GAIL INDIA LIMITED

CONSTRUCTION OF STEEL PIPELINE AND ASSOCIATED FACILITIES ON LMC TO M/S CARBORUNDUM UNIVERSAL LTD., HOSUR

VOLUME II OF II (TECHNICAL)

E-TENDER REF : 8000016425

(BID DOCUMENT NO - 034/LEPL/GAIL/15-R0)

LIMITED DOMESTIC COMPETITIVE BIDDING

Lyons Engineering Pvt. Ltd.

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		GAIL-ENG-GN-DOC-DL-001	
		Rev. 0	
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24	Data Sheet of Insulating Gasket	GAIL-STD-PI-DOC-DS-005	0
25	Data Sheet Clean Agent System	GAIL-STD-PI-DOC-DS-006	0
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28	Data Sheet - Globe Valve (0.75 to 1.5 Inch - Socket Welded Ends)	GAIL-STD-PI-DOC-DS-009	0
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30	QAP of Station Pipes	GAIL-STD-PI-DOC-QAP-004	0
31	QAP of Fittings	GAIL-STD-PI-DOC-QAP-005	0
32	QAP of Flanges	GAIL-STD-PI-DOC-QAP-006	0
33	QAP of Fastners	GAIL-STD-PI-DOC-QAP-007	0
34	QAP of Gaskets	GAIL-STD-PI-DOC-QAP-008	0

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37	QAP - Plug Valve	GAIL-STD-PI-DOC-QAP-011	0
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40	Cross Guide support for Bare Pipe Size 2" Thru 24" Type G3	GAIL-STD-PI-DWG-TP-003	0
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42	Guide Support for Bare Pipe Size 2" Thru 24" Type G1	GAIL-STD-PI-DWG-TP-005	0
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45	Low Support Sliding and Fixed for Pipe Size 3/4" Thru 1.5" Type L-15	GAIL-STD-PI-DWG-TP-008	0
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48	Pressure Tappings (PA,PG,PC,PT,PIC ETC.)	GAIL-STD-PI-DWG-TP-011	0
49	Detail of Pressure Connection Above Ground Pipe	GAIL-STD-PI-DWG-TP-012	0
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55	Vent and Drain on Line 2" and above	GAIL-STD-PI-DWG-TP-018	0
56	Vent and Drain on Line 1.5" and below	GAIL-STD-PI-DWG-TP-019	0
57	Typical Drawing for Flow Tee	GAIL-STD-PI-DWG-TP-020	0
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59	Typical Piping Arrangement for 30" section	GAIL-STD-PI-DWG-TP-022	0
60	Symbol of Piping Arrangement on Drawings	GAIL-STD-PI-DWG-TP-023	0
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64	Low Support Fixed for Bare & Insulated Pipe Size 2" Thru 24" Type L-6	GAIL-STD-PI-DWG-TP-027	0
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3	Technical Specification for Plain Cement Concrete and Allied Works	GAIL-STD-CV-DOC-TS-002	0
4	Technical Specification for Porta Cabin	GAIL-STD-CV-DOC-TS-003	0
5	Technical Specification for Chainlink Fencing	GAIL-STD-CV-DOC-TS-004	0
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7	Technical Specification for Masonry Work	GAIL-STD-CV-DOC-TS-006	0
8	Technical Specification for Plaster & Pointing	GAIL-STD-CV-DOC-TS-007	0
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10	Technical Specification for Road Work and Pavement	GAIL-STD-CV-DOC-TS-009	0
11	Technical Specification for Dismantle & Demolishing	GAIL-STD-CV-DOC-TS-010	0
12	Technical Specification for Barricades	GAIL-STD-CV-DOC-TS-011	0
13	Technical Specification for Standard Field Quality Plan	GAIL-STD-CV-DOC-TS-012	0
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17	Technical Specification for Roof Treatment & Floor Treatment (Anti-Termite)	GAIL-STD-CV-DOC-TS-016	0
18	Technical Specification for Sewer Drainage System	GAIL-STD-CV-DOC-TS-017	0
19	Technical Specification for Doors, Windows and Ventilator	GAIL-STD-CV-DOC-TS-018	0
20	Technical Specification for Floor Finishing	GAIL-STD-CV-DOC-TS-019	0
21	Technical Specification for Floor Finishing	GAIL-STD-CV-DOC-TS-020	0
22	Technical Specification for Boundary Wall, Retaining Wall	GAIL-STD-CV-DOC-TS-021	0
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24	Technical Specification for Pipe Culverts & Box Culverts	GAIL-STD-CV-DOC-TS-023	0
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26	Technical Specification for Earthwork for Underground piping	GAIL-STD-CV-DOC-TS-025	0
27	Technical Specification for Soil Investigation for Stations	GAIL-STD-CV-DOC-TS-026	0
28	Plot Plan for Dispatch Terminal (Typical)	GAIL-CV-DWG-CIV-001	0
29	Plot Plan for Receiving Terminal (Typical)	GAIL-CV-DWG-CIV-002	0
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F	**CATHODIC PROTECTION**		
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2	Technical Specification of Main Electrical Distribution board	GAIL-STD-EL-DOC-TS-002	0
3	Technical Specification of Cables	GAIL-STD-EL-DOC-TS-003	0
4	Technical Specification of Lighting System	GAIL-STD-EL-DOC-TS-004	0
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6	Technical Specification for Installation, Testing and Commissioning of Electrical Equipments.	GAIL-STD-EL-DOC-TS-06	0
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8	Data Sheet for Cables	GAIL-STD-EL-DOC-DS-002	0
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14	Typ. Installation of Power/Lighting Panel Flush mounted	GAIL-STD-EL-DWG-TP-006	0
15	Typ. Installation of Directly Burried Cables	GAIL-STD-EL-DWG-TP-008	0
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19	Typ. Earthing/Bonding of Pipes & Pipe Racks	GAIL-STD-EL-DWG-TP-012	0
20	Typ. Earthing of Gate & Fence	GAIL-STD-EL-DWG-TP-013	0
21	Typ. Earthing for Process Equipment	GAIL-STD-EL-DWG-TP-014	0
22	Typ. Installation of Street Light Fixture/FLP/Div.2 Area Light Fixture	GAIL-STD-EL-DWG-TP-015	0
23	Typ. Installation of Open Area Flood Light Fixture Mounted on Wall / Column	GAIL-STD-EL-DWG-TP-016	0
24	Typ. Installation of Flood Light Fixtures Mounted on Pole	GAIL-STD-EL-DWG-TP-017	0
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	STANDARD SPECIFICATION FOR INSTRUMENTS		
2	Standard specification for Pressure Gauges.	GAIL-STD-IN-DOC-TS-001	0
3	Standard specification for Pressure Safety Valves.	GAIL-STD-IN-DOC-TS-002	0
4	Standard specifications for Electronic Transmitters	GAIL-STD-IN-DOC-TS-003	0
5	Standard specification for RTDs and thermowell	GAIL-STD-IN-DOC-TS-004	0
6	Standard specifications for Instrument cables.	GAIL-STD-IN-DOC-TS-005	0
7	Standard specifications for Junction Boxes and cable Glands.	GAIL-STD-IN-DOC-TS-006	0
8	Standard specifications for instrument tube fittings	GAIL-STD-IN-DOC-TS-007	0
9	Standard specifications for instrument tubing	GAIL-STD-IN-DOC-TS-008	0
10	Standard Specification for Instrument Valve & Manifold	GAIL-STD-IN-DOC-TS-009	0
11	Standard specifications for Fire & Gas Detection System	GAIL-STD-IN-DOC-TS-011	0
12	Standard specifications for control Panels	GAIL-STD-IN-DOC-TS-012	0
13	Standard specifications for Pig Signalers	GAIL-STD-IN-DOC-TS-013	0
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15	Datasheet for Temperature Transmitter	GAIL-STD-IN-DOC-DS-002	0
16	Datasheet for Temperature Element (RTD) with Thermowell	GAIL-STD-IN-DOC-DS-003	0
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19	Datasheet for Temperature Gauges	GAIL-STD-IN-DOC-DS-006	0
20	Datasheet for Pressure Safety Valve	GAIL-STD-IN-DOC-DS-007	0
21	Datasheet for Scrapper/Pig Signaller/detector- Intrusive Type	GAIL-STD-IN-DOC-DS-008	0
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23	QAP for Temperature Transmitters	GAIL-STD-IN-DOC-QAP-001	0
24	QAP for RTDs and Thermowells	GAIL-STD-IN-DOC-QAP-002	0
25	QAP for Pressure Transmitters	GAIL-STD-IN-DOC-QAP-003	0
26	QAP for Pressure Gauges	GAIL-STD-IN-DOC-QAP-004	0

