS/WELDOLETS AND END CONNECTIONS LIKE CAP/PLUG/FLANGE & BLIND FLANGE SHALL BE AS PER PIPING MATERIAL SPECIFICATION.
3. LEGEND : V = VENT; D = DRAIN; C = CAP; F = FLANGE; RED. = REDUCER, COUPLING OR SWAGE; P = PLUG.
4. PLUGGED END OF VALVE OR FITTING SHALL BE THREADED.

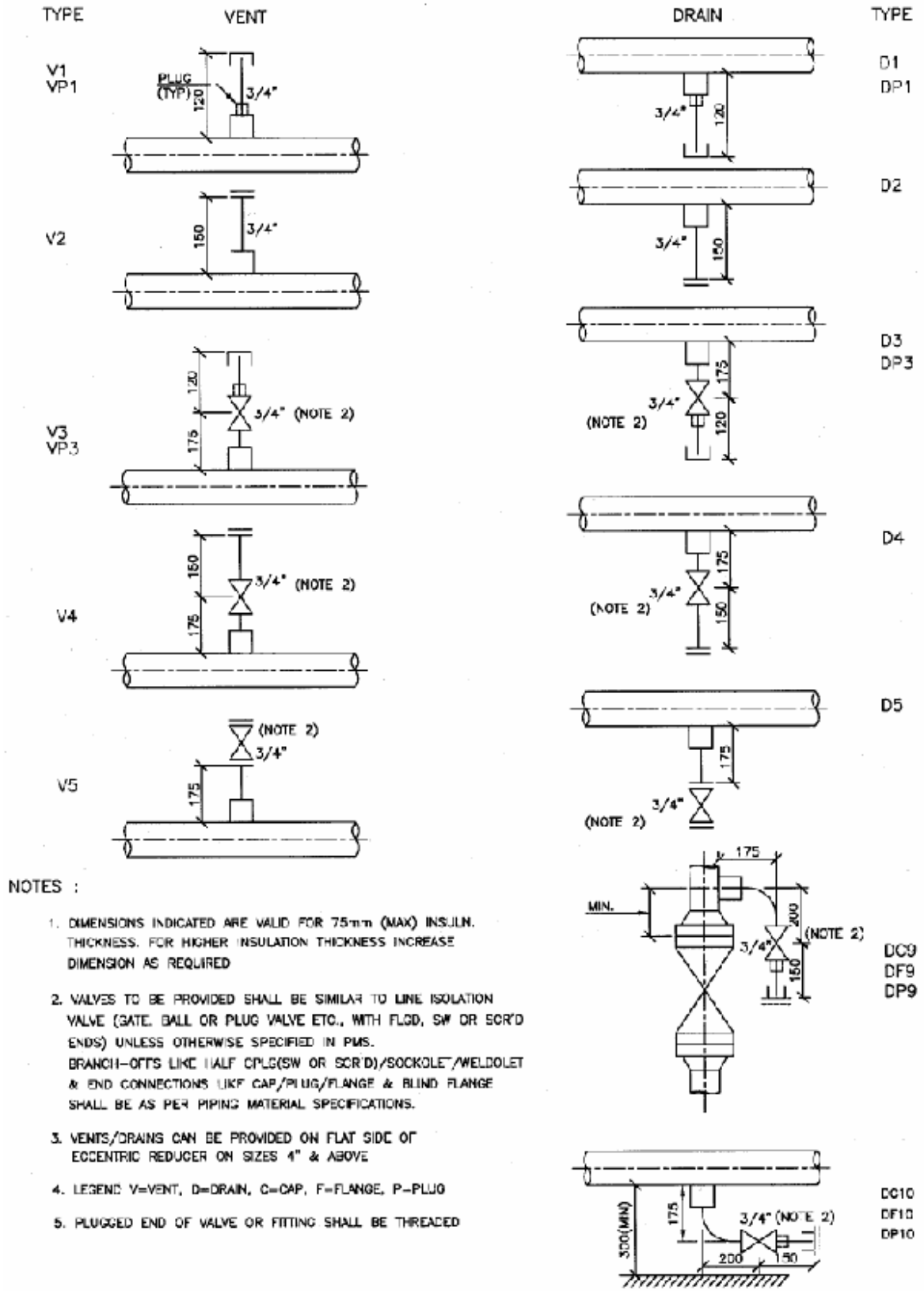
ENGINEERING STANDARD

GAIL INDIA LIMITED

VENTS AND DRAINS ON LINES (ON LINES 2 " & ABOVE)

GAIL-STD-ME-DOC-TS-004

0	12.01.19	Issued For Tender	AP	JR	SB



NOTES :

1. DIMENSIONS INDICATED ARE VALID FOR 75mm (MAX) INSULN. THICKNESS. FOR HIGHER INSULATION THICKNESS INCREASE DIMENSION AS REQUIRED
2. VALVES TO BE PROVIDED SHALL BE SIMILAR TO LINE ISOLATION VALVE (GATE, BALL OR PLUG VALVE ETC., WITH FLGD, SW OR SCR'D ENDS) UNLESS OTHERWISE SPECIFIED IN PMS. BRANCH-OFFS LIKE HALF CPLG(SW OR SCR'D)/SOCKOLET/WELDOLET & END CONNECTIONS LIKE CAP/PLUG/FLANGE & BLIND FLANGE SHALL BE AS PER PIPING MATERIAL SPECIFICATIONS.
3. VENTS/DRAINS CAN BE PROVIDED ON FLAT SIDE OF ECCENTRIC REDUCER ON SIZES 4" & ABOVE
4. LEGEND V=VENT, D=DRAIN, C=CAP, F=FLANGE, P=PLUG
5. PLUGGED END OF VALVE OR FITTING SHALL BE THREADED

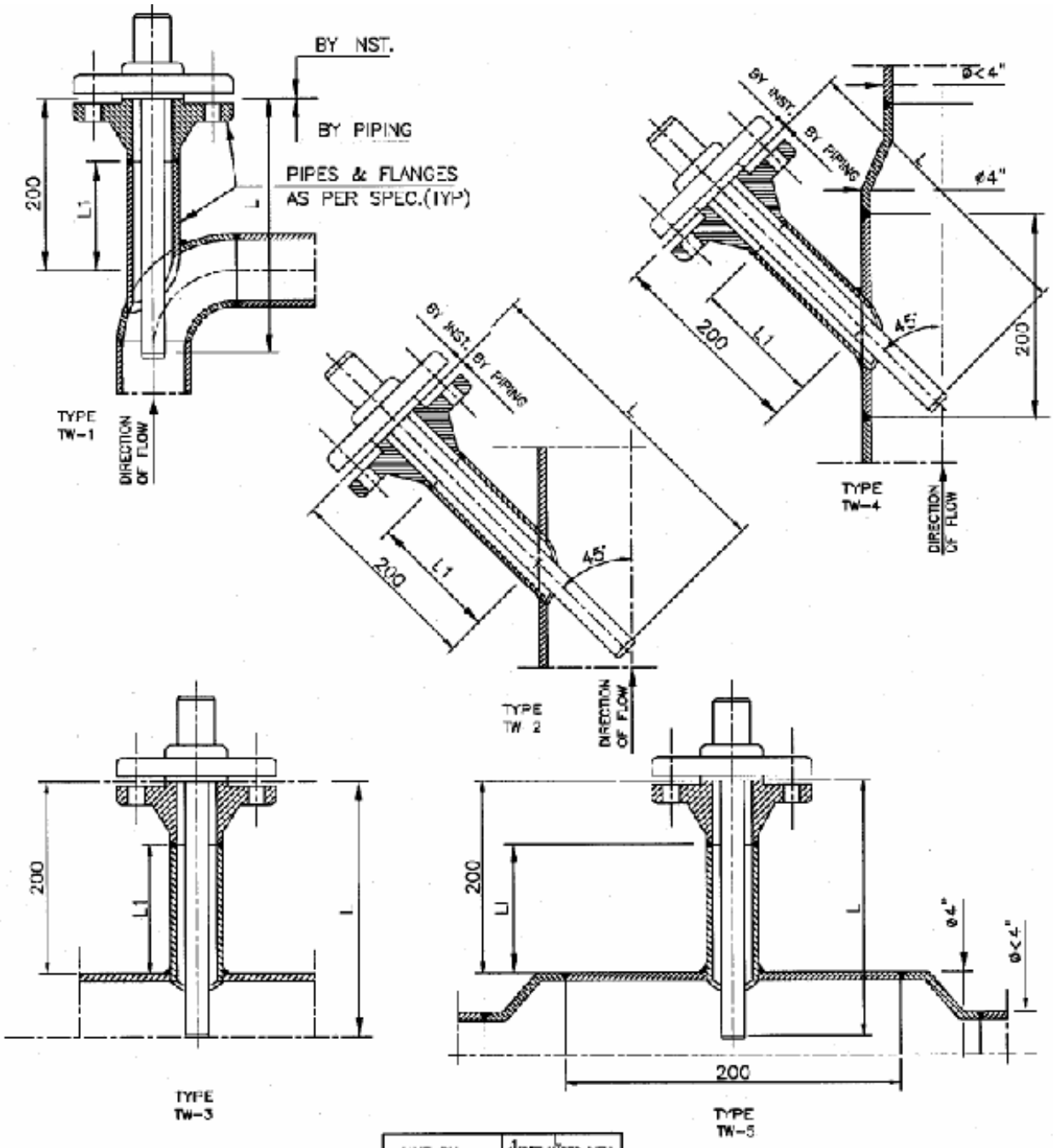
ENGINEERING STANDARD

GAIL INDIA LIMITED

WELLS INSTALLATION 1-1/2” Dia. Taps

GAIL-STD-ME-DOC-TS-005

0	12.01.19	Issued For Tender	AP	JR	SB



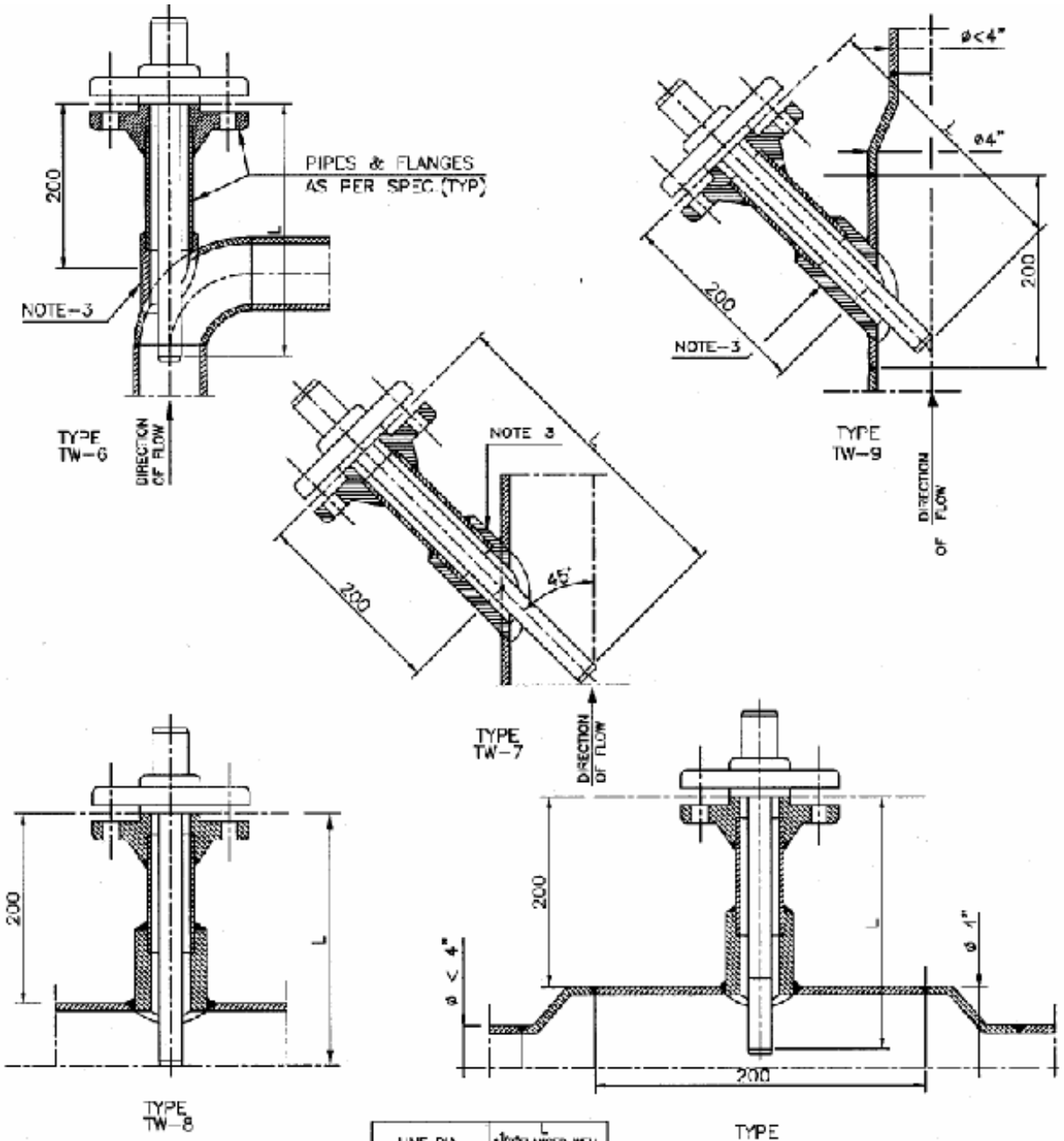
LINE DIA.	1½"FLANGED WELL
4"	280
6"	300
8"	300
10"	350
12"	350
14"	350
16"	400
18"	450
20" AND LARGER	500
VESSELS	AS REQUIRED

LINE ϕ	L1				
	150 #	300 #	600 #	900 #	1500 #
4"	138	132	124	111	111

NOTES:-

1. BOLTS, NUTS AND GASKETS BY PIPING.
2. MIN. CLEARANCE FOR REMOVAL L+350.
3. L1 – DIMENSIONS ARE CALCULATED FOR WN. R.F. FLANGE ONLY.
4. IN CASE ANY DEVIATION IS REQUIRED FOR INSTALLING T.W. TAPS FROM THIS STANDARD INST. DEPT. TO BE CONSULTED.

TYPE TW-1 : ELBOW MIN. 4" ϕ OR LARGER
TYPE TW-2 : VERTICAL LINE 4" ϕ OR LARGER
TYPE TW-3 : HORIZONTAL LINE 4" ϕ OR LARGER
TYPE TW-4 : VERTICAL LINE DIA. LESS THAN 4"
TYPE TW-5 : HORIZONTAL LINE DIA. LESS THAN 4"



LINE DIA.	L 1½"FLANGED WELL
4"	280
6"	300
8"	300
10"	350
12"	350
14"	350
16"	400
18"	400
20" AND LARGER	500
VESSELS	AS REQUIRED

NOTES:-

1. BOLTS, NUTS AND GASKETS BY PIP NG.
2. MIN CLEARANCE FOR REMOVAL L+350
3. COUPLING TO BE SPECIAL LENGTH.

TYPE TW-6 : ELBOW MIN 4" DIA. OR LARGER
TYPE TW-7 : VERTICAL LINE 4" DIA. OR LARGER
TYPE TW-8 : HORIZONTAL LINE 4" DIA. OR LARGER
TYPE TW-9 : VERTICAL LINE DIA. LESS THAN 4"
TYPE TW-10: HORIZONTAL LINE DIA. LESS THAN 4"

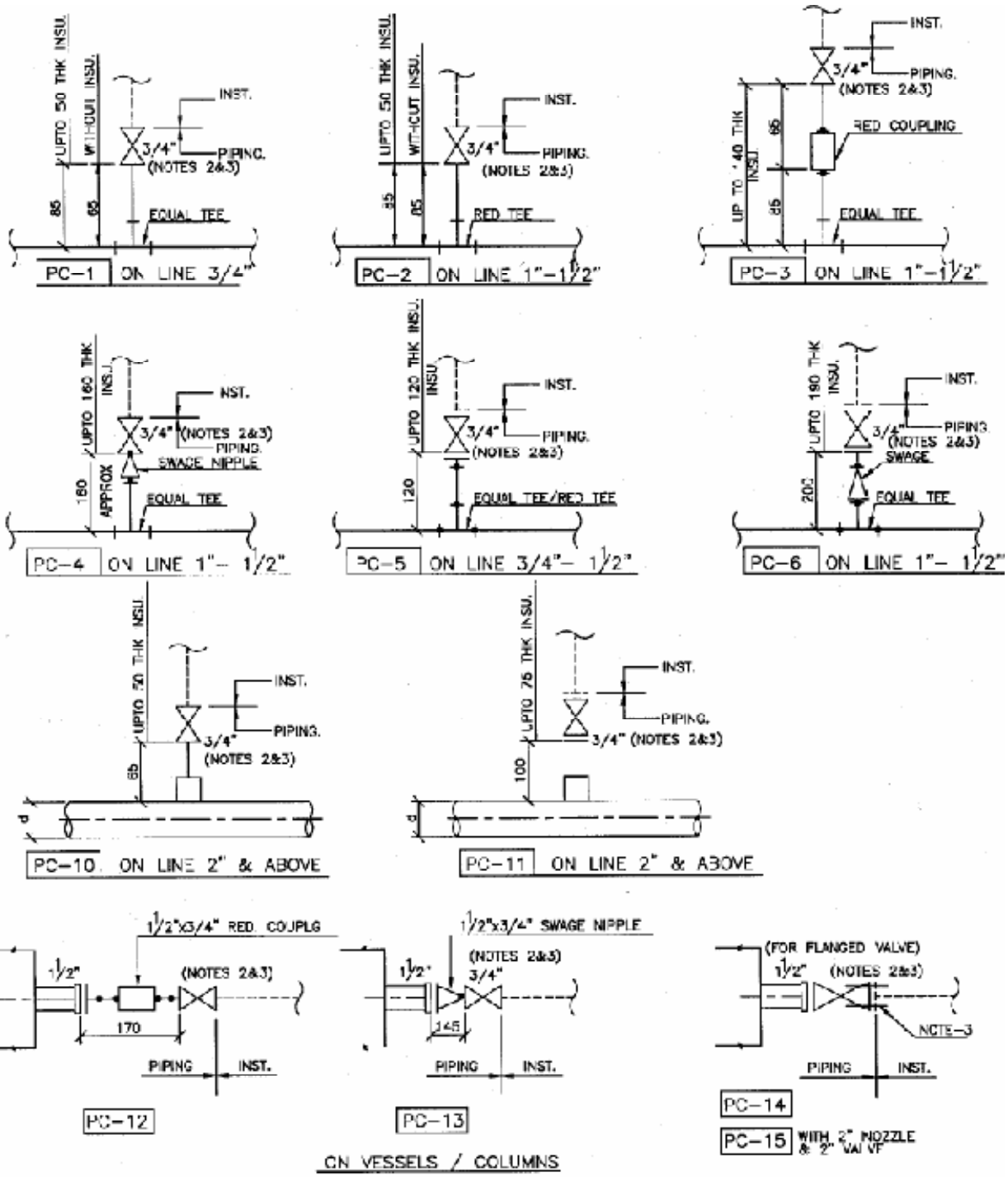
ENGINEERING STANDARD

GAIL INDIA LIMITED

PRESSURE TAPPING (PA, PG, PC, PT, PIC, ETC)

GAIL-STD-ME-DOC-TS-006

0	12.01.19	Issued For Tender	AP	JR	SB



NOTES :

1. THE INDICATED DIMENSIONS ARE MINIMUM WHICH ALSO COVER INSULATION TO THE EXTENT SHOWN ABOVE. IN CASE OF HIGHER THICKNESS OF INSULATION THAN INDICATED THE DIFFERENCE SHALL BE ADDED IN THE DIMENSIONS SHOWN ABOVE.
2. PRESSURE TAPPING SHALL BE PROVIDED WITH VALVE SIMILAR TO LINE ISOLATION VALVE (GATE, BALL OR PLUG VALVE ETC. WITH FLGD, S.W. OR SCR'D ENDS) UNLESS OTHERWISE SPECIFIED IN PMS, TEE(EQUAL OR REDUCING),/HALF COUPLING(S.W. OR SCR'D),/STUB IN/SOCKOLET/WELDOLET SHALL BE AS PER PIPING MATERIAL SPECS.
3. IN CASE OF FLGD VALVES BOLTING & GASKET ON BOTH SIDES OF VALVE SHALL BE IN PIPING SCOPE.
4. IN CASE OF TAPPING PROVIDED OTHER THAN INDICATED IN THIS STD FOR LAYOUT REASONS DETAILED DIMENSIONS WILL BE CALLED OUT.

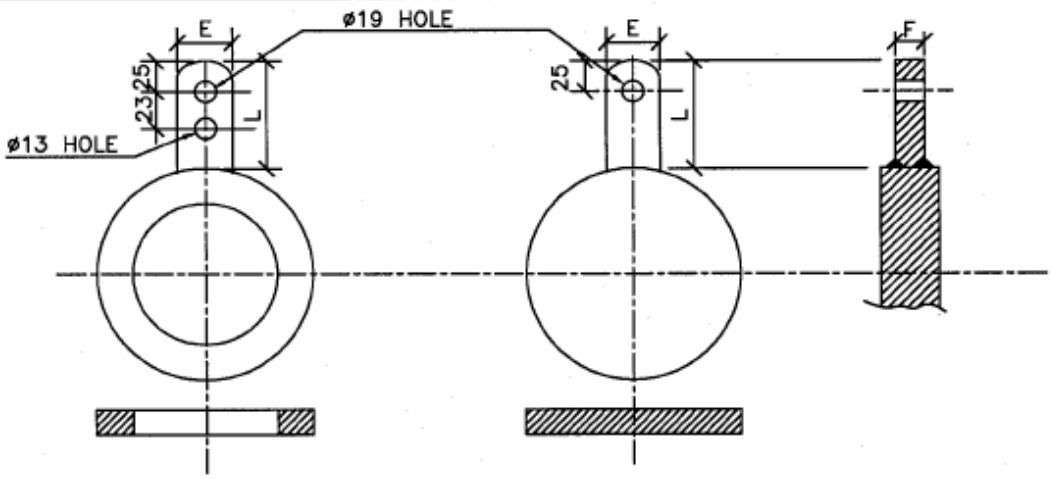
ENGINEERING STANDARD

GAIL INDIA LIMITED

DIMENSIONS FOR HANDLE PROJECTION FOR SPACER AND BLINDS: ½" – 24" NB (150#, 300#, 600# FF)

GAIL-STD-ME-DOC-TS-007

0	12.01.19	Issued For Tender	AP	JR	SB	
Rev	**Date**	**Purpose**	**Prepared By**	**Checked By**	**Approved By**	



PIPE SIZE INCH	150# FF			300# FF			600# FF		
	E	F	L	E	F	L	E	F	L
1/2"	25	3	100	25	6	100	25	6	110
3/4"	25	3	100	25	6	100	25	6	110
1"	25	3	100	25	6	100	25	6	110
1 1/2"	25	6	100	25	6	100	25	6	110
2"	25	6	100	25	6	100	25	6	110
2 1/2"	25	6	100	25	6	110	25	6	110
3"	40	6	105	40	6	110	40	8	110
4"	40	6	105	40	6	110	40	8	110
6"	40	6	105	40	6	110	40	8	115
8"	40	6	105	40	8	110	40	10	125
10"	40	8	105	40	10	110	40	10	125
12"	40	8	110	40	10	120	40	15	125
14"	40	10	120	40	15	120	40	15	145
16"	40	10	120	40	15	130	40	20	140
18"	40	10	120	40	20	130	40	20	140
20"	40	14	120	40	20	140	40	25	140
24"	50	16	120	50	20	140	50	25	145

NOTES :

1. ALL DIMENSIONS ARE IN MILLIMETRES
2. ALL OTHER DIMENSIONS SHALL BE AS PER ASME B16.48
3. MATERIAL SHALL BE AS PER MR.
4. THE HANDLE MAY BE INTEGRAL OR ATTACHED TO THE LINE BLANK/SPACER BY WELDING. IN CASE OF ATTACHMENT OF HANDLE BY WELDING, HEAT TREATMENT AND WELDING SHALL BE IN ACCORDANCE WITH ASME B31.3.

GAIL INDIA LIMITED

STANDARD SPECIFICATION

FOR

PIPELINE BALL VALVES

GAIL-STD-ME-DOC-TS-008

0	22.01.2019	Issued for Bid	RKS	AP	JR	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

CONTENTS

1.0 SCOPE

This specification covers the minimum requirements for design, manufacture, testing and supply of carbon steel ball valves of size DN 50mm (2") and above and ANSI class 150# thru 900# for use in onshore pipeline systems handling non sour hydrocarbons in liquid or gaseous phase including Liquefied Petroleum Gas (LPG).

This specification does not cover ball valves for sour hydrocarbons (liquid/gas) service as defined in NACE Standard MR-01-75.

2.0 REFERENCE DOCUMENTS

2.1 All valves shall be manufactured and supplied in accordance with the latest edition of American Petroleum Institute (API) Specification6D, Twenty Second edition, January 2002/ISO14313:1999, Petroleum and Natural Gas Industries – Pipeline Transportation Systems – Pipeline Valves, with additions and modifications as indicated in the following sections of this specification.
In addition to this specification, wherever applicable, the stringent requirements/ provisions/ amendments of the latest 23rd edition of API 6D (Effective October – 2008) shall also apply."

2.2 Reference has also been made in this specification to the latest edition (edition enforce at the time of issue of enquiry) of the following Codes, Standards and Specifications.

ASME B 31.3	-	Process Piping
ASME B 31.4	-	Pipeline Transportation System for Liquid Hydrocarbons and other Liquids
ASME B 31.8	-	Gas Transmission and Distribution Piping Systems
ASME B 16.5	-	Pipe Flanges and Flanged Fittings
ASME B 16.10	-	Face to Face and End to End Dimensions of Valves
ASME B 16.25	-	Butt-welding Ends
ASMEB 16.34	-	Valves-Flanged, Threaded and Welding Ends. ASME
B 16.47	-	Large Diameter Steel Flanges
API 1104	-	Welding Pipelines and Related Facilities

ASME Sec VIII	-	Boiler and Pressure Vessel Code – Rules for Construction of Pressure Vessels.
ASME Sec IX	-	Boiler and Pressure Vessel Code – Welding and Brazing Qualifications
ASTMA-370	-	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTMB-733	-	Auto catalytic Nickel Phosphorous Coating on Metals
MSS-SP-6	-	Standard Finishes for Contact Faces of Pipe Flanges and Connecting- end Flanges of Valves and Fittings.
MSS-SP-44	-	Steel Pipeline Flanges.
SSPC-VIS-1	-	Steel Structures Painting Council Visual Standard.

2.3 In case of conflict between the requirements of this specification, API 6D and the Codes, Standards and Specifications referred in clause2.2 above, the requirements of this specification shall govern.

3.0 MATERIALS

3.1 Material for major components of the valves shall be as indicated in Valve Data Sheet. Other components shall be as per Manufacturer's standard (suitable for the service conditions indicated in the data Sheet) and shall be subject to approval by Purchaser. In addition, the material shall also meet the requirements specified hereinafter.

All process wetted parts, metallic and nonmetallic, and lubricants shall be suitable for the service specified by the Purchaser. Manufacturer shall confirm that all wetted parts are suitable for treated water/ seawater environment, which may be used during field testing.

Nonmetallic parts of the valves (including O-rings, soft seals, etc.) intended for hydrocarbon gas service shall be resistant to explosive decompression.

3.2 Carbon steel used for the manufacture of valves shall be fully killed.

3.3 The carbon equivalent (CE) of valve end connections which are subject to further field welding by Purchaser shall not exceed 0.45 on check analysis for each heat of steel used, as calculated by the following formula:

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

3.4 For valves specified to be used for Gas service or High Vapour Pressure (HVP) liquid service/ LPG service, Charpy V-notch test on each heat of base material shall be conducted as per API 6D, Clause-7.5, for all pressure containing parts such as body, end flanges and welding ends as well as bolting material for pressure containing parts. Unless specified otherwise, the Charpy V-notch test shall be conducted at-29°C. Test procedure shall confirm to ASTM A 370. The Charpy V- notch test specimen shall be taken in the direction of principal grain flow and notched perpendicular to the original surface of plate or forging. The minimum average absorbed energy per set of three specimens shall be 27 J with an individual minimum per specimen of 22 J.

For valves specified to be used for other hydrocarbon services, Charpy V-notch requirements as stated above are not applicable, unless required by the specified material standard as a mandatory requirement.

When Low Temperature Carbon Steel (LTCS) materials are specified in Valve Data Sheet or offered by Manufacturer, the Charpy V-notch test requirements of applicable material standard shall be complied with.

3.5 For Valves specified to be used for Gas service or LPG service, Hardness test shall be carried out as per ASTM A 370 for each method of manufacture and each heat of steel used in the manufacture of valves. A full thickness cross section shall be taken for this purpose and the maximum hardness of the materials of valve components shall not exceed 248HV_{10}.

3.6 For all such valves where Carbon Steel is used as ball material, the ball shall have 75 micrometers (0.003 inches) thick Electroless Nickel Plating (ENP) as perASTM B 733 with following classification:

- SC2,TypeII,Class2.

The hardness of plating shall be minimum 50 RC.

3.7 HEAT TREATMENT

- After hot working and before re-heating for normalizing heat treatment, forging or casting shall be allowed to cool substantially below the transformation range. All forging or casting shall be heat treated by normalizing. Normalising shall be carried out in such a way that the base material acquires a fine grained perlitic structure.

- Heat treatment of welds: the rules of ASME VIII Div. 1 are applicable. If a required treatment is not feasible (seat damage, etc…), special agreement must be obtained from Purchaser/ Engineer and Control Authority, after the Manufacturer has proved good quality of welds.

4.0 DESIGN AND CONSTRUCTION REQUIREMENTS

4.1 Valve design shall meet the requirements of API Specification 6D and shall be suitable for the service conditions indicated in the Valve Data Sheet. The ASME Boiler & Pressure Vessel Code, Section VIII, Division 1 shall be used to design the valve body. Allowable stress requirements shall comply the provisions of ASME B31.3. In addition, corrosion allowance indicated in Valve Data Sheet shall be considered in valve design. However, the minimum wall thickness shall not be less than the minimum requirement of ASME B 16.34. The manufacturer shall have valid license to use API monogram on valves manufactured as per API 6D.

4.2 For above ground valves, valve body design shall be either fully welded or bolted type. Valve body joints with threads are not permitted.

For buried valves, valve body design shall be fully welded type only. Valve body joints with bolts or threads are not permitted.

4.3 Ball shall be of single piece, solid type construction.

4.4 Valves shall be Full bore (FB) or Reduced bore (RB) as indicated in the Valve Data Sheet. Full bore valves shall be suitable for the passage of all types of pipeline pigs including instrumented intelligent pigs and regular cleaning, batching and scraper pigs on regular basis without causing damage to either the valve component or the pig. The full bore valve shall provide an unobstructed profile for pigging operations in either direction. Full bore valves shall be designed to minimize accumulation of debris in the seat ring region to ensure that valve movement is not impeded.

The bore size of reduced bore valves shall be corresponding to that of a full bore valve of smaller nominal diameter as indicated in Table 4.4 of this specification. For sizes of a particular rating not covered in API 6D, the bore size of reduced bore valve shall be as per Manufacturer's standard.

TABLE - 4.4

Nominal Valve Size,	Nominal Valve size for Reduced Bore	Nominal Valve Size,	Nominal Valve Size For Reduced Bore
DN mm (NPS inches)	DN mm(NPS inches)	DN mm (NPS inches)	DN mm (NPS inches)

50(2)	50(2)	600(24)	500(20)
80(3)	50(2)	650(26)	550(22)
100(4)	80(3)	700(28)	600(24)
150(6)	100(4)	750(30)	600(24)
200(8)	150(6)	800(32)	650(26)
250(10)	200(8)	850(34)	700(28)
300(12)	250(10)	900(36)	750(30)
350(14)	250(10)	950(38)	800(32)
400(16)	300(12)	1000(40)	850(34)
450(18)	350(14)	1050(42)	900(36)
500(20)	400(16)	1200(48)	1050(42)

4.5 Ball mounting shall be trunnion or pivot type only. Valve design shall minimize the possibility of debris ingress into the trunnion as far as practicable.

4.6 Valve seats shall be with primary metal to metal contact. O-rings or other seals if used for drip tight sealing shall been cased in a suitable groove in such a manner that it can not be removed from seat ring and there is no extrusion during opening or closing operation at maximum differential pressure corresponding to valve class rating. The seat rings shall be so designed as to ensure sealing at low as well as high differential pressures and according to duty/ torque requirement of the valve and with a positive mechanical retention feature. Seat design with PTFE inserts is not acceptable.

4.7 Valves shall be designed to withstand a sustained internal vacuum of at least 1 (one) milli-bar in both open and closed positions.

4.8 All trunnion mounted ball valves shall have double block and bleed feature to facilitate complete flush, drain and venting of the valve body cavity. Valves shall be fitted with anti-static device conforming to BS5351. Inconformity with BS 5351 valve shall be designed with an anti blow-out stem so that the stem cannot be fully ejected by pressure inside the valve with the stem packing, gland retainer bolting removed.

4.9 Full Bore valves of nominal valve size 200 mm (8") & above and Reduced Bore valves of nominal valve size 250mm (10") & above, shall have provision for secondary sealant injection under full line pressure for seat and stem seals. All sealant injection connections shall be provided with an internal non-return valve. Valve design shall have a provision to replace the sealant injection fitting under full line pressure. Location and arrangement of sealant point shall be as per Fig.4.9.

4.10 Valves shall be provided with vent and drain connections. Location and arrangement of vents and drains shall be as per Fig.4.9. Body vent and drain shall be provided with valves (Ball or Plug type). Number and size shall be as per Fig.4.9.

4.11 Valve design shall ensure repair of stem seals/ packing under full line pressure.

4.12 Full Bore valves of nominal valve size DN 200 mm (8") & above and Reduced Bore valves of nominal valve size DN 250 mm (10") & above, shall be equipped with support foot and lifting lugs. Tapped holes and eye bolts shall not be used for lifting lugs. Height of support foot shall be kept minimum. The location and size of support foot/ lifting lugs shall ensure unrestrictive operation of vent/ drain valves.

4.13 Valve design shall be such as to avoid bimetallic corrosion between carbon steel and high alloy steel components, suitable insulation shall be provided as required.

4.14 For valves to be used in liquid service, the body cavity over-pressure shall be prevented by self-relieving seat rings/ assemblies. Self-relieving seat rings shall relieve at a body cavity differential pressure not exceeding 50% of the valve class rating pressure**.**

4.15 a) Valve ends shall be either flanged/ or butt welded or one end flanged and one end butt welded as indicated in the Valve DataSheet. Flanges of the flanged end cast/ forged body valves shall be integrally cast/ forged with the body of the valve. Face to face/ end to end dimensions shall conform to API 6D. Face to Face and end to end dimensions for valve sizes not specified in API6D shall be in accordance with ASME B 16.10. Face to face and end to end dimension not shown in API 6D or ASME B16.10 shall be as per Manufacturer's Standard and shall be subject to approval by Company.

b) Flanged end, if specified, shall have dimensions as per ASME B16.5 for valve sizes upto DN 600 mm (24") excluding DN 550mm (22") and as per MSS-SP-44/ ASMEB16.47 Series A for valve sizes DN 550 mm (22") and for DN 650 mm (26 inches) and above. Flange face shall be either raised face or ring joint type (RTJ) as indicated in Valve DataSheet. Flange face finish shall be serrated or smooth as indicated in Valve DataSheet. In case of RTJ flanges, the groove hardness shall be minimum 140 BHN.

c) Butt weld end preparation shall be as per ASME B 16.25. The thickness of the pipe to which the valve has to be welded shall be as indicated in the Valve Data Sheet. Valves shall be with or without transition pups. In case difference exists between thickness of welding ends of valve and connecting pipe, the welding ends of valve shall have bevel preparation as per ASME B 31.4 or ASME B 31.8 as applicable. In case valve is supplied with Pup piece (if specified in datasheet), the pup piece shall be welded on both ends which shall be considered as an integral part of the valve and hence strength test, hydrostatic test and leak test should be done with pup piece/ transition piece weld on valves.

4.16 Design of weld end valves shall be such that during field welding operation, the soft seals or plastic components of the valve (wherever used) is not liable to be damaged. The manufacturer shall furnish necessary field welding instructions and post weld test procedure to demonstrate integrity and leak tightness of valves after field welding operations.

4.17 Valve shall be provided with ball position indicator and stops of rugged construction at the fully open and fully closed positions.

4.18 Valves shall be suitable for either buried or above ground installation as indicated in valve Data Sheet.

4.19 When stem extension requirement is indicated in Valve Data Sheet, the valves shall have the following provisions.

a) Valves provided with stem extension shall have water proof outer casing. Length of stem extension shall be as indicated in Valve Data Sheet. The length indicated corresponds to the distance between centerline of the valve opening and the top of mounting flange for valve operating device (gear operator/ power actuator as applicable).

b) Vent and drain connections and sealant injection lines shall be terminated adjacent to the valve operator by means of suitable piping anchored to the valve body. The pipe used shall be API 5L Gr.B/ ASTM A106 Gr.B, with Sch. 80. Fittings shall be ASTM A105/ ASTM A234 Gr.WPB, Socket welded ANSI class 6000.

c) Stem extension and stem housing design shall be such that the complete assembly will form a rigid unit giving positive drive under all conditions with no possibility of free movement between valve body, stem extension or its operator.

d) Outer casing of stem extension shall have 3/8"or½" NPT plugs at the top and bottom, for draining and filling with oil to prevent internal corrosion.

4.20 OPERATING DEVICES

a) Valves shall have a power actuator or manual operator as indicated in the Valve Data Sheet. In case of manual operator, valve sizes, DN"100 mm (4") shall be wrench operated and valve sizes, DN• 150 mm (6") shall be gear operated. Each wrench operated valve shall be supplied with wrench. Valve design shall be such that damage due to malfunctioning of the operator or its controls will only occur in the operator gear train or power cylinder and that damaged parts can be replaced without the valve cover being removed.

b) The power actuator shall be in accordance with the Purchaser Specification issued for the purpose and as indicated in the Valve and Actuator Data Sheet. Operating time shall be as indicated in Valve Data Sheet. Valve operating time shall correspond to full close to full open/ full open to full close under maximum differential pressure corresponding to the valve rating. For actuated valves, the actuator's rated torque output shall be 1.25 times the break torque required to operate the ball valve under the maximum differential pressure corresponding to the Valve Class Rating.

c) For the manual operator of all valves, the diameter of the hand wheel or the length of operating wrench shall be such that under the maximum differential pressure, the total force required to operate the valve does not exceed 350 N. Manufacturer shall also indicate the number of turns of hand wheel (in case of gear operators) required for operating the valve from full open to full close position.

d) Direction of operation of hand wheel or wrench shall be in clock-wise direction while closing the valve. Hand wheels shall not have protruding spokes.

e) Gear operators, when provided, shall have a self-locking provision and shall be fully encased in water proof/ splash proof enclosure and shall be filled with suitable grease.

4.21 The tolerance on internal diameter and out of roundness at the ends for welded ends valves shall be as per connected pipe specification as indicated in the Valve Data Sheet.

4.22 When indicated in Material Requisition, valves shall have locking devices to lock the valve either in full open (LO) or full close (LC) position. Locking devices shall be permanently attached to the valve operator and shall not interfere with operation of the valve.

4.23 All welds shall be made by welders and welding procedures qualified in accordance with the provisions of ASME Section IX. The procedure qualification shall also

Include impact test and hardness test when required as per Clause 3.4 and 3.5 of this specification and shall meet the requirements as specified therein.

4.24 Repair by welding is not permitted for fabricated and forged body valves. However repair by welding as per ASME B 16.34 is permitted for cast body valves. Such repairs shall be carried out at casting supplier's care only. Repair shall be carried out before any heat treatment of casting is done. Repair welding procedure qualification shall also include impact test and hardness test when required as per clause 3.4 and
3.5 of this specification and shall meet the requirement as specified therein.

4.25 Valve stem shall be capable of withstanding the maximum operating torque required to operate the valve against the maximum differential pressure corresponding to applicable class rating. The combined stress shall not exceed the maximum allowable stresses specified in ASME section VIII, Division 1. For power actuated valves, the valve stem shall be designed for maximum output torque of the selected power actuator (including gear box, if any) at valve stem.

5.0 INSPECTION AND TESTS

5.1 The Manufacturer shall perform all inspection and tests as per the requirements of this specification and the relevant codes, prior to shipment, at his Works. Such inspection and tests shall be, but not limited to, the following:

5.1.1 All valves shall be visually inspected. The internal and external surfaces of the valves shall be free from any strikes, gouges, and other detrimental defects. The surface shall thoroughly cleaned and free from dirt, rust and scales.

5.1.2 Dimensional check on all valves shall be carried out as per the Purchaser approved drawings.

5.1.3 Chemical composition and mechanical properties shall be checked as per relevant material standards and this specification, for each heat of steel used.

5.1.4 Non-destructive examination of individual valve material and component consisting of but not limited to castings, forgings, plates and assembly welds shall be carried out by the Manufacturer.

a) Body castings of all valves shall be radiographically examined as per ASME B 16.34. Procedure and acceptance criteria shall be as per ASME B 16.34. The extent of the radiography shall be as under:

Pressure Class Rating	Valve Size	Extent of Radiography
ANSI 150# Class	All sizes	Nil
ANSI 300# Class	” DN 400 mm (16´) • DN 450 mm (18´)	Nil 100%
ANSI 600# Class and above	Allsizes	100%

All castings shall be wet magnetic particle inspected 100% of the internal surfaces. Method and acceptance shall comply with ASME B 16.34.

b) All valves, with body fabricated from plates or made by forgings, shall be ultrasonically examined in accordance with the procedure and acceptance standard of Annexure-E of ASME B 16.34.
All forgings shall be wet magnetic particle inspected 100% of the internal surfaces. Method and acceptance shall comply with ASME B 16.34.

c) Bodies and bonnets made by welded assembly of segments of castings, forgings, plates or combinations thereof shall be examined, as applicable, by methods of 5.1.4 (a) for cast components or 5.1.4 (b) for forged components and plates.

5.1.5 Full inspection by radiography shall be carried out on all welds of pressure containing parts. Acceptance criteria shall be as per ASME B31.4 or ASME B 31.8 as applicable and API1104.

5.1.6 Welds, which in Purchaser's opinion cannot be inspected by radiographic methods, shall be checked by ultrasonic or magnetic particle methods and acceptance criteria shall be as per ASME Sec.VIII, Division 1, Appendix 12 and Appendix 6 respectively.

5.1.7 a) All finished wrought weld ends subject to welding in field shall be 100% ultrasonically tested for lamination type defects for a distance of 50 mm from the end. Laminations shall not be acceptable.

b) Weld ends of all cast valves subject to welding in field shall be 100% radio-graphically examined and acceptance criteria shall be as per ASME B 16.34.

c) After final machining, all bevel surfaces shall be inspected by dye penetrant or wet magnetic particle methods. All defects longer than 6.35 mm are rejected, as are the defects between 6.35 mm and 1.59 mm that are separated by a distance less than 50 times their greatest length. Rejectable defects must be removed. Weld repair of bevel surface is not permitted.

5.1.8 All valves shall be tested in compliance with the requirements of API6D. During pressure, testing, valves shall not have sealant lines and other cavities filled with sealant, grease or other foreign material. The drain, vent and sealant lines shall be either included in the hydrostatic shell test or tested independently. The pressure shall be held for at least 30 minutes. No leakage is permissible during hydrostatic testing. The body cavity self-relieving feature meeting the requirements of clause 4.14 of this specification shall also be checked.

Hydrostatic and air seat test shall be performed after an acceptable shell test.

Fluid for shell and hydrostatic seat tests shall be liquid as water (which may contain a corrosion inhibitor), kerosene, or other fluid with a viscosity not greater than that of water. Temperature of test fluid shall not exceed 50^0C.

Valve test fixture loads applied to valve ends shall be limited to those required to effectively seal the valve ends.

Shell Test

- Each valve shall be given a shell test at the gauge pressure not less than 1.5 times the 38^0C rating gauged by ASME B 16.34, rounded off to the next higher 1bar increment. Shell test shall be conducted with the valve in a partially open position and with the valve ends closed.
- Drain lines and valves Shall be either included in the hydrostatic shell test, or tested separately.
- Duration of the shell test
  Duration of shell test shall not be less than 30 minutes.

- Visual leakage or harmful in elastic deformation are not acceptable.

Hydrostatic seat test

- Each valve shall be given a hydrostatic seat test at gauge pressure not less than 1.1 times the 38^0C rating gauged by ASME B 16.34, rounded off to the next higher 1 bar increment.

- Seat closure testing shall be performed with seat surfaces free of sealant, grease or other material that aids in sealing except as provided hereafter :

  - When necessary to prevent damage during valve actuation, a light oil of viscosity not greater than that of kerosene may be applied to sealing surface.
  - When valve primary design is based on the presence of a sealant material (lubricated plug valve), the sealant material may be in place.

- For valve of the double seating type such as gate, plug and ball valve, the test pressure shall be applied successively to each end of the closed valve and leakage to opposite end checked. Provision shall be taken before, for de- energizing these lf relieving pressure system.

o For soft seated valves there shall be no visible leakage – for metal seated valves the leakage rate shall not exceed 0.006 ml per minute and per mm of nominal pipe size (ND).

o For double block and bleed valve the following tests shall be performed:

Close valve, open body vent, apply seat test pressure to both ends of the valve.
Close valve, open body vent, apply seat test pressure to one end of the valve, release pressure and repeat test for the other end of the valve.

External leaktesting

- Under the supervision of the GAIL/ TPIA delegate, the Manufacturer shall check the external leak tightness of the body, stem and all external taps. This shall be done with soapsuds at an inner pressure of 6 bar. For underground valves, this test shall include piping, fittings and valves of the auxiliary lines for drain, vent/bleed and sealant connections.

FIRE TEST

- The Manufacturer shall supply valves qualified by fire testing as specified in API 6FA, Fire Test for Valves, or API Standard607 – Fire Test for Soft Seated Quarter-Turn Valves Latest Edition.

ANTI-STATIC DEVICETESTING

- If requested in the Purchase Order, all ball valves shall be submitted of to an anti-static testing in accordance with BS 5146.

VISUAL AND DIMENSIONAL EXAMINATION

- All valves shall be visually and dimensionally examined MSS-SP-55.

5.1.9 A supplementary air seat test as per API 6D (Appendix C, Para C.3.3) shall be carried out for all valves. A bubble tight seal is required without the use of any sealant. No leakage is allowed. Test pressure shall be held for at least 15 minutes.

5.1.10 Valves shall be subjected to Operational Torque Test as per Appendix C, Para C.6 of API 6D under hydraulic pressure equal to maximum differential pressure corresponding to the valve rating. For manually operated valves, it shall be established that the force required to operate the valve does not exceed the requirements stated in section 4.20(c) of this specification.

5.1.11 Power actuated valves shall be tested after assembly of the valve and actuator, at the valve Manufacturer's works. At least five Open-Close-Open cycles without internal pressure and five Open-Close-Open cycles with maximum differential pressure corresponding to the valve rating shall be performed on the valve actuator assembly. The time for Full Open to Full Close shall be recorded during testing. If required, the actuator shall be adjusted to ensure that the opening and closing time is within the limits stated in Valve Data Sheet.

Hand operator provided on the actuator shall also be checked after the cyclic testing, for satisfactory manual over-ride performance.
These tests shall be conducted on minimum one valve out of a lot of five (5) valves of the same size, rating and the actuator model/ type. In case, the tests do not meet the requirements, retesting/ rejection of the lot shall be decided by the Purchaser's Inspector.

5.1.12 Subsequent to successful testing as specified in clause 5.1.10 and 5.1.11 above, one(1) valve out of the total ordered quantity shall be randomly selected by the Company Representative for cyclic testing as mentioned below:

a) The valve shall be subjected to at least 100 Open-Close-Open cycles with maximum differential pressure corresponding to the valve rating.

b) Subsequent to the above, the valve shall be subjected to hydrostatic test and supplementary air seat test in accordance with clause 5.1.8 and 5.1.9.

In case this valve fails to pass these tests, the valve shall be rejected and two more valves shall be selected randomly and subjected to testing as indicated above. If both valves pass these tests, all valves manufactured for the order (except the valve that failed) shall be deemed acceptable. If either of the two valves fails to pass these tests, all valves shall be rejected or each valve shall be tested at the option of manufacturer.
Previously carried out test of similar nature shall be considered acceptable if same has been carried out by manufacturer in last two years. Valves of two sizes below and two sizes above the size of valve previously tested, and rating similar or one rating lower of valve tested previously, shall be qualified.

5.1.13 Checks shall be carried out to demonstrate that the dissimilar metals used in the valves are successfully insulated as per requirement of clause 4.13 of this specification.

5.2 Purchaser reserves the right to perform stage wise inspection and witness tests as indicated in clause 5.1 above at Manufacturer's works prior to shipment. Manufacturer shall give reasonable access and facilities required for inspection to the Purchaser's Inspector. Purchaser reserves the right to require additional testing at any time to confirm or further investigate a suspected fault. The cost incurred shall be to Manufacturer's account.

In no case shall any action of Purchaser or his inspector shall relieve the manufacturer of his responsibility for material, design, quality or operation of valves.

Inspection and tests performed/witnessed by the purchaser's inspector shall in no way relieve the manufacturer's obligation to perform the required inspection and tests.

6.0 TEST CERTIFICATES

Manufacturer shall submit the following certificates:

a) Mill test certificates relevant to the chemical analysis and mechanical properties of the materials used for the valve construction as per the relevant standards.
b) Test certificates of hydrostatic and pneumatic tests complete with records of timing and pressure of each test.
c) Test reports of radiograph and ultrasonic inspection.
d) Test report on operation of valves conforming to clause 5.1.10, 5.1.11 and 5.1.12 of this specification.
e) All other test reports and certificates as required by API 6D and this specification.

The certificates shall be valid only when signed by Purchaser's Inspector. Only those valves which have been certified by Purchaser's Inspector shall be dispatched from Manufacturer's works.

7.0 PAINTING, MARKING AND SHIPMENT

7.1 Valve surface shall be thoroughly cleaned, freed from rust and grease and applied with sufficient coats of corrosion resistant paint. Surface preparation shall be carried

Out by shot blasting to SP-6 in accordance with "Steel Structures Painting Council-Visual Standard SSPC-VIS-1". For the valves to be installed underground, when indicated in Valve Data Sheet, the external surfaces of buried portion of the valve shall be painted with three coats of suitable coaltar epoxy resin with a minimum dry film thickness of 300microns.

7.2 All valves shall be marked as per API6D. The units of marking shall be metric except nominal diameter, which shall be in inches.

7.3 Valve ends shall be suitably protected to avoid any damage during transit. All threaded and machined surfaces subject to corrosion shall be well protected by a coat of grease or other suitable material. All valves shall be provided with suitable protectors for flange faces, securely attached to the valves. Bevel ends shall be protected with metallic or high impact plastic bevel protectors.

7.4 All sealant lines and other cavities of the valve shall be filled with sealant before shipment.

7.5 Packaging and shipping instructions shall be as per API 6D.

7.6 On packages, following shall be marked legibly with suitable marking ink:

- **a)** Order Number
- **b)** Manufacturer's Name
- **c)** Valve size and rating
- **d)** Tag Number
- **e)** Serial Number

8.0 SPARES AND ACCESSORIES

8.1 Manufacturer shall furnish list of recommended spares and accessories for valves required during start-up and commissioning and supply of such spares shall be included in the price quoted by Manufacturer.

8.2 Manufacturer shall furnish list of recommended spares and accessories required for two years of normal operation and maintenance of valves and price for such spares shall be quoted separately.

9.0 DOCUMENTATION

Documentation to be submitted by Manufacturer to Purchaser is summarized below. Number of Copies (Hardcopies/ soft copies, etc.) shall be as indicated in CONTRACT document.

9.1 At the time of bidding, Manufacturer shall submit the following documents:

a) General arrangement/assembly drawings showing all features and relative positions and sizes of vents, drains, gear operator/actuator, painting, coating and other external parts together with overall dimension. General arrangement drawings shall also indicate weight of valve as well as actuator.

b) Sectional drawing showing major parts with reference numbers and material specification. In particular a blowup drawing of ball-seat assembly shall be furnished complying the requirement of clause 4.6 of this specification.

c) Reference list of similar ball valves manufactured and supplied in last five years indicating all relevant details including project, year, client, location, size, rating, service, etc.

d) Torque curves for the power actuated valves along with the break torque and maximum allowable stem torque. In addition, sizing criteria and torque calculations shall also be submitted for power actuated valves.

e) Clause wise list of deviations from this specification, if any.

f) Descriptive technical catalogues of the manufacturer.

g) Installation, Operational and Maintenance Manual.

h) Copy of valid API 6D Certificate.

i) Details of support foot including dimensions and distance from valve centerlinetobottomofsupportfoot.

j) List of recommended spares required during start-up and commissioning.

k) List of recommended spares required for 2 years of normal operation and maintenance.

9.2 Within three weeks of placement of order, the Manufacturer shall submit the following drawings, documents and specifications for Purchaser's approval:

a) Detailed sectional drawings showing all parts with reference numbers and material specifications.

b) Assembly drawings with overall dimensions and features. Drawing shall also indicate the number of turns of hand wheel (in case of gear operators) required for operating the valve from full open to full close position and the painting scheme. Complete dimensional details of support foot (where applicable) shall be indicated in these drawings.

c) Welding, heat treatment and testing procedures.

d) Details of corrosion resistant paint to be applied on the valves.

e) Design calculation for pressure containing parts.

f) Procedure for cyclic testing.

Manufacture of valves shall commence only after approval of the above documents. Once the approval has been given by Purchaser, any changes in design, material and method of manufacture shall be notified to Purchaser whose approval in writing of all changes shall be obtained before the valve is manufactured.

9.3 Within 30days from the approval date, Manufacturer shall submit to Purchaser one reproducible and six copies of the approved drawings, documents and specifications as listed in clause9.2 above.

9.4 Prior to shipment, Manufacturer shall submit to Purchaser following:

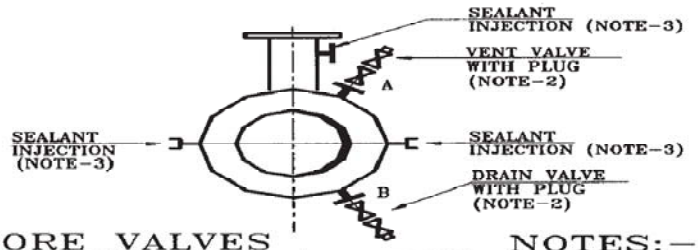
a) Test certificates as per clause 6.0 of this specification

b) Manual for installation, erection, maintenance and operation instructions including a list of recommended spares for the valves.

c) Test Reports shall be furnished listing as built drawing sand calculations, list of operations in Fabrication and control, the base material certificate, the chemical check analysis of the welding ends. The certificate of the Heat Treatment, the Mechanical Test, the NDE, the Pressure Testing, the Operational torque Test, the Quality Release Note and any other Test required by the Purchase Order. The valve individual number must be indicated in the respective 'Test Reports' to permit the correct traceability of each valve. The manufacturer shall furnish one copy of Test Report to the Inspection Agency and one copy to the Purchaser.

9.5 All documents shall be in English language only.

ABOVE GROUND INSTALLATION



FULL BORE VALVES

VALVE SIZE, DN(mm)	A, DN(mm)	B, DN(mm)
50 AND 150	–	15
200 TO 600	15	25
650 & ABOVE	15	50

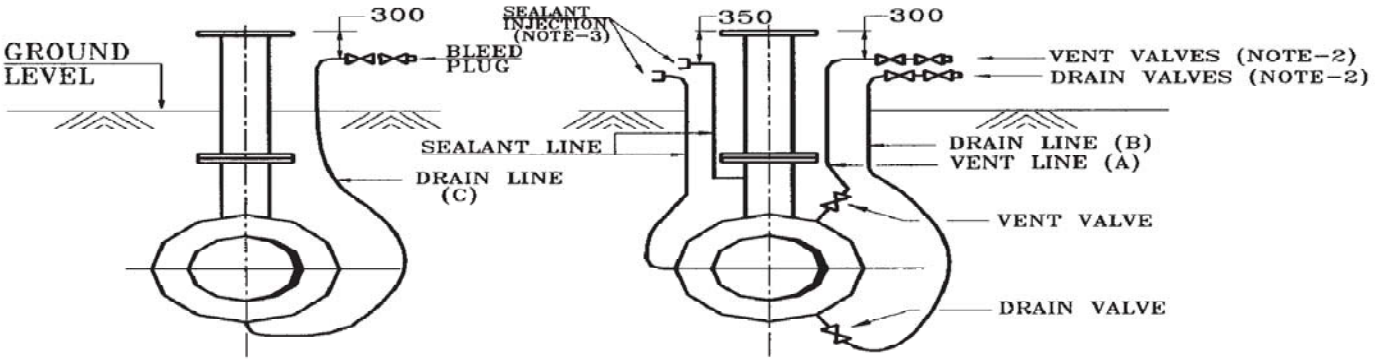
REDUCED BORE VALVES

VALVE SIZE, DN(mm)	A, DN(mm)	B, DN(mm)
50 AND 200	–	15
250 TO 750	15	25
ABOVE 750	15	50

NOTES:–

1. ALL VALVES (BALL OR PLUG) AND PLUGS FOR A AND B SHALL BE APPROVED BY THE PURCHASER.
2. VALVES OF SIZE 50 mm SHALL BE MANUFACTURED AS PER API–6D.
3. SEALANT POINTS SHALL BE PROVIDED FOR FULL BORE VALVES OF NOMINAL VALVE SIZE 200 mm (8") & ABOVE AND REDUCED BORE VALVES OF NOMINAL VALVE SIZE, DN 250 mm (10") AND ABOVE ONLY. SEALANT LINES SHALL HAVE PROVISION TO REPLACE THE SEALANT INJECTION FITTING UNDER FULL LINE PRESSURE.
4. ALL VENT/DRAIN CONNECTION SHALL BE WELDED WITH THE BODY.

UNDERGROUND INSTALLATION



FB VALVES DN 50 mm(2") TO DN 150 mm(6") FB VALVES ≥ DN 200 mm(8")
RB VALVES DN 50 mm(2") TO DN 200 mm(8") RB VALVES ≥ DN 250 mm(10")

FULL BORE (FB) VALVES

VALVE SIZE, DN(mm)	A, DN(mm)	B, DN(mm)	C, DN(mm)
50 AND 150	–	–	15
200 TO 300	25	25	–
350 TO 600	25	25	–
650 & ABOVE	50	50	–

REDUCED BORE (RB) VALVES

VALVE SIZE, DN(mm)	A, DN(mm)	B, DN(mm)	C, DN(mm)
50 AND 200	–	–	15
250 TO 400	25	25	–
450 TO 750	25	25	–
800 & ABOVE	50	50	–

NOTES:–

1. ALL VALVES (BALL OR PLUG) AND PLUGS FOR A AND B SHALL BE APPROVED BY THE PURCHASER.
2. VALVES OF SIZE 50 mm SHALL BE MANUFACTURED AS PER API–6D.
3. SEALANT POINTS SHALL BE PROVIDED FOR FULL BORE VALVES OF NOMINAL VALVE SIZE 200 mm (8") & ABOVE AND REDUCED BORE VALVES OF NOMINAL VALVE SIZE, DN 250 mm (10") AND ABOVE ONLY. SEALANT LINES SHALL HAVE PROVISION TO REPLACE TH SEALANT INJECTION FITTING UNDER FULL LINE PRESSU
4. ALL VENT/DRAIN CONNECTION IN BURIED SECTION SHALL BE OF WELDED CONSTRUCTION.

FIGURE–4.9

ENGINEERING STANDARD

GAIL INDIA LIMITED

STANDARD SPECIFICATION FOR

PIPELINE PLUG VALVE

GAIL-STD-ME-DOC-TS-009

0	22.03.19	Issued For Tender	RKS	AP	JR	
Rev	**Date**	**Purpose**	**Prepared By**	**Checked By**	**Approved By**	

CONTENTS

1.0 SCOPE

This Specification covers the minimum requirements for design, manufacture and supply of carbon steel plug valves of size DN 50 mm (2 inch) and above and ANSI class 150# thru 900# for use in onshore pipeline systems handling non sour hydrocarbons in liquid phase or gaseous phase including Liquefied Petroleum Gas (LPG).
This specification does not cover plug valves for sour hydrocarbons (liquid/gas) service as defined in NACE Standard MR-0l-75.

2.0 REFERENCE DOCUMENTS

2.1 All valves shall be manufactured and supplied in accordance with the American Petroleum
Institute (API) Specification 6D, Twenty second edition, January 2002 / ISO 14313:1999, Petroleum and Natural Gas Industries – Pipeline Transportation Systems – Pipeline Valves, with addition and modification as indicated in the following sections of this specification.

2.2 Reference has also been made in this specification to the latest edition of the following Codes, Standards and Specifications:

ASME B 31.3	:	Process Piping.
ASME B 31.4	:	Pipeline Transportation System for Liquid Hydrocarbons and Other Liquids.
ASME B 31.8	:	Gas Transmission and Distribution Piping Systems.
ASME B 16.5	:	Pipe Flanges and Flanged Fittings.
ASME B 16.25	:	Butt-welding Ends
ASME B 16.34	:	Valves -- Flanged, Threaded and Welding Ends.
ASME B 16.47	:	Large Diameter Steel Flanges.
API 1104	:	Welding Pipelines and Related Facilities.
ASME Sec VIII/IX	:	Boiler and Pressure Vessel Code.
ASTM A 370	:	Test Methods and Definitions for Mechanical Testing of Steel Products.
ASTM B 733	:	Auto catalytic Nickel Phosphorous Coating on Metals.

MSS-SP-6 : Standard Finishes for Contact Faces of Pipe Flanges and Connecting-end Flanges of Valves and Fittings.

MSS-SP-44 : Steel Pipe Line Flanges.

SSPC-VIS-1 : Steel Structures Painting Council Visual Standard.

2.3 In case of conflict between the requirements of this specification, API 6D and the Codes, Standards and Specifications referred in clause 2.2 above, the requirements of this specification shall govern.

3.0 MATERIALS

3.1 Material for major components of the valves shall be as indicated in Valve Data Sheet. In addition, the material shall also meet the requirements specified herein. Other components shall be as per Manufacturer's standard, which shall be subject to approval by Purchaser.

3.2 Carbon steel used for the manufacture of valves shall be fully killed.

3.3 The Carbon Equivalent (CE) of valve end connections which are subject to further field welding by Purchaser shall not exceed 0.45 in check analysis for each heat of steel used, as calculated by the following formula:

$$CE = C + \frac{Mn}{6} + \frac{Cr+Mo+V}{5} + \frac{Ni+Cu}{15}$$

3.4 For valves specified to be used for Gas service or High Vapour Pressure (HVP) liquid service, Charpy V-Notch test on each heat of base material shall be conducted as per API 6D, clause 3.7 for all pressure containing parts such as body, end flanges and welding ends as well as bolting material for pressure containing parts. Unless specified otherwise, the Charpy V-notch test shall be conducted at 0 °C. The Charpy V-notch test specimen shall be taken in the direction of - principal grain flow and notched perpendicular to the original surface of plate or forging. The minimum average absorbed energy per set of three specimens shall be 27 J with an individual minimum per specimen of 22 J.

For valves specified to be used for other hydrocarbon services, the Charpy V-notch requirements stated above are not applicable, unless required by the specified material standard as a mandatory requirement.

When Low Temperature Carbon Steel (LTCS) materials are specified in Valve Data Sheet or offered by Manufacturer, the Charpy V-notch test requirements of applicable material standard shall be complied with.

3.5 For all such valves where Carbon Steel /S.G. Iron is used as plug material, the plug shall have 75 microns (0.003 inches) thick Electroless Nickel Plating (ENP) as per ASTM B733 with following classification:

SC2, Type II, Class 2.
The hardness of plating shall be minimum 50 RC.

3.6 When the valves are specified to be used for Gas service or High Vapour Pressure (HVP) liquid ervice, hardness test shall be carried out on each heat of base material for all pressure containing parts of the valve. A full thickness cross section shall be taken for this purpose and the maximum hardness shall not exceed 248 HV10 based on minimum four (4) measurements representing the entire thickness.

For valves specified to be used for Low Vapour Pressure (LVP) liquid service, requirements as stated herein above are not applicable.

4.0 DESIGN AND CONSTRUCTION

4.1 Valve design shall meet the requirements of API Specification 6D and shall be suitable for the service conditions indicated in the Valve Data Sheet. The ASME Boiler & Pressure Vessel Code, Section VIII, Division 1 shall be used to design the valve body. Allowable stress requirements shall comply the provisions of ASME B31.3. In addition, corrosion allowance indicated in Valve Data Sheet shall be considered in valve design. However, the minimum wall thickness shall not be less than the minimum requirement of ASME B 16.34.

The manufacturer shall have valid license to use API monogram on valves manufactured as per API 6D.

4.2 Valve pattern area shall be as specified in the following table:

ANSI Rating	Size Range, DN mm (inch)	Pattern
150	50-100 (2-4)	Short
	150-300 (6-12)	Regular
	350 (14) & above	Venturi
300	50-100 (2-4)	Short
	150-300 (6-12)	Regular
	350 (14) & above	Venturi
600	50-250 (2-10)	Regular
	300 (12) & above	Venturi
900	50-250 (2-10)	Regular
	300 (12) & above	Venturi

4.3 Valves shall have an inherent feature using line pressure to ensure that the line pressure cannot cause taper locking of the plug / plug movement into the taper, i.e. valves shall be of "pressure - balanced" design.

4.4 Cover shall be bolted to the body and screwed connections are not acceptable.

4.5 Soft seats to achieve a seal between plug and body are not permitted.

4.6 All valves shall have the provision for secondary sealant injection under full line pressure for seat and stem seals. All sealant injection connections shall be provided with an internal non-return valve. Valve design shall have a provision (e.g. Ball Type Check Valve/Needle Valve) to replace the sealant injector fitting under full line pressure. Location and arrangement of sealant injection points shall be as per Figure-4.6.

4.7 When specified in the Vale Data Sheet, valves shall be designed to withstand a sustained internal vacuum of at least 1 (one) milli-bar in both open and closed position.

4.8 Valve design shall ensure repair of gland packing under full line pressure.

4.9 **a)** Valve ends shall be either flanged or butt-welded or one end flanged and one end butt welded as indicated in the Valve Data Sheet. Flanges of the flanged end cast body valves shall be integrally cast with the body of the valve. Face to face/end to end dimensions shall conform to API 6D.

b) Flanged end shall have dimensions as per ANSI B16.5 for valve sizes upto DN 600 mm (24"**)** (excluding DN 550 mm (22")) and as per MSS-SP-44 /ASME B16.47 Series A for valve sizes DN 550 mm (22"**)** and for DN 650 mm (26"**)** and above. Flange face shall be either raised face or ring joint type as indicated in Purchase Requisition. In case of RTJ flanges, the groove hardness shall be minimum 140 BHN.

c) Butt weld end preparation shall be as per ASME B 16.25. The thickness of the pipe to which the valve has to be welded shall be as indicated in the Valve Data Sheet. Valves shall be without transition pups. In case difference exists between thickness of welding ends of valves and connecting pipe, the Data Sheet shall be considered in valve design. However the minimum wall thickness shall not be less than the minimum requirement of ASME B 16.34. The welding ends of valve shall have bevel preparation as per ASME B31.4/ B31.8 as applicable.

4.10 Valves shall be provided with plug position indicator and stops of rugged construction at the fully open and fully closed positions.

4.11 When indicated in Material Requisition, valves shall have locking devices to lock the valve either in full open (LO) or full close (LC) position. Locking devices shall be permanently attached to the valve operator and shall not interfere with operation of the valve.

4.12 Valves shall be suitable for either buried or aboveground installation as indicated in Valve Data Sheet.

4.13 When stem extension requirement is indicated in Valve Data Sheet, the valves shall have the following provisions:

a) Valves provided with stem extension shall have waterproof outer casing. Length of stem extension shall be as indicated in Valve Data Sheet. The length indicated corresponds to the distance between centerline of the valve opening and the top of mounting flange for valve operating device (gear operator/power actuator as applicable)

b) Seat sealant injection lines shall be extended and terminated adjacent to the valve operator by means of suitable piping anchored to the valve body/ stem housing. The pipe used shall be API 5L Gr. B/ ASTM A106 Gr. B, with Sch. 160. Fittings shall be ASTM A105/ ASTM A234 Gr. WPB, Socket welded ANSI Class 6000.

c) Stem extension and stem housing design shall be such that the complete assembly will form a rigid unit giving positive drive under all conditions with no possibility of free movement between valve body, stem extension or its operator.

d) Outer casing of stem extension shall have ¾" or ½" NPT plugs at the top and bottom, for draining and filling with oil to prevent internal corrosion.

4.14 Operating Devices

a) Valves shall have a power actuator or manual operator as indicated in the Valve Data Sheet. In case of manual operator, valve sizes " DN 100 mm (4") shall be wrench operated and valve sizes DN 150 mm (6") shall be gear
operated. Each wrench operated valve shall be supplied with wrench. Valve design shall be such that damage due to malfunctioning of the operator or its controls will only occur in the operator gear train or power cylinder and that damaged parts can be replaced without the valve cover being removed.

b) The power actuator shall be in accordance with the Purchaser specification issued for the purpose and as indicated in the Valve and Actuator Data Sheet. Operating time shall be as indicated in Valve Data Sheet. Valve operating time shall correspond to full close to full open/ full open to full close under maximum differential pressure corresponding to the valve rating. For actuator valves, the actuator rated torque output shall be at least 1.25 times the break torque required to operate the valve under maximum differential pressure corresponding to the valve class rating.

c) For the manual operator of all valves, the diameter of the hand wheel or the length of operating Wrench shall be such that under the maximum

differential pressure, total force required to operate the valve does not exceed 350N. Manufacturer shall also indicate the number of turns of hand wheel (in case of gear operator) required to operate the valve from full open to full close position.

d) Direction of operation of hand wheel or wrench shall be in clock-wise direction while closing the valve.

e) Gear operators, when provided, shall have a self-locking provision and shall be fully encased in water proof/splash proof enclosure and shall be filled with suitable grease.

4.15 Repair by welding is not permitted for fabricated and forged body valves. However repair by welding as per ASME B 16.34 is permitted for cast body valves. Repair shall be carried out before any heat treatment of casting is done. Repair welding procedure qualification shall also include impact test and hardness test when required as per Clause 3.4 and 3.6 of this specification and shall meet the requirements as specified therein.

4.16 The tolerance on internal diameter and out of roundness at the ends for welded ends valves shall be as per connected pipe specification as indicated in the Valve Data Sheet.

4.17 Valve stem shall be capable of withstanding the maximum operating torque required to operate the valve against the maximum differential pressure corresponding to applicable class rating. The combined stress shall not exceed the maximum allowable stresses specified in ASME section VIII, Division 1.

For Power Actuated Valves, the valve stem shall be designed for maximum output torque of the selected power actuator (including gear box, if any) at the valve stem.

5.0 INSPECTION AND TESTS

5.1 The Manufacturer shall perform all inspection and tests as per the requirements of this specification and the relevant codes, prior to shipment, at his Works. Such inspection and tests shall be, but not limited to, the following:

5.1.1 Visual and dimensional check on all valves shall be carried out as per the Purchaser approved drawings.

5.1.2 Chemical composition and mechanical properties shall be checked as per relevant material standards and this specification, for each heat of steel used.

5.1.3 **a)** Non destructive examination of individual valve material and components consisting of but not limited to castings/ forgings shall be carried out by the Manufacturer.

b) Body castings of valves shall be radio-graphically examined as per ASME B16.34. Procedure and acceptance criteria shall be as per ASME B16.34. The extent of radiography shall be as follows:

ANSI Class 150#	-	All sizes	-	Nil
ANSI Class 300#	-	DN 400mm (16")	-	Nil
	-	DN 450mm (18")	-	100%
ANSI Class 600# and above	-	All sizes	-	100%

All castings shall be wet magnetic particle inspected 100% of the internal surfaces. Method and acceptance shall comply with ASME B 16.34.

c) All valves made by forgings shall be ultrasonically examined in accordance with the procedure and acceptance standard of Annexure E of ASME B16.34.

5.1.4 Areas, which in Purchaser's opinion cannot be inspected by radiographic methods, shall be checked by ultrasonic or magnetic particle methods and acceptance criteria shall be as per ASME Sec. VIII, Division 1, Appendix 12 and Appendix 6 respectively.

5.1.5 **a)** Weld ends of all cast valves subject to welding in field shall be 100 % radio-graphically examined and acceptance criteria shall be as per ASME B16.34.

b) After final machining, all bevel surfaces shall be inspected by dye penetrant or wet magnetic particle methods. All defects longer than 6.35 mm are rejected, as are the defects between 6.35 mm and 1.59mm that are separated by a distance less than 50 times their greatest length. Rejectable defects must be removed. Weld repair of bevel surface is not permitted.

c) All finished wrought weld ends subjects to welding in field shall be 100 percent ultrasonically tested for lamination type defects for a distance of 50 mm from the end. Laminations shall not be acceptable.

5.1.6 All valves shall be tested in compliance with the requirements of API 6D. The sealant lines shall be either included in the hydrostatic shell test or tested independently. No leakage is permissible during hydrostatic testing.

5.1.7 A supplementary air seat test as per API 6D Appendix C3 shall be carried out for all valves.. No leakage is allowed. Test pressure shall be held for at least 15 minutes.

5.1.8 Valves shall be subjected to Operational Torque Test as per API 6D Appendix C4 under hydraulic pressure equal to maximum differential pressure corresponding to the valve rating. For manually operated valves, it shall be established that the force

required to operate the valve does not exceed the requirements stated in section 4.14(c) of this specification.

5.1.9 Power actuated valves shall be tested after assembly of the valve and actuator, at the valve Manufacturer's works. At least five Open-Close-Open cycles without internal pressure and five Open-Close-Open cycles with maximum differential pressure corresponding to valve rating shall be performed on the valve actuator assembly. The time for full open to full close shall be recorded during testing. If required, the actuator shall be adjusted to ensure that the opening and closing time is within the limits stated in Valve data sheet.

Hand operator provided on the actuator shall also be checked after the cyclic testing, for satisfactory manual over-ride performance.

These tests shall be conducted on minimum one valve out of a lot of five (5) valves of the same size, rating and actuator model/type. In case the tests do not meet the requirements, retesting/rejection of the lot shall be decided by purchaser's Inspector.

5.2 Purchaser reserves the right to perform stage wise inspection and witness tests as indicated in clause 5.1 above at Manufacturer's works prior to shipment. Manufacturer shall give reasonable access and facilities required for inspection to the Purchaser's inspector. Purchaser reserves the right to require additional testing at any time to confirm or further investigate a suspected fault. The cost incurred shall be to Manufacturer's account.

In no case shall any action of Purchaser or his inspector shall relieve the Manufacturer of his responsibility for material, design, quality or operation of valves.

Inspection and tests performed/witnessed by the Purchaser's inspector shall in no way relieve the manufacturer's obligation to perform the required inspection and tests.

6.0 TEST CERTIFICATES

Manufacturer shall submit the following certificates:

a) Mill test certificates relevant to the chemical analysis and mechanical properties of the materials used for the valve construction as per the relevant standards.

b) Test certificates of hydrostatic and pneumatic tests complete with records of timing and pressure of each test.

c) Test reports of radiography and ultrasonic inspection.

d) Test report on operation of valves conforming to clause 5.1.8 and 5.1.9 of this specification.

e) All other test reports and certificates as required by API 6D and this specification.

The certificates shall be valid only when signed by Purchaser's Inspector. Only those valves which have been certified by Purchaser's Inspector shall be dispatched from Manufacturer's works.

7.0 PAINTING, MARKING AND SHIPMENT

7.1 Valve surface shall be thoroughly cleaned, freed from rust and grease and applied with sufficient coats of corrosion resistant paint. Surface preparation shall be carried out by shot blasting to SP-6 in accordance with "Steel Structures Painting Council - Visual Standard SSPC-VIS-I". For the valves to be installed underground, when indicated in Valve Data Sheet, the external surfaces of buried portion of the valve shall be painted with three coats of suitable coal tar epoxy resin with a minimum dry film thickness of 300 microns.

7.2 All valves shall be marked as per API 6D. The units of marking shall be metric except nominal diameter, which shall be in inches.

7.3 Valve ends shall be suitably protected to avoid any damage during transit. All threaded and machined surfaces subject to corrosion shall be well protected by a coat of grease or other suitable material. All valves shall be provided with suitable protectors for flange faces, securely attached to the valves. Bevel ends shall be protected with metallic or high impact plastic bevel protectors.

7.4 All sealant lines and other cavities of the valve shall be filled with sealant before shipment.

7.5 Packaging and shipping instructions shall be as per API 6D.

7.6 On packages, the following shall be marked legibly with suitable marking ink:

a) Order Number

b) Manufacturer's Name

c) Valve size and rating

d) Tag Number.

e) Serial Number

8.0 SPARES AND ACCESSORIES

8.1 Manufacturer shall furnish list of recommended spares and accessories for valves required during start-up and commissioning.

8.2 Manufacturer shall furnish list of recommended spares and accessories required for two years of normal operation and maintenance of valves.

8.3 Manufacturer shall quote for spares and accessories as per Material Requisition.

9.0 DOCUMENTATION

9.1 At the time of bidding, Manufacturer shall submit the following documents:

a) General arrangement drawings showing all features and relative positions and sizes of vents, drains, gear operator/actuator, painting, coating and other external parts together with overall dimensions.

b) Sectional drawing showing major parts with reference numbers and material specification.

c) Torque curves for the power actuated valves along with break torque and maximum allowable stem torque. In addition, sizing criteria and torque calculations shall also be submitted for power actuated valves.

d) Reference list of similar plug valves manufactured and supplied in last five years
indicating all relevant details including project, year, client, location, size, rating, service etc.

e) Descriptive technical catalogues of the manufacture.
f) Clause wise list of deviation from the specification, if any.

g) Installation, Operational and Maintenance Manual.
h) Copy of valid API 6D Certificate.

9.2 Within three weeks of placement of order, the Manufacturer shall submit four copies of, but not limited to, the following drawings, documents and specifications for Purchaser's approval:

a) Detailed sectional drawings showing all parts with reference numbers and materials specification.

b) Assembly drawings with overall dimensions and features. Drawing shall also indicate the number of turns of hand wheel (in case of gear operators) required for operating the valve from full open to full close position and the painting scheme.

c) Fabrication details of all valves.

d) Welding, Heat treatment and Testing procedures.

e) Details of corrosion resistant paint to be applied on the valves.

Manufacture of valves shall commence only after approval of the above documents. Once, the approval has been given by Purchaser, any changes in design, material and method of manufacture shall be notified to Purchaser whose approval in writing of all changes shall be obtained before the valve is manufactured.

9.3 Within 30 days from the approval date, Manufacturer shall submit to Purchaser one reproducible and six copies of all approved drawings, documents and specifications as listed in clause 9.2 above.

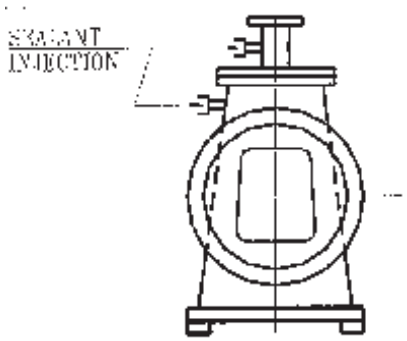
9.4 Prior to shipment, Manufacturer shall submit to Purchaser one reproducible and six copies of the following:

a) Test certificates as listed in clause 6.0 of this specification.

b) Manual for installation, erection, maintenance and operation instructions including a list of recommended spares for the valves.

All documents shall be in English language only.

ABOVE GROUND INSTALLATION



UNDER GROUND INSTALLATION

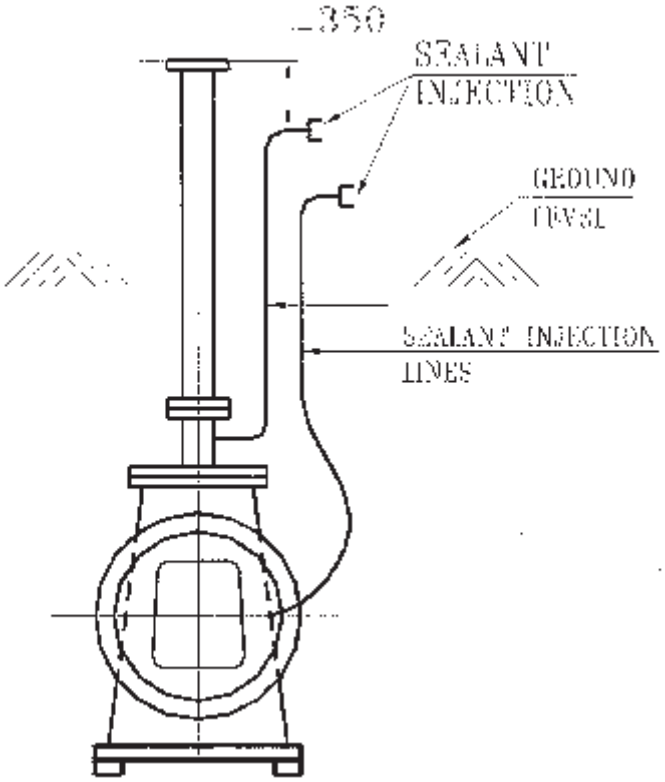


FIGURE- 4.6

ENGINEERING STANDARD

GAIL INDIA LIMITED

STANDARD SPECIFICATION FOR

CHECK VALVE

GAIL-STD-ME-DOC-TS-010

0	22.03.19	Issued For Tender	RKS	AP	JR	
Rev	**Date**	**Purpose**	**Prepared By**	**Checked By**	**Approved By**	

CONTENTS

1.0 SCOPE

This specification covers the minimum requirements for design, manufacture and supply of carbon steel check valves of size DN 50mm (2") and above and ANSI class 150, 300 and 600, for use in natural gas pipeline system and associated facilities.

2.0 REFERENCE DOCUMENTS

2.1 All valves shall be manufactured and supplied in accordance with the latest edition of American Petroleum Institute (API) Specification 6D or 594 or British Standard BS:1868, with additions and modifications as indicated in the following sections of this specification.

For Contractual purpose, the edition in force at the time of floating of the enquiry shall be termed as "latest edition".

3.0 MATERIALS

3.1 Material for major components of the valves shall be as indicated in Valve Data Sheet. Other components shall be as per Manufacturer's standards, which will be subject to approval by Purchaser.

3.2 Carbon steel used for the manufacture of valves shall be fully killed.

3.3 The Carbon Equivalent (CE) of valve end connections which are subject to further field welding by Purchaser, shall not exceed 0.45% (as calculated by the following formula) on check analysis for each heat of steel used :

$$CE = C + Mn/6 + (Cr+Mo+V)/5 + (Ni+Cu)/15$$

3.4 Charpy V-Notch test on each heat of base material shall be conducted as per API 6D, clause 7.5, for all pressure containing parts such as body, end flanges and welding ends as well as bolting material for pressure containing parts. Unless specified otherwise, the Charpy impact test shall be conducted at 0°C. The Charpy impact test specimen shall be taken in the direction of principal grain flow and notched perpendicular to the original surface of plate or forging.

The minimum average absorbed energy per set of three specimens shall be 27 J with an individual minimum per specimen of 22 J. No specimen shall exhibit less than 80 percent shear area.

3.5 All process – wetted parts, metallic and non-metallic, shall be suitable for the fluids and service specified by the Purchaser.

4.0 DESIGN AND CONSTRUCTION

4.1 Following types of check valves, meeting the requirements of applicable standards (refer clause 2.1 of this specification) are acceptable :

(i) Swing check valve
(ii) Dual plate check valve
(iii) Axial flow (Nozzle) check valve

Valve design shall be suitable for the service conditions indicated in Valve Data Sheet. Corrosion allowance indicated in Valve Data Sheet shall be considered in valve design.

4.2 In case of swing check valves, the disc hinge shall be mounted on the valve body and shall not be attached to the valve body cover. Valve body cover joint shall be of bolted design. Screwed covers shall not be used.