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28	QAP for Instrument Cables	GAIL-STD-IN-DOC-QAP-006	0
29	QAP for Pressure Safety Valves	GAIL-STD-IN-DOC-QAP-007	0
30	QAP for Pig Signaller	GAIL-STD-IN-DOC-QAP-008	0
31	QAP for GAS detector	GAIL-STD-IN-DOC-QAP-009	0
32	QAP for Gas over Oil Actuators	GAIL-STD-IN-DOC-QAP-010	0
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34	Drain for Single Line	STD-ENG-IN-DWG-TP-002	0
35	Pressure Instrument Installation Scope of Work	STD-ENG-IN-DWG-TP-003	0
36	Flow Meter Installation Scope of Work	STD-ENG-IN-DWG-TP-004	0
37	Thermowell Installation Scope of Work	STD-ENG-IN-DWG-TP-005	0
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50	Purge for Instrument Single Line	STD-ENG-IN-DWG-TP-018	0
51	Purge for Instrument Double Line	STD-ENG-IN-DWG-TP-019	0
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2	Standard Procedure for Fiber Optical Cable Testing	GAIL-STD-TL-DOC-TS-002	0
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3	Datasheet for Fiber Optic Cable	GAIL-STD-TL-DOC-DS-001	0
4	Datasheet for HDPE Duct	GAIL-STD-TL-DOC-DS-002	0
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GAIL INDIA LIMITED

CONSTRUCTION OF STEEL PIPELINE AND ASSOCIATED FACILITIES ON LMC TO M/S CARBORUNDUM UNIVERSAL LTD., HOSUR

VOLUME II OF II (TECHNICAL) – A

SCOPE OF WORK

E-TENDER REF :

(BID DOCUMENT NO - 034/LEPL/GAIL/15-R0)

Lyons Engineering Pvt. Ltd.

GAIL INDIA LIMITED

CONSTRUCTION OF STEEL PIPELINE AND ASSOCIATED FACILITIES ON LMC TO M/S CARBORUNDUM UNIVERSAL LTD., HOSUR

SCOPE OF WORK

GAIL-RFP-GN-DOC-SW-001

0	20.11.2019	Issued For Bid	SR	TR	SB	
Rev	**Date**	**Purpose**	**Prepared By**	**Checked By**	**Approved By**	

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1. INTRODUCTION

GAIL (India) Limited, the largest state-owned natural gas processing and distribution company and the youngest Maharatna company. GAIL is the nodal agency for transportation and supply of Natural Gas to various potential customers. The receipt of gas from the sources and its transportation and distribution is intended to be by means of a high-pressure trunk transmission gas grid from the gas receiving point to various customer stations.

In order to supply gas to CUMI, GAIL is laying 4" NB Pipeline to connect CUMI End inside plot / Receiving Terminal (as per indicative plot plan attached elsewhere). Work shall include all the interconnecting piping, civil, electrical, instrumentation works at Customer End and Hook-up.

Lyons Engineering Private Limited (LEPL) has been appointed as Engineering & Project Management Consultant by GAIL for the project.

Definitions:

Project	Construction of Steel Pipeline and associated facilities on LMC to M/s Carborundum universal ltd.,Hosur.
Owner/Company	GAIL (India) Limited
Consultant	Lyons Engineering Pvt. Ltd. (LEPL)
Construction Contractor	Route, Topography& Geotechnical Survey, Residual Engineering, Procurement and Construction etc,providing the required services.
Manufacturer, Vendor (or Supplier)	The organization selected to manufacture or supply the equipment, services or material, ordered in accordance with Technical Specification, data sheets etc.

1.1 PIPELINE FACILITY DESCRIPTION:

Line Size	:	4" NB
Length	:	As per SOR/Schematic diagram
Line Pipe Specification	:	API 5L Gr. X42, PSL2
Wall Thickness	:	6.4
Coating	:	3 Layer Polyethylene
Stations	:	Hook-up /Tap-off, Despatch, Receipt Station /Customer End.

1.2 PROPOSED FACILITIES:

Name of Customer Connectivity:

LMC to M/s Carborundum Universal ltd., Hosur.(7 Km)

Pipeline/Piping:
Laying of buried pipeline API 5L grade X42 from proposed tap-off point to Proposed Metering skid upto 7.0 km withTCP/PCP.

- Sv-2/Tap-off point/Dispatch Station:

  - Creation of 4" tapoff through 24"/12" tee from under execution 24"/600# pipeline from RT Singasandra to krishnagiri of KKBMPL phase-II.
  - Pig Launcher facilities with station piping.
  - Civil / Structural work.
  - Adequate fire extinguishers etc.
  - Earthing, Outdoor Lighting,Outdoor Lighting DB etc
  - Provision of Future Tap-off

- Customer End (Receiving Terminal):

  - Installation of metering skid
  - Pig Receiver facilities with station piping
  - Civil / Structural work, Boundary wall/ chainlink fencing with gate, Paving etc.
  - Adequate fire extinguishers etc.
  - Earthing, Outdoor Lighting,Outdoor Lighting DB etc.
  - Provision of Future Tap-off

- Telecom System: HDPE Duct & OFC Cable with accessories

- The following indicative drawings for above LMC consumers are attached elsewhere in the bid documents:

  i) Typical Pipeline Schematic Drawings
  ii) Typical P&ID
  iii) Typical Plot Plan

  The above drawings are indicative only and are furnished to the Bidder to understand the nature of work involved. Applicable Issued for Construction (IFC) drawings shall be progressively furnished by the Company/Owner to the Contractor, at an appropriate time during project execution stage. However, bidder/contractor shall submit all required input data to Company/Owner for the IFC drawings and perform residual engineering as required during project execution stage.

- This document covers the details of work tendered, scope of work, and scope of material supply pertaining to pipeline and associated facilities. All works and clauses of this document shall beapplicable unless specifically mentioned otherwise.

- This document shall be read in conjunction with List of Attachments, Schedule of Rates, specifications, standards, drawings and other documents forming a part of the Tender Document.

2. WORK TENDERED

Work tendered in this bid package consists residual engineering, procurement (except free issue supply), supply, installation, testing, pre-commissioning and commissioning of Pipeline, Sizes 4" and associated Terminal works from Tap off to Consumer end under last mile Connectivity.

The work involves in connectivity as follows:

- Laying of 4" pipeline between SV-2 terminal/Dispatch terminal to CUMI Receipt Station/ Metering Station at Consumers End.

- All Piping works at SV-2/tap off/ dispatch station including installation of Valves, insulating joints, flow tees etc.

- All piping works of Consumer end/ receipt station including installation of insulating joints, flow tees, valves, hook-up etc.

- Installation of metering units skid / filtration/ pressure reduction at consumer end.

- Installation of Pig traps/Jib Crane whenever required.

- Crossings of road, utilities, forest, underground pipelines and water crossings by Open cut, HDD and boring.

- Carrying out all topographical and geo-technical surveys, as required, preparation of crossing drawing, procedures and submitting the same for Company's approval. Installation works shall start only after getting Company approval of design documents.

- All works related to hydro testing and pre-commissioning & Overall Commissioning of the pipeline and terminal facility.

- Supply of Nitrogen for purging, if required / as advised by Engineer-In-charge Contractor shall also provide all assistance to Owner during commissioning

- Works related to Optical fiber cable and Permanent/ temporary cathodic protection.

- All associated mechanical, civil, structural, architectural, electrical, instrumentation work at station facilities.

- Any other work not mentioned but required for successful completion of work.

- Contractor shall be required to plan and mobilize his resources accordingly to meet completion target Schedule of Owner.

3. SCOPE OF WORK

The work shall be completed conforming to Engineering Design Basis, technical specifications, drawings, data sheets as furnished in the tender and any other information provided by Engineer-In-Charge. The general scope of work includes the following:

I. SURVEY & SITE VISIT (PIPELINE & TERMINALS)

- Site visit: Contractor shall make site visits along the pipeline route, identify all the salient features of terrain, availability of ROU and infrastructure along the pipeline route. Contractor shall also make site visits for terminal stations as per bid requirement.

- Contractor shall carry out topographic and geotechnical surveys required for entire pipeline route during execution of the project. It shall be carried out without any extra cost to the owner/company.

- The surveyed pipeline alignment shall be staked on ground. It shall be the responsibility of the Contractor to finalize the route and collect the survey data along the route. Contractor shall maintain and preserve survey monuments (staked on ground) such as bench marks and intersection points, till construction is completed.

- Topographic Survey

  Topographic surveys required for the entire pipeline route & local detours during execution of the project shall be carried out by the Contractor prior to execution of job without any extra cost to the owner. However, laying and construction of entire pipeline including detoured portion shall be within the scope of contractor and governed by SOR of tender without any cost implication. Contractor shall be deemed to have considered such eventualities while formulating his bid. Pipeline route map/ alignment sheet showing the pipeline route shall be submitted to Engineer-in-charge for approval prior to execution of the works.

  Indicative plot plan drawing for terminal station (CUMI consumer end) and SV-2/tap-off is provided for reference purpose.Contractor shall carry out topographic surveys required for terminal stations and submit the detail survey drawings to Engineer-in-charge for approval prior to execution of the works.

- Soil Investigation Survey

  It shall be Bidder's responsibility to familiarize himself with sub-soil conditions along the pipeline route, and workout the lengths of pipeline to be laid in different subsoil conditions including the quantum of asphalt/ concrete road cutting excavation that would be necessary. Price quoted by Bidder shall also be inclusive of all excavation. No extra compensation shall be payable to Contractor later on.

  Indicative plot plan drawing for terminal station (CUMI consumer end) and SV-2/tap-off is provided for reference purpose.contractor shall carry out soil investigation surveys required forwell in terminal stations and submit the detail survey drawings to Engineer-in-charge for approval prior to execution of the works.

II. PROCUREMENT OF MATERIALS & SUPPLY AT SITE

- Contractor shall procure and supply all materials other than Company supplied materials, required for permanent installation of pipeline and piping system in sequence and at appropriate time as per approved schedule requirements. All equipment, materials, components etc. shall be suitable for the intended service.

- Approved vendor list has been enclosed with the bid package for various items. For items which are not covered in the vendor list, Contractor shall obtain Company's prior approval for the vendor. Equipment/ material offered shall be field proven. Equipment requiring specialized maintenance or operation shall be avoided, as far as possible.

- Stores management including receipt, warehousing, preserving the material in good condition, issue of material to construction site, reconciling/ handing over surplus material to Company for Company supplied items at Company's storage yard.

- Carryout proper documentation of inspection and quality assurance programmers for bulk materials duly approved by Company. Contractor shall maintain an accurate and traceable listing of procurement records for the location, quality and character of all permanent materials in the Project.

- Contractor shall immediately report to the Company of all changes which will affect material quality, and recommend any necessary corrective actions to be taken.