4.3 Valves shall be provided with non-renewable integral type seats as indicated in Valve Data Sheet. Non-renewable seats shall be of a design which does not required renewal over the design life of the valve.

4.4 Valves shall be provided with drain connection as per the Manufacturer's standard. Drain tapping shall be provided in a position suitable to completely drain the valve with valve in horizontal position.

4.5 Valve ends shall be either flanged or butt welded or one end flanged and one end butt welded as indicated in Valve Data Sheet. Flanged end shall have dimensions as per ASME B16.5 for sizes upto DN 400mm (16"). Flanges of the flanged end cast body valves shall be integrally cast with the body of the valve.

4.6 Butt weld end preparation shall be as per ANSI B16.25. The thickness of the pipe to which the valve has to be welded shall be as indicated in Valve Data Sheet. Valves shall be without transition pups. In case difference exists between thickness of valve neck end and connecting pipe, the bevel end of valve shall be prepared as per ANSI B31.8 or ANSI B31.4, as applicable.

4.7 Valves of size DN 200mm (8") and above shall be equipped with lifting lugs. Tapped holes and eye bolts shall not be used for lifting lugs.

4.8 An arrow indicating the direction of flow shall be embossed or cast on the body of all valves.

4.9 All welds shall be made by welders and welding procedures qualified in accordance with the provisions of ASME Section IX. The welding and repair welding procedure qualification shall include impact test and shall meet the requirements of clause 3.4 of this specification.

4.10 Repair by welding is permitted for cast body valves subject to written approval by Purchaser and shall be carried out as per ANSI B16.34. Repair shall be carried out before any heat treatment of casting is done.

5.0 INSPECTION AND TESTS

5.1 The Manufacturer shall perform all inspection and tests as per the requirements of this specification and the relevant codes, prior to shipment at his works. Such inspection and tests shall be, but not limited to, the following :

5.1.1 All valves shall be visually inspected.

5.1.2 Dimensional check on all valves shall be carried out as per the Purchaser approved drawings.

5.1.3 Chemical compositions and mechanical properties shall be checked as per relevant material standards and this specification, for each heat of steel used.

5.1.4 (a) Where applicable, the body castings of valves shall be radiographically examined on 100% of the surface of critical areas as per ANSI B16.34. Procedure and acceptance criteria shall be as per ANSI B16.34.

(b) Where applicable, valve body made by forging and plate components shall be ultrasonically examined in accordance with procedure and acceptance standard of Annexure E of ANSI B16.34.

(c) The extent of radiography/ ultrasonic examination shall be as follows :

ANSI Class 150	All sizes	Nil
ANSI Class 300	d DN 400mm (16″)	Nil
	t DN 450mm (18″)	100%
ANSI Class 600 and above	All sizes	100%

5.1.5 All valves shall be tested in compliance with the requirements of applicable standard (refer clause 2.0).

5.2 Purchaser reserves the right to perform stage-wise inspection and witness tests as indicated in clause 5.1 above at Manufacturer's works prior to shipment. Manufacturer shall give reasonable access and facilities required for inspection to the Purchaser's Inspector.

Purchaser reserves the right to require additional testing at any time to confirm or further investigate a suspected fault. The cost incurred shall be to Manufacturer's account.

In no case shall any action of Purchaser or its Inspector relieve the Manufacturer of his responsibility for material, design, quality or operation of valves.

Inspection and tests performed/ witnessed by the Purchaser's Inspector shall in no way relieve the Manufacturer's obligation to perform the required inspection and tests.

6.0 TEST CERTIFICATES

Manufacturer shall submit the following certificates:

(i) Mill test certificates relevant to the chemical analysis and mechanical properties of the materials used for the valve construction as per the relevant standards.
(ii) Hydrostatic test certificates complete with records of timing and pressure of each test.
(iii) Test reports of radiograph and ultrasonic inspection, as applicable.
(iv) All other test reports and certificates as required by applicable standard and this specification.

The certificates shall be valid only when signed by Purchaser's Inspector. Only those valves which have been certified by Purchaser's Inspector shall be dispatched from Manufacturer's works.

7.0 PAINTING, MARKING AND SHIPMENT

7.1 Valve surface shall be thoroughly cleaned, freed from rust and grease and applied with sufficient coats of corrosion resistant paint. Surface preparation shall be carried out by shot blasting to SP-6 in accordance with "Steel Structures Painting Council – Visual Standard SSPC-VIS-1".

7.2 All valves shall be marked as per applicable standard. The units of marking shall be metric except nominal diameter which shall be in inches.

7.3 Valve ends shall be suitably protected to avoid any damage during transit. All threaded and machined surfaces subject to corrosion shall be well protected by a coat of grease or

other suitable material. All valves shall be provided with suitable protectors for flange faces, securely attached to the valves.

7.4 Packaging and shipping instructions shall be as per applicable standard.

7.5 On packages, the following shall be marked legibly with suitable marking ink:

(i) Order Number
(ii) Manufacturer's Name
(iii) Valve Size and Rating
(iv) Tag Number

8.0 SPARES AND ACCESSORIES

8.1 Manufacturer shall recommend and quote separately the spares for valves required for commissioning and two years of normal operation.

9.0 DOCUMENTATION

9.1 At the time of bidding, Manufacturer shall submit the following documents :

(a) General arrangement drawings showing all features together with overall dimensions and actual valve bore size.

(b) Sectional drawing showing major parts with reference numbers and material specification.

(c) Details of corrosion resistant paint proposed to be applied.

(d) Reference list of similar supplies of check valves, including project, year, client, location, size, rating, services, etc. shall be furnished by the Manufacturer for the last three years. **(The valves shall be proven for service indicated in Valve Data Sheet).**

9.2 Within three weeks of placement of order, the Manufacturer shall submit four copies of, but not limited to, the following drawings, documents and specifications for Purchaser's approval.

(a) Detailed sectional drawings showing all parts with reference numbers and material specification.

(b) Assembly drawings indicating overall dimensions, features and painting scheme.

Once the approval has been given by Purchaser, any changes in design, material and method of manufacture shall be notified to Purchaser whose approval in writing of all changes shall be obtained before the valve is manufactured.

9.3 Within 30 days from the approval date, Manufacturer shall submit to Purchaser one reproducible and six copies of all approved drawings, documents and specifications as listed in clause 9.2 above.

9.4 Prior to shipment, Manufacturer shall submit to Purchaser one reproducible and six copies of the following :

(a) Test certificates as listed in clause 6.0 of this specification.

(b) Manual for installation, erection, maintenance and operation instructions, including a list of recommended spares for the valves.

9.5 All documents shall be in English language.

10.0 GUARANTEE

10.1 Manufacturer shall guarantee that the materials and machining of valves and fittings comply with the requirements in this specification and in the Purchase Order.

10.2 Manufacturer is bound to replace or repair all valve parts which should result defective due to inadequate engineering or to the quality of materials and machining.

10.3 If valve defect or malfunctioning cannot be eliminated, Manufacturer shall replace the valve without delay,

10.4 Any defect occurring during the period of Guarantee shall be attended to by making all necessary modifications and repair of defective parts free of charge to the Purchaser as per the relevant clause of the bid document.

10.5 All expenses shall be to Manufacturer's account.

ENGINEERING STANDARD

GAIL INDIA LIMITED

STANDARD SPECIFICATION FOR

SEAMLESS FITTINGS AND FLANGES

SIZE UPTO DN 400 mm (16”)

GAIL-STD-ME-DOC-TS-011

0	22.03.19	Issued For Tender	RKS	AP	JR	
Rev	**Date**	**Purpose**	**Prepared By**	**Checked By**	**Approved By**	

CONTENTS

1.0 SCOPE

This specification covers the minimum requirements for the design, manufacture and supply of following carbon steel flanges and fittings of size upto DN 400 mm (16") to be installed in pipeline systems handling hydrocarbons in liquid or gaseous phase including Liquefied Petroleum Gas (LPG):

- Flanges such as welding neck flanges, blind flanges, spectacle blinds, spacers and blinds etc.
- Seamless fittings such as tees, elbows, reducers, caps, outlets etc.

This specification does not cover the above-mentioned items, which are to be installed in pipeline systems handling sour hydrocarbons (liquid/gas) service as defined in NACE Standard MR-01-75

2.0 REFERENCE DOCUMENTS

2.1 Reference has been made in this specification to the latest edition of the following Codes:

ASME B31.4 - Pipeline Transportation System for Liquid Hydrocarbons and Other Liquids
ASME B31.8 - Gas Transmission and Distribution Piping Systems

ASME B16.5 - Pipe Flanges and Flanged Fittings
ASME B16.9 - Factory Made Wrought Steel Butt Welding Fittings

ASME B16.11 - Forged Steel Fittings, Socket Welding and Threaded

ASME B16.48 - Steel Line Blanks

ASME Sec VIII/IX - Boiler and Pressure Vessel Code

ASTM A370 - Standard Test Methods and Definitions for Mechanical Testing of Steel Products
MSS-SP-25 - Standard Marking System for Valves, Fittings, Flanges and Unions

MSS-SP-44 - Steel Pipeline Flanges.
MSS-SP-75 - Specification for High Test Wrought Welded Fittings.

MSS-SP-97 - Forged Carbon Steel Branch Outlet Fittings-Socket Welding, Threaded and Butt welding Ends.

2.2 In case of conflict between the requirements of this specification and the requirements of above referred Codes and Standards, the requirements of this specification shall govern.

3.0 MANUFACTURER'S QUALIFICATION

Manufacturer who intends bidding for fittings must possess the records of a successful proof test, in accordance with the provisions of ASME B 16.9.

4.0 MATERIAL

4.1 The Carbon Steel used in the manufacture of flanges and fittings shall be fully killed. Material for flanges and fittings shall comply the material standard indicated in the Purchase Requisition. In addition, the material shall also meet the requirements specified hereinafter.

4.2 Each heat of steel used for the manufacture of flanges and fittings shall have Carbon Equivalent (CE) not greater than 0.45 calculated from check analysis in accordance with the following formula:

$$CE = C + \frac{Mn}{6} + \frac{Cr+Mo+V}{5} + \frac{Ni+Cu}{15}$$

4.3 For flanges and fittings specified to be used for Gas service or High Vapour Pressure (HVP) liquid service, Charpy V-notch test shall be conducted on each heat of steel. Unless specified otherwise, the Charpy V-notch test shall be conducted at 00 C in accordance with the impact test provisions of ASTM A- 370 for flanges and fittings.

The minimum average absorbed impact energy values of three full-sized specimens shall be 27 joules. The minimum impact energy value of any one specimen of the three specimens analyzed as above shall not be less than 80% of the above mentioned average value.

For flanges and fittings specified to be used for other hydrocarbon service, the Charpy V-notch test requirements as stated above are not applicable, unless required by the specified material standard as a mandatory requirement.
When Low Temperature Carbon Steel (LTCS) materials are specified in Purchase Requisition for flanges and fittings, the Charpy V-notch test requirements of applicable material standard shall be complied with.

4.4 For flanges and fittings, specified to be used for Gas service or High Vapour Pressure (HVP) liquid service, hardness test shall be carried out in accordance with ASTM A 370. Hardness testing shall cover at least 10% per item, per size, per heat, per manufacturing method. A full thickness cross section shall be taken for this purpose and the maximum hardness shall not exceed 248 HV10. For flanges and fittings, specified to

be used for other hydrocarbon services, the hardness requirements stated above are not applicable.

4.5 In case of RTJ flanges, the groove hardness shall be minimum 140 BHN.

5.0 DESIGN AND MANUFACTURE

5.1 Flanges such as weld neck flanges and blind flanges shall conform to the requirements of ASME B16.5.

5.2 Spectacle blind and spacer & blind shall conform to the requirements of ASME B16.48.

5.3 Fittings such as tees, elbows, reducers, etc. shall be seamless type and shall conform to ASME B 16.9 for sizes DN 50 mm (2") and above and ASME B16.11 for sizes below DN 50 mm (2").

5.4 Fittings such as weldolets, sockolets, nippolets, etc. shall be manufactured in accordance with MSS-SP-97.

5.5 Type, face and face finish of flanges shall be as specified in Purchase Requisition.

5.6 Flanges and fittings manufactured from bar stock are not acceptable.

5.7 All butt weld ends shall be bevelled as per ASME B16.5/ ASME B16.9/MSS-SP-97 as applicable.

5.8 Repair by welding on flanges and fittings is not permitted.

6.0 INSPECTION AND TESTS

6.1 The Manufacturer shall perform all inspections and tests as per the requirement of this specification and the relevant codes, prior to shipment at his works. Such inspections and tests shall be, not but limited to the following:

6.1.1 All flanges and fittings shall be visually inspected. The internal and external surfaces of the fittings shall be free from any strikes, gauges and other detrimental defects.

6.1.2 Dimensional checks shall be carried out on finished products as per ASME B16.5 for flanges, ASME B16.48 for spacers and blinds and ASME B16.9/ MSS-SP-97 as applicable for fittings and as per this specification.

6.1.3 Chemical composition and mechanical properties shall be checked as per relevant material standards and this specification, for each heat of steel used.

6.1.4 All finished wrought weld ends subject to welding in field, shall be 100% tested for lamination type defects by ultrasonic test. Any lamination larger than 6.35 mm shall not be acceptable.

6.2 Purchaser's Inspector reserves the right to perform stage wise inspection and witness tests, as indicated in clause 6.1 of this specification at Manufacturer's Works prior to shipment. Manufacturer shall give reasonable notice of time and shall provide, without charge, reasonable access and facilities required for inspection, to the Purchaser's Inspector.

Inspection and tests performed/ witnessed by Purchaser s Inspector shall in no way relieve the Manufacturer's obligation to perform the required inspection and tests.

7.0 TEST CERTIFICATES

Manufacturer shall furnish the following certificates:

a) Test certificates relevant to the chemical analysis and mechanical properties of the materials used for manufacture of flanges and fittings as per relevant standards and this specification.
b) Test Reports on non destructive testing.
c) Certificates for each fitting stating that it is capable of withstanding without leakage a test pressure, which results in a hoop stress equivalent to 100 % of the specified minimum yield strength for the pipe with which the fitting is to be attached without impairment of serviceability.

8.0 PAINTING, MARKING AND SHIPMENT

8.1 After all inspection and tests required have been carried out; all external surfaces shall be thoroughly cleaned to remove grease, dust and rust and shall be applied with standard mill coating for protection against corrosion during transit and storage. The coating shall be easily removable in the field.

8.2 Ends of all fittings and weld neck flanges shall be suitably protected to avoid any damage during transit. Metallic or high impact plastic bevel protectors shall be provided for fittings and flanges. Flange face shall be suitably protected to avoid any damage during transit.

8.3 All flanges and fittings shall be marked as per applicable dimension/manufacturing standard.

9.0 DOCUMENTATION

9.1 Prior to shipment, the Manufacturer shall submit six copies of the test certificates as listed in clause 7.0 of this specification.

9.2 All documents shall be in English Language only.

ENGINEERING STANDARD

GAIL INDIA LIMITED

STANDARD SPECIFICATION FOR

SEAMLESS FLANGES & WELDED FITTINGS

SIZE DN 450 mm (18”) AND ABOVE

GAIL-STD-ME-DOC-TS-012

0	22.03.19	Issued For Tender	RKS	AP	JR	
Rev	**Date**	**Purpose**	**Prepared By**	**Checked By**	**Approved By**	

CONTENTS

1.0 SCOPE:

This specification covers the minimum requirements for the design, manufacture and supply of following carbon steel flanges and fittings of size DN 450 mm (18") and above to be installed in pipeline systems handling hydrocarbons in liquid or gaseous phase including Liquefied Petroleum Gas (LPG):

- Flanges such as weld neck flanges, blind flanges, spectacle blinds, spacers and blinds, etc.
- Welded fittings such as tees, elbows, reducers, caps, outlets etc.

This specification does not cover the above-mentioned items, which are to be installed in pipeline systems handling sour hydrocarbons (liquid / gas) service as defined in NACE Standard MR-01-75.

2.0 REFERENCE DOCUMENTS:

2.1 Reference has been made in this specification to the latest edition of the following Codes, Standards and Specifications. ASME

B31.3	-	Process Piping
ASME B31.4	-	Pipeline Transportation System for Liquid Hydrocarbons and Other Liquids
ASME B31.8	-	Gas transmission and distribution piping system
ASME B16.5	-	Pipe Flanges and Flanged fittings
ASME B16.9	-	Factory made wrought steel Butt welding fittings
ASME B 16.25	-	Butt welding Ends
ASME B16.47	-	Large diameter steel Flanges
ASME B16.48	-	Steel line Blanks
ASME Sec VIII/IX	-	Boiler and Pressure Vessel code
ASTM A370	-	Standard test methods and Definitions for mechanical testing of Steel products
MSS-SP-25	-	Standard Marking system for Valves, Flanges, Fittings and Unions
MSS-SP-44	-	Steel Pipeline Flanges
MSS-SP-75	-	Specification for high Test Wrought Welded fittings

MSS-SP-97 - Forged Carbon Steel Branch Outlet Fittings- Socket Welding, Threaded and Butt Welding Ends

2.2 In case of conflict between the requirements of this specification and the requirements of above referred Codes and Standards, the requirements of this specification shall govern.

3.0 MANUFACTURER'S QUALIFICATION:

Manufacturer who intends bidding for fittings must possess the records of a successful proof test in accordance with the provisions of ASME B16.9 / MSS-SP-75, as applicable.

4.0 MATERIAL:

4.1 The Carbon Steel used in the manufacture of flanges and fittings shall be fully killed. Material for flanges and fittings shall comply the material standards indicated in the Purchase Requisition. In addition, the material shall also meet the requirements specified hereinafter.

4.2 Each heat of steel used for the manufacture of flanges and fittings shall have Carbon Equivalent (CE) not greater than 0.45 calculated from check analysis in accordance with the following formula:

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

4.3 For flanges and fittings specified to be used for Gas service or High Vapour Pressure (WP) liquid service, Charpy V-notch test shall be conducted on each heat of steel. Unless specified otherwise, the Charpy V-notch test shall be conducted at 0' C in accordance with the impact test provisions of ASTM A 370 for flanges and MSS-SP-75 for all fittings.

The minimum average absorbed impact energy values of three full-sized specimens shall be 27 joules. The minimum impact energy value of any one specimen of the three specimens analysed as above, shall not be less than 80% of the above mentioned average value.

For flanges and fittings specified to be used for other hydrocarbon service, the Charpy V-notch test requirements as stated above are not applicable, unless required by the specified material standard as a mandatory requirement.
When Low Temperature Carbon Steel (LTCS) materials are specified in Purchase Requisition for flanges and fittings, the Charpy V-notch test requirements of applicable material standard shall be complied with.

4.4 For flanges and fittings, specified to be used for Gas service or High Vapour Pressure (HVP) liquid service, hardness test shall be carried out as per ASTM A 370 for each heat of steel used. A full thickness cross section shall be taken for this purpose and the maximum hardness of base metal, weld metal and heat affected zone shall not exceed 248 HV_{10}.
For flanges and fittings, specified to be used for other hydrocarbon services, the hardness requirements stated above are not applicable.

4.5 In case of RTJ flanges, the groove hardness shall be minimum 140 BHN.

5.0 DESIGN AND MANUFACTURE:

5.1 Flanges such as weld neck flanges and blind flanges shall conform to the requirements of ASME B16.5 up to sizes DN 600 mm (24") excluding DN 550 mm (22'9, and MSS-SP-44 for sizes DN 550 mm (22") and ASME B16.47 (Series A) for sizes DN 650 mm (26") and above.

5.2 Spectacle blind and spacer & blind shall conform to the requirements of ASME B 16.48 up to sizes DN 600 mm (24"). For sizes DN 650 mm (26") and above, spectacle blind and spacer & blind shall conform to Manufacturer's standard.

5.3 Type, face and face finish of flanges shall be as specified in Purchase Requisition.

5.4 Fittings such as tees, elbows, reducers, etc. shall be either welded or seamless type. All fittings shall comply with the requirements of MSS-SP-75.

5.5 Fittings such as weldolets etc. shall be manufactured in accordance with MSS-SP-97.

5.6 Tees shall be manufactured by forging or extrusion method. Stub-in or pipe to pipe connection shall not be used in the manufacture of tees. The longitudinal weld seam shall be kept at 90 degree from the extrusion. Fittings shall not have any circumferential weld joint.

5.7 All butt weld ends shall be beveled as per ASME B16.5 / MSS-SP-44 / ASME B16.47 as applicable for flanges and MSS-SP-75/MSS-SP-97 as applicable for fittings.

5.8 The reinforcement of inside weld seam shall be removed for a distance of 100mm from each end of welded fittings.

5.9 All welds shall be made by welders and welding procedures qualified in accordance with provisions of ASME Sec. IX. The procedure qualification shall include Charpy V-notch test for weld heat affected zone and hardness test in accordance with clause 4.3 and 4.4 of this specification respectively.

5.10 Repair by welding on flanges and parent metal of fittings is not permitted. Repair of weld seam by welding shall be carried out by welders and welding procedures duly qualified as per ASME Section IX and records for each repair shall be

maintained. Repair welding procedure qualification shall include all tests, which are applicable for regular production welding procedure qualification.

6.0 INSPECTION AND TESTS:

6.1 The Manufacturer shall perform all inspections and tests as per the requirement of this specification and the relevant codes, prior to shipment at his works. Such inspections and tests shall be, not but limited to the following:

6.1.1 All flanges and fittings shall be visually inspected. The internal and external surfaces of the fittings shall be free from any strikes, gauges and other detrimental defects.

6.1.2 Dimensional checks shall be carried out on finished products as per ASME B16.5 / MSS-SP-44 / ASME B16.47 as applicable for flanges, ASME B 16.48 for spacers and blinds and ASME B 16.9 / MSS-SP-75/MSS-SP-97 as applicable for fittings and as per this specification.

6.1.3 Chemical composition and mechanical properties shall be checked as per relevant material standards and this specification, for each heat of steel used.

6.1.4 The non-destructive inspection shall be carried out as given below:

a) All butt and repair welds for welded fittings shall be examined 100 % by radiography. Acceptance criteria shall be as be ASME B 31.4 or ASME B 31.8 as applicable and API 1104.

b) When elbows of size 18" NB are manufactured, the first elbow of each radius, diameter and wall thickness shall be ultrasonically checked for sufficient wall thickness in areas where a minimum wall thickness is to be expected. This shall be followed by random inspection of one out of every three elbows of the same radius, diameter and wall thickness.

c) All finished wrought weld ends subject to welding in field, shall be 100% tested for lamination type defects by ultrasonic test. Any lamination larger then 6.35 mm shall not be acceptable.

d) Magnetic particle or liquid penetrant examination shall be performed on cold formed butt welding tees with extruded outlets (that are subjected to an extreme fibre elongation of greater than 5 %) as per the Supplementary Requirement SR 3 of MSS-SP-75.

e) Welds, which cannot be inspected by radiographic methods, shall be checked by ultrasonic or magnetic particle methods. Acceptance criteria shall be as per ASME Section VIII Appendix 12 and Appendix 6 respectively.

6.2 Purchaser's Inspector reserves the right to perform stage wise inspection and witness tests, as indicated in clause 6.1 of this specification at Manufacturer's Works prior to shipment. Manufacturer shall give reasonable notice of time and

shall provide, without charge, reasonable access and facilities required for inspection, to the Purchaser's Inspector.

Inspection and tests performed/witnessed by Purchaser's Inspector shall in no way relieve the Manufacturer's obligation to perform the required inspection and tests.

7.0 TEST CERTIFICATES:

Manufacturer shall furnish the following certificates:

a) Test certificates relevant to the chemical analysis and mechanical properties of the materials used for manufacture of flanges and fittings as per relevant standards and this specification.

b) Test Reports on radiography, ultrasonic inspection and magnetic particle examination.

c) Test reports of heat treatment carried out as per the specification. d)

Welding procedures and welders qualification reports.

e) Certificate for each fitting stating that it is capable of withstanding without leakage a test pressure, which results in a hoop stress equivalent to 100% of the specified minimum yield strength for the pipe with which the fitting is to be attached without impairment of serviceability.

8.0 PAINTING, MARKING AND SHIPMENT:

8.1 After all inspection and tests required have been carried out; all external surfaces shall be thoroughly cleaned to remove grease, dust and rust and shall be applied with standard mill coating for protection against corrosion during transit and storage. The coating shall be easily removable in the field.

8.2 Ends of all fittings and weld neck flanges shall be suitably protected to avoid any damage during transit. Metallic or high impact plastic bevel protectors shall be provided for flanges and fittings.

8.3 Flange face shall be suitably protected to avoid any damage during transit.

8.4 All flanges and fittings shall be marked as per applicable dimension / manufacturing standard.

9.0 DOCUMENTATION:

9.1 Prior to shipment, the Manufacturer shall submit six copies of the test certificates as listed in clause 7.0 of this specification.

9.2 All documents shall be in English Language only.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR

QUICK OPENING END CLOSURE

GAIL-STD-ME-DOC-TS-013

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SCOPE

This specification covers the minimum requirements for design, manufacture, testing and supply of quick opening end closures to be installed at various blow-down points/ lines handling non-sour hydro carbons in gaseous phase.

1.0 REFERENCE DOCUMENTS

Reference has been made in this specification to the latest edition (edition enforce at the time of issue of enquiry) of the following codes, standards and specifications:

a)	ASME B 31.8	:	Gas Transmission and Distribution Piping System
b)	ASME B 16.25	:	Butt - Welding Ends
c)	ASME Sec. VIII	:	Boiler and Pressure Vessels Code- Rules for the Construction of Pressure vessels
d)	ASME Sec. IX	:	Boiler and Pressure Vessels Code-Welding and brazing qualifications.
e)	API 6H	:	Specification on End closures, Connectors and Swivels
f)	API 1104	:	Specification for Welding Pipeline and Related Facilities
g)	SSPC-VIS-1	:	Steel Structures Painting Council

In case of conflict between the requirement of this specification and the requirements of above referred documents, the requirements of this specification shall govern.

3.0 MATERIALS

3.1 Carbon steel material used in the manufacture of pressure containing parts of quick opening enclosure shall be fully killed. In addition, the material shall also meet the requirements specified herein.

The minimum SMYS of the material of pressure containing part of the closure shall be 35,000 psi.

Other components shall be as per Manufacturer's Standard. However, all the materials used shall be suitable for the service Conditions indicated in the Data Sheets, which will be subject to approval by Purchaser.

3.2 Material of the ends to be field welded by Purchaser shall have carbon equivalent not more than 0.45 based on check analysis, for each heat of steel used, calculated as per the following formula:

$$CE = C + \frac{Mn}{6} + \frac{Cr+Mo+V}{5} + \frac{Ni+Cu}{15}$$

3.3 For quick opening end closures specified to be used for Gas service and LPG service, Charpy V-notch test shall be conducted at 0^0C on each heat of carbon steel material used in manufacture of quick opening end closures. Test procedure shall conform to ASTM A 370. The average absorbed impact energy values of three full-sized specimens shall be 27 Joules. The minimum impact energy value of any one specimen of the three specimens analyzed as above, shall not be less than 22 Joules.

When Low Temperature Carbon Steel (LTCS) materials are specified in Data Sheet or offered by Manufacturer, the Charpy V-notch test requirements of applicable material standard shall be complied with.

3.4 For quick opening end closures specified to be used for Gas service and LPG service, hardness test shall be carried out as per ASTM A 370 for each heat of steel used in the manufacture of pressure containing parts of traps. A full thickness cross section shall be taken for this purpose and the maximum hardness of base metal, weld metal and HAZ of all the pressure containing parts shall not exceed 248 $HV_{|}o$.

4.0 **DESIGN AND CONSTRUCTION**

4.1 End closure shall be designed in accordance with the provisions of ASME B 31.8 and ASME Sec. VIII Division 1. Design factor and corrosion factor shall be as indicated in the data sheet.

4.2 Diameter, thickness, material, ANSI rating of the pipeline with which the end closure to be welded shall be as indicated in the Data Sheets. End closure supplied shall be suitable for the same.

4.3 The quick opening end closure shall be of clamp ring/ band lock type or equivalent design and shall consists of a safety pressure release system allowing the opening only when there is no pressure in the trap. End closure shall be hand operated by a single lever operation and operable by one operator. Screwed type or plug -in type of end closures are not permitted.

4.4 End closure shall be suitable for installation in vertical position at an elevation of 2.0 meters above ground level.

4.5 The handing device shall be attached to the welding end hub, which shall be suitable for such attachment.

4.6 End closure shall be provided with a butt-welding end for direct welding with the pipeline. The weld end shall be prepared in accordance with ASME B 31.8.

4.7 All welds shall be made by welders and welding procedures qualified in accordance with the provisions of ASME Sec. IX. The procedure qualification shall also include impact test and hardness test as per clause 3.3 and 3.4 of this specification and shall meet the requirements as specified therein.

4.8 Completed assembly shall be stress relieved as per the provisions of the design codes.

4.9 The tolerance on internal diameter end out of roundness shall be as per connected pipe specifications indicated in the Data Sheet.

4.10 When closed, the closure shall provide a positive seal without any leakage. Gaskets or seals when provided for this purpose shall be self sealing and suitable for the service condition indicated in Annexure-I & Data Sheets.

5.0 INSPECTION AND TESTS

5.1 Manufacturer shall perform all inspection and tests as per the requirements of this specification and the relevant codes, standards and specifications, prior to shipment at his Works. Such inspection shall be, but not limited to, the following:

5.1.1 All closures shall be visually inspected. The internal and external surfaces shall be free from any strikes, gouges and other detrimental defects. The surfaces shall be thoroughly cleaned and free from dirt, rust and scales.

5.1.2 Chemical composition and mechanical properties shall be checked as per relevant material standards and this specification, for each heat of steel used.

5.1.3 Dimensional check shall be carried out as per the approved drawings.

5.1.4 Hydrostatic test shall be conducted for all end closures complete in all respects, at a pressure equal to 1.25 /1.4 times the design pressure for liquid / gas service as indicated in data sheet. Test duration shall be 15 minutes.

5.1.5 All butt welds shall be 100% radiographically inspected. Procedure and acceptance criteria shall be as per API 1104.

5.1.6 Welds, which cannot be radiographically inspected, shall be inspected by ultrasonic or magnetic particle methods. Procedure and acceptance criteria shall be as per ASME Sec. VIII, Appendix-U and Appendix VI respectively.

5.1.7 All finished wrought weld ends shall be ultrasonically inspected for lamination type defects for a distance of 50 mm from the end. Any lamination larger than 6.35 mm shall not be acceptable.

5.1.8 A minimum of two Closing and opening cycles shall be performed and correct operation of both quick opening and safety system shall be established.

5.2 Company inspector reserves the right to perform inspection and witness tests including hydrostatic test, as indicated in clause 5.1 at Manufacturer's works prior to shipment. Manufacturer shall give reasonable notice of time and shall provide without charge reasonable access and facilities required for inspection, to the Company's inspector. Only those closures, which have been inspected and certified by Company's Representative, shall be shipped.

Inspection and tests performed / witnessed by Company's Inspector shall in no way relieve the Manufacturer's obligation to perform the required inspection and tests.

6.0 TEST CERTIFICATES

Manufacturer shall furnish the following certificates:

a. Test Certificates relevant to chemical and mechanical properties of the material used as per the relevant standards.
b. Hydrostatic test certificates.
c. Report on Non-Destructive examination.
d. Certificate of satisfactory performance of end closure as per Clause 5.1.8.

7.0 PAINTING, MARKING AND SHIPMENT

7.1 After all inspection and tests required have been carried out, the exterior surface of Quick Opening End Closures shall be thoroughly cleaned, freed from rust and grease and applied with sufficient coats of corrosion resistant paint. Manufacturer shall indicate the type and corrosion resistant paint used in the drawings submitted for approval.

7.2 Marking shall be done on a stainless steel plate and affixed to the body permanently. Marking shall include the following:

a. Manufacturer's Name
b. Suitable for --------- Dia x ---------- Thick Pipeline.

c. ANSI Rating

d. Tag Number

7.3 Before shipment, closures shall be properly packed against damage during transportation.
Suitable protection shall be provided for the weld ends.

8.0 GUARANTEE

8.1 Manufacturer shall guarantee that the closure along with the davits is in compliance with the requirements of this specification for material and workmanship. Manufacturer shall replace or repair all parts which should result defective due to inadequate engineering of quality of material or workmanship. In case the defect cannot be eliminated, Manufacturer shall replace the closure without any delay. Any defects occurring within the time period specified elsewhere shall be required making all necessary modifications and repair of defective parts free of charge to the purchaser.

9.0 SPARES

9.1.1 Manufacturer shall furnish list of recommended spares and accessories for Quick Opening End Closures required during start-up and commissioning and supply of such spares shall be included in the price quoted by Manufacturer.

9.1.2 Manufacturer shall furnish list of recommended spares and accessories required for two years of normal operation and maintenance of Quick Opening End Closures and price for such spares shall be quoted separately.

10.0 DOCUMENTATION

Documentation to be submitted by Manufacturer to Company is summarized below. Number of Copies (Hard copies / soft copies etc.) shall be as indicated in CONTRACT document.

10.1 At the time of bidding, Manufacturer shall submit the following documents:

a) General arrangement drawing of end closure with overall dimensions and cross-sectional drawings.
b) Clause wise list of deviations from this specification, if any.

c) Reference list of similar previous supplies. Reference list of similar supplies of Quick Opening End Closures shall be furnished including project, Year of supply, Client, Size, Rating and Service for the last five years.

d) Quality Control Manual and Quality Control Plan.

e) List of recommended spares and accessories required during start-up and commissioning.

f) List of recommended spares and accessories required for **2** years of normal operation and maintenance.

10.2 Within three weeks of placement of order, the Manufacturer shall submit the following drawings, documents and specifications for approval:

a. Design calculations according to relevant codes for the end closure.

b. Closure assembly and sectional drawings showing all parts with materials and dimensions.

c. Welding procedure and method of manufacture.

Once the above-mentioned documents have been approved by the Company, any change in design, material and method of manufacture shall be notified to the Company, whose approval in writing of all changes shall be obtained before the closures are manufactured.

10.5 Within four weeks from the approval date, Manufacturer shall submit the approved drawings, documents and specifications listed in Clause 9.2 of above.

10.6 Prior to shipment, the Manufacturer shall submit the following:

a. Test certificates as listed in Clause 6.0 of this specification.

b. Manual for installation, erection instructions, maintenance and operation instructions.

10.7 All documents shall be in English Language only.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR

WELDING AND FABRICATION OF PIPING

GAIL-STD-ME-DOC-TS-014

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(This specification shall be used in conjunction with Welding Specification Charts).

1.0 GENERAL:

This specification shall be followed for the fabrication of all types to welded joints of piping system within the battery limits of the plant.

The welded pipe joints shall include the following:

a) All pipe joints, longitudinal butt welds, circumferential butt welds and socket welds.
b) Attachments of forgings, flanges and other supports to pipes. c)

Welded manifold headers and other sub-assemblies.

d) Welded branch connections with or without reinforcing pads.
e) Joints in welded/fabricated piping components.
f) The attachments of smaller connections for vents, drain drips and other instrument tapings.

Any approval granted by the Engineer-in-Charge or Owner's inspector, shall not relieve the Contractor of his responsibilities and guarantee.
This specification shall not be applicable for welding of pipelines for transportation of liquid petroleum and other similar products.

2.0 APPLICABLE CODES & STANDARDS:

All welding work, equipments for welding, heat treatment, other auxiliary functions and the welding personnel shall meet the requirements of the latest editions of the following accepted standards and procedures unless otherwise specified in the Welding Specification Chart and the Technical notes attached thereof. In the case of conflicting requirements, the requirements mentioned in welding Specification Chart/Technical Notes shall be applicable.

i) ASME Code for Pressure Piping - ASME B31.3
ii) ASME Boiler & Pressure Vessel Code, Sec II Part C, Material Specifications: Welding Rods, Electrodes and Filler metals.
iii) ASME Boiler & Pressure Vessel Code, Section V, Non destructive examination.
iv) ASME Boiler & Pressure Vessel Code, Section VIII, Rules for Construction of Pressure Vessels.

v) ASME Boiler & Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
vi) The Indian Boiler Regulations - IBR

In the event of any differences due to the additional requirements mentioned in this specification, over and above those obligatory as per codes, this specification shall be binding.

3.0 BASE METAL:

3.1 In general, use of carbon steel, alloy steel and stainless steel is envisaged. The details of the material specifications are given in the Welding Specification Chart.

3.2 The Contractor shall provide the manufacturer's test certificates for every heat of the materials supplied by him.

4.0 WELDING CONSUMABLES:

4.1 The Contractor shall provide, at his own expense, all the welding consumables necessary for the execution of the job such as electrodes, filler wires, argon etc. and these should bear the approval of the Engineer-in-Charge.

4.2 The welding electrodes and filler wires supplied by the Contractor shall conform to the class specified in the Welding Specification Chart. The materials shall be of the make approved by the Engineer-in-Charge.

4.3 Electrode qualification test records should be submitted as per the Exhibit-A (attached) in respect of the electrodes tested by the Contractor, for obtaining the approval of the Engineer-in-Charge.

4.4 The Contractor shall submit batch test certificates, from the electrode manufacturers, giving details of physical and chemical tests carried out by them, for each batch of electrodes to be used.

4.5 All electrodes shall be purchased in sealed containers and stored properly to prevent deterioration. The electrodes removed from the containers shall be kept in holding ovens at temperatures recommended by the electrode manufacturer. "Out of the oven time" or electrodes, before they are consumed, shall not exceed the limits recommended by the electrode manufacturer. The electrodes shall be handled with care to avoid any damage to the flux covering.

4.6 All low hydrogen type of electrodes shall be rebaked at 350°C for 1 hour minimum and stored in ovens kept at 80-100°C before use. Recommendations of the electrode manufacturer shall I be followed if available.

4.7 The electrodes, filler wires and flux used shall be free from rust, oil, grease. earth and other foreign matter which affect the quality of welding.

4.8 Tungsten electrodes used shall conform to **ASME** Sec. II C SFA 5.12 specification.

5.0 SHIELDING & PURGING GAS:

5.1 Argon gas used in GTA welding for shielding purposes shall be 99.995% pure. The purity of the gas shall be certified by the manufacturer. The rate of flow for shielding purposes shall be established through procedure qualification tests. Normally this rate may be 12-20 CFH.

5.2 Argon gas with a purity level of 99.995% shall be used for purging.

5.3 When GTAW process alone or a combination of GTAW and SMAW processes is recommended for the production of a particular joint, the purging shall be maintained during the root pass and for the first filling pass to minimize oxidation on the inner side of the pipe, unless otherwise specified in Welding Specification Chart.

5.4 Initial purging shall be maintained for sufficient period of time so that at least 4-5 times the volume between the dams is displaced, in order to completely remove the entrapped air. In no case should the initial purging period be less than 10 minutes. High gas pressure should be avoided.

5.5 After initial purging, the flow of the backing gas should be reduced to a point where only a slight positive pressure prevails. For systems, which have a small volume (up to ½ cubic foot) to be purged, a gas flow rate of 6-CFH is usually adequate. Systems of larger volume may require higher flow rates and these should be established during procedure qualification tests.

5.6 Gas backing (purging) is not required for socket type of welded joints.

5.7 Dams, used for conserving inert gas during purging, shall be removed after completion of the welding, and shall be accounted for. Wherever, removal of dams is not possible after welding, use of water-soluble dams should be made.

6.0 EQUIPMENTS & ACCESSORIES:

6.1 The Contractor should have the arrangement of sufficient number of welding and cutting equipments, auxiliaries, and accessories of sufficient capacities so as to meet the target / schedule.

6.2 All the equipments for performing the heat treatment, including transformers, thermocouples, pyro-meters, automatic temperature recorders (with suitable calibration arrangement etc.) shall be provided by the Contractor at his own expenses and these should bear the approval of the Engineer-in-Charge.

6.3 Contractor shall make necessary arrangements at his own expense, for providing the radiographic equipments, radiographic films, processing equipment all other darkroom facilities and all the equipments/materials required for cawing out the

dye penetrant / magnetic particle test/ultrasonic testing for satisfactory and timely completion of the job.

6.4 Redoing of any work, necessitated by faulty equipments or operation used by the Contractor, will be done at his own expense.

7.0 WELDING PROCEDURE:

7.1 Welding of various materials under this specification shall be carried out using one or more of the processes with the approval of the Engineer-in-Charge.

- Shielded Metal Arc Welding Process (SMAW).
- Gas Tungsten Arc Welding Process (GTAW)

7.2 The welding processes to be employed are given in the Welding Specification Chart. Any deviation desired by the Contractor shall be obtained through the express consent of the Engineer-in-Charge.

7.3 Automatic and semi-automatic welding processes shall be employed only with the express approval of the Engineer-in-Charge. The welding procedure adopted and consumables used shall be specifically approved.

7.4 A combination of different welding processes could be employed for a particular joint only after duly qualifying the welding procedure to be adopted and obtaining the approval of Engineer-in-Charge.

8.0 EDGE PREPARATION:

8.1 General

The edges to be welded shall be prepared to meet the joint design requirements by any of the following methods recommended:

(a) Carbon Steel
Gas cutting, machining or grinding methods shall be used. After gas cutting, oxides shall be removed by chipping or grinding.

(b) Low Alloy Steels (containing up to 5% Chromium).
Gas cutting, machining or grinding methods shall be used. After gas cutting, machining or grinding shall be carried out on the cut surface.

(c0 High alloy steel (> 5% Chromium) and stainless steels, nickel alloys:
Plasma cutting, machining or grinding methods shall be used. After plasma cutting, cut surfaces shall be machined or ground smooth.

8.2 Cleaning

(a) The ends to be welded shall be properly cleaned to remove paint, oil, grease, rust, oxides, sand, earth and other foreign matter. The ends shall be completely dry before the welding commences.

(b) On completion of each run, craters, welding irregularities, slag etc., shall be removed by grinding and chiseling. Wire brushes used for cleaning stainless steel joints shall have stainless steel wires and the grinding wheels used for grinding stainless steel shall be of a suitable type. Separate grinding wheels and wire brushes should be used for carbon steels and stainless steels.

9.0 ALIGNMENT & SPACING:

9.1 Components to be welded shall be aligned and spaced as per the requirements laid down in applicable code. Special care must be taken to ensure proper fitting and alignment when the welding is performed by GTAW process. Flame heating for adjustment and correction of ends is not permitted unless specifically approved by the Engineer-in-Charge.

9.2 A wire spacer of suitable diameter may be used for maintaining the weld root opening while tacking, but it must be removed after tack welding and before laying the root bead.

9.3 For pipes of wall thickness 5 mm and above, the ends to be welded shall be secured in position with the aid of couplers, yokes and 'C' clamps, to maintain perfect alignment. Yokes shall be detached after the completion of weld, without causing any surface irregularity. Any irregularity caused on the pipe surface must be suitably repaired to the satisfaction of the Engineer-in-Charge.

9.4 Tack welds, for maintaining the alignment, of pipe joints shall be made only by qualified welders using approved W S . Since the tack welds become part of the final weldment they shall be executed carefully and shall be free from defects. Defective tack welds must be removed prior to the actual welding of the joints.

9.5 Tacks should be equally spaced. Minimum number of tacks shall be:

3 tacks - for 2 1/2" and smaller dia. pipes

4 tacks - for 3" to 12" dia. pipes

6 tacks - for 14" and larger dia. pipes

9.6 Welding shall commence only after approval of fit-up by the Engineer-In-Charge.

10.0 WEATHER CONDITIONS:

10.1 The parts being welded and the welding personnel should be adequately protected from rain and strong winds. In the absence of such a protection no welding shall be carried out.

10.2 During field welding using GTAW process, particular care shall be exercised to prevent any air current affecting the welding process.

11.0 WELDING TECHNIQUE:

11.1 Root Pass

(a) Root pass shall be made with electrodes/filler wires recommended in the welding specification chart. For fillet welding, root welding shall be done with consumables recommended for filler passes. The preferred size of the electrodes is 2.5 mm diameter (12 SWG) but in any case not greater than 3.25 mm (10 SWG).

(b) Upward technique shall be adopted for welding pipe held fixed with its axis horizontal.

(c) The root pass of butt joints should be executed so as to achieve full penetration with complete fusion of the root edges. Weld projection inside the pipe shall be as per applicable code. It shall be limited 3mm map, when the applicable code does not place any restriction.

(d) Any deviation desired from the recommended welding technique and electrodes indicated in the welding specification chart should be adopted only after obtaining express approval of the Engineer-in-Charge.

(e) Welding shall be uninterrupted.

(f) While the welding is in progress care should be taken to avoid any kind of movement of the components, shocks, vibrations and stresses to prevent occurrence of weld cracks.

11.2 Joint Completion

(a) Joint shall be completed using the class of electrodes, recommended in the Welding Specification Chart. Size of the electrode shall not exceed 4 mm in diameter for stainless steels and alloy steels used for low temperature applications.

(b) Two weld beads shall not be started at the same point in different layers. (c) Butt joints shall be completed with a cover layer that would affect good fusion at the joint edges and a gradual notch free surface.

(d) Each weld joint shall have a workmanship like finish. Weld identification stamped

Metal stamping shall not be used on thin pipe having wall thickness less than 3.5mm. Suitable paint shall be used on thin wall pipes for identification.

(e) Rust preventive / protective painting shall be done after the weld joint has been approved.

11.3 Dissimilar Welds

Where welds are to be produced between carbon steels and alloy steels, preheat and post weld heat treatment requirements shall be those specified for corresponding alloy steels and filler wire / electrodes shall correspond to ER 70 S-G or AWS E-7016/7018 type. For welds between two dissimilar Cr-Mo low alloy steels, preheat and post weld heat treatments shall be those specified for higher alloy steel and electrodes used shall correspond to those specified for steel of lower alloy content. For carbon steel or alloy steel to stainless welds, use of filler wire / electrodes E / ER-309 / E-310 / E NiCr Fe-3 shall be made. The welding procedure, electrodes / filler wires to be used shall be approved by the Engineer-in-Charge.

12.0 HEAT TREATMENT:

12.1 Preheating

(a) No welding shall be performed without preheating the joint to 10°C (50°F) when the ambient temperature is below 10°C.
(b) Preheating requirements for the various materials shall be as per the Welding Specification Chart attached.
(c) Preheating shall be performed using resistance or induction heating methods. Preheating by gas burners, utilizing oxy-acetylene or oxy-propane gas mixtures, with neutral flame may also be carried when permitted by the Engineer-in-Charge
(d) Preheating shall extend uniformly to at least three times the thickness of the joint, but not less than 50 mm, on both sides of the weld.
(e) Preheating temperature shall be maintained over the whole length of the joint during welding. Temperature recorders shall be provided by the Contractor to record the temperature.

12.2 Post Heating

In case of alloy steel materials such as Cr-Mo steels, if the post weld heat treatment is not performed immediately after welding, the weld joint and adjacent portion of pipe, at least 50 mm on either side of weld, shall be uniformly heated to 300°C. This temperature shall be maintained for half an hour minimum, and then

wrapped in asbestos or insulation before allowing it to cool to room temperature. If the Post Heating temperature specified in the Welding Specification Charts exceeds 300°C, the same shall be followed. Similarly, if the welding specification chart specifies post-heat time, the same shall be applicable. Post weld heat treatment as specified in the Welding Specification Chart shall be carried out later on.

12.3 Post Weld Heat Treatment

(a) Post weld heat treatment, wherever required for joints between pipes, pipes and fittings, pipe body and supports shall be carried out as per the welding specification chart, applicable codes standards and the instructions of the Engineer-in-Charge.

(b) The Contractor shall submit for the approval of the Engineer-in-Charge, well before carrying out actual heat treatment, the details of the post weld heat treatment procedure as per Exhibit - B attached, that he proposes to adopt for each of the materials / assembly /parts involved.

(c) Post weld heat treatment shall be done in a furnace or by using an electronic resistance or induction-heating equipment, as decided by the Engineer-in-Charge.

(d) While caving out local post weld heat treatment, technique of application of heat must ensure uniform temperature attainment at all points of the portion being heat treated. Care shall be taken to ensure that width of heated band over which specified post weld heat treatment temperature attained is at least that specified in relevant applicable codes /standards.

(e) Throughout the cycle of heat treatment, the portion outside the heated band shall be suitably wrapped under insulation so as to avoid any harmful temperature gradient at the exposed surface of pipe. For this purpose temperature at the exposed surface should not be allowed to exceed 50% of the peak temperature.

(f) The temperature attained by the portion under heat treatment shall be recorded by means of thermocouple pyrometers. Adequate number of thermocouples should be attached to the pipe directly at equally spaced location along the periphery of the pipe joint. The minimum number of thermocouples attached per joint shall be 1 up to 6" dia., 2 up to 10" dia. and 3 for 12" dia. and above. However, the Engineer-in- Charge can increase the required number of thermocouples to be attached if found necessary.

(g) Automatic temperature recorders, which have been suitably calibrated, should be employed for measuring & recording the temp. The time-temp graph shall be submitted to Engineer-in-Charge immediately on completion of S.R. The calibration chart of each recorder should be submitted to the Engineer-in-Charge prior to starting the heat treatment operations and his approval should be obtained.

(h) Manufacturer's test certificate shall be submitted for the thermocouple materials.

(i) Immediately on completion of the Heat Treatment, the Post Weld Heat Treatment charts/records along with the hardness test results on the weld points, wherever required as per the Welding Specification Chart, shall be submitted to Engineer-in-Charge for his approval.

(j) Each joint shall bear an identification number, which shall be maintained in the piping sketch to be prepared by the Contractor. The joint identification number should appear on the corresponding post weld heat treatment charts. The chart containing the identification numbers and piping sketch shall be submitted to Engineer-in-Charge in suitable folders.

13.0 CLEANING OF THE WELD JOINTS:

All weld joints shall be free from adherent weld spatters slag, sward, dirt or foreign matter. This can be achieved by brushing. For stainless steels, brushes with only stainless steel bristles should be used.

14.0 INSPECTION AND TESTING:

14.1 General

(a) The Owner's inspector shall have free access to all concerned areas, where the actual work is being performed. The contractor shall also accord the Owner's Inspector all means and facilities necessary to carry out inspection.

(b) The Owner is entitled to depute his own inspector to the shop or field where prefabrication and erection of pipe lines is in progress for (but not limited to) the following objectives:

i) To check the conformance to relevant standards and suitability of various welding equipments and the welding performance.

ii) To witness the welding procedure qualification.

iii) To witness the welder performance qualification.

iv) To check whether shop / field welding being executed is in conformity with the relevant specifications and codes of practice followed in piping construction.

(c) Contractor shall intimate sufficiently in advance the commencement of qualification tests, welding works and acceptance tests, to enable the Owner's inspector to be present to supervise them.

14.2 Welding Procedure Qualification

Welding procedure qualification shall be carried out in accordance with the relevant requirements of ASME Sec. IX latest edition or other applicable codes and the job requirements. The contractor shall submit the welding procedure specification in format as per Exhibit-C (attached) immediately after the receipt of the order. Owner's inspector will review, check and approve the welding procedure submitted and shall release the procedure for qualification tests. The procedure qualification test shall be carried out by the Contractor at his own expense. A complete set of test results in the format as per Exhibit-D (attached) shall be submitted to the Owner's inspector for his approval immediately after completing the procedure qualification test and at least 2 weeks before the commencement of actual work. Standard test as specified in the code shall be carried out in all cases. In addition to these tests, other tests like macro/micro examination, hardness tests. Dye penetrant examination, charpy V-notch, Corrosion tests, impact tests etc. shall be carried out on specimens depending upon the type of base material, operating conditions and requirements laid own in the detailed drawings and specifications. It shall be the responsibility of the Contractor to carry out all the tests required to the satisfaction of the Owner's inspector.

14.3 Welder's Qualification

(a) Welders shall be qualified in accordance with the **ASME** Section-IX or other applicable codes. The Owners inspector shall witness the test and certify the qualification of each welder separately. Only those welders who have been approved by the Owner's Inspector shall be employed for welding. Contractor shall submit the welder qualification test reports in the format as per Exhibit-E (attached) and obtain express approval before commencement of work. It shall be the responsibility of Contractor to carry out qualification tests of welders. For welding of the steam piping, falling under the purview of Indian Boiler Regulations only those welders with IBR Certification, qualified by Boiler Inspectorate, and acceptable to the local Boiler Inspector authority shall be employed.

(b) The welders shall always have in their possession the identification card as shown in Exhibit4 and shall produce it on demand by the Owner's inspector. It shall be the responsibility of the Contractor to issue the identify cards after it has been duly certified by the Inspector.

(c) No welder shall be permitted to work without the possession of identify card.

(d) If a welder is found to perform a type of welding or in a position for which he is not qualified, he shall be debarred from doing any further work. All welds performed by an unqualified welder shall be cut and redone by a qualified welder at the expense of the Contractor

14.4 Visual Inspection

Inspection of all welds shall be carried out as per the latest editions of the applicable codes and specifications. All finished welds shall be visually inspected for parallel and axial alignment of the work, excessive reinforcement, concavity of welds, shrinkage cracks, inadequate penetration, unrepaired burn-through, under cuts, dimensions of the weld,
Surface porosity and other surface defects. Undercutting adjacent to the completed weld shall not exceed the limits specified in the applicable standard / code.

14.5 Radiographic Examination

(a) Contractor shall appoint agency for carrying out the radiography works at site from the list of agency (ies) enclosed in the bid document or separately supplied by owner.

(b) The Radiographic Examination procedures to be adopted shall be submitted by the contractor as per Exhibit-F and shall be got approved from the Owner's Inspector prior to employment. A person qualified to ASNT Level-II in Radiographic testing shall prepare the procedure. The Radiography Procedure shall be established to demonstrate that the required sensitivity can be consistently achieved under the most unfavorable parameters (e.g. source to film distance, geometric unsharpness, thickness etc.). The radiographic technique and procedure adopted shall conform of the requirements mentioned in Article 2 as well as Article 22 (SE 94, 142, 747, 999 & 1025) of ASME Sec.V. The IQI sensitivity obtained shall be equal to or better than the requirements mentioned in Article 2 of ASME Sec. V. Source side penetrameter shall be used in establishing radiographic procedure/ technique. The acceptance criteria shall be as per the relevant codes of Fabrication and over riding requirements if mentioned else where in the technical specifications of the contract. The Contractor shall be responsible for carrying out Radiography; rectification of defects and re-radiography of welds repaired / rectified at his cost.

(c) The extent of Radiography shall be as per specifications to be supplied to the Contractor. For welds between dissimilar materials, the extent of Radiographic Examination shall be the more stringent of the two recommended for the materials being welded. Wherever random Radiography is called for, in a particular piping class, the dissimilar materials weld joints shall essentially be included.

(d) Type of Radiation source and film to be used shall be as per Exhibit-H for carrying out radiographic examination. However if specifications (as given elsewhere in the contract) for some critical material require usage of X- Radiation, then Radiography shall be done using X-Rays only.

(e) The Contractor shall fulfill all the statutory and owner's safety requirements while Handling X-ray and Gamma-ray equipments.

(f) The joints for Radiography shall be selected by the Owner's Inspector and the Radiography shall be performed in his presence, if he instructs the contractor to do so. The contractor shall furnish all the radiographs, to the Owner's inspector immediately after processing along with evaluation by a person qualified to ASNT Level - II in Radiographic testing, inline with clause T-292 of Article 2 of ASME Sec. V. The certificate of ASNT Level-II (RT) personnel shall be submitted to owner's inspector for his approval prior to start of job.

(g) The Contractor shall provide the Owner's Inspector all the necessary facilities at site such as a dark room with controlled temperature, illuminator (viewer) suitable for varying densities, a duly calibrated electronic densitometer with batteries, magnifying glass, tracing papers, ruler marking pencils etc. to enable him to review the radiographs.

(h) Where random radiography is specified, the first weld of each welder shall be completely radiographed. In the case of pipe of size 6" and below, the first two welds shall be completely radiographed.

(i) For each weld performed by a welder found unacceptable, two additional checks shall be carried out on welds performed by the same welder. This operation is iterative and of the two additional welds for each weld deemed unsatisfactory shall be continued till such time that two consecutive welds of satisfactory quality are found for every defective weld.

(j) The Contractor shall carry out these additional radiographic testing at his own expense. To avoid the possibility of too many defective welds by a single welder remaining undetected for a long period to time, the Contractor shall promptly arrange for Radiographic Examination so that there is no accumulation of defective joints.

(k) Contractor shall quote rates for X-ray as well as Gamma Ray for joints indicated to be radiographed by X-ray in Table of Exhibit-H.

14.5.1 Check Shots

(a) Owner shall select 5% of the total joints radiographed on a day for check shots. Contractor shall carry out check shots as directed.

(b) Weld profiles of check shots shall be compared with weld profile observed in the earlier Radiographs. In the event of any one variation in the check shots and earlier Radiographs, contractor shall re-shoot the entire lot of joints radiographed by particular Radiography agency on the particular date. All the re-shot films shall be compared with the originally submitted films.

14.6 Liquid Penetrant and Magnetic Particle Examination

(a) Whenever such tests are specified, the tests shall be carried out on joints chosen by the Owner's inspector, as per ASME Section V article 6 and 7 respectively.

(b) For austenitic stainless steels and other nonmagnetic materials, liquid (dye) penetrant test shall be carried out. For carrying out this test, the materials shall be brought within a temperature limit of 15 - 50^0C.

14.7 Hardness Test

Hardness requirements for welds shall be as per the Welding Specification Chart (attached). Hardness testing shall be carried out by Vickers Hardness Tester during welding procedure qualification and shall be cross sectional. In all other cases, hardness testing may be carried out by Portable Shore Seleroscope hardness tester. Contractor shall produce documentary evidence / calibration certificate to the Owner's Inspector and obtain approval of the equipment.

14.8 Proof Tests

Hydrostatic and pneumatic tests shall be performed as per the requirements laid down by respective flushing and Testing specification/applicable codes to demonstrate the soundness of the welds. The tests shall be conducted after fulfilling the requirement of visual examinations, radiography etc. and after the entire work has been certified by the Owner's inspector to be fit for being subjected to such tests.

15.0 REPAIRS OF WELDS:

(a) Defects ascertained, through the inspection methods, which are beyond acceptable limits shall be removed after the joint is completely radiographed by the process of chipping and grinding.

(b) When the entire joint is judged unacceptable, the welding shall be completely cut and edges suitably prepare as per required alignment tolerances. The re-welded joint shall again be examined following standard practices.

(c) No repair shall be carried out without prior permission of the Owner's inspector.

(d) Repairs and / or work of defective welds shall be done in time to avoid difficulties in meeting the construction schedules.

16.0 DOCUMENTS TO BE SUBMITTED BY CONTRACTOR (4 COPIES EACH):

(a) Electrode and Welding Consumable Qualification Records as per Exhibit-A, for the Welding Consumables tested and approved for the work.

(b) Batch Test Certificates, for the Electrodes used, obtained from the Electrode Manufacturers.

(c) Proposed Heat Treatment Procedure as per Exhibit-B .

(d) Heat Treatment Charts.

(e) Weld joint hardness test results.

(f) Welding Procedure Specifications as per Exhibit-C immediately after receipt of the order.

(g) Welding Procedure Qualification records as per Exhibit-D.

(h) Welder Performance Qualification records as per Exhibit-E immediately after conducting Welder Qualification Tests.

(i) Radiography Procedure as per Exhibit-F and other NDT procedures.

(j) Radiographic test Report along with Radiographs and other NDT reports.

(k) Piping Sketch (Isometric) giving all the details regarding the pipe specifications, welded joints, joints radiographed magnetic particle, tested, ultrasonic tested, penetrant tested, joints heat treated, WPS used, welders identification number, etc.

EXHIBIT - A
Sheet 1 of 3

ELECTRODE QUALIFICATION TEST RECORD

A: Tested at (Site name) Date:

Manufacturer's Name :

Brand Name : Batch

Number & Size tested :

Classification & Code :

Intended for welding in position : In

combination with (if any) : Code of

Reference (used for testing) : Special

Requirements (if any) :

B: All-weld Tensile Test : Base

Material used : Pre-heat

temperature : Post weld heat

treatment details : Visual examination

: Radiographic examination results :

Tensile test results :

Identification No.	U.T.S	Yield Point	Elongation	Remarks

EXHIBIT - A Sheet 2 of 3

C: Impact Test Results

Test Temperature: **Notch in: Type of**

Specimens (Charpy): **Size of Specimens:**

Specimen No.	Impact Value	Average
1		
2		
3		

D: Chemical Analysis Results Electrode

Size Result :

Batch No. :

% C	% S	% P	% Si	% Mn	% Cr	% Ni	% Mo	OTHER

E: Fillet Weld Test Results :

Welding Positions : Base

Materials : Size of

electrode use : Visual

Inspection Results :

1)

2)

3)

EXHIBIT - A Sheet 3 of 3

Macro Test Results :

Fracture Test Results :

Remarks :

F: Other Test Results

1. Transverse tensile test : In combination with : Base material used : Position of welding : Preheat temperature : Post weld heat treatment : Radiography :

Identification No. U.T.S Fracture in Remarks

2. Guided Bend Test :

POSITION	IDENTIFICATION NO.	ROOT, FACE OR SIDE BEND	REMARKS
	1		
	2		
	3		

G. Any other tests : H.

Conclusions :

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PREPARED BY (CONTRACTOR) REVIEWED BY (CONTRACTOR) APPROVED BY (OWNER)

EXHIBIT – B
Sheet 1 of 2

STRESS RELIEF HEAT TREATMENT PROCEDURE SPECIFICATION

Contractor : -

Name of the Heat treater :

Name of the Project :_____ Specification:_____

Reference No. _____

1. General Details **Other Details**

Name of the equipment:_____

Type of heating: Elec. Res / Induction
(Tick mark applicable method)

Maximum Permissible Temp at Uncovered Parent Metal

Width of heated Band

Width of Insulation_____

Material:_____ **No. of Thermo Couples (dia wise)**

Type of Thermo Couples_____

2. Heat Treatment Cycle Details

Charging Temp (^{0}C)

Rate of heating (^{0}C/Hr.)

Soaking Temperature (^{0}C)_____

EXHIBIT – B Sheet 2 of 2

Soaking Time (Hrs.) _____ Rate of cooling (^{0}C/Hr.)_____ Method of Cooling_____

3. Other Details, if any _____

EXHIBIT – C
Sheet 1 of 3

FORMAT FOR WELDING PROCEDURE SPECIFICATION (WPS)

Company Name _____ BY
Welding Procedure Specification No._____ Date
Supporting PQR No. (S)_____ Revision No. _____ Date
Welding Process (es)_____ Type (s) _____
(Automatic, Manual, Machines or Semi Auto)

JOINTS

Joint Design
Backing (Yes)_____ (No)
Backing Material (Type)
Sketches Production Drawings. Weld Symbols Written_____

Description shod show the general arrangement of the parts to be welded. Where applicable, the root spacing and the details of weld groove may be specified

(At the option of the Manufacturer sketches may be attached to illustrate joint design weld layers and bead sequence e.g. for notch toughness procedures, for multiple process procedures, etc.)

BASE METALS

P No. _____ Group No. _____to P. No. _____ Group No._____ OR
Specification type and grade _____
to Specification type and grade_____ OR
Chem. Analysis and Mech. Prop. _____
to Chem. Analysis and Mech. Prop._____

Thickness Range:
Base Metal: Groove _____ Fillet _____
Deposited Weld Metal: Groove Fillet_____Fillet_____
Pipe Dia Range: Groove: _____ Fillet _____Other .

EXHIBIT-C
SHEET 2 OF 3

FILLER METALS

F. No._____ Other _____ A. No. Other _____ Spec. No. (SFA) AWS No. (Class) _____ Size of filler metals_____

(Electrodes, Cold Wire, Hot Wire etc.)

Electrode-Flux (Class)_____
Flux Trade Name _____
Consumable Inset _____ Each base metal/filler metal combination should be recorded individually.

WPS NO. _____ Rev. _____

POSITIONS:	**POST WELD HEAT TREATMENT**
Position(s) of Groove _____ **Welding Progression: Up___Down ___** **Position (S) of Fillet_____**	**Temperature Range_____** **Time Range _____**
PREHEAT	**GAS**
Preheat Temp. Min. **Inter pass Temp. Max.** **Preheat Maintenance_____**	**Shielding Gas (es) _____** **Percent Composition (mixtures)_____** **Flow Rate_____** **Gas Backing_____** **Trailing Shielding Gas Composition___**

ELECTRICAL CHARACTERISTICS

Current AC or DC _____ Polarity _____ Amps (Range) _____ Volts (Range) _____ (Amps and volts range should be recorded for each electrode size, Position, and thickness, etc. This information may be listed in a tabular form similar to that shown below)
Tungsten Electrode Size and Type _____

(Pure Tungsten, 2% Thoriated, etc)

EXHIBIT-C
SHEET 3 OF 3

Mode of Metal Transfer for GMAW _____
(Spray arc, short circuiting arc. etc.)

Electrode Wire feed speed range _____

TECHNIQUE

String or Weave Bead _____

Orifice or Gas Cup Size _____

Initial and Inter pass Cleaning (Brushing, Grinding, etc.) _____

Method ~~of Back Gouging~~ _____
Oscillation _____
Contact Tube to Work Distance _____
Multiple or Single Pass (per side) _____
Multiple or Single Electrodes _____
Travel Speed (Range) _____
Peening _____
Other _____

Weld Layers	Process	Filler Metal		Current		Volt Range	Travel Speed Range	Others
		Class	Dia.	Type Polarity	Amp. Rating			
								ex.: Remarks, Commer Hot wire Addition, Technique Torch Angle etc.

EXHIBIT – D
Sheet 1 of 3

FORMAT FOR PROCEDURE QUALIFICATION RECORD (PQR)

RECORD ACTUAL CONDITIONS USED TO WELD TEST COUPON

Company Name _____
Procedure Qualification record No._____ **Date** _____
WPS No. _____
Welding Process (es)_____**Type (s)** _____
(Automatic, Manual, Machines or Semi Auto)

JOINTS

Groove Design of Test Coupons

(For combination qualification, the deposited weld metal thickness shall be recorded for each Filler Metal or Process weld)

BASE METAL **Material Spec.** _____ **Type of Grade** _____ **P. No.** _____**to P. No.** _____ **Thickness of test coupon** _____ **Diameter of test coupon** _____ **Other** _____	**POST WELD HEAT TREATMENT** **Temperature** _____ **Time** _____ **Other** _____
FILLER METALS **Weld Metal Analysis A No.** **Size of Filler metal** **Filler Metal E No.** **SFA Specification** **AWS Classification** **Other** _____	**GAS** **Type of Gas or Gases** **Composition of Gas Mixture** **Other** _____

EXHIBIT – D Sheet 2 of 3

POSITION	ELECTRICAL CHARACTERSTICS
Position of Groove _____ Weld Progression (Uphill, Downhill) _____ Other _____	Current _____ Polarity _____ Amps. _____ Tungsten Electrode Size _____ Other _____
PREHEAT	**TECHNIQUE**
Preheat Temp. _____ Inter pass Temp. _____	Travel Speed _____ String or weave bead _____ Oscillation _____ Multi pass or single pass _____ Single or Multiple electrodes _____ Other _____

GUIDED BEND TEST

Type of Figure No.	Result

TOUGHNESS TESTS

Specimen No.	Notch Location	Notch Type	Test Temp.	Impact Value	Lateral Expansion		Drop weight	
					% Shear	Mils	Break	No Break

FILLET WELD TEST

Result – Satisfactory: Yes _____No _____ Penetration into Parent Metal: Yes _____No _____
Macro Results _____

EXHIBIT – D
Sheet 3 of 3

OTHER TESTS

Type of Test
Deposit Analysis
Other _____

Welder's Name _____ **Check No.** _____ **Stamp No.**
Test Conducted by _____ **Laboratory Test No.** _____

We certify that the statements in this record are correct and test welds were prepared, welded and tested in accordance with the requirements of Section IX of the ASME Code.

Date _____ **Manufacturer** _____
BY _____

(Details of record of tests are illustrative only and may be moulded to conform to the type and number of tests required by codes and specifications)

EXHIBIT – E
Sheet 1 of 2

FOMAT FOR MANUFACTURER'S RECORD FOR WELDER OR WELDING OPERATOR QUALIFICATION TESTS

Welder Name _____ Cheek No. _____ Stamp. No. _____

Using WPS No. _____ Rev. _____

The above welder is qualified for the following ranges Variable Record Actual Values Qualification Range Used in Qualification

Process _____ _____

Process Type _____ _____

Backing (metal,

Weld metal, flux, etc) _____ _____

Material Spec. _____ to _____ _____ to _____
Thickness
Groove _____ _____
Filler _____ _____
Diameter
Groove _____ _____
Filler _____ _____
Filler Metal
Spec. No. _____ _____
Class _____ _____
F. No. _____ _____
Position _____ _____
Weld Progression _____ _____
Gas Type _____ _____
Electrical Characteristics
Current _____ _____
Polarity _____ _____

EXHIBIT – E
Sheet 2 of 2

Guided Bend Test Results

Type of Figure No.	Result

Radiographic Test Results (for alternative qualification of groove welds by radiography)

Radiographic test results _____

Fillet Weld Test Results

Fracture Test (Describe the location, nature and size of any crack of tearing of the specimen _____
Length and Per Cent of Defects _____ inches _____%
Macro Test - Fusion
Appearance - Fillet Size(ing) _____ x _____ Convexity or Concavity ___

Test Conducted by _____ Laboratory - Test No. _____

We certify that the statements in this record are correct and that the test welds were prepared, Welded and tested in accordance with the requirements of Section IX of the ASME Code.

Date _____ **Organization_____**
BY _____

(Details of record tests are illustrative only and may be modified to conformation to the type & number of tests required by the Code)

Note: Any essential variables in addition to those above shall be recorded

EXHIBIT - F

RADIOGRAPHIC PROCEDURE QUALIFICATION RECORD FOR PIPE WELDING

1. Location
2. Date of Testing
3. Name of the Contractor/Agency
4. Material: Carbon steel/Alloy Steel / Stainless Steel

   4 A. Technique: DWSI/SWSI/DWDI
5. Diameter & Thickness:
6. Type of Weld Joint:
7. Radiation Source:
8. Intensifying Screens/Lead Screens:
9. Geometric Relationship:
10. Limit of Film Coverage:
11. Film Type and Make:
12. Exposure Time:
13. Processing:
14. Density:
15. Sensitivity:
16.* Type of penatrameter (source side):
17.* Type of penatrameter (Film side):

Signature of Contractor/Agency with Seal

Approval of GAIL's Inspector

* Refer Para regarding recommended practice on placement of Penetrameters, Article 22, SE 142, ASME Sec. V

* For "Random radiography" lines placement of Penetrameters as per Article 2, ASME Sec. V is permitted.

EXHIBIT – G

WELDER'S IDENTITY CARD

PHOTOGRAPH

1. **Name:**
2. **Identification:**
3. **Date of Testing:**
4. **Process**
5. **Thickness range**
6. **Diameter range**
7. **F. No.**
8. **Date of approval of welding**
9. **Position**

Approved by: **Employer's Signature with seal**

EXHIBIT – H TYPE OF SOURCE AND FILMS TO BE USED FOR RADIOGRAPHY

NOMINAL WALL THICKNESS (T) IN mm		SHOP WELDED JOINTS		FIELD WELDS	
19 ” T	All Materials	Gamma Ray	“AGFA D7” or equivalent	Gamma Ray	“AGFA D7” or equivalent
8 ” T <19	Carbon steel	Gamma Ray	“AGFA D5” or equivalent	Gamma Ray	“AGFA D5” or equivalent
	All other materials	Gamma Ray	“AGFA D4” or equivalent	Gamma Ray	“AGFA D4” or equivalent
T < 8	Carbon steel other than Inspection Class IV *	Gamma Ray	“AGFA D4” or equivalent	Gamma Ray	“AGFA D4 / D2” or equivalent
	All other material and Carbon Steel of Inspection Class IV *	X Ray	“AGFA D5” or equivalent	X-ray with "AGFA D5" or Equivalent to be used. Gamma Ray with "AGFA D4/D2" or Equivalent may be allowed only if in the opinion of the owner's inspector Joints are inaccessible for X-ray equipment and radiographic sensitivity is achieved	

Notes: Integral to above table

1. **Joints welded in field on Ground Level shall be considered as shop welded joints.**

2. **Very fine grain (High contrast) films slower than the above may have to be used, if required radiographic sensitivity is not achieved consistently.**

3. **AGFA means AGFA GAEVERTS.**

* **Refer Std. Spec. No. GAIL-STD-ME-DOC-TS-022**

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL NOTES FOR PIPES

GAIL-STD-ME-DOC-TS-015

0	22.03.19	Issued For Tender	RKS	AP	JR	
Rev	**Date**	**Purpose**	**Prepared By**	**Checked By**	**Approved By**	

TECHNICAL NOTES FOR PURCHASE OF PIPES

1.0 GENERAL

1.1 All pipes and their dimensions, tolerances, chemical composition, physical properties, heat treatment, hydrotest and other testing and marking requirements shall conform to latest codes and standards specified in the material requisition (MR). Deviation(s), if any, shall be clearly highlighted in the offer.

1.2 Testing

1.2.1 Test reports shall be supplied for all mandatory tests as per the applicable material specifications. Test report shall also be furnished for any supplementary tests as specified in the MR and clauses 1.10 & 1.11.

1.2.2 Material test certificates (Physical property, chemical composition & heat treatment report) shall also be furnished for the pipe supplied.

1.2.3 PMI shall be performed as per the scope and procedures as defined in the GAIL standard spec. for PMI at vendor's work

1.3 Manufacturing Process

1.3.1 Steel made by acid Bessemer process shall not be acceptable.

1.3.2 All longitudinally welded pipes other than IS 3589 should employ only automatic welding.

1.4 Pipe shall be supplied in single or double random length of 4 to 7 and 7 to 14 meters respectively.

1.5 a. Seamless and ERW pipes shall not have any circumferential seam joint in a random length. However, in case of E.FS.W. pipe, in one random length one welded circumferential seam of same quality as longitudinal weld is permitted. This weld shall be at least 2.5 m from either end. The longitudinal seams of the two portions shall be staggered by 90^0. Single random length in such cases shall be 5 to7 m.

b. Unless otherwise mentioned in the respective material code, E.FS.W. pipes < 36" shall not have more than one longitudinal seam joint and E.FS.W pipes 36" shall not have more than two longitudinal seam joints.

1.6 Pipe with screwed ends shall have NPT external taper pipe threads conforming to ASME/ ANSI B1,20.1 up to 1.5" NB & IS 554 for 2" to 6" NB.

1.7 Pipe with beveled end shall be in accordance with ASME B 16.25. Weld contour shall be as follows:

Material	Wall Thickness	Weld Contour
Carbon steel (except Low Temp. Carbon Steel)	Up to 22 mm	Figure 2 Type A
	> 22 mm	Figure 3 Type A
Alloy Steel, Stainless Steel & Low Temp. Carbon Steel	Up to 10 mm	Figure 4
	> 10 mm & Up to 25 mm	Figure 5 Type A
	> 25 mm	Figure 6 Type A

1.8 Galvanised pipes shall be coated with zinc by hot dip process conforming to IS 4736 / ASTM A 153.

1.9 All austenitic stainless steel pipes shall be supplied in solution annealed condition. All types of 321 or 347 stainless steel pipes shall be in a stabilized heat treated condition. Stabilized heat treatment shall be carried out subsequent to the normal solution annealing. Soaking time & holding temp. for stabilizing heat treatment shall be 900^0 C & 4 hrs respectively.

1.10 **I.G.C Test for Stainless Steel**

1.10.1 For all austenitic stainless steel pipes intergranular corrosion test shall have to be conducted as per following:

ASTM A 262 Practice “B” with acceptance criteria of “60 mils/year (max.)”.

OR

ASTM A 262 Practice “E” with acceptance criteria of “No cracks as observed from 20X magnification” & ‘Microscopic structure to be observed from 250X magnification”

1.10.2 When specifically asked for in MR for high temperature application of some grades of austenitic stainless steel (eg. SS 309, 310, 316, 316 H etc.) ASTM A 262 Practice “C” with acceptance criteria of “15 mils/year (max)” shall have to conducted.

1.10.3 For the IGC test as described in 1.10.1 & 1.10.2, two sets of samples shall be drawn from each solution annealing lot; one set corresponding to highest carbon content and the other set corresponding to the highest pipe thickness. When testing is conducted as per Practice “E”, photograph of microscopic structure shall be submitted for record.

1.11 All welded pipes indicated as “CRYO” & “LT” in MR shall be impact tested per requirement and acceptance criteria of ASME B 31.3. The impact test temperature shall be $(-)196^0$ C & $(-)\ 45^0$ C for stainless steel and carbon steel respectively unless specifically mentioned otherwise in the MR.

1.12 Pipes under “NACE” category shall meet the requirements given in MR-01-75

1.13 Specified heat treatment for carbon steel and alloy steel and solution annealing for stainless steel pipes shall be carried out after weld repairs. Number of weld repairs at the same spot shall be restricted to maximum two by approved repair procedure.

1.14 For black or galvanized pipes to IS 1239, the minimum percentage of elongation shall be 20 %.

1.15 All 1 Cr – 0.5 Moly & 1.25 Cr – 0.5 Moly seamless pipes shall be normalized and tempered.

1.16 For all welded Alloy steel pipes with mandatory requirement of heat treatment and radiography, radiography shall be performed after heat treatment.

2.0 IBR PIPES

2.1 IBR Documentation :

2.1.1 Pipes under purview of IBR shall be accompanied with IBR certificate original in Form IIIA, duly approved and countersigned by IBR authority/ local authority empowered by the Central Boiler of India. Photocopy of the original certificate duly attested by the local boiler inspector where the supplier is located is the minimum requirement for acceptance.

2.1.2 For material 1 ¼ Cr – ½ Mo (ASTM A335 Gr.P11 / A691 Gr. 1 ¼ Cr) & 2 ¼ Cr – 1 Mo (ASTM A 335 Gr. P22 / A 691 Gr. 2 ¼ Cr), Form III-A approved by IBR shall include the tabulation of E_t, S_c & S_r values for the entire temperature range given below. E_t, S_c & S_r values shall be such that throughout the temperature range

$E_t / 1.5$

Sr / 1.5 S_A

Sc

Where,

S_A : Allowable stress at the working metal temperature

E_t : Yield Point (0.2 % proof stress at the working metal temperature)

Sc : The average stress to produce elongation of 1% (creep) in 100000 hrs at the working metal temperature.

Sr : The average stress to produce rupture in 100000 hrs at working metal temperature and in no case more than 1.33 times the lowest stress to produce rupture at this temperature.

S_A (psi)												
Temp (^oF) Material	500	600	650	700	750	800	850	900	950	1000	1050	1100
A335 Gr. P 11	17200	16700	16200	15600	15200	15000	14500	12800	9300	6300	4200	2800
A691 Gr. 1 ¼ Cr	18900	18300	18000	17600	17300	16800	16300	15000	9900	6300	4200	2800
A 335 Gr. P22 / A691 Gr. 2 ¼ Cr	17900	17900	17900	17900	17900	17800	14500	12800	10800	7800	5100	3200

Note: S_A values given above are as per ASME B 31.3 – 1999. Values shall be as per the latest edition prevailing.

2.2 For carbon steel pipes under IBR the chemical composition shall conform to the following :

Carbon (max) : 0.25 %

Others (S, P, Mn) : As prescribed in IBR regulation.

The chemical composition as indicated in this cluse is not applicable for pipes other than IBR services.

3.0 HYDROSTATIC TEST

Refer Annexure – I

4.0 MARKING AND DESPATCH

4.1 All pipes shall be marked in accordance with the applicable codes, standards and specifications. In addition the purchase order number, the item code & special condition like “IBR”, “CRYO”, “NACE” etc. shall also be marked.

4.2 Pipes under “IBR”, “CRYO”, “NACE”, “H2 (Hydrogen)” shall be painted in red stripes, light purple brown stripes, canary yellow stripes and sea green stripes respectively longitudinally throughout the length for easy identification. Marking of pipes circumferentially for sizes 1” and below at one meter interval along the length of pipes is also acceptable.

4.3 Paint or ink for marking shall not contain any harmful metal or metallic salts such as zinc, lead or copper which cause corrosive attack on heating.

4.4 Pipes shall be dry, clean and free from moisture, dirt and loose foreign materials of any kind.

4.5 Pipes shall be protected from rust, corrosion and mechanical damage during transportation, shipment and storage.

4.6 Rust preventive used on machined surfaces to be welded shall be easily removable with a petroleum solvent and the same shall not be harmful to welding.

4.7 Both ends of the pipe shall be protected with the following material:

Plain end	:	Plastic Cap
Bevel end	:	Wood, Metal or Plastic Cover
Threaded end	:	Metal or plastic threaded cap

4.8 Pipes may be provided with plastic push fit type end caps/ steel caps without belt wire..

4.9 Plastic caps can also be used as end protector for galvanized pipe ends.

ANNEXURE – I

3.0 HYDROSTATIC TEST

3.1 All pipes shall be hydrostatically tested.

3.2 The mill test pressure shall be as follows :

3.2.1 Seamless, E.R.W. & Spiral welded :

a) Carbon Steel

Material Std.	Test Pressure Std.
ASTM A 106 Gr. B	ASTM A 530
API 5L Gr. B, Seamless	API 5L
API 5L, E.R.W.	API 5L
API 5L, Spiral	API 5L
ASTM A333 Gr.3 & 6, Seamless	ASTM A 530
ASTM A333 Gr.3 & 6, E.R.W	ASTM A 530

b) Seamless Alloy Steel

Material Std.	Test Pressure Std.
ASTM A335 Gr.. P1, P12, P11, P22, P5, P9	ASTM A 530
ASTM A268 TP 405, TP 410	ASTM A 530

c) Seamless Stainless Steel

Material Std.	Test Pressure Std.
ASTM A312 Gr. TP 304, 304L, 304H, 316, 316L, 316H, 321, 347	ASTM A 530

d) Seamless Nickel Alloy

Material Std.	Test Pressure Std.
ASTM B161 UNS No. 2200	ASTM B161
ASTM B165 UNS No. 4400	ASTM B165
ASTM B167 UNS No. 6600	ASTM B167
ASTM B407 UNS No. 8800	ASTM B407
API 5L Gr. B, Seamless	API 5L
API 5L, E.R.W.	API 5L
API 5L, Spiral	API 5L

ASTM A333 Gr.3 & 6, Seamless	ASTM A 530
ASTM A333 Gr.3 & 6, E.R.W	ASTM A 530

e) Welded Nickel Alloy

Material Std.	Test Pressure Std.
ASTM B725 UNS No. 2200, 4400	ASTM B725
ASTM B517 UNS No. 6600	ASTM B517
ASTM B514 UNS No. 8800	ASTM B514

3.2.2 Electric Fusion Welded

a) Carbon Steel & Alloy Steel E.FS.W (16" & above)

Material Std.	Test Pressure Std.
API 5L Gr. B ASTM A671 Gr.CC65, 70 (Cl.32) ASTM A672 Gr.C60, 65, 70 (Cl.12, 22) ASTM A671 Gr.CF60, 65, 66, 70 (Cl.32) ASTM A691 Gr.1/2 Cr, 1Cr, 1 ¼ Cr, 2 ¼ Cr, 5Cr, 9Cr (Cl.42)	P = 2ST / D S = 90% of SMYS Except for API 5L Gr. B S = 85% of SMYS For API 5L Gr. B T = Nominal Wall Thickness D = O.D of Pipe

b) Stainless Steel E.FS.W (2" to 6") :

The hydrostatic test pressure in kg/cm^2 for the following materials shall be as given below :

Material Gr. 1 :ASTM A 312 TP 304 / 304 H/ 316 / 316H/ 321/ 347 welded.
Material Gr. 2 :ASTM A 312 TP 304 L/ 316L welded.