- Submit periodic manufacturing progress reports highlighting hold ups and slippages, if any,to Company and take remedial measures.

- Interact with authorities such as Sales tax, Octroi, Excise,GST etc. as necessary and arrange for dispatch of materials to site.

- All purchase requisitions including purchase orders shall be approved by Company.

- Compliance with vendors and supplier's instructions and recommendations for transportation, handling, installation and commissioning.

- Contractor shall provide inspection of the items at vendor's works by the reputed inspection agency and shall submit inspection reports of OWNER‟s clearance. In case of pressure containing materials, contractor has to provide 3.2 certificate (as per EN10204) by the approved third-party inspection agency without any inspection agency without any extra costto the owner. In addition to the same, OWNER reserves the right to inspect any material supplied by the contractor at any stage of manufacturing and delivery by themselves or through their representative. Contractor scope includes to provide the intimation to the owner, for inspection at any stage. This intimation shall be given at least 10 days prior to the inspection. Any extra payment will not be release to the contractor due to this inspection.Contractor shall appoint anyone of the following TPIA for inspection purpose.

i. Lloyds Register of Industrial Services.
ii. Technischer Uberwachungs Verein (TUV)
iii. Det Norske Veritas (DNV)
iv. AIB – Vincotte
v. Bureau Veritas
vi. SGS
vii. American Bureau Services (ABS)
viii. Velosi Certification Services.

A. Materials to be Supplied by Company as Free Issue

i. Company shall supply following materials as free issue:

- 3 Layer PE externally & epoxy internally coated line pipe for main line
- Metering Skid, pressure reduction skid, filtration skid
- Permanent Scraper Trap
- Insulating Joints
- Flow Tees

ii. Free issue material shall be supplied from M/s GAIL designated stores as instructed by Engineer In charge. Further, Contractor shall also return any unused materials after completion of work to owners designated store or as directed by owner/ Engineer-in –Charge at its own cost.

B. Materials to be supplied by Contractor

All materials (other than those mentioned in clause A above, consumables, equipment required for completion and successful commissioning of entire pipeline system shall be procured and supplied by the Contractor as a minimum, the materials to be supplied by Contractor shall, but not limited by any way, be as follows:

i. The procurement and supply, in sequence and at appropriate time, of all materials and consumables required for completion of the Work as defined in this bid document except the Company free issue material, shall be entirely the Contractor's responsibility and price quoted for the execution of the Work shall be inclusive of supply of all these materials.

ii. All materials supplied by the Contractor shall be strictly in accordance with the requirements of relevant Company material specifications enclosed with the tender document.

iii. All equipment's, materials, components etc. shall be new and specifically purchased for this job. All material to be supplied by the Contractor shall be purchased from the approved vendors of the Company, duly inspected by LEPL/ Third party inspection agencies like Lloyds, Bureau Veritas etc. The list of approved vendor is enclosed along with bid document.

iv. All valves of all sizes and & ratings for mainline and at terminals, All Casing Pipes, Assorted pipes for all sizes and thickness fittings, flanges, O'lets (weldolets, sockolets,nippolets, threadolets etc.), spectacle blinds, spacer & blinds required for permanent installation in the system. Each item shall be inclusive of commissioning spares. List of such spares shall be made part of the offer and the quoted unit/total price shall be inclusive of the spares. In case of exigency of work, GAIL may procure valves, pipes as per SOR item list.

v. All stud bolts, nuts, all type of gaskets (metallic spiral wound / ring type) in requiredquantities to be used for permanent installation into the system for all sizes and ratings offlanges and flanged valves, equipment etc.

vi. All consumable such as welding electrodes, oxygen, acetylene, inert gases, all types of welding electrodes, filler wires, solder wires, brazing rods, flux etc. for welding/cutting and soldering purposes.

vii. All materials for all types of markers including paints Normal corrosive environment,cement, sand, reinforcements, structural steel, etc.

viii. All materials, equipment's, consumables including pigs required for magnetic cleaning and EGP.
ix. All materials required for weld joint coating, corrosion coating of LR bends, repair of damaged corrosion coating of line pipe. Contractor shall confirm that proposed field joint coating material is suitable for type of terrain encountered along pipeline route. Contractor shall take prior approval from Company for field joint coating material to be used.

x. Dirax or equivalent field joint coating material for HDD works.

xi. All materials required for sand/soft soil padding around pipeline and optical fibre cable,select backfill of approved quality, wherever required.

xii. All materials including consumables required for hook-up with adjoining pipeline section or wherever required.

xiii. All primer and paints for painting above ground piping shall be as per specification enclosed with the bid package.

xiv. Corrosion monitoring system wherever specified as per specification.

xv. Material for the maintenance of sand ridges and other materials for pipe stacking at Contractor's warehouse/storage yards/work site/ROU.

xvi. All materials for skin measurement instrument.

xvii. All temporary materials and consumables required for filling and pressurizing in connection with hydrostatic testing, dewatering, swabbing and pre-commissioning activities, etc.Including pipes, flanges, fittings, gaskets, bolts, nuts, etc. required for fabrication of temporary pig traps and /or test headers.

xviii. All materials required for repair/restoration of pavements, roads, canals, temporary water pipes, walls, other structures affected/damaged by Contractor's construction activities.Materials shall be equivalent/superior to those used for original construction of the facility.

xix. All pigs for cleaning, gauging, de-watering, swabbing, filling, pre-commissioning and commissioning of the pipeline.
xx. Pumps and water to be used for hydrostatic testing/ flushing. All materials & consumables such as Corrosion inhibitor, oxygen scavengers and bactericides, required during hydro-testing and idle time preservation, as required.

xxi. All casing pipes, casing insulators and end seals including materials for vent and drain and strapping CS conduit with pipe and carbon steel pipes for optical fibre cable (OFC)conduits in

required quantities. Size of casing pipe for carrier pipe and carbon steel conduitfor OFC shall be as follows:

a) 114.3mm, O.D. (4"), API 5 L Gr. B/ IS: 3589, for 4" carrier pipe
b) 168 mm OD, Sch.40 API 5L Gr-B steel conduit with HDPE inner duct for laying of OFC at crossings.

The Minimum thickness of casing Pipe shall be as per API 1102 . All CS casing Pipe/conduit shall have 300 micron external epoxy coating.

xxiii. All consumables and equipment's required for all types of tests and NDT such as radiography, ultrasonic testing, magnetic particle, dye penetrant examination etc. including radiography film etc.

x. All safety tools and tackles, devices, apparatus, equipment, personal safety gazettes to be used as personal protective equipment (such as helmets, safety belts, safety shoes, etc.)including ladders and scaffolding etc. complete as recommended by Engineer-in-Charge as per relevant safety standards.

xxiv. All structural steel material for all types of supports.

xxv. All materials and equipment for excavating trench or grading the Right-Of-Use pipeline and pipe laying/installation and other works.

xxvi. All steel materials such as structural steels, reinforcement steels and steel for all types of supports, foundations, ladders, platforms etc. including Bolts, nuts, washers, U bolts,clamps, clips, gaskets, Shims, wedges and packing plates (Machined wherever required)and materials required for fabrication of low friction sliding bearing supports.

xxvii. All fencing, gate and steel materials such as structural steels, reinforcement steels and steel for all types of supports, foundations, ladders, platforms, etc.

xxviii. All materials, manpower, spares, tools & tackles and consumables for carrying out pre-commissioning activities and during commissioning (including bi-directional and foam pigs, Air compressor, nitrogen required for achieving the specified criteria for pipeline purging prior to declaring pipeline fit for commissioning) necessary piping and instrumentation connection for measuring flow rate, pressure, temperature etc., temporary facilities for blow down/ venting/ flaring along with necessary piping, valves &instrumentation as well as consumables and manpower required during pre-commissioning and commissioning.

xxix. All materials (100% solid epoxy coating 500micron thick) for corrosion protection of buried piping (pipes, fittings, flanges, valves, etc.).

xxx. Required quantities of Nitrogen for pre-commissioning & commissioning works.
xxxi. All spares for pre-commissioning and commissioning as required for all items supplied by Contractor for the entire pipeline system.

xxxii. All Civil/Structures items, Electrical, Instrumentation, Telecom, Cathodic Protection materials in complete as per requirement specified in all different sections.

xxxiii. Any other material not specifically listed herein, but required for successful completion of the Work.

C. Conditions for Company Supplied Material

i. The Contractor shall be responsible for taking over of the material and subsequent handling, hauling, transportation to the actual work site(s)/fabrication yard(s) and storage &safe keeping of the materials.

ii. The Contractor shall inspect all Company supplied free issue materials at the time of taking over from the Company and defects noticed, if any, shall be brought to the notice of Company/Company representative and jointly recorded. Once the material has been taken over by the Contractor, all the responsibility for safe keeping of the materials and repair of damage/ defects to pipe & pipe coating shall rest with the Contractor.

iii. Contractor shall receive and take over the pipes progressively as per construction requirements. At the time of taking-over from Coating Contractor/GAIL's designated storage, Contractor shall perform inspection of pipes and pipe coating for all defects in the presence of Company's Representative. Contractor shall repair all defects occurring after taking over including those during transportation and handling. Rebuffing for dents (in bevels) less than 1 mm in depth shall be carried out by Contractor ahead of welding in the field at no extra cost to Company. Contractor shall progressively takeover the required quantity of bare & coated line pipe from the warehouse.

Return of surplus bare & coated line pipes at warehouse to Company's designated storage yard is installation Contractor's scope including loading, transportation, unloading,handling, stacking of pipes at company's storage yard and getting the pipes inspected from Company's representative at storage yard.

Any repairs to 3-layer polyethylene coating shall be carried out by Contractor using suitable material compatible with parent coating system and meeting the requirements of coating system specified in specification attached with the Bid Package. The coating repair material and procedure for application shall be submitted to Company for approval prior tostart of construction.Repair of PE coated pipes in field shall be carried out as follows in accordance with bid specification.

iv. Rebuffing of dents in bevels less than 1 mm in depth shall be carried out by Contractor ahead of welding in the field at no extra cost to Company.

v. On completion of the works Contractor shall submit a "Material Appropriation Statement" forall materials supplied by the Company as free issue materials.

vi. Every month the Contractor shall submit to the Company an account for the material issued to the Contractor in the Performa prescribed by Engineer-in-Charge.

vii. For the purpose of accounting of pipes all cut pieces in length of 2 m and above when returned to the Company's storage point shall be considered as serviceable material. All pipes measuring less than 2 m shall be treated as scrap/wastage.

viii. All unused pipes and serviceable/ scrap material shall be the property of the Company and shall be returned by Contractor to Company at Company's designated storage point(s)

D. Storage of Materials:

i. All materials shall be preserved against deterioration and corrosion due to poor or improper storage while under the custody of the Contractor.

ii. All materials shall be duly protected by the Contractor at his own cost with the appropriate preservatives like primer, lacquer, coating, grease etc. and shall be covered with suitable material to prevent them from direct exposure to sun, rain, wind and dust.

iii. Pipes shall be stacked according to the identification marks and stacks shall be arrangedon sleepers / sand bags at least 300 mm above ground.

iv. The Contractor shall check that valves, fittings, specials etc. are not subjected to corrosion from hydrostatic test water remaining in the piping. Any such condition when detected should be brought to the notice of Engineer-in-Charge and remedial measures taken as directed.

v. All machined surface shall be properly greased and should be maintained and protected from damages.

vi. Openings of equipment, machinery, valves etc. shall be kept blocked / covered with blinds to prevent entry of foreign matter.

vii. As far as possible materials shall be transported to the site of erection only just prior to the actual erection and shall not be left around indefinitely on ground but kept on packing/sleepers etc. to maintain the minimum distance from the ground as specified and/or as per directions of Engineer-in-Charge.

III. QUALITY ASSURANCE & QUALITY CONTROL

a. Contractor shall prepare Quality Assurance & Quality Control Plan for project.

b. Contractor shall ensure adequate quality assurance and control including stage wise inspection, testing and certification.

c. Contractor shall appoint an independent TPIA for supply of material (Other than free issue) from Owner's vendor list. The TPIA appointed by contractor shall be common for inspection of complete scope of supply. All inspection reports shall be submitted for owner's review/approval. All materials like station pipes, fittings, valves etc. shall be supplied with required certificate / approved document.

d. Contractor shall Carryout proper documentation of inspection and quality assurance programme for all equipment and bulk materials duly approved by Owner.

e. QAP samples are enclosed as part of bid shall be followed by Contractor without any deviation as is basis.