Size	Pipe Schedule : 10S		Pipe Schedule : 40S		Pipe Schedule : 80S	
	Material Gr.1	Material Gr.2	Material Gr.1	Material Gr.2	Material Gr.1	Material Gr.2
2"	100	80	155	130	230	190
3"	80	60	155	130	230	190
4"	80	50	155	130	230	190
6"	65	35	90	75	155	130

c) Stainless Steel E.FS.W (8” and above)

Material Std.	Test Pressure Std.
ASTM A358 TP 304L, 304, 304H, 316L, 316, 316H, 321, 347 (Classes 1, 3 & 4)	P = 2ST/D S = 85% of SMYS T = Nominal Wall Thickness D = O.D. of pipe
ASTM A358 TP 304L, 304, 304H, 316L, 316, 316H, 321, 347 (Classes 2 & 5)	P = 2ST/D S = 72% of SMYS T = Nominal Wall Thickness D = O.D. of pipe

3.2.3 Carbon Steel Pipes to IS Standards:

Material Std.	Test Pressure Std.
IS 1239	IS 1239
IS 3589	IS 3589

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL NOTES FOR PIPELINE VALVE

GAIL-STD-ME-DOC-TS-016

Rev	Date	Purpose	Prepared By	Checked By	Approved By	
0	22.03.19	Issued For Tender	RKS	AP	JR	

CONTENTS

TECHNICAL NOTES FOR VALVES

1.0 GENERAL

1.1 Vendor shall supply valves in accordance with the valve specification sheets along with auxiliaries, if any, such as gear operator, bypasses, drains etc. wherever specified in the specification sheets, subject notes and other enclosures to the material requisition (MR).

1.2 Vendor shall quote in strict accordance with the valve data / specification sheets, subject technical notes and all other enclosures to the MR. Deviations to the specification / data sheets, subject technical notes and other enclosures of the MR, if any, shall be asked as explained in clause 2.0.

1.3 All codes and standards for manufacture, testing, inspection etc. shall be of latest editions.

2.0 DOCUMENTATION

2.1 Vendor shall submit the following with the offer:

2.1.1 Manufacturer's complete descriptive and illustrative catalogue / literature.

2.1.2 Detailed dimensioned cross section drawing with parts /material lists, weight etc.for the ball valves, plug valves, butterfly valves, diaphragm valves and valves to manufacturer's standard.

2.1.3 Drawings for valves with accessories like gear operator, hydraulic / pneumatic operator, motor, extension bonnet, extended stems with stands, bypass etc. giving major salient dimensions.

2.1.4 One copy of the valve specification sheets signed as "Accepted" by the manufacturer with all deviations marked clearly.

2.1.5 If the valve is regretted or has no deviation, the manufacturer shall write clearly on valve specification sheets as "Regret" or "No Deviation".

2.1.6 For subject notes, if there is any deviation, the same shall be listed clause-wise. Even clauses which are acceptable shall be categorically confirmed as "Accepted".

2.1.7 On failure to submit documents as specified in clauses 2.1.1 to 2.1.6 above, the offer is likely to be rejected.

2.2 The following documents shall be submitted after placement of the order:

2.2.1 Vendor shall submit for approval drawings mentioned in clauses 2.1.2 & 2.1.3 before start of manufacture. No other drawing shall be submitted for approval.

2.2.2 Test report shall be supplied for all mandatory tests as per the applicable code. Test reports shall also be furnished for any supplementary tests as specified in clauses 3.13, 3.14 & 3.15.

2.2.3 Material test certificates (physical properties, chemical composition & heat treatment report) of the pressure containing parts shall be furnished for the valves supplied. Material test certificates for the other parts shall also be furnished for verification during inspection.

3.0 DESIGN AND CONSTRUCTION

3.1 Valve shall be designed, manufactured, tested, inspected and marked as per the manufacturing standards; design codes and standards (latest editions) indicated in the respective valve specification sheets. Any conflict between the requisition, enclosures, specification sheets and referred standard codes shall be brought to the notice of the purchaser for clarifications. But generally, specification sheets and enclosures of the requisition including subject notes shall govern. After issue of the Purchase Requisition (PR) no deviation to specification / standards shall be permitted through vendor drawing approval. Approval of drawings shall be valid only for design / constructional features.

3.2 All flanged valves shall have flanges integral (except forged valves) with the valve body. Flange face finish shall be normally specified in the valve specification sheet as serrated finish, 125 AARH etc. The interpretation for range of face finish shall be as follows:

Stock Finish	:	1000 µ in AARH max.
Serrated Finish / Smooth Finish/ 125 AARH	:	Serrations with 125 to 250 µ in AARH
Extra Smooth Finish / 63 AARH	:	32 TO 63 µ in AARH

3.3. For all weld end valves with bevel end as per ASME B16.25 the contour of bevel shall be as follows:

Material	Wall Thickness	Weld Contour
Carbon Steel (Except Low Temp. Carbon Steel)	Upto 22 mm	Figure 2 Type A
	> 22 mm	Figure 3 Type A
Alloy Steel, Stainless Steel & Low Temp. Carbon Steel	Upto 10 mm	Figure 4
	> 10 mm & Upto 25 mm	Figure 5 Type A
	> 25 mm	Figure 6 Type A

3.4 For flanged valves with ring joint flanges the hardness shall be as follows

Flange Material	**Min. Hardness of Groove (BHN)**
Carbon Steel	140
1%Cr to 5%Cr	150
Type 304, 316. 321, 347	160
Type 304L, 316L	140

3.5 Following requirements for check valves shall be met over and above the valve spec sheet requirements:

3.5.1 Unless specified otherwise in the data sheet all check valves 3" & above (except in 900#, 1500# & 2500# rating) shall have a drain boss at location "G" (Refer Fig.No.1 of ASME B16.34). A tapped drain hole with plug shall be provided as per ASME B16.34. Threads shall be as per ASME B1.20.1 (Taper) NPT.

3.5.2 Wherever check valve disc assembly is supported from the cover of the check valves the following shall be ascertained.

i) Positive location /positioning of cover must he provided to ensure correct alignment of the valve disc.

ii) Hinge pin design must permit accurate alignment of the disc and valve seat.

3.5.3 For heavy check valves, provisions shall be available for lifting by way of lugs, eye bolts and other such standard devices.

3.6 If an overlay weld-deposit is used for the body seat ring seating surface, the corrosion resistance of the seat ring base material shall be at least equal to the corrosion resistance of the material of the shell.

3.7 Following valve bypass requirements shall be met:

3.7.1 By-pass requirement for Gate valves is indicated in the respective data sheets. As a rule, the following shall be followed:

ANSI 150 Class : On sizes 26" and above

ANSI 300 Class : On sizes 16" and above

ANSI 600 Class	:	On sizes 6” and above
ANSI 900 Class	:	On sizes 4” and above
ANSI 1500 Class	:	On sizes 4” and above
ANSI 2500 Class	:	On sizes 3” and above

3.7.2 The by-pass piping arrangement shall be such that clearance between main valve body and by-pass assembly shall be the minimum possible for layout reasons.

3.7.3 By-pass valve shall be a globe valve. The sizes shall be as under:

On main valve ” 4”	:	1/2” or more
On main valve > 4” but < 10”	:	3/4” or more
On main valve > 10”	:	1” or more

The by-pass arrangement shall be as specified in Specification Sheet No.12 - 13.

3.7.4 Vendor shall supply the by-pass valve duly tested and fitted to the main valve. Valves with by-pass shall have the direction of flow marked on the main valve. By- pass attachment to the main valve body shall not be screwed. All fillet welds for bypass installation shall be 100% examined by DP/ MP test.

3.8 Valve body / bonnet shall be forged / cast as specified. Forgings are acceptable in place of casting but not vice-versa.

3.9 Material of construction of yoke shall be minimum equivalent to body / bonnet material.

3.10 Stem shall be forged or machined from forged / rolled bar. No casting is permitted. However, integral stern of cast stainless steel ball valve is acceptable.

3.11 Stelliting / Hardfacing by deposition, shall be minimum 1.6 mm. Renewable seat rings shall he seal welded.

3.12 For Low Temperature & Cryogenic valve requirements, refer Specification. @ Sheet no-17.

3.13 Valves under “NACE” category shall meet the requirements specified in MR unless otherwise specified.

3.14 For all austenitic stainless steel valves Inter Granular Corrosion (IGC) test shall be conducted as per the following:

3.15.1 ASTM A262 Practice "B" with acceptance criteria of "60 mils/year (max.)" for all materials - forged, rolled, wrought and casting.

Qr

ASTM A262 Practice "E" with acceptance criteria of "No cracks as observed from 20X magnification" for all materials other than castings. Microscopic structure to be observed from 250X magnification" in addition.

3.15.2 When specifically asked for in MR for high temperature application of some grades- of austenitic stainless steel (e.g. SS 309, 310, 316, 316H etc) ASTM A262 Practice "C" with acceptance criteria of "15 mils/year (max.)" shall be conducted.

3.15.3 For the IGC test as described in Clauses 3.15.1 & 3.15.2, two sets of samples shall be drawn from each solution annealing lot. One set shall correspond to the highest Carbon content and the other to the highest pressure rating. When testing is conducted as per practice "E", photograph of the microscopic structure shall be submitted for record.

3.16 All types of 321 or 347 stainless steel valves shall be in a stabilised heat treated condition. Stabilising heat treatment shall be carried out subsequent to the normal solution annealing. Soaking temperature and holding time for stabilising heat treatment shall be 900°C and 4 hours respectively.

3.17 Spiral wound bonnet gaskets are to be provided with inner/ outer ring except when encapsulated gaskets type body-bonnet joints are employed. Outer ring may be avoided in case of non-circular spiral wound gasket used in 150# valve provided the outermost layer of spiral touches the bolts ascertaining the centering.

3.18 Ball/ Plug/ Butterfly Valves:

3.18.1 As a prequalification, fire safe test as per API 607 / API 6FA / BS 6755 Part II shall be carried out on soft seated ball, plug & butterfly valves and also on lubricated plug valves. The test shall be witnessed and certified by a third party inspection agency like Lloyds, B.V., DNV etc. The vendor has to submit test certificate for the particular design of the valve offered.

3.18.2 Each valve shall be supplied with a lever / wrench except for gear operated / motor operated valves.

3.18.3 Soft-seated ball, plug & butterfly valves shall he supplied with antistatic devices.

3.18.4 Soft-seated BW / SW end ball valves shall have a 100mm long seamless pipe nipple welded to each end of the valve. Nipples are to be welded prior to assembling Teflon seats *I* seals. Specifications of the nipples shall be as indicated in the **MR.**

3.18.5 The face-to-face dimensions of all ball valves shall be same as those of gate valves of the corresponding ANSI class (except 10" onwards in Class 150 where the face-to-face dimensions shall be as per API 6D long pattern).

3.18.6 The ball of ball valve shall not protrude outside the end flanges of valve.

3.18.7 Ball valves shall be of floating ball/ trunnion mounted type as per following:

150#	8" & below 10" & above	Floating ball Trunnion mounted
300#	4" & below 6" & above	Floating ball Trunnion mounted
600# & above	1.5" & below 2" & above	Floating ball Trunnion mounted

3.18.8 Unless otherwise specified in the data sheets, bore of all reduced bore ball valves shall be limited to one size lower than the nominal bore.

3.19 The MOVs are to be installed in an open area and the actuators shall be suitable for all weather conditions. The testing of complete assemblies of MOVs along with the actuators shall be done by the supplier at his works. Torque details for MOVs shall be furnished by the bidder / supplier in the format attached with the MR.

4.0 OPERATION

4.1 Generally the valves are hand wheel or lever operated. Gear operation shall be provided as under:

Valve Type	Class	Size Requiring Gear-Operator
Gate Valve & Diaphragm Valve	150 Class	14" and larger
	300 Class	14" and larger
	600 Class	12" and larger
	900 Class	6" and larger
	1500 Class	3" and larger
	2500 Class	3" and larger
Globe Valve	900 Class	6" and larger
	1500 Class	3" and larger
	2500 Class	3" and larger
Ball Valve / Plug Valve (Other than pressure balance plug valves)	150 Class	6" and larger
	300 Class	6" and larger
	600 Class	4" and larger
	900 Class	3" and larger
	1500 Class	3" and larger
Butterfly Valve	150, 300 Class	6" and larger

For sizes lower than these ranges, hand wheel / lever / wrench shall be provided. For pressure balance plug valves manufacturer's recommendation shall be acceptable provided the requirements specified in clause 4.6 are met.

4.2 Gear operator shall be as under, with position indicators for open / close positions and with limit stops. (Limit stops are not applicable for gate and globe valves).

For Gate / Globe / Diaphragm Valves	Totally enclosed bevel gear in grease case with grease nipples / plugs.
For Ball / Plug / Butterfly Valves	Totally enclosed helical worm or combination of helical worm and spur gear in grease case with grease nipples / plugs.

4.3 Where gear operator is not called for as per Clause 4.1 but vendor recommends a gear operator, he shall highlight such case(s).

4.4 Gear operator shall be so designed as to operate effectively with the differential pressure across the closed valve equal to the cold non-shock pressure rating.

4.5 Ball, plug and butterfly valves, even with wrench or lever operators shall have "Open" position indicators with limit stops.

4.6 Hand wheel diameter shall not exceed 750mm and lever length shall not exceed 500mm on either side. Effort to operate shall not exceed 35 Kg at hand-wheel periphery. However, failing to meet the above requirements, vendor shall offer gear operated valve and quote as per clause 4. 3.

5.0 INSPECTION AND TESTING

5.1 Every valve shall be subjected to all the mandatory tests and checks called in the respective codes / data sheet by GAIL inspection or any third party as approved by the owner. For IBR valves refer clause 7.0.

5.2 Every valve, its components and auxiliaries must be subjected to all the mandatory tests and checks called for in the respective codes, data sheets etc. by the manufacturer.

5.3 Though the extent of inspection shall be as under, exact extent with hold points shall he decided by GAIL inspection office and recorded in the form of inspection plan. In case of third party inspection, the inspection plan shall be approved by the purchaser.

Forged Valves:

1. Visual and dimensional inspection.
2. Review of material test certificates.
3. Any mandatory or supplementary test.
4. Hydrostatic test on 10% valves selected on random basis.
5. Strip check is required for 1 % of total ordered quantity of valves (min. 1 No.) against each specification lot.

Cast Steel Valves:

1. Visual and dimensional inspection.
2. Review of material test certificates.
3. Review of radiographic reports or any other NDT tests wherever applicable as per data sheet.
4. Any mandatory or supplementary test.
5. Hydrostatic test 100% for body, 10% other test.

6, Strip check is required for 1 % of total ordered quantity of valves (mm. 1 No.) against each specification lot.

Samples for strip check shall be selected at random and shall generally be in the highest size in the lot.

5.4 In case of motor operated or actuator operated valves, functional / operational checks as per the requirements of the specifications shall be made on each valve.

5.5 Positive Material Identification (PMI) shall be performed as per the scope and procedures as defined in the 'Specification for Positive Material Identification **(PMI)** at Vendor's Works'

6.0 RADIOGRAPHY OF CAST VALVES

6.1 Valve castings shall undergo radiographic examination as specified below. However, for sizes 24" & below in 150# and 16" & below in 300#, radiography percentage specifically mentioned in individual valve material spec sheet shall govern.

Material	Rating	Size Range	Radiography
All	150#	24" and below	NIL
		26" and above*	100%
	300#	16" and above	NIL
		18" and above	100%
	600# & above	All Sizes	100%

*No radiography is required for valves of size • 26" in cooling water service.

Radiography specified as random 10% or 20% etc. in the respective valve data sheet implies 10% or 20% etc. of number of valves ordered against each item number with a minimum of one valve against each item.

6.2 Radiography procedure, areas of casting to be radiographed shall be as per ASME B16.34 and acceptance criteria shall be as per ASME B16.34 Annexure-B. However for areas of

casting to be radiographed for types of valves not covered in ASME B16.34, vendor shall enclose details of areas to be radiographed in line with ASME B16.34.

6.3 For random radiography wherever specified in individual data sheets, the sampling shall be as per size of the quantity ordered for each foundry.

6.4 Radiography wherever specified in the data sheets or as per clause 6.1 shall be done by X- ray / Û-ray to get the required sensitivity.

6.5 Over and above the stipulations laid down in clauses 6.1, 6.2, 6.3 & 6.4, all valve castings when sourced indigenously shall only be procured from foundries approved by GAIL.

7.0 IBR CERTIFICATION

7.1 For valves described **"IBR",** valves shall be in accordance with the latest IBR (Indian Boiler Regulation) including the requirements specified in the specification

7.2 For SW/ BW end carbon steel valves under **IBR,** the chemical composition shall conform to the following:

Carbon (Max)	:	0.25%
Others (S, P, Mn)	: :	As per **IBR** regulations

The above composition is not valid for non-IBR valves.

7.3 Valves coming under the purview of **"IBR"** (Indian Boiler Regulations) shall each be individually accompanied by **IBR** certificate original in Form **Ill-C** duly approved by **IBR authority** / **local authority** empowered by the Central Boiler Board of India. Photocopy of original certificate duly attested by the local boiler inspector where the supplier is located is the minimum requirement for acceptance.

7.4 All **"IBR"** valves shall be painted red in body-bonnet/ body-cover joint.

8.0 MARKING

8.1 Valve markings, symbols, abbreviations etc. shall be in accordance with MSS-SP-25 or the standard referred in specification sheet as applicable. Vendor's name, valve rating, material designation, nominal size, direction of flow (if any) etc. shall be integral on the body.

8.2 Each valve shall have a corrosion resistant tag giving size, valve tag / code no., securely attached to the valve body.

8.3 Paint or ink for marking shall not contain any harmful metal or metal salts such as zinc, lead or copper which cause corrosive attack on heating.

8.4 Carbon Steel / Alloy Steel valves shall be painted with one coat of inorganic zinc silicate (minimum DFT 65 to 75 microns).

9.0 DISPATCH

9.1 Valve shall be dry, clean and free from moisture, dirt and loose foreign materials of any kind.

9.2 Valves shall be protected from rust, corrosion and any mechanical damage during transportation, shipment and storage.

9.3 Rust preventive on machined surfaces to be welded shall be easily removable with a petroleum solvent or shall not be harmful to welding.

9.4 Each end of valve shall he protected with the following materials

Flange Face	:	Wood or Plastic Cover
Bevelled End	:	Wood or Plastic Cover
SW & SCRD.End	:	Plastic Cap

9.5 End protectors of wood/ plastic to be used on flange faces shall be attached by at least three bolts and shall not be smaller than the outside diameter of the flange. However plastic caps for SW & SCRD end valves shall be press fit type.

9.6 End protectors to be used on bevelled end shall be securely and tightly attached.

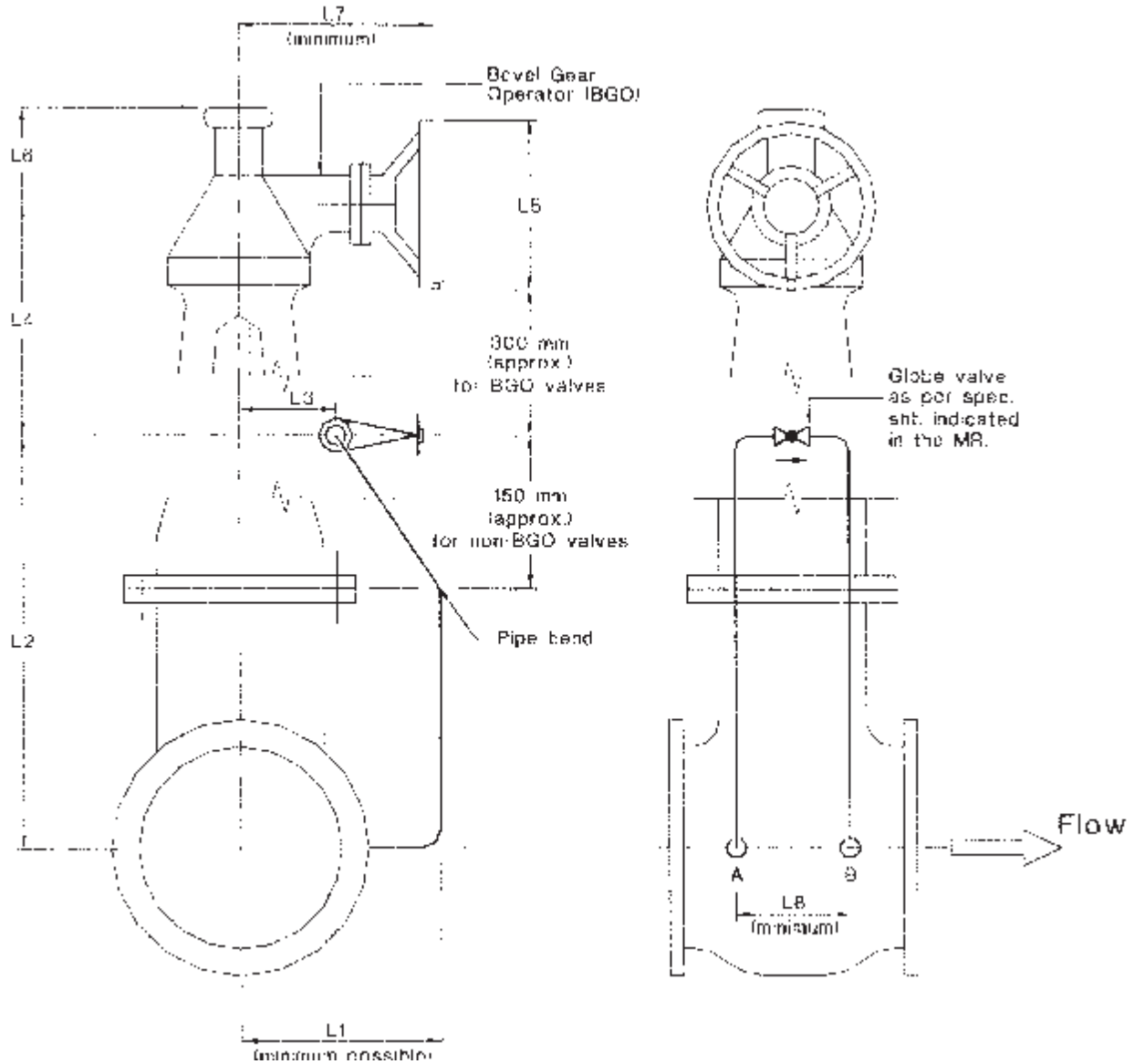
9.7 For special service valves additional requirement of dispatch shall be prescribed in data sheet.

10.0 ATTACHMENTS (Cut out the irrelevant attachments)

Bypass Piping Arrangement
Special Requirement for Low temperature and Cryogenic Valves

Data Sheet Format for Torque Values of MOVs

BYPASS PIPING ARRANGEMENT



NOTES:

The orientation & location of hand wheel of bevel gear operator & the bypass arrangement shall be strictly as per this sketch.

2. The bypass pipe ends shall be socket/butt welded to the body wall of the main valve.
3. The bypass arrangement shall be properly clamped to & supported by the body of the main valve.
4. Basic design of bypass shall be to MSS-SP-45 & ASME B16.34.
5. Material of bypass pipe & 90° elbows shall be same or equivalent to the body material of the Valve.
6. Vendor shall furnish dimensions L1 to L8.

SPECIAL REQUIREMENTS FOR LOW TEMPERATURE & CRYOGENIC VALVES

1.0 Scope

All valves of Low Temperature Carbon Steel (LTCS) and all grades of austenitic SS (CRYO) material are categorized as cryogenic valves. All these valves shall have extended bonnet as per BS 6364 except check valves. Valves shall be suitable for installation in any position (on vertical, horizontal or skewed pipe line).

Following qualification criteria shall be met by the valve vendors to quote valves for cryogenic services.

2.0 Qualification Criteria

Both cryogenic test (clause 2.1) and reference list (clause 2.2) together, as indicated herein shall be considered for vendor qualification and vendor shall furnish the same, along with his offer. Vendors whose current supply does not cover valves of all sizes, materials and ratings (cryogenic test and reference list) required by MR, should confirm/ furnish the following for consideration of their offer:

i). Evidence of having conducted successfully at least one cryogenic test as per BS 6364. Test certificate and reference list shall be furnished with the offer.

ii). Vendor shall confirm to conduct cryogenic test per clauses 2.1 & 2.3 for the remaining valves not later than 12 weeks from the date of purchase order.

Offers of vendors who do not comply with above requirements would be rejected.

Cryogenic test need not be conducted for every order. Test conducted previously, which need not be against GAIL order, is sufficient.

2.1 Cryogenic Test

Vendors to furnish copies of cryogenic test certificate for tests conducted as per details given below:

i). Shall be as per BS: 6364.

ii). Test temperature, unless specifically called for otherwise in the individual MR, shall be -45°*C* for LTCS and -196°C for all grades of austenitic stainless steel.

iii). Tests carried out on a particular size of one type of valve, pressure rating and material shall qualify all sizes equal to and below the test valve size for the same type, pressure

rating and material. In case of austenitic SS any one grade would qualify for all other grades of austenitic SS.

iv). Tests shall have to be witnessed and certified by any one of the following third party inspection agencies; M/s Lloyd, By, DNV, TUV or GAIL.

2.2 Reference List

Vendor shall furnish reference list for valves supplied for cryogenic service indicating the name of client, year of supply. size, material, pressure rating, type of valve and quantity.

2.3 Post Order Testing Procedure

i). Before conducting post order testing, vendor shall submit the following for approval:

a). Test procedure (as per BS 6364).

b). Cross-section drawing of the valve with material of construction.

c). Schematic of test rig (as per BS 6364) with complete details.

ii). Test has to be conducted on largest size of order for each type of valve and for each material and class rating. Vendor shall offer one, two or three valves for selection of test valve by inspector depending upon whether quantity of largest valve in the order is one, two or three and more than three respectively.

In the event of failure of the test valve to meet the specification requirements, the vendor shall conduct test on two more valves. If the other two valves which pass test successfully are of lower size, then the qualification will be valid only to sizes up to - which test has been conducted successfully.

iii). In case of non-conductance of cryogenic test(s) within 12 weeks or failure in the test(s) conducted after receipt of order, the owner reserves the right to invoke any of the provisions of the purchase order including cancellation of the purchase order at the risk and cost of vendor,

3.0 Bonnet extension, wherever specified in the valve sheet to BS:6364 shall be for "non cold box application" unless otherwise specified in the MR. Even if not called for in valve sheet, valves indicated as "LT" or 'CRYO" shall be supplied with bonnet extension.

4.0 Bonnet and Gland extension joints shall be of butt welded construction.

5.0 Repair welding procedure for austenitic stainless steel valves in "CRYO" service shall have to be qualified for impact test as per ASME B31.3. Minimum acceptable impact energy shall he 20 J or lateral expansion of 0.38 mm at temperature of -196^0C

6.0 Wherever impact test of SS studs / nuts is called for in the data sheet, the impact value shall be 27 J at the intended service temperature specified in the data sheets.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL NOTES FOR BUTT WELDED, SOCKET WELDED AND SCREWED FITTINGS

GAIL-STD-ME-DOC-TS-017

0	22.03.19	Issued For Tender	RKS	AP	JR	
Rev	**Date**	**Purpose**	**Prepared By**	**Checked By**	**Approved By**	

1.0 GENERAL

1.1 Chemical composition, physical properties, tests, dimensions and tolerances, heat treatment and marking shall conform to the applicable latest codes / standards / specifications as specified in the material requisition (MR). Any deviation shall be highlighted on a separate sheet by the vendor in the quotation itself.

1.2 Test reports shall be supplied for all mandatory tests as per the material specifications. Test reports shall also be furnished for any supplementary tests as specified in the MR, Clauses 1.7.8, 1.9, 1.10 & 1.11. Material test certificates (physical properties, chemical composition & heat treatment report) shall also be furnished for fittings supplied.

1.3 All fittings shall be seamless in construction unless otherwise specified. If fittings are specified as welded, the same shall conform to Clause 1.7. Seamless fittings can be supplied in place of welded fitting but with maximum negative tolerance of 0.3mm (max.) on wall thickness. Welded fittings shall not be acceptable in place of seamless fittings.

1.4 Outside diameters and wall thickness (unless otherwise mentioned) of butt welded fittings shall be in accordance with ASME B36.10 and ASME B36.19 as applicable.

1.5 For reducing butt weld fittings having different wall thicknesses at each end, the greater wall thickness of the fitting shall be employed and inside bore at each end shall be matched with the specified inside diameter.

1.6 Bevelled ends for all fittings shall conform to ASME B16.25. Contour of bevel shall be as follows:

Material	Wall Thickness	Wall Contour
Carbon Steel (Except Low Temp. Carbon Steel)	Upto 22 mm	Figure 2 Type A
	> 22 mm	Figure 3 Type A
Alloy Steel, Stainless Steel & Low Temp. Carbon Steel	Upto 10 mm	Figure 4
	> 10 mm & Upto 25 mm	Figure 5 Type A
	>25 mm	Figure 6 Type A

1.7 Welded Fittings:

1.7. 1 All welded fittings shall be double welded. Inside weld projection shall not exceed 1.6 mm. Welds shall be ground smooth at least 25 mm from the ends.

1.7.2 For fittings made out of welded pipe, the welded pipe shall be double welded type & shall be manufactured with the addition of filler metal.

1.7.3 Welded tees shall not be of fabricated (stub-in) type.

1.7.4 All welded fittings shall be normalised & 100% radiographed by X-ray on all welds made by fitting manufacturers & also on the parent materials.

1.7.5 Welded pipes employed for manufacture of fittings shall be made by automatic welding only.

1.7.6 All welded carbon steel, alloy steel & stainless steel fittings shall have maximum negative tolerance of 0.3 mm.

1.7.7 Specified heat treatment for carbon steel & alloy steel fittings shall be carried out again after weld repairs.

1.7.8 Irrespective of the material code requirement, all welded fittings indicated in the MR as "Cryo"& "LT" shall meet impact test requirements of ASME B31.3. The impact test temperature shall be -196 ^{0}C & -45 ^{0}C for stainless steel & carbon steel respectively unless specifically mentioned otherwise in the MR.

1.8 Stainless Steel Fittings:

1.8.1 All stainless steel fittings shall be supplied in solution heat treated condition.

1.8.2 Solution annealing for stainless steel fittings shall be carried out again after weld repairs.

1.8.3 For all stainless steel fittings Inter Granular Corrosion (IGC) test shall have to be conducted as per the following:

ASTM A 262 Practice "B" with acceptance criteria of "60 mils/year (max.)".

Or

ASTM A 262 Practice "E" with acceptance criteria of "no cracks as observed from 20X magnification" & "microscopic structure to be observed from 250X- magnification

1 .8.4 When specifically asked for in MR for high temperature application of some grades of austenitic stainless steel (e.g. SS309, 310,316,316H etc.) ASTM A 262 Practice "C" with acceptance criteria of "15 mils/year" shall have to be conducted.

1.8.5 For the IGC test as described in Clauses 1.8.3 & 1.8.4, two sets of samples shall be drawn from each solution treatment lot, one set corresponding to the highest carbon content and other set to the highest fitting thickness. When testing is conducted as per ASTM A 262 Practice "E", photograph of microscopic structure shall be submitted for record.

1.9 Fittings under "NACE" category shall meet the requirements of MR-01-75.

1.10 Thickness *I* schedule lower or higher than specified shall not be accepted.

1.11 The gasket contact surfaces of stub ends shall be flat with face finish specified in the requisition. Interpretation on the specified face finish is as follows:

Serrated Finish : Serrations with 250 to 500 μ in AARH

Smooth Finish/125 AARH : Serrations with 125 to 250 μ in AARH

1.12 Seamless stub ends shall not have any welds on the body.

1.13 Galvanized fittings shall be coated with zinc by hot dip process conforming to IS 4736 / ASTM A153.

1.14 Threaded ends shall have NPT taper threads in accordance with ASME/ANSI B1.20.1 upto 1.5" NB & IS 554 from 2" to 6" NB.

1.15 Unless and otherwise specified in the MR, all socket welded and screwed fittings shall be in accordance with ASME B16.11 to the extent covered in the specification except for unions which shall be in accordance with MSS-SP-83.

1.16 Special fittings like weld-o-let, sock-o-let, sweep-o-let etc. which are not covered in ASME, MSS-SP & GAIL Standards shall be as per manufacturer's standards. Contours of these fittings shall meet the requirements of ASME B31.3. Manufacturer shall submit drawings / catalogues of these items along with the offer.

1.17 Length of all long half couplings shall be 100 mm unless otherwise specified in the MR.

1.18 All seamless pipes employed for manufacturing of fittings shall be required to have undergone hydro test to ASTM A 530. Welded pipes employed for manufacture of fittings shall be tested as given below:

Welded Pipe Employed For Manufacture of Welded Fittings.	Test Criteria
ASTM A671 Gr. C65,70 (C1.32) ASTM A672 Gr. C60,65,70 (Cl. 12, 22) ASTM A671 Gr. CF6O,65,70,66 (Cl.32) ASTM A691 Gr. ½Cr, 1Cr, 1'%Cr, 2'ACr, 5Cr, 9Cr (Cl.42)	P = 2ST/ D S = 90% of SMYS. T Nom. Wall Thickness D = O.D. of Pipe.
API5L ASTM A358 TP 304, 304L, 304H, 318, 318L, 318H, 321, 347 (Cl. 1, 3, 4)	P= 2ST/D S = 85% of SMYS. T = Nom. Wall Thickness D = O.D. of Pipe.
ASTM B725	ASTM B725
ASTM B517	ASTM B517
ASTM B514	ASTM B514

1.19 The bevel ends of all butt weld fittings shall undergo 100% MP/ DP test.

1.20 Swage nipples (concentric/eccentric) if specified as pipe materials are acceptable in forging materials (upto 1½") and wrought fitting materials (above 1½") also in the corresponding material grades.

1.21 Abbreviations for ends of swages and nipples shall be as follows: PBE

	:	Plain Both Ends
TBE	:	Threaded Both Ends
TOE	:	Threaded One End TSE
	:	Threaded Small End TLE
	:	Threaded Large End

2.0 IBR REQUIREMENTS

2.1 IBR Documentation Required:

2.1.1 Fittings under the purview of "IBR" (Indian Boiler Regulations) shall be accompanied with original IBR certificate in Form Ill-C duly approved and countersigned by IBR authority / local authority empowered by Central Boiler Board of India. Photocopy of the original certificate duly attested by the local boiler inspector where the supplier is located is the minimum requirement for acceptance.

2.1.2 For materials 1¼Cr - ½Mo (ASTM A234 Gr.WP11 & ASTM A234 Gr.WP11W) & 2¼Cr - 1Mo (ASTM A234 Gr.WP22 & ASTM A234 Gr.WP22W), where fittings are manufactured from pipe, Form III-C approved by IBR shall include the tabulation of E_t, S_c, & S_r values for the entire temperature range given below. E_t, S_c, & S_r values shall be such that throughout the temperature range

$$\left.\begin{array}{ll} E_t / 1.5 & \geq \\ S_r / 1.5 & \geq \\ S_c & \geq \end{array}\right| S_A$$

S_A: Allowable stress at the working metal temperature.

E_t: Yield point (0.2% proof stress at the working metal temperature)

S_c: The average stress to produce elongation of 1% (creep) in 100000 hrs at the working metal temperature.

S_r : The average stress to produce rupture in 100000 hrs at the working metal temperature and in no case more than 1.33 times the lowest stress to produce rupture at this temperature.

S_A (psi)												
Temp(°F) Material	500	600	650	700	750	800	850	900	950	1000	1050	1100
A 234 Gr.WP11 / A234 Gr.WP11W	21700	20900	20500	20100	19700	19200	18700	13700	9300	6300	4200	2800
A 234 Gr.WP22 / A234 Gr.WP22W	17900	17900	17900	17900	17900	17800	14500	12800	10800	7800	5100	3200

Note: S_A values given above are from ASME B31.3-1996. Values shall be as per the latest edition prevailing.

2.2 For carbon steel fittings described "IBR" chemical composition shall conform to the following:

Carbon (max) : 0.25 %
Others (S, P, Mn) : As prescribed in IBR regulations
The above composition is not valid for **Non-IBR** fittings.

3.0 MARKING AND DESPATCH

3.1 Each fitting shall be legibly and conspicuously stamped in accordance with the requirements of applicable standards along with special condition like "IBR", "Cryo", "NACE" etc.

3.2 Steel die marking with round bottom punch may be permitted on body of butt weld CS & lower alloy steel fittings, but for SS & higher alloy steel fittings, the same should be marked by electro-etching only.

3.3 Paint or ink for marking shall not contain any harmful metals or metal salts such as Zinc, Lead or Copper which causes corrosive attack on heating.

3.4 Fittings shall be dry, clean and free of moisture, dirt and loose foreign materials of any kind.

3.5 Fittings shall be protected from rust, corrosion and mechanical damage during transportation, shipment and storage.

3.6 Rust preventive used on machined surfaces to be welded shall be easily removable with a petroleum solvent and the same shall not be harmful to welding.

3.7 Fittings under "IBR", "Cryo", "NACE" shall be painted in red, light purple and canary yellow stripes respectively for easy identification. Width of the stripe shall be 25 mm.

3.8 Each end of fitting shall be protected with a wood, metal or plastic cover.

3.9 Each size of fitting shall be supplied in separate packaging marked with the purchase order number, item code number, material specification, size and schedule / thickness/ rating.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL NOTES FOR FLANGES, SPECTACLE BLINDS AND DRIP RINGS

GAIL-STD-ME-DOC-TS-018

0	22.03.19	Issued For Tender	RKS	AP	JR	
Rev	**Date**	**Purpose**	**Prepared By**	**Checked By**	**Approved By**	

1.0 GENERAL

1.1 All items, their dimensions, tolerances, chemical composition, physical properties, heat treatment and testing etc. shall conform to the latest codes and standards specified in the requisition. Deviations, if any, shall be clearly highlighted on a separate sheet by the vendor in the quotation itself.

1.2 Testing

1.2.1 Test reports shall be supplied for all mandatory tests as per the relevant material specifications. Test reports shall also be furnished for any supplementary tests as specified in the requisition & Clauses 1.11, 1.12 & 1.15.

1.2.2 Material test certificates (physical property, chemical composition & heat treatment report) shall also be furnished for the flanges supplied.

1.2.3 Positive Material Identification (PMI) shall be performed as per the scope and procedures as defined in the 'Specification for Positive Material Identification (PMI) at Vendor's Works.

1.3 Ends of weld neck flanges shall be bevelled to suit the schedule / thickness of matching pipe, as specified in the requisition.

1.4 Bevel end details for welding neck flanges shall be as per ASME B 16.25. Contour of bevel end shall be as follows:

Material	Wall Thickness	Weld Contour
Carbon Steel (Except Low Temp. Carbon Steel)	Upto 22 mm	Figure 2 Type A
	> 22 mm	Figure 3 Type A
Alloy Steel, Stainless Steel & Low Temp. Carbon Steel	Upto 10 mm	Figure 4
	> 10 mm & Upto 25 mm	Figure 5 Type A
	> 25 mm	Figure 6 Type A

1.5 Bore of socket weld flanges & reducing blind flanges shall suit the outside diameter and schedule/ thickness of matching pipe.

1.6 Bore of slip on flanges shall suit the outside diameter of matching pipe.

1.7 Flange face finish shall be normally specified in the requisition as serrated finish, 125 AARH etc. The interpretation for range of face finish shall be as follows:

Stock Finish	:	1000 μ in AARH max.
Serrated Finish/125 AARH	:	Serrations with 125 to 250 μ in AARH
63 AARH	:	32 TO 63 μ in AARH

1.8 Galvanised flanges shall be coated with zinc by hot dip process conforming to IS 4736/ ASTM A153.

1.9 Ends of screwed flanges unless otherwise specified shall have taper threads as per ASME/ ANSI B1.20.1 (upto 1.5" NB) and IS 554 (for 2" to 6" NB).

1.10 For ring joint flanges, blinds and spacers the hardness shall be as follows:

Flange Material	Min. Hardness of Groove (BHN)
Carbon Steel	140
1% Cr to 5% Cr	150
Type 304, 316, 321, 347	160
Type 304L, 316L	140

1.11 For ring joint flanges, blinds and spacers, the hardness shall be recorded in the test report.

1.12 Flanges, blinds, drip rings under "NACE" category shall meet the requirements given in MR-01-75 unless otherwise specified.

1.13 All austenitic stainless steel flanges shall be supplied in solution annealed condition.

1.14 I.G.C. Test for Stainless Steels:

1.14.1 For all austenitic stainless steel flanges, blinds, drip rings & Fig.8 flanges inter-granular corrosion test shall have to be conducted as per following:

ASTM A262 Practice 'B' with acceptance criteria of "60 mils/year (max.)".

OR

ASTM A262 Practice 'E' with acceptance criteria of "No cracks as observed from 20X magnification" & "Microscopic structure to be observed from 250X magnification"

1.14.2 When specifically asked for in requisition for high temperature application of some grades of austenitic stainless steel (like SS309, 310, 316, 316H etc.) ASTM A262 Practice 'C' with acceptance criteria of "15 mils/year" shall have to be conducted. When testing is conducted as per Practice 'E', photograph of microscopic structure shall be submitted for record.

1.14.3 For the IGC test as described in 1.15.1 & 1.15.2 two sets of samples shall be drawn from each solution treatment lot; one set corresponding to highest carbon content and the other corresponding to the highest rating / thickness.

1.15 All types of 321 or 347 stainless steel flanges shall be in a stabilised heat treated condition.
Stabilising heat treatment shall be carried out subsequent to the normal solution annealing. Soaking temperature and holding time for stabilising heat treatment shall be 900°C and 4 hours respectively.

1.16 AWWA C207 flanges shall be hub type.

2.0 IBR REQUIREMENTS

2.1 IBR Documentation:

2.1.1 Flanges coming under the purview of IBR (Indian Boiler Regulations) shall be accompanied with 1BR Certificate original in Form III C duly approved and countersigned by IBR authority / local authority empowered by Central Boiler Board of India. Photocopy of original certificate duly attested by the local boiler inspector where the supplier is located is the minimum requirement for acceptance.

2.2 For carbon steel flanges described as "IBR", chemical composition shall conform to the following:

Carbon (max.) : 0.25%

Others (S, P, Mn) : As prescribed in IBR Regulation

The chemical composition as indicated in this clause is not applicable for flanges other than IBR.

3.0 SPECIAL REQUIREMENTS FOR HYDROGEN SERVICE

3.1 Method of Manufacture

3.1.1 All carbon steel flanges having wall thickness 9.53 mm and above shall be normalised. The normalising heat treatment shall be a separate heat treatment operation and not a part of the hot forming operation.

3.1.2 All alloy steel (Cr-Mo) flanges shall be normalised and tempered. The normalising and tempering shall be a separate heat treatment operation and not a part of the hot forming operation.

3.2 Impact Test

3.2.1 For all carbon steels and alloy steels with wall thickness over 19 mm, Charpy-V Notch impact testing shall be carried out in accordance with paragraph UG-84 of ASME Section VIII, Div-I per heat of material and per heat treating batch. Impact test specimen shall be in accordance with ASTM A370. Impact energies at 0 °C shall average greater than 27J (20 ft- lb) per set of 3 specimens, with a minimum of 19J (15 ft-lb).

4.0 MARKING AND DESPATCH

4.1 All items shall be legibly and conspicuously stamped in accordance with the requirements of applicable ASME, API and MSS Standards. In addition, GAIL item code, purchase order number & special conditions like "IBR", "CRYO", "NACE" 'H2" etc. shall also be stamped.

4.2 All items coming under the purview of "IBR", "CRYO" , "NACE" & "H2'(hydrogen) shall be painted in red stripes, light purple stripes, canary yellow stripes & sea green stripes (25 mm width) respectively for easy identification.

4.3 Paint or ink for marking shall not contain any harmful metal or metal salts such as zinc, lead or copper which cause corrosive attack on heating.

4.4 All items shall be dry, clean and free from moisture, dirt and loose foreign materials of any kind.

4.5 All items shall be protected from rust, corrosion and mechanical damage during transportation, shipment and storage.

4.6 Rust preventive on machined surfaces to be welded shall be easily removable with a petroleum solvent and the same shall not be harmful to welding.

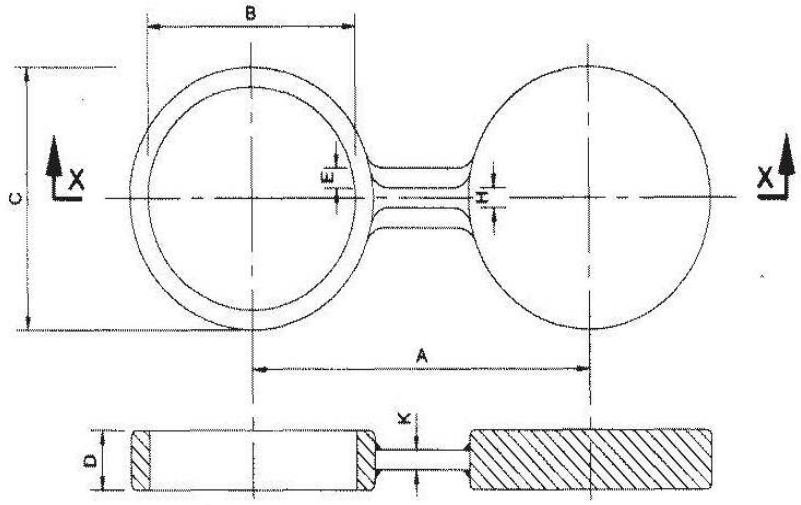
4.7 Each end of flange shall he protected with the following materials: Flange face

	:	Wood, metal or plastic cover
Bevelled end	:	Wood, metal or plastic cover
Threaded end	:	Plastic plug
Socket welding end	:	Plastic cover or plug

4.8 Each size of flanges, blinds, etc. shall be supplied in separate packagings marked with the purchase order number, item code number, material specification, size and rating.

5.0 ATTACHMENTS

Specification for Positive Material Identification (PMI) at Vendor's Works – GAIL-STD-ME-DOC-TS-025



SECTION-XX

PIPE SIZE INCH.	150 # FF							300 # FF							600 # FF							PIPE SIZE INCH.
	A	B	C	D	E	H	K	A	B	C	D	E	H	K	A	B	C	D	E	H	K	
1"	106	29	82	5	10	16	4	117	29	70	5	10	19	4	117	29	70	5	10	19	4	1"
1½"	175	43	82	5	10	16	4	144	43	92	5	10	22	4	144	43	92	7	10	22	4	1½"
2"	152	55	102	7	10	19	4	162	55	106	7	10	19	4	162	55	106	10	10	19	4	2"
2½"	165	64	121	7	15	19	4	180	64	127	10	15	22	6	180	64	127	15	15	22	6	2½"
3"	187	80	134	7	15	19	4	203	80	146	10	15	22	6	203	80	146	15	15	22	6	3"
4"	225	106	170	8	15	19	6	227	106	170	13	15	22	6	257	106	190	18	15	26	6	4"
6"	279	157	218	11	15	22	6	312	157	248	16	15	22	6	340	157	263	24	15	28	6	6"
8"	338	207	275	15	15	22	6	373	207	305	21	15	26	8	399	207	314	30	15	32	10	8"
10"	410	260	325	18	20	26	8	440	260	350	26	20	29	10	491	260	397	37	20	35	10	10"
12"	483	312	405	19	20	26	8	508	312	410	30	20	32	10	543	312	454	43	20	35	15	12"
14"	575	342	443	22	20	29	10	571	342	480	34	20	32	15	586	342	488	48	20	38	15	14"
16"	582	393	501	26	20	29	10	630	393	536	38	20	35	15	662	393	560	54	20	42	20	16"
18"	629	443	545	28	20	32	10	691	443	592	43	20	35	20	714	443	608	62	20	45	20	18"
20"	689	496	600	30	25	32	15	751	496	650	48	25	35	20	794	496	678	67	25	45	20	20"
24"	802	597	710	37	25	35	15	861	597	772	57	25	42	20	902	597	785	81	25	54	25	24"
26"	804	648	770	38	50	22	30	876	648	830	63	50	22	30	916	648	862	86.5	50	22	50	26"
28"	964	696	830	41	50	22	30	940	696	895	67	50	22	30	963	696	910	93	50	22	50	28"
30"	914	750	882	45	60	22	30	996	750	950	72	50	22	40	1022	750	960	99.5	50	22	50	30"

NOTES :-

1. THICKNESS 0.15 BASED ON PLATE MATERIAL A 205 GR.C AND WITH 1.5 MM CORROSION ALLOWANCE ON EACH FACE.
2. PROVID CONCENTRIC SERRATED FINISH ON BOTH SIDES WITH GROOVES 0.8 MM APART AND DEPTH APPROX 0.4 MM.
3. DIMENSIONS ARE FOR FLANGES TO ANSI B 16.5 FOR SIZES UP TO 24.0, MSS.SP.44 FOR SIZES ABOVE 24 FOR FLANGES TO API 605 CALCULATE DIMENSIONS.
4. THE DIAMETER RATING AND MATERIAL SPEC SHALL BE MARKED AT THE BLIND DISC CENTER.
5. MATERIAL AS PER LINE CLASS.
6. JACK SCREW TO BE PROVIDED FOR SPCL. BLINDS 6" AND ABOVE.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL NOTES FOR BOLTS AND NUTS (PIPING)

GAIL-STD-ME-DOC-TS-019

0	22.03.19	Issued For Tender	RKS	AP	JR	
Rev	**Date**	**Purpose**	**Prepared By**	**Checked By**	**Approved By**	

TECHNICAL NOTES FOR BOLTS AND NUTS

1. The process of manufacture, heat treatment, chemical and mechanical requirements and marking for all stud bolts, m/c bolts, jack screws and nuts shall be in accordance with the codes/standards and specifications given in the requisition. Deviation (s), if any, shall be clearly highlighted in the quotation. The applicable identification symbol in accordance with the material specification shall be stamped on each bolt and nut.

2. a. Test reports shall be supplied for all mandatory tests as per the relevant material specifications.
b. Material test certificate shall also be furnished. (Heat Analysis, Product Analysis and Mechanical Requirement)

3. All bolting shall be as per ANSI B 18.2.1 for studs, M/c bolts and jack screws and ANSI B 18.2.2 for nuts.

4. Threads shall be unified (UNC for 1" dia and 8UN for > 1" dia) as per ANSI B. 1.12 with class 2A fit for studs, M/c bolts and jack screws and class 2B fit for nuts.

5. Stud bolts shall be threaded full length with two heavy hexagonal nuts. Length tolerance shall be in accordance with the requirement of table F2 of Annexure-F of ANSI B *16.5.*

6. The nuts shall be double chamfered, semi-finished, heavy hexagonal type and shall be made by the hot forged process and stamped as per respective material specification.

7. Heads of jack screws and m/c bolts shall be heavy hexagonal type. Jack screw end shall be rounded.

8. Each size of studs & m/c bolts with nuts and jack screws shall be supplied in separate containers marked with size and material specifications. 'CRYO' shall be marked additionally in case 'CRYO' is specified in the requisition.

9. All items shall be inspected and approved (stagewise) by GAIL inspector or any other agency authorised by GAIL.

10. The heat treatment for stud bolts & nuts shall be as per code unless mentioned otherwise.

11. All austenitic stainless steel bolts, nuts, screws shall be supplied in solution annealed condition unless specified otherwise in the material specification.

12. Any additional requirements specified in the requisition shall be fully complied with.

13. Stud bolts, m/c bolts, nuts & jack screws shall be impact tested wherever specified in the material specification and also where the material specification is indicated as "CRYO". For S.S. nuts and bolts minimum impact energy absorption shall be 27 Joules and test temperature shall be -196.^{0}C unless mentioned otherwise in code. For other materials impact energy and test shall be as per respective code.

14. Bolts/nuts of material of construction B7M/ 2HM shall be 100% Hardness tested as per supplementary requirement S3 of ASTM A193.

15. When specified as galvanised, the studs, m/c bolts and nuts shall be hot dip zinc coated in accordance with requirements of class C of ASTM A153.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL NOTES FOR GASKETS

GAIL-STD-ME-DOC-TS-020

0	22.03.19	Issued For Tender	RKS	AP	JR	
Rev	**Date**	**Purpose**	**Prepared By**	**Checked By**	**Approved By**	

1.0 GENERAL

1.1 All gaskets shall conform to the codes/standards and specifications given in the requisition. Vendor shall strictly comply with MR/PR stipulations and no deviations shall be permitted

1.2 Process of manufacture, dimensions and tolerances not specified in requisition shall be in accordance with the requirements of the manufacturer's standards.

1.3 Testing

1.3.1 Test reports shall be supplied for all mandatory tests for gaskets as per the standards specified in the requisition.

1.3.2 Chemical composition and hardness of RTJ gaskets shall also be furnished in the form of test reports on samples.

1.3.3 For Spiral wound material following shall be furnished:

a. Manufaturer's test certificate for filler material and spiral material as per the relevant material specifications.

b. Manufacturer's test certificate for raw materials and tests for compressibility/ seal-ability & recovery as per the relevant material specifications.

1.3.4 PMI shall be performed as per the scope and procedures defined in the Specification for PMI at Vendor's works for ring type joint gaskets.

1.3.5 Refer 'Inspection and Test Plan for Gaskets.

1.4 Full face gaskets shall have bolt holes punched out.

1.5 Filler material for spiral wound gaskets shall not have any color or dye.

1.6 All spiral wound gaskets shall be supplied with outer ring. Material of outer ring shall be CS unless otherwise specified in the MR.

1.7 For spiral wound gaskets, material of Inner Compression ring shall be same as spiral strip material. In addition to the requirements as per code and as specified in the MR, inner ring shall be provided for the following:

a. Sizes 26" and above b.

Class 900 and above

1.8 Hardness of metallic RTJ gaskets shall not exceed the values specified below unless otherwise specified in MR:

Ring Gasket Material	**Maximum Hardness (BHN)**
Soft Iron	90
Carbon Steel	120
5 Cr., ½ Mo	130
Type 304, 316, 321, 347	140
Type 304L, 316L	120

1.9 Face finish of metallic RTJ gaskets shall be 32 to 63 AARH.

1.10 Gaskets of different types and sizes shall be placed in separate shipping containers and each container clearly marked with the size, rating, material specification and item code.

1.11 All items shall be inspected and approved by GAIL Inspector or any other agency authorized by GAIL.

1.12 Any additional requirements specified in the requisition, shall be fully complied with.

1.13 Non-metallic ring gaskets as per ASME B16.21 shall match flanges to ASME B 16.5 up to 24" (except 22" size) and to ASME B 16.47 B above 24" unless specified otherwise. For 22" size, the matching flange standard shall be MSS-SP44 unless specified otherwise.

1.14 Spiral wound gasket as per ASME B 16.20 shall match flanges to ASME B 16.5 up to 24" (except 22" size) and to ASME B 16.47 B above 24" unless specifically mentioned otherwise. For 22" size, the matching flange standard shall be MSS-SP44 unless specified otherwise.

1.15 Abbreviation

(I)	:	Inner Ring
(O)	:	Outer Ring
CAF	:	Compressed Asbestos Fibre
GRAFIL	:	Grafoil Filler

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR FABRICATION AND ERECTION OF PIPING

GAIL-STD-ME-DOC-TS-021

0	22.03.19	Issued For Tender	RKS	AP	JR	
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Abbreviations:

PMI	:	Positive Material Identification
NDT	:	Non Destructive Testing
P&ID	:	Process and Instrumentation Diagram
A.S.	:	Alloy Steel
C.S.	:	Carbon Steel
C.I.	:	Cast Iron
S.S.	:	Stainless Steel
LTCS	:	Low Temperature Carbon Steel
NACE	:	National Association of Corrosion Engineers

CONTENTS

1.0 SCOPE

This specification covers general requirements of fabrication and erection of above ground and trench piping systems at site. The specification covers the scope of work of contractor, basis of work to be carried out by contractor and standards, specifications and normal practice to be followed during fabrication and erection by the contractor.

2.0 SCOPE OF WORK OF CONTRACTOR

Generally the scope of work of contractor shall include the following:

2.1 Transportation of required piping materials (as described in Cl.2.l.1), pipe support (material as described in Cl. 2.3) and all other necessary piping materials from Owner's storage point or contractor's storage point (in case of contractor's scope of supply) to work site/ shop including raising store requisitions for issue of materials in the prescribed format & maintaining an account of the materials received from Owner's stores.

2.1.1 Piping materials include the following but not limited to the same.

a. Pipes (All sizes and schedule)
b. Flanges (All sizes, types & Pressure ratings).
c. Fittings (All sizes, types and schedule)
d. Valves (All sizes, types and Ratings)

e. Gaskets (All sizes, types & Ratings)

f. Bolts, Nuts or M/C Bolts (All types)

g. Expansion Joint/Bellows (All types)

h. Specialty items like online filters, ejectors, sample coolers, steam traps, strainers, air traps etc.
i. Online instruments like control valve, orifice flange, rotameter, safety valves etc.

2.2 Shop & field fabrication and erection of piping in accordance with documents listed under C1.3.0 i.e. 'BASIS OF WORK' including erection of all piping materials enumerated above.

2.3 Fabrication and erection of pipe supports like shoe, saddle, guide, stops, anchors, clips, cradles, hangers, turn buckles, supporting fixtures, bracket cantilevers, struts, teeposts including erection of spring supports and sway braces.

2.4

2.4.1 Fabrication of piping specials like special radius bends, reducers, miters etc.
2.4.2 Fabrication of plain and threaded nipples from pipes as required during erection.

2.4.3 Fabrication of swage nipples as and when required.
2.4.4 Fabrication of odd angle elbow like 60°, 30° or any other angle from 90/45° elbows as and when required.

2.4.5 Fabrication of flange, reducing flange, blind flange, spectacle blinds as and when required.
2.4.6 Fabrication of stub-in connection with or without reinforcement.

2.4.7 Grinding of edges of pipes, fittings, flanges etc. to match mating edges of uneven/ different thickness wherever required.

2.5 Modifications like providing additional cleats, extension of stem of valve, locking arrangement of valves etc. as and when required.
2.6 Preparation of Isometrics, bill of materials, supporting details of all NON-IBR lines upto 2- ½" within the unit battery limit and get subsequent approval from Engineer-in- Charge as and when called for.

2.7 Obtaining approval for drawings prepared by contractor from statutory authority, if required.

2.8 Spun concrete lining of the inside of pipes 3" NB & above including fittings and flanges as required in accordance with specification.
2.9 Rubber lining inside pipes, fittings, flanges as and when required, in accordance with specification.

2.10 Radiography, stress relieving, dye penetration, magnetic particle test etc. as required in specification.
2.11 Performing PMI using alloy analysers as per 'Standard Specification for Positive Material Identification at Construction Sites.

2.12 Casting of concrete pedestals and fabrication & erection of small structures for pipe supports including supply of necessary materials.

2.13 Providing insert plates from concrete structures and repair of platform gratings around pipe openings.

2.14 Making material reconciliation statement and return of Owner's supply left over materials to Owner's storage.

2.15 Flushing and testing of all piping systems as per standard specification for inspection, flushing and testing of piping systems.

2.16 Pickling (as and when applicable) as per standard specification for chemical cleaning of C.S. suction piping of compressors.

2.17 Submission of job execution procedure as per standard specification for review and approval of Engineer-in-charge covering all above activities.

3.0 BASIS FOR WORK

3.1 The complete piping work shall be carried out in accordance with the following

3.1.1 "Approved for Construction" drawings and sketches issued by GAIL to the Contractor - Plans and/ or Isometrics.

3.1.2 "Approved for Construction" drawings and sketches issued by Turn-key bidders to the Contractor - Plans and/or Isometrics.

3.1.3 Approved Process licensors standards and specifications.

3.1.4 Drawings, sketches and documents prepared by contractor duly approved by Engineer-in- Charge (such as isometrics of small bore piping and offsite piping etc.)

3.1.5 Approved construction job procedures prepared by Contractor as stipulated in 2.16

3.1.6 GAIL specifications/documents as

below: **a.** Process and Instrument

Diagram. **b.** Piping Materials

Specification

c. Piping support standards.
d. Line list
e. Piping support indices (only in offsite), if supports are not shown in plan.
f. Standard specification of Non-destructive Requirement of Piping
g. Welding specification charts for piping classes

h. Standard Specification for Pressure Testing of Erected Piping System
i. Welding specification for fabrication of piping
j. Any other GAIL or OTHER specifications attached with Piping Material Specification or special condition of contract (such as standard for cement lining of pipe, standard of jacketed piping, standard for steam tracing, Dimensional Tolerances etc.)
k. Procedure for storage, preservation and positive identification of materials at Contractors works / stores.

3.1.7 Following codes, standards and regulations

a.	ASME B 31.3	:	Process Piping
b.	ASME Sec. VIII	:	Code for unfired pressure vessel.
c.	IBR Regulations		
d.	IS: 823	:	Code for procedure for Manual Metal Arc welding of Mild Steel (for structural steel).
e.	NACE Std.	:	Code for Sour Services material requirements MR-0 1-75

Note: All codes referred shall be latest edition, at the time of award of contract.

3.2 Deviations

Where a deviation from the "Basis of Work and approved job procedure described above is required or where the basis of work does not cover a particular situation, the matter shall be brought to the notice of Engineer - in - Charge and the work carried out only after obtaining

4.0 FABRICATION

4.1 Piping Material

Pipe, pipe fittings, flanges, valves, gaskets, studs bolts etc. used in a given piping system shall be strictly as per the "Piping Material Specification" for the "Pipe Class" specified for that system. To ensure the above requirement, all piping material supplied by the Owner / Contractor shall have proper identification marks as per relevant standards / GAIL specifications/ Licensors specification. Contractor shall provide identification marks on left over pipe lengths wherever marked up pipe lengths

have been fabricated I erected. Material traceability is to be maintained for AS., SS., NACE, LTCS, material for Hydrogen service and other exotic materials by way of transferring heat number, etc. (hard punching) as per approved procedure. This shall be in addition to colour coding for all piping materials to avoid mix-up.

For the purpose of common understanding the construction job procedure, to be submitted by the contractor, shall include proposal for
- Maximizing prefabrication, inspection and testing at fabrication shop with minimum field joints.
- Positive material identification, handling, storage & preservation.

4.2 Dimensional Tolerances

Dimensional tolerances for piping fabrication shall be as per GAIL Standard. The Contractor shall be responsible for working to the dimensions shown on the drawings. However, the Contractor shall bear in mind that there may be variations between the dimensions shown in the drawing and those actually existing at site due to minor variations in the location of equipments, inserts, structures etc. To take care of these variations "Field Welds" shall be provided during piping fabrication. An extra pipe length of 100 mm over and above the dimensions indicated in the drawing may be left on one side of the pipe at each of the field welds. During erection, the pipe end with extra length at each field weld shall be cut to obtain the actual dimension occurring at site. Isometrics, if supplied may have the field welds marked on them. However, it is the responsibility of the Contractor to provide adequate number of field welds. In any case no extra claims will be entertained from the Contractor on this account. Wherever errors I omissions occur in drawings and Bills of Materials it shall be the Contractor's responsibility to notify the Engineer-in-Charge prior to fabrication or erection.

4.3 IBR Piping

4.3.1 Contractor shall be supplied generally with all drawings for steam piping falling under the purview of Indian Boiler Regulations duly approved by Boiler Inspectorate. The Contractor shall carry out the fabrications, erection and testing of this piping as per requirements of Indian Boiler Regulations and to the entire satisfaction of the local Boiler Inspector. The Contractor shall also get the approval of IBR inspector for all fabrication and testing done by him at his own cost. All certificates of approval shall be in proper JBR forms.

4.3.2 Approval of boiler inspector on the drawings prepared by the contractor shall be obtained by the contractor at his own cost.

4.4 Pipe Joints

The piping class of each line specifies the type of pipe joints to be adopted. In general, joining of lines 2" and above in process and utility piping shall be accomplished by butt-welds. Joining of lines 1-1/2" and below shall be by socket

welding/ butt welding/ threaded joints as specified in "Piping Material Specifications". However, in piping 1-1/2" and below where socket welding/ threaded joints are specified butt - welds may be used with the approval of Engineer-in-Charge for pipe to pipe joining in long runs of piping. This is only applicable for non-galvanized piping without lining.

Flange joints shall be used at connections to Vessels, Equipment's, Valves and where required for ease of erection and maintenance as indicated in drawings.

4.5 Butt Welded and Socket Welded Piping

End preparation, alignment and fit-up of pipe pieces to be welded, welding, pre-heating, post-heating and heat treatment shall be as described in the welding specification and NDT specification.

4.6 Screwed Piping

In general, Galvanized piping shall have threads as per IS:554 or ANSI B2.l NPT as required to match threads on fittings, valves etc. All other piping shall have threads as per ANSI B2.l, tapered unless specified otherwise.

Threads shall be clean cut, without any burrs or stripping and the ends shall be reamed. Threading of pipes shall be done preferably after bending, forging or heat treating operations. If this is not possible, threads shall be gauge checked and chased after welding heat treatment etc.

During assembly of threaded joints, all threads of pipes and fittings shall be thoroughly cleaned of cuttings, dirt, oil or any other foreign matter. The male threads shall be coated with thread sealant and the joint tightened sufficiently for the threads to seize and give a leak proof joint.

Threaded joints to be seal-welded shall be cleaned of all foreign matter, including sealant and made up to full thread engagement before seal welding.

4.7 Flange Connections

All flange facings shall be true and perpendicular to the axis of pipe to which they are attached. Flanged bolt holes shall straddle the normal centerlines unless different orientation is shown in the drawing.

Wherever a spectacle blind is to be provided, drilling and tapping for the jack screws in the flange, shall be done before welding it to the pipe.

4.8 Branch Connections

Branch connections shall be as indicated in the piping material specifications. For end preparation, alignment, spacing, fit-up and welding of branch connections refer welding specifications. Templates shall be used wherever required to ensure accurate cutting and proper fit-up.

For all branch connections accomplished either by pipe to pipe connections or by using forged tees the rates quoted for piping shall be inclusive of this work.

Reinforcement pads shall be provided wherever indicated in drawings/ specifications etc.

4.9 Bending

Bending shall be as per ASME B31.3 except that corrugated or creased bends shall not be used.

Cold bends for lines 1-1/2" and below, with a bend radius of 5 times the nominal diameter shall be used as required in place of elbows wherever allowed by piping specifications. Bending of pipes 2" and above may be required in some cases like that for headers around heaters, reactors etc.

The completed bend shall have a smooth surface, free from cracks, buckles, wrinkles, bulges, flat spots and other serious defects. They shall be true to dimensions. The flattening of a bend, as measured by the difference between the maximum and minimum diameters at any cross-section, shall not exceed 8% and 3% of the nominal outside diameter, for internal and external pressure respectively.

4.10 Forging and forming

Forging and forming of small bore fittings, like reducing nipples for piping 1-1/2" and below, shall be as per ASME B 31.3.

4.11 Mitre Bends and Fabricated Reducers

The specific application of welded mitre bends and fabricated reducers shall be governed by the Piping Material Specifications. Generally all 90 deg. mitres shall be 4-piece 3-weld type and 45 deg. mitres shall be 3-piece 2-weld type as per GAIL Standard unless otherwise specified. Reducers shall be fabricated as per directions of Engineer-in-Charge. The radiographic requirements shall be as per Material Specifications for process and utility systems and NDT Specification for steam piping under IBR, radiographic requirements of IBR shall be complied with.

4.12 Cutting and Trimming of Standard Fittings & Pipes

Components like pipes, elbows, couplings, half-couplings etc. shall be cut / trimmed / edge prepared wherever required to meet fabrication and erection requirements, as per drawings and instructions of Engineer-in-Charge. Nipples as required shall be prepared from straight length piping.

4.13 Galvanized Piping

Galvanized carbon steel piping shall be completely cold worked, so as not to damage galvanized surfaces. This piping involves only threaded joints and additional external threading on pipes may be required to be done as per requirement.

4.14 Jacketed Piping

The Jacketing shall be done in accordance with GAIL Specification or Licensors specification as suggested in material specification or special condition of contract.

Pre-assembly of jacketed elements to the maximum extent possible shall be accomplished at shop by Contractor. Position of jump over and nozzles on the jacket pipes, fittings etc. shall be marked according to pipe disposition and those shall be prefabricated to avoid damaging of inner pipe and obstruction of jacket space. However, valves, flow glasses, in line instruments or even fittings shall be supplied as jacketed.

4.15 Shop Fabrication / Pre-Fabrication

The purpose of shop fabrication or pre-fabricationm is to minimise work during erection to the extent possible. Piping spool, after fabrication, shall be stacked with proper identification marks, so as facilitate their withdrawal at any time during erection. During this period all flange (gasket contact faces) and threads shall be adequately fabricated by coating with a removable rust preventive. Care shall also be taken to avoid any physical damage to flange faces and threads.

4.16 Miscellaneous

4.16.1 Contractor shall fabricate miscellaneous elements like flash pot, seal pot, sample cooler, supporting elements like turn buckles, extension of spindles and interlocking arrangement of valves, operating platforms as required by Engineer-in-Charge.

4.16.2 Spun Concrete Lining

The work of inside spun concrete lining of pipes and specials of diameter 3 and above shall be done as per material specifications and special condition contract.

4.16.3 Fabrication of pipes from plate

Pipes shall be fabricated at site as and when required as per the specifications attached and the actual Piping Material Specification.

5.0 ERECTION

5.1 Cleaning of Piping before Erection

Before erection all pre-fabricated spool pieces, pipes, fittings etc. shall be cleaned inside and outside by suitable means. The cleaning process shall include removal of all foreign matter such as scale, sand, weld spatter chips etc. by wire brushes, cleaning tools etc. and blowing with compressed air/or flushing out with water. Special cleaning requirements for some services, if any shall be as specified in the piping material

specification or isometric or line list. SS jacketed piping requiring pickling shall be pickled to remove oxidation and discolouring due to welding.

5.2 Piping Routing

No deviations from the piping route indicated in drawings shall be permitted without the consent of Engineer-in-Charge.

Pipe to pipe, pipe to structure / equipments distances / clearances as shown in the drawings shall be strictly followed as these clearances may be required for the free expansion of piping / equipment. No deviations from these clearances shall be permissible without the approval of Engineer-in-Charge.

In case of fouling of a line with other piping, structure, equipment etc. the matter shall be brought to the notice of Engineer-in-Charge and corrective action shall be taken as per his instructions.

5.3 Cold Pull

Wherever cold pull is specified, the Contractor shall maintain the necessary gap, as indicated in the drawing. Confirmation in writing shall be obtained by the Contractor from the Engineer-in-Charge, certifying that the gap between the pipes is as indicated in the drawing, before drawing the cold pull. Stress relieving shall be performed before removing the gadgets for cold pulling.

5.4 Slopes

Slopes specified for various lines in the drawings / P&ID shall be maintained by the Contractor. Corrective action shall be taken by the Contractor in consultation with Engineer- in-Charge wherever the Contractor is not able to maintain the specified slope.

5.5 Expansion Joints/ Bellows

Installation of Expansion Joints/Bellows shall be as follows:

5.5.1 All Expansion joints / Bellows shall be installed in accordance with the specification and Installation drawings, supplied to the Contractor.

5.5.2 a. Upon receipt, the Contractor shall remove the Expansion Joints/ Bellows from the Case (s) and check for any damage occured during transit.

b. The Contractor shall bring to the notice of the Engineer-in- Charge any damage done to the bellows / corrugations, hinges, tie-rods, flanges / weld ends etc.

c. Each Expansion Joint / Bellow shall be blown free of dust! foreign matter with compressed air or cleaned with a piece of cloth.

5.5.3 a. For handling and installation of Expansion Joints, great care shall be taken while aligning. An Expansion Joints shall never be slinged from bellows corrugations / external shrouds, tie / rods, angles.

b. An Expansion Joints / Bellow shall preferably be slinged from the end pipes/ flanges or on the middle pipe.

5.5.4 a. All Expansion Joints shall be delivered to the Contractor at "Installation length", maintained by means of shipping rods, angles welded to the flanges or weld ends or by wooden or metallic stops.

b. Expansion Joints stop blocks shall be carefully removed after hydrostatic testing. Angles welded to the flanges or weld ends shall be trimmed by saw as per manufacturer's instructions and the flanges or weld ends shall be ground smooth.

5.5.5 a. The pipe ends in which the Expansion Joint is to be installed shall be perfectly aligned or shall have specified lateral deflection as noted on the relevant drawings.

b. The pipe ends/ Flanges shall be spaced at a distance specified in the drawings.

5.5.6 The Expansion Joint shall be placed between the mating pipe ends / flanges and shall be tack welded/ bolted. The mating pipes shall again be checked for correct alignment.

5.5.7 Butt-welding shall be carried out at each end of the expansion joint. For flanged Expansion Joint, the mating flanges shall be bolted.

5.5.8 After the Expansion Joint is installed the Contractor shall ensure that the mating pipes and Expansion Joints are in correct alignment and that the pipes are well supported and guided.

5.5.9 The Expansion Joint shall not have any lateral deflection. The Contractor shall maintain parallelism of restraining rings or bellows convolutions.

5.5.10 Precautions

a. For carrying out welding, earthing lead shall not be attached with the Expansion Joint.

b. The Expansion bellow shall be protected from arc weld spot and welding spatter.

c. Hydrostatic Testing of the system having Expansion Joint shall be performed with shipping lugs in position. These lugs shall be removed after testing and certification is over.

5.6 Flange Connections

While fitting up mating flanges, care shall be exercised to properly align the pipes and to check the flanges for trueness, so that faces of the flanges can be pulled together, without inducing any stresses in the pipes and the equipment nozzles. Extra care shall be taken for flange connections to pumps, turbines, compressors, cold boxes, air coolers etc. The flange connections to these equipments shall be checked for misalignment, excessive gap etc. after the final alignment of the equipment is over. The joint shall be made up after obtaining approval of Engineer-in-Charge.

Temporary protective covers shall be retained on all flange connections of pumps, turbines, compressors and other similar equipments, until the piping is finally connected, so as to avoid any foreign material from entering these equipments.

The assembly of a flange joint shall be done in such a way that the gasket between these flange faces is uniformly compressed. To achieve this, the bolts shall be tightened in a proper sequence. All bolts shall extend completely through their nuts but not more than 1/4".

Steel to C.I. flange joints shall be made up with extreme care, tightening the bolts uniformly after bringing flange flush with gaskets with accurate pattern and lateral alignment.

5.7 Vents and Drains

High point vents and low point drains shall be provided as per the instructions of Engineer- in-Charge, even if these are not shown in the drawings. The details of vents and drains shall be as per piping material specifications / job standards.

5.8 Valves

Valves shall be installed with spindle / actuator orientation / position as shown in the layout drawings. In case of any difficulty in doing this or if the spindle orientation / position is not shown in the drawings, the Engineer-in-Charge shall be consulted and work done as per his instructions. Care shall be exercised to ensure that globe valves, check valves, and other uni-directional valves are installed with the "Flow direction arrow "on the valve body pointing in the correct direction. If the direction of the arrow is not marked on such valves, this shall be done in the presence of Engineer-in-Charge before installation.

Fabrication of stem extensions, locking arrangements and interlocking arrangements of valves (if called for), shall be carried out as per drawings/ instructions of Engineer-in- Charge.

5.9 Instruments

Installation of in-line instruments such as restriction orifices, control valves, safety valves, relief valves, rotameters, orifice flange assembly, venturimeters, flowmeters etc. shall form a part of piping erection work.

Fabrication and erection of piping upto first block valve / nozzle / flange for installation of offline Instruments for measurement of level, pressure, temperature, flow etc. shall also form part of piping construction work. The limits of piping and instrumentation work will be shown in drawings / standards / specifications. Orientations / locations of take-offs for temperature, pressure, flow, level connections etc. shown in drawings shall be maintained.

Flushing and testing of piping systems which include instruments mentioned above and the precautions to be taken are covered in flushing, testing and inspection of piping (GAIL Stds). Care shall be exercised and adequate precautions taken to avoid damage and entry foreign matter into instruments during transportation, installation, testing etc.

5.10 Line Mounted Equipments / Items

Installation of line mounted items like filters, strainers,, steam traps, air traps, desuperheaters, ejectors, samples coolers, mixers, flame arrestors, sight glasses etc. including their supporting arrangements shall form part of piping erection work.

5.11 Bolts and Nuts

The Contractor shall apply molycoat grease mixed with graphite powder (unless otherwise specified in piping classes) all bolts and nuts during storage, after erection and wherever flange connections are broken and made-up for any purpose whatsoever. The grease and graphite powder shall be supplied by the Contractor within the rates for piping work.

5.12 Pipe Supports

Pipe supports are designed and located to effectively sustain the weight and thermal effects of the piping system and to prevent its vibrations. Location and design of pipe supports will be shown in drawings for lines 3" NB & above for line below 3" NB Contractor shall locate and design pipe supports in line with GAIL Stds. and obtain approval of Engineer - in - Charge on drawings prepared by Contractor, before erection. However, any extra supports desired by Engineer-in-Charge shall also be installed.

No pipe shoe I cradle shall be offset unless specifically shown in the drawings.

Hanger rods shall be installed inclined in a direction opposite to the direction in which the pipe moves during expansion.

Preset pins of all spring supports shall be removed only after hydrostatic testing and insulation is over. Springs shall be checked for the range of movement and adjusted if necessary to obtain the correct positioning in cold condition. These shall be subsequently adjusted to hot setting in operating condition. The following points shall be checked after installation, with the Engineer-in-Charge and necessary confirmation in writing obtained certifying that:

- All restraints have been installed correctly.
- Clearances have been maintained as per support drawings.
- Insulation does not restrict thermal expansion.
- All temporary tack welds provided during erection have been fully removed.
- All welded supports have been fully welded.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION OF NON DESTRUCTIVE EXAMINATION OF PIPING

GAIL-STD-ME-DOC-TS-022

0	22.03.19	Issued For Tender	RKS	AP	JR	
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Abbreviation :-

DP/LP : Dye Liquid Panetrant

MP : Magnetic Particle

CS : Carbon Steel

AS : Alloy Steel

SS : Stainless Steel

ASTM : American Society for Testing & Materials

ASME : American Society of Mechanical Engineers

IBR : Indian Boiler Regulations

PM : Piping Material Specification

ASNT : American Society of Non-Destructive Testing

PCN : Personal Certification in Non-Destructive Testing

PWHT: Post Weld Heat Treatment

UST : Ultrasonic Testing

HS&E : Safety, Health & Environment

CONTENTS

1. GENERAL

1.1 SCOPE

The specification covers the General Requirements for Non- Destructive Examinations of shop and field fabricated piping.

1.2 RELATED CODES AND ENGINEERING STANDARDS

Referred codes/ standards are as follows. Latest edition of following codes/standard shall be followed:

a. ASME Boiler and Pressure Vessels codes, Section V & VIII (Div.-1) including Addenda
b. ASME B 31.3
c. ANSI B 31.8
d. ASME B16.5
e. ASME B 16.34
f. PCN/ ASNT
g. PMS
h. In addition to that all general specification dealing with welding and fabrication of various equipment shall apply.

1.3 CONFLICT

Where a conflict occurs between this Specification and any of the above Codes or standards the more stringent shall apply. The CONTRACTOR shall inform the OWNER in writing and receive written certification form the OWNER/ CONSULTANT. The CONTRACTOR shall have readily available for use at the request of the OWNER, latest editions of all codes, specification and standards necessary for execution of the work at work site.

1.4 NDE COMPANY CERTIFICATION

All Non Destructive Examination (NDE) Contractor's contracted by the OWNER or working for fabricators or Contractor's carrying out work on the OWNER behalf shall have in place an up-to-date Quality Control Manual and Code of Practice which shall cover the following:

i) All aspects of NDE of which the CONTRACTOR, SUB-CON TRACTOR is qualified.
ii) Current resumes of all presently employed personnel including their certifications (PCN, ASNT, CGSB or equivalent).
iii) All proposed specific NDE procedure,

A registered copy of QC manual shall be made available to OWNER and shall be

reviewed and approved by the OWNER quality assurance personnel prior to services being used. Updates to the Manual shall be forwarded to the registered holder as they become available.
The OWNER will review and approve element's i), ii) & iii) above: prior to start on any said company work. Any approval given by the OWNER does not relieve the CONTRACTOR of his obligations under governing, codes, rules and specifications. All equipment shall be certified and current, to recognized calibration standard and in first class working condition.
Full compliance with all governmental and local regulatory requirements of HS&E which shall be fully complied with.

2.0 VISUAL INSPECTION

Visual examination shall be carried out before, during and after fabrication in accordance with ASME Sec. V article 9 and ASME B31.3. Cracks, (regardless of size and location) and under cutting or any evidence of poor workmanship, materials, etc., if not repairable shall be cause for rejection.
Welds shall be visually inspected wherever accessible in accordance with the following requirements:

1	Internal misalignment	1.5 MM or Less
2	Cracks or lack of fusion Incomplete penetration (for	None permitted.
3	Incomplete penetration (for other than 100% Radiography butt-weld)	Depth shall not exceed the lesser of 0.8 MM or 0.2 times thickness of thinner component joined by butt-weld. The total length of such imperfections shall not exceed 38 MM in any 150 MM of weld length.
4	Surface porosity and exposed slag inclusions (4.7mm. Nom Wall thickness and less)	Not permitted
5	Concave root surface (SLICK UP)	For single sided welded joints concavity of the root surface shall not reduce the total thickness of joint including reinforcement to less than the thickness of the thinner of the components being joined.
6	Weld ripples irregularities	2.5 MM or Less
7	Lack of uniformity in bead width	2.5 MM or Less
8	Lack of uniformity of leg length	2.5 MM or Less
9	Unevenness of Bead	2.0 MM or Less
10	Weld Undercutting	0.8 MM or 1/4 thickness of thinner components joined by butt weld, whichever is less. (shall be smooth finished)
11	Overlap	1.5 mm or less

12	Bead Deflection	2.5 mm or less
13	External weld reinforcement and internal weld protrusion (when backing rings are not used) shall be fused with and shall merge smoothly into the component surfaces. The height of the lesser projection of external weld reinforcement or internal weld protrusion from the adjacent base material surface shall not exceed the following limits :	
	Wall thickness of thinner component joined by butt weld (MM)	Weld reinforcement or internal weld protrusion (MM) Max
	6.4 and under	1.6
	Over 6.4 – 12.7	3.2
	Over 12.7 – 25.4	4.0
	Over 25.4	4.8
14	Throat thickness of fillet welds: Nominal thickness of the thinner component x 0.7 or more.	
15	Flattening: Flattening of a bend, as measured by difference between the nominal outside diameter and minimum or maximum diameter at any cross section shall not exceed 5% of the nominal outside diameter of pipe.	
16	Reduction of Wall Thickness: Reduction of wall thickness of a bend, as measured by difference between the nominal thickness and minimum thickness shall not exceed 10% of the nominal wall thickness of pipe. Welds having any imperfections which exceed the limitations specified in various clauses shall be repaired by welding, grinding or overlaying etc.	

Welds having any of imperfections which exceed the limitations specified in various clauses of 2.1 shall be repaired by welding, grinding, overlaying etc.
However number of times of repair welding for the same weld shall be as follows:

	MATERIAL	NO. OF TIMES OF REPAIR WELDING
1.0	CS UP TO 300#	3 OR LESS
2.0	CS ABOVE 300#	2 OR LESS

3. NON DESTRUCTIVE EXAMINATION

3.1 The type and extent of Weld Examination shall be in accordance with Table-1. All visual and supplementary methods of girth weld examination shall be in accordance with ASME B31.3 & the requirements of this standard specification.

3.2 Welds between dissimilar material shall be examined by method & to the extent required for the material having the more stringent examination.

3.3 Following categories of critical piping are classified under inspection Class IV (100 % radiography):

a) High Pressure : Classes 900# & above
b) Severe Cyclic : As defined by ASME B 31.3
c) Low Temperature : Below temperature of -45 Deg C.

d)	Critical Service	:	Hydrogen, Oxygen, NACE, Caustic, Chlorine & such other critical services.
e)	High alloys	:	5 Cr. & above for all pressure classes
f)	High Temperature	:	Above 500 Deg.C

3.4 **EXTENT OF INSPECTION AND TESTING**

a) Piping systems which are designed and constructed in accordance with ASME Standard B 31.3, Chemical Plant and Petroleum Refinery Piping, shall be radiographed as per Table - I.

b) Piping systems which are designed and constructed in accordance with ASME B31.8 standard for gas pipeline systems shall have all welds radiographically inspected for 100%,

c) Hardness testing shall be carried out of welds on vessels and piping in sour or corrosive service and 10% of local PWHT weld as per ASTM Specification E 10, ANSI 1331.3.

3.5 The CONTRACTOR shall prepare and maintain documentation to track percentage of welds tested and the weld repair rate. The proposed documentation shall be made available for review and approval.