IV. CONSTRUCTION: INSTALLATION, ERECTION & TESTING

a. Contractor shall carry out construction work as per approved "Issued for Construction" drawings, procedures, specification and applicable codes and standards. Any changes at site shall need prior approval from the Engineer-In-Charge.

b. Contractor shall receive and takeover of all owner supplied free issue materials from the designated place(s) of issue. The transportation including loading, unloading, handling, storing till installation of materials shall be the responsibility of contractor.

c. Contractor shall be responsible for delivery and handling of bought out material at site.

d. Contractor shall prepare planning and monitoring schedule.

e. Contractor shall obtain no objection certificates (NOC) from authorities, land owners or any other statutory body.Company has obtained most of the clearances, No objection certificates (NOC) for laying pipeline & for stations from concerned authorities. However, for some of the permissions, if not available, Contractor shall do the follow up with the concerned authorities to get the permissions to execute the job in time. In such cases, all statutory payments required for such permissions shall be reimbursed by Company at actuals. Contractor shall obtain permits/clearance from concerned authorities before actual commencement of the job at site including preparation and establishment of safety procedures for laying pipeline.

f. Contractors shall Liaison and coordinate with all statutory authorities having jurisdiction during the actual execution of work.

g. Contractor shall also coordinate and use his best deeds to carry out the construction of pipeline with the general permission provided by client.

h. Contractor shall mobilize adequate manpower, machinery, tools, tackles, consumables etc for construction.Immediately after award of individual work, Contractor shall make a visit to the route to establish the route and familiarize with the working conditions so as to plan for deployment of manpower and machinery.

i. Contractor shall arrange and take possession of any additional land required for construction purposes.

j. Contractor shall do clearing and grading of ROU and station plots.

k. Contractor shall do stringing, welding and lowering of main pipeline.

l. Contractor shall do work in restricted ROU along with large number of utilities & utility crossing.Most of the areas the Pipeline shall be laid along the road and industrial area. The ROU shall be restricted. Excavated trench & pits in area near heavy traffic and other areas of movement, shall not be left open without barricading.

Contractor may plan to work in the Night shift to avoid traffic while crossing roads & utilities. But Contractor has to plan and take approval from Engineer-In-charge/ Client and Concerned Authorities before start of construction. Contractor to arrange all lighting and safety precaution for the same.

In some areas where mechanized excavation is not possible, Contractor shall have to do manual Excavation also.

m. Contractor shall do earthwork such as excavation, trenching for all depths and all types of soil, rock blasting and back filling including bottom/top padding as per specification.

n. To ensure adequate quality control, contractor shall make arrangement for stage wise inspection and testing during construction work at site.

o. Contractor shall carry out NDT as specified in the tender along with selection of production joints and carrying out the relevant tests as specified in the bid document.

p. Contractor shall carry out concrete coating of Line Pipes, wherever required in addition to the location specified in Alignment / Crossing Drawings as per approved design. All materials, equipment, instruments and consumables required for concrete coating for providing anti-buoyancy to the pipeline, concrete slabs for pipeline protection, crossing bank protection including slope breakers wherever required as per applicable specification/drawings.

q. Contractor shall make Cold Bends from API 5L Gr. X42 / X52 / X60 ERW Line Pipe (ERW Pipe shall be supplied free issue by owner/company). Line pipe grade can be changed depends upon the requirement and availability by GAIL.

r. Site restoration shall be done by Contractor as per original condition and to the satisfaction of GAIL Project Manager/designated authority/owner/farmer and NOC to be obtained to this effect.

s. Contractor shall carry out Cleaning, Hydro-testing, Swabbing, Drying, Gauge Pigging, including supply of materials, consumables, tools and tackles, equipment/machineries and manpower.

t. Pipeline gauging shall be performed prior to install any elbow in between two sections. All individuals sections shall be checked in same method for pipeline gauging.

u. No branch connection or Tee, underground Valve shall be installed before hydrostatic test.

v. After welding of elbow with pipeline section, one-gauge pig run has to be carried out as per 95% ID of Elbow on or before water filling for hydrostatic test.

w. If pipeline passes through the edge of small lined drain/ RCC Drain/ Stone Pitching required restoration shall be carried out after completion of laying works. Prior approval needs to be taken regarding construction and restoration procedure from Engineer-In-Charge.

x. Contractor shall carryout AC & DC interference surveys and shall take suitable measures for the mitigations of AC & DC interference.

y. Contractor shall carry out Installation, Testing &Commissioning of TCP (Temporary Cathodic Protection) and PCP (Permanent Cathodic Protection).

z. Contractor shall carry out Land and site development work for stations including earth filling wherever required.

aa. Contractor shall carry out Civil works for stations including RCC approach road wherever required.

ab. Contractor shall carry out Installation of Electrical items like Distribution Boards for Outdoor Lightings, Cables, Poles, Solar Lights, Earthing Materials etc. as applicable as per Technical specification of RFP document.

ac. Contractor shall carry out Mounting/Installation of all field instruments like Pressure Gauge (PG), etc. as per P&ID.

ad. Contractor shall carry out HDD crossing (wherever applicable) as specified in the tender specification.

ae. Hydrostatic testing of Pipeline shall exclude valves at tap off stations, and terminals and facilities that are to be installed as a part of the stations. Temporary test headers shall be provided and the pipeline shall be hydrostatically tested between the temporary test headers

only. The pipeline shall be hydrostatically tested at least 1.5 times of Design pressure. But the maximum hydro test pressure shall not exceed 90 % SMYS of the pipe material at any location and at any point of time of the lowest wall thickness of that section. The highest point of the test section shall be subjected to the minimum test pressure as specified above. Hydro test shall be for 24 hours duration.

Hydro test shall be done with corrosion inhibitor and dosage of corrosion inhibitor shall be suitable for 3 months.

Subsequent to separate hydro testing of pipeline and associated facilities, tie-in/hook up shall be carried out by the Contractor. Pipes/prefabricated assembly used for such tie-in shall be pretested to a test pressure specified for the pipeline. All materials required for the fabrication of the test headers shall be provided by the Contractor at no extra cost to Company. After successful completion of hydrostatic testing, the Contractor shall de water the pipeline as per the directions of Engineer-in-charge.

af. Piping facilities between the insulating joint and hook up point/battery limit and all above ground facilities installed by Contractor shall be hydrostatically tested to a test pressure equivalent to 1.5 times design pressure in accordance with “Standard specification for Inspection, Flushing and Testing of Piping System” enclosed with the Contract document.Duration of testing shall be minimum 6 hours. All valves in the piping network being hydro tested shall be kept in the crack open position.

ag. For any welding the electrodes, consumables and flux shall be of same manufacturer. Weld ability Test Shall be carried out on line pipe segment of 12 meter each. Thereafter, RT will be taken of joint after 24hours and 72 hours followed by destructive testing as per QAP.

ii. Contractor shall carry out minimum one sample considered for Production Weld Test sample. The sample selection shall be selected by TPIA/Client/Client Representative.

ah. Contractor shall carry out fabrication of station piping and construction & installation of pipe supports.

ai. Contractor shall carry out installation, commissioning of free issue material like filtration and metering skid including loading, unloading, transportation from anywhere of GAIL designated store location.

aj. Contractor shall carry out Hook up / tie-in of pipeline and piping system with terminal facilities.

aj. Contractor shall carry out Idle time preservation of the pipeline (if required).

ak. It is envisaged that dewatering and swabbing operations shall be carried out as a part ofpre-commissioning activities. Dewatering of pipeline after hydrostatic testing shall be takenup by Contractor only when Contractor is ready for swabbing operations.

al. Contractor shall carry out Pre-hydro testing and Post-hydro testing of all cased crossings and after major crossings and or additionally imposed by Engineer-In-Charge/ Concerned authorities.