3.5 CONTRACTOR shall not deviate from any requirement of this specification without written approval to do so from OWNER

3.6 No exemption permitted in regards to full HS&E compliance.

3.7 Open drains vents or other open ended line shall be leak tested only.

4. **TABLE-I (with applicable Notes)**

TABLE 1 : CLASS, TYPE & EXTENT OF WELD EXAMINATION

INSPECTION CLASS: I

IN SP N. CLAS S	SERVICE	MATERIA L (NOTE-3)	TEMP DEG C	PRESS CL. B16.5/ B16.34	PIPING CLASS	TYPE OF EXAM.	TYPE OF WELD EXAMINATION				
							GIRTH BUT T WEL D	SCKT WEL D (NOTE 2)	ATTACHME NT WELD	FAB. BRNC H WELD (NOTE 1)	FAB MITR / RED
1	CATEGORY 'D' FLUID SERVICE	CARBON STEEL	0-186	150 # UP TO 10.55 KG/ CM^2	A3A, A3Y, J2A, J3A, J5A, A4Y, A5Y	a) VISUAL	100%	100 %	100%	100%	100%
		AUSTENETIC SS	(-) 29 TO 86		A3K	b) LP (NOTE 4, 6, 9)	---	---	---	10%	10%
		HDPE	(-) 20 TO 50		A1Z, A4Z, A5Z						
		CUPRO NICKEL	(-) 29 TO 60								

REMARKS FOR ABOVE TABLE:

1. LP TEST NOT APPLICABLE TO NON-METALLIC CLASSES

2. MITRES & FABRICATED REDUCERS ARE PERMITTED ONLY IF SPECIFIED IN PMS.

TABLE 1 : CLASS, TYPE & EXTENT OF WELD EXAMINATION (CONTD.)

INSPECTION CLASS: II

IN SP N. CL AS S	SERVICE	MATE RIAL (NOTE -3)	TEM P DEG C	PRESS CL. B16.5/ B16.34	PIPING CLASS	TYPE OF EXAM.	TYPE OF WELD EXAMINATION				
							GIRTH BUT T WEL D	SOCKT WEL D (NO TE-2)	ATTA CHME NT WELD	FAB. BRNC H WELD (NOTE I)	FAB. MIT R/ RED
II -	a) ALL SERVICES COVERED UNDER INSPECTION CLASS-I BUT EXCEEDING CATEGORY- D PR./TEMP. LIMITATION.	CS	-29 TO 400	150 # UP TO 10.55 KG/ CM^2	A1A, A6A, A7A, A8A, A9A, A11A, A13A, A15A, A20A, A32A, A33A, A33Y	a) VISUAL	100 %	100 %	100 %	100 %	100 %
						b) RADIOGRAPHY (NOTE 5, 6)	10%	---	---	---	50%
	b) ALL SERVICES EXCEPT COVERED UNDER CLASS – I BUT NON-TOXIC, NOT SUBJECTED TO SEVERE CYCLIC CONDITIONS	CS (IBR)			A2A	c) MP/LP/ (NOTE 4,6, 10,11)	---	10%	---	10%	50%
						d) HARDNESS	NO TE-7	NO TE-7	NOTE-7	NOTE-7	NOTE -7

REMARKS FOR ABOVE TABLE:

1. FOR A2A IBR SERVICE NOTE-8 IS ALSO APPLICABLE
2. FOR A33A & A33Y FIRE WATER SERVICE, NOTE-12 IS ALSO APPLICABLE.
3. EXTENT OF HARDNESS TEST FOR A11A IS 100%.
4. MITRES & FABRICATED REDUCERS ARE PERMITTED ONLY IF SPECIFIED IN PMS.

TABLE 1 : CLASS, TYPE & EXTENT OF WELD EXAMINATION (CONTD.)

INSPECTION CLASS: III

IN SP N. CL AS S	SERVICE	MATE RIAL (NOTE -3)	TEM P DEG C	PRES S CL. B16.5/ B16.3 4	PIPING CLASS	TYPE OF EXAM.	TYPE OF WELD EXAMINATION				
							GIRTH BUTT WELD	SCK T WEL D (NO TE 2)	ATTA CHME NT WELD	FAB. BRNC H WELD (NOTE 1)	FAB MITR / RED
III -	a) TOXIC, NON-LETHAL & FLAMMAB LE	CS	ABO VE (-)29	150 #	---	a) VISUAL	100%	100 %	100%	100%	100%
-	b) FLAMMAB LE / NON FLAMMAB L & TOXIC / NON-TOXIC; NOT SUBJECT TO SEVERE CYCLIC CONDITIO NS	KILLED CARBO N STEEL	(-) 45 TO 204	150# TO 600#	A4A, B4A, D4A	b) RADIO GR APHY (NOTE 5, 6)	20%	---	---	---	100%
-	ALL GENERAL SERVICES EXCEPT THOSE SUBJECT TO SEVERE CYCLIC CONDITIO NS.	CARBO N STEEL	(-) 29 TO 427	300# TO 600#	B1A, B6A, B9A, B13A, B32A, D1A	c) MP/LP/ (NOTE 4,6, 11)	---	20%	---	20%	---
		CS (IBR)			B2A, D2A	d) HARDN ES S	NOTE-7	NOTE - 7	NOTE-7	NOTE-7	NOTE -7

REMARKS FOR ABOVE TABLE:

1. FOR IBR SERVICE B2A & D2A NOTE-8 IS ALSO APPLICABLE

2. MITRES & FABRICATED REDUCERS ARE PERMITTED ONLY IF SPECIFIED IN PMS.

5. ULTRASONIC WELD EXAMINATION

Ultrasonic Operators
Ultrasonic operators supplied by the NDE CONTRACTOR shall be certified to a General Standards Board (ASNT/PCN) approved by the OWNER.

UT testing shall be carried out :

(i) As per ASME B31.3 and ASME Sec. V article 5.
(ii) All category 'D' welds which are not being radio graphed and all other welds configuration, which does not permit to be radio graphed, shall be ultrasonic tested.

(iii) All tie-in welds where pressure testing are not possible.
(iv) Ultrasonic testing, in lieu of radiography, is acceptable only where radiography is not practicable e.g. branch connections

6. INSPECTION

The CONTRACTOR shall extend all facilities, assistance and co-operate fully with the OWNER in all aspects of inspection and NDE and shall give adequate notice of any required fabrication inspection stages, together with sufficient time for thorough inspection by the OWNER. OWNER shall have the right to establish hold points at any point in the fabrication sequence. Records and evidence of all weld examinations shall be available at all times for OWNER to review and approve. OWNER may use any method of inspection necessary to establish quality control and ensure adherence to welding procedures. OWNER shall have the right to accept or reject any weld not meeting the requirements of this specification. . CONTRACTOR shall intimate sufficiently in advance the commencement of qualification test, welding works and acceptance tests to enable the owner/ owner's representative to be present to supervise them. Any discrepancies between the approved WPS and the production welds noted by OWNER, any or all of the work made under these conditions is subject to rejection.

Applicable Notes to Table-I

1. Branch weld shall consist of the Welds between the pipe & reinforcing element (if any), nozzles & reinforcing element and the pipe & nozzle under the reinforcing element. Reinforcing element to be interpreted as pads, saddles, weldolets, sockolets etc.
2. Seal welds of threaded joints shall be given the same examination as socket welds.
3. Unless specifically stated, all materials shall be for Non-IBR service.

4. Magnetic particle & the Liquid penetrant method of examination shall be in accordance with section-V of the ASME Boiler and Pressure Vessels Code, Article VII and VI respectively. The entire area of the accessible finished weld surface shall be examined. Selected root runs, subject to a maximum of 10%, before finished weld, may also be examined, at the discretion of the engineer-in-charge.

a) Wherever MP/LP testing is specified, either MP or LP test may be used. But wherever only MP test is specified, LP method of examination may be used only if MP examination is impractible in the field as concurred by GAIL site-in-charge.
b) "Random 10%" of LP/MP test shall mean testing, by applicable test, one weld for each ten welds or less made by the same welding procedure or operator or both. Similarly "Random 20%" shall mean testing, by applicable test, one weld for each five welds or less made by the same welding procedure or operator or both.
c) When Liquid Penetrant examination is specified, the surface shall be free of peened discontinuities. Abrasive blast cleaning shall be followed by light surface grinding prior to liquid penetrant examination.
d) Inspection shall be performed in the welds excluding those for which radiography has been done.
e) Girth weld, branch weld, attachment weld & socket weld of 3-1/2% Ni stell shall be Liquid Penetrant tested only when welded with austenitic material where MP test has been specified.

5. **Radiography**

General –

- X - Ray is the preferred radiographic method. Use of Gamma ray for examination is not permitted. Particular attention shall be paid to using radiographic ultra fine grain film suitable for the application, maintaining correct radiographic geometry during exposure, obtaining correct density also required by the appropriate standard and the correct placement and exposure of image quality indicators (IQI's or penetrameters).
- ASTM wire type IQI's are preferred. GAIL may permit the use of ASTM hole type IQI's on a pre-approved basis, provided the NDT CONTRACTOR can demonstrate satisfactory results.
- Radiographic technique shall produce maximum contrast and good definition of IQI wires. The inability to view the appropriate wire or hole on any radiograph shall be cause for automatic rejection of that radiograph which shall be re- radiographed at no expense to GAIL
- Operator Certification

Radiographers supplied by the CONTRACTOR shall be certified to ASNT Level II, AWS QC] and as per AWS B1.10 (guide for non-destructive inspection of welds). An operator qualified to ASNT Level I may assist the Level II operator but all film and sentencing interpretation shall be carried out by a Level ll or higher operator who shall sign off all report sheets. Visual welding inspection shall be conducted only by a qualified welding inspector, who shall have a minimum AWS (QC. I) CWI or CSWIP 3.1 certification. GAIL shall review and approve all QA/QC personnel prior to deployment on the project.

a) "Random 10% or 20% radiography" shall mean examination not less than one from each 10 welds or less in case of "Random 10% radiography" or one from each five welds or less in case of "Random 20% radiography" made by the same welding procedure or Welder or both. Irrespective of percentage, no. of welds to be radiographed shall be minimum 1. However first two welds made by each welder shall also be radiographed in case of "Random radiography". Welds selected for examination shall not include flange welds and shall be radiographed for their entire length. However, where it is impossible or impracticable to examine the entire weld length of field welds for either random or 100% radiography, and if the same impossibility is agreeable to GAIL site-in-charge, then a single 120 Deg. Exposure of the weld length may be given a Magnetic Particle test or Liquid Penetrant test. However in such case for ferro-magnetic materials, only MP test shall be acceptable for classes higher than 600#.

b) In-process examination shall not be substituted for any required radiographic examination.

c) Number of radiographs per one circumferential weld shall be as per ASME Sec. V Article 2 and 22.

6. When radiography or other non-destructive inspection is specified, acceptance criteria for repairs or defects shall be as follows:

a) In case of 100% examination, any unacceptable weld shall be repaired and re-inspected.

b) If required random examination reveals a defect requiring repair, then:

b.1 Two additional examination of the same type shall be made of the same kind of item (if welded joint, then by the same welding procedure or operator or both).

b.2 If the group of items examined as required by b.1 above is acceptable, the item requiring repair shall be repaired or replaced and

re-examined as required and all items represented by this additional examination shall be accepted.

b.3 If any of the items examined as required by b.1 above reveals a defect requiring repair, two further comparable items shall be examined for each defective item found by examination.

b.4 If all the items examined as required by b.3 are acceptable, the items requiring repair shall be repaired or replaced and reexamined as required, and all items represented by this further examination shall be acceptable.

b.5 Number of times repair welding could b done for the same weld before acceptance shall be as follows:

Material	**No. of times repair welding is allowed**
C.S. upto 300#	3 or less
C.S. above 300#	2 or less
Killed Steel	2 or less
Low alloy steel	2 or less
Austenitic S.S.	2 or less
3.5 Ni Steel	2 or less
Al & Al base alloy	2 or less
Cu & Cu base Alloy	2 or less
Others	2 or less

b.6 Welds not found acceptable for allowed number of times of repair as per b.5 above shall be replaced and reexamined.

b.7 If any of the items examined as required by b.4 above reveals a defect requiring repair, all items represented by these examination shall be either:

- repaired or replaced and reexamined as required.
- Fully examined and repaired or replaced as necessary, and Re-examined as necessary.

7. Hardness Test:

a) Hardness test shall be in accordance with ASTM specification E10. Hardness tests of the heat affected zone shall be made at a point as near as practicable to the edge of the weld. One test per weld shall be performed.

b) Hardness test where specifically called out in Table-I of this specification or in PMS, shall be carried out irrespective of thickness and to the extent (%age) as mentioned therein.

c) All welds which are given heat treatment shall be hardness tested. Hardness test shall be performed after final heat treatment.

d) A minimum of 10% of Welds of hot formed and hot bent materials in each heat treatment batch which are furnace heat treated and 100% of those which are locally heat treated, shall be hardness tested.

e) For C-0.5 Mo steels, a minimum of 10% of welds shall be hardness tested.

f) Hardness test requirement not covered in b) & e) above shall be as per ASME B 31.3.

g) The hardness limit applies to the weld and heat affected zone. Following hardness values shall be maintained:

BASE METAL GROUP	MAXIMUM HARDNESS (BHN/ RC)
CS	238BHN/ RC22
CS (NACE)	200 BHN
Cr 0.5% or less	225 BHN
Cr 0.5% & up to 2%	225 BHN
Cr 2.25% & up to 10%	241 BHN
18/8 SS (NACE)	RC 22

8. For IBR service lines, following IBR requirements shall apply in addition to the notes 4, 5, 6, 7, 12 and Table-I. In case of conflict between above notes and these requirements , the more stringent ones shall apply. IBR Piping shall be erected of IBR inspector approved material and construction procedure. Erected piping shall be hydro-tested, inspected and approved by IBR inspector.

a) Piping over 102 mm (4") bore:
10% of welds made by each welder on a pipeline with a minimum of two welds per welder, selected at random, shall be subjected to radiography.

b) Piping 102 mm (4"0 bore and under, but not less than 38 mm (1-1/2") bore:
2% of welds made by each welder on a pipeline with a minimum of one weld per welder, selected at random, shall be subjected to radiography or may be cut for visual examination and tests.

c) Piping less than 38 mm (1.5") bore:
Special tests are not normally required but 2% of weldfs by each welder on a pipe line may be cut out from the pipeline for the visual examination and bend tests.

d) **Retests:**

If any test specification is unsatisfactory, two further weld specimens for retests shall be selected from the production welds and subjected to tests. In the event of failure of any retest specimens, the production welds carried out by this welder subsequent to the previous test shall be given special consideration.

9. For fabricated fittings LP test shall be done on the final pass of welding only, in addition to visual examination.

10. For mitres and fabricated reducers, LP/ MP test shall be done on root pass in addition to radiography applicable to circumferential joint of respective piping class.

11. For branch connections, LP/ MP test shall be done on root pass and final pass.

12. 10% of the butt weld joints shall be radiographed, however 50% of these butt weld joints shall be field weld joints.

13. For lined specs, testing (MP/LP/Radiography etc.) shall be performed before lining.

14. **DOCUMENTS TO BE SUBMITTED BY THE CONTRACTOR**

a) Electrode and welding consumables qualification records for the welding consumables tested and approved for the work.
b) Batch test certificate, for the electrodes used, obtained from the Electrode Manufacturers.
c) Proposed heat treatment chart procedure.
d) Heat treatment chart.
e) Weld joint tensile, hardness test, Impact test result.
f) Welding procedure specification immediately after receipt of order.
g) Welding procedure qualification records.
h) Welder performance qualification records immediately after conducting welder qualification tests.
i) Radiography procedure.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR INSPECTION, FLUSHING AND TESTING OF PIPING SYSTEMS

GAIL-STD-ME-DOC-TS-023

0	22.03.19	Issued For Tender	RKS	AP	JR	
Rev	**Date**	**Purpose**	**Prepared By**	**Checked By**	**Approved By**	

CONTENTS Sl. No.

Abbreviations

PMI : Positive Material Identification

ppm : parts per million

S.S. : Stainless Steel

1.0 SCOPE

This specification covers the general requirements for inspection, flushing and testing of piping systems. However testing of steam lines falling under IBR shall also be governed by Indian Boiler Regulations.

Flushing and testing of all piping systems shall be witnessed by the Engineer-In-Charge.

2.0 INSPECTION

During various stages and after completion of fabrication and erection, the piping system shall be inspected by the Engineer-In-Charge to ensure that:

- Proper piping material has been used.
- PMI has been performed as per 'Standard Specification for Positive Material Identification at Construction Sites, GAIL-STD-ME-DOC-TS-025.
- Piping has been erected as per drawings and instructions of Engineer-In-Charge.
- All supports have been installed correctly.
- Test preparations mentioned in this specification have been carried out.

3.0 FLUSHING

Flushing of all lines shall be done before pressure testing.

Flushing shall be done by fresh potable water or dry compressed air, wherever water flushing is not desirable, to clean the pipe of all dirt, debris or loose foreign material.

Required pressure for water flushing shall meet the fire hydrant pressure or utility water pressure. For air flushing, the line / system will be pressurised by compressed air at the required pressure which shall be 50 psi maximum. The pressure shall then be released by quick opening of a valve, already in line or installed temporarily for this purpose. This procedure shall be repeated as many times as required till the inside of the pipe is fully cleaned.

In line instruments like control valves, orifice plates, rotameters, safety valves and other instruments like thermowells which may interfere with flushing shall not be included in flushing circuit.

The screens / meshes shall be removed from all permanent strainers before flushing. Screens I meshes shall be reinstalled after flushing but before testing.

During flushing temporary strainers shall be retained. These shall be removed, cleaned and reinstalled after flushing but before testing.

In case an equipment such as column, vessel, exchanger etc. form part of a piping circuit during flushing. This shall be done with the approval of Engineer-In-Charge. However, equipments thus included in the circuit shall be completely drained and dried with compressed air after flushing is completed.

During flushing discharged water/air shall be drained to the place directed by the Engineer-In-Charge. If necessary, proper temporary drainage shall be provided by the contractor.
Care shall be taken during flushing so as not to damage/spoil work of other agencies. Precautions shall also be taken to prevent entry of water/foreign matter into equipments, electric motors, instruments, electrical installations etc. in the vicinity of lines being flushed.

The contractor shall carry out all the activities required before, during and after the flushing operation, arising because of flushing requirements, such as but not limited to the following:
Dropping of valves, specials, distance pieces, inline instruments and any other piping part before flushing. The flanges to be disengaged for this purpose shall be envisaged by the contractor and approved by the Engineer-In-Charge. These flanges shall be provided with temporary gaskets at the time of flushing.

After flushing is completed and approved, the valve distance pieces, piping specials etc. shall be reinstalled by the contractor with permanent gaskets. However, flanges at equipment nozzles and other places where isolation is required during testing, only temporary gaskets shall be provided.

Records in triplicate shall be prepared and submitted by the contractor for each piping system for the flushing done in the proforma provided/approved by the Engineer-in-Charge.

4.0 TESTING

4.1 Extent of Testing

With the exclusion of instrumentation, piping systems fabricated or assembled in the field shall be tested irrespective of whether or not they have been pressure tested prior to site welding of fabrication.

To facilitate the testing of piping systems, vessels and other equipments may be included in the system with the prior approval of Engineer-In-Charge if the test pressure specified is equal to or less than that for the vessels and other equipments.

Pumps, compressors and other rotary equipments shall not be subjected to field test pressure.

Lines which are directly open to atmosphere such as vents, drains, safety valves discharge need not be tested, but all joints shall be visually inspected. Wherever necessary, such lines shall be tested by continuous flow of fluid to eliminate the possibility of blockade. However, such lines if provided with block valve shall be pressure tested up to the first block valve.
Seats of all valves shall not be subjected to a pressure in excess of the maximum cold working pressure of the valve. Test pressure applied to valves shall not be greater than the manufacturer's recommendation nor less than that required by the applicable code. Where allowable seat pressure is less than test pressure, test shall be made through an open valve.

Instruments in the system to be tested, shall be excluded from the test by isolation or removals, unless approved otherwise by the Engineer-In-Charge.
Restrictions which interfere with filling, venting and draining such as orifice plates etc. shall not be installed unless testing is complete.

Control valves shall not be included in the test system. Where bypasses are provided test shall be performed through the bypass and br necessary spool shall be used in place of the control valve.

Pressure gauges which are part of the finished system, but cannot withstand test pressure shall not be installed until the system has been tested. Where piping systems to be tested are directly connected at the battery limits to piping for which the responsibility rests with other agencies, the piping to be tested shall be isolated from such piping by physical disconnection such as valve or blinds.

4.2 General Requirements / Test Preparation for Testing

Testing shall be carried out with permanent gaskets installed unless specified otherwise or instructed by the Engineer-in-Charge.

No pressure test shall be carried out against closed valve unless approved by the Engineer-in-Charge.

The Engineer-in-Charge shall be notified in advance by the Contractor, of the testing sequence and programme, to enable him to be present for witnessing the test. The Contractor shall be fully responsible for making arrangements with the local boiler inspector to witness the tests for steam lines falling under IBR. IBR certificates for these tests shall be obtained in the relevant IBR forms and furnished to the Engineer-in-Charge.

Before testing, all piping shall be cleaned by flushing to make it free from dirt, loose scale, debris and other loose foreign materials.

All piping systems to be hydrostatically tested shall be vented at the high points and the systems purged of air before the test pressure is applied.
Wherever in the line any void exists due to any reasons, like absence of control valves, safety valves, check valves etc. it shall be filled with temporary spools.

All joints welded, screwed or flanged shall be left exposed for examination during the test. Before pressuring the lines, each weld joint shall be cleaned by wire brush to free it from rust and any other foreign matter.

Where a system is to be isolated at a pair of companion flanges, a blank shall be inserted between the companion flanges. Minimum thickness of the blank shall be designed in accordance with applicable design code.

Open ends of piping system where blanks cannot be used, such as pumps, compressors, turbines or wherever equipment or pipe spools have been recovered or disconnected prior to hydrostatic testing, shall be blinded off by using standard blind flanges of same rating as the piping system being tested.

Pressure gauges used in testing shall be installed as close as possible to the lowest point in the piping system to be tested, to avoid overstressing of any of the lower portions of the system. For longer lines and vertical lines , two or more pressure gauges shall be installed at locations decided by the Engineer-in-Charge.

For lines containing check valves any of the following alternatives shall be adopted for pressure testing:
Whenever possible pressurize up-stream side of valve.
Replace the valve by a temporary spool and reinstall the valve after testing.

Provide blind on valve flanges and test the upstream and downstream of the line separately and remove the blind after testing. At these flanges, temporary gaskets shall be provided during testing and shall be replaced by permanent gaskets subsequently.
For check valves in lines 1 ½" and below flapper or seat shall be removed during testing (if possible). After completion of testing the flapper! seat shall be refitted.

Gas lines when hydrostatically tested shall be provided with additional temporary supports during testing as directed by the Engineer-in-Charge.

Piping which is spring or counter-weight supported shall be temporarily supported, where the weight of the fluid would overload the support. Retaining pins for spring

supports shall be removed only after testing is completed and test fluid is completely drained.

When testing any piping system, air or steam of approximately 2 kg/cm2g may be used as preliminary test to detect missing gaskets etc. as this avoids the necessity of draining the line to make repairs. However, steam shall not be used for this purpose, if the steam temperature is more than the design temperature of the line.

For jacketed pipes testing of core pipes shall be done on individual pieces where the pipe is continuously jacketed, before it is jacketed. The outer jacket shall be tested separately as a system. For piping with discontinuous jacketing the core pipe and the jacket shall be tested as separate continuous systems.

4.3 Testing Media, Test Pressure and Test Pressure Gauges

4.3.1 Testing Media

In general all pressure test shall be hydrostatic using iron free water, which is clean and free of silt. Maximum chlorine content in water for hydrostatic testing for S.S. piping shall be 15-20 ppm.

Air shall be used for testing only if water would cause corrosion of the system or overloading of supports etc. in special cases as directed by Engineer-in-Charge.

Where air/water tests are undesirable, substitute fluids such as gas oil, kerosene, methanol etc. shall be used as the testing medium, with due consideration to the hazards involved. These test fluids shall be specified in the line list given to the contractor.

4.3.2 Test Pressure

The hydrostatic! Pneumatic test pressure shall be as indicated in the line list or as per the instruction of Engineer-in-Charge.
The selection of the piping system for one individual test shall be based on the following:
Test pressure required as per line list.
Maximum allowable pressure for the material of construction of piping.

Depending upon the above requirements and based on construction progress, maximum length of piping shall be included in each test.

4.3.3 Test Pressure Gauge

All gauges used for field testing shall have suitable range so that the test pressure of the various systems falls in 40% to 80% of gauge scale range. Gauge shall be of a good quality and in first class working condition.

Prior to the start of any test or periodically during the field test programme, all test gauges shall be calibrated using a standard dead weight gauge tester or other suitable approved testing apparatus. Any gauge showing an incorrect zero reading or error of more than ± 2% of full scale range shall be discarded .The Engineer-in- Charge shall check the accuracy of master pressure gauge used for calibration.

4.4 Testing Procedure

4.4.1 Hydrostatic Test

All vents and other connections used as vents shall be left open while filling the line with test fluid for complete removal of air. In all lines for pressurising and depressurising the system, temporary isolating valves shall be provided if valve vents, drains do not exist in the system.
Pressure shall be applied only after the system / line is ready and approved by the Engineer-in- charge.

Pressure shall be applied by means of a suitable test pump or other pressure source which shall be isolated from the system as soon as test pressure is reached and stabilised in the system.

A pressure gauge shall be provided at the pump discharge for guidance in bringing the system to the required pressure.

The pump shall be attended constantly during the test by an authorized person. The pump shall be isolated from the system whenever the pump is to be left unattended.
Test pressure shall be maintained for a sufficient length of time to permit thorough inspection of all joints for leakage or signs of failure. Any joint found leaking during a pressure test shall be retested to the specified pressure after repair. Test period shall be maintained for a minimum of three hours.

The pump and the piping system to be tested are to be provided with separate pressure indicating test gauges. These gauges are to be checked by the standard test gauge before each pressure test.

Care shall be taken to avoid increase in the pressure due to temperature variation during the test.

4.4.2 Air Test

When testing with air, pressure shall be supplied by means of a compressor. The compressor shall be portable type with a receiver, after cooler and oil separator.

Piping to be tested by air shall have joints covered with a soap and water solution so that the joints can be examined for leaks.

All other details shall be same as per hydrotesting procedure (specified above).

4.5 Completion of Testing

After the hydrostatic test has been completed, pressure shall be released in a manner and at a rate so as not to endanger personnel or damage equipments.

All vents and drains shall be opened before the system is to be drained and shall remain open till all draining is complete, so as to prevent formation of vacuum in the system. After draining, lines / systems shall be dried by air.

After testing is completed the test blinds shall be removed and equipment / piping isolated during testing shall be connected using the specified gaskets, bolts and nuts. These connections shall be checked for tightness in subsequent pneumatic tests to be carried out by the contractor for complete loop / circuit including equipments (except rotary equipments).

Pressure test shall be considered complete only after approved by the Engineer-in- Charge. Defects, if any, noticed during testing shall be rectified immediately and retesting of the system / line shall be done by the contractor at his cost.

4.6 Test Records

Records in triplicate shall be prepared and submitted by the contractor for each piping system, for the pressure test done in the proforma provided/approved by the Engineer-in-Charge. Records shall also be submitted for the PMI undertaken as per Std. Specification No. GAIL-STD-ME-DOC-TS-025

ENGINEERING STANDARD

GAIL INDIA LIMITED

STANDARD SPECIFICATION FOR SHOP AND FIELD PAINTING

GAIL-STD-ME-DOC-TS-024

0	22.03.19	Issued For Tender	RKS	AP	JR	
Rev	**Date**	**Purpose**	**Prepared By**	**Checked By**	**Approved By**	

CONTENTS

1.0 GENERAL

1.1 These technical specifications shall be applicable for the work covered by the contract, and without prejudice to the various codes of practice, standard specifications etc. It is understood that contractor shall complete the work in all respects with the best quality of materials and workmanship and in accordance with the best engineering practice and instructions of Engineer-in-charge.

1.2 Wherever it is stated in the specification that a specific Material is to be supplied or a specific work is to be done, it shall be deemed that the same shall be supplied or carried out by the contractor.

Any deviation from this standard without written deviation permit from appropriate authority will result in rejection of job.

2.0 SCOPE

Scope of work covered in the specification shall include, but not limited to the following.

2.1 This specification defines the requirements for surface preparation, selection and application of paints on external surfaces of equipment, vessels, machinery, piping, ducts, and steel structures, external & internal protection of storage tanks for all services, RCC Chimney & MS Chimney with or without Refractory lining and Flare lines etc.

2.2 Extent of Works

2.2.1 The following surfaces and materials shall require shop, pre-erection and field painting :

a. All un-insulated CS & AS equipment like columns, vessels, drums, storage tanks, heat exchangers, pumps, compressors, electrical panels and motors etc.

b. All un-insulated carbon and low alloy piping fittings and valves (including painting of identification marks), furnace, ducts and stacks.

c. All items contained in a package unit as necessary.

d. All structural steel work, pipe, structural steel supports, walkways, hand rails, ladders, platforms etc .

e. RCC / MS chimneys with or without refractory lining & Flare lines.

f. Identification colour bands on all piping as required including insulated aluminum clad, galvanized, SS and non-ferrous piping.

g. Identification lettering / numbering on all painted surfaces of equipment / piping insulated aluminum clad, galvanized, SS and non-ferrous piping.

h. Marking / identification signs on painted surfaces of equipment / piping for Hazardous service.

i. Supply of all primers, paints and all other materials required for painting other than Owner's supply.

j. Over insulation surface of equipments and pipes wherever required.

k. Painting under insulation for carbon steel and stainless steel as specified.

l. Repair work of damaged / pre-erection / fabrication shop primer and weld joints at field.

2.2.2 The following surfaces and materials shall not be painted unless otherwise specified:

a. Un-insulated austenitic stainless steel.
b. Plastic and / or plastic coated materials.
c. Non ferrous materials like Aluminum, Galvanized "piping", "gratings" and "Hand rails" etc. except G.I. Towers.

2.3 Documents

2.3.1 The contractor shall perform the work in accordance with the following documents issued to him for execution of work.

a. Bill of quantities for Piping, equipment, machinery and structures etc.

b. Piping Line List.

c . Painting specifications including special civil defense requirement.

2.4 Unless otherwise instructed final painting on pre-erection / shop primed pipes and equipments shall be painted in the field, only after mechanical completion and testing on system are completed, as well as, after completion of steam purging wherever required.

2.5 Changes and deviations required for any specific job due to clients requirement or otherwise shall be referred to GAIL for deviation permit.

3.0 CODES & STANDARDS

3.1 Without prejudice to the provision of Clause 1.1 above and the detailed specifications of the contract, the following codes and standards shall be followed for the work covered by this contract.

IS-5	:	Colour coding
IS-101	:	Methods of test for ready mixed paints and enamels
IS-2379:1990	:	Indian Standard for Pipe line identification – colour Code
ASTM	:	American Standard test methods for paints and coatings
ASA A 13.1-1981	:	Scheme for Identification of piping systems: American National Standards Institution.

3.2 Surface Preparation Standards:

Following standards shall be followed for surface preparations:

3.2.1 Swedish Standard: SIS-05 5900-1967 / ISO-8501-1-1988 (Surface preparations standards for Painting Steel Surfaces).

This standard contains photographs of the various standards on four different degrees of rusted steel and as such is preferable for inspection purpose by the Engineer-in-Charge.

3.2.2 Steel Structures Painting Council, U.S.A. (Surface Preparation Specifications (SSPC – SP)

3.2.3 British Standards (Surface Finish or Blast-cleaned for Painting) BS-4232.

3.2.4 National Association of Corrosion Engineers, U.S.A. (NACE)

3.2.5 Various International Standards equivalent to Swedish Standard for surface preparation are given in Table-I.

3.3 The contractor shall arrange, at his own cost, to keep a set of latest edition of any one of the above standards and codes at site.

3.4 The paint manufacturer's, instructions shall be followed as far as practicable at all times. Particular attention shall be paid to the following:

a. Instructions for storage to avoid exposure as well as extremes of temp.

b. Surface preparation prior to painting.

c. Mixing and thinning.

d. Application of Paints and the recommended limit on time intervals between coats.

4.0 EQUIPMENT

4.1 All tools, brushes, rollers, spray guns, abrasive material, hand / power tools for cleaning and all equipments, scaffolding materials, shot / wet abrasive blasting, water blasting equipments & air compressors etc. required to be used shall be suitable for the work and all in good order and shall be arranged by the contractor at site and in sufficient quantity.

4.2 Mechanical mixing shall be used for paint mixing operations in case of two pack systems except that the Engineer-in-Charge may allow the hand mixing of small quantities at his discretion.

5.0 SURFACE PREPARATION, SHOP COAT, COATING APPLICATION & REPAIR AND DOCUMENTATION

5.1 General

5.1.1 In order to achieve the maximum durability, one or more of following methods of surface preparation shall be followed, depending on condition of steel surface and as instructed by Engineer-in-Charge. Adhesion of the paint film to surface depends largely on the degree of cleanliness of the metal surface. Proper surface preparation contributes more to the success of the paint protective system:

a. Manual or hand tool cleaning
b. Mechanical or power tool cleaning.

c. Blast cleaning.

5.1.2 Mill scale, rust, rust scale and foreign matter shall be removed fully to ensure that a clean and dry surface is obtained. The minimum acceptable standard in case of manual or hand tool cleaning shall be St.2 or equivalent, in case of mechanical or power tool cleaning it shall be St.3 or equivalent, in case of blast cleaning it shall be Sa 2 ½ or equivalent as per Swedish Standard SIS-055900-1967 / ISO-8501-1-1988. Where highly corrosive conditions exist, blast cleaning shall be Sa3 as per Swedish Standard.

Remove all other contaminants, oil, grease etc. by use of an aromatic solvent prior to surface cleaning.

5.1.3 Blast cleaning shall not be performed where dust can contaminate surfaces undergoing such cleaning or during humid weather conditions having humidity exceeding 85% .

5.1.4 Irrespective of the method of surface preparation, the first coat of primer must be applied on dry surface. This should be done immediately and in any case within 4 hours of cleaning of surface. However, at times of unfavorable weather conditions, the Engineer-in-Charge shall have the liberty to control the time

period, at his sole discretion and / or to insist on re-cleaning, as may be required, before primer application is taken up. In general, during unfavorable weather conditions, blasting and painting shall be avoided as far as practicable.

5.1.5 The external surface of R. C .C. chimney to be painted shall be dry and clean. Any loose particle of sand, cement, aggregate etc. shall be removed by scrubbing with soft wire brush if necessary, acid etching with 10 - 15% HCL solution for about 15 minutes shall be carried out and surface must be thoroughly washed with water to remove acid & loose particles then dry completely before application of paint.

5.2 Procedure of Surface Preparation

5.2.1 Blast Cleaning

5.2.1.1 Air Blast Cleaning

The surfaces shall be blast cleaned using one of the abrasives: Al_2O_3, particles chilled cast iron or malleable iron and steel at pressure of 7 kg/cm^2 at appropriate distance and angle depending on nozzle size maintaining constant velocity and pressure. Chilled cast iron, malleable iron and steel shall be in the form of shot or grit of size not greater than 0.055" maximum in case of steel and malleable iron and 0.04" maximum in case of chilled iron. Compressed air shall be free from moisture and oil. The blasting nozzles should be Venturi style with tungsten carbide or boron carbide as the materials for liners. Nozzles orifice may vary from 3/16" to 3/4". On completion of blasting operation, the blasted surface shall be clean and free from any scale or rust and must show a grey white metallic lusture. Primer or first coat of paint shall be applied within 4 hours of surface preparation. Blast cleaning shall not be done outdoors in bad weather without adequate protection or when there is dew on the metal which is to be cleaned. Surface profile shall be uniform to provide good key to the paint adhesion (i.e. 35 to 50 microns). If possible vacuum collector shall be installed for collecting the abrasives and recycling.

5.2.1.2 Water Blast cleaning

Environmental, health and safety problems associated with abrasive blast cleaning limit the application of Air Blast Cleaning in many installations. In such case water blast cleaning is resorted to.

Water Blast Cleaning can be applied with or without abrasive and high pressure water blasting. The water used shall be inhibited with sodium chromate / phosphate. The blast cleaned surface shall be washed thoroughly with detergents and wiped with solvent and dried with compressed Air. For effective cleaning, abrasives are used. The most commonly used pressure for high pressure water blast cleaning for maintenance surface preparation is 3000 to 6000 psi at 35-45 liters / minute water volume and pressures up to 10000 psi and water volume of 45 liters / minute provide maximum cleaning.

The water blast cleaned surface shall be comparable to SSPC-SP-12 / NACE NO. 5. The operation shall be carried out as per SSPC guidelines for water Blast cleaning. The indicative value for sand injection is as given below:

Air	:	300 to 400 Cu. ft / min.
Water	:	5- 10 liters/min. with corrosion inhibitor
Sand	:	200 - 400 lbs / hr.
Nozzle	:	0.5 to 1" dia

Special equipments for water blast cleaning with abrasives now available shall be used.

5.2.2 Mechanical or Power tool cleaning

Power tool cleaning shall be done by mechanical striking tools, chipping hammers, grinding wheels or rotating steel wire-brushes. Excessive burnish of surface shall be avoided as it can reduce paint adhesion. On completion of cleaning, the detached rust mill scale etc. shall be removed by clean rags and / or washed by water or steam and thoroughly dried with compressed air jet before application of paint.

5.2.3 Manual or hand tool cleaning

Manual or hand tool cleaning is used only where safety problems limit the application of other surface preparation procedure and hence does not appear in the specifications of paint systems.

Hand tool cleaning normally consists of the following:

a. Hand de-scaling and / or hammering

b. Hand scraping

c. Hand wire brushing

Rust, mill scale spatters, old coatings and other foreign matter, shall be removed by hammering, scrapping tools, emery paper cleaning, wire brushing or combination of the above methods. On completion of cleaning, loose material shall be removed from the surface by clean rags and the surface shall be brushed, swept, de-dusted and blown off with compressed air / steam to remove all loose matter. Finally the surface may be washed with water and dried for effective cleaning.

5.3 Non compatible shop coat primer

The compatibility of finishing coat should be confirmed from the paint manufacturer. In the event of use of primer such as zinc Rich epoxy, inorganic zinc silicate etc. as shop coat, the paint system shall depend on condition of shop coat. If shop coat is in satisfactory condition showing no major defects, the shop coat shall not be removed. The touch up primer and finishing coat(s) shall be identified for application by Engineer-in charge.

5.4 Shop coated (coated with primer & finishing coat) equipment should not be repainted unless paint is damaged.

5.5 Shop primed equipment and surfaces will only be 'spot cleaned' in damaged areas by means of power tool brush cleaning and then spot primed before applying one coat of field primer unless otherwise specified. If shop primer is not compatible with field primer then shop coated primer should be completely removed before application of selected paint system for particular environment.

5.6 For packaged units / equipment, shop primer should be as per the paint system given in this specification. However, manufacturer's standard can be followed after review.

5.7 Coating Procedure and Application :

5.7.1 Surface shall not be coated in rain, wind or in environment where injurious air bone elements exists, when the steel surface temperature is less than 5^0F above dew point, when the relative humidity is greater than 85% or when the temperature is below 40°F.

5.7.2 Blast cleaned surface shall be coated with one complete application of primer as soon as practicable but in no case later than 4 hrs. in the same day.

5.7.3 To the maximum extent practicable, each coat of material shall be applied as a continuous film uniform thickness free of probes. Any spots or areas missed in application shall be recoated and permitted to dry before the next coat is applied. Applied paint should have the desired wet film thickness.

5.7.4 Each coat shall be in proper state of cure or dryness before the application of succeeding coat. Material shall be considered dry for recoating when an additional coat can be applied without the development of any detrimental film irregularities, such as lifting or loss of adhesion of the under coat. Manufacturer instruction shall be followed for inter coat interval.

5.7.5 When the successive coat of the same colour have been specified, alternate coat shall be tinted, when practical, sufficiently to produce enough contrast to indicate complete coverage of the surface. The tinting material shall be compatible with the material and not detrimental to its service life.

5.7.6 Air spray application shall be in accordance with the following:

a. The equipment used shall be suitable for the intended purpose, shall be capable of properly atomizing the paint to be applied, and shall be equipped

with suitable pressure regulators and gauges. The air caps, nozzles, and needles shall be those recommended by the manufacturer of the equipment for the material being sprayed. The equipment shall be kept in satisfactory condition to permit proper paint application.

b. Traps or separators shall be provided to remove oil and condensed water from the air. These traps or separators must be of adequate size and must be drained periodically during operations. The air from the spray gun impinging against the surface shall show no condensed water or oil.

c. Ingredients shall be kept properly mixed in the spray pots or containers during application by continuous mechanical agitation.

d. The pressure on the material in the pot and the air at the gun shall be adjusted for optimum spraying effectiveness. The pressure on the material in the pot shall be adjusted when necessary for changes in elevation of the gun above the pot. The atomizing air pressure at the gun shall be high enough to properly atomize the paint but not so high as to cause excessive fogging of paint, excessive evaporation of solvent, or less by overspray.

e. Spray equipment shall be kept sufficiently clean so that dirt, dried paint, and other foreign materials are not deposited in the paint film.
Any solvents left in the equipment shall be completely removed before applying paint to the surface being painted.

f. Paint shall be applied in a uniform layer, with overlapping at the edge of the spray pattern. The spray patterns shall be adjusted so that the paint is deposited uniformly. During application, the gun shall be held perpendicular to the surface and a distance which will ensure that a wet layer of paint is deposited on the surface. The trigger of the gun should be released at the end of each stroke.

g. All runs and sags shall be brushed out immediately or the paint shall be removed and the surface repainted.

h. Areas inaccessible to the spray gun shall be painted by brush; if not accessible by brush, daubers or sheepkins shall be used.

i. All name plates, manufacturer's identification tags, machined surfaces, instrument glass, finished flange faces, control valve items and similar items shall be masked to prohibit coating deposition. If these surfaces are coated, the component shall be cleaned and restored to its original condition.

j. Edges of structural shapes and irregular coated surfaces shall be coated first and an extra pass made later.

k. If spray gun shows choking, immediately de-choking procedure shall be followed.

5.7.7 Airless spray application shall be in accordance with the following procedure: as per steel structure paint Manual Vol. 1 & Vol.2 by SSPC, USA. Air less spray relies on hydraulic pressure rather than air atomization to produce the desired spray. An air compressor or electric motor is used to operate a pump to produce pressures of 1,000 to 6,000 psi. Paint is delivered to the spray gun at this pressure through a single hose within the gun; a single paint stream is divided into separate streams, which are forced through a small orifice resulting in atomization of paint without the use of air. This results in more rapid coverage with less overspray. Airless spray usually is faster, cleaner, more economical and easier to use than conventional air spray.

Airless spray equipment is mounted on wheels, and paint is aspirated in a hose that sucks paint from any container, including drums. The unit shall have inbuilt agitator that keep the paint uniformly mixed during the spraying. The unit shall consist of inbuilt strainer. A usually very small quantity of thinning is required before spray. Incase of High Build epoxy coatings (two pack), 30: 1 pump ratio and 0.020-0.023" tip size will provide a good spray pattern. Ideally fluid hoses should not be less than 3/8" ID and not longer than 50ft to obtain optimum results.

In case of gun choking, dechoking steps shall be followed immediately.

5.7.8 Brush application of paint shall be in accordance with the following :

a. Brushes shall be of a style and quality that will enable proper application of paint.
b. Round or oval brushes are most suitable for rivets, bolts, irregular surfaces, and rough or pitted steel. Wide flat brushes are suitable for large flat areas, but they shall not have width over five inches.
c. Paint shall be applied into all corners. d.

Any runs or sags shall be brushed out.

e. There shall be a minimum of brush marks left in the applied paint.
f. Surfaces not accessible to brushes shall be painted by spray, daubers, or sheepkin.

5.7.9 Manual Application by sling (where 6'O clock position of pipe is not approachable).

A canvas strip (alternatively a tinplate strip) about 450mrn wide and 1.5m long is hold under the pipe by two men. Liquid coating is poured on the sling at each side of the pipe. The men holding this sling move it up and down and walk slowly forward while fresh coating is poured on the pipe and they manipulate the sling so that an even coating is obtained all round the bottom.

This work shall be done very carefully and by experienced personnel. There shall not be any formation of "Whiskers" and holes in the coating. The coating film shall be inspected by mirror.

5.7.10 For each coat, the painter should know the WFT corresponding to the specified DFT and standardize the paint application technique to achieve the desired WFT. This has to be ensured in the qualification trial.

5.8 Drying of coated Surfaces

5.8.1 No coat shall be applied until the preceding coat has dried. The material shall be considered dry for re-coating when another coat can be applied without the development of any film irregularities such as lifting or loss of adhesion of undercoats. Drying time of the applied coat should not exceed maximum specified for it as a first coat; if it exceeds the paint material has possibly deteriorated or mixing is faulty.

5.8.2 No paint shall be force dried under conditions which will cause checking, wrinkling, blistering formation of pores, or detrimentally affect the condition of the paint.

5.8.3 No drier shall be added to a paint on the job unless specifically called for in the manufacturer's specification for the paint.

5.8.4 Paint shall be protected from rain, condensation, contamination, snow and freezing until dry to the fullest extent practicable.

5.9 Repair of damaged paint surface

5.9.1 Where paint has been damaged in handling and in transportation, the repair of damaged coating of pre-erection / fabrication shall be as given below.

5.9.2 Repair of damaged inorganic zinc silicate primer after erection / welding:
Quickly remove the primer from damaged area by mechanical scraping and emery paper to expose the white metal. Blast clean the surface if possible. Feather the primer over the intact adjacent surface surrounding the damaged area by emery paper.

5.9.3 Repair of damaged pre-erection and shop priming in the design temperature of -90°C to 500°C.

- Surface preparation shall be done as per procedure 5.9.2.
- One coat of F-9 shall be applied wherever damaged was observed on pre- erection / pre-fabrication / shop primer of inorganic zinc silicate coating (F-9). F-9 shall not be applied if damaged area is not more than 5x5 cm.

5.10 PAINT APPLICATION

5.10.1 Shop priming / pre-erection priming with F9 or F12 shall be done only on blasted surface.

5.10.2 Shop priming / pre-erection priming with F9 or F12 shall be done only with airless spray.

5.10.3 For large flat surface field painting shall be done by airless spray otherwise brush can be used.

5.11 Documentation

- A written quality plan with procedure for qualification trials and for the actual work.
- Daily progress report with details of weather conditions, particular of applications, no of coats and type of materials applied, anomalies, progress of work versus programmed.
- Results of measurement of temperatures relative humidity, surface profile, film thickness, holiday detection, adhesion tests with signature of appropriate authority.
- Particulars of surface preparation and paint application during trials and during the work.
- Details of non-compliance, rejects and repairs.
- Type of testing equipments and calibration.
- Code and batch numbers of paint materials used.

TABLE – 1 (FOR CLAUSE 5.0)
SURFACE PREPARATION STANDARDS

S. NO.	DESCRIPTION	VARIOUS INTERNATIONAL STANDARDS (EQUIVALENT)				REMARKS
		SWEDISH STD. SIS-05-5900 1967	SSPC-SP USA	NACE USA	BRITISH STD. BS-4232: 1967	
1	**MANUAL OR HAND TOOL CLEANING** REMOVAL OF LOOSE RUST, LOOSE MILL SCALE AND LOOSE PAINT. CHIPPING, SCRAPPING, SANDING AND WIRE BRUSHING. SURFACE SHOULD HAVE A FAINT METALLIC SHEEN	ST. 2	SSPC-SP-2	-	-	THIS METHOD IS APPLIED WHEN THE SURFACE IS EXPOSED TO NORMAL ATMOSPHERIC CONDITIONS WHEN OTHERMETHODS CANNOT BE ADOPTED AND ALSO FOR SPOT CLEANING DURING MAINTENANCE PAINTING
2	**MECHANICAL OR POWER TOOL CLEANING** REMOVAL OF LOOSE RUST, LOOSE MILL SCALE AND LOOSE PAINT TO DEGREE SPECIFIED BY POWER TOOL CHIPPING, DESCALING, SANDING, WIRE BRUSHING AND GRINDING, AFTER REMOVAL OF DUST, SURFACE SHOULD HAVE PRONOUNCED METALLIC SHEEN	St. 3	SSPC-SP-3	-	-	

TABLE – 1 (FOR CLAUSE 5.0)
SURFACE PREPARATION STANDRADS

S. NO.	DESCRIPTION	VARIOUS INTERNATIONAL STANDARDS (EQUIVALENT)				REMARKS
		SWEDISH STD. SIS-05-5900 1967	SSPC-SP USA	NACE USA	BRITISH STD. BS-4232: 1967	
3	**BLAST CLEANING (AIR & WATER)**					
	THERE ARE FOUR COMMON GRADES OF BLAST CLEANING					
3.1	**WHITE METAL**					
	BLAST CLEANING TO WHITE METAL CLEANLINESS, REMOVAL OF ALL VISIBLE RUST, MILL SCALE, PAINT & FOREIGN MATTER 100% CLEANLINESS WITH DESIRED SURFACE PROFILE	SA 3	SSPC-SP-5	NACE #1	FIRST QUALITY	WHERE EXTREMELY CLEAN SURFACE CAN BE EXPECTED FOR PROLONGED LIFE OF PAINT SYSTEM
3.2	**NEAR WHITE METAL**					
	BLAST CLEANING TO NEAR WHITE METAL CLEANLINESS, UNTIL AT LEAST 95% OF EACH ELEMENT OF SURFACE AREA IS FREE OF ALL VISIBLE RESIDUES WITH DESIRED SURFACE PROFILE	SA 2 ½	SSPC-SP-10	NACE #2	SECOND QUALITY	THE MINIMUM REQUIREMENT FOR CHEMICALLY RESISTANT PAINT SYSTEMS SUCH AS EPOXY, VINYL, POLYURETHANE BASED AND INORGANIC ZINC SILICATE PAINTS, ALSO FOR CONVENTIONAL PAINT SYSTEMS USED UNDER FAIRLY CORROSIVE CONDITIONS TO OBTAIN DESIRED LIFE OF PAINT SYSTEM

TABLE – 1 (FOR CLAUSE 5.0)
SURFACE PREPARATION STANDRADS

S. NO.	DESCRIPTION	VARIOUS INTERNATIONAL STANDARDS (EQUIVALENT)				REMARKS
		SWEDISH STD. SIS-05-5900 1967	SSPC-SP USA	NACE USA	BRITISH STD. BS-4232: 1967	
3.3	**COMMERCIAL BLAST** BLAST CLEANING UNTIL AT LEAST TWO-THIRDS OF EACH ELEMENT OF SURFACE AREA IS FREE FROM ALL VISIBLE RESIDUES WITH DESIRED SURFACE PROFILE	SA 2	SSPC-SP-6	NACE #3	THIRD QUALITY	FOR STEEL REQUIRED TO BE PAINTED WITH CONVENTIONAL PAINTS FOR EXPOSURE TO MILDLY CORROSIVE ATMOSPHERE FOR LONGER LIFE OF THE PAINT SYSTEM
3.2	**BRUSH OFF BLAST** BLAST CLEANING TO WHITE METAL CLEANLINESS, REMOVAL OF ALL VISIBLE RUST, MILL SCLAE, PAINT & FOREIGN MATTER, SURFACE PROFILE IS NOT SO IMPORTANT	SA 1	SSPC-SP-7	NACE #4	-	

6.0 PAINT MATERIALS

Paint manufacturer shall furnish all the characteristics of the paint material on printed literature, along with the test certificate for all the specified characteristics given in this specification. All the paint materials shall be of first quality and confirm to the following general characteristics as per tables 6.1, 6.2 & 6.3.

PAINT MATERIALS

TABLE NO.: 6.1 (PRIMERS)

S.NO.	DESCRIPTION	P-2	P-4	P-6
1	Technical Name	Chlorinated rubber Zinc Phosphate primer	Etch Primer / wash primer	Epoxy Zinc phosphate primer
2	Type and composition	Single pack, air drying chlorinated rubber based medium plasticized with unsaponifiable plasticizer, pigmented with Zinc phosphate	Two pack polyvinyl Butyral resin medium cured with phosphoric acid solution pigmented with zinc tetroxy chromate.	Two component polyamide cured epoxy resin medium, pigmented with zinc phosphate.
3	Volume Solids (approx)	40%	7 - 8 %	40%
4	DFT (Dry film thickness) per coat (approx).	40 - 50 MICRON	8 - 10 MICRON	40 - 50 MICRON
5	Theoretical covering capacity in M2/coat/litre(approx)	8 - 10	8 - 10	8 - 10
6	Weight per liter in kg (approx)	1.3	1.2	1.1
7	Touch dry at 30°C (approx)	30 MINUTES	2 HOURS	AFTER 30 MINUTES
8	Hard dry at 30°C (approx)	MIN.: 8 HOURS MAX: 24 HOURS	MIN.: 2 HOURS MAX: 24 HOURS	MIN.: 8 HOURS MAX: 3 - 6 MONTHS
9	Over coating interval(approx)	MIN.: 8 HOURS MAX: NO LIMITATION	MIN.: 4-6 HOURS MAX: 24 HOURS	MIN.: 8 HOURS MAX: 3 - 6 MONTHS
10	Pot life (approx) at 30°C for two component paints (approx)	NOT APPLICABLE	NOT APPLICABLE	8 HOURS

PAINT MATERIALS

TABLE NO.: 6.2 (FINISH PAINTS)

S.NO.	DESCRIPTION	F-2	F-3	F-6	F-7
1	Technical Name	Acrylic polyurethane finish paint	Chlorinated rubber based finish paint	Epoxy-High Build finish paint	High build coal tar epoxy coating
2	Type and composition	Two-pack aliphatic isocynate cured acrylic finish paint	Single pack plasticized chlorinated rubber based medium with chemical and weather resistant pigments	Two pack polyamide/polyamine cured epoxy resin medium suitably pigmented	Two pack polyamide cured epoxy resin blended with coal tar medium, suitably pigmented
3	Volume Solids (approx)	40%	40 %	62%	65%
4	DFT (Dry film thickness) per coat (approx).	30 - 40 MICRON	40 - 50 MICRON	100 - 125 MICRON	100 - 125 MICRON
5	Theoretical covering capacity in M2/coat/litre(approx)	10 - 13	8 - 10	5 - 6	5.2 – 6.5
6	Weight per liter in kg (approx)	1.3	1.2	1.4	1.5
7	Touch dry at 30'C (approx)	1 HOUR	30 MINUTES	3 HOURS	4 HOURS
8	Hard dry at 30'C (approx)	12 HOURS	8 HOURS	12 HOURS	48 HOURS
9	Over coating interval(approx)	MIN.: 12 HOURS MAX: UNLIMITED	MIN.: 12 HOURS MAX: UNLIMITED	MIN.: 12 HOURS MAX: 5 DAYS	MIN.: 24 HOURS MAX: 5 DAYS
10	Pot life (approx) at 30'C for two component paints (approx)	6 – 8 HOURS	NOT APPLICABLE	4 - 6 HOURS	4 - 6 HOURS

PAINT MATERIALS

TABLE NO.: 6.3 (FINISH PAINTS)

S.NO.	DESCRIPTION	Γ 8	Γ 9	Γ 11	Γ 12
1	Technical Name	Self priming type surface tolerant High Build Epoxy coating (Complete rust control coating)	Inorganic Zinc Silicate coating	Heat resistant synthetic medium based two pack Aluminum paint suitable up to 250°C dry temperature	Heat resistant silicone Aluminum paint suitable up to 500°C dry temperature
2	Type and composition	Two pack epoxy resin based suitably pigmented and capable of adhering to manually prepared surface and old coating	A two pack air drying self curing solvent based Inorganic Zinc silicate coating	Heat resistant synthetic medium based two pack Aluminum paint suitable up to 250°C	Single pack silicone resin based medium with aluminum flakes
3	Volume Solids (approx)	72%	60 %	25%	20%
4	DFT (Dry film thickness) per coat (approx).	100 - 125 MICRON	65 - 75 MICRON	20 - 25 MICRON	20 - 25 MICRON
5	Theoretical covering capacity in M2/coat/litre(approx)	6 – 7.2	8 - 9	10 - 12	8 – 10
6	Weight per liter in kg (approx)	1.4	2.3	1.2	1.1
7	Touch dry at 30°C (approx)	3 HOUR	30 MINUTES	3 HOURS	30 MINUTES
8	Hard dry at 30°C (approx)	24 HOURS	12 HOURS	12 HOURS	24 HOURS
9	Over coating interval(approx)	MIN.: 10 HOURS MAX: 6 MONTHS	MIN.: 8 HOURS AT 20°C, 50% RH MAX: UNLIMITED	MIN.: 16 HOURS MAX: UNLIMITED	MIN.: 16 HOURS MAX: UNLIMITED
10	Pot life (approx) at 30°C for two component paints (approx)	90 MINUTES	4 – 6 HOURS	NOT APPLICABLE	NOT APPLICABLE
11	Temperature resistance	-	-	250°C	500°C

F-14: Specially formulated polyamine cured coal tar epoxy suitable for -45^{0}C to 125°C for application under insulation

F-15: Two pack cold cured epoxy phenolic coating suitable for -45^{0}C to 125°C for application under insulation

F-16: Epoxy siloxane Amercoat 738

Notes:

1.0 Covering capacity and DFT depends on method of application. Covering capacity specified above are theoretical. Allowing the losses during the application, minimum specified DFT should be maintained.

2.0 All primers and finish coats should be cold cured and air dried unless otherwise specified.

3.0 All paints shall be applied in accordance with manufacturer's instructions for surface preparation, intervals, curing and application. The surface preparation, quality and workmanship should be ensured.

4.0 Technical data sheets for all paints shall be supplied at the time of submission of quotations.

6.4 List of recommended manufacturers

The paints shall conform to the specifications given above and the best quality in their products range of the manufacturers listed in Annexure-I.

7.0 PAINT SYSTEMS

The paint system should vary with type of environment envisaged in and around the plants. Three types of environment as given below are considered for selection of paint system. The paint system is also given for specific requirements.

PRIMERS & FINISH COATS COVERED IN TABLE NOS.7.0 to 15.0

PRIMERS

P-2 : Chlorinated Rubber Zinc Phosphate Primer

P-4 : Etch Primer / Wash Primer

P-6 : Epoxy Zinc Phosphate Primer

FINISH COATS / PAINTS

F-2 : Acrylic - Polyurethane finish paint
F-3 : Chlorinated Rubber Finish Paint
F-6 : High Build Epoxy finish coating
F-7 : High Build Coal Tar epoxy coating
F-8 : Self priming surface Tolerant High Build Epoxy coating
F-9 : Inorganic Zinc Silicate coating
F-11 : Heat resistant Synthetic medium based Aluminum paint
F-12 : Heat resistant Silicone Aluminum paint
F-14 : Specially formulated polyamine cured coal for Epoxy coating
F-15 : Epoxy phenolic coating
F-16 : Epoxy Siloxane coating: Amercoat 738

TABLE 7.1: PRE-ERECTION / PRE-FABRICATION AND SHOP PRIMING FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL, STEEL STRUCTURES, PIPING AND EQUIPMENT ETC.

S.NO.	DESIGN TEMP. IN ^{0}C	SURFACE PREPARATION	PAINT SYSTEM	TOTAL DFT IN MICRONS (MIN.)	REMARKS
7.1.1	-90TO 400	SSPC-SP-10	1 COAT OF F-9	65-75	No over coating is to be done
7.1.2	401 TO 500	SSPC-SP-10	1 COAT OF F-12	40-50	Finish coat at site

TABLE 7.2: REPAIR OF PRE-ERECTION / PRE-FABRICATION AND SHOP PRIMING AFTER ERECTION / WELDING FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL, ITEMS IN ALL ENVIRONMENTS.

S.NO.	DESIGN TEMP. IN ^{0}C	SURFACE PREPARATION	PAINT SYSTEM	TOTAL DFT IN MICRONS (MIN.)	REMARKS
7.2.1	-90TO 400	SSPC-SP-3 (for repair only) SSPC-SP-10	1 COAT OF F-9	65-75	For damaged area of more than 5cm x 5cm
7.2.2	401 TO 500	SSPC-SP-3 (for repair only) SSPC-SP-10	2 COATS OF F-12	40 50	For damaged area of more than 5cm x 5cm

TABLE 8.0: FIELD PAINT SYSTEM FOR NORMAL CORROSIVE ENVIRONMENT (FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL)

All normal Corrosive areas such as Offsites, External surfaces of un insulated Columns, Vessels, Heat Exchangers, Blowers, Piping, Pumps, Towers, Compressors, Structural Steel Works, RCC Chimney with or without refractory lining inside Chimney (All environments), excluding Tank tops, Flare lines, D.M. Plants, interior of Tanks etc., Flare lines for normal corrosive environment also to be painted as per Table 9.0

S.NO.	DESIGN TEMP. IN °C	SURFACE PREPARATION	PAINT SYSTEM		TOTAL DFT IN MICRONS (MINIMUM)	REMARKS
			FILED PRIMER	FINISH PAINT		
8.1	-90 to -15	SSPC-SP-10	REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75 MICRONS DFT / COAT	NONE	65-75	No over coating to be done. Follow repair procedure only on damaged areas of pre erection / pre-fabrication primer / coating F-9
8.2	-14 to 80	SSPC-SP-10	REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75 MICRONS DFT / COAT + 2 COATS OF P-2 @ 40 MICRON DFT / COAT (2 X 40 = 80)	2 COATS OF F-3 @ 40 MICRON DFT / COAT(2x40=80)	225	
8.3	81 to 250	SSPC-SP-10	REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75 MICRONS DFT / COAT	3 COATS OF F-11 @ 20 MICRON DFT / COAT(3x20=60)	125	
8.4	251 to 400	SSPC SP 10	REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75 MICRONS DFT / COAT	2 COATS OF F-12 @ 20 MICRON DFT / COAT(2x20=40)	105	
8.5	401 to 500	SSPC-SP-10	REPAIR AS PER 7.2.2	2 COATS OF F-12 @ 20 MICRON DFT / COAT(2x20=40)	80	

NOTE:

1. **For MS Chimney with or without Refractory lining, 8.3, 8.4 and 8.5 shall be followed.**
2. **For external surfaces of RCC Chimney: 2 Coats of F-6 @ 100 micron DFT / Coat to obtain 2 X 100 = 200 micron DFT shall be applied after making surface preparation as per guide lines in 5.1.5.**

TABLE 9.0: FIELD PAINT SYSTEM FOR CORROSIVE ENVIRONMENT (FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL)

For all corrosive areas above ground where H_2S, SO_2 fumes or spillages of acid /alkali /salt are likely to come in contact with surfaces such as external surfaces of un insulated Columns, Vessels, Heat Exchangers, Blowers, Piping, Pumps, Towers, Compressors, Flare Lines, Structural Steel etc.

S.NO.	DESIGN TEMP. IN ^0C	SURFACE PREPARATION	PAINT SYSTEM		TOTAL DFT IN MICRONS (MINIMUM)	REMARKS
			FILED PRIMER	FINISH PAINT		
9.1	-90 to -15	SSPC-SP-10	REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75 MICRONS DFT / COAT	NONE	65-75	Repair of pre-erection / pre-fabrication primer shall be done wherever damage is observed. Surface preparation is required only for repairing of damaged pre-erection / fabrication primer
9.2	11 to 80	SSPC SP 10	REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75 MICRONS DFT / COAT + 1 COAT OF P-6 @ 40 MICRON DFT / COAT	1 COAT OF F-6 @ 100 MICRON DFT/ COAT + 1 COAT OF F-2 @ 40 MICRON DFT/COAT	245	
9.3	81 to 400	SSPC-SP-10	REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75 MICRONS DFT / COAT	2 COATS OF F-12 @ 20 MICRON DFT / COAT (2 X 20 = 40)	105	
9.4	400 to 500	SSPC-SP-10	REPAIR AS PER 7.2.2	2 COATS OF F-12 @ 20 MICRON DFT / COAT (2 X 20 = 40)	80	

TABLE 10.0: FIELD PAINT SYSTEM FOR HIGHLY CORROSIVE AREAS (FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL) EXTERNAL SURFACES OF UNINSULATED COLUMNS, VESSELS, HEAT EXCHANGERS, BLOWERS, PIPING, PUMPS, TOWERS, COMPRESSORS, FLARE LINES, STRUCTURAL STEEL ETC.

Exposed to spillage or fumes of HCL, H_2SO_4, Salty water, Water impingement, Chlorides etc.

S.NO.	DESIGN TEMP. IN ^0C	SURFACE PREPARATION	PAINT SYSTEM		TOTAL DFT IN MICRONS (MINIMUM)	REMARKS
			FILED PRIMER	FINISH PAINT		
10.1	-90 to -15	SSPC-SP-10	REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 55-75 MICRONS DFT / COAT	NONE	65-75	Repair procedure of pre-erection / fabrication primer shall be followed. No over coating is allowed.
10.2	-14 to 80	SSPC-SP-10	REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 55-75 MICRONS DFT / COAT + 1 COAT OF F-6 @ 40 MICRON DFT / COAT	2 COATS OF F-6 @ 100 MICRON DFT / COAT (2 X 100 = 200) + 1 COAT OF F-2 @ 40 MICRON DFT/COAT	345	
10.3	81 to 400	SSPC-SP-10	REPAIR OF PRE FABRICATION PRIMER 1 COAT OF F-9 @ 55-75 MICRONS DFT / COAT	2 COATS OF F-12 @ 20 MICRON DFT / COAT (2 X 20 = 40)	105	Surface preparation is required only for repairing of damaged pre-erection / fabrication primer
10.4	400 to 500	SSPC-SP-10	REPAIR AS PER 7.2.2	2 COATS OF F-12 @ 20 MICRON DFT / COAT (2 X 20 = 40)	80	

TABLE 11.0: FIELD PAINT SYSTEM FOR CARBON STEEL STORAGE TANKS (EXTERNAL) FOR ALL ENVIRONMENTS

S.NO.	DESIGN TEMP. IN °C	SURFACE PREPARATION	PAINT SYSTEM FILED PRIMER	FINISH PAINT	TOTAL DFT IN MICRONS (MINIMUM)	REMARKS
11.1	EXTERNAL SHELL, WIND GIRDERS APPARATUSES, ROOF TOPS OF ALL ABOVE GROUND TANK INCLUDING TOP SIDE OF FLOATING ROOF OF OPEN TANK AS WELL AS COVERED FLOATING ROOF TANK AND ASSOCIATED STRUCTURAL WORKS, ROLLING AND STATIONARY LADDERS, SPIRAL STAIRWAYS, HAND RAILS FOR ALL ENVIRONMENTS FOR CRUDE OIL, LDO, HSD, ATF, KEROSENE, GASOLENE, MOTOR SPIRIT, DM WATER, FIREWATER, RAW WATER, POTABLE WATER, ACIDS, ALKALIES SOLVENTS AND CHEMICALS ETC.					
11.1.1	-14 to 80	SSPC-SP-10	1 COAT OF F-9 @ 65-75 MICRONS DFT / COAT + 1 COAT OF F-6 @ 40 MICRON DFT / COAT 65 + 40 = 105	1 COAT OF F-6 @ 100 MICRON DFT/ COAT + 2 COATS OF F-2 @ 40 MICRON DFT/COAT	285	F-6 SHOULD BE SUITABLE FOR OCCASIONAL WATER IMMERSION
11.1.2	81 to 500	SSPC-SP-10	1 COAT OF F-9* @ 65-75 MICRONS DFT / COAT	2 COATS OF F-12 @ 20 MICRON DFT / COAT (2 X 20 = 40)	105	
11.2	EXTERNAL SURFACES OF BOTTOM PLATE (SOIL SIDE) FOR ALL STORAGE TANKS					
11.2.1	-14 to 80	SSPC-SP-10	1 COAT OF F-9* @ 65-75 MICRONS DFT / COAT	3 COATS OF F-7 @ 100 MICRON DFT / COAT (3 X 100 – 300)	355	F-7 SHOULD BE SUITABLE FOR IMMERSION SERVICE OF THE PRODUCTS GIVEN.

* SAME AS PRE-ERECTION / PRE-FABRICATION PRIMER

TABLE 12.0: FIELD PAINT SYSTEM FOR CARBON STEEL AND ALLOY STEEL STORAGE TANKS (INTERNAL)

S.NO.	DESIGN TEMP. IN °C	SURFACE PREPARATION	PAINT SYSTEM		TOTAL DFT IN MICRONS (MINIMUM)	REMARKS
			FILED PRIMER	FINISH PAINT		
12.1	INTERNAL SURFACES OF UNDERSIDE OF FLOATING ROOF, INTERNAL SURFACE OF CONE ROOF, BOTTOM PLATE, ROOF STRUCTURE, STRUCTURAL STEEL, LADDERS, SUPPORTS FOR STORING CRUDE OIL, LDO, AND HSD (EXCLUDING WHITE OIL PRODUCTS)					
12.1.1	-14 to 80	SSPC-SP-10	1 COAT OF F-9 @ 65-75 MICRONS DFT / COAT	3 COATS OF F-7 @ 100 MICRON DFT/ COAT 3 X 100 = 300	365	F-7 SHOULD BE SUITABLE FOR IMMERSION SERVICE OF THE PRODUCTS GIVEN.
12.2	BARE SHELL OF INSIDE FLOATING ROOF TANKS AND CONE ROOF TANKS FOR PRODUCTS MENTIONED IN 12.1.					
12.2.1	-14 to 80	SSPC-SP-10	PHOSPHATING TREATMENT WITH PHOSPHATING CHEMICALS (2 COATS)	2 COATS @ 10 MICRON DFT / COAT 2 X 10 = 20	20	
12.3	FLOATING CONE ROOF TANKS FOR PETROLEUM PRODUCTS SUCH AS ATF, GASOLINE, NAPTHA, KEROSENE, MOTOR SPIRIT, INSIDE OF BOTTOM PLATE, UNDERSIDE OF FLOATING ROOF AND SHELL ABOVE MAXIMUM LIQUID LEVEL AND STRUCTURAL STEEL, LADDERS ETC.					F-6 SHOULD BE SUITABLE FOR IMMERSION SERVICE OF PETROLEUM PRODUCTS LIKE ATF, KEROSENE, PETROL ETC.
12.3.1	14 to 80	SSPC SP 10	1 COAT OF F-9 @ 65-75 MICRONS DFT / COAT	3 COATS OF F 6 @ 100 MICRON DFT/ COAT 3 X 100 = 300	365	
12.4	BARE SHELL OF INSIDE OF FLOATING CONE ROOF TANKS FOR PRODUCTS MENTIONED IN 12.3					
12.4.1	-14 to 80	SSPC-SP-10	1 COAT OF F-9 @ 65-75 MICRONS DFT / COAT	NONE	65-75	NO OVERCOATING IS ALLOWED.

							SAME AS PER PRE-FRECTION PRIMER, IF ANY.
12.5	INTERNAL PROTECTION OF FIXED ROOF TYPE STORAGE TANKS FOR POTABLE WATER : INSIDE OF SHELL, UNDER SIDE OF ROOF STRUCTURE INSIDE SURFACE, BOTTOM PLATE AND STRUCTURAL STEEL WORKS, LADDERS, WALKWAYS, PLATFORMS ETC.						
12.5.1	-14 TO 80	SSPC-SP-10	2 COATS OF F-6 @ 40 MICRON DFT / COAT 2 X 40 = 80	2 COATS OF F-6 @ 100 MICRON DFT / COAT 2 X 100 = 200	280	F-6 SHALL BE SUITABLE FOR IMMERSION SERVICE	
12.6	D.M. (DEMINERALISED WATER) AND HYDROCHLORIC ACID (HCL) : INTERNAL SHELL, BOTTOM PLATE AND ALL ACCESSORIES						
12.6.1	-14 TO 60	SSPC-SP-10	EBONITE RUBBER LINING				
12.7	ES TANKS (INTERNAL SHELL, BOTTOM PLATE ROOF AND ALL ACCESSARIES)						
12.7.1	ALL	SSPC-SP-10	3 COATS OF VINYL CHLORIDE CO-POLYMER AMERCOAT 23 @ 75 MICRON DFT / COAT		225		
12.8	INSIDE PONTOON AND INSIDE OF DOUBLE DECK OF ALL FLOATING ROOFS						
12.8.1	ALL	SSPC-SP-3	1 COAT OF F-8 @ 100 MICRON DFT / COAT	1 COAT OF F-6 @ 100 MICRON DFT / COAT	200		
12.9	INTERNAL SURFACES OF AMINE & SOUR WATER STORAGE TANKS						
12.9.1	-14 TO 80	SSPC-SP-10	1 COAT OF F-9 @ 65 – 75 MICRON DFT / COAT	2 COATS OF F-15 @ 75 MICRON DFT / COAT 2 X 75 = 150	215 - 225		

TABLE 13.0: COATING SYSTEM FOR EXTERNAL SIDE OF UNDER GROUND CARBON STEEL PLANT PIPING AND TANKS

S.NO.	DESIGN TEMP. IN ^0C	SURFACE PREPARATION	PAINT SYSTEM		TOTAL DFT IN MICRONS (MINIMUM)	REMARKS
			FILED PRIMER	FINISH PAINT		
13.1	CARBON STEEL PLANT PIPING (UNDER GOUND)					
13.1.1	YARD COATING					
13.1.1.1	25 to 60	SSPC-SP-10	1 COAT OF SYNTHETIC FAST DRYING PRIMER TYPE-B AS PER AWWA-C-203 (1991)	4 MM THK. COALTAR COATING WRAPPING AS PER AWWA-C-203 IN 2 LAYERS OF EACH 2MM THICKNESS	4 MM	CTE COATING SHALL CONFIRM TO 120 / 5 AS PER BS: 4164
13.1.2	OVER THE DITCH COATING					
13.1.2.1	25 TO 60	SSPC-SP-10	1 COAT OF SYNTHETIC FAST DRYING PRIMER TYPE-B AS PER AWWA-C-203 (1991)	2 LAYERS OF COALTAR BASED TAPE COATING AS PER AWWA-C-203	4 MM	
13.2	CARBON STEEL PLANT PIPING (UNDERGROUND)					
13.2.1	61 TO 400	SSPC-SP-10	1 COAT OF F-9 @ 65-75 MICRON DFT/COAT	NONE	65-75	
13.3	EXTERNAL SIDE OF UNINSULATED UNDERGROUND STORAGE TANKS					
13.3.1	-40 TO 80	SSPC-SP-10	1 COAT OF F-9 @ 65-75 MICRON DFT/COAT	3 COATS OF F-7 @ 100 MICRON DFT/COAT 3 X 100 = 300	365	
13.3.2	-90 TO -41 & 81 TO 400	SSPC-SP-10	1 COAT OF F-9 @ 65-75 MICRON DFT/COAT OR 1 COAT OF AMERCOT 738 @ 250 MICRON DFT/COAT	NONE / NONE	65 – 75 / 250	

TABLE 14.0: PAINTING UNDER INSULATION FOR INSULATED (HOT, COLD & SAFETY) CARBON STEEL, LOW ALLOY STEEL, LOW TEMPERATURE CARBON STEEL, STAINLESS STEEL PIPING, STORAGE TANKS, AND EQUIPMENTS IN ALL ENVIRONMENTS

S.NO.	DESIGN TEMP. IN °C	SURFACE PREPARATION	PAINT SYSTEM		TOTAL DFT IN MICRONS (MINIMUM)	REMARKS
			FILED PRIMER	FINISH PAINT		
14.1	INSULATED CARBON STEEL, LOW ALLOY STEEL, LTCS PIPING / EQUIPMENT / TANKS					
14.1.1	-45 TO 125	SSPC-SP-10	REPAIR OF PREFABRICATION PRIMER F-9 @ 65-75 MICRONS DFT / COAT	2 COATS OF F-14 @ 125 MICRON DFT/COAT OR 3 COATS OF F-15 @ 80 MICRON DFT/COAT	315	FOR OTHER TEMP. RANGES NO PAINTING IS REQUIRED UNDER INSULATION
14.1.2	OPERATING TEMP. -45 TO 125, BUT DESIGN TEMP. IS 126 - 400	SSPC-SP-10	REPAIR OF PREFABRICATION PRIMER F-9 @ 65-75 MICRONS DFT / COAT	3 COATS OF F-12 @ 20 MICRON DFT/COAT	105-115	
14.2	INSULATED STAINLESS STEEL INCLUDING ALLOY-20 PIPING					
14.2.1	BELOW 0 TO ALL MINUS TEMP.	ALUMINUM SHEETING WITH ALUMINUN FOIL AND "CHLORIDE FREE MINERAL SEALTENT CONTAINING BARIUM CHROMATE" SHALL BE APPLIED				IF THE PIPING AND EQUIPMENT ARE ALREADY ERECTED, THEN SURFACE SHALL BE PREPARED BY CLEANING WITH EMERY PAPER AND WASH / FLUSH WITH CHLORIDE FREE DM WATER FOLLOWED BY WIPING WITH ORGANIC SOLVENT NO PRE-ERECTION PRIMER TO BE APPLIED.
14.2.2	0 TO 120	SSPC-SP-10 (15-25 MICRON SURFACE PROFILE)	NONE	2 COATS OF F-14 @ 125 MICRON DFT / COAT OR 3 COATS OF F-15 @ 80 MICRON DFT/COAT	250	
14.2.3	121 TO 500	SSPC-SP-10	NONE	3 COATS OF F-12 @ 20 MICRON DFT/COAT 3 X 20 = 60	60	
14.2.4	501 TO 1000	SSPC SP 10	NONE	1 COAT OF AMERCOAT 738 @ 150 MICRON DFT/COAT	150	
14.2.5	CYCLIC SERVICE -196 TO 480 (EXCEPT -45 TO 120)	SSPC-SP-10	NONE	1 COAT OF AMERCOAT 738 @ 150 MICRON DFT/COAT	150	ONLY AMERCOAT 738 FROM AMERON IS AVAILABLE FOR THIS TEMP. RANGE.
14.3	NO PAINTING IS REQUIRED FOR INSULATED MONEL, INCOLOY AND NICKEL LINES.					

TABLE 15.0: INTERNAL PROTECTION OF CARBON STEEL WATER BOXES AND TUBE SHEETS OF COOLERS / CONDENSERS, WATER BOXES, CHANNELS, PARTITION PLATES, END COVERS, AND TUBE SHEETS ETC.

S.NO.	DESIGN TEMP. IN ^0C	SURFACE PREPARATION	PAINT SYSTEM		TOTAL DFT IN MICRONS (MINIMUM)	REMARKS
			FILED PRIMER	FINISH PAINT		
15.1	UP TO 65	SSPC-SP-10	1 COAT OF P-6 @ 40 MICRON DFT/COAT	2 COATS OF F-7 @ 125 MICRON DFT/COAT 2 X 125 = 250	290	FOR CS
15.2	UP TO 65 NON-FERROUS AND BRASS TUBE SHEETS	SSPC-SP-3	1 COAT OF P-4 @ 8 MICRON DFT/COAT 1 COAT OF P-6 @ 40 MICRON DFT/COAT	2 COATS OF F-7 @ 125 MICRON DFT/COAT 2 X 125 = 250	30	FOR NON FERROUS SURFACES

TABLE 16.0: FIELD PAINTING SYSTEM FOR GI TOWERS / NON-FERROUS TUBE SHEET

S.NO.	DESIGN TEMP. IN ^0C	SURFACE PREPARATION	PAINT SYSTEM		TOTAL DFT IN MICRONS (MINIMUM)	REMARKS
			FILED PRIMER	FINISH PAINT		
16.1	UP TO 65	SSPC-SP-3	1 COAT OF P-4 @ 8 MICRON DFT/COAT + 1 COAT OF P-6 @ 40 MICRON DFT/COAT	2 COATS OF F-2 @ 40 MICRON DFT/COAT 2 X 40 = 80	130	SHADE AS PER DEFECNE REQUIREMENTS
16.2	UP TO 65 NON-FERROUS AND BRASS TUBE SHEETS	SSPC-SP-3	1 COAT OF P-4 @ 8 MICRON DFT/COAT + 1 COAT OF P-6 @ 40 MICRON DFT/COAT	2 COATS OF F-7 @ 125 MICRON DFT/COAT 2 X 125 = 250	300	

17.0 STORAGE:

17.1 All paints and painting materials shall be stored only in rooms to be arranged by contractor and approved by Engineer-in-charge for the purpose. All necessary precautions shall be taken to prevent fire. The storage building shall preferably be separate from adjacent building. A signboard bearing the words "PAINT STORAGE- NO NAKED LIGHT- HIGHLY INFLAMABLE" shall be clearly displayed outside.

18.0 COLOUR CODE FOR PIPING:

For identification of pipelines, the colour code as per Table 18.1 shall be used. Paint materials for color coding shall be as specified in this standard in clause-6.0.

18.1 Colour coding scheme for pipes, equipment, machinery & structures:

SR. NO.	DESCRIPTION	GROUND COLOUR	FIRST COLOUR BAND	SECOND COLOUR BAND
18.1.1	ALL KINDS OF WATER			
	DRINKING WATER	Sea Green	French Blue	Signal Red
	DE-MINERALISED WATER	-do-	Gulf Red	-
	COOLING WATER	-do-	French Blue	-
	BOILER FEED WATER	-do-	Gulf Red	-
	CONDENSATE	-do-	Light Brown	Signal Red
	QUENCH WATER	-do-	Dark Grey	-
	WASH WATER	-do-	Canary Yellow	-
	PROCESS WATER	-do-	Oxide Red	-
	FIRE WATER	Fire Red	Crimson Red	-
	SEA WATER	Sea Green	White	-
18.1.2	STEAM			
	VERY HIGH PRESSURE STEAM (VHP)	Aluminium to IS2339	Signal Red	-
	HIGH PRESSURE STEAM (SH)	-do-	French Blue	-
	MEDIUM PRESSURE STEAM (SM)	-do-	Gulf Red	-
	LOW PRESSURE STEAM (SL)	-do-	Canary Yellow	-
	DILUTION STEAM / PURGE STEAM	-do-	Grey	Canary Yellow
18.1.3	COMPRESSED AIR	Sky Blue	Signal Red	-
	PLANT AIR	-do-	Silver Grey	-
	INSTRUMENT AIR	-do-	French Blue	-
	NITROGEN	Canary Yellow	Black	-
	OXYGEN	-do-	White	-
	CO_2	-do-	Light Grey	-

SR. NO.	DESCRIPTION	GROUND COLOUR	FIRST COLOUR BAND	SECOND COLOUR BAND
18.1.4	GASES			
	FUEL GAS AND SOUR GAS	Canary Yellow	Grey	Dark Violet
	CHARGE GAS	-do-	Signal Red	French Blue
	RESIDUE GAS, LPG	-do-	Oxide Red	White
	ACETYLENE	-do-	Service Brown	-
	SWEET GAS	-do-	Grey	-
18.1.5	ACIDS AND CHEMICALS			
	SULFURIC ACID	Dark Violet	Brilliant Green	Light Orange
	NITRIC ACID	-do-	French Blue	-do-
	HYDROCHLORIC ACID	-do-	Signal Red	-do-
	ACETIC ACID	-do-	Silver Grey	-do-
	CAUSTIC	Smoke grey	Light orange	-
	CHLORINE	Canary Yellow	Dark violet	-do-
18.1.6	HYDRO CARBONS			
	NAPTHAS	Dark Admiralty Grey	Brilliant Green	Black
	PROPYLENE	-do-	-do-	Smoke Grey
	PROPYLENE C.G.(LIQ)	-do-	-do-	Gulf Red
	ETHYLENE GLYCOL	-do-	-Do-	-
	ETHYLENE DICHLORIDE	-do-	Gulf Red	-
	BENZENE	-do-	Canary Yellow	-
	BUTADIENE	-do-	Black	
	ETHANE(LIQ)	Dark Admiralty Grey	Light Grey	French Blue
	PROPYLENE(LIQ)	-do-	Signal Red	Black
	ETHYLENE(LIQ)	-do-	Light Grey	Black
	TAR	-do-	Signal Red	Brilliant Green
	AROMATIC GASOLINE	-do-	Brilliant Green	Canary Yellow
	METHANOL(LIQ)	-do-	White	Gulf Red
	PYROLYSIS GASOLINE	-do-	Brilliant Green	Black
	MIXED C4(LIQ)	-do-	Signal Red	Light Brown
	LPG(LIQ)	-do-	Brilliant Green	Dark Violet
	KEROSENE	Light Brown	-do-	-
	DIESEL OIL(WHITE)	-do-	-do-	-
	DIESEL OIL(BLACK)	-do-	-	

18.2 The colour code scheme is intended for identification of the individual group of the pipeline. The system of colour coding consists of a ground colour and colour bands superimposed on it.