Contractor shall submit a detailed procedure for leak detection during hydrotest. Suchmethod of detection shall consume minimum possible time to complete the hydrotestactivity within contractual completion schedules. This procedure needs approval of the Engineer-in-charge.

am. Contractor shall make proper waste disposal system for construction and related works.

qq. Contractor shall carry out all incidental and associated works and any other works not specifically listed there in but are required to be carried out to complete entire work related to pipelines and terminal.

an. Contractor shall carry out Induction and strict implementation of Health, Safety & Environment (HSE) procedures including safety organization, HSE plan, providing PPE, providing adequate barricades at work site wherever required, conducting periodic audit and ensuring the implementation of HSE measures. Contractor shall be fully responsible & liable for ensuring & implementing HSE at site & shall hold Engineer-In-Charge fully indemnify from all liabilities & consequences.

V. PRE-COMMISSIONING & COMMISSIONING

Contractor shall carry out Golden joints clearance.
Contractor shall carry out Drying as per specifications.
Contractor shall carry out Gauge pigging of main line as described.
Contractor shall carry out Pre-Commissioning of complete system including, Filtration, metering and Pressure Reducing skid (If applicable)

Overall commissioning activities including drying, nitrogen purging etc. for entire pipeline and terminals shall be performed the Contractor. Contractor shall mobilize all equipment, consumables, nitrogen and manpower for carrying out pigging, drying, inertisation and commissioning activities.

VI. PROJECT MANAGEMENT INCLUDING DOCUMENT CONTROL SYSTEM

Preparation of detailed project schedule.

Preparation of Project Execution Methodology.

Material Management Plan

Planning & Scheduling

Monitoring and Reporting of progress on each front of the project.

Contractor shall be required to work on the material management module of GAIL. Service entry sheet of goods received and invoice entry in SAP capturing to be done by the Contractor.

Deployment of competent qualified & experienced Project & Construction Personnel. Key manpower shall meet the requirements specified in bid document. Contractor shall submit site organogram with CV of respective personnel to Engineer-In-Charge.

Expediting and Monitoring of all procurement excluding free issue material and construction activities with approved vendors / sub-Contractors.

Contractor shall submit following deliverables for adequate monitoring of project:

- Daily Progress Report (DPR) for construction works of project
- Weekly Progress Report (WPR) for Procurement covering all stages of material Including construction progress.

- Monthly Progress Report (MPR) with comparison.

The details of content of the above reports shall be prepared by the Contractor for approval of Engineer-In-Charge.

Receipt of GAIL free issued materials i.e. Line Pipe, Filtration, Metering, IJ, Valves and other free issue materials if any.

Installation of all free issue material including Filtration and Metering with necessary modification if needed.

VII. PROJECT CLOSE OUT

Submission of all as built documentation, inspection reports, purchase orders, material reconciliation report, NDT records both in soft and hard copy duly approved by Engineer-In-Charge.

Submission of all NOC's from landowners, statutory authorities and agencies having jurisdiction.

Submission of relevant documents, Operation & Maintenance manuals, guarantee/ warrantee test certificates of all the items supplied by Contractor for the execution of the complete scope of work.

Submission of operational acceptance report including all the documents, test certificates etc.

Pre-Commissioning and Commissioning

- Pre-commissioning activities such as Hydro-testing, Swabbing, Drying, Gauge Pigging, Vacuum drying and nitrogen purging for mainline & station piping system for mainline.
- Pre-Commissioning of complete system including Filtration and Pressure Reducing skid (If applicable)

- Commissioning with Natural Gas. This also includes commissioning ofcomplete pipeline system i.e. pipeline, spurline, Civil, Electrical including Cathodic Protection,Instrumentation and associated works / facilities.

- Commissioning of Pipeline and associated systems including supply of materials (temporary, permanent or consumables), tools and tackles (including special tools & tackles) and manpower.

VIII. OWNER'S RESPONSIBILITY

a) Issuing clearance to contractor to work in the ROU only
b) Land for Station
c) Providing all free issue materials
d) Providing Approved "Issued For Construction Drawing"(shall be issued by Engineer-In-Charge)
e) Refer commercial volume

4. DETAILED SCOPE OF WORK

4.1 PIPELINE LAYING WORKS

- "Receiving and Taking-over" as defined in the specifications stacking in the yards / dump site and stringing of pipes in Right-of-use (ROU), including arranging all necessary intermediate storage area(s) required there till the coated pipes are installed in permanent installation.

- Transportation of pipes from the designated dumpsite to designated ROU/ROW for stringing.
- Carrying out inspection of OWNER supplied materials if any at the time of receiving and taking-over.

- For pipes where cutting out involves more than 25 mm from pipe ends, ultrasonic inspection shall be carried out at pipe ends as per relevant clause of line pipe specification enclosed with the tender including supply of all equipments. Contractor shall take prior approval from Company for the agency engaged for carrying out ultrasonic inspection.

- Loading, unloading, handling stacking, storing and transportation to workshop / work site of all materials that may be used for the construction of pipeline system supplied by Client/Contractor at their designated stack yard /dump site /store.

- The contractor shall notify the owner the probable date of commencement of work at ROU site at least two (2) weeks in advance to enable the owner to arrange handing over of the ROU / site on the date requested. Should contractor fail in such notification, the owner shall not be liable for any claim by contractor, of whatsoever nature, for delay in the available of a ROU / site.

- Mobilizing and providing all equipments, manpower (skilled and unskilled), consumables and other resource etc. as required for the execution of complete work and thereafter demobilizing the same upon completion of work.

- Contractor shall mobilize the machinery and manpower as defined in the tender document. Each contractor shall be responsible for the entire scope of work of individual part including commissioning and gas in and shall mobilize the equipment and manpower accordingly.