18.3 Ground Colours as given in Table-18.1 shall be applied throughout the entire length for un insulated pipes, on the metal cladding & on surfaces covered by Clause 2.2.2, ground colour coating of minimum 2m length or of adequate length not to be mistaken as colour band shall be applied at places requiring colour bands. Colour band(s) shall be applied at the following location.

a. At battery limit points

b. Intersection points & change of direction points in piping ways.

c. Other points, such as midway of each piping way, near valves, junction joints of service appliances, walls, on either side of pipe culverts.

d. For long stretch / yard piping at 50M interval.

e. At start and terminating points.

18.4 Identification Sign

18.4.1 Flow direction shall be indicated by an arrow in the location stated in Para a, b ,c & d and as directed by Engineer-in-Charge.

18.4.2 Colours of arrows shall be black or white and in contrast to the colour on which they are superimposed.

18.4.3 Product names shall be marked at pump inlet, outlet and battery limit in a suitable size as approved by Engineer-in-Charge.

18.4.4 Size of arrow shall be either of those given in 18.5.

18.5 Colour Bands

18.5.1 As a rule, minimum width of colour band shall conform to the following table.

Nominal Pipe Size	Width: L(mm)
3" NB and below	25mm
above 3" NB upto 6" NB	50mm
above 8" NB upto 12" OD	75mm
above 12" OD	100mm

Note: For insulated pipes, nominal pipe size means the outside diameter of the insulation.

Nominal pipe size figures are to be in inches.

18.5.2 Colour band(s) shall be arranged in the sequence shown in Table 18.1 and the sequence follows the direction of flow. The relative proportional width of the first colour band to the subsequent bands shall be 4: 1, minimum width of any band shall be as per Clause 18.5.1.

18.6 Whenever it is required by the Engineer-in-Charge to indicate that a pipeline carries a hazardous material, a hazard marking of diagonal strips of black and golden yellow as per IS:2379 shall be painted on the ground colour.

19.0 IDENTIFICATION OF VESSELS, PIPING ETC.:

19.1 Equipment number shall be stenciled in black or white on each vessel, column, equipment & machinery (insulated or un insulated) after painting. Line number in black or white shall be stenciled on all the pipe lines of more than one location as directed by Engineer-in-Charge, Size of letters printed shall be as below:

Column & Vessels	-	150 mm (high)
Pump, compressor and other machinery	-	50 mm (high)
Piping	-	40 - 150 mm

19.2 Identification of storage tanks:

The storage tanks shall be marked as detailed in the drawing.

20.0 PAINTING FOR CIVIL DEFENCE REQUIREMENTS:

21.1 Following items shall be painted for camouflaging if required by the client. a.

All columns
b. All tanks in offsites. c.
Large Vessels
d. Spheres

20.2 Two coats of selected finishing paint as per defense requirement shall be applied in a particular pattern as per 20.3 and as per the instructions of Engineer-in-Charge.

20.3 Method of camouflaging

20.3.1 Disruptive painting for camouflaging shall be done in three Colours in the ratio of 5:3:2 (Dark Green : Light Green : Medium Brown) (all matt finish).

20.3.2 The patches should be asymmetrical and irregular.
20.3.3 The patches should be inclined at 30 Degree to 60 Degree to the horizontal.

20.3.4 The patches should be continuous where two surfaces meet at an angle.

20.3.5 The patches should not coincide with corners.

20.3.6 Slits and holes shall be painted in dark shades.

20.3.7 Width of patches should be 1 to 2 meters.

21.0 INSPECTION AND TESTING

21.1 All painting materials including primers and thinners brought to site by contractor

for application shall be procured directly from manufactures as per specifications and shall be accompanied by manufacturer's test certificates. Paint formulations without certificates are not acceptable.

21.2 Engineer-in-Charge at his discretion may call for tests for paint formulations. Contractor shall arrange to have such tests performed including batch wise test of wet paints for physical & chemical analysis. All costs there shall be borne by the contractor.

21.3 The painting work shall be subject to inspection by Engineer-in-Charge at all times. In particular, following stage wise inspection will be performed and contractor shall offer the work for inspection and approval of every stage before proceeding with the next stage. The record of inspection shall be maintained in the registers. Stages of inspection are as follows:

a. Surface preparation b.

Primer application

c. Each coat of paint

In addition to above, record should include type of shop primer already applied on equipment e. g. Red oxide zinc chromate or zinc chromate or Red lead primer etc.

Any defect noticed during the various stages of inspection shall be rectified by the contractor to the entire satisfaction of Engineer-in-Charge before proceeding further. Irrespective of the inspection, repair and approval at intermediate stages of work, contractor shall be responsible for making good any defects found during final inspection / guarantee period / defect liability period as defined in general condition of contract. Dry film thickness (DFT) shall be checked and recorded after application of each coat and extra coat of paint should be applied to make-up the DFT specified without any extra cost to owner, the extra cost should have prior approval of Engineer-In-Charge .

21.4 Primer Application

After surface preparation, the primer should be applied to cover the crevices, corners, sharp edges etc. in the presence of inspector nominated by Engineer-in-Charge.

21.5 The shades of successive coats should be slightly different in colour in order to ensure application of individual coats, the thickness of each coat and complete coverage should be checked as per provision of this specification. This should be approved by Engineer-in-Charge before application of successive coats.

21.6 The contractor shall provide standard thickness measurement instrument with appropriate range(s) for measuring Dry film thickness of each coat, surface profile page for checking of surface profile in case of blast cleaning, Holiday detectors and pinhole detector and positector whenever required for checking in case of immersion conditions.

21.7 Prior to application of paints on surfaces of chimneys, the thickness of the individual coat shall be checked by application of each coat of same paint on M.S. test panel. The thickness of paint on test panel shall be determined by using gauge such as 'Elkometer'. The thickness of each coat shall be checked as per provision of this specification. This shall be approved by Engineer-in-Charge before application of paints on surface of chimney.

21.8 At the discretion of Engineer-in-Charge, the paint manufacturer must provide the expert technical service at site as and when required. This service should be free of cost and without any obligation to the owner, as it would be in the interest of the manufacturer to ensure that both surface preparation and application are carried out as per their recommendations.

21.9 Final inspection shall include measurement of paint dry film thickness, Adhesion, Holiday detection check of finish and workmanship. The thickness should be measured at as many points/locations as decided by Engineer-in-Charge and shall be within + 10% of the dry film thickness, specified in the specifications.

21.10 The contractor shall arrange for spot checking of paint materials for Sp. gr., flow time(ford cup) and spreading rate.

22.0 GUARANTEE

22.1 The contractor shall guarantee that the chemical and physical properties of paint materials used are in accordance with the specifications contained herein / to be provided during execution of work.

22.2 The contractor shall produce test reports from manufacturer regarding the quality of the particular batch of paint supplied. The Engineer-in-Charge shall have the right to test wet samples of paint at random, for quality of same, as stipulated in Clause 11 above. Batch test reports of the manufacturer's for each batch of paints supplied shall be made available by the contractor.

23.0 QUALIFCATION CRITERIA OF PAINTING CONTRACTOR:

Painting contractor who is awarded any job for GAIL, Projects under this standard must have necessary equipments, machinery, tools and tackles for surface preparation, paint application and inspection. The contractor must have qualified, trained and experienced surface preparator , paint applicator, inspector and supervisors. The contractor supervisor, inspector, surface preparator and paint applicator must be conversant with the standards referred in this specification. The contractors capacity, capability and competency requirements for the job shall be quantified in the tender document and shall be assessed by GAIL team before awarding any job.

24.0 PROCEDURE FOR APPROVAL OF NEW COATING MATERIALS AND MANUFACTURERS

Following procedure is recommended to be followed for approval of new manufacturers.

24.1 The manufacturer should arrange testing of the inorganic zinc silicate coating materials as per the list of tests given in para 24.5 below from one of the reputed Government laboratories.

24.2 Samples of coating materials should be submitted to the Govt. laboratory in sealed containers with batch no. and test certificate on regular format of manufacturer's testing laboratory. The sampling shall be certified and sealed by a certifying agency.

24.3 All test panels should be prepared by Govt. testing agency coloured photographs of test panels should be taken before and after the test and should be enclosed along with test report.

Sample batch no. and manufacturer's test certificate should be enclosed along with the report. Test report must contain details of observation and rusting if any, as per the testing code. Suggested Government laboratories are:

- RRL ,Hyderabad
- HBTI, Kanpur
- DMSRDE, Kanpur
- IIT, Mumbai
- BIS Laboratories.
- UDCT, Mumbai

RITES, Calcutta

PDIL

24.4 Manufacturers should intimate the Company, details of sample submitted for testing, name of Govt . testing agency, date, contact personnel of the Govt. testing agency. At the end of the test the manufacturer should submit the test reports to the company for approval. The manufacturer(s) shall be qualified based on the results of these tests and other assessment and the Company's decision in this regard shall be final and binding on the manufacturer.

24.5 Test required for evaluation of acceptance of coating materials for offshore application.

TEST	**ASTM TEST METHOD**

DENSITY	-	D 1475
DIPPING PROPERIES	-	D 823
FILM CHARACTERSTICS		
DRYING TIME	-	D 1640
FLEXIBILITY	-	D 1737 / D 522
HARDNESS	-	D 3363
ADHESION	-	D 2197
ABRASION RESISTANCE	-	D 968 / D 1044
DFT / COAT	-	AS PER SSPC GUIDELINES
STORAGE STABILITY	-	D 1849
RESISTANCE TO		
HUMIDITY FOR 2000 HRS.	-	D 2247
SALT SPRAY FOR 2000 HRS		B 117
ACCELERATED WEATHERING		D 822
%Zn IN DFT	-	G 53

24.6 Coating system for panel test shall be decided after discussion with GAIL.

ANNEXURE-I

LIST OF RECOMMENDED MANUFACTURERS

INDIAN VENDORS

1. Asian paints(1) Ltd.
2. Berger Paints Ltd.
3. Goodlass Nerolac paints Ltd.
4. Jenson and Nicholson paints Ltd. & ChokuGu Jenson & Nicholson Ltd.
5. Shalimar paints Ltd.
6. Sigma coatings, Mumbai
7. CDC Carboline Ltd.
8. Premier products Ltd.
9. Coromandel paints & chemicals Ltd.
10. Anupam enterprises
11. Grand polycoats
12. Bombay paints Ltd.
13. Vanaprabha Esters & Glycer , Mumbai
14. Sunil paints and Varnishes Pvt. Ltd.
15. Courtaulds coatings & Sealants India(Pvt.) Ltd.
16. Mark-Chem Incorporated, Mumbai (for phosphating chemicals only)
17. VCM Polyurethane Paints (for polyurethane paints only)

FOREIGN VENDORS FOR OVERSEAS PRODUCTS

1. Sigma coatings, Singapore
2. Ameron, USA.
3. Kansai paint, Japan
4. Hempel paints, USA.
5. Valspar Corporation, USA
6. Courtaulds coatings, UK.

Note : This list is subjected to revision based on fresh approval.

LIST OF RECOMMENDED MANUFACTURER'S PRODUCTS

SL.NO	MANUFACTURERS NAME	P2 CHLORINATED RUBBER ZP PRIMER	P4 ETCH PRIMER/WASH PRIMER	P6 EPOXY ZINC PH. PRIMER	F-9 INORGANIC ZINC SILICATE PRIMER/COATING
1.	ASIAN PAINTS (I) LTD	ASIOCHLOR HB.ZN.PH. PRIMER RO PC168	APCOVYL WP636 (PC 335)	APCODUR HB.RO.ZP-PC433	APCOCIL 605
2.	BERGER PAINTS LTD	LINOSOL HIGH BUILD ZP PRIMER	BISON WASH PRIMER	EPILUX 610	ZINC ANODE 304
3.	AMERON/GOODLASS NEROLAC PAINTS LTD.	-	AMERCOAT 187	AMERCOAT 71	DIMETCOTE-9
4.	JENSON & NICHOLSON PAINTS LTD. AND CHOKUGU JENSON-NICHOLSON	JENSOLAC CHLORINATED RUBBER HB ZN.PH. PRIMER	J&N ETCH PRIMER	EPILAC ZINC PHOSPHATE PRIMER.	-
5.	SHALIMAR PAINTS LTD	CHLOROKOTE ZINC PHOSPHATE PRIMER GREY	TUFFKOTE ETCH PRIMER	EPIGUARD 4 ZINC PHOSPHATE PRIMER GREY	TUFFKOTE ZILICATE TL
6.	SIGMA COATINGS,	SIGMA NUCOL UNICOAT 7321	SIGMACOVER PRIMER (7413)	COLTURIET CM PRIMER 7412	SIGMASIL MC (7568)
7.	CDC CARBOLINE LTD.	-	-	CARBOLINE 893	CARBOZINC 11
8.	PREMIER PRODUCTS LTD.	-	-	P-15/3A U-16/92	U17/92 ETHYL SILICATE INORGANIC ZINC
9.	CORAMANDEL PAINTS & CHEMICALS LTD.	COROCLORE CR HB. ZN. PH. PRIMER	CPC WASH PRIMER	COROPEX EPOXY ZN. PH. HIGH BILD PRIMER	-
10.	ANUPAM ENTERPRISES	ANUCHLOR ZP PRIMER	ANUPRIME-291	ANUPAM ANLICOR A-EZP-500	-

SL.NO.	MANUFACTURERS NAME	P2	P4	P6	F9
11.	GRAND POLYCOATS	GP CHLOROPRIME 601	GP PRIME 401	-	-
12.	BOMBAY PAINTS LTD./ HEMPEL MARINE PAINTS	HEMPA TEX HIGHBUILD 4633	PENTOLITE WASH PRIMER 8520	HEMPEL'S SHOP PRIMER E1530	GALVASOL 1570
13.	VANAPRABHA ESTERS & GLYCERIDES,	VEGCHLOR HB PRIMER 1143	VEG WASH PRIMER 1181	VEGEPOX 1241 Z/P	-
14.	SUNIL PAINTS AND VARNISHES PVT. LTD.	SUNCHLOR HB ZINC PHOSPHATE PRIMER	SUN WASH	SUNPOXY ZINC PHOSPHATE PRIMER	-
15.	COURTAULDS COATINGS LTD	-	-	INTERGARD 251	INTERZINC
16	MARK-CHEM INCORPORATED, (FOR PHOSPHATING CHEMICALS ONLY)	RUST PREVENTIVE LIQUID DRSAIO			
17.	VCM POLYURETHANE PAINTS(FOR POLY EURETHANE PAINTS ONLY)				
18	JOTUN PAINTS			EPOXY CQ SPECIAL ZINC PHOSPHATE PRIMER	JOTACOTE-2
19	KCC PRODUCTS (KOREA)				EZ 180(N)

SL.NO	MANUFACTURERS NAME	F2 ACRYLIC-POLYURETHANE FINISH PAINT	F3 CHLORINATED RUBBER FINISH PAINT	F-6 HIGH BUILD EPOXY FINISH PAINT	F-7 HIGH BUILD COAL TAR EPOXY COATING
1.	ASIAN PAINTS (I) LTD	APCOTHANE CF676 (PC 1109)	ASIOCHLOR CF 621 (PC 161)	APCODUR HB COATING 9466	APCODUR CF 300
2.	BERGER PAINTS LTD	BERGER TIIANE ENAMEL(81)	LINDSOL CHLORINATED RUBBER HB COATING	EPILUX 04 AND 73 HB EPOXY COATING	EPILUX 555
3.	AMERON/GOODLASS NEROLAC PAINTS LTD.	AMERCOAT 450GL	AMERCOAT 515	AMERCOAT 383 HS	AMERCOAT 78HB
4.	JENSON & NICHOLSON PAINTS LTD. AND CHOKUGU JENSON-NICHOLSON	J&N 993 HB POLYURETHANE FINISH PAINT.	JENSOLAC HB CHLORINATED RUBBER FINISH PAINT	EPILAC 981 ENAMEL	EPILAC SOLVENTLESS COAL TAR EPOXY COATING
5.	SHALIMAR PAINTS LTD	SHALITHANE FINISH	CHLORKOTE FINISH	EPIGARD XL FINISH	BIPIGARD S BLACK HB COAL TAR EPOXY COATING
6.	SIGMA COATINGS	SIGMADOUR HS SEMIGLOSS 7530	SIGMA NUCOL FINISH 7308	SIGMA COVER CM7456	COLTURIET TCN 300
7.	CDC CARBOLINE LTD.	CARBOLINE 132		CARBOLINE 191	CARBOMASTIC-14
8.	PREMIER PRODUCTS LTD.	U3/92 POLYURETHANE	CR-71, CR FINISH PAINT	42B/4A HIGH BUILD EPOXY	350B/3A, COAL TAR EPOXY COATING
9.	COROMANDEL PAINTS & CHEMICALS LTD.	-	COROCLORE CR FINISHING	COROPEX EPOXY HB COATING	COROPEX EPOXY COAL TAR COATING
10.	ANUPAM ENTERPRISES	ANUTHANE ENAMEL	ANUCHLOR HB ENAMEL	DURACCAT-6000	COROGUARD
11.	GRAND POLYCOATS	GP COAT 131, 132, GP BOND 141	GP CHLOROGAURD 631	GP GAURD HP234	POLYGUARD CE

SL.NO.	MANUFACTURERS NAME	F2	F3	F6	F7
12.	BOMBAY PAINTS LTD./ HEMPEL MARINE PAINTS	PENTATHANE FP 4510	HEMPATEX HIBUILD 4633	HEMPADUR HIGH BUILD 5520	HEMPADUR 1510
13.	VANAPRABHA ESTERS & GLYCERIDES,	VEGTHANE FP 3641	VEGCHLOR FP 3140	VEGEPOX 3235 VEGEPOX 3552	VEGEPOX 4285
14.	SUNIL PAINTS AND VARNISHES PVT. LTD.	SUNTHANE (ALIPHATIC)	SUNCHLOR HB CR COATING	LPOXY HB PS 901	LPOXY BLACK P.S.551
15.	COURTAULDS COATINGS LTD	INTERTHANE		INTEGARD EM SERIES	INTERTUFJXA 006 /007/010
16	MARK-CHEM INCORPORATED, (FOR P-HOSPHATING CHEMICALS ONLY)				
17.	VCM POLYURETHANE PAINTS(FOR POLY URETHANE PAINTS ONLY)	PPCOTHANE ALIPHATIC POLYURETHANE FINISH PAINT			
18	JOTUN PAINTS	HARDTOP AS		PENGUARD HB	JOTAGUARD 85
19	KCC PRODCUTS KOREA			KOEPOX TOPCOAT HB FT 5740	EH 173

SL.NO	MANUFACTURER'S NAME	F8 EPOXY MASTIC COATING SURFACE TOLERANT	F-11 HEAT RESISTANT SYNTHETIC MEDIUM ALUMINIUM PAINT	F-12 HEAT RESISTANT SILICONE AL. PAINT.
1.	ASIAN PAINTS (I) LTD	APCODOR CF 640	ASIAN HR ALUMINIUM PAINT (PC 300)	HR SILICONE ALUMINIUM PAINT (PC 189)
2.	BERGER PAINTS LTD	PROTECTOMASTIC	FERROTOL HR ALUMINIUM PAINT	BERGER HEAT RESISTANT SILICONE ALUMINIUM PAINT
3.	AMERON/GOODLASS NEROLAC PAINTS LTD.	AMERLOCK 400		AMERCOAT 878
4.	JENSON & NICHOLSON PAINTS LTD. AND CHOKUGU JENSON-NICHOLSON	-	FERROTECT SYNTHETIC RUBBER H/R ALUMINIUM PAINT-4000	FERROTECT SILICONE HEAT RESISTING PAINT-1000
5.	SHALIMAR PAINTS LTD	EPIPLUS 50	HEAT RESISTING LUSTROL ALUMINIUM	LUSTOTHERM HIGH TEMP ALUMINIUM PAINT
6.	SIGMA COATINGS	SIGMA EPTCP ALUMINIUM	HIGH TEMPERATURE RESISTANT EPOXY SYSTEM UPTO 200° C 4062	AROSTA FINISH HR
7.	CDC CARBOLINE LTD.	CARBOMASTIC-15	CARBOLINE 1248	CARBOLINE 4674
8.	PREMIER PRODUCTS LTD.	HB EPOXY MASTIC 150B/150A		
9.	CORAMANDEL PAINTS & CHEMICALS LTD.	-	SILVOTOL HR ALUMINIUM PAINT	CPC SILICONE HR ALUMINIUM PAINT
10.	ANUPAM ENTERPRISES	ANUMASTIC - 102	-	ANUPAM HEAT GUARD

SL.NO.	MANUFACTURERS NAME	F-8	F-11	F-12
11.	GRAND POLYCOATS	GP PRIME GUARD 235	-	-
12.	BOMBAY PAINTS LTD./HEMPEL MARINE PAINTS	HEMPADUR 1708	KANGAROO HHR ALUMINIUM 4950	PENTOLITE HRR ALUMINIUM 4951
13.	VANAPRABHA ESTERS & GLYCERIDES,	VEGEPOX MASTIC 2255	VEG HR AL PAINT TO IS21339	VEG HHR AL PAINT TO 600°C
14.	SUNIL PAINTS AND VARNISHES PVT. LTD.	LPOXY HIGHBUILD P.S.901		
15.	COURTAULDS COATINGS LTD	INTERPLUX 56		INTERTHERM 50
16	MARK-CHEM INCORPORATED, (FOR PHOSPHATING CHEMICALS ONLY)			
17.	VCM POLYURETHANE PAINTS(FOR POLY URETHANE PAINTS ONLY)			
18	JOTUN PAINTS	JOTUMATIC 87		SOLVELITT HEAT RESISTANT SILICONE PAINT
19	KCC PRODUCTS KOREA	EH 4158H		QT 606

NOTE: THIS LIST IS SUBJECT TO REVISION BASED ON FRESH APPROVAL / REAPPROVAL / DELETION.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR POSITIVE MATERIAL IDENTIFICATION (PMI) AT VENDOR'S WORKS

GAIL-STD-ME-DOC-TS-025

0	22.03.19	Issued For Tender	RKS	AP	JR	
Rev	**Date**	**Purpose**	**Prepared By**	**Checked By**	**Approved By**	

1.0 SCOPE

This specification applies to the requirements for Positive Material Identification (PMI) to be performed at the vendors' works on Metallic Alloys Materials procured either directly by the GAIL/Owner/Contractor or indirectly through the sub-vendors.

1.2 Any post order deviation from this specification must be approved by Owner/ GAIL in the Deviation/ Waiver Permit Format enclosed with Material Requisition.

1.3 This specification covers the procedures and methodology to be adopted to assure that the chemical composition of the alloy material is consistent with the material specifications as specified in purchase documents using "Alloy Analyzer" at the time of final inspection before dispatch.

1.4 The scope of this specification shall include but shall not be limited to Positive Material Identification (PMI) to be performed on Alloy Materials listed below:

- Alloy Steel Pipes including Pipes
- Alloy Steel Flanges & Forgings
- Alloy Steel Fittings including Clad Fittings
- Alloy Steel fasteners
- Alloy Cast & Forged steel valves
- Alloy Steel Instrumentation Items (Control Valves, Safety Valves etc.)
- Longitudinal Pipe & Fittings Welds.
- Gaskets (for Ring Type Joints)

Following Items shall be excluded from scope of PMI examination:

- Gasket other than for Ring Type Joints
- Internal Components of Valves

1.5 All grades of material supplies including Stainless Steels shall be liable for PMI test at site. In case of any defective materials being found at site, the vendor shall be responsible to effect replacement of such defective materials at project site without any delays to the satisfaction of GAIL.

2.0 REFERENCE DOCUMENTS

2.1 API Recommended Practice 578 (First Edition, May 1999) – Material Verification Programme for new and Existing Alloy Piping System.

3.0 DEFINITIONS

3.1 **Vendor:** Any Supplier or Manufacturer on whom an order is placed for the supply of referred items. This definition shall also include any sub-vendor or manufacturer on whom a sub- order is placed by the vendor.

3.2 **Inspection Lot:** A group of items offered for inspection covered under same size, Heat and Heat treatment lot.

3.3 **Alloy Material:** Any metallic material (including welding filler material) that contains alloying elements such as chromium, nickel, molybdenum or vanadium, which are intentionally added to enhance mechanical or physical properties and/ or corrosion resistance.

4.0 PMI EXAMINATION

4.1 The vendor shall submit a procedure of PMI to comply with the requirements of this Specification Approval of PMI Procedure shall be obtained from Owner/ GAIL/ TPI prior to commencing manufacture/ inspection of product.

4.2 PMI examination of alloy materials is independent of any certification, markings or colour coding that may exist and is aimed at verifying that the alloy used are as per specified grades.

4.3 The Vendor shall identify all incoming alloy materials and maintain full traceability of all alloy materials, including all off-cuts. Transfer of identification marks shall be undertaken prior to cutting to ensure maintenance of identification on off-cuts.

4.4 The Vendor shall ensure that all alloy materials are segregated and stored in separately identified locations to prevent the mix up of materials of different alloy specifications or alloy material with carbon steel. Non ferro-magnetic materials shall be segregated at all times from ferro-magnetic materials.

4.5 PMI examination is subject to surveillance inspection by Owner/ GAIL/ TPI.

5.0 ACCEPTABLE METHODS FOR PMI

5.1 The method used for PMI examination shall provide a quantitative determination of the alloying elements like Cr, Mo, Ni, V in Alloy Steel items.

5.2 Instrument or methods used for PMI examination shall be able to provide quantitative, recordable, elemental composition results for positive identification of alloying elements present.

5.3 The acceptable instruments for alloy analyzer shall be either "Portable X-Ray Fluorescence" or Optical Emission" type each capable of verifying the percentage of alloy elements within specified range.

5.4 Chemical spot testing, magnets, alloy sorters and other methods using eddy current or triboelectric testing methods are not acceptable for PMI examination.

5.5 The PMI instruments shall have the sensitivity to detect the alloying elements in the specified range.

5.6 All PMI instruments shall have been serviced within a 6 month period of the time of use to verify the suitability of batteries, sources etc, the data of the last service shall be stated on the PMI Report Form (Sample enclosed).

5.7 Each analyzer must be calibrated according to the manufacturer's specification at the beginning and end of each shift. Instrument must be checked against known standard for each alloy type to be inspected during the shift.

5.8 Certified samples, with full traceability, of a known alloy materials shall be available for use as a random spot check on the instrument calibration.

5.9 The surfaces to be examined shall be prepared by light grinding or abrasive paper and solvent cleaner. Evidence of Arc burn resulting from examination shall be removed by light grinding or abrasive paper.

5.10 Alloy Steel ring type joint gaskets shall be inspected by using portable X-Ray Flourescence instrument.

5.11 Testing shall be done as per the procedures outlined by the manufacturers of alloy analyzer being used. Modification of these procedures if any, must be approved by Owner/ GAIL.

5.12 The persons performing PMI shall demonstrate their capabilities to the satisfaction of Owner/ GAIL visiting engineer. If the vendor has qualified operator on their rolls, he may perform the examination. Otherwise PMI examination shall be sub-contracted to an independent testing agency approved by GAIL.

5.13 Whenever material is identified as not meeting requirements by the visiting engineer a rejection note shall be issued.

6.0 EXTENT OF PMI EXAMINATION

6.1 Following sampling plan shall be applicable for PMI examination of various alloy items:

A. Flanges, Fittings, Valves, RTJ Gaskets _ 100%

B. Pipes _ 100% (for pipes procured from traders)

- 2 random samples drawn from each size/ Heat/ Lot (for pipes procured directly from Mills)

C. Fasteners

Lot Size	**Sample Size**
Upto 100	2% (Min2)
101 to 500	1% (Min 3)
501 and above	0.5% (Min5)

Note:

a. For Welded Pipes and Fittings, PMI shall be performed on base metal as well as weldments.

b Whenever any sample drawn to PMI test on the basis of percentage selection in B & C above, fails to meet specification requirements, 100% of items of lot shall be tested for PMI

7.0 RECORDING AND DOCUMENTATION

The results of PMI examination shall be recorded in a Report Format as enclosed with this specification.

8.0 MARKING

8.1 All alloy materials tested by PMI shall be identified using either of the following methods by indicating "PMI OK"

8.2 **a)** Bar Code/ Hologram Sticker

b) A low stress stamp marking

POSITIVE MATERIAL IDENTIFICATION REPORT BULK MATERIAL					Page of
Project:	**Client**			**Job No**	
PMI Report No.	**Vendor/ sub- Vendor**				
Purchase Order No:	**Testing Agency**				
Purchase Requisition No:	**PMI Location**				
Bulk Item Type (as per requisition)					
Material Specification/ Grade **Number of Items in Lot**					
Requisition Item No./ Description	**Alloy content, Weight (%)**				**Remarks** **Accept/ Reject**
Element	**Cr**	**Mo**	**Ni**	**V**	**t**
Specified range					
Actual Observations **1.**					
2.					
3.					
4					
5					
6					
7					
8					
Instrument Type/ ID **Last Service date**	**Inspection Agency**				**Witnessed by**

ENGINEERING STANDARD

GAIL INDIA LIMITED

STANDARD SPECIFICATION FOR FILTER SEPARATOR

GAIL-STD-ME-DOC-TS-026

0	22.03.19	Issued For Tender	RKS	AP	JR	
Rev	**Date**	**Purpose**	**Prepared By**	**Checked By**	**Approved By**	

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1.0 **GENERAL**

1.1 This specification outlines the minimum requirements under which the manufacturer shall design, manufacture, test, supply and erect Filter Separators for separating solid & liquid contaminants from the gas stream.

1.2 **Order of Precedence**

The following order of precedence shall govern in interpretation of various requirement and data:

- Data sheets
- This specification
- Codes & standards
- Vendor's standards

2.0 **SCOPE OF SUPPLY**

2.1 The vendor's scope of supply shall comprise of filters complete in all respects as per the detailed scope of supply indicated below as a minimum:

The filters shall comprise of the following:

(i) Filter Separator along with necessary filtering elements and sump.
(ii) Necessary nozzles, companion flanges, blind flanges (with nuts, bolts, gaskets etc.) on the filter separator as specified in the data sheets.
(iii) Filter element, supporting arrangement inside the vessel.
(iv) All internals, e.g. vane packing, filter elements.
(v) Quick opening closure for maintenance and filter element replacement.
(vi) Name plate with bracket
(vii) Necessary supports for filter separator as per attached Technical Specification (T.S.)
(viii) Cleats for platforms and ladders.
(ix) Lifting lugs/ erection lugs.
(x) GA drawing for approval shall be submitted within one month from FOI
(xi) Foundation bolts.
(xii) Documents as called in "Vendor Data Requirement Sheet". (xiii) Spare parts for two years normal operation.

3.0 SCOPE OF SERVICES

(i) Engineering, design and manufacturing.
(ii) Procurement of raw materials, etc., from sub-vendors.
(iii) Preparation and submission of documentation & GA Drawings for design approval by Purchaser / consultant.
(iv) Quality Assurance Plan (QAP)
(v) Inspection and testing as per Technical Specification
(vi) Surface preparation, protective coating and painting as per Technical Specification
(vii) Packaging for transportation to site and supply.
(viii) Erection and testing.

4.0 DESIGN

4.1 Complete design of equipment as per the latest code shall be the responsibility of the supplier. Strict compliance with the requirements of code / equipment specification, this specification and any other referred document shall be fully ensured.

Following codes & standards (latest edition) shall be followed for design, manufacture, testing etc. of the equipment:

(i)	ASME Sec-VIII Div-1	:	Boiler and Pressure Vessel Code
(ii)	ASME Sec-IX	:	Welding and Brazing Qualifications
(iii)	ASME Sec-II & ASTM	:	Material Specifications
(iv)	ANSI B16.5	:	Pipe Flanges & Pipe Fittings
(v)	ANSI B16.1	:	Forged Steel Fittings Socket Welded & Threaded
(vi)	ANSI B16.47	:	Large Diameter Steel Flanges
(vii)	ANSI B36.10	:	Welding & Seamless Wrought Steel Pipe

4.2 For purpose of material selection, national code of the country of origin shall also be acceptable provided the vendor specifically establishes, to the satisfaction of the purchaser, the equivalence or superiority of the proposed material with respect to those specified.

5.0 TECHNICAL REQUIREMENTS

5.1 Acceptance Criteria :

5.1.1 The vendor or his collaborators (for process/ equipment design) should have supplied at least 10 filter separators, of which at least 4 must have successfully completed at least 16000 hours (approx. 2 years) of continuous service for similar capacity, performance and design conditions.

Vendor shall submit along with his bid proposal, Vendor's / Collaborator's Reference List for Filter Separators, giving the following minimum information :

(i) Name & address of the Client
(ii) Equipment Type/ Model No.
(iii) Operating Data (Fluid/ Contaminant, Flow Rate, Design Temperature & Pressure)
(iv) Performance Data
(v) Year of Commissioning

5.1.2 In case the vendor has collaborative / back-up arrangement with a foreign manufacturer of repute, the vendor shall clearly indicate in his offer the extent of back-up assistance provided by the collaborators for the vendor's scope of work.

5.2 The equipment shall be of the type as mentioned in the data sheets and shall meet the duty requirements and performance parameters as mentioned therein.

5.3 The material of construction of various parts of the equipment shall be as mentioned in the data sheets.

5.4 The vessel shall conform to Purchaser’s Standard Specification.

5.5 In case of the vendor's fabrication shop is not Purchaser / Consultant’s approved for the thickness of vessel involved, the vendor shall either (i) get the vessel fabricated by an outside Purchaser approved vendor or (ii) get the vessel rolled by one of the Purchaser’s / Consultant’s approved vendor and get the fabrication done at his own shop, subject to welding procedure qualification by Purchaser.

5.6 Suitable baffle plates shall be provided in the vessels for proper fluid flow distribution.

5.7 Corrosion allowance of 1.5mm shall be considered for all carbon steel parts, unless otherwise mentioned in the data sheets.

5.8 Dished ends shall be of seamless construction, torispherical type 2:1 ellipsoidal type and shall be heat treated after forming as per ASME Sec. VIII Div.1.

5.9 All nozzles less than or equal to 2" NB size shall be provided with 2 Nos. 6mm thick stiffeners at 90 degree to each other.

5.10 All nozzles above 3" NB size shall be provided with reinforcement pads. Calculations for reinforcement pads as per ASME shall be submitted for purchaser's approval. Alternatively, Purchaser's standard shall be followed.

5.11 All flanges upto 150# rating shall be of weld neck type (for size upto 100 NB). All flanges above 150# rating shall be weld neck type only irrespective of the nozzle size.

5.12 Quick opening closure for vessels, if specified in the data sheet, shall be of **PEERLESS/ GRINELL/ PECO/ SIIRTEC/ HUBER YALE/ GD ENGG/ TUBE TURN (U.S.A.)** make only conforming to ASME requirements. The closure shall be equipped with locking device which can be opened only when the vessel is completely depressurised. Alternatively, swing bolts with pin arrangement shall be provided for the closure, if specified in the data sheet. The swing bolts shall be of one piece construction without welding. Hinge pins shall be forged and of the same material as the swing bolts.

A davit/ hinged arrangement shall be provided for the closure for convenient handling. The closure shall have perfect sealing arrangement to prevent leakage.

5.13 The filtering elements shall be able to withstand without damage the pressure differential created by choked conditions. The maximum allowable differential pressure (bursting pressure) shall be indicated in the bid proposal.

5.14 The material of the filtering elements shall be chosen by the vendor based on his past experience with similar service to suit the duty requirements. Bidder shall submit a list of past installations of the offered filtering element for similar service.

5.15 The filtering/ pack element shall be of **PECO / FILTAN / FACET / VELCON / ACS / BURGESS MANNING** make only. The type, model and numbers of elements shall be selected based on the supplier's recommendation.

5.16 Safety valves included in vendor's scope, shall be designed as per pressure safety valve specification. The supply of PSV's shall be as per the list of PSV vendors enclosed with PSV specification.

5.17 Insulation/ fireproofing cleats of specified width shall be provided on the vessels, if indicated in the data sheets. The pitch and other details of the cleats shall be as per Purchaser's standard.

6.0 INSPECTION AND TESTING

6.1 Equipment shall be subjected to stage wise expediting, inspection and testing at vendor's/ sub-vendor's works by purchaser/ its authorized inspection agency. Vendor shall submit

Quality Assurance (QA) procedures before commencement of fabrication. Approved QA procedures shall form the basis for equipment inspection.

6.2 Testing at vendor's works shall include but not be limited to the following:

(i) Non destructive tests such as radiography, dye penetration tests.
(ii) Hydrostatic test at 150% of design pressure for the vessel.
(iii) Any other tests as per data sheets/ standards/ codes.

6.3 All raw materials shall be inspected at source and test certificates to enable proper identification shall be submitted.

6.4 All equipment shall be inspected during various stages of manufacture starting from identification of raw materials to completion. The equipment shall be considered acceptable for dispatch only after final certification for acceptance is issued by the inspector.

6.5 Bought-out items or items sub-contracted to other sub-suppliers shall also be inspected at the sub-supplier's works.

6.6 Inspection by third party, if specified, shall be arranged by the supplier. It shall be responsibility of the supplier to make available to the inspector all the new / revised drawings, calculations and other enquiry documents.

6.7 Inspection order on third party shall also include specific instructions for marking copies of all correspondence from inspecting authorities to purchaser/ consultant and reporting monthly progress of the order to purchaser/consultant complete responsibility of getting approval of drawings/ calculations and documents from inspecting authority shall be that of the supplier.

6.8 In case of site fabricated / assembled equipment, same inspection agency shall be responsible for inspection, testing at site.

6.9 In case of castable refractory, 3 nos. slab of each size shall be cast at site before application and tested to meet the refractory specification in the presence of the inspector.

6.10 Unless otherwise stated gaskets used during testing shall be same as specified for operating conditions. After testing, gaskets used during testing shall be replaced by new gaskets.

6.11 The following NDT requirements are mandatory in addition to the requirements of code/ specifications.

(a) Ultrasonic Examinations

(i) Butt weld in thickness ≥ 50mm as supplement to radiography.

(ii) Full penetration welds of nozzle attachments on equipments shell/head of thickness ≥ 50mm as substitute to radiography.

(b) Magnetic particle / liquid penetrant examination

(i) All edges of plates and openings in shell of C.S. having thickness over 50mm and low alloy steel/ S.S. having thickness over 25mm.

(ii) Root-run and final layer of all butt welds.

(iii) Fillet welds of 3½% nickel and S.S.

(iv) Each layer of weld deposit in case of S.S. overlay.

(v) Knuckle surface of dished ends / toriconical sections and pipe bends.

(vi) Skirt to head joint.

(vii) In case of heat treated equipment final examination as stated above for all weld surfaces shall be carried out after heat treatment.

(c) Radiography

(i) Radiography, when called for, shall be applicable to all pressure welds, i.e., longitudinal and circumferential.

(ii) When formed heads are made of welded plates/ petal construction all the weld seams prior to forming and after forming shall be fully radiographed.

(iii) All the weld T joints shall be radiographed.

(iv) Radiography examination of welds in Cr-Mo and Cr-Mo steel shall preferably be carried out after heat treatment. If radiography is carried out prior to heat treatment, the welding and adjacent areas of base metal shall be examined by MP/DP examination after heat treatment.

6.12 All completed equipment shall be tested hydrostatically as per the requirements of specification/ codes in presence of the inspecting authority. Pneumatic test of completed equipment shall be carried out only when specially mentioned in the specification sheets. Water used for testing of S.S. equipment shall not have a chloride content exceeding 30 ppm, C.S. 30 ppm.

6.13 When required as per specifications/ code, strain gauge measurements shall be carried out on outside circumstance during hydraulic testing. The results shall be plotted both during pressurising and depressurising and procedure of such strain measurements shall have prior approval of Purchaser / Consultant.

6.14 Any or all the tests, at purchaser's option, shall be witnessed by purchaser/ its authorised inspection agency. However, such inspection shall be regarded as check-up and in no way absolve the vendor of this responsibility.

7.0 PROTECTION AND PAINTING

7.1 All exposed carbon steel parts to be painted shall be thoroughly cleaned from inside and outside to remove scale, rust, dirt and other foreign materials by wire brushing and sand blasting as applicable. Minimum acceptable standard in case of power tool cleaning shall be St. 3 and in case of blast cleaning shall be Sa 2½ as per Swedish Standard SIS 0055900.

7.2 Non-ferrous materials, austenitic stainless steels, plastic or plastic coated materials, insulated surfaces of equipment and pre-painted items shall not be painted.

7.3 Stainless steel surfaces both inside and outside shall be pickled and passivated.

7.4 Machined and bearing surfaces shall be protected with varnish or thick coat of grease.

7.5 Depending on the environment, following primer and finish coats shall be applied.

	Environment	**Description**		
(i)	Normal Industrial	Surface Preparation	:	Sa 2½
		Primer	:	2 coats of Red oxide Zinc Chromate each 25 microns (min.) thick.
		Finish Coat	:	2 coats of synthetic enamel, each 25 microns (min.) thick.
(ii)	Corrosive Industrial	Surface Preparation	:	Sa 2½
		Primer	:	2 coats of Epoxy Zinc Chromate each 35 microns (min.) thick.
		Finish Coat	:	2 coats of Epoxy high build paint each 100 microns (min.) thick.
(iii)	Coastal and Marine	Surface Preparation	:	Sa 2½
		Primer	:	2 coats of high build Chlorinated Rubber Zinc Phosphate, each 50 microns (min.) thick.
		Finish	:	2 coats of Chlorinated rubber paint, each 35 microns (min.) thick.

(iv)	All Environment (temp. 80-400°C)	Surface Preparation	:	Sa 2½
		Finish	:	2 coats of heat resistant aluminium paint suitable for specified temp. each 20 μ thick. (All values refer to dry film thickness).

7.6 The colour of finish coat shall be intimated to vendor after placement of order.

8.0 PACKAGING AND IDENTIFICATION

8.1 All packaging shall be done in such a manner as to reduce the volume. The equipment shall be dismantled into major components suitable for shipment and shall be properly packed to provide adequate protection during shipment. All assemblies shall be properly match marked for site erection.

8.2 Attachments, spares parts of the equipment and small items shall be packed separately in wooden-cases. Each item shall be appropriately tagged with identification of main equipment, its denomination and reference number of the respective assembly drawing.

8.3 Detailed packing list in water-proof envelope shall be inserted in the package together with equipment.

8.4 Each equipment shall have an identification plate giving salient equipment data, make, year of manufacture, equipment number, name of manufacturer, etc.

9.0 SPARE PARTS

9.1 Vendor shall submit his recommended list of spare parts with recommended quantities and itemised prices for first two years of operation of the equipment. Proper coding and referencing of spare parts shall be done so that later identification with appropriate equipment will be facilitated.

9.2 Recommended spares and their quantities should take into account the related factors of equipment reliability, effect of equipment downtime upon production and safety, cost of parts and availability of vendor's service facilities around proposed location of equipment.

9.3 Vendor shall also submit a list of recommended commissioning spares with quantities and the itemised prices.

10.0 INFORMATION/ DOCUMENTS/ DRAWINGS TO BE SUBMITTED WITH THE OFFER

Contractor shall submit with the offer four copies each of the following:

10.1 Vendor shall submit process design calculations for sizing of the equipment & internals together with all supporting documents/ catalogues/ monographs, etc., with the bid.

10.2 Manufacturer's complete descriptive and illustrative catalogue/ literature.

10.3 The completion schedule activity wise.

10.4 Enclosed data sheet duly filled-in.

10.5 In case of failure to submit the documents listed above, the offer may be rejected.

11.0 INFORMATION/ DOCUMENTS/ DRAWINGS TO BE SUBMITTED BY SUCCESSFUL VENDOR

Successful Contractor shall submit six copies unless noted otherwise, each of the following:

11.1 Inspection & test reports for all mandatory tests as per the applicable code as well as test reports for any supplementary tests, in nicely bound volumes.

11.2 Material test certificates (physical property, chemical composition, make, heat treatment report, etc.) as applicable for items in nicely bound volumes.

11.3 Statutory test certificates, as applicable.

11.4 Filled in Quality Assurance Plan (QAP) for Purchaser's/ Consultant's approval. These QAPs shall be submitted in four copies with in 15 days from LOI/ FOI.

11.5 WPS & PQR, as required.

11.6 Within two (2) weeks of placement of order, the detailed fabrication drawings along with process and mechanical design calculations for Purchaser's/ Consultant's approval.

11.7 Detailed completion schedule activity wise (Bar Chart), within one week of placement of order.

11.8 Weekly & fortnightly progress reports for all activities including procurement.

11.9 Purchase orders of bought out items soon after placement of order.

11.10 Manufacturer's drawings for bought out items, in 4 copies, for Purchaser's / Consultant's approval within 4 weeks.

11.11 Manufacturer related information for design of civil foundation & other matching items within 6 weeks of FOI / LOI.

11.12 All approved drawings/ design calculation/ maintenance/ operating manual documents as well as inspection and test reports for Owner's/ Consultants reference/ record in nicely category-wise bound volumes separately.

11.13 A list of documents to be furnished along with supply.

Note: All drawings, instructions, catalogues, etc., shall be in English language and all dimensions shall be metric units.

ENGINEERING STANDARD

GAIL INDIA LIMITED

PIPING MATERIAL SPECIFICATION

GAIL-STD-ME-DOC-TS-028

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CONTENTS

1.0 SCOPE

1.1 The scope shall include piping and tap-off points and other associated work at respective Terminals.

This document covers minimum requirements for various piping materials necessary for the design of the piping and other facilities coming under the project. This specification shall be read in conjunction with various Codes and Standards of latest edition, as applicable.

2.0 CODES AND STANDARDS

2.1 Pipeline and pipeline terminal facilities envisaged as part of this project shall be designed and engineered primarily in accordance with the provisions of the latest edition of the following codes:

(i) **ASME B 31.8** - Gas transmissions and Distribution Piping System

(ii) **ASME B 31.3** - Process Piping.

(iii) **OISD Standard 226** - Natural Gas Transmission Pipeline and City Gas Distribution Networks.

2.2 All codes, standards and specifications referred herein shall be the latest edition of such documents.

2.3 For sake of brevity the initials of the society to which the codes are referred may be omitted in the specifications, for example, B16.5 is a code referring to ASME; A106 is a code referring to ASTM.

2.4 In addition, GAIL specifications and standards for various piping and pipeline materials shall also be applicable.

3.0 MATERIAL SPECIFICATIONS

Individual piping class has been generally designed to cover a set of service operating within pressure-temperature consideration as per ASME B16.5/ B16.34 or part of it. Deviations of material from class specifications may occur due to specific design conditions and/ or availability. These deviations are permissible if they equal or better the individual class requirements and shall be subjected to approval on case-to-case basis.

All materials shall conform to detailed specifications / data sheets for items as applicable

4.0 CLASS DESIGNATION CODE

The piping class designation shall generally consist of three digits made up of a letter, number, letter e.g. A1A, A3A, A4A, B1A, D1A, E1A, etc. as follows:

First letter indicates ASME Class rating e.g. A

– Class 150

B – Class 300

D – Class 600

E – Class 900

The middle number indicates differences in the specifications within the same class rating and material.

The last letter indicates type of material. e.g. A – Carbon steel.

5.0 PIPELINE

5.1 NA

6.0 PIPING

6.1 Carbon steel pipe shall be made by open hearth, electric furnace or basic oxygen process only. The steel used shall be fully killed and made with fine grain structure. The grade and wall thickness of various sizes of pipes shall be as per piping material specification for the applicable class.

6.2 Pipe dimensions shall be in accordance with ASME B 36.10 for carbon steel ASTM standard pipes, API 5L for carbon steel API 5L grade pipes & ASME 36.19 for stainless steel pipe.

6.3 All pipe threads shall conform to American Standard taper as per ASME B1.20.1 NPT, unless otherwise specified.

6.4 For butt weld end, bevel shall be in accordance with API specification 5L or ASME B 16.25 as applicable.

7.0 FITTINGS

7.1 Fully killed carbon steel shall be used in the manufacture of fittings. The fitting shall have carbon equivalent not exceeding 0.45, based on check analysis.

7.2 Threaded joints, if used, shall conform to American Standard taper as per ASME B1.20.1 NPT.

7.3 Dimensions of socket welded/ screwed fittings shall conform to ASME B 16.11. Swage shall be as per BS 3799.

7.4 Dimensions of steel butt welded fittings shall be as per ASME B 16.9/ MSS-SP-75.

7.5 Bore of socket welded fittings shall suit outside diameter (OD) of pipe and its thickness.

7.6 Butt welding ends shall conform to API specification 5L or ASME B 16.25 as applicable. In case of difference in thickness of matching ends, requirements of ASME B 31.4/B 31.3 shall apply.

7.7 Integrally reinforced forged branch fittings such as Threadolet, Sockolet, Weldolet etc. shall be as per MSS-SP-97. Fittings not covered in ASME B16.9 and MSS-SP-97 shall conform to manufacturer's standard.

7.8 Fittings thickness tolerances shall match pipe thickness tolerance.

8.0 BENDS

8.1 Unless otherwise specified for process piping, elbow of radius R = 1.5 D shall only be used. Minimum Bend Radius D = Specified Outside Diameter.

8.2 Bends with a bend radius of 3 times nominal pipe diameter can be used on fabricated lines up to and including 1 ½" pipe size for utility services if essentially required.

8.3 Miters shall not be used.

9.0 FLANGES

9.1 Pressure Temperature rating of flanges shall conform to B16.5/ MSS-SP44/ B16.47 Series A, as applicable.

9.2 Dimensions of flanges shall be in accordance with B16.5/ MSS-5P44/ B16.47 Series A, as applicable.

9.3 Neck of weld neck (WN) flanges shall suit pipe bore and thickness.

9.4 Bore of socket welded (SW) flanges shall suit pipe O.D. and its thickness.

9.5 Threads for screwed flanges, if used, shall conform to American Standard taper as per ASME B 1.20.1 NPT.

9.6 Sizes for blind flanges shall be indicated by nominal pipe size.

9.7 Unless specified otherwise in Piping Material Specification the flange face finish shall be as per ASME B16.5.

9.8 Butt welding ends of WN flanges shall conform to ASME B 16.25.

9.9 Spectacle blind/ spacer & blinds shall be in accordance with ASME B16.48/ manufacturer's standard.

9.10 Two jack screws, 180^0 apart shall be provided in spectacle blind or spacer & blind assemblies as per GAIL standards.

10.0 GASKETS

10.1 Non metallic gaskets for flanged pipe joints shall conform to ASME B 16.21. Gasket material end thickness shall be as indicated in piping material specification for the applicable piping class.

10.2 Spiral wound metallic gasket with compressed asbestos filler shall conform to ASME B16.20/ API 601. All spiral wound gaskets shall be provided with stainless steel centering ring.

10.3 Spiral wound gasket shall be self-aligning type.

10.4 For RTJ flanges, octagonal ring type gaskets of soft iron with maximum hardness of 90 BHN conforming to ASME B 16.20 shall be used.

11.0 BOLTING & THREADS

11.1 Nuts for stud bolts shall be American Standard Hexagon Heavy Series and double chamfered.

11.2 Dimension and tolerances for stud bolts and nuts shall be as per ASME B18.2.1 and 18.2.2 with full threading to ASME B 1.1 Class 2A thread for bolts and Class 2B for nuts. Diameter and length of stud bolts shall be as per ASME B 16.5/ ASME B16.47 with full threading.

11.3 Threads for nuts shall be as per ASME B 1.1

Nuts for stud bolts dia ¼" to 1" **:** UNC-2B

Nuts for stud bolts dia 1⅛ %" to 3¼ : 8UN-2B

11.4 Threads for stud bolts shall be as per ASME B 1.1, as follows:

Stud bolts dia ¼" to 1" : UNC-2A

Stud bolts dia 1⅛ %" to 3¼ : 8UN-2A

11.5 Threads for threaded pipe, fitting, flanges and valve shall be in accordance with B1.20.1 taper threads, unless specified otherwise.

11.6 Heads of jack screws shall be heavy hexagonal type. Jack screw end shall be rounded. Stud bolts shall be fully threaded with two hexagonal nuts.

12.0 THREAD SEALANT

12.1 Threaded joints shall be made with 1" wide PTFE jointing tape.

13.0 VALVES

13.1 Valve ends shall be per piping material specification for various piping class.

13.2 All buried valves shall be provided with stem extension, sealant, vent/drain and shall have butt welded ends as per relevant specification/ data sheet.

13.3 Flange dimensions and face finish of flanged end valves shall conform to clause 9.0 of this specification.

13.4 Butt welding ends of Butt Welded valves shall conform to ASME B 16.25.

13.6 Face to face and end to end dimensions shall conform to applicable standards.

13.7 Valves shall conform to following standards unless specified otherwise in piping material specification for various piping class.

Flanged/ Socket Welded end valves (1½" and below)

Design STD. for Process lines

Gate Valves	:	API 602
Globe Valves	:	BS 5352
Ball Valves	:	BS 5351
Plug Valves	:	BS 5353

Flanged/ Butt Welded end valves (2" and above)

Design STD. for Process Lines

Gate Valves	:	API 6D
Globe Valves	:	BS 1873
Check Valves	:	API 6D
Ball Valves	:	API 6D
Plug Valves	:	API 6D

13.8 All manual operated valves shall be provided with wrench *I* hand wheel or gear operator as specified here in below.

13.8.1 Gate Valves

For ANSI class 150 and 300	:	Hand wheel operated for size ≤12" NB. Gear operated for size ≥14" NB.
For ANSI class 600	:	Hand wheel operated for size ≤ 10" NB. Gear operated for size ≥ 12" NB
For ASME class 900	:	Hand wheel operated for size ≤ 6" NB. Gear operated for size ≥ 8" NB

13.8.2 Globe Valves

For ANSI class 150, 300, 600	-	Hand Wheel operated for all size
For ASME class 900	-	Hand wheel operated for size ≤ 4" NB. Gear operated for size ≥ 6" NB

13.8.3 Ball valves & Plug Valves

For all ANSI class	:	Wrench operated for size ≤ 4" NB. Gear operated for size ≥ 6" NB.

13.8.4 Gas Actuated Valves

Gas actuated valves shall be as per P & IDs. The actuator shall have provision for remote operation as per P & IDs. All gas actuated valves shall have additional provision of hand wheel operation.

14.0 HYDROTESTING VENTS AND DRAINS

In terminal piping, high point vents and low point drains required for the purpose of hydrotesting shall be of size 0.75". These vents & drains shall consist of gate valves with blind flange assembly.

15.0 PIPELINE SPECIALITY ITEMS

Pipeline Specialty items viz., Flow Tee, Insulating Joints, LR bends etc. shall be as per respective data sheets, specifications and Project Specific drawing showing Mainline & Terminal materials.

TABLE – 2

Class/ Rating	Basic Material	Spl. Reqt.	C.A. (mm)	Service
A1A/ 150	**Carbon Steel**	**NON IBR**	**1.5**	NON-CORROSIVE PROCESS-FLAMMABLE/NON FLAMMABLE,NON LETHALHYDROCARBONS, AMMONIA , STEAM & CONDENSATE (NON-IBR): UTILITIES(WATER,INST AIR, PLANT AIR ,NITROGEN, CARBONDIOXIDE) BEYOND A3A AND A10A, AND LUBE OIL BEFORE THE FILTER.
A3A/ 150	**Carbon Steel**	**NON IBR**	**1.5**	NON CORROSIVE UTILITIES (ABOVE GROUND) CATEGORY "D" FLUID – COOLING WATER, INSTRUMENT AIR, PLANT AIR, INERT GAS, CARBON DI OXIDE (DRY), NITROGEN, CONDENSATE, BOILER FEED WATER (NON IBR). THIS CLASS DOES NOT COVER UNDERGROUND PIPING NOR THE FIRE WATER SERVICE.
A4A/ 150	**Carbon Steel**	**LOW TEMP SERVICE**	**1.5**	NON CORROSIVE PROCESS-FLAMMABLE / NON-FLAMMABLE, NON-LETHAL-BELOW - 29DEG C AND UPTO -45 DEG C.HYDROCARBONS, XYLENE, METHANOL,NH3, GAS FLARE ETC.
A93A/ 150	**Carbon Steel**	**NON IBR**	**1.5**	FIRE WATER (ABOVE GROUND / UNDER GROUND)
B1A/ 300	**Carbon Steel**	**NON IBR**	**1.5**	NON CORROSIVE PROCESS - FLAMMABLE / NON FLAMMABLE, NON LETHAL - HYDROCARBONS, AROMATICS, AMMONIA, SWEET GAS, FLUSHING OIL AND OTHER UTILITIES -MP CONDENSATE, INSTRUMENT AIR, PLANT AIR, NITROGEN, AMMONIA GASETC. ABOVE CLASS 'A1A'.
B4A/ 300	**Carbon Steel**	**LOW TEMP SERVICE**	**1.5**	NON CORROSIVE PROCESS-FLAMMABLE/ NON FLAMMABLE, NON LETHAL-BELOW-29 DEG C AND UPTO -45 DEG C HYDROCARBONS, XYLENE, METHANOL, NH3, GAS FLARE ETC.
D1A/ 600	**Carbon Steel**	**NON IBR**	**1.5**	REGASIFIED LNG/ NATURAL GAS
D4A/ 600	**Carbon Steel**	**LOW TEMP SERVICE**	**1.5**	NON CORROSIVE PROCESS-FLAMMABLE/ NON FLAMMABLE, NON LETHAL-BELOW-29 DEG C AND UPTO -45 DEG C HYDROCARBONS, XYLENE, METHANOL, NH3, GAS FLARE ETC.
J2A/ 150	**Carbon Steel (Galv.)**	**NON IBR**	**0**	POTABLE WATER (ABOVE GROUND ONLY), FIRE WATER-SPRINKLER SYSTEM AFTER ORIFICE

CORROSION ALLOWANCE: Above mentioned corrosion allowance is only for station piping.

ANNEXURE A

PIPING MATERIAL SPECIFICATION

(A1A - CLASS 150#)

PIPING CLASS : **A1A, 150** #
BASE MATERIAL : CARBON STEEL
CORROSION ALLOWANCE : 1.5 MM **SPECIAL**

REQUIREMENT : NON IBR

TEMPERATURE (Deg. C) AND PRESSURE (Kg/Sq. cm g) RATINGS

TEMP	-29	38	50	100	150	200
PRESS	19.98	19.98	19.57	18.05	16.11	14.07

SERVICE : NON CORROSIVE PROCESS - FLAMMABLE / NON FLAMMABLE, NON LETHAL-HYDROCARBONS, AMMONIA, STEAM & GAS CONDENSATE (NON- IBR), UTILITIES (WATER, INST, AIR, NITROGEN, CARBON DIOXIDE) AND LUBE OIL BEFORE THE FILTER.

NOTES

1. ALL VENTS AND DRAINS SHALL BE PROVIDED WITH GATE VALVE WITH BLIND FLANGE ASSEMBLY UNLESS OTHERWISE INDICATED IN P&ID.

2. NDT OF WELDS SHALL BE AS FOLLOWS:
   RADIOGRAPHY : ALL BUTT WELDS - 100%

   MPI : SOCKET WELDS - 100%

3. PIPING DESIGN AS PER ASME B 31.8 & OISD 226.
4. CHARPY V-NOTCH TEST & HARDNESS TEST SHALL BE CONDUCTED FOR PIPE, FITTINGS AND FLANGES.
5. ALL BRANCH CONNECTIONS INCLUDING VENT, DRAIN, PRESSURE AND TEMPERATURE CONNECTION SHALL BE AS PER BRANCH CONNECTION TABLE GIVEN ON NEXT PAGE. THE BRANCH DETAILS INDICATED IN APPLICABLE STANDARD SHALL BE IGNORED.
6. FOR VALVES, REFER RESPECTIVE VALVE DATA SHEETS. FOR HANDLE PROJECTION REFER STD. DRG- GAIL-STD-ME-DOC-TS-007.
7. **SPECIAL NOTES**

ITEM	SIZE	DESCRIPTION
MAINTENANCE JOINTS	ALL	FLANGED TO BE KEPT MINIMUM
PIPE JOINTS	1.5" & BELOW	SW COUPLING
	2.0" & ABOVE	BUTT WELDED
DRAINS	ON LINES ≤1.5"	REFER GAIL STD. GAIL-STD-ME-DOC-TS-003
	ON LINES ≥2.0"	AS PER P&ID OR 0.75" REFER STD. GAIL-STD-ME-DOC-TS-004
VENTS	ON LINES ≤1.5"	REFER GAIL STD –GAIL-STD-ME-DOC-TS-003
	ON LINES ≥2.0"	AS PER P&ID OR 0.75" REFER STD. GAIL-STD-ME-DOC-TS-004
TEMP. CONN	1.5"	FLANGED, INSTALLATION AS PER GAIL STD – GAIL-STD-ME-DOC-TS-005
PRESS. CONN	0.75"	SW NIPPLE WITH GATE VALVE TO SPEC AS PER STD. GAIL-STD-ME-DOC-TS-006

BRANCH PIPE (SIZE IN INCHES)																	BRANCH PIPE (SIZE IN INCHES)
	72															72	
	70															70	
	68															68	
	66															66	
	64															64	
	62															62	
	60															60	
	58															58	
	56															56	
	54															54	
	52															52	
	50															50	
	48															48	
	46															46	
	44															44	
	42															42	
	40															40	
	38															38	
	36															36	
	34															34	
	32															32	
	30															30	
	28															28	
	26															26	
	24															24	
	22															22	
	20															20	
	18															18	
	16															16	
	14															14	
	12															12	
	10														T	10	
	8.0													T	T	8.0	
	6.0												T	T	T	6.0	
	5.0															5.0	
	4.0										T		T	T	T	4.0	
	3.5															3.5	
	3.0								T		T		T	W	W	3.0	
	2.5															2.5	
	2.0						T		T		T		W	W	W	2.0	
	1.5					T	T		S		S		S	S	S	1.5	
	1.25															1.25	
	1.0			T		T	S		S		S		S	S	S	1.0	
	0.75		T	T		T	S		S		S		S	S	S	0.75	
	0.5	T	T	T		T	S		S		S		S	S	S	0.5	
		0.500	0.750	1.000	1.250	1.500	2.000	2.500	3.000	3.500	4.000	5.000	6.000	8.000	10.00		

RUN PIPE (SIZES IN INCH) – A1A

CODE	DESCRIPTION		
F	SADDLE FUSED JT	**T**	TEES
H	H.COUPLING	**W**	WELDOLETS
P	PIPE TO PIPE	**I**	INSTRUMENT TEE
R	REINFORCED	**X**	REFER NOTES
S	SOCKOLETS	**L**	SWEEPOLET

Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch./ Thk	Dim. STD	Material	Description
Pipe Group (A1A)						
PIPE	00.500	00.750	S160	B 36.10	ASTMA 106 GR.B	PE, SEAMLESS
PIPE	01.000	01.500	XS	B 36.10	ASTMA 106 GR.B	PE, SEAMLESS
PIPE	02.000	02.000	XS	B 36.10	ASTMA106 GR.B (CHARPY)	BE, SEAMLESS
PIPE	03.000	03.000	STD	B 36.10	ASTMA106 GR.B (CHARPY)	BE, SEAMLESS
PIPE	04.000	04.000	STD	B 36.10	ASTMA106 GR.B (CHARPY)	BE, SEAMLESS
PIPE	06.000	06.000	STD	B 36.10	ASTMA106 GR.B (CHARPY)	BE, SEAMLESS
PIPE	8.000	14.000	6.4	API 5L	API 5L GR.B PSL2	BE, SEAMLESS
PIPE	16.000	18.000	6.4	API 5L	API 5L GR.B PSL2	BE, SAW
PIPE	20.000	20.000	7.1	API 5L	API 5L GR.B PSL2	BE, SAW
NIPPLE	00.500	00.750	M	B 36.10	ASTMA 106 GR.B	PBE, SEAMLESS
NIPPLE	01.000	01.500	M	B 36.10	ASTMA 106 GR.B	PBE, SEAMLESS
Flange Group (A1A)						
FLNG.WN	00.500	01.500	M	B-16.5	ASTM A 105	150, RF/125AARH
FLNG.WN	02.000	24.000	M	B-16.5	ASTM A 105 (CHARPY)	150, RF/125AARH
FLNG.BLIND	00.500	01.500		B-16.5	ASTM A 105	150, RF/125AARH
PLNG.BLIND	02.000	24.000		B-16.5	ASTM A105 (CHARPY}	150, RF/125AARH
FLNG.FIG8	00.500	01.500		B-16.48	ASTM A 105	150, RF/125AARH

FLNG.FIG8	02.000	08.000		B-16.48	ASTM A105 (CHARPY)	150, RF/125AARH
SPCR &BLIND	10.000	24.000		B-16.48	ASTM A105 (CHARPY)	150, RF/125AARH
Fitting Group (A1A)						
ELBOW.90	00.500	0..750		B-16.11	ASTM A 105	SW, 6000
ELBOW.90	01.000	1.500		B-16.11	ASTM A 105	SW, 3000
ELBOW.90	02.000	24.000		B-16.9	ASTM A 234,GR. WPB (CHARPY)	BW, 1.5D
ELBOW.45	00.500	00.750		B-16.11	ASTM A 105	SW, 6000
ELBOW.45	01.000	01.500		B-16.11	ASTMA 105	SW, 3000
ELBOW.45	02.000	24.000	M	B-16.9	ASTM A234,GR. WPB (CHARPY)	BW, 1.5D
T.EQUAL	00.500	00.750		B 16.11	ASTM A 105	SW, 6000
T.EQUAL	01.000	01.500		B 16.11	ASTM A 105	SW, 3000
T.EQUAL	02.000	24.000	M	B-16.9	ASTM A234,GR.WPB (CHARPY)	BW
T.RED	00.500	00.750		B-16.11	ASTM A 105	SW, 6000
T.RED	01.000	01.500		B-16.11	ASTMA 105	SW, 3000
T.RED	02.000	24.000	M, M	B-16.9	ASTM A234,GR. WPB (CHARPY)	BW
REDUC.CONC	02.000	24.000	M,M	B-16.9	ASTM A234,GR. WPB (CHARPY)	BW
REDUC.ECC	02.000	24.000	M,M	B-16.9	ASTM A234,GR. WPB (CHARPY)	BW
SWAGE.CONC	00.500	03.000	M,M	BS-3799	ASTM A 105 (CHARPY)	PBE
SWAGE.ECC	00.500	03.000	M,M	BS-3799	ASTM A 105 (CHARPY)	PBE
CAP	00.500	00.750		B-16.11	ASTMA 105	SCRF, 6000
CAP	01.000	01.500		B-16.11	ASTMA 105	SCRF, 3000
CAP	02.000	24.000	M	B-16.9	ASTM A234,GR. WPB (CHARPY)	BW
CPLNG.FULL	00.500	00.750		B-16.11	ASTM A 105	SW, 6000
CPLNG.FULL	01.000	01.500		B-16.11	ASTM A 105	SW, 3000
CPLNG-HALF	00.500	00.750		B-16.11	ASTM A 105	SW, 6000
CPLNG.HALF	01.000	01.500		B-16.11	ASTM A 105	SW, 3000

CPLNG.LH	00.500	00.750		B-16.11	ASTM A 105	SW, 6000
CPLNG.LH	01.000	01.500		B-16.11	ASTM A 105	SW,3000
CPLNG.RED	00.500	00.750		B-16.11	ASTM A 105	SW, 6000
CPLNG.RED	01.000	01.500		B-16.11	ASTM A 105	SW, 3000
O'let Group (A1A)						
SOCKOLET	00.500	0.750		MSS-SP97	ASTM A 105	SW, 6000
SOCKOLET	01.000	01.500		MSS-SP97	ASTM A 105	SW, 3000
WELDOLET	02.000	10.000	M, XXS	MSS-SP97	ASTMA 105 (CHARPY)	BW
Valves Group (A1A)						
VLV.GATE	00.500	01.500		API-602	BODY-ASTM A 105, TRIM-STELLITED, STEM13%CR. STEEL	SW,800, 3000,B-16.11
VLV.GLOBE	00.500	01.500		BS-5352	BODY-ASTM A 105,TRIM-STELLITED, STEM13%CR STEEL	SW,800, 3000,B-16.11
VLV.CHECK	00.500	01.500		BS-5352	BODY-ASTMA 105,TRIM-STELLITED	SW,800, 3000, B-16.11
Bolt Group (A1A)						
BOLT.STUD	00.500	24.000		B18.2	BOLT: 193 GR.B7,NUT: A194 GR. 2H	
Gasket Group (A1A)						
GASKET	00.500	24.000		B16.20-ANSI B 16.5	SP,WND, SS316+CAF	SPIRAL, 150

ANNEXURE B

PIPING MATERIAL SPECIFICATION

(A3A - CLASS 150#)

PIPING CLASS : **A3A, 150** #

BASE MATERIAL : CARBON STEEL

CORROSION ALLOWANCE : 1.5 MM **SPECIAL**

REQUIREMENT : NON IBR

TEMPERATURE (Deg. C) AND PRESSURE (Kg/Sq. cm g) RATINGS

SERVICE : NON CORROSIVE UTILITIES (ABOVE GROUND) – COOLING WATER, INERT GAS, INSTRUMENT AIR, CONDENSATE

NOTES

1. ALL VENTS AND DRAINS SHALL BE PROVIDED WITH GATE VALVE WITH BLIND FLANGE ASSEMBLY UNLESS OTHERWISE INDICATED IN P&ID.
2. NDT REQUIREMENT AS PER GAIL STANDARD GAIL-STD-ME-DOC-TS-022
3. FOR VALVES REFER VALVE DATA SHEET

SPECIAL NOTES

ITEM	SIZE	DESCRIPTION
MAINTENANCE JOINTS	ALL	FLANGED TO BE KEPT MINIMUM
PIPE JOINTS	1.5" & BELOW	SW COUPLING 3000 #
	2.0" & ABOVE	BUTT WELDED
DRAINS	ON LINES ≤1.5"	REFER GAIL STD.GAIL-STD-ME-DOC-TS-003
	ON LINES ≥2.0"	AS PER P&ID OR 0.75" GAIL-STD-ME-DOC-TS-004
VENTS	ON LINES ≤1.5"	REFER GAIL STD GAIL-STD-ME-DOC-TS-003
	ON LINES ≥2.0"	AS PER P&ID OR 0.75", GAIL-STD-ME-DOC-TS-004
TEMP. CONN	1.5"	FLANGED, INSTALLATION AS PER GAIL STD. GAIL-STD-ME-DOC-TS-005
PRESS. CONN	0.75	SW NIPPLE WITH GATE VALVE TO SPEC AS PER STD. GAIL-STD-ME-DOC-TS-006

BRANCH PIPE (SIZE IN INCHES)															BRANCH PIPE (SIZE IN INCHES)
	72													72	
	70													70	
	68													68	
	66													66	
	64													64	
	62													62	
	60													60	
	58													58	
	56													56	
	54													54	
	52													52	
	50													50	
	48													48	
	46													46	
	44													44	
	42													42	
	40													40	
	38													38	
	36													36	
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	22													22	
	20													20	
	18													18	
	16													16	
	14													14	
	12													12	
	10													10	
	8.0													8.0	
	6.0												T	6.0	
	5.0													5.0	
	4.0										T		P	4.0	
	3.5													3.5	
	3.0								T		P		P	3.0	
	2.5													2.5	
	2.0						T		P		P		P	2.0	
	1.5					T	T		H		H		H	1.5	
	1.25													1.25	
	1.0			T		T	H		H		H		H	1.0	
	0.75		T	T		T	H		H		H		H	0.75	
	0.5	T	T	T		T	H		H		H		H	0.5	
		0.500	0.750	1.000	1.250	1.500	2.000	2.500	3.000	3.500	4.000	5.000	6.000		

(A3A)

CODE	DESCRIPTION		
F	SADDLE FUSED JT	**T**	TEES
H	H.COUPLING	**W**	WELDOLETS
P	PIPE TO PIPE	**I**	INSTRUMENT TEE
R	REINFORCED	**X**	REFER NOTES
S	SOCKOLETS	**L**	SWEEPOLET

Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch./ Thk	Dim. STD	Material	Description
Pipe Group (A3A)						
PIPE	00.500	1.50	HVY	IS-1239-I	IS-1239 (BLACK)	PE, C. WELDED
PIPE	02.000	06.000	HVY	IS-1239-I	IS-1239 (BLACK)	PE, C. WELDED
NIPPLE	00.500	01.50	HVY	IS-1239-I	IS-1239 (BLACK)	PE, C. WELDED
Flange Group (A3A)						
FLNG.SW	00.500	01.500	M	B-16.5	ASTM A 105	150, RF/125AARH
FLNG.SO	02.000	06.000		B-16.5	ASTM A 105 (CHARPY)	150, RF/125AARH
FLNG.BLIND	00.500	01.500		B-16.5	ASTM A 105	150, RF/125AARH
FLNG.BLIND	2.00	6.00		B-16.5	ASTM A105 (CHARPY}	150, RF/125AARH
FLNG.FIG8	00.500	01.500		B-16.48	ASTM A 105	150, RF/125AARH
FLNG.FIG8	02.000	06.000		B-16.5	ASTM A105 (CHARPY)	150, RF/125AARH
Fitting Group (A3A)						
ELBOW.90	00.500	01.500		B-16.11	ASTM A 105	SW,3000
ELBOW.90	02.00	06.00	STD	B-16.9	ASTM A 234 GR. WPB (CHARPY)	BW, 1.5D
ELBOW.45	00.500	01.50		B-16.11	ASTM A 105	SW, 3000
ELBOW.45	02.000	06.000	STD	B-16.9	ASTM A 234 GR. WPB (CHARPY)	BW, 1.5D
T.EQUAL	00.500	01.50		B 16.11	ASTM A 105	SW, 3000

T.EQUAL	02.00	06.00	STD	B 16.11	ASTM A 234 GR. WPB (CHARPY)	BW
T.RED	00.500	01.500		B-16.11	ASTM A 105	SW, 3000
T.RED	02.000	06.00	STD	B-16.9	ASTM A 234 GR. WPB (CHARPY)	BW
REDUC.CONC	02.000	06.000	STD,STD	B-16.9	ASTM A234,GR. WPB (CHARPY)	BW
REDUC.ECC	02.000	06.000	STD,STD	B-16.9	ASTM A234,GR. WPB (CHARPY)	BW
SWAGE.CONC	00.500	03.000	STD,STD	BS-3799	ASTM A 105 (CHARPY)	PBE
SWAGE.ECC	00.500	03.000	STD,STD	BS-3799	ASTM A 105 (CHARPY)	PBE
CAP	00.500	01.50		B-16.11	ASTMA 105	SCRF, 3000
CAP	02.000	06.00	STD	B-16.9	ASTM A234,GR. WPB (CHARPY)	BW
CPLNG.FULL	00.500	01.50		B-16.11	ASTM A 105	SW, 3000
CPLNG-HALF	00.500	01.50		B-16.11	ASTM A 105	SW, 3000
CPLNG.LH	00.500	01.50		B-16.11	ASTM A 105	SW, 3000
CPLNG.RED	00.500	01.50		B-16.11	ASTM A 105	SW, 3000
UNION	0.50	01.500		BS-3799	ASTM A 105	SW, 3000
Valves Group (A3A)						
VLV.GATE	00.250	01.500		API-602	BODY-ASTM A 105, TRIM-STELLITED, STEM13%CR. STEEL	SW,800, 3000,B-16.11
VLV.GATE	02.00	24.00		API-600	BODY-ASTM A 216, WCB, TRIM-STELLITED, STEM13%CR. STEEL	FLGD, 150, B 16.5, RF/125AARH
VLV.GLOBE	00.25	01.500		BS-5352	BODY-ASTM A 105,TRIM-STELLITED, STEM13%CR STEEL	SW,800, 3000,B-16.11
VLV.GLOBE	02.00	16.00		BS-1873	BODY-ASTM A 216, WCB, TRIM-STELLITED, STEM13%CR. STEEL	FLGD, 150, B 16.5, RF/125AARH
VLV.CHECK	00.250	01.500		BS-5352	BODY-ASTMA 105,TRIM-STELLITED	SW,800, 3000, B-16.11
VLV.CHECK	02.00	24.00		BS 1868	BODY-ASTM A 216, GR. WCB, TRIM 13% CR. SREEEL	FLGD, 150, B 16.5, RF/125AARH

VLV.BALL	00.500	16.00		BS-5351	BODY-ASTM A 105,A 216 GR. WCB TRIM-BODY SEAT - RPTFE	FLGD, 150, , B 16.5, RF/125AARH
VLV.BTRFLY	03.500	24.00		BS-5155	BODY-ASTM A 216 GR., WCB, TRIM- 13% CR. STEEL	WAFL, 150, B-16.5 WAF/125AARH
Bolt Group (A3A)						
BOLT.STUD	00.500	6.000		B18.2	BOLT: A 307, GR. B, NUT: A 563 GR.B	
Gasket Group (A3A)						
GASKET	00.500	6.000		B16.21-ANSI B 16.5	IS-2712- GR.-W/3	RING, 150, 2 MM
TRAP/ STRAINER GROUP (A3A)						
TRP	00.500	1.50		MANF'S STD	B:A105, T:13%CR, S:SS304	FLGD, THRMDNMC, 150, RF/125AARH
TRP	01.500	6.000		MANUF STD	B:A285GR.C; INT: SS304	CONETYPE, 150, FF/125 AARH
TRP	00.500	1.500		MANUF STD	B:A105; INT: SS304	SW, Y-TYPE, 800
TRP	02.00	6.000	M	MANUF STD	B:A234GR. WPB; INT: SS304	BW, T - TYPE

ANNEXURE C

PIPING MATERIAL SPECIFICATION

(B1A - CLASS 300#)

PIPING CLASS : **(B1A), 300 #**

BASE MATERIAL : CARBON STEEL

CORROSION ALLOWANCE : 1.5 MM

SPECIAL REQUIREMENT : NON IBR

TEMPERATURE (Deg. C) AND PRESSURE (Kg/Sq. cm g) RATINGS

TEMP	-29	38	50	100	150
PRESS	52.1	52.1	51.09	47.52	45.98

SERVICE

NON CORROSIVE PROCESS- FLAMMABLE / NON FLAMMABLE, NON LETHAL-HYDROCARBONS, AROMATICS, AMMONIA, SWEET GAS, FLUSHING OIL AND OTHER UTILITIES -MP CONDENSATE, INSTRUMENT AIR, PLANT AIR, NITROGEN, AMMONIA GAS ETC.

NOTES

1. ALL VENTS AND DRAINS SHALL BE PROVIDED WITH GATE VALVE WITH BLIND FLANGE ASSEMBLY UNLESS OTHERWISE INDICATED IN P&ID.
2. NDT OF WELDS SHALL BE AS FOLLOWS:

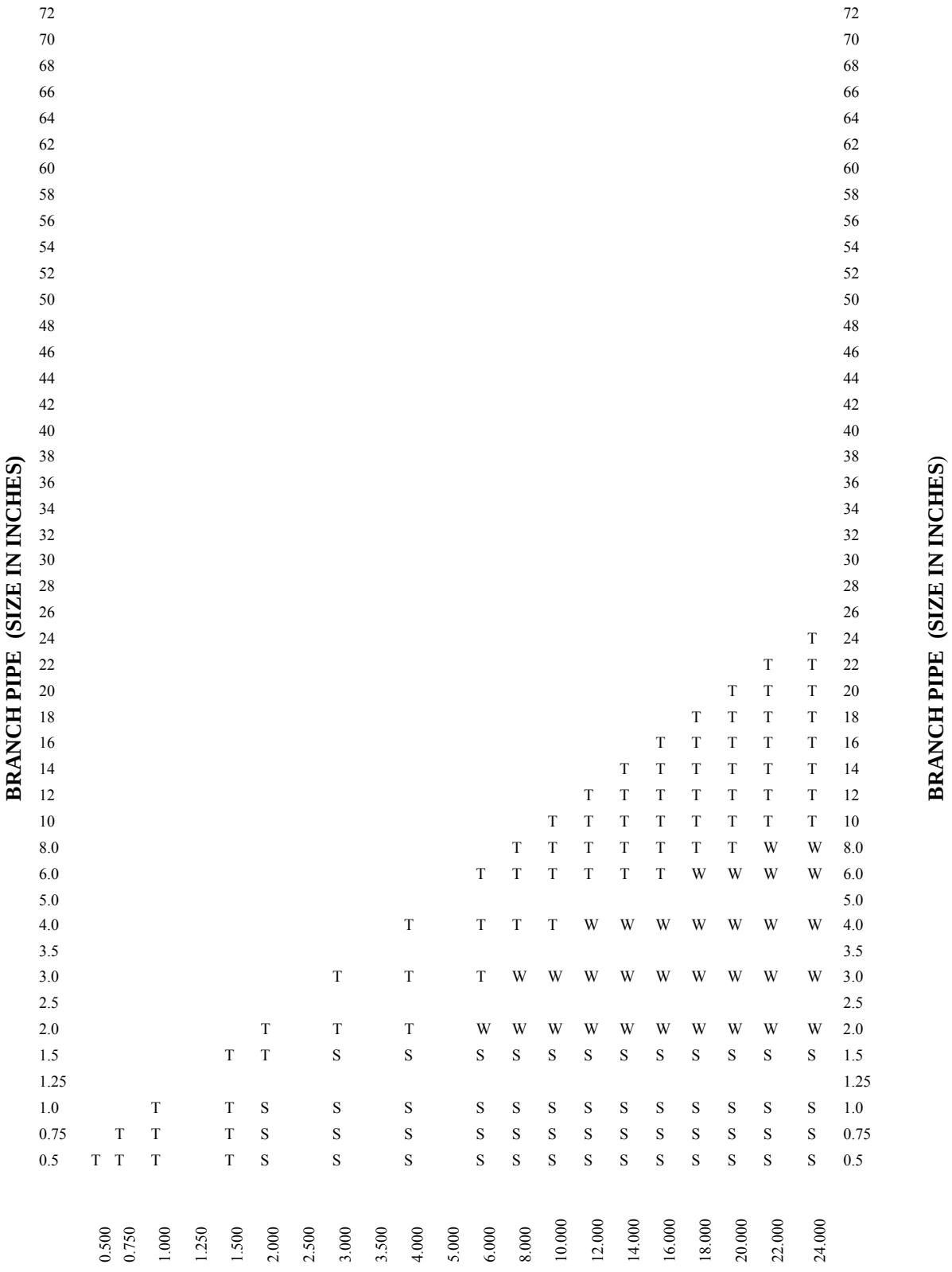
   RADIOGRAPHY : ALL BUTT WELDS - 100%

   MPI : SOCKET WELDS - 100%

3. PIPING DESIGN AS PER ASME B 31.8 & OISD 141 & 226
4. FLANGES OF SIZE 22" SHALL BE AS PER MSS-SP-44.
5. CHARPY V-NOTCH TEST & HARDNESS TEST SHALL BE CONDUCTED FOR PIPE, FITTINGS AND FLANGES.
6. ALL BRANCH CONNECTIONS INCLUDING VENT, DRAIN, PRESSURE AND TEMPERATURE CONNECTION SHALL BE AS PER BRANCH CONNECTION TABLE GIVEN ON NEXT PAGE. THE BRANCH DETAILS INDICATED IN APPLICABLE STANDARD SHALL BE IGNORED.
7. FOR VALVES REFER RESPECTIVE VALVE DATA SHEET.

SPECIAL NOTES

ITEM	SIZE	DESCRIPTION
MAINTENANCE JOINTS	ALL	FLANGED, TO BE KEPT MINIMUM
PIPE JOINTS	1.5" & BELOW	SW COUPLING
	2.0" & ABOVE	BUTT WELDED
DRAINS	ON LINES ≤1.5"	REFER GAIL STD.GAIL-STD-ME-DOC-TS-003
	ON LINES ≥2.0"	AS PER P&ID OR 0.75"; GAIL STD. GAIL-STD-ME-DOC-TS-004
VENTS	ON LINES ≤1.5"	REFER GAIL STD. GAIL-STD-ME-DOC-TS-003
	ON LINES ≥2.0"	AS PER P&ID OR 0.75". GAIL-STD-ME-DOC-TS-004
TEMP. CONN	1.5"	FLANGED, INSTALLATION AS PER GAIL STD. GAIL-STD-ME-DOC-TS-005
PRESS. CONN	0.75"	SW NIPPLE WITH GATE VALVE TO SPEC AS PER STD. GAIL-STD-ME-DOC-TS-006


BRANCH PIPE (SIZE IN INCHES)
BRANCH PIPE (SIZE IN INCHES)
72 70 68 66 64 62 60 58 56 54 52 50 48 46 44 42 40 38 36 34 32 30 28 26 24 22 20 18 16 14 12 10 8.0 6.0 5.0 4.0 3.5 3.0 2.5 2.0 1.5 1.25 1.0 0.75 0.5
0.500 0.750 1.000 1.250 1.500 2.000 2.500 3.000 3.500 4.000 5.000 6.000 8.000 10.000 12.000 14.000 16.000 18.000 20.000 22.000 24.000
RUN PIPE (SIZES IN INCH) – B1A

CODE	DESCRIPTION		
F	SADDLE FUSED JT	**T**	TEES
H	H.COUPLING	**W**	WELDOLETS
P	PIPE TO PIPE	**I**	INSTRUMENT TEE
R	REINFORCED	**X**	REFER NOTES
S	SOCKOLETS	**L**	SWEEPOLET

Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch./ Thk	Dim. STD	Material	Description
Pipe Group (B1A)						
PIPE	00.500	00.750	S160	B 36.10	ASTMA 106 GR.B	PE, SEAMLESS
PIPE	01.000	01.500	XS	B 36.10	ASTMA 106 GR.B	PE, SEAMLESS
PIPE	02.000	02.000	XS	B 36.10	ASTMA106 GR.B (CHARPY)	BE, SEAMLESS
PIPE	03.000	03.000	STD	B 36.10	ASTMA106 GR.B (CHARPY)	BE, SEAMLESS
PIPE	04.000	06.000	STD	B 36.10	ASTMA106 GR.B (CHARPY)	BE, SEAMLESS
PIPE	08.000	08.000	7.9	API 5L	API 5L GR.B PSL2	BE, SEAMLESS
PIPE	10.000	10.000	9.3	API 5L	API 5L GR.B PSL2	BE, SEAMLESS
PIPE	12.000	12.000	10.3	API 5L	API 5L GR.B PSL2	BE, SEAMLESS
PIPE	14.000	14.000	11.1	API 5L	API 5L GR.B PSL2	BE, SEAMLESS
PIPE	16.000	16.000	12.7	API 5L	API 5L GR.B PSL2	BE, SAW
PIPE	18.000	18.000	14.3	API 5L	API 5L GR.B PSL2	BE, SAW
PIPE	20.000	24.000	15.9	API 5L	API 5L GR.B PSL2	BE, SAW
NIPPLE	00.500	00.750	M	B 36.10	ASTM A 106 GR.B	PBE, SEAMLESS
NIPPLE	01.000	01.500	M	B 36.10	ASTM A 106 GR.B	PBE, SEAMLESS
Flange Group (B1A)						
FLNG.SW	00.500	01.500	M	B-16.5	ASTM A 105	300, RF/125AARH
FLNG.WN	02.000	24.000	M	B-16.5	ASTM A 105 (CHARPY)	300, RF/125AARH
FLNG.WN	18.000	20.000	M	B-16.5	ASTM A 105 (CHARPY)	300, RF/125AARH
FLNG.BLIND	00.500	01.500		B-16.5	ASTM A 105	300, RF/125AARH
FLNG.BLIND	02.000	20.000		B-16.5	ASTM A105 (CHARPY}	300, RF/125AARH

FLNG.FIG8	00.500	01.500		B-16.48	ASTM A 105	300, RF/125AARH
FLNG.FIG8	02.000	08.000		B-16.48	ASTM A105 (CHARPY)	300, RF/125AARH
SPCR &BLIND	10.000	20.000		B-16.48	ASTM A105 (CHARPY)	300, RF/125AARH
Fitting Group(B1A)						
ELBOW.90	00.500	0..750		B-16.11	ASTM A 105	SW, 6000
ELBOW.90	01.000	1.500		B-16.11	ASTM A 105	SW, 3000
ELBOW.90	02.000	16.000	M	B-16.9	ASTM A 234,GR. WPB CHARPY)	BW, 1.5D
ELBOW.90	18.000	20.000	M	B- 16.9	ASTM A 234,GR. WPB CHARPY)	BW, 1.5D
ELBOW.45	00.500	00.750		B-16.11	ASTM A 105	SW, 6000
ELBOW.45	01.000	01.500		B-16.11	ASTM A 105	SW, 3000
ELBOW.45	02.000	16.000	M	B-16.9	ASTM A234, GR. WPB CHARPY)	BW, 1.5D
ELBOW.45	18.000	20.000	M	B 16.9	ASTM A234, GR. WPB CHARPY)	BW, 1.5D
T.EQUAL	00.500	00.750		B 16.11	ASTM A 105	SW, 6000
T.EQUAL	01.000	01.500		B 16.11	ASTM A 105	SW, 3000
T.EQUAL	02.000	16.000	M	B-16.9	ASTM A234,GR.WPB (CHARPY)	BW
T.EQUAL	18.000	20.000	M	B – 16.9	ASTM A234,GR.WPB (CHARPY)	BW
T.RED	00.500	00.750		B-16.11	ASTM A 105	SW, 6000
T.RED	01.000	01.500		B-16.11	ASTM A 105	SW, 3000
T.RED	02.000	16.000	M, M	B-16.9	ASTM A234,GR. WPB(CHARPY)	BW
T.RED	18.000	20.000	M, M	B – 16.9	ASTM A234,GR. WPB(CHARPY)	BW
REDUC.CONC	02.000	16.000	M,M	B-16.9	ASTM A234,GR. WPB(CHARPY)	BW
REDUC.CONC	18.000	26.000	M,M	B-16.9	ASTM A234,GR. WPB(CHARPY)	BW
REDUC.ECC	02.000	16.000	M,M	B-16.9	ASTM A234,GR. WPB(CHARPY)	BW
REDUC.ECC	18.000	20.000	M,M	B – 16.9	ASTM A234,GR. WPB(CHARPY)	BW

SWAGE.CONC	00.500	03.000	M,M	BS-3799	ASTM A 105 (CHARPY)	PBE
SWAGE.ECC	00.500	03.000	M,M	BS-3799	ASTM A 105 (CHARPY)	PBE
CAP	00.500	00.750		B-16.11	ASTM A 105	SCRF, 6000
CAP	01.000	01.500		B-16.11	ASTM A 105	SCRF, 3000
CAP	02.000	16.000	M	B-16.9	ASTM A234,GR. WPB (CHARPY)	BW
CAP	18.000	20.000	M	B – 16.9	ASTM A234,GR. WPB (CHARPY)	BW
PLUG	00.500	00.750		B 16.11	ASTM A 105	SCRM, 6000
PLUG	01.000	01.500		B 16.11	ASTM A 105	SCRM, 3000
CPLNG.FULL	00.500	00.750		B-16.11	ASTM A 105	SW, 6000
CPLNG.FULL	01.000	01.500		B-16.11	ASTM A 105	SW, 3000
CPLNG-HALF	00.500	00.750		B-16.11	ASTM A 105	SW, 6000
CPLNG.HALF	01.000	01.500		B-16.11	ASTM A 105	SW, 3000
CPLNG.LH	00.500	00.750		B-16.11	ASTM A 105	SW, 6000
CPLNG.LH	01.000	01.500		B-16.11	ASTM A 105	SW,3000
CPLNG.RED	00.500	00.750		B-16.11	ASTM A 105	SW, 6000
CPLNG.RED	01.000	01.500		B-16.11	ASTM A 105	SW, 3000
O' let group(B1A)						
SOCKOLET	00.500	0.750		MSS-SP97	ASTM A 105	SW, 6000
SOCKOLET	01.000	01.500		MSS-SP97	ASTM A 105	SW, 3000
WELDOLET	02.000	10.000	M, XXS	MSS-SP97	ASTMA 105 (CHARPY)	BW
Valves Group (B1A)						
VLV.GATE	00.500	01.500		API-602	BODY-ASTM A 105, TRIM-STELLITED, STEM13%CR. STEEL	SW,800, 3000,B-16.11
VLV.GATE	02.000	20.000		API-6D	BODY-ASTM A 216 GR. WCB TRIM-STELLITED, STEM 13% CR. STEEL	FLGD, 300, B-16.5, RF/ 125 AARH
VLV.GLOBE	00.500	01.500		BS-5352	BODY-ASTM A 105,TRIM-STELLITED, STEM13%CR STEEL	SW,800, 3000,B-16.11
VLV.GLOBE	02.000	20.000		BS-1873	BODY-ASTM A 216 GR. WCB TRIM-STELLITED, STEM 13% CR. STEEL	FLGD, 300, B-16.5, RF/ 125 AARH

VLV.CHECK	00.500	01.500		BS-5352	BODY-ASTMA 105,TRIM-STELLITED	SW,800, 3000, B-16.11
VLV.CHECK	2.000	20.000		API -6D	BODY-ASTM A 216 GR. WCB TRIM-STELLITED, STEM 13% CR. STEEL	FLGD, 300, B-16.5, RF/ 125 AARH
VLV.BALL	00.500	01.500		BS-5351	BODY-ASTM A 105,TRIM-SEAT RPTFE	FLGD, 300, B-16.5, RF/ 125 AARH
VLV.BALL	02.000	20.000		API-6D	BODY-ASTM A 216 GR. WCC/ A234 GR WPC, TRIM-SEAT AISI 4140+0.003" ENP/ AISI 410	FLGD, 300, B-16.5, RF/ 125 AARH
VLV.BALL	02.000	02.000		API-6D	BODY-ASTM A 216 GR. WCC/ A234 GR WPC, TRIM-SEAT AISI 4140+0.003" ENP/ AISI 410	BW, 300, B-16.25, RF/ 125 AARH
VLV.PLUG	00.500	01.500		BS-5353	BODY-ASTM A 105, PLUG-A 105 +0.003" ENP	SW,800 3000, B-16.11
VLV.PLUG	02.000	20.000		API-6D	BODY-ASTM A 216 GR. WCB PLUG-A 216 GR. WCB+0.003" ENP	FLGD, 300, B-16.5, RF/ 125 AARH
Bolt Group(B1A)						
BOLT.STUD	00.500	26.000		B18.2	BOLT: 193 GR.B7,NUT: A194 GR. 2H	
Gasket Group (B1A)						
GASKET	00.500	20.000		B16.20-ANSI B 16.5	SP,WND, SS316+CAF	SPIRAL, 300
GASKET	26.000	20.000		B16.20-ANSIB 16.5	SP,WND, SS316+CAF	SPIRAL, 300

ANNEXURE D

PIPING MATERIAL SPECIFICATION

(D1A - CLASS 600#)

PIPING CLASS	**:**	**D1A, 600** #
BASE MATERIAL	**:**	CARBON STEEL
CORROSION ALLOWANCE	**:**	1.5 MM **SPECIAL**
REQUIREMENT	**:**	NON IBR

TEMPERATURE (Deg. C) AND PRESSURE (Kg/Sq. cm g) RATINGS

SERVICE - REGASIFIED LNG (R-LNG) / Natural Gas

NOTES

1. ALL VENTS AND DRAINS SHALL BE PROVIDED WITH GATE VALVE WITH BLIND FLANGE ASSEMBLY UNLESS OTHERWISE INDICATED IN P&ID.

2. NA

3. BALL VALVE TO BE USED IN MAIN LINE SHALL HAVE BUTT WELDED ENDS.

4. MAINLINE WELDING AND NDT REQUIREMENTS OF WELDS SHALL AS PER SPECIFICATION – 0001-01-04-02-001.

5. BARRED TEE SHALL BE WELDED TYPE FOR USE IN MAINLINE ONLY. MATERIAL SHALL BE AS PER ATTACHED TABLE-3 FOR PIPELINE SPECIALITY ITEMS.

6. LR BEND,IJ,L/R, PIG SIG. SHALL BE FOR USE IN MAINLINE ONLY, MATERIAL AS PER TABLE-3.

7. NDT OF WELDS EXCLUDING MAINLINE SHALL BE AS FOLLOWS:

RADIOGRAPHY	:	ALL BUTT WELDS	-	100%
MPI	:	SOCKET WELDS	-	100%

   ALL OTHER REQUIREMENT SHALL BE AS PER GAIL-STD-ME-DOC-TS-022

8. PIPING DESIGN AS PER ASME B 31.8 & OISD 141

9. FLANGES OF SIZE 22" SHALL BE AS PER MSS-SP-44.

10. CHARPY V-NOTCH TEST & HARDNESS TEST SHALL BE CONDUCTED FOR PIPE, FITTINGS AND FLANGES.

11. ALL BRANCH CONNECTIONS INCLUDING VENT, DRAIN, PRESSURE AND TEMPERATURE CONNECTION SHALL BE AS PER BRANCH CONNECTION TABLE GIVEN ON NEXT PAGE. THE BRANCH DETAILS INDICATED IN APPLICABLE STANDARD SHALL BE IGNORED.

12. CORROSION ALLOWANCE OF 1.5 MM HAS BEEN CONSIDERED FOR TERMINAL PIPING AND 0.0 MM FOR MAIN PIPELINE

13. FOR DIMENSIONS OF HANDLE PROJECTION FOR SPACER & BLIND – REFER STD. DRG.-GAIL-STD-ME-DOC-TS-007

14. **SPECIAL NOTES - D1A**

ITEM	SIZE	DESCRIPTION
MAINTENANCE JOINTS	ALL	FLANGED, TO BE KEPT MINIMUM
PIPE JOINTS	1.5" & BELOW	SW COUPLING
	2.0" & ABOVE	BUTT WELDED
DRAINS	ON LINES ≤1.5"	REFER GAIL STD. GAIL-STD-ME-DOC-TS-003
	ON LINES ≥2.0"	AS PER P&ID OR 0.75" REFER STD.GAIL-STD-ME-DOC-TS-004
VENTS	ON LINES ≤1.5"	REFER GAIL STD. GAIL-STD-ME-DOC-TS-003
	ON LINES ≥2.0"	AS PER P&ID OR 0.75". REFER STD. GAIL-STD-ME-DOC-TS-004
TEMP. CONN	1.5"	FLANGED, INSTALLATION AS PER GAIL STD. GAIL-STD-ME-DOC-TS-005
PRESS. CONN	0.75"	SW NIPPLE WITH GATE VALVE TO SPEC AS PER STD. GAIL-STD-ME-DOC-TS-006

BRANCH PIPE (SIZE IN INCHES)		0.500	0.750	1.000	1.250	1.500	2.000	2.500	3.000	3.500	4.000	5.000	6.000	8.000	10.000	12.000	14.000	16.000	18.000	20.000	22.000	24.000	26.000	28.000	30.000		BRANCH PIPE (SIZE IN INCHES)
	72																									72	
	70																									70	
	68																									68	
	66																									66	
	64																									64	
	62																									62	
	60																									60	
	58																									58	
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	40																									40	
	38																									38	
	36																									36	
	34																									34	
	32																									32	
	30																								T	30	
	28																									28	
	26																						T		T	26	
	24																					T	T		T	24	
	22																				T	T	T		T	22	
	20																			T	T	T	T		T	20	
	18																		T	T	T	T	T		T	18	
	16																	T	T	T	T	T	T		T	16	
	14																T	T	T	T	T	T	T		T	14	
	12															T	T	T	T	T	T	T	T		T	12	
	10														T	T	T	T	T	T	T	T	W		T	10	
	8.0													T	T	T	T	T	T	T	W	W	W		W	8.0	
	6.0												T	T	T	T	T	T	W	W	W	W	W		W	6.0	
	5.0																									5.0	
	4.0										T		T	T	T	W	W	W	W	W	W	W	W		W	4.0	
	3.5																									3.5	
	3.0								T		T		T	W	W	W	W	W	W	W	W	W	W		W	3.0	
	2.5																									2.5	
	2.0						T		T		T		W	W	W	W	W	W	W	W	W	W	W		W	2.0	
	1.5					T	T		S		S		S	S	S	S	S	S	S	S	S	S	S		S	1.5	
	1.25																									1.25	
	1.0			T		T	T		S		S		S	S	S	S	S	S	S	S	S	S	S		S	1.0	
	0.75		T	T		T	T		S		S		S	S	S	S	S	S	S	S	S	S	S		S	0.75	
	0.5	T	T	T		T	S		S		S		S	S	S	S	S	S	S	S	S	S	S		S	0.5	

RUN PIPE (SIZES IN INCH) – D1A

F	SADDLE FUSED JT	**T**	TEES
H	H.COUPLING	**W**	WELDOLETS
P	PIPE TO PIPE	**I**	INSTRUMENT TEE
R	REINFORCED	**X**	REFER NOTES
S	SOCKOLETS	**L**	SWEEPOLET

Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch./ Thk	Dim. STD	Material	Description
Pipe Group (D1A)						
PIPE	00.500	00.750	S160	B 36.10	ASTM A 106 GR.B	PE, SEAMLESS
PIPE	01.000	01.500	XS	B 36.10	ASTM A 106 GR.B	PE, SEAMLESS
PIPE	02.000	02.000	XS	B 36.10	ASTM A106 GR.B (CHARPY)	BE, SEAMLESS
PIPE	03.000	06.000	XS	B 36.10	ASTM A106 GR.B (CHARPY)	BE, SEAMLESS
PIPE	08.000	08.000	14.3	API 5L	API 5L GR.B PSL2	BE, SEAMLESS
PIPE	10.000	10.000	12.7	API 5L	API 5L X-52 PSL2	BE, SEAMLESS
PIPE	12.000	12.000	14.3	API 5L	API 5L X-52 PSL2	BE, SEAMLESS
PIPE	14.000	14.000	14.3	API 5L	API 5L X - 52 PSL2	BE, SEAMLESS
PIPE	16.000	16.000	17.5	API 5L	API 5L GR.X-52 PSL2	BE, SAW
PIPE	18.000	18.000	19.1	API 5L	API 5L GR.X-52 PSL2	BE, SAW
PIPE	20.000	20.000	20.6	API 5L	API 5L GR.X-52 PSL2	BE, SAW
PIPE	24.000	24.000	19.1	API 5L	API 5L GR.X-52 PSL2	BE, SAW
PIPE	28.00	28.00	22.2	API 5L	API 5L GR.X-52 PSL2	BE, SAW
PIPE	30.00	30.00	23.8	API 5L	API 5L GR.X-52 PSL2	BE, SAW
NIPPLE	00.500	00.750	M	B 36.10	ASTM A 106 GR.B	PBE,SEAMLESS
NIPPLE	01.000	01.500	M	B 36.10	ASTM A 106 GR.B	PBE, SEAMLESS
Flange Group (D1A)						
FLNG.SW	00.500	01.500	M	B-16.5	ASTM A 105	600, RF/125AARH
FLNG.WN	02.000	8.000	M	B-16.5	ASTM A 105 (CHARPY)	600, RF/125AARH
FLNG.WN	10.000	24.000	M	B- 16.5	ASTM A 694 GR. F-52 (CHARPY)	600, RF/125AARH
FLNG.WN	28.000	30.000	M	B-16.47-A	ASTM A 694 GR. F-52 (CHARPY)	600, RF/125AARH

FLNG.BLIND	00.500	01.500		B-16.5	ASTM A 105	600, RF/125AARH
FLNG.BLIND	02.000	24.000		B-16.5	ASTM A105 (CHARPY}	600, RF/125AARH
FLNG.BLIND	26.000	30.000		B16.47A	ASTM A105 (CHARPY}	600, RF/125AARH
FLNG.FIG8	00.500	01.500		B-16.48	ASTM A 105	600, RF/125AARH
FLNG.FIG8	02.000	08.000		B-16.48	ASTM A105 (CHARPY)	600, RF/125AARH
SPCR &BLIND	10.000	24.000		B-16.48	ASTM A105 (CHARPY)	600, RF/125AARH
SPCR &BLIND	26.000	30.000		MNF'S STD	ASTM A516 GR.70 (CHARPY)	600, RF/125AARH
Fitting Group (D1A)						
ELBOW.90	00.500	0..750		B-16.11	ASTM A 105	SW, 6000
ELBOW.90	01.000	1.500		B-16.11	ASTM A 105	SW, 3000
ELBOW.90	02.000	8.000	M	B-16.9	ASTM A 234,GR. WPB (CHARPY)	BW, 1.5D
ELBOW.90	10.000	30.000	M	MSS-SP75	MSS-SP75 GR.WPHY-52	BW, 1.5D
ELBOW.45	00.500	00.750		B-16.11	ASTM A 105	SW, 6000
ELBOW.45	01.000	01.500		B-16.11	ASTM A 105	SW, 3000
ELBOW.45	02.000	8.000	M	B-16.9	ASTM A234, GR. WPB (CHARPY)	BW, 1.5D
ELBOW.45	10.000	30.000	M	MSS-SP75	MSS-SP75 GR.WPHY-52	BW, 1.5D
PIPE BEND	18.000	30.000	M	MSS-SP75	MSS-SP75 GR.WPHY-52	BW, 1.5D
T.EQUAL	00.500	00.750		B 16.11	ASTM A 105	SW, 6000
T.EQUAL	01.000	01.500		B 16.11	ASTM A 105	SW, 3000
T.EQUAL	02.000	8.000	M	B-16.9	ASTM A234,GR.WPB (CHARPY)	BW
T.EQUAL	10.000	30.000	M	MSS-SP75	MSS-SP75 GR.WPHY-52	BW
T.RED	00.500	00.750		B-16.11	ASTM A 105	SW, 6000
T.RED	01.000	01.500		B-16.11	ASTM A 105	SW, 3000
T.RED	02.000	8.000	M, M	B-16.9	ASTM A234,GR. WPB(CHARPY)	BW
T.RED	10.000	30.000	M, M	MSS-SP75	MSS-SP75 GR.WPHY-52	BW
REDUC.CONC	02.000	8.000	M,M	B-16.9	ASTM A234,GR. WPB(CHARPY)	BW
REDUC.CONC	10.000	30.000	M,M	MSS-SP75	MSS-SP75 GR.WPHY-52	BW
REDUC.ECC	02.000	8.000	M,M	B-16.9	ASTM A234,GR. WPB(CHARPY)	BW
REDUC.ECC	10.000	30.000	M,M	MSS-SP75	MSS-SP75 GR.WPHY-52	BW

SWAGE.CONC	00.500	03.000	M,M	BS-3799	ASTM A 105 (CHARPY)	PBE
SWAGE.ECC	00.500	03.000	M,M	BS-3799	ASTM A 105 (CHARPY)	PBE
CAP	00.500	00.750		B-16.11	ASTM A 105	SCRF, 6000
CAP	01.000	01.500		B-16.11	ASTM A 105	SCRF, 3000
CAP	02.000	8.000	M	B-16.9	ASTM A234,GR. WPB (CHARPY)	BW
CAP	10.000	30.000	M	MSS-SP75	MSS-SP75 GR.WPHY-52	BW
PLUG	00.500	00.750		B 16.11	ASTM A 105	SCRM, 6000
PLUG	01.000	01.500		B 16.11	ASTM A 105	SCRM, 3000
CPLNG.FULL	00.500	00.750		B-16.11	ASTM A 105	SW, 6000
CPLNG.FULL	01.000	01.500		B-16.11	ASTM A 105	SW, 3000
CPLNG-HALF	00.500	00.750		B-16.11	ASTM A 105	SW, 6000
CPLNG.HALF	01.000	01.500		B-16.11	ASTM A 105	SW, 3000
CPLNG.LH	00.500	00.750		B-16.11	ASTM A 105	SW, 6000
CPLNG.LH	01.000	01.500		B-16.11	ASTM A 105	SW,3000
CPLNG.RED	00.500	00.750		B-16.11	ASTM A 105	SW, 6000
CPLNG.RED	01.000	01.500		B-16.11	ASTM A 105	SW, 3000
O' let group (D1A)						
SOCKOLET	00.500	0.750		MSS-SP97	ASTM A 105	SW, 6000
SOCKOLET	01.000	01.500		MSS-SP97	ASTM A 105	SW, 3000
WELDOLET	02.000	16.000	M, XXS	MSS-SP97	ASTMA 105 (CHARPY)	BW
WELDOLET	18.000	20.000	M, M	MSS-SP97	ASTMA 694 GR. F-52 (CHARPY)	BW
Valves Group (D1A)						
VLV.GATE	00.500	01.500		API-602	BODY-ASTM A 105, TRIM-STELLITED, STEM13%CR. STEEL	SW,800, 3000,B-16.11
VLV.GLOBE	00.500	01.500		BS-5352	BODY-ASTM A 105,TRIM-STELLITED, STEM13%CR STEEL	SW,800, 3000,B-16.11
VLV.CHECK	00.500	01.500		BS-5352	BODY-ASTMA 105,TRIM-STELLITED	SW,800, 3000, B-16.11
VLV.BALL	00.500	01.500		BS-5351	BODY-ASTM A 105,TRIM-SEAT RPTFE	FLGD, 600, B-16.5, RF/ 125 AARH

VLV.BALL	02.000	24.000		API-6D	BODY-ASTM A 216 GR. WCC/ A234 GR WPC, TRIM-SEAT AISI 4140+0.003" ENP/ AISI 410	FLGD, 600, B-16.5, RF/ 125 AARH
VLV.BALL	26.000	30.000		API-6D	BODY-ASTM A 216 GR. WCC/ A234 GR WPC, TRIM-SEAT AISI 4140+0.003" ENP/ AISI 410	BW, 600, B-16.25, RF/ 125 AARH
VLV.BALL	02.000	30.000		API-6D	BODY-ASTM A 216 GR. WCC/ A234 GR WPC, TRIM-SEAT AISI 4140+0.003" ENP/ AISI 410	BW, 600, B-16.25, RF/ 125 AARH
VLV.PLUG	00.500	01.500		BS-5353	BODY-ASTM A 105, PLUG-A 105 +0.003" ENP	SW, 800 3000, B-16.11
VLV.PLUG	02.000	24.000		API-6D	BODY-ASTM A 216 GR. WCB PLUG-A 216 GR. WCB+0.003" ENP	FLGD, 600, B-16.5, RF/ 125 AARH
VLV.PLUG	02.000	24.000		API-6D	BODY-ASTM A 216 GR. WCB PLUG-A 216 GR. WCB+0.003" ENP	BW, 600, B-16.25, RF/ 125 AARH
Bolt Group (D1A)						
BOLT.STUD	00.500	30.000		B18.2	BOLT: 193 GR.B7,NUT: A194 GR. 2H	
Gasket Group (D1A)						
GASKET	00.500	24.000		B16.20-ANSI B16.5	SP,WND, SS316+CAF	SPIRAL, 600
GASKET	26.000	30.000		B16.20-ANSI B16.47A	SP,WND, SS316+CAF	SPIRAL, 600

ANNEXURE E

PIPING MATERIAL SPECIFICATION

(A4A - CLASS 150#)

PIPING CLASS : **A4A, 150** #

BASE MATERIAL : CARBON STEEL

CORROSION ALLOWANCE : 1.5 MM

SPECIAL REQUIREMENT : LOW TEMPERATURE SERVICE

TEMPERATURE (Deg. C) AND PRESSURE (Kg/Sq. cm g) RATINGS

TEMP	-45	38	50	100	150
PRESS	18.76	18.76	18.55	17.74	16.11

SERVICE

NON CORROSIVE PROCESS-FLAMMABLE / NON-FLAMMABLE, NON-LETHAL-BELOW -29DEG C AND UPTO -45 DEG C.HYDROCARBONS, XYLENE, METHANOL, NH3, GAS FLARE ETC.

NOTES

1. ALL VENTS AND DRAINS SHALL BE PROVIDED WITH GATE VALVE WITH BLIND FLANGE ASSEMBLY UNLESS OTHERWISE INDICATED IN P&ID.
2. NDT OF WELDS SHALL BE AS FOLLOWS:

   RADIOGRAPHY : ALL BUTT WELDS - 100%

   MPI : SOCKET WELDS - 100%

3. PIPING DESIGN AS PER ASME B 31.8 & OISD 141 & 226
4. IMPACT TESTING IS REQUIRED
5. ALL BRANCH CONNECTIONS INCLUDING VENT, DRAIN, PRESSURE AND TEMPERATURE CONNECTION SHALL BE AS PER BRANCH CONNECTION TABLE GIVEN ON NEXT PAGE. THE BRANCH DETAILS INDICATED IN APPLICABLE STANDARD SHALL BE IGNORED.
6. FOR VALVES REFER RESPECTIVE VALVE DATA SHEET.
7. FOR DIMENSIONS OF HANDLE PROJECTION FOR SPACER & BLIND, REFER Std. SPEC. GAIL-STD-ME-DOC-TS-007

SPECIAL NOTES

ITEM	SIZE	DESCRIPTION
MAINTENANCE JOINTS	ALL	FLANGED, TO BE KEPT MINIMUM
PIPE JOINTS	1.5" & BELOW	SW COUPLING
	2.0" & ABOVE	BUTT WELDED
DRAINS	ON LINES ≤1.5"	REFER GAIL STD GAIL-STD-ME-DOC-TS-003
	ON LINES ≥2.0"	AS PER P&ID OR 0.75" REFER STD. GAIL-STD-ME-DOC-TS-004
VENTS	ON LINES ≤1.5"	REFER GAIL STD. GAIL-STD-ME-DOC-TS-003
	ON LINES ≥2.0"	AS PER P&ID OR 0.75".REFER STD. GAIL-STD-ME-DOC-TS-003
TEMP. CONN	1.5"	FLANGED, INSTALLATION AS PER GAIL STD.GAIL-STD-ME-DOC-TS-005
PRESS. CONN	0.75"	SW NIPPLE WITH GATE VALVE TO SPEC AS PER STD. GAIL-STD-ME-DOC-TS-006

BRANCH PIPE (SIZE IN INCHES)	0.500	0.750	1.000	1.250	1.500	2.000	2.500	3.000	3.500	4.000	5.000	6.000	8.000	10.000	12.000	14.000	BRANCH PIPE (SIZE IN INCHES)
72																	72
70																	70
68																	68
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64																	64
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14																T	14
12															T	T	12
10														T	T	T	10
8.0													T	T	T	T	8.0
6.0												T	T	T	T	T	6.0
5.0																	5.0
4.0										T		T	T	T	W	W	4.0
3.5																	3.5
3.0								T		T		T	W	W	W	W	3.0
2.5																	2.5
2.0						T		T		T		W	W	W	W	W	2.0
1.5					T	T		S		S		S	S	S	S	S	1.5
1.25																	1.25
1.0			T		T	S		S		S		S	S	S	S	S	1.0
0.75		T	T		T	S		S		S		S	S	S	S	S	0.75
0.5	T	T	T		T	S		S		S		S	S	S	S	S	0.5

RUN PIPE (SIZES IN INCH) A4A

CODE	DESCRIPTION		
F	SADDLE FUSED JT	**T**	TEES
H	H.COUPLING	**W**	WELDOLETS
P	PIPE TO PIPE	**I**	INSTRUMENT TEE
R	REINFORCED	**X**	REFER NOTES
S	SOCKOLETS	**L**	SWEEPOLET

Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch./ Thk	Dim. STD	Material	Description
Pipe Group (A4A)						
PIPE	00.500	00.750	S160	B 36.10	ASTM A 333 GR.6	PE, SEAMLESS
PIPE	01.000	01.500	XS	B 36.10	ASTM A 333 GR.6	PE, SEAMLESS
PIPE	02.000	02.000	XS	B 36.10	ASTM A 333 GR.6	BE, SEAMLESS
PIPE	03.000	14.000	STD	B 36.10	ASTM A 333 GR.6	BE, SEAMLESS
NIPPLE	00.500	00.750	M	B 36.10	ASTM A 333 GR.6	PBE,SEAMLESS
NIPPLE	01.000	01.500	M	B 36.10	ASTM A 333 GR.6	PBE, SEAMLESS
Flange Group (A4A)						
FLNG. WN	00.500	14.000	M	B-16.5	ASTM A 350 GR. LF2	150, RF/125 AARH
FLNG.BLIND	00.500	14.000		B-16.5	ASTM A 350 GR. LF2	150, RF/125 AARH
FLNG.FIG.8	00.500	8.000		ASME-B16.48	ASTM A 350 GR. LF2	150, FF/125 AARH
SPCR &BLIND	10.000	14.000		ASME-B16.48	ASTM A 350 GR. LF2	150, FF/125 AARH
Fitting Group (A4A)						
ELBOW.90	00.500	0.750		B-16.11	ASTM A 350 GR.LF2	SW, 6000
ELBOW.90	01.000	1.500		B-16.11	ASTM A 350 GR.LF2	SW, 3000
ELBOW.90	02.000	14.000	M	B-16.9	ASTM A 420 GR.WPL6	BW, 1.5D
ELBOW.45	00.500	0.750		B-16.11	ASTM A 350 GR.LF2	SW, 6000
ELBOW.45	01.000	1.500		B-16.11	ASTM A 350 GR.LF2	SW, 3000
ELBOW.45	02.000	14.000	M	B-16.9	ASTM A 420 GR.WPL6	BW, 1.5D
T.EQUAL	00.500	00.750		B 16.11	ASTM A 350 GR.LF2	SW, 6000
T.EQUAL	01.000	01.500		B 16.11	ASTM A 350 GR.LF2	SW, 3000
T.EQUAL	02.000	14.000	M	B-16.9	ASTM A 420 GR.WPL6	BW
T.RED	00.500	00.750		B-16.11	ASTM A 350 GR.LF2	SW, 6000
T.RED	01.000	01.500		B-16.11	ASTM A 350 GR.LF2	SW, 3000

T.RED	02.000	14.000	M, M	B-16.9	ASTM A 420 GR.WPL6	BW
REDUC.CONC	02.000	14.000	M,M	B-16.9	ASTM A 420 GR.WPL6	BW
REDUC.ECC	02.000	14.000	M,M	B-16.9	ASTM A 420 GR.WPL6	BW
SWAGE.CONC	00.500	03.000	M,M	BS-3799	ASTM A 350 GR.LF2	PBE
SWAGE.ECC	00.500	03.000	M,M	BS-3799	ASTM A 350 GR.LF2	PBE
CAP	00.500	00.750		B-16.11	ASTM A 350 GR.LF2	SCRF, 6000
CAP	01.000	01.500		B-16.11	ASTM A 350 GR.LF2	SCRF, 3000
CAP	02.000	14.000	M	B-16.9	ASTM A 420 GR.WPL6	BW
CPLNG.FULL	00.500	00.750		B-16.11	ASTM A 350 GR.LF2	SW, 6000
CPLNG.FULL	01.000	01.500		B-16.11	ASTM A 350 GR.LF2	SW, 3000
CPLNG-HALF	00.500	00.750		B-16.11	ASTM A 350 GR.LF2	SW, 6000
CPLNG.HALF	01.000	01.500		B-16.11	ASTM A 350 GR.LF2	SW, 3000
CPLNG.LH	00.500	00.750		B-16.11	ASTM A 350 GR.LF2	SW, 6000
CPLNG.LH	01.000	01.500		B-16.11	ASTM A 350 GR.LF2	SW,3000
CPLNG.RED	00.500	00.750		B-16.11	ASTM A 350 GR.LF2	SW, 6000
CPLNG.RED	01.000	01.500		B-16.11	ASTM A 350 GR.LF2	SW, 3000
O' let group(A4A)						
SOCKOLET	00.500	0.750		MSS-SP97	ASTM A 350 GR.LF2	SW, 6000
SOCKOLET	01.000	01.500		MSS-SP97	ASTM A 350 GR.LF2	SW, 3000
WELDOLET	02.000	10.000	M, XXS	MSS-SP97	ASTM A 350 GR.LF2	BW
Valves Group (A4A)						
VLV.GATE	00.500	01.500		API-602	BODY-ASTM A 350 GR. LF2, TRIM-STELLITED, STEM SS-304	SW,800, 3000,B-16.11
VLV.GLOBE	00.500	01.500		BS-5352	BODY-ASTM A 350 GR.LF2, TRIM-STELLITED, STEM SS304	SW,800, 3000,B-16.11
VLV.CHECK	00.500	01.500		BS-5352	BODY-ASTM A 350, GR.LF2, TRIM-STELLITED	SW,800, 3000, B-16.11
Bolt Group (A4A)						
BOLT.STUD	00.500	14.000		B18.2	BOLT: A 320 GR.L7, NUT:A194 GR.4	

Gasket Group (A4A)						
GASKET	00.500	14.000		B16.20-ANSI B16.5	SP,WND, SS316+CAF	SPIRAL, 150

ANNEXURE E

PIPING MATERIAL SPECIFICATION

(B4A - CLASS 300#)

PIPING CLASS	**:**	**B4A, 300** #
BASE MATERIAL	**:**	CARBON STEEL
CORROSION ALLOWANCE	**:**	1.5 MM
SPECIAL REQUIREMENT	**:**	LOW TEMPERATURE SERVICE

TEMPERATURE (Deg. C) AND PRESSURE (Kg/Sq. cm g) RATINGS

TEMP	-45	38	50	100	150
PRESS	48.95	48.95	48.44	46.19	44.76

SERVICE

NON CORROSIVE PROCESS-FLAMMABLE / NON-FLAMMABLE, NON-LETHAL-BELOW -29DEG C AND UPTO -45 DEG C.HYDROCARBONS, XYLENE, PROPYLENE, LPG, METHANOL, NH3, and GAS FLARE ETC.

NOTES

1. ALL VENTS AND DRAINS SHALL BE PROVIDED WITH GATE VALVE WITH BLIND FLANGE ASSEMBLY UNLESS OTHERWISE INDICATED IN P&ID.
2. NDT OF WELDS SHALL BE AS FOLLOWS:

   RADIOGRAPHY : ALL BUTT WELDS - 100%

   MPI : SOCKET WELDS - 100%

3. PIPING DESIGN AS PER ASME B 31.8 & OISD 141 & 226
4. IMPACT TESTING IS REQUIRED
5. ALL BRANCH CONNECTIONS INCLUDING VENT, DRAIN, PRESSURE AND TEMPERATURE CONNECTION SHALL BE AS PER BRANCH CONNECTION TABLE GIVEN ON NEXT PAGE. THE BRANCH DETAILS INDICATED IN APPLICABLE STANDARD SHALL BE IGNORED.
6. FOR VALVES REFER RESPECTIVE VALVE DATA SHEET.
7. FOR DIMENSIONS OF HANDLE PROJECTION FOR SPACER & BLIND, REFER Std. SPEC. GAIL-STD-ME-DOC-TS-007

ITEM	SIZE	DESCRIPTION
MAINTENANCE JOINTS	ALL	FLANGED, TO BE KEPT MINIMUM
PIPE JOINTS	1.5" & BELOW	SW COUPLING
	2.0" & ABOVE	BUTT WELDED
DRAINS	ON LINES ≤1.5"	REFER GAIL STD. GAIL-STD-ME-DOC-TS-003
	ON LINES ≥2.0"	AS PER P&ID OR 0.75" REFER STD. GAIL-STD-ME-DOC-TS-004
VENTS	ON LINES ≤1.5"	REFER GAIL STD. GAIL-STD-ME-DOC-TS-003
	ON LINES ≥2.0"	AS PER P&ID OR 0.75". GAIL-STD-ME-DOC-TS-004
TEMP. CONN	1.5"	FLANGED, INSTALLATION AS PER GAIL STD. GAIL-STD-ME-DOC-TS-005
PRESS. CONN	0.75"	SW NIPPLE WITH GATE VALVE TO SPEC AS PER STD. GAIL-STD-ME-DOC-TS-006

68																	68	
66																	66	
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8.0													T	T	T	T	8.0	
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5.0																	5.0	
4.0										T		T	T	T	W	W	4.0	
3.5																	3.5	
3.0								T		T		T	W	W	W	W	3.0	
2.5																	2.5	
2.0						T		T		T		W	W	W	W	W	2.0	
1.5					T	T		S		S		S	S	S	S	S	1.5	
1.25																	1.25	
1.0			T		T	T		S		S		S	S	S	S	S	1.0	
0.75		T	T		T	T		S		S		S	S	S	S	S	0.75	
0.5	T	T	T		T	S		S		S		S	S	S	S	S	0.5	
	0.500	0.750	1.000	1.250	1.500	2.000	2.500	3.000	3.500	4.000	5.000	6.000	8.000	10.000	12.000	14.000		

RUN PIPE (SIZES IN INCH) – B4A

CODE	DESCRIPTION		
F	SADDLE FUSED JT	**T**	TEES
H	H.COUPLING	**W**	WELDOLETS
P	PIPE TO PIPE	**I**	INSTRUMENT TEE
R	REINFORCED	**X**	REFER NOTES
S	SOCKOLETS	**L**	SWEEPOLET

Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch./ Thk	Dim. STD	Material	Description
Pipe Group (B4A)						
PIPE	00.500	00.750	S160	B 36.10	ASTM A 333 GR.6	PE, SEAMLESS
PIPE	01.000	01.500	XS	B 36.10	ASTM A 333 GR.6	PE, SEAMLESS
PIPE	02.000	02.000	XS	B 36.10	ASTM A 333 GR.6	BE, SEAMLESS
PIPE	03.000	10.000	STD	B 36.10	ASTM A 333 GR.6	BE, SEAMLESS
PIPE	12.000	14.000	S40	B 36.10	ASTM A 333 GR.6	BE, SEAMLESS
NIPPLE	00.500	00.750	M	B 36.10	ASTM A 333 GR.6	PBE,SEAMLESS
NIPPLE	01.000	01.500	M	B 36.10	ASTM A 333 GR.6	PBE, SEAMLESS
Flange Group (B4A)						
FLNG. SW	00.500	1.50	M	B-16.5	ASTM A 350 GR. LF2	300, RF/125 AARH
FLNG. WN	02.000	14.000	M	B-16.5	ASTM A 350 GR. LF2	300, RF/125 AARH
FLNG.BLIND	00.500	14.000		B-16.5	ASTM A 350 GR. LF2	300, RF/125 AARH
FLNG.FIG.8	00.500	8.000		ASME-B16.48	ASTM A 350 GR. LF2	300, FF/125 AARH
SPCR &BLIND	10.000	14.000		ASME-B16.48	ASTM A 350 GR. LF2	300, FF/125 AARH
Fitting Group (B4A)						
ELBOW.90	00.500	0.750		B-16.11	ASTM A 350 GR.LF2	SW, 6000
ELBOW.90	01.000	1.500		B-16.11	ASTM A 350 GR.LF2	SW, 3000
ELBOW.90	02.000	14.000	M	B-16.9	ASTM A 420 GR.WPL6	BW, 1.5D
ELBOW.45	00.500	0.750		B-16.11	ASTM A 350 GR.LF2	SW, 6000
ELBOW.45	01.000	1.500		B-16.11	ASTM A 350 GR.LF2	SW, 3000
ELBOW.45	02.000	14.000	M	B-16.9	ASTM A 420 GR.WPL6	BW, 1.5D
T.EQUAL	00.500	00.750		B 16.11	ASTM A 350 GR.LF2	SW, 6000
T.EQUAL	01.000	01.500		B 16.11	ASTM A 350 GR.LF2	SW, 3000

T.EQUAL	02.000	14.000	M	B-16.9	ASTM A 420 GR.WPL6	BW
T.RED	00.500	00.750		B-16.11	ASTM A 350 GR.LF2	SW, 6000
T.RED	01.000	01.500		B-16.11	ASTM A 350 GR.LF2	SW, 3000
T.RED	02.000	14.000	M, M	B-16.9	ASTM A 420 GR.WPL6	BW
REDUC.CONC	02.000	14.000	M,M	B-16.9	ASTM A 420 GR.WPL6	BW
REDUC.ECC	02.000	14.000	M,M	B-16.9	ASTM A 420 GR.WPL6	BW
SWAGE.CONC	00.500	03.000	M,M	BS-3799	ASTM A 350 GR.LF2	PBE
SWAGE.ECC	00.500	03.000	M,M	BS-3799	ASTM A 350 GR.LF2	PBE
CAP	02.000	14.000	M	B-16.9	ASTM A 420 GR.WPL6	BW
CPLNG.FULL	00.500	00.750		B-16.11	ASTM A 350 GR.LF2	SW, 6000
CPLNG.FULL	01.000	01.500		B-16.11	ASTM A 350 GR.LF2	SW, 3000
CPLNG-HALF	00.500	00.750		B-16.11	ASTM A 350 GR.LF2	SW, 6000
CPLNG.HALF	01.000	01.500		B-16.11	ASTM A 350 GR.LF2	SW, 3000
CPLNG.LH	00.500	00.750		B-16.11	ASTM A 350 GR.LF2	SW, 6000
CPLNG.LH	01.000	01.500		B-16.11	ASTM A 350 GR.LF2	SW,3000
CPLNG.RED	00.500	00.750		B-16.11	ASTM A 350 GR.LF2	SW, 6000
CPLNG.RED	01.000	01.500		B-16.11	ASTM A 350 GR.LF2	SW, 3000
O' let group (B4A)						
SOCKOLET	00.500	0.750		MSS-SP97	ASTM A 350 GR.LF2	SW, 6000
SOCKOLET	01.000	01.500		MSS-SP97	ASTM A 350 GR.LF2	SW, 3000
WELDOLET	02.000	4.000	M, XXS	MSS-SP97	ASTM A 350 GR.LF2	BW
Valves Group (B4A)						
VLV.GATE	00.500	01.500		API-602	BODY-ASTM A 350 GR. LF2, TRIM-STELLITED, STEM SS-304	SW,800, 3000,B-16.11
VLV.GATE	00.200	24.000		API-600	BODY-ASTM A 352 GR. LCB, TRIM-STELLITED, STEM SS-304	FLGD,300, B16.5, RF/125AARH
VLV.GLOBE	00.500	01.500		BS-5352	BODY-ASTM A 350 GR.LF2, TRIM-STELLITED, STEM	SW,800, 3000,B-16.11

					SS304	
VLV.GLOBE	02.000	12.000		BS-1873	BODY-ASTM A 352 GR.LCB, TRIM-STELLITED, STEM SS304	FLGD,300, B16.5, RF/125AARH
VLV.CHECK	00.500	1.500		BS-5352	BODY-ASTM A 350, GR.LF2, TRIM-STELLITED	SW,800, 3000, B-16.11
VLV.CHECK	02.000	24.000		BS-1868	BODY-ASTM A 352, GR.LCB, TRIM-STELLITED	FLGD,300, B16.5, RF/125AARH
VLV.BALL	00.500	16.000		BS-5351	BODY-ASTM A 352, GR.LCB/ ASTM A350, GR.LF2, TRIM-BODY SEAT-RPTFE	FLGD,300, B16.5, RF/125AARH
Bolt Group (B4A)						
BOLT.STUD	00.500	14.000		B18.2	BOLT: A 320 GR.L7, NUT:A194 GR.4	
Gasket Group (B4A)						
GASKET	00.500	14.000		B16.20-ANSI B16.5	SP,WND, SS316+CAF	SPIRAL, 300
Trap/ Strainer Group (B4A)						
STRNR.TEMP	01.500	14.00		GAIL STD.	B:A516GR.70(NORM); INT:SS304	CONETYPE,300,FF/125AARH
STRNR.TEMP	00.500	1.500		GAIL STD.	B:A350GR.LF2 (NORM);INT:SS304	SW, Y-TYPE, 800
STRNR.TEMP	02.000	14.000	M	GAIL STD.	B:A420GR.WPL6; INTR:SS304	BW, T-TYPE

ANNEXURE F

PIPING MATERIAL SPECIFICATION

(D4A - CLASS 600#)

PIPING CLASS : **D4A, 600** #

BASE MATERIAL : CARBON STEEL

CORROSION ALLOWANCE : 1.5 MM

SPECIAL REQUIREMENT : LOW TEMPERATURE SERVICE

TEMPERATURE (Deg. C) AND PRESSURE (Kg/Sq. cm g) RATINGS

TEMP	-45	38	50	100	150
PRESS	97.89	97.89	96.77	92.48	89.63

SERVICE

NON CORROSIVE PROCESS-FLAMMABLE / NON-FLAMMABLE, NON-LETHAL-BELOW -29DEG C AND UPTO -45 DEG C.HYDROCARBONS, XYLENE, METHANOL, NH3, GAS FLARE ETC.

NOTES

1. ALL VENTS AND DRAINS SHALL BE PROVIDED WITH GATE VALVE WITH BLIND FLANGE ASSEMBLY UNLESS OTHERWISE INDICATED IN P&ID.
2. NDT OF WELDS SHALL BE AS FOLLOWS:

   RADIOGRAPHY : ALL BUTT WELDS - 100%

   MPI : SOCKET WELDS - 100%

3. PIPING DESIGN AS PER ASME B 31.8 & OISD 141 & 226
4. IMPACT TESTING IS REQUIRED
5. ALL BRANCH CONNECTIONS INCLUDING VENT, DRAIN, PRESSURE AND TEMPERATURE CONNECTION SHALL BE AS PER BRANCH CONNECTION TABLE GIVEN ON NEXT PAGE. THE BRANCH DETAILS INDICATED IN APPLICABLE STANDARD SHALL BE IGNORED.
6. FOR VALVES REFER RESPECTIVE VALVE DATA SHEET.
7. FOR DIMENSIONS OF HANDLE PROJECTION FOR SPACER & BLIND, REFER Std. SPEC. GAIL-STD-ME-DOC-TS-007

ITEM	SIZE	DESCRIPTION
MAINTENANCE JOINTS	ALL	FLANGED, TO BE KEPT MINIMUM
PIPE JOINTS	1.5" & BELOW	SW COUPLING
	2.0" & ABOVE	BUTT WELDED
DRAINS	ON LINES ≤1.5"	REFER GAIL STD. GAIL-STD-ME-DOC-TS-003
	ON LINES ≥2.0"	AS PER P&ID OR 0.75", REFER STD. GAIL-STD-ME-DOC-TS-004
VENTS	ON LINES ≤1.5"	REFER GAIL STD. GAIL-STD-ME-DOC-TS-003
	ON LINES ≥2.0"	AS PER P&ID OR 0.75". REFER STD. GAIL-STD-ME-DOC-TS-004
TEMP. CONN	1.5"	FLANGED, INSTALLATION AS PER GAIL STD. GAIL-STD-ME-DOC-TS-005
PRESS. CONN	0.75"	SW NIPPLE WITH GATE VALVE TO SPEC AS PER STD. GAIL-STD-ME-DOC-TS-006

	0.500	0.750	1.000	1.250	1.500	2.000	2.500	3.000	3.500	4.000	5.000	6.000	8.000	10.000	12.000	14.000	16.000	18.000	
70																			70
68																			68
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12															T	T	T	T	12
10														T	T	T	T	T	10
8.0													T	T	T	T	T	T	8.0
6.0												T	T	T	T	T	T	W	6.0
5.0																			5.0
4.0										T		T	T	T	W	W	W	W	4.0
3.5																			3.5
3.0								T		T		T	W	W	W	W	W	W	3.0
2.5																			2.5
2.0						T		T		T		W	W	W	W	W	W	W	2.0
1.5					T	T		S		S		S	S	S	S	S	S	S	1.5
1.25																			1.25
1.0			T		T	T		S		S		S	S	S	S	S	S	S	1.0
0.75		T	T		T	T		S		S		S	S	S	S	S	S	S	0.75
0.5	T	T	T		T	S		S		S		S	S	S	S	S	S	S	0.5

RUN PIPE (SIZES IN INCH) – D4A

CODE	DESCRIPTION		
F	SADDLE FUSED JT	T	TEES
H	H.COUPLING	W	WELDOLETS
P	PIPE TO PIPE	I	INSTRUMENT TEE
R	REINFORCED	X	REFER NOTES
S	SOCKOLETS	L	SWEEPOLET

Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch./ Thk	Dim. STD	Material	Description
Pipe Group (D4A)						
PIPE	00.500	00.750	S160	B 36.10	ASTM A 333 GR.6	PE, SEAMLESS
PIPE	01.000	01.500	XS	B 36.10	ASTM A 333 GR.6	PE, SEAMLESS
PIPE	02.000	02.000	XS	B 36.10	ASTM A 333 GR.6	BE, SEAMLESS
PIPE	03.000	3.000	STD	B 36.10	ASTM A 333 GR.6	BE, SEAMLESS
PIPE	4.000	4.000	XS	B 36.10	ASTM A 333 GR.6	BE, SEAMLESS
PIPE	06.000	06.000	XS	B 36.10	ASTM A 333 GR.6	BE, SEAMLESS
PIPE	08.000	8.000	XS	B 36.10	ASTM A 333 GR.6	BE, SEAMLESS
PIPE	10.000	10.000	XS	B 36.10	ASTM A 333 GR.6	BE, SEAMLESS
PIPE	12.000	12.000	19.0	B 36.10	ASTM A 333 GR.6	BE, SEAMLESS
PIPE	14.000	14.000	20.6	B 36.10	ASTM A 333 GR.6	BE, SEAMLESS
PIPE	16.000	16.000	22.2	B 36.10	ASTM A 333 GR.6	BE, SAW
PIPE	18.000	18.000	25.4	B 36.10	ASTM A 333 GR.6	BE, SAW
NIPPLE	00.500	00.750	M	B 36.10	ASTM A 333 GR.6	PBE,SEAMLESS
NIPPLE	01.000	01.500	M	B 36.10	ASTM A 333 GR.6	PBE, SEAMLESS
Flange Group (D4A)						
FLNG. SW	00.500	1.50	M	B-16.5	ASTM A 350 GR. LF2	600, RF/125 AARH
FLNG. WN	02.000	18.000	M	B-16.5	ASTM A 350 GR. LF2	600, RF/125 AARH
FLNG.BLIND	00.500	18.000		B-16.5	ASTM A 350 GR. LF2	600, RF/125 AARH
FLNG.FIG.8	00.500	8.000		ASME-B16.48	ASTM A 350 GR. LF2	600, FF/125 AARH
SPCR &BLIND	10.000	18.000		ASME-B16.48	ASTM A 350 GR. LF2	600, FF/125 AARH
Fitting Group (D4A)						
ELBOW.90	00.500	0.750		B-16.11	ASTM A 350 GR.LF2	SW, 6000
ELBOW.90	01.000	1.500		B-16.11	ASTM A 350 GR.LF2	SW, 3000

ELBOW.90	02.000	14.000	M	B-16.9	ASTM A 420 GR.WPL6	BW, 1.5D
ELBOW.90	16.000	18.000	M	B-16.9	ASTM A 420 GR.WPL6-W	BW, 1.5D
ELBOW.45	00.500	0.750		B-16.11	ASTM A 350 GR.LF2	SW, 6000
ELBOW.45	01.000	1.500		B-16.11	ASTM A 350 GR.LF2	SW, 3000
ELBOW.45	02.000	14.000	M	B-16.9	ASTM A 420 GR.WPL6	BW, 1.5D
ELBOW.45	16.000	18.000	M	B-16.9	ASTM A 420 GR.WPL6-W	BW, 1.5D
T.EQUAL	00.500	00.750		B 16.11	ASTM A 350 GR.LF2	SW, 6000
T.EQUAL	01.000	01.500		B 16.11	ASTM A 350 GR.LF2	SW, 3000
T.EQUAL	02.000	14.000	M	B-16.9	ASTM A 420 GR.WPL6	BW
T.EQUAL	16.000	18.000	M	B-16.9	ASTM A 420 GR.WPL6-W	BW
T.RED	00.500	00.750		B-16.11	ASTM A 350 GR.LF2	SW, 6000
T.RED	01.000	01.500		B-16.11	ASTM A 350 GR.LF2	SW, 3000
T.RED	02.000	14.000	M, M	B-16.9	ASTM A 420 GR.WPL6	BW
T.RED	16.000	18.000	M, M	B-16.9	ASTM A 420 GR.WPL6-W	BW
SWAGE.CONC	00.500	03.000	M,M	BS-3799	ASTM A 350 GR.LF2	PBE
SWAGE.ECC	00.500	03.000	M,M	BS-3799	ASTM A 350 GR.LF2	PBE
CAP	00.500	0.750		B-16.11	ASTM A 350, GR.LF2	SCRF, 6000
CAP	01.000	1.500		B-16.11	ASTM A 350 GR.LF2	SCRF, 3000
CAP	02.000	18.000	M	B-16.9	ASTM A 420 GR.WPL6	BW
PLUG	00.500	0.750		B-16.11	ASTM A 350, GR.LF2	SCRM, 6000
PLUG	01.000	1.500		B-16.11	ASTM A 350 GR.LF2	SCRM, 3000
CPLNG.FULL	00.500	00.750		B-16.11	ASTM A 350 GR.LF2	SW, 6000
CPLNG.FULL	01.000	01.500		B-16.11	ASTM A 350 GR.LF2	SW, 3000
CPLNG-HALF	00.500	00.750		B-16.11	ASTM A 350 GR.LF2	SW, 6000
CPLNG.HALF	01.000	01.500		B-16.11	ASTM A 350 GR.LF2	SW, 3000
CPLNG.LH	00.500	00.750		B-16.11	ASTM A 350 GR.LF2	SW, 6000
CPLNG.LH	01.000	01.500		B-16.11	ASTM A 350 GR.LF2	SW,3000
CPLNG.RED	00.500	00.750		B-16.11	ASTM A 350 GR.LF2	SW, 6000

CPLNG.RED	01.000	01.500		B-16.11	ASTM A 350 GR.LF2	SW, 3000
O' let group (D4A)						
SOCKOLET	00.500	0.750		MSS-SP97	ASTM A 350 GR.LF2	SW, 6000
SOCKOLET	01.000	01.500		MSS-SP97	ASTM A 350 GR.LF2	SW, 3000
WELDOLET	02.000	6.000	M, XXS	MSS-SP97	ASTM A 350 GR.LF2	BW
Valves Group (D4A)						
VLV.GATE	00.500	01.500		API-602	BODY-ASTM A 350 GR. LF2, TRIM-STELLITED, STEM SS-304	SW,800, 3000,B-16.11
VLV.GLOBE	00.500	01.500		BS-5352	BODY-ASTM A 350 GR.LF2, TRIM-STELLITED, STEM SS304	SW,800, 3000,B-16.11
VLV.CHECK	00.500	1.500		BS-5352	BODY-ASTM A 350, GR.LF2, TRIM-STELLITED	SW,800, 3000, B-16.11
VLV.PLUG	00.500	1.500		BS-5353	BODY-ASTM A 350, GR.LF2, PLUG:A350 GR.LF2+0.003" ENP	SW,800, 3000, B-16.11
VLV.PLUG	02.000	18.000		API-6D	BODY-ASTM A 352, GR.LCB/ ASTM A350, GR.LF2, TRIM-SS 304/ SS316	BW, 600, B-16.25
Bolt Group (D4A)						
BOLT.STUD	00.500	18.000		B18.2	BOLT: A 320 GR.L7, NUT:A194 GR.4	
Gasket Group (D4A)						
GASKET	00.500	18.000		B16.20-ANSI B16.5	SP,WND, SS316+CAF	SPIRAL, 600

ANNEXURE G

PIPING MATERIAL SPECIFICATION

(J2A - CLASS 150#)

PIPING CLASS : **J2A, 150 #**

BASE MATERIAL : **CS (Galv.)**

CORROSION ALLOWANCE : 0 MM

SPECIAL REQUIREMENT :

TEMPERATURE (Deg. C) AND PRESSURE (Kg/Sq. cm g) RATINGS

SERVICE

POTABLE WATER (ABOVE GROUND), FIRE WATER-SPRINKLER SYSTEM AFTER ORIFICE

NOTES

1. NDT REQUIREMENTS AS PER GAIL STANDARD – GAIL-STD-ME-DOC-TS-022
2. THREADED JOINTS SHALL BE MADE WITH 1" WIDTH PTFE JOINTING TAPE.
3. SURFACES WHERE GALVANISING HAS BEEN BURNT OFF SHALL BE WIRE BRUSHED AND COLD GALVANISED WITH ZINC COATING COMPOUND.

SPECIAL NOTES

ITEM	SIZE	DESCRIPTION
MAINTENANCE JOINTS	1.5" & BELOW	UNIONS (SCRF) TO BE KEPT MINIMUM
	2" & ABOVE	FLANGED (SCREWED) TO BE KEPT MINIMUM
PIPE JOINTS	UP TO 6"	SCREWED COUPLING
DRAINS	ON LINES ≤1.5"	REFER GAIL STD. GAIL-STD-ME-DOC-TS-003
	ON LINES ≥2.0"	AS PER P&ID OR 0.75" REFER STD. GAIL-STD-ME-DOC-TS-004
VENTS	ON LINES ≤1.5"	REFER GAIL STD. GAIL-STD-ME-DOC-TS-003
	ON LINES ≥2.0"	AS PER P&ID OR 0.75". REFER STD. GAIL-STD-ME-DOC-TS-004
TEMP. CONN	1.5"	FLANGED, INSTALLATION AS PER GAIL STD. GAIL-STD-ME-DOC-TS-005
PRESS. CONN	0.75"	SCREWED NIPPLE WITH VALVE TO SPEC. GAIL-STD-ME-DOC-TS-006

	0.500	0.500	0.750	1.000	1.250	1.500	2.000	2.500	3.000	3.500	4.000	5.000	6.000	
70														70
68														68
66														66
64														64
62														62
60														60
58														58
56														56
54														54
52														52
50														50
48														48
46														46
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36														36
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32														32
30														30
28														28
26														26
24														24
22														22
20														20
18														18
16														16
14														14
12														12
10														10
8.0														8.0
6.0													T	6.0
5.0														5.0
4.0											T		T	4.0
3.5														3.5
3.0									T		T		T	3.0
2.5														2.5
2.0							T		T		T		T	2.0
1.5						T	T		T		T		T	1.5
1.25														1.25
1.0				T		T	T		T		T		T	1.0
0.75			T	T		T	T		T		T		T	0.75
0.5	T	T	T	T		T	T		T		T		T	0.5

RUN PIPE (SIZES IN INCH) – J2A

CODE	DESCRIPTION		
F	SADDLE FUSED JT	**T**	TEES
H	H.COUPLING	**W**	WELDOLETS
P	PIPE TO PIPE	**I**	INSTRUMENT TEE
R	REINFORCED	**X**	REFER NOTES
S	SOCKOLETS	**L**	SWEEPOLET

Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch./ Thk	Dim. STD	Material	Description
Pipe Group (J2A)						
PIPE	00.500	06.000	HVY	IS-1239-I	IS-1239 (GALV)	SCRM, WELDED
Flange Group(J2A)						
FLNG. SCRD	00.500	06.00		B-16.5	ASTM A 105 (GALV.)	150, FF/125 AARH
FLNG.BLIND	00.500	06.000		B-16.5	ASTM A 105 (GALV.)	150, FF/125 AARH
FLNG.FIG.8	00.500	06.000		ASME-B16.48	ASTM A 105 (GALV.)	150, FF/125 AARH
Fitting Group(J2A)						
ELBOW.90	00.500	1.500		B-16.11	ASTM A 105 (GALV.)	SCRF, 3000
ELBOW.90	02.000	6.000		IS-1239-II	IS-1239 (PART-II) (GALV.)	SCRF, NA
ELBOW.45	00.500	1.500		B-16.11	ASTM A 105 (GALV.)	SCRF, 3000
ELBOW.45	02.000	6.000		IS-1239-II	IS-1239 (PART-II) (GALV.)	SCRF, NA
T.EQUAL	00.500	01.500		B-16.11	ASTM A 105 (GALV.)	SCRF, 3000
T.EQUAL	02.000	6.000		IS-1239-II	IS-1239 (PART-II) (GALV.)	SCRF, NA
T.RED	00.500	01.500		B-16.11	ASTM A 105 (GALV.)	SCRF, 3000
T.RED	02.000	6.000		IS-1239-II	IS-1239 (PART-II) (GALV.)	SCRF, NA
SWAGE.CONC	00.500	03.000	M,M	BS-3799	ASTM A 105 (GALV.)	TBE
SWAGE.ECC	00.500	03.000	M,M	BS-3799	ASTM A 105 (GALV.)	TBE
CAP	00.500	1.500		B-16.11	ASTM A 105 (GALV.)	SCRF, 3000
CAP	02.000	6.000		IS-1239-II	IS-1239 (PART-II) (GALV.)	SCRF, NA
CPLNG.FULL	00.500	01.500		B-16.11	ASTM A 105 (GALV.)	SCRF, 3000
CPLNG.HALF	00.500	01.500		B-16.11	ASTM A 105 (GALV.)	SCRF, 3000
CPLNG.LH	00.500	01.500		B-16.11	ASTM A 105 (GALV.)	SCRF, 3000
CPLNG.RED	00.500	01.500		B-16.11	ASTM A 105 (GALV.)	SCRF, 3000

UNION	00.500	06.000		IS-1239-II	IS-1239 (PART-II) (GALV.)	SCRF, NA
Valves Group(J2A)						
VLV.GATE	00.500	01.500		IS:778 CL.2	BODY-IS 318 GR.2 LEADED TIN BRONZE, TRIM-IS320 ALLOY HT2	SCRF, CL.2, 3000, B-1.20.1
VLV.GATE	02.000	6.000		IS:780	BODY-IS 210,GR.FG 200, TRIM-IS 320 ALLOY HT2	FLGD, PN 1.6, B 16.1,FF/125AARH
VLV.GLOBE	00.500	01.500		IS:778 CL.2	BODY-IS 318 GR.2 LEADED TIN BRONZE, TRIM-IS320 ALLOY HT2	SCRF, CL.2, 3000, B-1.20.1
VLV.CHECK	00.500	1.500		IS:778 CL.2	BODY-IS 318 GR.2 LEADED TIN BRONZE, TRIM-IS320 ALLOY HT2	SCRF, CL.2, 3000, B-1.20.1
VLV.CHECK	02.000	6.000		IS:5312 (PT-1)	BODY-IS 210 GR.FG 200, TRIM-IS 320 ALLOY HT2	FLGD, PN1.6, B-16.1, FF/125AARH
Bolt Group(J2A)						
BOLT.M/C	00.500	6.000		B18.2	BOLT: A 307, GR.B (GALV), NUT:A563 GR.B (GALV)	
Gasket Group(J2A)						
GASKET	00.500	6.000		B16.21-ANSI B16.5	BUTYL RUBBER	FULL FACE, 150, 2MM

ANNEXURE H

PIPING MATERIAL SPECIFICATION

(A93A - CLASS 150#)

PIPING CLASS : **A93A, 150** #

BASE MATERIAL : CARBON STEEL

CORROSION ALLOWANCE : 1.5 MM

SPECIAL REQUIREMENT :

TEMPERATURE (Deg. C) AND PRESSURE (Kg/Sq. cm g) RATINGS

TEMP	0	38	50	65
PRESS	18.9	18.9	18.9	18.9

SERVICE

FIRE WATER (ABOVE GROUND / UNDER GROUND)

NOTES

1. FOR T-TYPE BW STRAINERS, REFER STD. DRAWINGS.
2. FORGINGS ARE ACCEPTABLE IN LIEU OF PLATE MATERIAL.
3. SIZES GIVEN IN PMS ARE NOMINAL BORE FOR O.D. OF IS 3589 PIPES REFER ANSI B36.10.
4. BUTTERFLY VALVE SHALL BE LUGGED WAFER TYPE UP TO 24" AND DOUBLE FLANGED BODY FOR SIZES BEYOND 24".
5. PIPE THICKNESS ARE JOB SPECIFIC BASED ON THE SOIL PROPERTIES OF JOB SITE AND DEPTH OF TOP OF PIPE OF 1.5M. NO LIVE LOAD HAS BEEN CONSIDERED FOR CALCULATION OF PIPE THICKNESS. LIVE LOADS WHEREVER EXPECTED SHALL BE SUITABLY TAKEN CARE OF.
6. NDT REQUIREMENT SHALL BE SAME AS FOR CLASS A1A OF GAIL STANDARD GAIL-STD-ME-DOC-TS-022
   AND TAC REQUIREMENT FOR RADIOGRAPHY SHALL ALSO BE COMPLIED WITH.

SPECIAL NOTES

ITEM	SIZE	DESCRIPTION
MAINTENANCE JOINTS	ALL	FLANGED, TO BE KEPT MINIMUM
PIPE JOINTS	1.5" & BELOW	SW COUPLING
	2.0" & ABOVE	BUTT WELDED
DRAINS	ON LINES ≤1.5"	REFER GAIL STD.GAIL-STD-ME-DOC-TS-003
	ON LINES ≥2.0"	AS PER P&ID OR 0.75" REFER STD. GAIL-STD-ME-DOC-TS-004
VENTS	ON LINES ≤1.5"	REFER GAIL STD. GAIL-STD-ME-DOC-TS-003
	ON LINES ≥2.0"	AS PER P&ID OR 0.75"REFER STD. GAIL-STD-ME-DOC-TS-004
TEMP. CONN	1.5"	FLANGED, INSTALLATION AS PER GAIL STD. GAIL-STD-ME-DOC-TS-005
PRESS. CONN	0.75"	SW NIPPLE WITH GATE VALVE TO SPEC AS PER STD. GAIL-STD-ME-DOC-TS-006

	0.500	0.750	1.000	1.250	1.500	2.000	2.500	3.000	3.500	4.000	5.000	6.000	8.000	10.000	12.000	14.000	
70																	70
68																	68
66																	66
64																	64
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18																	18
16																	16
14																T	14
12															T	R	12
10														T	R	R	10
8.0													T	R	R	R	8.0
6.0												T	P	R	R	R	6.0
5.0																	5.0
4.0										T		R	P	R	R	R	4.0
3.5																	3.5
3.0								T		P		R	P	R	R	R	3.0
2.5																	2.5
2.0						T		P		P		R	P	R	R	R	2.0
1.5					T	T		H		H		H	H	H	H	H	1.5
1.25																	1.25
1.0			T		T	H		H		H		H	H	H	H	H	1.0
0.75		T	T		T	H		H		H		H	H	H	H	H	0.75
0.5	T	T	T		T	H		H		H		H	H	H	H	H	0.5

RUN PIPE (SIZES IN INCH) – A93A

CODE	DESCRIPTION		
F	SADDLE FUSED JT	**T**	TEES
H	H.COUPLING	**W**	WELDOLETS
P	PIPE TO PIPE	**I**	INSTRUMENT TEE
R	REINFORCED	**X**	REFER NOTES
S	SOCKOLETS	**L**	SWEEPOLET

Item Type	Lower Size (Inch)	Upper Size (Inch)	Sch./ Thk	Dim. STD	Material	Description
Pipe Group (A93A)						
PIPE	00.500	01.500	HVY	IS-1239-I	IS-1239 (BLACK)	PE, C. WELDED
PIPE	02.000	06.000	HVY	IS-1239-I	IS-1239 (BLACK)	BE, C. WELDED
PIPE	08.000	12.000	6.0	IS-3589	IS-3589 GR.410	BE, WELDED
PIPE	14.000	14.000	8.0	IS-3589	IS-3589 GR.410	BE, SEAMLESS
NIPPLE	00.500	01.500	HVY		IS-1239 (BLACK)	PBE, C. WELDED
Flange Group(A93A)						
FLNG. SW	00.500	1.50	M	B-16.5	ASTM A 105	150, RF/125 AARH
FLNG. SO	02.000	14.000		B-16.5	ASTM A 105	150, RF/125 AARH
FLNG.BLIND	00.500	14.000		B-16.5	ASTM A 105	150, RF/125 AARH
FLNG.FIG.8	00.500	8.000		ASME-B16.48	ASTM A 105	150, FF/125 AARH
SPCR &BLIND	10.000	14.000		ASME-B16.48	ASTM A 105	150, FF/125 AARH
Fitting Group(A93A)						
ELBOW.90	00.500	1.500		B-16.11	ASTM A 105	SW, 3000
ELBOW.90	02.000	6.000	STD	B-16.9	ASTM A 234 GR.WPB	BW, 1.5D
ELBOW.90	8.000	14.000	M	B-16.9	ASTM A 234 GR.WPB-W	BW, 1.5D
ELBOW.45	00.500	1.500		B-16.11	ASTM A 105	SW, 3000
ELBOW.45	02.000	6.000	STD	B-16.9	ASTM A 234 GR.WPB	BW, 1.5D
ELBOW.45	08.000	14.000	M	B-16.9	ASTM A 234 GR.WPB-W	BW, 1.5D
T.EQUAL	00.500	01.500		B 16.11	ASTM A 105	SW, 3000
T.EQUAL	02.000	6.000	STD	B 16.9	ASTM A 234 GR.WPB	BW
T.EQUAL	08.000	14.000	M	B-16.9	ASTM A 234 GR.WPB-W	BW
T.RED	00.500	01.500		B-16.11	ASTM A 105	SW, 3000
T.RED	02.000	06.000	STD.,STD	B-16.9	ASTM A 234 GR.WPB	BW

T.RED	08.000	14.000	M, M	B-16.9	ASTM A 234 GR.WPB-W	BW
REDUC.CONC	02.000	06.000	STD.,STD	B-16.9	ASTM A 234 GR.WPB	BW
REDUC.CONC	08.000	14.000	M, M	B-16.9	ASTM A 234 GR.WPB-W	BW
REDUC.ECC	02.000	06.000	STD.,STD	B-16.9	ASTM A 234 GR.WPB	BW
REDUC.ECC	08.000	14.000	M, M	B-16.9	ASTM A 234 GR.WPB-W	BW
SWAGE.CONC	00.500	03.000	M,M	BS-3799	ASTM A 105	PBE
SWAGE.ECC	00.500	03.000	M,M	BS-3799	ASTM A 105	PBE
CAP	00.500	1.500		B-16.11	ASTM A 105	SCRF, 3000
CAP	02.000	6.000	STD	B-16.9	ASTM A 234 GR.WPB	BW
CAP	08.000	14.000	M	B-16.9	ASTM A 234 GR.WPB	BW
CPLNG.FULL	00.500	01.500		B-16.11	ASTM A 105	SW, 3000
CPLNG.HALF	00.500	01.500		B-16.11	ASTM A 105	SW, 3000
CPLNG.LH	00.500	01.500		B-16.11	ASTM A 105	SW, 3000
CPLNG.RED	00.500	01.500		B-16.11	ASTM A 105	SW, 3000
UNION	00.500	01.500		BS-3799	ASTM A 105	SW, 3000
Valves Group(A93A)						
VLV.GATE	00.500	01.500		API-602	BODY-ASTM A 105, TRIM-STELLITED, STEM 13%CR. STEEL	SW,800, 3000,B-16.11
VLV.GATE	02.000	24.000		API-600	BODY-ASTM A 216 GR.WCB, TRIM-13% CR. STEEL	FLGD, 150, B16.5, RF/125AARH
VLV.GLOBE	00.500	01.500		BS-5352	BODY-ASTM A 105, TRIM-STELLITED, STEM 13%CR. STEEL	SW,800, 3000,B-16.11
VLV.GLOBE	02.000	16.000		BS-1873	BODY-ASTM A 216 GR.WCB, TRIM-13% CR. STEEL	FLGD, 150, B16.5, RF/125AARH
VLV.CHECK	00.500	1.500		BS-5352	BODY-ASTM A 105, TRIM-STELLITED,	SW,800, 3000,B-16.11
VLV.BTRFLY	02.000	24.000		BS-5155	BODY-ASTM A 216 GR. WCB, TRIM-13% CR.STEEL,	WAFL, 150, B16.5, WAF/ 125AARH
Bolt Group(A93A)						
BOLT.STUD	00.500	14.000		B18.2	BOLT: A 193 GR.B7, NUT:A194 GR.2H	
Gasket Group(A93A)						

GASKET	00.500	14.000		B16.21-ANSI B16.5	IS-2712-GR. W/3	RING, 150, 2MM
Trap/ Strainer Group(A93A)						
STRNR.PERM	00.500	1.500		MNF'STD	B:A105;INT;SS304	SW, Y-TYPE, 800
STRNR.PERM	02.000	6.000	M	GAIL STD	B:A234GR.WPB;INT:SS304	BW, T-TYPE
STRNR.PERM	08.000	14.000	M	GAIL STD	B:A234GR.WPBW;INT:SS304	BW, T-TYPE

GAIL INDIA LIMITED

DATASHEET

FOR

BALL VALVES 2 INCHES TO 24 INCHES

GAIL-STD-IN-DOC-DS-022

0	11.04.2019	Issued for Bid	AP	JR	SB	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Valve Manufacturer		**-------**	
Actuator Manufacturer		**-------**	
Valve Tag No.			
Purchaser's spec.:	GAIL-STD-ME-DOC-TS-008	**ANSI Rating:**	150#/300# /600#
Design standard:	API 6D	**Piping class:**	A1A / B1A / D1A
SIZE, mm (IN) NB:	50 (2") – 600 (24")	**VALVE BORE:**	FULL
Ends:	Flanged End as per ASME B16.5 RF/ BW End as per ASME 16.25	**Face finish of flanges:**	125 AARH (Smooth Finish), if FL
VALVE DESIGN CONDITIONS:			
Corrosion Allowance:	1.5 mm	**Temperature, ^{0}c:**	-29 TO 65
Service	Natural Gas	**Installation:**	Above Ground/ Below Ground
Design factor:	0.5		
CONNECTING PIPE DETAILS:			

VALVE OPERATOR REQUIREMENT		**STEM EXTENSION REQUIREMENT**	
Type of Operator	---------	**Stem Extension**	NOT REQUIRED
Operator Spec. No.:	----------	**Length of Stem extension, m**	NA
Operator Data Sheet:	**--------**		

VALVE MATERIAL SPECIFICATION:		
PART DESCRIPTION	**SPECIFIED MATERIAL**	**MATERIAL OFFERED**
Body	ASTM A 216 Gr. WCB/ ASTM A 216 Gr. WCC/ ASTM A 350 LF2	
Ball	(ASTM A 216 Gr. WCB/ ASTM A 216 Gr. WCC/ ASTM A350 LF2) + 0.003" ENP	
Body Seat Rings	(AISI 4140 + 0.003" ENP) / AISI 410/ A 350 LF2 & PTFE	
Seat Seal (Secondary)	VITON or Superior	
Stem	(AISI 4140 + 0.003" ENP) / AISI 410/ ASTM A 350 LF2 + 0.003" ENP	
Stem seal	PTFE / VITON	
Stud, Bolts	ASTM A 193 Gr. B7/ Gr. B7M	
Nuts	ASTM A 194 Gr. 2H/ Gr. 4/ Gr. 7	

Note:

1. The data sheet shall be read in conjunction with technical specification for ball valves Doc.No. GAIL-STD-ME-DOC-TS-008 & Technical Notes for Pipeline Valves Doc. No. GAIL-STD-ME-DOC-TS-016.
2. All inspection and testing shall be carried out as per API 6D.
3. Fire test shall be carried out as per fire testing as specified in API 6FA.

For BW Valve

1. Material of body shall have guaranteed minimum yield strength of 2/3rd of pipe strength. In case the same cannot be guaranteed, valve shall be provided with a 300 mm pup piece integrally welded to the valve whose strength shall be equivalent to attached pipe specification.

2. For the welding end, the out of roundness (i.e. difference between maximum and minimum ID at pipe end) shall be maximum 4.5 mm for 36" size and 3.5 mm for up to 30" size. Tolerance on internal diameter at pipe ends shall be same as diameter tolerance for the pipe ends indicated in API 5L Table-10

For BW/ FE Valve

1. All valves shall have provision for local operation as well as remote actuated operation. Refer Datasheet for Gas Powered Valve Actuator.
2. The data sheet shall be read in conjunction with valve specification, actuator specification & actuator data sheet enclosed in the bid.

For Manual Valve

1. Requirement of manual operator (Wrench/ Hand wheel/ Gear Operator) shall be as per Specification for Ball Valve, Spec. No. GAIL-STD-ME-DOC-TS-008.
2. Separate wrench shall be provided with each wrench-operated valve.

GAIL INDIA LIMITED

DATASHEET

FOR

BLL VALVES 0.5 INCHES TO 1.5 INCHES

GAIL-STD-IN-DOC-DS-023

0	11.04.2019	Issued for Bid	AP	JR	SB	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Valve Manufacturer		**-------**	
Actuator Manufacturer		**-------**	
Valve Tag No.			
Purchaser's spec.:	GAIL-STD-ME-DOC-TS-016	**ANSI Rating:**	800#
Design standard:	BS EN ISO 17292	**Piping class:**	D1A
SIZE, mm (IN) NB:	15 (1/2") TO 40 (1 ½")	**VALVE BORE:**	As per P&ID
Ends:	BOTH ENDS SW AS PER ASME B 16.11	**Face finish of flanges:**	Not Applicable
VALVE DESIGN CONDITIONS:			
Corrosion Allowance:	1.5 mm	**Temperature, ^{0}c:**	-29 TO 65
Service	Natural Gas	**Installation:**	Above Ground
Design factor:	0.5		
CONNECTING PIPE DETAILS:			
Diameter (NB),mm	----------		
Wall Thickness, mm	----------		
VALVE OPERATOR REQUIREMENT		**STEM EXTENSION REQUIREMENT**	
Type of Operator	Manual	**Stem Extension**	NOT REQUIRED
Operator Spec. No.:	----------	**Length of Stem extension, m**	NA
Operator Data Sheet:	**----------**		

VALVE MATERIAL SPECIFICATION:		
PART DESCRIPTION	**SPECIFIED MATERIAL**	**MATERIAL OFFERED**
Body	ASTM A 105	
Ball	13% Cr. Steel	
Body Seat	RPTFE / DELRIN	
Gland	13% Cr. Steel	
Stem	13% Cr. Steel (no casting)	
Stem seal	Grafoil	
Stud, Bolts	ASTM A 193 Gr. B7	
Nuts	ASTM A 194 Gr. 2H	

Note:

1. Valves shall have ball position indicator.
2. Stops shall be provided to ensure positive alignment of ball with ports and ensure proper installation of handle.
3. Painting of the valves shall be as per manufacturer's standard.
4. All test shall be as per BS EN 12266-1
5. Material test certificates and Hydrostatic test reports shall be furnished prior to dispatch.
6. Detailed dimensional drawings showing cross section with part numbers and materials shall be submitted for information at the time of bidding.
7. The above-mentioned drawings shall also be submitted for Purchaser's approval prior to manufacture of the valves.
8. Fire safe test shall be as per API 607 IVth edition (1993) / BS EN 12266-2.
9. Floating ball valve shall be provided with pressure equalization seats to relieve the Body – bonnet cavity pressure to the upstream side.
10. All valves shall be bi-directional type.
11. Valves shall be wrench operated. Each valve shall be supplied with one wrench.
12. Gland packing assembly shall permit repair of gland packing under full line pressure.
13. Stem seal shall be renewable with valve open on stream.

14. The data sheet shall be read in conjunction with technical notes for valves.

15. 10% valves in each size shall undergo hydrostatic test of seat. Soft seat shall be replaced after hydrostatic test. After hydrostatic test valves shall be air tested.

16. Bidder to furnish soft seat details such as type, grade & class selected for RPTFE from ASTM D 4745 with manufacturer's recommendations like pressure- temperature rating from curve / table.

17. Stem seal/ Body seal material shall be provided with corrosion inhibitor.

18. Ball valve shall have lock open (LO) / lock close (LC) provision, if indicated in the P&ID.

GAIL INDIA LIMITED

DATASHEET

FOR

BALL VALVES 2 INCHES TO 24 INCHES (LTCS)

GAIL-STD-IN-DOC-DS-024

0	11.04.2019	Issued for Bid	AP	JR	SB	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Valve Manufacturer		**-------**	
Actuator Manufacturer		**-------**	
Valve Tag No.			
Purchaser's spec.:	GAIL-STD-ME-DOC-TS-008	**ANSI Rating:**	150#/ 300# / 600#
Design standard:	API 6D	**Piping class:**	A4A/B4A/D4A
SIZE, mm (IN) NB:	NB≥ 2"	**VALVE BORE:**	FULL
Ends:	Flanged End as per ASME B16.5 RF/ BW End as per ASME 16.25	**Face finish of flanges:**	125 AARH (Smooth Finish), if FL
VALVE DESIGN CONDITIONS:			
Corrosion Allowance:	1.5 mm	**Temperature, ^{0}c:**	-45 TO 65
Service	Natural Gas	**Installation:**	Above Ground/ Below Ground
Design factor:	0.5		
CONNECTING PIPE DETAILS:			

VALVE OPERATOR REQUIREMENT		**STEM EXTENSION REQUIREMENT**	
Type of Operator	-----	**Stem Extension**	NOT REQUIRED
Operator Spec. No.:	-----	**Length of Stem extension, m**	Not Applicable
Operator Data Sheet:	**-----**		

VALVE MATERIAL SPECIFICATION:		
PART DESCRIPTION	**SPECIFIED MATERIAL**	**MATERIAL OFFERED**
Body	A 352 Gr. LCB/A 350 Gr. LF2	
Ball	SS316/ A 352 Gr.LCB/A 350 Gr. LF2 with 75 ŋENP coating	
Body Seat Rings	VITON/DEVLON for Floating type and SS316/ ASTM A352 Gr. LCB / A 350 GR. LF2 with 75 Micron ENP coating for Trunnion Mounted type	
Seat Seal (Secondary)	VITON/DEVLON for TMBV	
Stem	[(ASTM A350 Gr. LF2/SS 316)+75 microns ENP](No casting)	
Stem seal	VITON/PTFE	
Stud, Bolts	ASTM A320 Gr. 7	
Nuts	A194 Gr. 4	

Note:

1. The data sheet shall be read in conjunction with Technical Specification for Ball Valves Doc.No. GAIL-STD-ME-DOC-TS-008 & Technical Notes for Pipeline Valves Doc. No. GAIL-STD-ME-DOC-TS-016.
2. All inspection and testing shall be carried out as per API 6D.
3. Fire test shall be carried out as per fire testing as specified in API 6FA.

For BW Valve

1. Material of body shall have guaranteed minimum yield strength of 2/3rd of pipe strength. In case the same cannot be guaranteed, valve shall be provided with a 300 mm pup piece integrally welded to the valve whose strength shall be equivalent to attached pipe specification.
2. For the welding end, the out of roundness (i.e. difference between maximum and minimum ID at pipe end) shall be maximum 4.5 mm for 36" size and 3.5 mm for up to 30" size. Tolerance on internal diameter at pipe ends shall be same as diameter tolerance for the pipe ends indicated in API 5L Table-10

For BW/ FE Valve

1. All valves shall have provision for local operation as well as remote actuated operation. Refer Datasheet for Gas Powered Valve Actuator.

2. The data sheet shall be read in conjunction with valve specification, actuator specification & actuator data sheet enclosed in the bid.

For Manual Valve

1. Requirement of manual operator (Wrench/ Hand wheel/ Gear Operator) shall be as per Specification for Ball Valve, Spec. No. GAIL-STD-ME-DOC-TS-008.

2. Separate wrench shall be provided with each wrench-operated valve.

GAIL INDIA LIMITED

DATASHEET

FOR

BLL VALVES 2 INCHES AND BELOW

GAIL-STD-IN-DOC-DS-025

0	11.04.2019	Issued for Bid	AP	JR	SB	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Valve Manufacturer		**-------**	
Actuator Manufacturer		**-------**	
Valve Tag No.			
Purchaser's spec.:	GAIL-STD-ME-DOC-TS-008	**ANSI Rating:**	800#
Design standard:	BS EN 17292	**Piping class:**	D4A
SIZE, mm (IN) NB:	NB < 2"	**VALVE BORE:**	FULL
Ends:	BOTH ENDS SHALL BE SW AS PER ASME B 16.11	**Face finish of flanges:**	Not Applicable.
VALVE DESIGN CONDITIONS:			
Corrosion Allowance:	1.5 mm	**Temperature, ^{0}c:**	-45 TO 65
Service	Natural Gas	**Installation:**	Above Ground/ Below Ground
Design factor:	0.5		
CONNECTING PIPE DETAILS:			

VALVE OPERATOR REQUIREMENT		**STEM EXTENSION REQUIREMENT**	
Type of Operator	Manual	**Stem Extension**	NOT REQUIRED
Operator Spec. No.:	-------	**Length of Stem extension, m**	NA
Operator Data Sheet:	**------**		

VALVE MATERIAL SPECIFICATION:		
PART DESCRIPTION	**SPECIFIED MATERIAL**	**MATERIAL OFFERED**
Body	ASTM A350 GR. LF2	
Ball	SS 304/316 with 75ŋENP Coating	
Body Seat	RPTFE/ DELRIN	
Gland	SS304/SS316	
Stem	SS 304/316 + 75 ŋENP(No casting)	
Body Seal	Grafoil	
Stem Seal	Grafoil	
Body Studs	ASTM A320 Gr. 7	
Nuts	A194 Gr. 4	

Note:

1. Material test certificates and hydrostatic test reports shall be furnished prior to dispatch.
2. Detailed dimensional drawings showing cross-section with part numbers and Materials shall be submitted for Purchaser's approval prior to manufacture of the valves.
3. All tests shall be as per BS: 12266-1
4. Valves shall have ball position indicator.
5. Stops shall be provided to ensure positive alignment of ball with ports and ensure proper installation of handle.
6. Each valve shall be provided with a wrench.
7. Valves shall be inspected and approved by Purchaser before dispatch.
8. Gland packing assembly shall permit repair of gland packing under full line pressure.
9. Fire safe test shall be as per API 607 IV th edition (1993) / BS EN 12266-2.
10. Charpy V-notch & Hardness test for body, body adaptor, end flanges, ball, body seat rings, stem & studs / nuts shall be conducted as per relevant material code.

11. Ball valve shall have lock open (LO) / lock close (LC) provision, if indicated in the P&ID.

GAIL INDIA LIMITED

DATASHEET

FOR

GLOBE VALVE 2 INCHES TO 24 INCHES

GAIL-STD-IN-DOC-DS-026

0	11.04.2019	Issued for Bid	AP	JR	SB	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Valve Manufacturer		**-------**	
Actuator Manufacturer		**Not Applicable**	
Valve Tag No.		**-------**	
Purchaser's spec.:	GAIL-STD-ME-DOC-TS-016	**ANSI Rating:**	150#/300#/600#
Design standard:	BS 1873 / API 6D	**Piping class:**	A1A / B1A/D1A
SIZE, mm (IN) NB:	50 (2") TO 400 (20")		
Ends:	BOTH ENDS FLANGED AS PER ASME B16.5	**Face finish of flanges:**	125 AARH (Smooth Finish), if FL
VALVE DESIGN CONDITIONS:			
Corrosion Allowance:	1.5 mm	**Temperature, ^{0}c:**	-29 TO 65
Service	Natural Gas	**Installation:**	Above Ground
Design factor:	0.5		
CONNECTING PIPE DETAILS:			
Diameter (NB) mm	**------**		
Wall Thickness, mm	**------**		
Grade	**------**		

VALVE MATERIAL SPECIFICATION:		
PART DESCRIPTION	**SPECIFIED MATERIAL**	**MATERIAL OFFERED**
Body	ASTM A 216 Gr. WCB	
Bonnet (Bolted)	ASTM A 216 Gr. WCB	
Stem (Rising)	13% Chrome Steel (No Casting)	
Disc (Loose Plug/ Ball type)	13% Chrome Steel facing / 13% Chrome Steel	
Body Seat Ring	13% Chrome Steel facing / 13% Chrome Steel	
Stem Packing	Graphite Asbestos with sacrificial corrosion inhibitor and inconel wire reinforcement	
Hand Wheel	Malliable Iron/ Cast Steel/Duct Iron/ Fab Steel	
Bonnet Bolts	ASTM A 193 Gr. B7	
Bonnet Nuts	ASTM A 194 Gr 2H	
Bonnet Gasket	Spiral wound SS 304 + CA Filler	

Note:

1. Charpy V-notch test on each heat of base material shall be conducted for all pressure containing parts such as body, end flange, welding ends as well as bolting material as per ASTM A-370. The test shall be conducted at -29 deg C. The mini. Avg. absorbed energy per set of three specimen shall BE 27J with individual minimum per specimen of 22J.
2. Hardness test shall be carried out on each heat of base material for all pressure containing parts of the valve. A full thickness cross section shall be taken for this purpose and the maximum hardness shall not exceed 248 HV10 based on minimum four measurements representing the entire thickness.
3. Valves shall be thoroughly cleaned and applied with sufficient coats of corrosion resistant paint. Surface preparation shall be carried out by shot blasting to SP-6 in accordance with "Steel Structures Painting Council – Visual Standard SSPC VIS-1".
4. Testing shall be as per BS EN 12266-1.
5. 100% Valve castings shall undergo radiographic examination.
6. Stem packing shall be renewable with Valve Open on stream.

7. Painting of the valves shall be as per Manufacturer's Standard.
8. Material Test certificates and hydro test reports shall be furnished prior to dispatch.
9. The data sheet shall be read in conjunction with technical notes for valves.

GAIL INDIA LIMITED

DATASHEET

FOR

GLOBE VALVE – ½" to 1 ½" INCHES

GAIL-STD-IN-DOC-DS-027

0	11.04.2019	Issued for Bid	AP	JR	SB	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Valve Manufacturer		**-------**	
Actuator Manufacturer		**Not Applicable**	
Valve Tag No.		**-------**	
Purchaser's spec.:	GAIL-STD-ME-DOC-TS-016	**ANSI Rating:**	800#
Design standard:	BS 5352	**Piping class:**	A1A/A3A/B1A/D1A
SIZE, mm (IN) NB:	15 (1/2") TO 40(1½")		
Ends:	SW, 3000# as per ASME B 16.11	**Face finish of flanges:**	125 AARH (Smooth Finish), if FL
VALVE DESIGN CONDITIONS:			
Corrosion Allowance:	1.5 mm	**Temperature, ^{0}c:**	-29 TO 65
Service	Natural Gas	**Installation:**	Above Ground
Design factor:	0.5		
CONNECTING PIPE DETAILS:			
Diameter (NB) mm	**------**		
Wall Thickness, mm	**------**		
Grade	**------**		

HYDROSTATIC AND AIR TEST PRESSURE			
Hydrostatic Test Pressure (min) Kg/cm2		**Test Pressure (min) Kg/cm2**	**Duration**
	Body	As per standard	As per standard
	Seat	As per standard	As per standard
Air Test Pressure		6	As per standard

VALVE MATERIAL SPECIFICATION:		
PART DESCRIPTION	**SPECIFIED MATERIAL**	**MATERIAL OFFERED**
Body	ASTM A 105	
Bonnet (Bolted)	ASTM A 105	
Stem (Rising)	13% Chrome Steel (No Casting)	
Disc (Loose Plug/ Ball type)	13% Chrome Steel (Stellited)	
Body Seat Ring	13% Chrome Steel (Stellited)	
Stem Packing	Graphite	
Hand Wheel	Malliable Iron/ Cast Steel/Duct Iron	
Bonnet Bolts	ASTM A 193 Gr. B7	
Bonnet Nuts	ASTM A 194 Gr 2H	
Bonnet Gasket	Spiral wound SS 304 + CA Filler	

Note:

1. The data sheet shall be read in conjunction with Technical notes for valve (Doc. no. GAIL-STD-ME-DOC-TS-016).
2. Testing shall be as per BS: 12266-1.
3. Stem packing shall be renewable with Valve Open on stream.
4. Material test certificates and hydrotest reports shall be furnished prior to dispatch.
5. The data sheet shall be read in conjunction with technical notes on valves.

GAIL INDIA LIMITED

DATASHEET

FOR

GLOBE VALVE - 2 INCHES TO 24 INCHES

GAIL-STD-IN-DOC-DS-028

0	11.04.2019	Issued for Bid	AP	JR	SB	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Valve Manufacturer		**-------**	
Actuator Manufacturer		**Not Applicable**	
Valve Tag No.		**-------**	
Purchaser's spec.:	GAIL-STD-ME-DOC-TS-016	**ANSI Rating:**	600#/ 300# / 150#
Design standard:	BS 1873	**Piping class:**	D4A / B4A /A4A
SIZE, mm (IN) NB:	NB $\geq$ 2"		
Ends:	BOTH ENDS FLANGED AS PER ASME B16.5	**Face finish of flanges:**	Smooth 125 AARH / Serrated
VALVE DESIGN CONDITIONS:			
Corrosion Allowance:	1.5 mm	**Temperature, ^{0}c:**	-45 TO 65
Service	Natural Gas	**Installation:**	Above Ground
Design factor:	0.5		
CONNECTING PIPE DETAILS:			
Diameter (NB) mm	**------**		
Wall Thickness, mm	**------**		
Grade	**------**		

VALVE MATERIAL SPECIFICATION:		
PART DESCRIPTION	**SPECIFIED MATERIAL**	**MATERIAL OFFERED**
Body	ASTM A352 Gr. LCB/ A 350 GR. LF2	
Bonnet (Bolted)	ASTM A352 Gr. LCB/ A 350 GR. LF2	
Stem (Rising)	SS316 (No casting) / A 350 GR. LF2	
Disc (Loose Plug/ Ball type)	SS316/ ASTM A352 Gr. LCB /A 350 GR. LF2 + Stellited	
Body Seat Ring	SS316/ ASTM A352 Gr. LCB / A 350 GR. LF2 + Stellited	
Stem Packing (Renewable with valve open on stream)	Corrosion inhibited die formed flexible graphite with braided anti extrusion rings	
Hand Wheel	Malleable Iron/ Cast Steel/ Fab. Steel	
Bonnet Bolts	ASTM A320 Gr.L7	
Bonnet Nuts	ASTM A194 Gr.4	
Bonnet Gasket	Spiral Wound SS 316 with Grafoil	

Note:

1. Valve specification sheet shall be read in conjunction with technical notes for Valves.
2. Valve shall be designed for intrinsically fire safe.
3. Testing shall be as per BS EN 12266-1, approved QAP, this specification and other relevant standards.
4. Charpy 'V' notch test on each heat of base material shall be conducted as per relevant material code.
6. Hardness test shall be carried out as per relevant material code.
7. Stem packing shall be renewable with valve open on stream.
8. Painting procedure of the valves shall be as per Manufacturer's Standard.
9. Material Test Certificates and Hydro Test Reports shall be furnished prior to dispatch.

GAIL INDIA LIMITED

DATASHEET

FOR

PLUG VALVE SIZE 2 INCHES TO 24 INCHES

GAIL-STD-IN-DOC-DS-029

0	11.04.2019	Issued for Bid	AP	JR	SB	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Valve Manufacturer		**-------**	
Actuator Manufacturer		**-------**	
Valve Tag No.			
Purchaser's spec.:	GAIL-STD-ME-DOC-TS-009	**ANSI Rating:**	600#
Design standard:	API 6D	**Piping class:**	D1A
SIZE, mm (IN) NB:	50 (2") TO 600 (24")		
Ends:	BOTH ENDS BW AS PER ASME B 16.25	**Face finish of flanges:**	NOT APPLICABLE
VALVE DESIGN CONDITIONS:			
Corrosion Allowance:	1.5 mm	**Temperature, ^{0}c:**	-29 TO 65
Service	Natural Gas	**Installation:**	ABOVE GROUND
Design factor:	0.5		
CONNECTING PIPE DETAILS:			
Diameter (NB), mm	-		
Wall Thickness, mm	-		
Grade	API 5L Gr. X60		
VALVE OPERATOR REQUIREMENT		**STEM EXTENSION REQUIREMENT**	
Type of Operator	Manual (Note-1)	**Stem Extension**	Not Required
Operator Spec. No.:	**-**	**Length of Stem extension, m**	-
Operator Data Sheet:	**-**		

VALVE MATERIAL SPECIFICATION:		
PART DESCRIPTION	**SPECIFIED MATERIAL**	**MATERIAL OFFERED**
Body	ASTM A 216 Gr. WCB	
Plug	(ASTM A 216 Gr. WCB) + 0.003" ENP	
Cover	ASTM A 216 Gr. WCB	
Stem	(AISI 4140 + 0.003" ENP) / AISI 410	
Stem seal	PTFE / GRAPHITE / VITON	
Stud, Bolts	ASTM A 193 Gr. B7	
Nuts	ASTM A 194 Gr. 2H	

Note:

1. Requirement of Manual operator (Wrench / Hand Wheel / Gear operator) shall be as per Specification - GAIL-STD-ME-DOC-TS-009.

2. Separate wrench shall be provided with each wrench operated valve.

3. Data Sheets shall be read in conjunction with Valve specifications - GAIL-STD-ME-DOC-TS-009.

4. Inspection and testing shall be as per Valve specification GAIL-STD-ME-DOC-TS-009, API 6D and other relevant standards.

GAIL INDIA LIMITED

DATASHEET

FOR

PLUG VALVE SIZE 0.5 INCHES TO 1.5 INCHES

GAIL-STD-IN-DOC-DS-030

0	11.04.2019	Issued for Bid	AP	JR	SB	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Valve Manufacturer		**-------**	
Actuator Manufacturer		**-------**	
Valve Tag No.			
Purchaser's spec.:	GAIL-STD-ME-DOC-TS-009	**ANSI Rating:**	800#
Design standard:	BS 5353	**Piping class:**	D1A/B1A/A1A
SIZE, mm (IN) NB:	15 (1/2") TO 40 (1 ½")		
Ends:	SW, 3000# as per ASME B 16.11	**Face Finish of Flange**	Not Applicable
VALVE DESIGN CONDITIONS:			
Corrosion Allowance:	1.5 mm	**Temperature, ^{0}C:**	-29 TO 65
Service	Natural Gas	**Installation:**	Above Ground/ Below Ground
Design factor:	0.5		
CONNECTING PIPE DETAILS:			
Diameter (NB), mm	----------		
Wall Thickness, mm	----------		
Grade	----------		
VALVE OPERATOR REQUIREMENT		**STEM EXTENSION REQUIREMENT**	
Type of Operator	MANUAL	**Stem Extension**	NOT REQUIRED
Operator Spec. No.:	AS ENCLOSED	**Length of Stem extension, m**	NA
Operator Data Sheet:	**AS ENCLOSED**		

VALVE MATERIAL SPECIFICATION:		
PART DESCRIPTION	**SPECIFIED MATERIAL**	**MATERIAL OFFERED**
Body	ASTM A 105	
Plug (Lubricated)	ASTM A 105 + 0.003" ENP	
Cover	ASTM A 105	
Stem	(AISI 4140 +0.003" ENP)/ AISI 410	
Stem Seal	PTFE / GRAPHITE	
Body Stud / Nuts	ASTM A193 Gr.B7/ A194 Gr. 2H	
Lubricant Screw	Manufacturer's Standard	

Note:

1. Stem packing shall be renewable with Valve open on stem.
2. Valve shall have inherent feature using the line pressure to ensure that the line pressure cannot cause taper locking of the plug/ plug movement into the taper i.e. valve shall be of "pressure balanced" design.
3. All valves shall be provided with valve position indicator.
4. Painting of the valve shall be as per manufacturer's standard.
5. Material Test Certificates and Hydro Test reports shall be furnished prior to dispatch.
6. All tests shall be as per BS EN 12266-1.
7. Detailed dimensional drawings showing cross section with part numbers and materials shall be submitted for Purchaser's approval prior to manufacture of valves.
8. Minimum port area for regular pattern shall be 55%.
9. Separate wrench shall be provided with each valve.

GAIL INDIA LIMITED

DATASHEET

FOR

PLUG VALVE SIZE - 2”-24” (LTCS)

GAIL-STD-IN-DOC-DS-031

0	11.04.2019	Issued for Bid	AP	JR	SB	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Valve Manufacturer		**-------**	
Actuator Manufacturer		**-------**	
Valve Tag No.			
Purchaser's spec.:	GAIL-STD-ME-DOC-TS-009	**ANSI Rating:**	150# /300# /600#
Design standard:	API 6D	**Piping class:**	A4A/B4A /D4A
SIZE, mm (IN) NB:	NB ≥ 2"	**Face Finish of Flange**	Not Applicable
Ends:	BOTH ENDS FLNGED AS PER ASME B 16.5	**Valve Pattern**	Regular
VALVE DESIGN CONDITIONS:			
Corrosion Allowance:	1.5 mm	**Temperature, ^{0}c:**	-45 TO 65
Service	Natural Gas	**Installation:**	Above Ground/ Below Ground
Design factor:	0.5		
CONNECTING PIPE DETAILS:			
Diameter (NB), mm	----------		
Wall Thickness, mm	----------		
Grade	----------		
VALVE OPERATOR REQUIREMENT		**STEM EXTENSION REQUIREMENT**	
Type of Operator	MANUAL	**Stem Extension**	NOT REQUIRED
Operator Spec. No.:	----------	**Length of Stem extension, m**	NA
Operator Data Sheet:	**--------**		

VALVE MATERIAL SPECIFICATION:		
PART DESCRIPTION	**SPECIFIED MATERIAL**	**MATERIAL OFFERED**
Body	A 352 Gr. LCB/A 350 Gr. LF2	
Plug (Lubricated)	SS316/ A 352 Gr. LCB/A 350 Gr. LF2 with 75 µ ENP coating	
Cover	ASTM A216 Gr. WCB/ A234 Gr. WPB	
Stem	SS 316 (No casting) / A 350 Gr. LF2	
Stem Seal	PTFE/Graphite	
Body Stud / Nuts	ASTM A320 Gr.L7 / ASTM A194 Gr.4	

Note:

1. Requirement of Manual operator (Wrench / Hand Wheel / Gear operator) shall be as per Specification - GAIL-STD-ME-DOC-TS-009.
2. Separate wrench shall be provided with each wrench operated valve.
3. Data Sheets shall be read in conjunction with Valve specifications - GAIL-STD-ME-DOC-TS-009.
4. Inspection and testing shall be as per Valve specifications - GAIL-STD-ME-DOC-TS-009, API 6D and other relevant standards.

GAIL INDIA LIMITED

DATASHEET

FOR

PLUG VALVE SIZE - 0.5 -1.5 In (LTCS)

GAIL-STD-IN-DOC-DS-032

0	11.04.2019	Issued for Bid	AP	JR	SB	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Valve Manufacturer		**-------**	
Actuator Manufacturer		**-------**	
Valve Tag No.			
Purchaser's spec.:	GAIL-STD-ME-DOC-TS-009	**ANSI Rating:**	800#
Design standard:	BS 5353	**Piping class:**	D4A
SIZE, mm (IN) NB:	15 (1/2") TO 40 (1 ½")	**Face Finish of Flange**	Not Applicable
Ends:	SW, 3000# as per ASME B 16.11	**Valve Pattern**	Regular
VALVE DESIGN CONDITIONS:			
Corrosion Allowance:	1.5 mm	**Temperature, ^{0}c:**	-45 TO 65
Service	Natural Gas	**Installation:**	Above Ground/ Below Ground
Design factor:	0.5		
CONNECTING PIPE DETAILS:			
Diameter (NB), mm	----------		
Wall Thickness, mm	----------		
Grade	----------		
VALVE OPERATOR REQUIREMENT		**STEM EXTENSION REQUIREMENT**	
Type of Operator	MANUAL	**Stem Extension**	NOT REQUIRED
Operator Spec. No.:	AS ENCLOSED	**Length of Stem extension, m**	NA
Operator Data Sheet:	**AS ENCLOSED**		

VALVE MATERIAL SPECIFICATION:		
PART DESCRIPTION	**SPECIFIED MATERIAL**	**MATERIAL OFFERED**
Body	A 352 Gr. LCB/A 350 Gr. LF2	
Plug (Lubricated)	SS316/ A 352 Gr. LCB/A 350 Gr. LF2 with 75 µ ENP coating	
Cover	ASTM A216 Gr. WCB/ A234 Gr. WPB	
Stem	SS 316 (No casting) / A 350 Gr. LF2	
Stem Seal	PTFE/Graphite	
Body Stud / Nuts	ASTM A320 Gr.L7 / ASTM A194 Gr.4	
HYDROSTATIC AND AIR TEST PRESSURES		
Hydrostatic Test Pressure (Kg/cm2g)	Body : 209.0, Seat : 152.9	
Test Pressure with Air (Kg/cm2 g)	6.0	

Note:

1. Stem packing shall be renewable with Valve open on stem.
2. Valve shall have inherent feature using the line pressure to ensure that the line pressure cannot cause taper locking of the plug/ plug movement into the taper i.e. valve shall be of "pressure balanced" design.
3. All valves shall be provided with valve position indicator.
4. Painting of the valve shall be as per manufacturer's standard.
5. Material Test Certificates and Hydro Test reports shall be furnished prior to dispatch.
6. All tests shall be as per BS EN 12266-1.
7. Detailed dimensional drawings showing cross section with part numbers and materials shall be submitted for Purchaser's approval prior to manufacture of valves.
8. Minimum port area for regular pattern shall be 55%.
9. Separate wrench shall be provided with each valve.

GAIL INDIA LIMITED

DATASHEET

FOR

CHECK VALVE SIZE 2 – 24 INCHES

GAIL-STD-IN-DOC-DS-033

0	11.04.2019	Issued for Bid	AP	JR	SB	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Valve Manufacturer		**-------**	
Actuator Manufacturer		**-------**	
Valve Tag No.			
Purchaser's spec.:	GAIL-STD-ME-DOC-TS-016	**ANSI Rating:**	600#/300#/150#
Design standard:	API 6D	**Piping class:**	D1A/ B1A/A1A
SIZE, mm (IN) NB:	50 (2") AND ABOVE	**VALVE PORT:**	Regular
Ends:	BOTH ENDS FLANGED AS PER ASME B 16.5, WNRF	**Face finish of flanges:**	125 AARH (Smooth Finish), if FL
VALVE DESIGN CONDITIONS:			
Corrosion Allowance:	1.5 mm	**Temperature, ^{0}c:**	-29 TO 65
Service	Natural Gas	**Installation:**	Above Ground
Design factor:	0.5		
CONNECTING PIPE DETAILS:			
Diameter (NB),mm	-------		
Wall Thickness, mm	-------		
VALVE OPERATOR REQUIREMENT		**STEM EXTENSION REQUIREMENT**	
Type of Operator	Manual	**Stem Extension**	NOT REQUIRED
Operator Spec. No.:	AS ENCLOSED	**Length of Stem extension, m**	NA
Operator Data Sheet:	**AS ENCLOSED**		

VALVE MATERIAL SPECIFICATION:		
PART DESCRIPTION	**SPECIFIED MATERIAL**	**MATERIAL OFFERED**
Body	ASTM A 216 Gr. WCB	
Cover (Bolted)	ASTM A 216 Gr. WCB	
Disc	ASTM A216 Gr. WCB + 13% Cr. Steel (facing)	
Disc Hinge	ASTM a216 Gr. WCB	
Hinge Pin	13% Cr. Steel (No Casting)	
Cover Stud Bolts	ASTM A 193 Gr. B7/ B7M	
Cover Nut	ASTM A 194 Gr.2H/4/7	
Cover Gasket	SS 316 Spiral Wound with Grafoil Filler	
	Inconel X-750	

Note:

1. The data sheet shall be read in conjunction with Technical notes for valve (Doc. no. GAIL-STD-ME-DOC-TS-016).
2. Seat shall be non-renewable integral type only.
3. Valve shall be suitable for Horizontal / Vertical installation.
4. All inspection and testing shall be as per API 6D.
5. Compressed asbestos filler (CAF) shall not be used for body sealing / gasket material.

GAIL INDIA LIMITED

DATASHEET

FOR

CHECK VALVE SIZE 2 – 24 INCHES

GAIL-STD-IN-DOC-DS-034

0	11.04.2019	Issued for Bid	AP	JR	SB	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Valve Manufacturer		**-------**	
Actuator Manufacturer		**-------**	
Valve Tag No.			
Purchaser's spec.:	GAIL-STD-ME-DOC-TS-016	**ANSI Rating:**	150#
Design standard:	API 6D	**Piping class:**	A4A
SIZE, mm (IN) NB:	NB ≥ 50 (2")	**VALVE PORT:**	Regular
Ends:	BOTH ENDS FLANGED AS PER ASME B 16.5, WNRF	**Face finish of flanges:**	125 AARH (Serrated)
VALVE DESIGN CONDITIONS:			
Corrosion Allowance:	1.5 mm	**Temperature, ^{0}c:**	-45 TO 65
Service	Natural Gas	**Installation:**	Above Ground
Design factor:	0.5		
CONNECTING PIPE DETAILS:			
Diameter (NB),mm	-------		
Wall Thickness, mm	-------		
VALVE OPERATOR REQUIREMENT		**STEM EXTENSION REQUIREMENT**	
Type of Operator	Manual	**Stem Extension**	NOT REQUIRED
Operator Spec. No.:	AS ENCLOSED	**Length of Stem extension, m**	NA
Operator Data Sheet:	**AS ENCLOSED**		

VALVE MATERIAL SPECIFICATION:		
PART DESCRIPTION	**SPECIFIED MATERIAL**	**MATERIAL OFFERED**
Body	ASTM A352 Gr. LCB/ A 350 GR. LF2	
Cover (Bolted)	ASTM A352 Gr. LCB/ A 350 GR. LF2	
Disc/ Plates	SS316/ ASTM A352 Gr. LCB/ A 350 GR. LF2 +Stellited	
Disc Hinge	SS316/ ASTM A352 Gr. LCB / A 350 GR. LF2	
Hinge Pin	SS 316 (No casting) / A 350 Gr. LF2	
Cover Stud Bolts	ASTM A320 Gr.L7	
Cover Nut	ASTM A194 Gr.4	
Cover Gasket	SS 304/316 Spiral Wound with Grafoil	
Spring	Inconel X-750	

Note:

1. The data sheet shall be read in conjunction with Technical notes for valve (Doc. no. GAIL-STD-ME-DOC-TS-016).
2. Seat shall be non-renewable integral type only.
3. Valve shall be suitable for Horizontal / Vertical installation.
4. All inspection and testing shall be as per API 6D.
5. Compressed asbestos filler (CAF) shall not be used for body sealing / gasket material.

GAIL INDIA LIMITED

BIDDER SCOPE OF SUPPLY AND INSTALLATION

GAIL-STD-GN-DOC-GEN-001

Rev.	Date	Purpose	Prepared By	Checked By	Approved By	
0	15.01.2019	Issued for Bid	RKS	UNU	UNU	

BIDDERS'S SCOPE OF SUPPLY AND INSTALLATION

DESCRIPTION	Supply	Installation
1.0 Instruments		
1.1 All field mounted instruments & equipments.	By Bidder	By Bidder
1.2 All instruments in a) Gas metering skid consisting of Filtration, Gas Pressure Letdown & gas metering with/ without flow control b) Filtration with pressure reduction skid	By Bidder	By Bidder
1.3 All instruments in Field mounted Solar panel/ Control room mounted Metering panel for Gas metering system package and wall mounted control panel for pressure reduction skid	By Bidder	By Bidder
1.5 Installation of skid at GAIL Site.	--	BY GAIL
2.0 Panels		
2.1 Control panel (for installation in control room)	By Bidder	By GAIL
2.2 Field mounted solar powered flow computers	By Bidder	By Bidder
3.0 Junction boxes		
3.1 For interconnection between field and Control panels	By Bidder	By Bidder
3.2 For interconnection between field Instruments and junction boxes in Gas metering skids	By Bidder	By Bidder
3.3 Separate junction box for:		
a) For 4-20 mA dc signals (intrinsic safe and non-intrinsic safe)	By Bidder	By Bidder
b) For RTD signals	By Bidder	By Bidder
c) Flow meter signals	By Bidder	By Bidder
d) For contact signals	By Bidder	By Bidder
e) For LEL signals (as applicable)	By Bidder	By Bidder
f) For GC Signals (as applicable)		
g) For Interlock and shutdown signals	By Bidder	By Bidder
h) For power supply to various instruments	By Bidder	By Bidder
i) For any other signal not covered but required for completion of job	By Bidder	By Bidder
4.0 Cables		
4.1 Between field instruments and junction boxes in the skid and local panels in the skid	By Bidder	By Bidder

4.2	Between junction boxes and control room panel including GC Cable (power and signal) wherever applicable.	By Bidder	By GAIL
4.3	Suitable Hardware and Communication cables for all control room Instruments (like FC, Printers, Laptop, SCADA/ GPRS Modem connectivity etc.) and various connectivity.	By Bidder	By Bidder
4.4	Any other cable / other Harware/ Software not covered but required for completion of job.	By Bidder	By Bidder
5.0	**Installation materials**		
5.1	Impulse tubing/piping, tube/pipe fittings, valves and valve manifolds etc. as required.	By Bidder	By Bidder
5.2	valves, pipes and fittings, Blind flanges, Matching end flanges of skid,	By Bidder	By Bidder
5.3	Cable trays, cable glands and accessories	By Bidder	By Bidder
5.4	Instrument stanchions, supports, canopies/ sunshields, supports for cable tray all consumables.	By Bidder	By Bidder
5.5	Cabinet for custody transfer instruments, platform and cross over for operation & maintenance of the equipments. Grouting accessories nuts and bolts	By Bidder	By Bidder
6.0	**Earthing**		
6.1	Earthing strips, earthing cable required for the skid/ field and panel	By Bidder	By GAIL
6.2	Earthing PIT & Interconnection between pit and panel/ skid	By GAIL	By GAIL
7.0	Power Supply Distribution for Gas metering system package	By Bidder	By Bidder
8.0	Civil works & Foundation for installation of metering skid	By GAIL	By GAIL
9.0	Special tools and tackles	By Bidder	-
10.0	Spares and spare parts	By Bidder	-
11.0	Documentation as per this package	By Bidder	

Note:

Supervision for Installation & commissioning is in bidder's Scope. Bidder shall quote Man day rate separately for each SOR item, which shall be valid for minimum 24 months from date of issuance of FOI. The items not mentioned above, but mentioned elsewhere in tender or required to complete the job shall be supplied, installed by the bidder.

GAIL INDIA LIMITED

BIDDER DATA REQUIREMENTS

GAIL-STD-GN-DOC-GEN-002

0	15.01.2019	Issued for Bid	RKS	UNU	UNU	
Rev	**Date**	**Purpose**	**Prepared By**	**Checked By**	**Approved By**	

BIDDER DATA REQUIREMENT

1.0 BIDDER DRAWING /DOCUMENT REQUIREMENT

1.1 This section defines the requirement for Drawing / Document / Data for Gas metering package to be furnished by Bidder, during and after execution of the project. This shall include all-

(i) Basic Engineering Documents
ii) Detailed Engineering Documents.
III) Documents for Procurement
IV) Study, Schematic and Construction drawings.
v) All Manufacturer/Supplier/Sub-Vendor related Drawings, Manuals andother Technical Literature.
vi) All As Built Drawing/Documents
vii) Any other Drawing/Document/Deliverable not specifically covered butgenerated by Bidder as part of project execution.

1.2 Bidder shall Submit all Drawings/ Documents generated by them to GAIL for Approval/Review/ Records. These categories are as defined below:

Approval Category : Critical Drawing/ Documents for which GAIL approval is essential.
Review Category; Drawing /Documents which GAIL shall review and comment.
Records: Drawing /Documents essentially retained by GAIL/PMC for Information/Records.

However Bidder shall note that approval/Review of any drawing by GAIL does not absolve the Bidder from the responsibility of ensuring complete compliance to the requirements. Noncompliance to the requirement observed at any stage of Project execution shall be rectified by Bidder without any FINANCIAL implication.

1.3 Bidder shall follow following philosophy with respect to number of copies to besubmitted at different stages of Project execution.

Initial submission: 2 sets of Hard Copy + 2 sets on Portable Media.(for each skid/ SOR item)

Final / after approval/ For Construction: 2 sets of Hard Copy + 2 sets on Portable Media.
Final as Built: 2 sets of Hard Copy + 2 sets on Portable Media. (FOR each skid/ SOR Item)

1.4 Bidder shall note that Language of all documents during Engineering, execution stage, all final documents and as-built documents shall be English.

1.5 Bidder shall on award of Contract prepare and submit for GAIL approval a detailed drawing document schedule as mentioned in Annexure in XII. The schedule shall ensure sequential and logical sequence of document submission. Bidder shall ensure that subsequent documents are submitted only after the basic documents have been reviewed /approved. Haphazard and en-Bulk submission of documents shall not be entertained.

BIDDER DATA REQUIREMENT

S. No.	Description	Approval	Review	Records	Remarks
1	Drawing and Document Schedule	•			
2	Instrument Index			•	
3	Vendor List for Instruments and accessories	•			
4	Instrument datasheet & Sizing calculations	•			
5	Power consumption list Skid wise			•	
6	Material Requisition		• For criticalItems only		
7	Purchase Requisition		• For critical items only		
8	Functional Schematic		• complex &critical loops only		
9	Instrument Loop Drawings			•	
10	Detailed P&ID for Gas metering system package	•			
11	Control Panel layout	•			
12	Control panel front arrangement	•			
13	Power Supply Distribution			•	
14	Cabinet / Rack GAD's			•	
15	Control room equipment / panels overall dimensional drawings (including foundation details, weights and clearances required)			•	
16	Wiring diagram for Metering panels/ Control panels			•	
17	Instrument Cable Schedule		•		
18	Metering skid and control panel interconnection details			•	
19	Instrument location, JB location drawings			•	
20	Gas metering system General arrangement drawing with foundation details	•			
21	Instrument Termination details			•	

22	Instrument installation drawings		• Forcritical items only		
23	Instrument grounding details		•		
24	Bill of material for installation items			•	
25	Special test equipment / tool requirement for maintenance			•	
26	Spare part list for: a) Mandatory spares b) Start up and commissioning		•		
27	Statutory body certificates for hazardous area		•		
28	Test / calibration / inspection certificates for all instruments			•	
29	Inspection and test (FAT) procedures for Gas metering system package	•			
30	Complete catalogues with part list for all Bidder supplied instruments, control etc.			•	
31	Installation, operation and maintenance manuals			•	
32	Closing time calculation for slam shut valves		•		
33	Custody transfer approval certificates		•		
34	Design (including GAD &PIID) for metering skids from the certifying agency mentioned elsewhere.			*	

Notes:

1. As built drawings / documents shall be provided for all items for each skid.
2. Critical items include items like Gas Metering system, Gas detectors, Slam shut valve, Pressure regulator, Flow Control Valves, Ultrasonic flow meter, turbine meter, PD Meter, Pressure relief valve, Transmitters, etc.
3. Any other documents not listed under critical item but necessary for quality control shall be decided with Bidder after placement of the order.

TECHNICAL SPECIFICATION - QUESTIONNAIRE

This questionnaire shall be duly filled in and submitted alongwith un-priced sets of offers to avoid further queries and to ensure proper evaluation of your offer in time. If this is not complied with, your offer is liable to be rejected.

ANSWER `YES', `NO' OR `NOT APPLICABLE'

Sl. No.	Description	Bidder's Response (YES / NO/ NOT APPLICABLE)
1.	**Do you Have any deviation to the following :**	
i)	General specifications (Clause wise)	
ii)	Special requirements (Clause wise)	
iii)	Instrument specifications indicated in the data sheets, Technical specifications/ details.	
iv)	The scope of supply as indicated in the Scope of work and specifications.	
	If `Yes', have you included the list of deviations? (If no deviations are furnished, It will be assumed that all the specifications and requirements of the subject requisition are complied with and no deviation whatever will be accepted after the placement of order).	
2.	Have you included in the quoted price for the mounting accessories, cables, special calibration kits and equipment (complete with technical details) required, if any, for the erection, commissioning and maintenance of the Instruments?	
3.	Have you enclosed the relevant technical catalogue/ literature in ENGLISH language including model decoding details, drawings etc. necessary for the evaluation of your offer?	
4	Have you attached / confirmed that the documents required as per the vendor data requirements will be supplied after placement of order?	
5	Do you confirm to submit certificates from statutory bodies viz. BASEEFA, FM, CSA etc. for the explosion proof construction/ intrinsically safe design of the instruments wherever specified?	
5.	Have you confirmed that certification from statutory bodies viz. Lloyds, TUV, NMI, PTB etc. will be furnished wherever specified?	
6.	Have you attached the Noise calculations for regulators, with complete details as per tender requirement?	
7.	Have you submitted the pressure drop calculation across the individual Metering skid components and total pressure drop across the complete metering skid?	
8.	Have you attached the completely filled data sheets for all the instruments, equipments and mechanical items with all relevant details like make & model no., size etc.	
9.	Have you attached all the documents in English language?	

Sl. No.	Description	Bidder's Response (YES / NO/ NOT APPLICABLE)
10.	Have you enclosed detailed technical specifications and Catalogue of each offered item?	
11.	Do you Confirm that the all bought out items (like Filtration, FCV, PCV, SSV, Flow meter, Ball Valves, Globe valves, Check valves, Plug valves, PSV/ CRV, Flow Computers, GC, LEL detection system etc.) has been selected from the vendor's list provided in tender document (the bought out items shall be as per tender requirement and make and model of items shall be subjected to fulfilling tender requirement and approval by GAIL).	
12.	Have you furnished the CCOE certificate for Hand Held Communicator?	
13.	For each SOR items, Have you offered Flow computer, Gas Chromatograph, turbine meter / Ultrasonic Flow meters from the vendor list and these offered items have type approval for custody transfer application. Have you enclosed Type certification for the selected and offered Make & Model of Flow computer, Gas Chromatograph and Ultrasonic Flow meters? (Any deviation to be brought to notice of GAIL) *strike off which ever is not applicable.	
14	Have you enclosed Type approval for the selected and offered Make, Model of Slam shut valves and PCV (Regulators).	
15	Do you confirm to provide, after award, the **Logistic support certificate** for offered Make/ Model of all the major items like Flow computer, Flow Meter, SSV, PCV (Regulator), FCV, Filtration system, Hand Held Communicator, Electro Pneumatic Positioner/ I/P converter from the respective Original Equipment Manufacturer (OEM)?	
16	Have you furnished **Equipment Qualification Form** for offered Make/ Model of all the major items like Flow computer, Flow Meter, SSV, PCV (Regulator), FCV, Filtration system, Hand Held Communicator, Electro Pneumatic Positioner/ I/P converter from the manufacturer?	
17	Have you furnished details for control panel/ solar panel including system architecture, make/ model of its components?	
18	Have you furnished Performance Guarantee Certificate for the metering skid?	
19	Do you agree that after the award of contract, details shall be provided by you for our review/ approval for qualification of TPI and their representative appointed by you? The TPI appointed by you shall be qualified enough for inspection to be carried out at various stages of manufacturing of Metering skid.	
20	For each SOR items, Have you offered SSV and Regulator (PCV) from the vendor list and these offered items have type approval. Have you enclosed Type certification for the selected and offered Make & Model of SSV and Regulator (PCV)? (Any deviation to be brought to notice of GAIL)	

Sl. No.	Description	Bidder's Response (YES / NO/ NOT APPLICABLE)
21	Do you confirm to comply the conditions mentioned in Section IV (Special conditions of Contract) of bid document.	
22	Do you agree a) that in case the above information is found to be incorrect, the bid is likely to be rejected and no explanation/ clarification shall be entertained/ sought from bidder. b) In case there is ambiguity in respect to make, model and size of any component/ item, the make/ model/ size most suitable for this application shall be selected/ considered by GAIL.	

Note: If the answer (for questionnaire sr. no. 2 to 21 is in negative, then furnish details thereof.

GAIL INDIA LIMITED

LIST OF VENDOR FOR BOUGHT - OUT ITEMS

GAIL-STD-GN-DOC-GEN-004

0	15.01.2019	Issued for Bid	RKS	UNU	UNU	
Rev.	**Date**	**Purpose**	**Prepared By**	**Checked By**	**Approved By**	

LIST OF VENDORS FOR BOUGHT-OUT ITEMS

1) PRESSURE REGULATOR AND SLAM SHUT VALVE

1) M/s Pietro Fiorentini S.p.A. (Italy)
2) M/s Emerson Process Management (USA)
3) M/s RMG-Regel Messtechnik (Germany)
4) M/s Mokveld Valves BV (Netherlands)
5) M/s Schlumberger (USA)
6) M/s Gorter Controls B V (Netherlands)
7) M/s Instromet International NV
8) M/s Emerson Process Mgmt asia Pacific Pte Ltd.
9) M/s Nirmal Industrial Controls Pvt Ltd. (up to 6" size only)
10) M/s ESME Valves Ltd
11) M/s Kaye & Macdonald Inc.
12) M/s Nuovo Pignone SPA (Italy) (GE Oil Co.)
13) M/s Richards Industries (Formerly Treloar)
14) M/s Samson AG Mess-und Regeltechnik
15) M/s Tormene Gas Technology
16) M/s Dresser Inc, USA (upto 8" size, 300# class only)

2) FLOW COMPUTERS

1) M/s Daniel Measurement and Control Inc. (USA)
2) M/s Instromet International (Belgium)
3) M/s FMC Measurement Solutions (UK)
4) M/s Emerson Process Management (Singapore)
5) M/s Bistol Babcock
6) M/s RMG (Germany)
7) M/s OMNI Flow Computers Inc.
8) M/s Thermo Fisher, USA

3) TURBINE METERS

1) M/s Daniel (USA)
2) M/s RMG (Germany)
3) M/s INSTROMET (Belgium)
4) M/s Sensus Metering System Inc
5) M/s Rockwin Flowmeter (India)
6) M/s Vemmtec Messtechnik Gmbh, (Germany)
7) M/s ITRON GmbH (Germany)

4) POSITIVE DISPLACEMENT FLOW METERS

1) M/s FMG
2) M/s RMG (Germany)
3) M/s Elster Instromet
4) M/s Romet
5) M/s Dresser
6) M/s ITRON GmbH (Germany)

5) JUNIOR/ SIMPLEX ORIFICE FITTINGS (METER RUN, FLOW CONDITIONER, ORIFICE PLATE AND ASSEMBLY)

1) M/s Emerson
2) M/s FMC, USA
3) M/s PIETRO FIORENTINI. ITALY
4) M/s CANALTA CONTROLS, CANADA

6) DRY GAS FILTER & FILTER SEPERATOR

1) M/s Grand Prix Fab (Pvt.) Ltd.(New Delhi)
2) M/s Perry Equipment, USA
3) M/s Faudi Filter, Germany
4) M/s Forain S.r.l., Italy
5) M/s ABB,Faridabad
6) M/s Burgess Manning, USA
7) M/s Multitex Filtration Engineers India
8) M/s Triveni Plenty Engg. Ltd. (New Delhi)
9) M/s Siirtec International Contractor SPA (Italy)
10) M/s Flashpoint,Pune india
11) M/s Filteration Engineers (I) Pvt Ltd, India
12) M/s Gujarat Otofilt, India
13) M/s Tormene Gas Technology
14) M/s Ultrafilter (India) Pvt Ltd, India
15) M/s Ravi Techno Systems Pvt Ltd, India
16) M/s SIIRTEC NIGI SPA
17) M/s Filtan Filter Anlagenbau Gmbh
18) M/s Fairley Arlon BV
19) M/s PECO Facet
20) M/s EPE EPENSTENNER GMBH
21) M/s Filtrex srl
22) M/s Petromar Engineered Soln
23) M/s Plenty Filter
24) M/s EUROFILTEC
25) M/s PTI Technologies Inc
(26) M/s Nirmal, Mumbai

7) Quick Opening End Closure (QOEC)

1) Forain S.R.L.
2) GD Engineering
3) Pipeline Engineering, UK
4) Siirtec Nigi SPA
5) TD Williamson
6) PEERLESS
7) GRINELL
8) HUBER YALE
9) TUBE TURN (U.S.A.)
10) PIPELINE TECHNOLOGIES, FRANCE

8) FILTER ELEMENT

1) M/s PECO-FACET
2) M/s PALL-FILTERITE
3) M/s VELCON
4) M/s BURGESS MANNING

9) BALL VALVES, Pipe Line (API 6D)

1) M/s Hopkinsons Limited (UK)
2) M/s O.M.S. Saleri (Italy)
3) M/s Pibi Viesse SPA (Italy)
4) M/s Nuovo Pignone (Italy)
5) M/s Perar SPA (Italy)
6) M/s Larsen & Toubro Ltd. (New Delhi)
8) M/s Pietro Fiorentini (Italy)
9) M/s Raimondi Valve S.p.A. (Italy)
10) M/s VIZA Valves (China)
11) M/s Cooper Cameron Valv Italy SRL-FRM, Itly
12) M/s Fraz Schuck GMBH, Germany (Formerly Borsig)
13) M/s ITAG, Germany
14) M/s Kitamura Valve manufacturing Co. Ltd
15) M/s MSA A.S.
16) M/s PCC Ball Valves SRL
17) M/s Petrol Valves SRL
18) M/s Tormene Gas Technology SPA (VALVITALIA)
19) M/s Virgo Engineers Ltd. India
20) M/s Weir Valves & Controls UK Ltd.
21) M/s Microfinish Valves Ltd, India
22) M/s Flowchem, India
23) M/s Flow Control Technologies (France)
24) M/s Friedrich Krombach GMBH &CO.Kg
25) M/s Grove Valve And Regulators Co (USA)
26) M/s JC Fabrica DE Valvulas S.A. (Sharjah)
27) M/s Guichon Valves (France)
28) M/s Hindle Cockburns Limited
29) M/s Cameron Italy SRL

10) PLUG VALVES

1) M/s Grove Dresser Italia S.p.A. (Italy)
2) M/s Nordstrom Valves Inc. (USA)
3) M/s Serck Audo Valves (England)
4) M/s Breda Energia Sesto industria SPA (Italy)
5) M/s Fisher Xomox Sanmar Ltd. (Chennai)
6) M/s L&T (Audco India) Ltd. (New Delhi)

11) GLOBE VALVES

1) M/s BDK Engineering Industries Limited,Hubli, (Karnataka)
2) M/s Datre Corporation Limited Kolkata
3) M/s KSB Pumps Ltd, NOIDA
4) M/s Larsen & Toubro Ltd.
5) M/s KF Industries Alberta, Canada
6) M/s Ornate Valves Pvt. Ltd., Mumbai
7) M/s Panchvati Valves & Flanges Pvt. Ltd., Mumbai
8) M/s Steel Strong valves India Pvt. Ltd., India
9) M/s A.V. Valves Ltd. Agra
10) M/s Shalimar Valves Pvt. Ltd.,Navi Mumbai

11) M/s JC Fabrica de Valvulas, S.A Barecelona Spain

12) CHECK VALVES

1) M/s Malbranque (France)
2) M/s Mannesmann Demag (Germany)
3) M/s Petrol Valve (Italy)
4) M/s True Flow Rona (Belgium)
5) M/s L&T (Audco) India Ltd. (Chennai)
6) M/s BHEL, OFE & OE Group (New Delhi)
7) M/s Advance valves Pvt Ltd.
8) M/s A V Valves Ltd.
9) M/s BDK Engineering Industries Ltd. India
10) M/s Foress Engg (I) Ltd. (Aurangabad)
11) M/s Valvitalia Italy
12) M/s KSB Pumps Ltd. Loimbattore), India
13) M/s Nandina Iron & Steels
14) M/s Nitcon valve Industries Pvt. Ltd. India
15) M/s Oswal Industries Ltd. India
16) M/s Panchvati Valves & Flanges Pvt. Ltd. India
17) M/s Petrochemical Engineering Enterprises, India
18) M/s Sakhi Engineers Pvt. Ltd.
19) M/s Shalimar Valves Pvt. Ltd.
20) M/s Steel Strong valves India Pvt. Ltd., India

13) PRESSURE SAFETY VALVES

1) M/s Keystone Valves (India) Pvt. Ltd.
2) M/s Larson & Toubro Ltd.
3) M/s Mekaster Engg Ltd..
4) M/s Tyco Sanmar Ltd. (New Delhi)
5) M/s Anderson Greenwood Crosby
6) M/s BHEL (Trichy)
7) M/s Curtiss Wright Flow Control Corporation
8) M/s Dresser Inc.
9) M/s Fukui Seisakusho Co. Ltd
10) M/s Lesser GmbH & Co KG
11) M/s Nakakita Seisakusho Co Ltd
12) M/s Nuovo Pignone SPA (Italy) (GE Oil co)
13) M/s Parcol SPA
14) M/s Safety Systems UK Ltd
15) M/s Tai Milano SPA
16) M/s Weir Valves & Controls France
17) M/s Bliss Anand Pvt Ltd.

14) FLOW CONTROL VALVES

1. M/s arca regler gmbh
2. M/s ast apparecchi di sicurezza e tenuta spa
3. M/s cci valve technology gmbh
4. M/s ge oil & gas india pvt. ltd
5. M/s dresser produits industriels
6. M/s emerson process mangmnt chennai pvt. ltd
7. M/s forbes marshall arca p ltd
8. M/s flowserve india control pvt ltd-bangalor
9. M/s flowserve pte ltd
10. M/s italvalv s.n.c

11. M/s koso india pvt ltd
12. M/s kent introl uk ltd
13. M/s ksb mil controls limited
14. M/s motoyama engg works ltd
15. M/s metso flow control oy
16. M/s severn glocon india pvt ltd
17. M/s samson controls pvt ltd
18. M/s severn glocon ltd
19. M/s samson ag mess-und regeltechnik
20. M/s spx valves & controls (formerly dezurik)
21. M/s weir valves & controls uk ltd
22. M/s bellino srl

15) CONTROL PANEL & ACCESSORIES

1) M/s Keltron Controls Ltd., Kerala
2) M/s ELECHMEC Corporation Ltd., Mumbai
3) M/s Industrial Controls & Appliances Pvt. Ltd.,
4) M/s Alstom System Ltd., Noida
5) M/s ABB Instruments Ltd., New Delhi
6) M/s Emerson Process Management (I) Pvt. Ltd.
7) M/s Larsen & Toubro Ltd.
8) M/s Control & Automation, New Delhi
9) M/s GE Fanuc Systems Pvt. Ltd., New Delhi
10) M/s Rockwell Automation (I) Ltd., Ghaziabad
11) M/s Honeywell Automation Ltd.
13) M/s RITTAL
14) M/s Pyrotech Elcronics Pvt Ltd.
15) M/s Positronics Pvt Ltd.
16) M/s Electronics Corporation of India Ltd.

16) LEVEL GAUGES/ LEVEL INSTRUMENTS

1) M/s Bliss Anand
2) M/s Chemtrols
3) M/s V-Automat
4) M/s Levcon
5) M/s NIVO Controls
6) M/s Sbeletro Mechanicals
7) M/s TRAC

17) SS FITTINGS / TUBING,

1) M/s SWAGELOCK (USA)
2) M/s PARKER (USA)
3) M/s HOKE (USA)
4) M/s Sandvik
5) M/s Arya Crafts & Engineering Pvt Ltd
6) M/s Autoclave Engineers Fluid Components
7) M/s Anderson Greenwood Crosby
8) M/s Baumer Technologies India Pvt. Ltd
9) M/s Comfit & Valves Pvt. Ltd.

18) JUNCTION BOXES AND CABLES GLANDS

1. BALIGA LIGHTING EQUIPMENTS (P) LIMITED
2. FLEXPRO ELECTRICALS PVT LTD
3. FLAMEPROOF EQUIPMENTS PVT.LTD
4. FCG POWER INDUSTRIES PVT LTD
5. FCG FLAMPROOF CONTROL GEARS P. LTD
6. PETROLEUM SAFETY PRODUCTS IND. PVT. LTD
7. KAYSONS TECHNO EQUIPMENT P LTD
8. SUDHIR SWITCHGEARS PVT LTD

19) CONTROL AND SIGNAL CABLES

1. M/s Associated Cables Pvt Ltd
2. M/s Associated Flexibles & Wires [P] Ltd
3. M/s CMI Limited
4. M/s Cords Cable Industries Ltd
5. M/s Delton Cables Limited
6. M/s Elkay Telelinks Ltd
7. M/s KEI Industries Limited
8. M/s Polycab Wires Pvt Ltd
9. M/s Suyog Electricals Ltd
10. M/s Thermo Cables Ltd
11. M/s T C Communication Pvt. Ltd
12. M/s Udey Pyrocables Pvt. Ltd
13. M/s KEC International - Mysore
14. M/s Leoni Cable Solutions (India) Pvt Ltd
15. M/s Leoni KERPEN GMBH

20) INDICATORS & CONTROLLERS

1) M/s Yokogawa
2) M/s EUROTHERM CHESSEL
3) M/s HONEYWELL
4) M/s Emerson

21) BARRIERS

1) M/s MTL
2) M/s STHAL
3) M/s P&F
4) M/s Phoenix

22) FASTENERS

1) AEP Company, India
2) Boltmaster India Pvt. Ltd. India
3) Deepak Fasteners Limited India
4) Fasteners & Allied Products Pvt. Ltd.
5) Hardwin Fasteners Pvt. Ltd. India
6) J.J. Indistries India
7) Multi fasteners Pvt. Ltd. India
8) Nexo Indistries, India
9) Pioneer Nuts and Bolts Pvt. Ltd.
10) Precision Auto Engineering Works, India

11) Sandeep Engineering, India
12) Syndicate Engineering Industries, India.

23) Fitting Block Forged-Carbon Steel

1) Eby Fasteners, India
2) Leader valves Ltd. India
3) M.S. Fitting Mfg. Co. Pvt. Ltd. India
4) R. N. Gupta & Co. Ltd. India

24) Fittings from Seamless Pipe-Carbon Steel

1. M/s Commercial Supplying Agency, Mumbai
2. M/s Dee Development Engineers Ltd.
3. M/s Eby Industries, Mumbai
4. M/s Flash Forge Pvt. Ltd., Vishakhapatnam
5. M/s Gujarat Infra Pipes Pvt. Ltd., Vadodara
6. M/s M.S. Fittings Mfg. Co. Pvt. Ltd., Kolkata
7. M/s Stewarts & Lloyds of India Ltd., Kolkata
8. M/s Teekay Tubes Pvt. Ltd., Mumbai
9. M/s Pipe Fit,Baroda
10. M/s Sky Forge, Faridabad
11. M/s S&G, Faridabad
12. M/s Sawan Engineers, Baroda
13. Eby Fasteners, India
14. R.N. Gupta & Co. Ltd, India
15. Exten Engg Pvt Ltd
16. Sivananda Pipe & Fittings Ltd
17. Chero Piping SPA, Italy
18. CSA Fittings, India
19. EBY Fasteners, India
20. Fittnox SRL, Italy
21. Keonsae High Pressure Co. Ltd., South Korea
22. Munro & Miller Fittings Ltd., U.K.
23. TK Corporation, South Korea
24. Tube Turn (India) Pvt Ltd., India
25. Topaz Piping Industries, India
26. Technoforge SPA, Italy
27. P.K. Tubes & Fittings Pvt. Ltd., India
28. Vivial Forge Pvt. Ltd., Vadodara

25) Flanges :

1. M/s Aditya Forge Ltd., Vadodara
2. M/s Amforge Industries Ltd., Mumbai
3. M/s CD Engineering Co., Ghaziabad
4. M/s Echjay Forgings Pvt. Ltd. (Bombay), Mumbai
5. M/s Echjay Industries Ltd., Rajkot
6. M/s Forge & Forge Pvt. Ltd., Rajkot
7. M/s Golden Iron & Steel Works, New Delhi
8. M/s JK Forgings, New Delhi
9. M/s Metal Forgings Pvt. Ltd., Mumbai
10. M/s Perfect Marketings Pvt. Ltd., New Delhi
11. M/s Sky Forge, Faridabad
12. M/s S&G, Faridabad
13. Chaudhry Hammer Works Ltd, India
14. JAV Forgings (P) Ltd, India
15. Kunj Forgings Pvt Ltd, India
16. MS Fittings Mgf. Co. Pvt. Ltd.
17. R.N. Gupta & Co. Ltd, India

18. R.P. Engineering Pvt Ltd, India
19. Sanghvi Forgings & Engineering Ltd
20. Shri Ganesh Forgings Ltd., India
21. Uma Shankar Khandelwal & Co., India
22. Sawan Engineers, Baroda
23. Stewarts & Lloyds of India Ltd., Kolkata
24. Engineering Services Enterprises
25. Abasi Engineersing Works, India
26. Anandmayee Forgings Pvt Ltd, India
27. CD Industries., India
28. Fivebros Forgings Vot Ltd., India
29. Good Luck Engineering Co., India
30. Korea Flange, South Korea
31. Lal Metal Forge Ltd, India
32. Melesi Officine
33. Amlrojie Melesi & C. srl. Italy
34. Nicola Galperti & Figlio S.P.A India
35. Paramount Forge, India
36. Pradeep Metal Limited, India
37. Punjab Steel Works (the), India
38. R.D.Forge, India
39. Shah Industrial & Comml. Corporation, India
41. Vivial Forge Pvt. Ltd., Vadodara

26) Gaskets Spiral Wound

1) IGP Engineers Pvt. Ltd., India
2) Madras Industrial Products, India
3) Starflex Sealing India Pvt Ltd, India

27) Pipe – Carbon Steel (Seamless) to ASTM STDS.

1) BHEL (Trichy), India
2) Heavy Metals & Tubes Ltd (Mehsana), India
3) Indian Seamless Metal Tubes Ltd, Ahmednagar, India
4) Indian Seamless Metal Tubes Ltd, Baramati, India
5) Jindal Saw Ltd (Nashik Works), India
6) Mahalaxmi Seamless Ltd, India
7) Maharashtra Seamless Ltd, India
8) Sainest Tubes Pvt Ltd, India
9) Wuxi Erquan Special Steel Tube Co. Ltd.

28) Pipe - Carbon Steel to Indian Standards

1) Advance Steel Tube Ltd., India
2) Asian Mills Pvt Ltd, India
3) BMW Industries Ltd(Bansal Mech Works) , India
4) Goodluck Steel Tubes Ltd, India
5) Indus Tube Limited, India
6) Jindal Pipes Ltd, India
7) Jindal Saw Ltd (Kosi Works) , India
8) Lalit Profiles & Steel Ind Ltd. , India
9) Lloyd Metals & Engineers Ltd. , India
10) Maharashtra Seamless Ltd, India
11) Man Industries Ltd, India
12) Mukat Tanks & Vessels Ltd., India
13) North Eastern Tubes Ltd.
14) Pratibha Pipes & Strl Pvt Ltd
15) PSL Limited (Nani Chirai)
16) PSL Limited (Chennai)
17) Ratnamani Metals & Tubes Ltd
18) Sri Sarbati Steel Tubes Ltd

19) Steel Authority of India Ltd
20) Surindra Engineering Co Ltd (Rajpura), India
21) Surindra Engineering Co Ltd (Mumbai), India
22) Surya Roshni Ltd, India
23) Swastik Pipes Ltd,, India
24) The Tata Iron & Steel Co Ltd, India
25) Welspun Gujarat Stahl Rohren Ltd, India

29) Pipe & Tubulars to API Standards

1) BHEL (Trichy), India
2) Indian Seamless Metal Tubes Ltd, Ahmednagar, India
3) Indian Seamless Metal Tubes Ltd, Baramati, India
4) Jindal Pipes Ltd, India
5) Jindal SAW Ltd (Kosi Works)
6) Jindal SAW Ltd (Nashik Works)
7) Lalit Profiles & Steel Industries Ltd
8) Lloyds Metals & Engineers Ltd
9) Maharashtra Seamless Ltd, India
10) Man Industries (I) Ltd
11) Mukat Tanks & Vessels Ltd
12) Ratnamani Metals & Tubes Ltd
13) Steel Authority of India Ltd
14) Surindra Engineering Co Ltd (Mumbai), India
15) Surya Roshni Ltd, India
16) Welspun Gujarat Stahl Rohren Ltd, India

30) Pipe - Carbon Steel (Welded) to ASTM Standards

1) Jindal Saw Ltd (Kosi Works) , India
2) Lalit Profiles & Steel Ind Ltd. , India
3) Man Industries Ltd, India
4) Mukat Tanks & Vessels Ltd., India
5) Ratnamani Metals & Tubes Ltd
6) Surindra Engineering Co Ltd (Mumbai), India

31) Field Instruments (P, DP, F, L, T)

1) ABB Ltd (Faridabad), India
2) ABB Automation Ltd, India
3) Emerson Process Mgmt Asia Pacific PTE Ltd,
4) Emerson Process Mgmt India Pvt Ltd,
5) Fuji Electric Instruments Co Ltd
6) Honeywell Automation India Ltd,
7) Honeywell Inc.
8) Yokogawa Electric Corp.
9) Yokogawa India Ltd
10) Invensys India Pvt.Ltd

32) Gas Chromatograph

1) ABB Ltd (Faridabad), India
2) Daniel Measurement & Control
3) Instromet International, NV
4) RMG Regal+Messtechnik GmbH
5) Yokogawa

33) I/P Converters

1) ABB Ltd (Faridabad), India
2) ABB Automation Ltd, India
3) Emerson Process Management Asia Pacific PTE Ltd
4) Emerson Process Management India Pvt Ltd, India

5) IMI Watson Smith Ltd.
6) Moore Controls Ltd
7) MTL India
8) Shreyas Instruments Pvt Ltd, India
9) Thermo Brandt Instruments

34) Instrument Valves & Manifolds

1) Anderson Greenwood Crosby
2) Astec Valves & Fittings Pvt Ltd, India
3) Aura Inc.
4) Autoclave Engineers Fluid Components
5) Chemtrols Engineering Ltd, India
6) Circor Instrumentation Ltd
7) Excel Hydro Pneumatics Pvt Ltd, India
8) Excelsior Engg Works, India
9) Ham-Let (Israel-Canada) Ltd
10) Hyd-Air Engg. Works Lonavala, India
11) Micro Precision Products Pvt Ltd, India
12) Parker Hannifin Corporation
13) Precision Engineering Industries, India
14) Prime Engineers
15) Swagelok Co.
16) Swastic Engineering Works, India
17) Technomatic (India) Pvt Ltd, India
18) Waree Instruments ltd
19) M/s Comfit & Valves Pvt.Ltd
20) M/s Arya Crafts & Engg.Pvt. Ltd

35) Junction Boxes (Flame Proof)

1) Baliga Lighting Equipments (P) Ltd, India
2) FCG Flameproof Control Gears P. Ltd., India
3) FCG Power Industries Pvt Ltd, India
4) Flameproof Equipments Pvt Ltd, India
5) Flexpro Electricals Pvt Ltd, India
6) Govan Industries (India) P Ltd, India
7) Prompt Engineering Works, India
8) Sudhir Switchgears Pvt Ltd, India

36) L E L Detection System

1) Crowcon Detection Instruments Ltd
2) Detection Instruments (I) Pvt Ltd
3) Detector Electronics Corporation
4) Drager Safety AG & Co. KGAA
5) General Monitors Ireland Ltd
6) Mine Safety Appliances Company
7) MSA – Mines safety appliances(India) ltd
8) Industrial Scientific Oldham France S.A.
9) Riken Keiki Co Ltd
10) Simrad Optronics Icare
11) Honeywell Analytics
12) Net Safety Monitoring Inc.
13) Simtronics SAS

37) Pressure Gauges

1) AN Instruments Pvt Ltd
2) Badotherm Process Instruments B.V.
3) Baumer Bourdon Haenni S.A.S
4) British Rototherm Co Ltd

5) Budenberg Gauge Co Ltd
6) Dresser Inc
7) Forbes Marshall (Hyd) Pvt Ltd
8) General Instrument Consortium
9) H. Guru Instruments (South India) Pvt Ltd
10) Manometer (India) Pvt Ltd
11) Nagano Keiki Seisakusho Ltd
12) Hirlekar Precision, India
13) Waaree Instruments Ltd
14) Walchandnagar Industries Ltd (Tiwac Divn)
15) Wika Alexander Wiegand & Co GmbH
16) Wika Instruments India Pvt Ltd
17) Ashcroft India Pvt Ltd.

38) Temperature Gauges

1) AN Instruments Pvt Ltd.
2) Badotherm Process Instruments B.V.
3) Bourdon Haenni S.A.
4) Dresser Inc.
5) General Instruments Consortium
6) H. Guru Instruments (South India) Pvt Ltd
7) Nagano Keiki Seisakusho Ltd
8) Solartron ISA
9) Walchandnagar Industries Ltd (Tiwac Divn)
10) Wika Alexander Wiegand & Co GmbH
11) Wika Instruments India Pvt Ltd
12) M/s Pyro Electric, Goa
13) M/s Ashcroft India Pvt Ltd.

39) Temperature Elements, Thermo-wells

1) ABB Automation Ltd
2) Altop Industries Ltd
3) Bourdon Haenni S.A.
4) Detriv Instrumentation & Electronics Ltd
5) General Instruments Consortium
6) Invensys Software Systems (S) PTE Ltd.
7) Japan Thermowell Co Ltd
8) Nagman Sensors Pvt Ltd
9) Tecnomatic SPA
10) Tempsen Instrument India Ltd
11) Thermo Electric Co. Inc.
12) Thermo-Couple Products Co
13) Thermo-Electra B.V.
14) Wika Alexander Wiegand & Co GmbH
15) Altop Industries Ltd., Baroda
16) M/s Nagman Sensors (Pvt.) Ltd.
17) M/s Pyro Electric, Goa

40) ULTRASONIC FLOW METERS

1) M/s Daniel (USA)
2) M/s RMG (Germany)
3) M/s INSTROMET (Belgium)
4) M/s Sick Maihak, Germany
5) M/s FMC, Germany

41) MCBs

1) Havells

2) Indo Asian
3) MDS

42) RELAYS

1) OEN
2) Jyoti

43) POWER SUPPLY UNIT

1) ELNOVA
2) APLAB

44) PRINTERS

1) Compaq
2) Dell
3) IBM
4) HP
5) EPSON

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Notes:

1. Bidder can select equipments of two different makes, selected from the VENDOR LIST provided above and mention the same in the checklist for technical evaluation as per Annexure-X (a) attached with the tender. The offered bid must include filled datasheet indicating make, model, size, rating of offered instrument/ equipment duly supported by sizing calculation of offered equipment (wherever applicable).
2. Vendors who have already supplied above equipments in other terminals of GAIL India Ltd, shall also be considered qualified for this tender provided the supplied equipments are commissioned and running successfully and they have not been put on holiday.
3. Equipment(s)/ Instrument(s) of any make which is offered by one bidder and acceptable to GAIL (I) Ltd shall be accepted for other bidder also. After placement of order, on request of the successful bidder list of other qualified makes for a particular item (for which successful bidder wants to change the vendor) shall be provided.
4. Bidder shall take prior approval of the make /model no of the offered item and it shall be from the list given above. However additional vendors will be considered in exceptional cases, provided they have supplied for similar application to reputed gas transmission/distribution companies, in quantities at least half the numbers being supplied for this tender, and working satisfactorily for minimum 6 months. Documentary evidence substantiating above shall be submitted for taking approval.

GAIL INDIA LIMITED

SPECIAL INSTRUCTIONS TO BIDDER

GAIL-STD-GN-DOC-GEN-005

0	15.04.19	Issued for Bid	RKS	UNU	UNU	
Rev.	Date	Purpose	Prep. by	Check by	Appro. by	

SPECIAL INSTRUCTION TO BIDDERS

BIDDING INSTRUCTIONS

A1. Bidders must follow the following guidelines while submitting their offer. Offers not complying to these guidelines shall be rejected summarily without any intimation to the Bidder.

a) Furnish quotations only for those items that bidder can supply strictly as per Specifications including fulfillment of PTR (Proven Track Record) criteria as per BEC.

b) In case of any deviation in their offer, Bidder shall only furnish a technical deviation list in format attached as "Deviation form" for the deviations (if any). Deviations shall be highlighted clause wise. If discrepancy exists between the deviation list and any other part of the offer, deviation list shall prevail. If deviation list is not furnished in the offer, it shall be considered that no deviation exists. Generally, deviations are not acceptable and owner reserves the right to reject the offer with out any further clarifications. Evaluations shall be made based on deviation / compliance statement only.

c) No correspondence whatsoever shall be entered into or entertained after the bid submission.

d) The submission of prices by the vendor shall be construed to mean that they have confirmed compliance with all technical specifications of the corresponding item(s).

e) Vendor to note that a pre-bid meeting shall be held in which, the vendor can seek any clarification / confirmation if required. Vendor shall ensure that this conference is attended by both the technical and commercial personnel of the vendor who should have thoroughly scrutinized the tender beforehand so that all issues are finally resolved in this meeting. Also the queries to be discussed during pre-bid meeting shall be sent, at least 2 days in advance.

A2 Vendor shall be responsible for selection of correct make and model of the instruments/ equipments to meet the purchaser's specifications. In case the make/ model is required to be changed at a later stage, to meet the purchaser's specifications as per the requisition, the same shall be done by the vendor without any price and delivery implications.

A3. Only the proposals which meet the Bid Evaluation Criteria (BEC) shall be technically and commercially evaluated. In support of meeting the experience criteria as indicated in BEC, bidders must fill in Annexure X(a). Absence of any of the information listed therein will be considered as not having the requisite experience

A4. Various components of the gas metering skid (e.g. SSV, Pressure regulating valves, Filtration system, Turbine / Ultrasonic / Orifice Gas flow meters, GC, LEL detection system, Flow computers, Flow control Valves, DPT, Pressure & temperature transmitters, Receiver instruments, Valves) being offered shall be from the reputed manufacturers and each component must have been in use for similar application and worked satisfactorily for at least 4000 hrs as on bid due date. Vendor to furnish Proven Track Record in the offer for offered model indicating model number of the above items supplied, name of plant, name of client, type of application, month and year of supply and commissioning of the plant, name & address of the contact person. Items without field proven shall not be considered for evaluation. PTR shall be furnished in the EQC forms attached along with the supportive documentation in support of its proven performance.

A5. Vendor shall furnish performance guarantee certificate in the formats attached herewith. Also vendor shall be required to submit logistic support certificate from OEM of the equipment in case of award.

A6 Vendor to note that it is a NO DEVIATION tender. VENDOR SHALL FILL & FURNISH TECHNICAL DEVIATION (if any) in the format enclosed. If no deviation has been indicated by bidder in the Format provided, it will be presumed that bidder has confirmed to comply tender condition and there is deviation.

A7 Bidder to also necessarily submit the details (Make, Model, Ref Page of offered documents No. etc. for EQC, Logistic support, Sizing calculation, Type certification/ approval, etc) of the major items offered for each SOR item separately in the Checklist Format attached (5.10a- Annexure-X(a)). Bidder to note that in case of unfilled, incomplete and incorrect Checklist Format for all / any SOR item, bid is liable

for rejection. Only offered make/ Model for individual Skid component to be indicated in the checklist format for each SOR item(s) separately.

CERTIFICATE OF LOGISTIC SUPPORT

1. LOGISTIC SUPPORT CERTIFICATE:

1.1 Vendor must furnish Certificate for providing necessary support services in favour of the Owner (M/s GAIL) for Gas Metering Skid committing themselves to provide logistic to purchaser in the format furnished along with.

1.2 For major bought-out items like Flow meter, flow computer, slam shut valve, pressure regulator, FCV, Filtration, Transmitters etc, this certificate must be furnished from each of the Sub vendors clearly indicating type, model no. etc.

1.3 The Certificate must be signed with seal by the official signatory on the company's letterhead.

CERTIFICATE FOR LOGISTICS SUPPORT

(To be signed by Manufacturer's corporate level signatory on company's letterhead)

I, on behalf of M/s_____ confirm that the Gas metering skid Items (Turbine/ PD flow meter / flow computer/ Filtration / Pressure Regulator (PCV) / FCV/ SSV/ Field transmitters/ controller etc.) quoted by M/s_____ for M/s GAIL against Bid document No._____shall continue to be supported by us for a period of minimum 10 years.

The quoted system shall not be withdrawn from Indian market as a matter of our corporate policy. I further confirm that in case of placement of order by GAIL on us, we shall continue to support GAIL in providing back-up engineering, maintenance support and spare part support for a period of 10 years from the date of placement of order.

SIGNATURE WITH SEAL
AUTHOURIZED, SENIOR
MANAGEMENT LEVEL
SIGNATORY

DEVIATION FORM

ITEM: GAS METERING SKID

BID DOCUMENT No. _____

Name of Vendor: -

Schedule of deviation: -

Sr. No.	Spec No	Clause No	Requirements as per bid document	Deviations by Vendor	Clarifications	Remarks

Signature of authorized Signatory of vendor ……

Name of authorized signatory ……

Stamp & Date ……

Note :

1. Additional sheets may be used by bidder as required.
2. bidder shall furnish here a consolidated list of deviations taken in his offer with necessary remarks for such deviations.
3. Deviations mentioned elsewhere in the offer but not listed in this form shall not be binding on the owner. Any such deviations indicated elsewhere (other than this form) shall render the offer non-responsive and shall be liable for rejection.
4. All the other clauses of the tender, not listed herein shall be deemed to be fully complied by the bidder.
5. All other clauses of the tender shall be deemed to be fully complied by the bidder.
6. Only the deviations listed herein, in conjunction with the tender shall constitute the contract requirements for the award of job to the bidder.

EQUIPMENT QUALIFICATION CRITERION (EQC) FORM

Proven Track Record for the offered Filtration system, Slam shut valve, Pressure regulators, safety valves, Flow meters, flow computers, FCV, High Pressure Gas supply train etc. shall be furnished by the bidder in the format given below.

Sr. No	Make & Model No. of offered Instrument	Manufacturing location	Manufacturing since date/year	Name of the project installation with PO nos.	Type of Application	Working successfully since Date / year	Details of major breakdowns till date (if any)	User's Name, Address Tel /FAX No. of Contact person	Remarks

The PTR for each item shall be furnished in the above format separately. In addition for the flow meters and Flow computers bidder shall furnish the documentary evidence in support of the proven performance like, Type Approval Certificate along with calibration certificates/ reports approved by MNI, PTB or equivalent Flow Labs of repute.

Check List For SOR ITEM No. 1 (Metering skid)							
NAME OF BIDDER:							
OFFER NO & DATE :							
QUOTED FOR SOR ITEM NO. :							
Sl. No.	BEC CLAUSE NO.	DOCUMENT REFERENCE AGAINST THE CLAUSE	P.O REF. NO. & DATE	INLET / OULET SIZE & RATING OF SUPPLIED SKID	SUPPLIED TO (NAME OF CUSTOMER)	Page No. Ref (Attached with Bid Document)	Remarks
1							
2							
3							
4							
5							
NOTE : BIDDER SHALL SUBMIT THE SEPARATE CHECK LIST (BEC) FOR EACH QUOTED SKID.							

GAIL INDIA LIMITED

TYPICAL FAT MANUAL / PROCEDURE

GAIL-STD-GN-DOC-GEN-007

0	15.01.2019	Issued for Bid	RKS	UNU	UNU	
Rev.	**Date**	**Purpose**	**Prepared By**	**Checked By**	**Approved By**	

FACTORY ACCEPTANCE TEST

Doc. No.: _____, Rev: 0

Date _____

FACTORY ACCEPTANCE TEST PROCEDURE

Project Description:

METERING SKIDs/ PRS SKIDs

P.O./FOI Ref : ---------- Dated----------

TABLE OF CONTENTS

1. PREFACE

1.1 Introduction:

This document defines procedure for Factory acceptance Test (FAT) to be carried out for Orifice/Turbine/RPD/Ultrasonic meter based Metering Skid(s).The purpose of carrying out FAT is to check functionality of the entire natural Gas fiscal metering skid (Filtration, Pressure regulation, Metering system) with respect to agreed technical documents.

The Vendor representative /TPI representative appointed by GAIL/ TPI representative appointed by Vendor shall have requisite qualification and relevant experience in the field of custody transfer Measurement Systems.

Factory Acceptance test is categorized onto two sections viz.

A: Factory Acceptance Test for the Metering package

Factory Acceptance Test for the Metering package consisting of Panel/Field Mounted electronic measurement instruments like Flow computers, GC controller etc. shall be carried out in the premises of vendor. The purpose of this FAT is to verify the integration of the fiscal metering functionality with respect to the following:

1. Metering panel mechanical construction and painting
2. Metering panel electrical and instrumentation arrangement within the panel.
3. Simulating metering skid's field inputs to metering system using test equipment
4. Operation and configuration of the flow computer functions
5. "Live" analyzer inputs to the metering system using the test gas
6. Analyzer house mechanical construction and painting
7. Analyzer house electrical & instrumentation work
8. Analyzers operation
9. Analyzer data management to the fiscal metering system
10. Project Documentation/ Test Records/Mechanical and Other Test certificates/Orifice meter Calibration certificates /Turbine meter Calibration certificates /USM Calibration certificates/ GC Calibration Gas certificates/Instrument calibration certificates/ Loop Drawings/GAD Metering Panel Instrument Arrangement, P & IDs Etc.

B. Factory Acceptance test for the Metering Skid along with other skid-mounted instruments

Factory Acceptance test for the Metering Skid along with other skid-mounted instruments shall be carried out at vendors place. The purpose of this FAT is to verify the skid construction with respect to the following:

1. Metering skid mechanical construction and painting
2. Metering skid electrical and instrumentation construction
3. Metering skid's equipment operation and field instruments calibration
4. Metering skid's Manufacturer's Data Record (MDR)
5. Leak test for the skids

6. Verification of Test/Calibration certificates /Datasheets/other skid and components related documentation/GADs/P & IDs

The nominated representatives of TPI from GAIL (India Limited) and vendors representatives will witness and sign-off the FAT.

NOTE: A**ll the tests, inspection, checking, data-configuration etc. shall be conducted as per FAT procedure by the vendor and the same shall be submitted to GAIL for review before calling for witnessing FAT by GAIL representative. The Records/ Test Reports/ calibration reports/ certificates, configuration sheet for flow computers and other relevant documents should be prepared / obtained by the vendor and sent to GAIL for review before calling for FAT. Bidder shall give advance intimation of minimum 7 days for FAT. Following documents shall be furnished along with the intimation for FAT.**

1. **Configuration report (for FC, GC, USM, Metering supervisory system) duly filled and signed by TPI and QC department of Bidder.**
2. **Functional design specifications for Metering system including Metering supervisory system along with screen shots.**
3. **Duly filled and signed FAT procedure document after conducting internal FAT**
4. **Calibration Report of Primary Flow Elements (Orifice/Turbine/Ultrasonic Flow meter).**
5. **Calibration Report of Secondary Instrumentation(Transmitters, gauges, associated electronic instruments like flow computers, I/P convertors etc).**
6. **GC calibration Report and Calibration Gas certificate .**
7. **Confirmation of Bidder's TPI representative of requisite experience in Gas Flow measurement systems.**
8. **List of Software, mandatory spares, commissioning items (including cable with type and length, canopy, Test/calibration equipment, loose supplied items, Laptop etc) as per tender requirement.**
9. **Relevant documents for smooth conduction of FAT like Data Sheets/ Test and Calibration Certificates/Loop drawings/Manufacturer's Data Record (MDR)/Project Documentation/ Test Records/Mechanical and Other Test certificates/USM Calibration certificates/ GC Calibration Gas certificates/Instrument calibration certificates/ /GADs/P & IDs/FDS etc.**

1.2 Scope:

The FAT will confirm the compliance of Metering Skid with the project specifications. The purpose of FAT is to check the performance of each component as well as entire skid. Upon completion of the test described in the following procedures and acceptance of the same, the system will be considered to be ready to be dispatched to the site. All the physical & functional tests are described in the remaining sections. When each functional test has been completed, the TPIA appointed by GAIL & Customer appointed TPIA representative, will indicate acceptance of the tests by signing the test certificates.

All the equipment / instruments/ items shall be installed (as far as possible) for functionality demonstration during FAT. In case some of the items cannot be erected/ installed during FAT, list of such item along with the reason for not installing the same shall be provided before start of FAT. FAT shall not be conducted before approval of such list by Client. In case difference in calculated values (calculated by different Instruments) is observed for any parameter, the list of such parameters along with values and suitable reason for such deviation to be submitted to

GAIL in advance for review by GAIL/ GAIL's Representative. In case deviation is observed in the parameter-values displayed by various components, the same shall be recorded and may result in to rejection of FAT.

All connectivity/ its simulation mentioned elsewhere in tender (like Laptop, Printers, Flow meter, SCADA, FCetc.) shall be established and demonstrated during FAT. Non-compliance to any of these shall result in rejection of acceptance of Metering skid

1.3 Reference Documents:

Design Documents of Skid

Document No.

1. P& ID for Skid Drawing No. ----------
2. System Architecture Diagram Drawing No……..
3. Metering Skid-GA Drawing for Skid Drawing No. ----------
4. Analyzer house- GA Drawing for Skid Drawing No. ----------
5. Functional Design Specification (FDS)
6. Functional Design Basis
7. Base frame and Foundation Drawing No. ----------
8. Base frame Calculation Doc. No. ----------
9. Instrument Index
10. Field Junction Box Wiring Diagram
11. Cable Schedule
12. Metering Panel Layout Diagram
13. Metering Panel Wiring & Power Distribution Diagram
14. Process Hook-up Diagram
15. Modbus Map for serial interface
16. Sizing calculation sheet for flow elements/Pressure reduction system compnents
17. Loop Drawings
18. Quality assurance plan - Mechanical Items Doc. No. ----------
19. Quality assurance plan – Instrumentation Equipment Doc. No. ----------
20. Material Test certificate, Radiography test report, Hydro-test certificate _____
21. Type approval certificates for Primary Metering Elements and flow profilers- _____

Datasheet / Drawing of Equipment:

1. Orifice/ Turbine/PD Flow meter/Ultrasonic Meter –Data sheet No._____
2. Upstream/ Downstream Flow conditioners/ Flow straighteners – Drawing No._____
3. Pressure Transmitter – Data Sheet No._____
4. Differential Pressure Transmitter- Data Sheet No._____
5. RTD with Temperature Transmitter– Data Sheet No._____
6. Pressure Gauge – Data sheet No._____
7. Temperature Gauge – Date sheet No._____

8. Differential Pressure Gauge- Data Sheet No._____
9. Flow Computer – Data Sheet No._____
10. Flow Control Valves – Data sheet No._____
11. Pressure Control Valve (Regulator) – Data Sheet No_____
12. Slam Shut of Valve– Calculation, GA Drawing No._____
13. Pressure safety Valve – Data Sheet No._____
14. Creep relive Valves – Data Sheet No._____
15. solar panel, battery , battery charger(power source)_____
16. Ball Valves ---------- make - Drawing No._____
17. Plug / Globe Valves - Drawing No._____
18. Check Valves- Drawing No._____
19. Cartridge Filter – Design data Doc. No._____
20. Control Panel _____
21. Gas Chromatograph including controller _____
22. LEL detection system including controller and field detectors----------
23. Metering supervisory system----------
24. Barriers_____
25. Junction Boxes & Cable Glands_____
26. Calibration certificates of Orifice/Turbine/RPD/Ultrasonic Metering System_____
27. Gas chromatograph Datasheets
28. Sample Probe Datasheets

1.4 Orientation of Witnesses:

TPIA Representative appointed by Vendor Shall be competent person in the field of flow measurement. The Name along with qualification and relevant experience in Flow metering shall be approved by M/s GAIL prior to participation and witness of FAT.

All representatives shall be briefed on details/ description/ operating principles of the Metering Skid for this project before commencing the FAT.

Test Equipment

Any electronic masters shall be calibrated at least once in a year from a reputed / NABL accredited laboratory. All the masters used for calibration shall have traceability to National / International standards. Valid certificate to be submitted during FAT. The following is a list of traceable calibrated test equipment used for verifying the functionality of the Control Panel and skids mounted instruments.

- Digital Multi-meter (DMM)
- Multifunction Loop calibrator
- Frequency Generator
- Laptop with requisite soft wares/Modbus simulator etc.
- HART communicator

1.5 Test Certificates:
Upon completion of the tests mentioned in this document, Test Certificates should be filled with the results and signed / stamped by all the parties.

1.6 Check list: Complete job is summarized in the Checklist as per attachment.

1.7 Action List:
Any discrepancies noted during the functional tests shall be defined, recorded and summarized in the Action List Form. Once proper action has been taken on those points, this Action List shall be signed / stamped by Customer/ TPIA duly filled with the results.

1.8 Review of Project Documentation

The project documentation shall consist of approved engineering submission drawings. Any discrepancies noted during the functional tests shall be clearly marked-up in these documents for revised submission to Customer as the final As-Built copy. The list of submission documents is as defined in the Vendor Drawing & Document Schedule.

1.9 Review of Internal Test Records

The internal test records performed prior to the FAT shall be made available to the GAIL/TPI for review. These records shall be used for comparison of test results with those during the FAT or for record purposes should random testing be performed for certain instruments/equipment.

1.11 Review of Competency of TPI Representative

The competency of the TPI representative shall be ascertained prior to commencement of the FAT.

2. VISUAL INSPECTION OF SKID

2.1 Skid Review:

The Skid will be inspected for installation of all the components as per approved P & ID and approved G.A. Drawing. Dimensional Checking shall be done as per approved G.A. Drawing. Skid will also be inspected for correctness of installed Equipments/ instruments (including make/Model of instruments) and approachability for maintenance. The Skid will be inspected for proper support with rubber pads / clamps for the major equipments/ Instruments, pipes and impulse lines.

2.2 Test Certificate for Visual Inspection:

Upon completion of the visual inspection described in this section, the test certificate for Visual Inspection of skid should be dully filled and signed by both parties.

2.2.1 Visual Inspection of Metering Control Panel and Analyzer House

(a) Metering Control Panel

2.2.1.1 Introduction

This section of the test procedure describes the visual inspection of the Control Panel. Panel assemblies, wiring ,instrument arrangements are to be checked for compliance to the approved drawings & specifications.

2.2.1.2 Inspection of Metering Control Panel & Dimensional Details

Check the Control Panel to ensure that the physical dimensions and layout are as indicated in the Control Panel Layout Diagrams. The Control Panel's framework and other aspects are also inspected for good quality finishing.

2.2.1.3 Inspection of Paint Work

Check the exterior and interior of the Control Panel to ensure that the painting work is of good quality and meeting the Painting specification requirements.

2.2.1.4 Panel Equipment Layout & Inventory Check

The Flow Computers, GC Controller, DC Power Supplies, PLC, Ethernet switches, Fiber optic converter, Circuit Breakers, Various Isolators ,convertors and Splitter, Supervisory flow computers, Printers, Audio Visual annunciation system ,Push buttons and switches, Flow controllers etc. are checked to ensure that the physical arrangement on the panels is in accordance with the Control Panel Layout Diagrams.

2.2.1.5 Panel Wiring

Wire sizes and terminations in the Metering Control Panel are checked as indicated in the control panel wiring & schematic diagrams. All the loops are in conformity with the approved Drawings. Check the functional test as per Data sheet. Installation of equipments and components as per approved documents. Check for placement of equipment for easy workability and maintenance. Operation of Fan, Light and other items. Check for cable identification mark, tags, cable dressing.

2.2.1.6 Power Distribution

The AC and DC power distribution system of the Control Panel are checked for conformance to the Control Panel wiring Diagrams. Hot stand by functionality of Power supply in control panel to be checked.

2.2.1.7 Grounding Details

The grounding system of the Control Panel is checked for conformance to the wiring drawings. Door alignment, locks and overall dimensions to be checked.

2.2.1.8 Maintenance Accessibility

Check for placement of equipment for easy workability and maintenance. Check the orientation and installation of the equipment as per approved drawings.

2.2.1.9 Test Certificate for Visual Inspection of Panel

Upon completion of the visual inspection described in this section, the test certificate for Visual Inspection of Metering Panel should be dully filled and signed by both parties.

(b)Analyzer House Visual Inspection

2.2.2.1 Introduction

This section of the test procedure describes the visual inspection of the Analyzer House. Analyzer House layout, Analyzers installation and hook-ups are to be checked as per the Analyzer House GA & Sampling Schematic drawings.

2.2.2.2 Inspection of dimensional Details

Check the Analyzer Houses to ensure that the physical dimensions are in accordance with the Analyzer House GA Drawings.

2.2.2.3 House Equipment Layout

Location of Analyzers, Power Distribution Boards, Circuit Breakers, PLC, Smoke & Gas Detectors, Beacons, Alarm panel, Manual Call point etc. are to be checked in accordance with the Analyzer House GA drawings.

2.2.2.4 House Inventory Check

Inventory check shall be performed as indicated in the House GA drawings.

2.2.2.5 Power Distribution & Electrical Check

The Power distribution system (AC & DC) of the Analyzer Houses is checked. Ensure all cable entries in and out of the analyzer are through Glands/Entries suitable for the area classification. Check if the tagging of the cables and wires are as per the drawings.

2.2.2.6 Grounding Details

The grounding system of the Analyzer Houses is checked. Check that suitable earthling connection is provided outside the House for further tie-in as indicated under the analyzer House layout drawings.

2.2.2.7 Maintenance Accessibility

The Analyzer Houses are checked for proper physical layout of equipment to ensure adequate maintenance accessibility within the House for the analyzers. Sample tubings and placement of cylinders, regulators etc. shall be checked for ease of maintenance.

2.2.2.8 Test Certificate for Visual Inspection of House

Upon completion of the visual inspection as described in this section, the *Test Certificate for Visual Inspection of Analyzer Houses* should be duly completed and signed by all parties.

3. FACTORY ACCEPTANCE TEST:

3.1 Hydrostatic Test (if not performed earlier)

3.1.1 Complete skid shall be offered for hydrostatic test.

3.1.2 Non Corrosive water shall be used for hydro testing at ambient temperature.

3.1.3 During the hydro test Flow meter, SSV, PCV and FCV and filter cartridges / elements shall not be installed with pipeline as internals will get damaged in contact with water.

3.1.4 All valves shall be kept at open position.
3.1.5 Either inlet or outlet pipe shall be closed with blind flange, the other side will be connected with water line (hose pipe) to fill up water inside the skid.
3.1.6 After filling water, the skid shall be pressurized to the required test pressure kg/cm² from skid outlet to PCV outlet and then pressurized to the required test pressure from skid inlet to PCV Inlet.
3.1.7 Maintain this pressure for four to six hours.
3.1.8 Pressure should not exceed hoop stress of the line pipe at any given moment of time.
3.1.9 No leakage is allowed through any joints and shell.
3.1.10 Record pressure and temperature reading at 30 minutes interval.

3.2 Pneumatic Test

3.2.1 After completion of hydro-test, drain out water from the skids.
3.2.2 Pass the air through the entire skid for some time to dry out the pipeline.
3.2.3 Assemble the Flow meter, SSV, PCV and impulse tubes in pipe line.
3.2.4. Keep all valves open and close either inlet or outlet side pipe with blind flange.
3.2.5 Pressurize the entire skid by air/ nitrogen up to 7 kg/cm² and hold for one hour.
3.2.6 No leakage/ drop in pressure is allowed.
3.2.7 Check the leakage using soap water.

3.3 Functional test of SSV, PCV and FCV

3.3.1 Set point of PCV– set the required pressure of PCV as per approved data sheet/ approved P&ID by Pilot adjusting screw.
3.3.2 Set point of SSV - Increase the PCV pressure to cross the set point of SSV. The SSV should trip at set pressure value as per approved data sheet/ approved P&ID. Record the Over Pressure Shut off value during test. (Checking of CRV Set pressure not incorporated)

3.3.3 Check the CRV setting at required Set pressure.

3.3.4 Check the pressure settings of PCV Active and monitor.

3.3.5 SSV's Limit switch feedback (contact) signal to be checked with Multimeter (Supervisory system).
3.3.6 In case of isolation/crossover Valves with limit switch, feedback (contact) signal to be checked with Multimeter (Supervisory system).
.
3.3.7 Flow control valves position (0-100%) shall be checked by simulation of analogue signal (4-20 mA signal) including entire Loop with all the components installed or from Supervisory System.

3.3.8 Test report/ record for Set pressure of PCV/ SSV/PSV/CRV shall be reviewed during FAT.

3.4 Functionality Test of Flow Computer

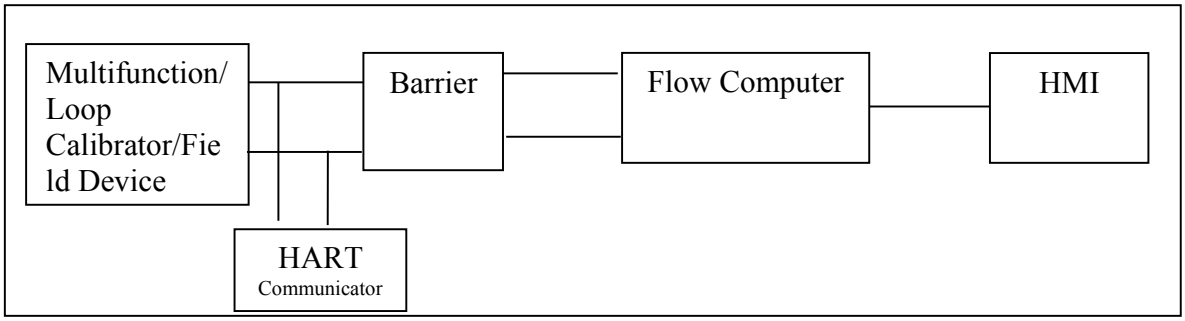
3.4.1 Configuration check, parameter settings/ checking etc shall be carried out as per the approved Data Sheet / Tender specifications/ FDS.
3.4.2 checking of Volumetric flow rate (corrected and uncorrected), Energy flow rate, Mass flow rate by simulation of Flow meter signal using Function Generator/ any other equipment. The signal to be simulated from input connections from meter head so that entire loop including Barriers,

terminal blocks etc. are included in the loop. Volumetric Flow shall be simulated to cover the entire range of the metering skid. Various Totalizes
(Volume , Energy and Mass), shall also be checked.

3.4.3 Flow validation against standard software to be carried out for applicable AGA standards like(AGA3, AGA7, AGA 10, AGA 8, ISO 6976,GPA 2145 with GPA 2172 etc.).

3.4.4 **Analog Input Test Procedure**
(Pressure, Temperature, Differential Pressure)

i. Set-up the test equipment as per Figure shown below.
ii. Vary the Multifunction/Loop Calibrator to inject an analog signal corresponding to 0% (4mA), 25 %(8 mA),50% (12mA), 75%(16mA) and 100% (20mA). In case of Complete Loop being on HART Protocol, simulate 0%, 25%, 50 % ,75% and 100% of process value using HART communicator.
iii. Verify the Process values and the corresponding mA (if applicable) and engineering units displayed on the Flow Computer and confirm the readings on HMI . Record in the Test Certificate for the respective transmitter.
iv. Compute the % error between the reading on the Flow Computer and corresponding value injected using the Loop Calibrator.
v. Simulate a cable breakage or equipment failure and confirm that corresponding alarm is generated and in-use value of the device automatically switches to use the configured default value.
vi. Decrease/Increase the signal values below the low alarm level and above the high alarm level to verify the correct operation of the low/high alarms on the Flow Computer and HMI.



Line Temperature, Line Pressure, Differential Pressure etc. shall be checked including the complete loop (with barriers and Terminal Blocks).

vii. Interface data of flow computer with RTU – Measurement by Laptop using suitable Modbus simulator software.
viii. Visual checking of instrumentation cable connection including cable gland, cable tag nos. JB mounting installation, cable dressing, Installation of various panel instruments/equipment etc. as per approved drawing, wiring diagram.
ix. Facility of entry of Atmospheric pressure and temperature by operator to be verified.
x. Various Units of measurement (Pressure, flow rate, heating value, energy etc.) shall be checked as per approved documents.
xi. Functioning of PID loop (AO) for FCV shall be checked by simulation.

3.4.5 Analog Output Test Procedure (Flow Control Valve)

i. Set-up the test equipment as per Figure 3.2.2 shown below.
ii. Vary the analog signal from HMI/ Flow computer to 0% (4mA), 25 %(8 mA),50% (12mA) ,75% (16mA) and 100% (20mA).
iii. Record the mA displayed on the multimeter.
iv. Compute the % error between the reading on the Station Computer and corresponding value displayed on the multimeter.
v. Provision to accept FCV set-point through Remote (SCADA/ GSM/GPRS Modem) and local (FC Keypad/ metering supervisory system) shall be demonstrated.

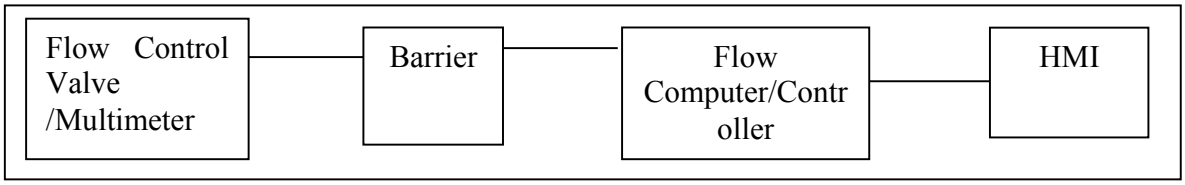
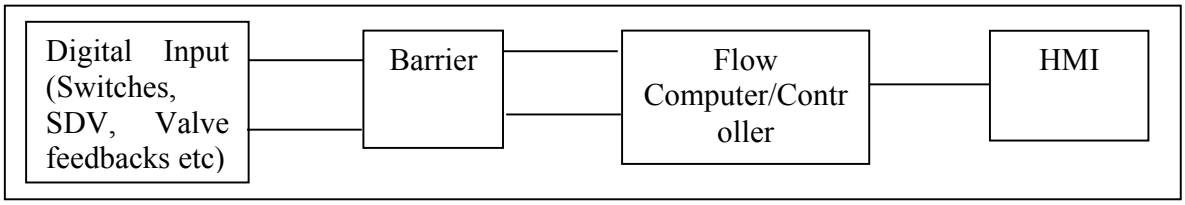


Figure 3.2.2 – Equipment setup for 4-20 mA Analog output Test

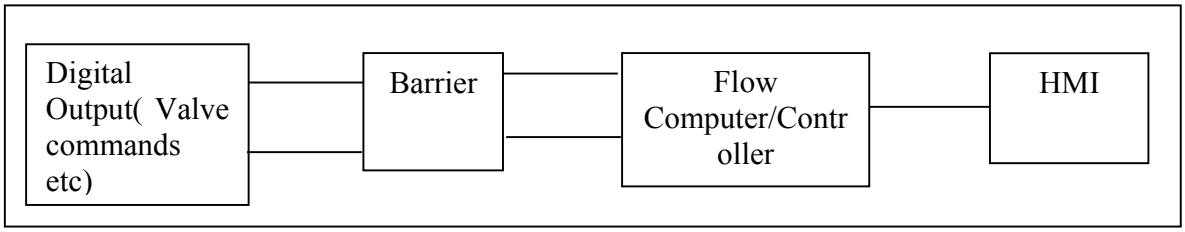
3.4.6 Digital Input Test Procedure (Slam shut valve & Control valve feedbacks)

i. Connect the switch to the input terminals of the station computer as shown in figure 3.2.3.
ii. Switch on and off the switch and observe the respective input changing status on the Input card and the HMI
iii. Record observations



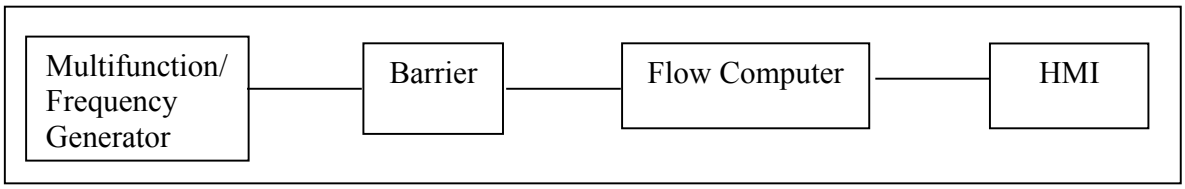
3.4.7 Digital Output Test Procedure (Valve Commands)

i. Connect the multimeter to the output terminals as per the approved wiring diagram
ii. Generate the output command from HMI/Flow computer/Controller and observe the respective status change on the Digital Output and multimeter
iii. Record observations



3.4.8 USM Pulse Input/ Turbine meter Test Procedure

i. Set up as per Figure below.
ii. Fix Pressure, Temperature ,Gas Composition and other configuration Data like K-factor etc. in keypad mode.
iii. Connect Frequency generator to the USM / turbine terminals.
iv. Simulate frequency signal (varying from Zero to full range) and verify the flow on the flow computers. Check entire designed flow range by varying the frequency of the signal.
v. Remove the frequency generator to simulate cable breakage or equipment failure and confirm that the flow computer does not record any flow during this period.
vi. Record the flow rate, total flow rate onto the test certificate for Ultrasonic flow meter.
vii. Flow totalization (Accumulated standard volumetric flow) shall be captured in Flow computer Hourly Flow Report and compared with standard software calculated accumulated flow.



3.4.9 Flow Computer Calculation Test Procedure – USM on Pulse Input/Turbine Meter

i. Set-up the test circuit as per Figure 3.2.4 & 3.2.5 above.
ii. Set the mode of the Pressure and Temperature inputs at the Flow Computer to keypad mode in order to fix the Pressure and Temperature value at the respective testing value.
iii. Set the Gas Composition to keypad Mode.
iv. Input the simulated flow value from frequency generator corresponding to normal operating flow of the flow computer.
v. Set the K-Factor and other parameters as in the Calibration certificate.
vi. The following calculations will have to be done on the stream flow computers:-
   a. Mass Flow rate
   b. Mass Total
   c. Energy Flow rate
   d. Energy Total
   e. Standard Volume Flow rate
   f. Standard Volume Total
   g. Uncorrected Volume Flow rate
   h. Uncorrected Volume Total
   i. AGA 7, AGA 8 & AGA 10
   j. ISO6976 /GPA 2172/GPA 2145

3.4.10 Flow Computer Calculation Test Procedure- USM on Serial Input

i. Set-up the test circuit as per Figure 3.2.4 & 3.2.5 above.
ii. Set the mode of the Pressure and Temperature inputs at the Flow Computer to keypad mode in order to fix the Pressure and Temperature value at the respective testing value.
iii. Set the Gas Composition to keypad Mode.
iv. Set the Gas Velocity to Keypad mode corresponding to normal operating flow.

v. The following calculations will have to be done on the stream flow computers:-

a. Mass Flow rate
b. Mass Total
c. Energy Flow rate
d. Energy Total
e. Standard Volume Flow rate
f. Standard Volume Total
g. Uncorrected Volume Flow rate
h. Uncorrected Volume Total
i. AGA 7, AGA 8 & AGA 10
j. ISO6976 /GPA 2172/GPA 2145

3.4.11 Power Supply Redundancy Test – If applicable (Power Supply redundancy Test Procedure)

(i) Switch-off one of the two incoming power supplies to the metering panel and check that the metering system is still functional, by checking the data on Flow Computer

(ii) Check that on disconnection of one power supply, an alarm is generated at Flow Computer & HMI.

3.4.12 Flow Computer Power Recycle Test

The Flow Computer shall be tested by recycling the power to verify no changes to the non-reset table fixed configuration values happen, and that the application program does not get corrupted upon start-up.

3.4.13 Flow Computer Totalizer Test Procedure

(Gross volume, Std. volume, Mass, Energy)

(i) Set-up the test equipment as per Figure 3.2.4 above.

(ii) Set mode of the Pressure and Temperature inputs at the Flow Computer to keypad mode in order to fix the Pressure and Temperature value at the normal operating value.

(iii) Fix the Gas Composition Data to keypad mode.

(iv) Simulate the Flow rate values by simulation (pulses or serial).

(v) Let the Flow computer accumulate pulses/ accumulate flow for one complete hour so that hourly report is generated in flow computer and HMI. If possible Reset all totalizers within the Flow Computer to zero before starting simulation.

(vi) Record the cumulative gross volume, standard volume, mass and energy registered onto the test certificate for Flow Computer Totalizer Test.

3.4.14 Flow Computer Reports

Various Reports and formats shall be verified like, Current report, Hourly Reports, Daily Reports, Shift reports, weekly and Monthly Reports.

3.4.15 Flow Computer and GC Communication

(i) Set-up the test equipment as per Figure shown below.

(ii) Establish the communication with Flow computer and Laptop on Modbus simulator program.

(iii) Write Different values in Gas composition registers through modbus simulator and verify the reading on Flow Computer and HMI.

(iv) Define Various alarms limits in Flow computer(L,LL, H,HH) for different gas components . Vary the readings of registers through modbus simulator and verify the alarm on Flow computer and HMI.

(v) Simulate analyzer failure and verify that the Flow computer reverts to the default mode of operation as per the configuration .

3.4.16 Other Miscellaneous Points/Tests

(i) Line Temperature, Line Pressure, Differential Pressure etc. shall be checked including the complete loop (with barriers and Terminal Blocks).
(ii) Simulation of Flow Computer output to SCADA by GSM Modem.
(iii) GC data input to Flow computer from SCADA via GSM modem.
(iv) Proper entry of the Turbine/ PD meter error curve, K factors, Meter factors as per the calibration certificateetc.
(v) Checking of Audit Trail/Events facility in the flow computer and its printing.
(vi) Checking of Alarm History
(vii) Checking of Various reports (Minute, hourly, daily, weekly, monthly, current/snapshot etc.)
(viii) Availability and functioning of USB/Serial/Ethernet ports with connecting cables for communication of various devices/ Instruments/ Equipment(like GSM, RTU/ SCADA, Printers, Laptop,GCetc) with flow computers.
(ix) functioning of standalone Software for flow calculation verification to be checked.
(x) Check functioning of Control Panel / Solar Panel.(If applicable)
(xi) Check functioning of Batteries for Solar Panel. (If applicable)
(xii)Provision to calculate Energy Flow rate and totalized Energy through both GCV and NCV shall be demonstrated. For easy switchover selection of NCV and GCV for Energy flow rate calculation shall be provided in Flow computer.
(xiii) In case of USM , Proper entry of the Meter error curve, K factors, Meter factors as per the calibration certificate in USM Electronics/Flow computer (as applicable). Checking of Complete calibration certificate data with USM configuration in meter electronics to be verified.
(xiv) In case of Orifice meter,checking of Relevant configuration data as per the Orifice Calibration/ Inspection sheet like (Meter tube dia, Orifice Diaetc).

3.4.17 Test Certificates on Functional Tests for Flow Computer

Upon completion, the test certificates for the various instruments pages should be duly completed and signed by all parties.

3.5 Gas Chromatograph Test

The Gas Chromatograph will be verified using calibration gas as sample gas. The GC shall analyze the calibration gas as a sample stream. Five analysis reports shall be obtained, and the results shall be tabulated and compared against the known calibration gas composition.

3.5.1 Test Procedure

(i) Inspect all joints of fittings, ferrules, valves etc. to check for any leakage.
(ii) Inject know concentration calibration gas as sample stream.
(iii) Let the column flush for two runs. Start accepting results from third analysis cycle.
(iv) Let GC runs for 5 consecutive analyses.
(v) If the gas analysis of the calibration gas is within the tolerance provided, repeatability test is successful and this test is completed. Complete the Test Certificate Sheet.
(vi) If the analysis is out of the tolerance specified, then complete the Instrument Calibration Sheet and investigate the cause of the non-compliance and repeat the test.
(vii) Upon completing the above tests, gas composition shall be downloaded to the Flow Computer through serial communication. The Flow Computer shall use these readings and calculate the density, compressibility, mass flow rate, volume flow rate and heating values under Flow Computer Calculations.
(viii) Various calculations as per Relevant standards

3.5.2 Test Certificate on Functional Tests for Gas Chromatograph

Upon completion, the test certificates for the Gas Chromatograph should be duly completed and signed by all parties.

Various reports formats like Current report, Daily average report , Custom average reports, Calibration reports shall be checked and customized.
Calculation as per ISO 6976/GPA 2172/GPA2145 will be verified . AGA 8 compressisblity calculation will be verified.

3.6 HMI Functional Test

3.6.1 Time Synchronization Test –If applicable

(i) Simulate the time synchronization from using laptop with standard Modbus TCP program.
(ii) Verify the time for PLC, HMI and flow computers.

3.6.2 Report Format Check

Verify the report formats
1. Snapshot/Current report
2. Hourly report
3. Daily report
4. Weekly report
5. Monthly report
6. Meter verification report

3.6.3 Meter Verification Test

1. Select the Pay and Check meter. Check meter shall be in NO FLOW status.
2. Align the valve in series.
3. Simulate the flow and then start the meter verification.
4. Run for 10 minutes and stop the meter verification.
5. Verify the meter verification report.
6. Reset the meter verification

3.7 Environment Protection:

Insulation of metering system panel and Environmental enclosure for custody metering equipments shall be checked visually during FAT.

3.8Solar Panel (wherever applicable):

(i) Certificates for Solar Panel, Batteries and charger including Junction Boxes shall be checked as per approved documents.
(ii) For each stream, carry out the functional test as per approved Document.
(iii) No. of Batteries with model, current/ power rating, AmpHour rating as per approved Battery sizing Calculation to be checked
(iv) Output Voltage of each streams shall be recorded.
(v) Visual Check: Support for Solar Panel, Battery enclosure/ mounting, Cable, identification marking, cable trays etc.

4.0 Spares:

List to be prepared and submitted in advance for approval by GAIL for all the spares, (like mandatory spares, commissioning spares, cables, Softwares etc.) materials required for erection, installation, testing, commissioning etc as per P.O. terms/ tender documents. During FAT test, all these items as per list shall be verified by TPIA and GAIL representative. All these items shall be clearly identified with proper tags/ identification no. Foundation bolts, stud and bolts for interconnection etc, mating flanges, Blind flanges etc. shall also be checked during FAT. List of applicable software licensed in name of GAIL shall also be prepared in advance and the same shall be reviewed during FAT.

5.0 Painting:
The painting shall be carried after cleaning the surface by sand blasting to remove all scale, rust, rust scale, paint, oil or foreign particles etc. and maintain the surface finishing as Sa 2 ½ .
Primer Coat – Zinc rich epoxy primer of thinness of 75 Micron (DFT).
Interim coat – polyamide epoxy of thickness 125 Micron (DFT)
Finished Coat –polyurethane of thickness 75 Micron (DFT).
Total Thickness- 275 Micron (DFT)
The color code of pipelines – Golden Yellow
Other colors as per the approved color scheme.

6.0 Documents Review:
After completion of all tests, Documents like material test certificates, Radiography test, Hydro-test, calibration/ test reports etc. for Ball valves/ Plug valves/ CRV/ NRV/ PSV/ FCV/ Filters, pipes, fittings, Tee/ elbow/ weld joints, Flow meters, Flow computers and associated electronics shall be reviewed to check the compliance with the tender specifications and approved QAP for the equipments / instruments.

7.0 Annexure to FAT Manual:

Apart from FAT procedure, FAT Manual shall have Annexure which shall include the following:

a. List of all the loose items with details to be provided by vendor (like Mandatory Spares, commissioning spares, Consumables, Parts of metering skids, Parts of Solar panel, mating flanges, Gaskets, materials required for installation of skid, Communication cable(FC- laptop) for laptop, Earthing strips, Cable Trays, cable glands, plugs, blind flanges, lugs, ferrules, earthing Cables, Mounting Accessories, any other hardware required for establishing various connectivity mentioned elsewhere, Software etc.) to be enclosed as Annexure in the FAT Manual for our review/ approval. The items mentioned in the list (Annexure) shall be demonstrated during FAT.
b. List of all the reports (like calibration reports for various Instruments, test reports for all the equipments, CCOE certificates etc.), with details like Report no., date, description etc shall also be prepared as Annexure of FAT manual. The same shall also be reviewed during FAT

Any discrepancy observed during FAT shall be recorded/ noted in the Action list. Issue of Inspection Release note/ Dispatch clearance shall be subject to compliance of all the FAT Check-list points/ Action list.

TEST CERTIFICATE

VISUAL INSEPCTION OF SKID

Project: PRS/ METERING SKID

Customer: M/s GAIL INDIA LTD, New Delhi
P.O. No.:---------- Dtd. ----------

Sr. No	POINT INSPECTED	RESULTS FOUND OK
1	Skid checked as per P & ID and GA Drawing	YES / NO
2	Process parameter in Name Plate	YES / NO
3	Lifting hook	YES / NO
4	Copper jumper for all flanges	YES / NO
5	Earthing Connection at base frame	YES / NO
6	Insulation for Metering system	YES / NO
7	Instrumentation cable connection, cable dressing and JB mounting,installation etc. as per wiring diagram.	YES / NO
8	Identification Tags for cable and all Instruments	YES / NO
9	Painting colour of pipe line (golden Yellow)	YES / NO
10	Spares as per P.O. requirement	YES / NO
11	Foundation bolt and Mating flanges	YES / NO
12.	Support for all the equipments/ Instruments, Pipe, Trays	YES / NO
13.	Adequacy of Platform and Cross-over, jump-over, for Access, approach for operation and maintenance	YES / NO
14.	Proper Placement of Instruments for easy workability And operation and Maintenance	YES / NO

Company Representative **TPIA** **GAIL's representative**

Date:

TEST CERTIFICATE

HYDROTEST OF SKID/ SPOOLS

Project: PRS/ METERING SKID

Customer: M/s GAIL INDIA LTD, New Delhi
P.O. No.:----------dated----------

Test Pressure: 1) _____Kg/cm2 (g) up to PCV,
2) _____ Kg/cm2 (g) after PCV

Test Media: Water
Duration: minimum 240 minutes

	TIME	Pressure before PCV	Pressure after PCV
1			
2			
3			
4			
5			
6			
7			
8			

POINT INSPECTED	**RESULT FOUNDOK**
a) Leak test at flange joints and other connections **up to PCV**	**YES / NO**
b) Leak test at flange joints and other connections **after PCV**	**YES / NO**

_____ _____ _____
Company Representative **TPIA** **GAIL's representative**

Date:

TEST CERTIFICATE

PNEUMATIC TEST OF METERING SKID/ PRS SKID

Project: METERING / PRS SKID FOR GAIL
Customer: M/s GAIL INDIA LTD, New Delhi
P.O. No.:---------- Dtd. ----------

Test Pressure: 7.0 Kg/cm2(g)
Test Media: Air / Nitrogen Gas
Duration: 60 minutes

POINT INSPECTED	**RESULT FOUNDOK**
Leak test at flange joints and other connections	**YES / NO**

_____	_____	_____
Company Representative	**TPIA**	**GAIL's representative**

Date:

TEST CERTIFICATE

DIMENSIONAL INSPECTION

Project: PRS/ METERING SKID FOR GAIL
Customer: M/s GAIL INDIA LTD, New Delhi
P.O. No.:---------- Dtd. ----------

Sr. No	Parameters Requirement	ResultFound
1.	Base Frame Dimension As per approved Foundation drawing	YES / NO
2.	Height of inlet pipe from base in mm _____	YES / NO
3.	Height of Outlet pipe from base in mm _____	YES / NO
4.	Upstream Meter Tubes Lengthin mm _____	YES / NO
5.	(Compliance to relevant AGA Standard)	YES / NO
6.	Down stream Meter tube Length in mm _____ (Compliance to relevant AGA Standard)	YES / NO
7.	Location of Thermowells as per relevant AGA standatd	YES / NO
8.	Cable and trays from Metering system to control room ……Mtrs	YES / NO
9.	Painting thickness of pipe line as per approved Specifications: 275 microns (DFT)	YES / NO

_____ _____ _____

Company Representative **TPIA** **GAIL's representative**

Date:

Note : Strike off, whichever is not applicable.

FAT CHECK LIST

PRESSURE REGULATION SYSTEM

Project: PRS/ METERING SKID
Customer: M/s GAIL INDIA LTD, New Delhi
P.O. No.:---------- Dtd. ----------

SR. No.	ITEM	CHECKED		REMARKS
1.	Set Point of PCV- 1 -------- Bar(g)	O Accepted	O Rejected	
2.	Set Point of PCV- 2 -------- Bar(g)	O Accepted	O Rejected	
3.	Set Point of PCV-3 --------- Bar(g)	O Accepted	O Rejected	
4.	Set Point of PCV- 4 -------- Bar(g)	O Accepted	O Rejected	
5.	Set Point of SSV-1 ---------- Bar(g)	O Accepted	O Rejected	
6.	Set Point of SSV-2 ---------- Bar(g)	O Accepted	O Rejected	
7.	Set Point of CRV/PSV---------- Bar(g)	O Accepted	O Rejected	

Company Representative **TPIA** **GAIL's representative**

Date :

FIELD TRANSMITTERS

Project: PRS/ METERING SKID
Customer: M/s GAIL INDIA LTD, New Delhi
P.O. No.:---------- Dtd. ----------

SR. No.	ITEM DESCRIPTION	LOCALINDICATION CHECKED	REMARKS
1.	Inlet Pressure Transmitter		
(a)	Functionality check	O Accepted O Rejected	
(b)	Simulation of complete loop from Transmitter to Flow computer including barriers	O Accepted O Rejected	
(c)	HART Functionality check	O Accepted O Rejected	
2.	Inlet Temperature Transmitter	O Accepted O Rejected	
(a)	Functionality check	O Accepted O Rejected	
(b)	Simulation of complete loop from Transmitter to Flow computer including barriers	O Accepted O Rejected	
(c)	HART Functionality check	O Accepted O Rejected	
3.	Diff Pressure Transmitter- Filter 1	O Accepted O Rejected	
(a)	Functionality check	O Accepted O Rejected	
(b)	Simulation of complete loop from Transmitter to Flow computer including barriers	O Accepted O Rejected	
(c)	HART Functionality check	O Accepted O Rejected	
4.	Diff Pressure Transmitter- Filter 2	O Accepted O Rejected	
(a)	Functionality check	O Accepted O Rejected	
(b)	Simulation of complete loop from Transmitter to Flow computer including barriers	O Accepted O Rejected	
(c)	HART Functionality check	O Accepted O Rejected	
5.	Metering Pressure Transmitter Stream-1	O Accepted O Rejected	
(a)	Functionality check	O Accepted O Rejected	
(b)	Simulation of complete loop from Transmitter to Flow computer including barriers	O Accepted O Rejected	
(c)	HART Functionality check	O Accepted O Rejected	
6.	Metering Pressure Transmitter Stream-2	O Accepted O Rejected	
(a)	Functionality check	O Accepted O Rejected	
(b)	Simulation of complete loop from Transmitter to Flow computer including	O Accepted O Rejected	

	barriers		
(c)	HART Functionality check	O Accepted O Rejected	
7.	Metering Temp. Transmitter –Stream-1	O Accepted O Rejected	
(a)	Functionality check	O Accepted O Rejected	
(b)	Simulation of complete loop from Transmitter to Flow computer including barriers	O Accepted O Rejected	
(c)	HART Functionality check	O Accepted O Rejected	
8.	Metering Temp. Transmitter –Stream-2	O Accepted O Rejected	
(a)	Functionality check	O Accepted O Rejected	
(b)	Simulation of complete loop from Transmitter to Flow computer including barriers	O Accepted O Rejected	
(c)	HART Functionality check	O Accepted O Rejected	
9.	Metering Diff. Pressure Transmitter Stream-1 (for Orifice meter)	O Accepted O Rejected	
(a)	Functionality check	O Accepted O Rejected	
(b)	Simulation of complete loop from Transmitter to Flow computer including barriers	O Accepted O Rejected	
(c)	HART Functionality check	O Accepted O Rejected	
10.	Metering Diff. Pressure Transmitter Stream-2 (for Orifice meter)	O Accepted O Rejected	
(a)	Functionality check	O Accepted O Rejected	
(b)	Simulation of complete loop from Transmitter to Flow computer including barriers	O Accepted O Rejected	
(c)	HART Functionality check	O Accepted O Rejected	

Company Representative **TPIA** **GAIL's representative**

Date :

FLOW COMPUTER

Project: ULTRASONIC / TURBINE / PD FLOW METER BASED METERING SKID

Customer: M/s GAIL INDIA LTD, New Delhi
P.O. No.:---------- Dtd. ----------

Tag No.: Stream-1

Inspection / Simulation done for	CHECKED/ OBSERVED	REMARKS
Corrected Volumetric Flow rate (SCMH) against AGA calculation software	O Accepted O Rejected	
Uncorrected Volumetric Flow rate (CMH) against AGA calculation software	O Accepted O Rejected	
Corrected Volumetric Flow rate (SCMH) by complete Flow Loop Simulation for entire range	O Accepted O Rejected	
Uncorrected Volumetric Flow rate (CMH) by complete Flow Loop Simulation for entire range	O Accepted O Rejected	
Volumetric Totalizer- Uncorrected (M3) by simulation against AGA software	O Accepted O Rejected	
Volumetric Totalizer- Uncorrected (M3) by complete Flow Loop Simulation for entire range	O Accepted O Rejected	
Volumetric Totalizer- Corrected (M3) by simulation against AGA software	O Accepted O Rejected	
Volumetric Totalizer- Corrected (M3) by complete Flow Loop Simulation for entire range	O Accepted O Rejected	
Mass Flow rate (kg/ hr)	O Accepted O Rejected	
Mass Totalizer (KG)	O Accepted O Rejected	
Energy Flow rate (Kcal/ hr)	O Accepted O Rejected	
Energy Totalizer	O Accepted O Rejected	
Calorific value selection for Energy Calculation (GCV/NCV)	O Accepted O Rejected	
Pipe Line Temperature °C(Units and Range)	O Accepted O Rejected	
Pipe Line Pressure Kg/Cm2g / Bar(g) (Units and Range)	O Accepted O Rejected	
Atmospheric pressure entry provision at site condition	O Accepted O Rejected	
Base Pressure/ Base Temperature entry provision	O Accepted O Rejected	
Complete Configuration check, parameter settings	O Accepted O Rejected	
PID controller Analog O/P check	O Accepted O Rejected	
Functioning of PID loop for FCV (though PID O/P Signal)	O Accepted O Rejected	
Interface data of flow computer with RTU – Measurement by Laptop	O Accepted O Rejected	
Various Units of measurement (Flow rate in MMSCMD or SCM/Hr, heating value in Kcal/SCM, energy in MMBTU)	O Accepted O Rejected	
Flow computer o/p to SCADA by GSM modem	O Accepted O Rejected	
GC data input to Flow computer via GSM modem	O Accepted O Rejected	
K factors for meter error curves	O Accepted O Rejected	

Audit trail printout (to be attached)	O Accepted O Rejected	
Software for flow calculation verification	O Accepted O Rejected	
Flow set point and Gas composition through GSM Modem	O Accepted O Rejected	
GC data input to Flow computer via GC controller	O Accepted O Rejected	
Various Report Formats	O Accepted O Rejected	
Alarm generation and Records	O Accepted O Rejected	
FC power Boot up sequence for no loss of configuration data (on power recycle)	O Accepted O Rejected	

_____ _____ _____

Company Representative TPIA GAIL's representative

Date :

FLOW COMPUTER

Project: ULTRASONIC / TURBINE / PD FLOW METER BASED METERING SKID
Customer: M/s GAIL INDIA LTD, New Delhi
P.O. No.:---------- Dtd. ----------

Tag No.: Stream-2

Inspection / Simulation done for	CHECKED/ OBSERVED	REMARKS
Corrected Volumetric Flow rate (SCMH) against	O Accepted O Rejected	

AGA calculation software		
Uncorrected Volumetric Flow rate (CMH) against AGA calculation software	O Accepted O Rejected	
Corrected Volumetric Flow rate (SCMH) by complete Flow Loop Simulation for entire range	O Accepted O Rejected	
Uncorrected Volumetric Flow rate (CMH) by complete Flow Loop Simulation for entire range	O Accepted O Rejected	
Volumetric Totalizer- Uncorrected (M3) by simulation against AGA software	O Accepted O Rejected	
Volumetric Totalizer- Uncorrected (M3) by complete Flow Loop Simulation for entire range	O Accepted O Rejected	
Volumetric Totalizer- Corrected (M3) by simulation against AGA software	O Accepted O Rejected	
Volumetric Totalizer- Corrected (M3) by complete Flow Loop Simulation for entire range	O Accepted O Rejected	
Mass Flow rate (kg/ hr)	O Accepted O Rejected	
Mass Totalizer (KG)	O Accepted O Rejected	
Energy Flow rate (Kcal/ hr)	O Accepted O Rejected	
Energy Totalizer	O Accepted O Rejected	
Calorific value selection for Energy Calculation (GCV/NCV)	O Accepted O Rejected	
Pipe Line Temperature °C(Units and Range)	O Accepted O Rejected	
Pipe Line Pressure Kg/Cm2g / Bar(g) (Units and Range)	O Accepted O Rejected	
Atmospheric pressure entry provision at site condition	O Accepted O Rejected	
Base Pressure/ Base Temperature entry provision	O Accepted O Rejected	
Complete Configuration check, parameter settings	O Accepted O Rejected	
PID controller Analog O/P check	O Accepted O Rejected	
Functioning of PID loop for FCV (though PID O/P Signal)	O Accepted O Rejected	
Interface data of flow computer with RTU – Measurement by Laptop	O Accepted O Rejected	
Various Units of measurement (Flow rate in MMSCMD or SCM/Hr, heating value in Kcal/SCM, energy in MMBTU)	O Accepted O Rejected	
Flow computer o/p to SCADA by GSM modem	O Accepted O Rejected	
GC data input to Flow computer via GSM modem	O Accepted O Rejected	
K factors for meter error curves	O Accepted O Rejected	
Audit trail printout (to be attached)	O Accepted O Rejected	
Software for flow calculation verification	O Accepted O Rejected	
Flow set point and Gas composition through GSM Modem	O Accepted O Rejected	
GC data input to Flow computer via GC controller	O Accepted O Rejected	
Various Report Formats	O Accepted O Rejected	
Alarm generation and Records	O Accepted O Rejected	

FC power Boot up sequence for no loss of configuration data (on power recycle)	O Accepted O Rejected	

Company Representative **TPIA** **GAIL's representative**

Date :

FLOW COMPUTER

Project: ORIFICE FLOW METER BASED METERING SKID
Customer: M/s GAIL INDIA LTD, New Delhi
P.O. No.:---------- Dtd. ----------

Tag No.: Stream-1

Inspection / Simulation done for	CHECKED/ OBSERVED		REMARKS
Volumetric Flow rate (SCMH)	O Accepted	O Rejected	
Totaliser (SCM)	O Accepted	O Rejected	
Mass Flow rate (kg/ hr)	O Accepted	O Rejected	
Energy Flow rate (Kcal/ hr)	O Accepted	O Rejected	
Pipe Line Temperature °C	O Accepted	O Rejected	
Pipe Line Pressure Kg/Cm2g / Bar(g)	O Accepted	O Rejected	
Atmospheric pressure entry at site condition	O Accepted	O Rejected	
Base Pressure/ Base Temperature entry	O Accepted	O Rejected	

Configuration check, parameter settings	O Accepted	O Rejected	
PID controller Analog O/P check	O Accepted	O Rejected	
Functioning of PID loop for FCV (though PID O/P Signal)	O Accepted	O Rejected	
Interface data of flow computer with RTU – Measurement by Laptop	O Accepted	O Rejected	
Various Units of measurement (Flow rate in MMSCMD or SCM/Hr, heating value in Kcal/SCM, energy in MMBTU)	O Accepted	O Rejected	
Flow computer o/p to SCADA by GSM modem	O Accepted	O Rejected	
GC data input to Flow computer via GSM modem	O Accepted	O Rejected	
Pipe diameter, Beta Ratio	O Accepted	O Rejected	
Audit trail printout (to be attached)	O Accepted	O Rejected	
Software for flow calculation verification	O Accepted	O Rejected	
Flow set point and Gas composition through GSM Modem	O Accepted	O Rejected	
GC data input to Flow computer via GC controller	O Accepted	O Rejected	
Various Report Formats	O Accepted	O Rejected	
Alarm generation and Records	O Accepted	O Rejected	
FC power Boot up sequence for no loss of configuration data (on power recycle)	O Accepted	O Rejected	

Company Representative **TPIA** **GAIL's representative**

Date :

FLOW COMPUTER

Project: ORIFICE FLOW METER BASED METERING SKID FOR GAIL

Customer: M/s GAIL INDIA LTD, New Delhi

P.O. No.:---------- Dtd. ----------

Tag No.: Stream-2

Inspection / Simulation done for	**CHECKED/ OBSERVED**		**REMARKS**
Volumetric Flow rate (SCMH)	O Accepted	O Rejected	
Totaliser (SCM)	O Accepted	O Rejected	
Mass Flow rate (kg/ hr)	O Accepted	O Rejected	
Energy Flow rate (Kcal/ hr)	O Accepted	O Rejected	
Pipe Line Temperature °C	O Accepted	O Rejected	
Pipe Line Pressure Kg/Cm2g / Bar(g)	O Accepted	O Rejected	
Atmospheric pressure entry at site condition	O Accepted	O Rejected	
Base Pressure/ Base Temperature entry	O Accepted	O Rejected	
Configuration check, parameter settings	O Accepted	O Rejected	
PID controller Analog O/P check	O Accepted	O Rejected	
Functioning of PID loop for FCV by simulation	O Accepted	O Rejected	
Interface data of flow computer with	O Accepted	O Rejected	

RTU – Measurement by Laptop		
Various Units of measurement (Flow rate in MMSCMD or SCM/Hr, heating value in Kcal/SCM, energy in MMBTU)	O Accepted O Rejected	
Flow computer o/p to SCADA by GSM modem	O Accepted O Rejected	
GC data input to Flow computer from SCADA via GSM modem	O Accepted O Rejected	
Pipe diameter, Beta ratio	O Accepted O Rejected	
Audit trail printout (to be attached)	O Accepted O Rejected	
Software for flow calculation verification	O Accepted O Rejected	
Flow set point and Gas composition through GSM Modem	O Accepted O Rejected	
GC data input to Flow computer via GC controller	O Accepted O Rejected	
Various Report Formats	O Accepted O Rejected	
Alarm generation and Records	O Accepted O Rejected	
FC power Boot up sequence for no loss of configuration data (on power recycle)	O Accepted O Rejected	

_____ _____ _____

Company Representative TPIA GAIL's representative
Date :

FLOW CONTROL VALVES

Project: ORIFICE/ TURBINE/PD FLOW METER BASED METERING SKID FOR GAIL
Customer: M/s GAIL INDIA LTD, New Delhi

P.O. No.:---------- Dtd. ----------

Tag No.: Stream-1

INSPECTION		CHECKED/ OBSERVED	REMARKS
HMI Set Point (% Open)/ Current	**Open Position**		
100 % / 4 mA	100 %	O Accepted O Rejected	
75 % / 8 mA	75 %	O Accepted O Rejected	
50 % / 12 mA	50 %	O Accepted O Rejected	
25 % / 16 mA	25 %	O Accepted O Rejected	
0 % 20 mA	0 %	O Accepted O Rejected	

Tag No.: Stream-2

INSPECTION		CHECKED/ OBSERVED	REMARKS
HMI Set Point (% Open)/ Current	**Open Position**		
100 % / 4 mA	100 %	O Accepted O Rejected	
75 % / 8 mA	75 %	O Accepted O Rejected	
50 % / 12 mA	50 %	O Accepted O Rejected	
25 % / 16 mA	25 %	O Accepted O Rejected	
0 % 20 mA	0 %	O Accepted O Rejected	

_____ _____ _____

Company Representative TPIA GAIL's representative

Date :

ULTRASONIC FLOW METER

Customer: M/s GAIL INDIA LTD, New Delhi
P.O. No.:---------- Dtd. ----------

Tag No.: Stream-1

Inspection / Simulation done for	CHECKED/ OBSERVED	REMARKS
Make/ Model/ for Flow meter	O Accepted O Rejected	
USM Probes installation	O Accepted O Rejected	
Installation of USM in skid	O Accepted O Rejected	
Communication with respective Flow computers	O Accepted O Rejected	
Wet Calibration report	O Accepted O Rejected	
Software for SOS calculation as per AGA 10	O Accepted O Rejected	
Communication ports and its functionality	O Accepted O Rejected	
Complete Pulse Loop simulation including Pulse Barriers	O Accepted O Rejected	

Tag No.: Stream- 2

Inspection / Simulation done for	CHECKED/ OBSERVED	REMARKS
Make/ Model/ for Flow meter	O Accepted O Rejected	
USM Probes installation	O Accepted O Rejected	
Installation of USM in skid	O Accepted O Rejected	

Communication with respective Flow computers	O Accepted	O Rejected	
Wet Calibration report	O Accepted	O Rejected	
Software for SOS calculation as per AGA 10	O Accepted	O Rejected	
Communication ports and its functionality	O Accepted	O Rejected	
Complete Pulse Loop simulation including Pulse Barriers	O Accepted	O Rejected	

Company Representative **TPIA** **GAIL's representative**

Date :

TURBINE/PD FLOW METER

Customer: M/s GAIL INDIA LTD, New Delhi
P.O. No.:---------- Dtd. ----------

Tag No.: Stream-1

Inspection / Simulation done for	**CHECKED/ OBSERVED**		**REMARKS**
Make/ Model/ for Flow meter	O Accepted	O Rejected	
Meter outputs(HF/LF/INDEX Mechanical counter)	O Accepted	O Rejected	
Installation of Turbine/ PD meter in skid	O Accepted	O Rejected	
Communication with Flow computers	O Accepted	O Rejected	
Wet Calibration report	O Accepted	O Rejected	
Complete Pulse Loop simulation including Pulse Barriers	O Accepted	O Rejected	
Functional test of Mechanical Index Head counter	O Accepted	O Rejected	

Tag No.: Stream- 2

Inspection / Simulation done for	**CHECKED/ OBSERVED**		**REMARKS**
Make/ Model/ for Flow meter	O Accepted	O Rejected	
Meter outputs(HF/LF/INDEX Mechanical counter)	O Accepted	O Rejected	
Installation of Turbine/ PD meter in skid	O Accepted	O Rejected	
Communication with Flow computers	O Accepted	O Rejected	
Wet Calibration report	O Accepted	O Rejected	

Complete Pulse Loop simulation including Pulse Barriers	O Accepted O Rejected	
Functional test of Mechanical Index Head counter	O Accepted O Rejected	

Company Representative **TPIA** **GAIL's representative**

Date :

PULSE BARRIER

Project: ORIFICE/ TURBINE/ PD FLOW METER BASED METERING SKID FOR GAIL
Customer: M/s GAIL INDIA LTD, New Delhi

P.O. No.: ---------- Dtd. ----------

Sr. No.	% of Freq Range	Input Freq. from Master calibrator (Hz) **(A)**	Frequency reading in Flow computer (Hz) **(B)**	Checked	ERROR (%)= **(A-B) x 100 / A**
1	0			O Accepted O Rejected	
2	10			O Accepted O Rejected	
3	20			O Accepted O Rejected	
4	30			O Accepted O Rejected	
5	40			O Accepted O Rejected	
6	50			O Accepted O Rejected	
7	60			O Accepted O Rejected	
8	70			O Accepted O Rejected	
9	80			O Accepted O Rejected	
10	90			O Accepted O Rejected	
11	100			O Accepted O Rejected	

(Note: simulation shall be done on the Maximum frequency of the Flow Meter.)

Company Representative **TPIA** **Customer representative**

Date :

ANALOG BARRIER

Project: ORIFICE/ TURBINE/ PD FLOW METER BASED METERING SKID FOR GAIL
Customer: M/s GAIL INDIA LTD, New Delhi

P.O. No.: ---------- Dtd. ----------

Sr. No.	INPUT VOLTAGE/ CURRENT	OUTPUT	Checked	Remarks
1			O Accepted O Rejected	
2			O Accepted O Rejected	
3			O Accepted O Rejected	
4			O Accepted O Rejected	
5			O Accepted O Rejected	
6			O Accepted O Rejected	
7			O Accepted O Rejected	
8			O Accepted O Rejected	
9			O Accepted O Rejected	
10			O Accepted O Rejected	

Company Representative **TPIA** **Customer representative**

Date :

GAS CHROMATOGRAPH

Project: ULTRASONIC FLOW METER BASED METERING SKID FOR GAIL
Customer: M/s GAIL INDIA LTD, New Delhi

P.O. No.:---------- Dtd. ----------

Inspection / Simulation done for	CHECKED/ OBSERVED	REMARKS
MAKE/ Model of GC	O Accepted O Rejected	
GC controller/ remote configurator Installation in control panel	O Accepted O Rejected	
Parameter settings/ configuration/ application software loading, default values etc for GC controller/ remote configurator	O Accepted O Rejected	
Sample Probes, Tools for insertion/ removal	O Accepted O Rejected	
Calibration Gas cylinders, carrier gas cylinders, self acting pressure regulator for Cylinders (calibration gas/ carrier gas) with stand, mounting arrangement	O Accepted O Rejected	
Field Analyser with Stand	O Accepted O Rejected	
Composition of calibration gases	O Accepted O Rejected	
Shed for Analyser, Cable for remote configurator/ controller, communication with various devices, instruments, equipmentsetc	O Accepted O Rejected	
Communication between GC and Laptop and GC data simulation	O Accepted O Rejected	
Simulation of GC data input to Flow computer (through GSM Modem and SI), Metering supervisory system and RTU/ SCADA and via GSM modem	O Accepted O Rejected	
Functionality/ simulation of communication ports for communication with flow computers, Laptop, Metering supervisory system, RTU/ SCADA, Printers,	O Accepted O Rejected	
Interface of GC with RTU/ SCADA, Flow computers, LAPTOP, Printer, Metering supervisory system etc	O Accepted O Rejected	
Calibration methods, Various Units of measurement (heating value in Kcal/SCM,Energy in MMBTU)	O Accepted O Rejected	
Communication with RTU/ SCADA	O Accepted O Rejected	

GC data input to Flow computer through SCADA and through GSM MODEM	O Accepted O Rejected	
Calibration run and Chromatogram for 3 consecutive runs	O Accepted O Rejected	

Company Representative **TPIA** **GAIL's representative**

Date :

METERING SUPERVISORY SYSTEM

Project: ULTRASONIC FLOW METER BASED METERING SKID FOR GAIL
Customer: M/s GAIL INDIA LTD, New Delhi

P.O. No.:---------- Dtd. ----------

Inspection / Simulation done for	**CHECKED/ OBSERVED**	**REMARKS**
MAKE/ Model of PC, Printer and other peripherals	O Accepted O Rejected	
Installation of PC, Printer and other peripherals in control panel	O Accepted O Rejected	
Application software loaded in system and license	O Accepted O Rejected	
Development of Graphics, Alarm summary etc as per P&ID and other approved documents	O Accepted O Rejected	
Simulation of Field signals (analog and digital)	O Accepted O Rejected	
Functionality/ simulation of communication for communication with Flow computers, Laptop, RTU/ SCADA, Printers, GC etc.	O Accepted O Rejected	
Licensed copy of HMI software	O Accepted O Rejected	
ALARM Log generation	O Accepted O Rejected	
Events Log generation	O Accepted O Rejected	
History Log generation	O Accepted O Rejected	
Data entry facility and password protection	O Accepted O Rejected	
Pay Check operation and report generation	O Accepted O Rejected	

Company Representative **TPIA** **GAIL's representative**

Date :

TEMPERATURE

Project: ORIFICE/ TURBINE/ PD FLOW METER BASED METERING SKID FOR GAIL
Customer: M/s GAIL INDIA LTD, New Delhi

P.O. No.: ---------- Dtd. ----------

Input Value (Ohm)	Expected Output (DEC C)	Actual Output in FC (DEC C)	ERROR	Checked	Remarks
	-30			O Accepted O Rejected	
	-20			O Accepted O Rejected	
	-10			O Accepted O Rejected	
	0			O Accepted O Rejected	
	10			O Accepted O Rejected	
	20			O Accepted O Rejected	
	30			O Accepted O Rejected	
	40			O Accepted O Rejected	
	50			O Accepted O Rejected	
	60			O Accepted O Rejected	
	70			O Accepted O Rejected	

Company Representative **TPIA** **Customer representative**

Date :

PRESSURE TRANSMITTER

Project: ORIFICE/ TURBINE/ PD FLOW METER BASED METERING SKID FOR GAIL
Customer: M/s GAIL INDIA LTD, New Delhi

P.O. No.: ---------- Dtd. ----------

Input Value (% of Full Range)	Input pressure (Kg/cm2)	Expected Output (Kg/cm2)	Actual Output in FC (Kg/cm2)	ERROR	Checked	Remarks
0					O Accepted O Rejected	
25					O Accepted O Rejected	
50					O Accepted O Rejected	
75					O Accepted O Rejected	
100					O Accepted O Rejected	

Company Representative **TPIA** **Customer representative**

Date :

TEST CERTIFICATE

SOLAR PANEL(wherever APPLICABLE)

Project: TURBINE/ PD FLOW METER BASED METERING SKID FOR GAIL
Customer: M/s GAIL INDIA LTD, New Delhi
P.O. No.:---------- Dtd. ----------

Type of Skid :

POINT INSPECTED	**OBSERVATION/RESULT FOUND**
1) Functional check of Solar panel in stream-1	**Yes / NO**
2) Output Voltage _____ VDC in stream-1	**Yes/ NO**
3) No. of _____(Ah) Batteries per stream_____	**Yes/ NO**
4) Functional check of Solar panel in stream-2	**Yes / NO**
5) Output Voltage _____ VDC in stream-2	**Yes/ NO**
6) Identification mark/ tagging	**Yes/ NO**
7) Adequacy of the Solar panel system mounting arrangement, fittings, requires cable and other hardware	**Yes/ NO**

Remarks (if any):

_____ _____ _____
Company Representative **TPIA** **GAIL's representative**

Date :

CHECK LIST

Project:: METERING SKID FOR GAIL
Customer: M/s GAIL INDIA LTD, New Delhi

P.O. No.: ---------- Dtd. ----------

Sr. No.	Description	Accepted (Yes/ No)
1.	Installation of all the equipments in Skid as per approved make, model and size/ rating	
2.	Installation of all the equipments/ components (including printers, metering supervisory system, FC, GC controller, LEL detection system, converter, Modem etc.) in control panel as per approved make, model and size/ rating	
3.	Dimensional inspection, Size/ dimension of skid, straight length of meter tube, location of thermo-well, height etc.	
4.	Painting quality, Size/ dimension of control panel	
5.	Functionality of PT, TT, DPT, FCV, HMI etc,	
6.	Functionality with set-point of PCV, SSV, PSV, CRV etc.	
7.	Pneumatic leak check of entire skid	
8.	Functionality of Flow meter after flowing air/ nitrogen	
9.	Configuration of flow computers and Gas chromatograph	
10.	a) Location of JB and Enclosure b) Cable tags, Cable dressing etc.	
11.	Configuration and functionality of Metering supervisory system	
12.	Printer functionality and Laptop connectivity	
13.	Functionality of LEL detection system	
14.	Functionality of control panel, simulation of SCADA and GSM	
15.	Availability of adequate Platforms, approach, Cross over and Jump over	
16.	Review of Calibration reports for Instrumentation items, CCOE approval of field equipments and cylinders	
17.	Review of i) TC/ report, documents for all mechanical items, valves, meter, pipes and fittings. ii) Radiography, vendor qualification iii) JBs	
18.	a) Support with pads and clamps for valves, Pipe, PSV outlet, Skid vents, impulse tubing etc. b) Copper jumpers for all flanges.	
19	Availability of adequate no. of Handle for Valves, Blind flanges, Matting flange, expander, tool and tackles.	
20	Review of Software, mandatory spares, commissioning items, cable, canopy, loose items as per list attached with FAT	

Company Representative **TPIA** **GAIL's representative**

Date :

ACTION LIST

Project::ORIFICE/ TURBINE / PD /USM FLOW METER BASED METERING SKID FORGAIL
Customer: M/s GAIL INDIA LTD, New Delhi

P.O. No.:---------- Dtd. ----------

Sr. No.	Description	Action By

1.		
2.		
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14.		

_____ _____ _____

Company Representative TPIA GAIL's representative

Date :

REVIEW OF DOCUMENTS

Project: ORIFICE/ TURBINE/ PD /USM FLOW METER BASED METERING SKID FOR GAIL
Customer: M/s GAIL INDIA LTD, New Delhi

P.O. No.:---------- Dtd. ----------

Sr. No.	DOCUMENTS REVIEWED	Checked	Remarks
1.	Radiography Test for all items of skid (as per List prepared by vendor and attached as Annexure)	O Accepted O Rejected	

2.	Dye Penetration Test for all items of skid (as per List prepared by vendor and attached as Annexure)	O Accepted O Rejected	
3.	Test Certificate (for Filtration system, Slam Shut valves, Pressure Regulator (PCV), PSV, CRV, FCV, NRV, Flow profiler, Flow meter, Isolation Ball Valves, Plug valves, Flow computer, PT, DPT, PG, DPG, Thermo-well, RTD, Solar panel, JBs, Pipe spools etc.)	O Accepted O Rejected	
4.	Hydro test for all items of skid (as per List prepared by vendor and attached as Annexure)	O Accepted O Rejected	
5.	Material test Report for all items of skid (as per List prepared by vendor and attached as Annexure)	O Accepted O Rejected	
6.	Certification as per 3.1 for all Pressure Equipments (as per approved List prepared by vendor and attached as Annexure)	O Accepted O Rejected	
7.	Calibration Report for PT, DPT, TT, PSV, CRV, Flow Computer, Flow Meter and Test report for SSV, PCV.	O Accepted O Rejected	
8.	Welding Procedure Specification, Welder qualification.	O Accepted O Rejected	
9.	Configuration Sheet for Flow computers	O Accepted O Rejected	
10.	Compliance Certification for Painting of skid including all items (Filtration system, PRS, Valves, PSVs, CRVs etc) and Solar panel	O Accepted O Rejected	
11.	Material Correlation Chart & Welding Joints Correlation Chart	O Accepted O Rejected	

Company Representative **TPIA** **Customer representative**

Date :

TEST CERTIFICATE

VISUAL INSPECTION OF CONTROL PANEL

Project: TURBINE/ PD FLOW METER BASED METERING SKID FOR GAIL
Customer: M/s GAIL INDIA LTD, New Delhi
Panel Tag No:
P.O. No.:---------- Dtd. ----------

Type of Skid :

Sr. No	DOCUMENTS REVIEWED	Checked	Remarks
1	INTERNAL TEST RECORDS REVIEWED	O Accepted O Rejected	
2	INSPECTION OF METERING CONTROL PANELS & DIMENSIONAL DETAILS AS PER APPROVED DRAWINGS	O Accepted O Rejected	
3	INSPECTION OF PAINT WORK	O Accepted O Rejected	

4	PANEL EQUIPMENT ,ITEM,ACCESSORIES AS PER APPROVED DRAWINGS	O Accepted O Rejected	
5	PANEL INTERNAL WIRING AS PER APPROVED DRAWINGS	O Accepted O Rejected	
6	POWER DISTRIBUTION	O Accepted O Rejected	
7	GROUNDING DETAILS	O Accepted O Rejected	
8	MAINTENANCE ACCESSIBILITY	O Accepted O Rejected	
9	FUNCTIONAL CHECK AS PER DATA SHEET	O Accepted O Rejected	
10	HOT STAND BY FUNCTIONALITY OF POWER SUPPLY, GSM MODEM	O Accepted O Rejected	
11	DOOR ALIGNMENT AND SEALING	O Accepted O Rejected	
12	IDENTIFICATION MARK/ TAGGING (CABLE, INSTRUMENTS).	O Accepted O Rejected	
13	CABLE DRESSING, PLUGGING OF SPARE HOLES	O Accepted O Rejected	
14	FAN, TUBE LIGHT	O Accepted O Rejected	
15	SPARE INVENTORY ADEQUECY	O Accepted O Rejected	

_____ _____ _____

Company Representative TPIA Customer representative

Date :

TEST CERTIFICATE

VISUAL INSPECTION OF ANALYSER HOUSE

Project: TURBINE/ PD FLOW METER BASED METERING SKID FOR GAIL
Customer: M/s GAIL INDIA LTD, New Delhi
Analyser House Tag No:
P.O. No.:---------- Dtd. ----------

Type of Skid :

Sr. No.	DOCUMENTS REVIEWED	Checked	Remarks
1	INTERNAL TEST RECORDS REVIEWED	O Accepted O Rejected	
2	INSPECTION OF ANALYZER HOUSE&DIMENSIONAL DETAILS	O Accepted O Rejected	
3	INSPECTION OF PAINT WORK	O Accepted O Rejected	

4	HOUSE EQUIPMENT LAYOUT &INVENTORY CHECK	O Accepted O Rejected	
5	POWER DISTRIBUTION &ELECTRICAL CHECK	O Accepted O Rejected	
6	GROUNDING DETAILS	O Accepted O Rejected	
7	MAINTENANCE ACCESSIBILITY	O Accepted O Rejected	

Company Representative **TPIA** **Customer representative**

Date :

(VARIFICATION OF ITEM LIST)

Sl No.	Description	Qty. (as per P&ID)	Make and Model	Certification (During FAT)	Certification (During receipt at Stores / Site)	Remarks
1	Pressure regulator (Active and Monitor)					
2	Slam Shut Valve					
3	Turbine meters					
4	Positive displacement					
5	Ultrasonic flow meter					
6	Junior/ simplex orifice fittings (meter run, flow conditioner, orifice plate					
7	Dry / Wet gas filter & filter separator					
8	Quick opening end closure (QOEC)					
9	Filter element					

10	Ball valve					
11	Plug Valves					
12	Globe Valves					
13	Check Valves					
14	Pressure safety valves (PSV)					
15	Creep relief valve (CRV)					
16	Flow control valves					
17	control panel & accessories					
18	Level gauges/ level instruments					
19	Control and signal cables					
20	Barriers					
21	Field instruments (PT, DPT,TT,LT)					
23	Gas chromatograph					
24	I/P converters					
25	LEL detection system					
26	Instrument valves & manifolds					
27	Junction boxes					
28	Pressure Guage					
29	Temperature Guages					
30	Flow computer					
31	GPRS modem					
32	License Software					
33	Laptop					
34	Communication Cable					
35	Battery					

(Vendor) **(Vendor's TPI)** **(GAIL / TPI)**

Mandatory Spare List

Sl No.	Spare	Qty (SET)	Certification during FAT	Certification during receipt at Site/ Store
(a)	**For Pressure reduction system (for all SOR items):**			
1	Repair kit for each type and size/ Model of Regulator/PCV (Diaphragm, O-rings, soft seat, cone etc)	01		
2	Repair kit for each type of pilot (Diaphragm, O-rings etc)	01		
3	Repair kit for SDV (Diaphragm, soft seat, O-rings etc.)	01		
(b)	**For filtration system (for all SOR items)**			
1	Filter Element installed in each Filter - 02 sets (each set shall consist of the No. of Filter Elements installed in both streams of Filtration skid.) [If each Filter stream is having one filter element/ cartridge, then total 4 nos. of filter element/ cartridge shall be supplied]	02		
2	O-Ring for Filters (all type of O-Rings)– 01 set (each set shall consist of all the O-rings / gaskets installed in both streams of Filters.) [If each Filter stream is having one set of	01		

	O-ring, then installed in both streams of Filters.) [If each Filter stream is having one set of O-ring, then total 2 sets of O-ring shall be supplied]			

(Vendor) **(Vendor's TPI)** **(GAIL / TPI)**

DETAILED SPECIFICATION FOR GPRS GATEWAY/CELLULAR GATEWAY

S No	DESCRIPTION	SPECIFICATION
1	**Cellular Interface**	
1.1	Standard	GPRS
1.2	Band Option	Quad Band 850/900 and 1800/1900 MHz
1.3	GPRS Multi Slot Class	Class 10
1.4	GPRS Terminal Device Class	Class B
1.5	Cellular Connectivity	2G & 3G
1.6	GPRS Coding Schemes	CS1 to CS4
1.7	GPRS	ALWAYS ON
1.8	IP support	Static & Dynamic
1.9	SIM CONTROL	3 Volt
1.10	Self IP reporting	Self ip reporting on dual redundant static ips on a single listner port.
1.11	Watch Dog timer	for auto rebooting of GPRS Gateway modem
1.12	Authentication Protocol	CHAP/PAP/MS-CHAP/MS-CHAPV2/etc.
1.13	Private APN / Static IP	Enterprise private network service provided by a telecom operator
2	**SIM INTERFACE**	
2.1	Number of SIMS	1
2.2	SIM CONTROL	3 Volt
3	**Serial INTERFACE**	
3.1	Number of ports	RS232 one port(db-9)
3.2	ESD Protection	15 KV
3.3	Power EFT / Surge protection	2 KV
4	**Serial**	

	communication Parameters	
4.1	Data Bits	8
4.2	Stop Bits	1,1.5,2
4.3	Parity	none, even odd,space,mark
4.4	Flow Control	none, RTS/CTS,XON/XOFF
4.5	Baudrate	9.6kbps to 19.2bps
5	**Software**	
5.1	Network Protocol	TCP/IP, UDP
5.2	Operation Mode	TCP Server, TCP client,UDP
5.3	data transfer on Serial port	Protocol Independent
5.4	Configuration tool/software for GPRS Gateway modem	GUI based Configuration & troubleshooting from Centralized Management software over GPRS as well as from local serial port of GPRS Gateway Modem.
5.5	Remote Configuration by	GPRS
6	**Management Software**	
6.1	Central manager	Centralized Management software for providing connectivity with remote GPRS Gateways & its configuration.
7	**Physical Characteristics**	
7.1	HOUSING	industrial Grade Metallic Housing with IP 30 protection
7.2	Mounting	DIN RAIL Mounting
7.3	LED lighting indication	Separate LED status for power, Network, Data Transmission
9	**Environmental Limits**	
9.1	Operating Temperature:	0°C to 55°C
9.2	Operating Humidity:	5 to 95% RH
9.3	Power Requirements	Input Voltage: 12 VDC
9.4	RF:	EN301 489-1
		EN301 489-7
		EN301 511

<table>
<tr><td></td><td></td><td></td></tr>
<tr><td rowspan="2">9.5</td><td rowspan="2">EMC:</td><td>CE: EN55022 Class A / EN55024</td></tr>
<tr><td>FCC: FCC part 15 subpart B, Class A</td></tr>
<tr><td>9.6</td><td>Antenna</td><td>0dB gain, if signal strength on particular site is low than vendor has to provide 3db/5db gain antenna at no additional cost.</td></tr>
<tr><td>10</td><td>Network Security</td><td></td></tr>
<tr><td>10.1</td><td>VPN</td><td>Full-featured IPSec (main mode and aggressive mode) PPTP/L2TP/GRE/SSL VPN
<table>
<tr><td></td><td>Encryption</td><td>Authentication</td><td>DH-Group</td></tr>
<tr><td>Phase-I</td><td>3DES</td><td>MD5</td><td>2</td></tr>
<tr><td>Phase-II</td><td>3DES</td><td>MD5</td><td>None</td></tr>
<tr><td></td><td colspan="3">Parameters</td></tr>
<tr><td>IKE</td><td colspan="3">Remote & local DNS</td></tr>
<tr><td>Peer Identification</td><td colspan="3">Pre shared Key</td></tr>
<tr><td>Mode</td><td colspan="3">Aggressive</td></tr>
</table></td></tr>
<tr><td>11</td><td>Power</td><td></td></tr>
<tr><td>11.1</td><td>TX Power</td><td>1Watt GSM 1800/1900
2 Watt EGSM 850/900</td></tr>
<tr><td>12</td><td>Dimension</td><td></td></tr>
<tr><td></td><td>Maximum Dimension</td><td>12.5x28.0x92.5mm(4.94x1.10x3.64 in)</td></tr>
</table>

Note: For above specification two GPRS remote Gateway , IG 601PH09 (INHAND make) and E206xt (Maestro make) has been tested and is acceptable model as same are currently running with in existing GAIL GPRS setup. For other proposed GPRS model , compatibility testing with Cyberoam CR100ing GPRS VPN Server of GAIL needs to be carried out for acceptability of the model.

Further Modbus communication through GPRS needs to be demonstrated during FAT of the system.

(DURING FAT)
(List of Items in the Skid)

Sl No.	Description	Qty. (as per P&ID)	Make and Model	Certification(During FAT)	Certification (During receipt at Stores / Site)	Remarks
1	Pressure regulator (Active and Monitor)					
2	Slam Shut Valve					
3	Turbine meters					
4	Positive displacement					
5	Ultrasonic flow meter					
6	Junior/ simplex orifice fittings (meter run, flow conditioner,					
7	Dry / Wet gas filter & filter separator					
8	Quick opening end closure (QOEC)					
9	Filter element					
10	Ball valve					
11	Plug Valves					
12	Globe Valves					
13	Check Valves					
14	Pressure safety valves(PSV)					
15	Creep relief valve (CRV)					
16	Flow control valves					
17	control panel & accessories					
18	Level gauges/ level instruments					
19	Control and signal cables					
20	Barriers					
21	Field instruments (PT, DPT,TT,LT)					
23	Gas chromatograph					
24	I/P converters					
25	LEL detection system					
26	Instrument valves &					

	manifolds					
27	Junction boxes					
28	Pressure Guage					
29	Temperature Guages					
30	Flow computer					
31	GPRS modem					
32	License Software					
33	Laptop					
34	Communication Cable					
35	Battery					
36	Battery charger					

(Vendor) **(Vendor's TPI)** **(GAIL / TPI during FAT)**

Mandatory Spare List

Sl No.	Spare	Qty (SET)	Certification during FAT	Certification during receipt at Site/ Store
(a)	**For Pressure reduction system (for all SOR items):**			
1	Repair kit for each type and size/ Model of Regulator/PCV(Diaphragm, O-rings, soft seat, cone etc)	**01**		
2	Repair kit for eachtype of pilot (Diaphragm, O-rings etc)	**01**		
3	Repair kit for SDV (Diaphragm, soft seat, O-rings etc.)	**01**		
(b)	**For filtration system (for all SOR items)**			
1	Filter Element installed in each Filter -02 sets(each set shall consist of the No. of Filter Elements installed in both streams of Filtration skid.) [If each Filter stream is having one filter element/ cartridge, then total 4 nos. of filter element/ cartridge shall be supplied]	**02**		
2	O-Ring for Filters (all type of O-Rings)– 01 set(each set shall consist of all the O-rings / gaskets installed in both streams of Filters.) [If each Filter stream is having one set of O-ring, then installed in both streams of Filters.) [If each Filter stream is having one set of O-ring, then total 2 sets of O-ring shall be supplied]	**01**		

(Vendor) **(Vendor's TPI)** **(GAIL /TPI)(GAIL store/site receipt)**

Attachment-1(FC)

Standard NG Flowcomputer Paramaters required for SCADA in case of 2 Stream in one Flowcomputer

SNo	Point Description	Unit	Modbu start address	Modbu end address	Read/Write Access
1	Stream 1 Inlet Pressure (Terminals with only Field mounted FC)	KG/CM2	1 (40001)	2 (40002)	Read
2	Stream 1 Inlet Temperature (Terminals with only Fieldmounted FC)	DEGC	3 (40003)	4 (40004)	Read
3	Stream 1 Meter Pressure	KG/CM2	5 (40005)	6 (40006)	Read
4	Stream 1 Meter Temperature	DEGC	7 (40007)	8 (40008)	Read
5	Stream 1 Corrected Volume Flow Rate	SM3/HR	9 (40009)	10 (40010)	Read
6	Stream 1 Corrected Todays Running Total Volume	SM3	11 (40011)	12 (40012)	Read
7	Stream 1 Yesterday's Volume Total	SM3	13 (40013)	14 (40014)	Read
8	Stream 1 Corrected Energy Flow Rate	MMBTU/HR	15 (40015)	16 (40016)	Read
9	Stream 1 Corrected Todays Running Total Energy	MMBTU	17 (40017)	18 (40018)	Read
10	Stream 1 Yesterday's Energy Total	MMBTU	19 (40019)	20 (40020)	Read
11	Stream 1 Compressibility Factor (Zf)		21 (40021)	22 (40022)	Read
12	Stream 1 Gross Calorific Value (GCV) (Where On-Line GC not available)	KCAL/M3	23 (40023)	24 (40024)	Read
13	Stream 1 Net Calorific Value (NCV) (Where On-Line GC not available)	KCAL/M3	25 (40025)	26 (40026)	Read
14	Stream 1 Average Days GCV (Where On-Line GC not available)		27 (40027)	28 (40028)	Read
15	Stream 1 Average Days NCV (Where On-Line GC not available)		29 (40029)	30 (40030)	Read
16	Stream 1 Specific Gravity (Where On-Line GC not available)		31 (40031)	32 (40032)	Read/Write
17	Stream 1 Carbon Dioxide Content (Where On-Line GC not available)	%	33 (40033)	34 (40034)	Read/Write
18	Stream 1 Nitrogen Content N2 (Where On-Line GC not available)	%	35 (40035)	36 (40036)	Read/Write
19	Stream 1 Methane Content C1 (Where On-Line GC not available)	%	37 (40037)	38 (40038)	Read/Write
20	Stream 1 Ethane Content C2 (Where On-Line GC not available)	%	39 (40039)	40 (40040)	Read/Write
21	Stream 1 Propane Content C3 (Where On-Line GC not available)	%	41 (40041)	42 (40042)	Read/Write
22	Stream 1 iButane Content iC4 (Where On-Line GC not available)	%	43 (40043)	44 (40044)	Read/Write
23	Stream 1 nButane Content nC4 (Where On-Line GC not available)	%	45 (40045)	46 (40046)	Read/Write
24	Stream 1 iPentane Content iC5 (Where On-Line GC not available)	%	47 (40047)	48 (40048)	Read/Write
25	Stream 1 nPentane Content nC5 (Where On-Line GC not available)	%	49 (40049)	50 (40050)	Read/Write
26	Stream 1 Hexane+ Content(C6+) (Where On-Line GC not available)	%	51 (40051)	52 (40052)	Read/Write
27	Stream 1 FCV Setpoint (Auto) (Where FCV available)		53 (40053)	54 (40054)	Read/Write
28	Stream 1 FCV % Opening Manual Setpoint (where FCV available)	%	55 (40055)	56 (40056)	Read/Write
29	Stream 1 FCV % Opening Feedback (Where FCV available)	%	57 (40057)	58 (40058)	Read
30	Stream 1 Battery Voltage (Terminals with only Fieldmounted FC)	VOLT	59 (40059)	60 (40060)	Read
31	Stream 1 DP (If available)		61 (40061)	62 (40062)	Read
32	Stream 2 Inlet Pressure (Terminals with only Field mounted FC)	KG/CM2	63 (40063)	64 (40064)	Read
33	Stream 2 Inlet Temperature (Terminals with only Fieldmounted FC)	DEGC	65 (40065)	66 (40066)	Read
34	Stream 2 Meter Pressure	KG/CM2	67 (40067)	68 (40068)	Read
35	Stream 2 Meter Temperature	DEGC	69 (40069)	70 (40071)	Read
36	Stream 2 Corrected Volume Flow Rate	SM3/HR	71 (40071)	72 (40072)	Read
37	Stream 2 Corrected Todays Running Total Volume	SM3	73 (40073)	73 (40074)	Read
38	Stream 2 Yesterday's Volume Total	SM3	75 (40075)	76 (40076)	Read
39	Stream 2 Corrected Energy Flow Rate	MMBTU/HR	77 (40077)	78 (40078)	Read
40	Stream 2 Corrected Todays Running Total Energy	MMBTU	79 (40079)	80 (40080)	Read
41	Stream 2 Yesterday's Energy Total	MMBTU	81 (40081)	82 (40082)	Read
42	Stream 2 Compressibility Factor (Zf)		83 (40083)	84 (40084)	Read
43	Stream 2 Gross Calorific Value (GCV) (Where On-Line GC not available)	KCAL/M3	85 (40085)	86 (40086)	Read
44	Stream 2 Net Calorific Value (NCV) (Where On-Line GC not available)	KCAL/M3	87 (40087)	88 (40088)	Read
45	Stream 2 Average Days GCV (Where On-Line GC not available)		89 (40089)	90 (40090)	Read
46	Stream 2 Average Days NCV (Where On-Line GC not available)		91 (40091)	92 (40092)	Read
47	Stream 2 Specific Gravity (Where On-Line GC not available)		93 (40093)	94 (40094)	Read/Write
48	Stream 2 Carbon Dioxide Content (Where On-Line GC not available)	%	95 (40095)	96 (40096)	Read/Write
49	Stream 2 Nitrogen Content N2 (Where On-Line GC not available)	%	97 (40097)	98 (40098)	Read/Write
50	Stream 2 Methane Content C1 (Where On-Line GC not available)	%	99 (40099)	100 (40100)	Read/Write
51	Stream 2 Ethane Content C2 (Where On-Line GC not available)	%	101 (40101)	102 (400102)	Read/Write
52	Stream 2 Propane Content C3 (Where On-Line GC not available)	%	103 (40103)	104 (40104)	Read/Write
53	Stream 2 iButane Content iC4 (Where On-Line GC not available)	%	105 (40105)	106 (40106)	Read/Write
54	Stream 2 nButane Content nC4 (Where On-Line GC not available)	%	107 (40107)	108 (40108)	Read/Write
55	Stream 2 iPentane Content iC5 (Where On-Line GC not available)	%	109 (40109)	110 (40110)	Read/Write
56	Stream 2 nPentane Content nC5 (Where On-Line GC not available)	%	111 (40111)	112 (40112)	Read/Write
57	Stream 2 Hexane+ Content(C6+) (Where On-Line GC not available)	%	113 (40113)	114 (40114)	Read/Write
58	Stream 2 FCV Setpoint (Auto) (Where FCV available)		115 (40115)	116 (40116)	Read/Write
59	Stream 2 FCV % Opening Manual Setpoint (where FCV available)	%	117 (40117)	118 (40118)	Read/Write
60	Stream 2 FCV % Opening Feedback (Where FCV available)	%	119 (40119)	120 (40120)	Read
61	Stream 2 Battery Voltage (Terminals with only Fieldmounted FC)	VOLT	121 (40121)	122 (40122)	Read
62	Stream 2 DP (If available)		123 (40123)	124 (40124)	Read
	COMMUNICATION PARAMETERS			60 (40060)	
	PROTOCOL	Baud Rate	Data Bits		Stop Bit
	RS 232 (for Modem) / RS 485 (for RTU)	9600	8	Parity	1
				None	