- The Company shall obtain a general permission from most of the authorities having jurisdiction over the area as necessary for construction of the pipeline. However, for some of the permissions, if not available, Contractor shall do the follow up with the concerned authorities to get the permissions to execute the job in time. However, all statutory payments required for such permissions shall be reimbursed by Company at actuals. Contractor shall also obtain the necessary permits like work permit/ excavation permit/ trench opening permit etc. for all works from the authorities having jurisdiction before the actual execution of various phases of the works and all stipulations/ conditions/recommendations of the said authorities shall be strictly complied with no extra cost to Company. Contractor shall also obtain all necessary

permissions from the concerned authorities for installation of pipeline at railways, roads and water / nala, drain crossings. Company may, however, assist Contractor in obtaining such permissions, wherever required, by issuing recommendation letters etc. In case of damage to other utilities/infrastructure, Contractor shall be responsible and the required compensation, as per the directions of concerned authorities, shall be paid by the Contractor. After completion of work, Contractor shall obtain a certificate from the concerned authorities that the job has been completed as per their requirement and the area/land has been restored to their satisfaction.

- Staking, clearing, grading, fencing of Right-of-Use (ROU) as required, trenching to all depths in all types of soil including soft, hard rock, controlled rock blasting / rock blasting by special techniques, chiselling or otherwise cutting etc. to a width to also accommodate the cable conduit as per relevant standards, drawings, specification etc. Transportation of coated pipes to ROU along the route, stringing, aligning, bending, welding, NDT including radiography by X-ray and ultrasonic inspection, field weld joint coating including supply of all materials, protective coating of long radius bends including supply of all materials, protective coating of long radius bends if applicable including supply of materials as per specification sand padding, laying and lowering of the pipeline, back filling, slope breakers as required, carrying out rail, road, canal, utility and submerged minor and major water course crossings including installation of carrier pipe inside casing pipe at cased crossing wherever required, bank stabilization of water course crossing as required, crossing of river / canal by conventional method and arranging all additional temporary land / area required for construction purposes. Supply and installation of anti buoyancy measures viz. continuous concrete coating, saddle weights, extra cover etc. on pipeline as shown in approved drawings and as directed by OWNER, installation of supports wherever required, supply of select backfill material as required, clean-up, pigging, flushing, gauging, hydrostatic testing with quantity of inhibitor as required, dewatering with the additive, at required dosage, swabbing, pre-commissioning and commissioning of complete pipeline system, including all associated works as per relevant specifications, standards and approved drawings.

- Welding of all **Golden Tie**-in joints including tie-in joints and bends on either side of water body crossing / with adjoining pipeline installed by others / other facilities as required, cutting of test header, rebevelling and tie-in with adjacent pipeline segments. The welding shall be mainly semi automatic/ manual type and contractor shall follow the technical specifications as defined in the tender document.

- Field weld joint coating shall be by heat shrink sleeve / other suitable material as per specification enclosed with bid package compatible of pipe coating material. Any damage in coating shall be repaired as per the approved procedure and the same shall be holiday tested after joint coating.

- Carrying out corrosion coating of Long Radius (LR) bends if any. Coating shall be carried out by heat shrink sleeve / other suitable material as per specification enclosed with bid package for field joint coating.

- Supply and Installation of casing pipes (by open cut / jacking / boring) assembly, including supply of all material viz. casing pipe, casing insulators and end seal, vents and drains etc. complete, at cased crossings as per the drawings / specifications enclosed with bid package.

- All works / provisions including installation of slope breakers to be provided in the trench in areas where slope is more than 1 in 10.

- Sand / soft soil padding around pipe wherever required in areas where trenching has been done in rock including supply of sand / soft soil. The thickness of sand / soft soil padding at the bottom of pipe shall be 300mm in rocky areas.

- Installation of all inline / online instruments / valves / insulation joints / appurtenances etc. as per requirements of approved drawings.

- Providing 300-micron high built abrasive resistant epoxy on the external surface of 6" CS conduits meant for OFC (in crossings) wherever required.

- Contractor shall firm the method of crossing of roads such as open cut / boring / HDD up in consultation with concerned authorities and Company. The Contractor shall also take due care to identify and take due precautions so as not to disturb or damage the utilities like cables, water lines and other structures.

i. No damage should be caused to any irrigation sources, while laying the pipeline through road crossings.

ii. The flood banks of the River / Canal should be brought to the original condition, if they are damaged while the laying of the pipeline. Stabilization of banks shall be carried out as per requirements of concerned authorities.

iii. In general the top of the pipeline shall be taken at least 2.5 meter below the scour level of river crossing. The top of pipeline shall be at least 1.5m to 2.0m below the drain / canal bed unless specified other wise. The minimum cover requirements shall be as defined in drawings/ technical specifications as defined in the bid document.

iv. Pre-construction survey, preparation of the detailed construction methodology / plan and time etc. shall have to be finalized by Contractor in consultation with concerned authorities having jurisdiction over canals / rivers. Company shall provide assistance by providing introductory letters.

v. Pre-construction surveys, preparation of detailed construction method statement and calculations for Owner's approval.

vi. Surveys like Geo-technical, Hydrological and Topographical for pipeline route, Station plots, Rail and Road crossing etc and water crossings.

vii. Site preparation, arranging required land for setting up of string fabrication yard and obtaining necessary permissions from concerned authorities.

viii. Preparation of pipeline Launch way, continuous concrete coating of pipes, repair of damages to corrosion and concrete coating, string preparation, field

welding, NDT including radiography, pre-test for completed strings, corrosion and concrete coating of field joints, trenching, laying at approved depth, stabilization of banks, post installation hydro-test, capping, providing and installing of markers, etc.

- Contractor shall cross the road / canal etc. by HDD/ trench less method at locations as directed by Owner / Consultant as per crossings survey drawing done by contractor. Before start of HDD, the contractor shall ascertain by pre-construction survey all underground obstacles namely electrical / telecommunication cable, foreign pipeline water line, drain / sewerage line and prepare crossing profile drawings showing all elevation & levels. The contractor shall also ascertain the type of soil & their terrain whether rocky or normal by way of trial pit etc. before start of job. The contractor shall submit procedure; profile drawing with complete design calculations of HDD as per requirement of ASME B31.8 / OISD norms and safety requirement that pipe is not under stress during and after crossing for Owner / Consultant's approval prior to start the execution of work.

- Contractor shall ensure all safety norms regarding distances from end point or from bottom of crossing and also ensure that external coating of pipe is not damaged during pulling & handling of pipe for crossing. For field joint coating in pipeline string made for HDD, special type of heat shrink sleeve shall be used as per specification enclosed with the tender. For line pipe coating repair, special type of high shear strength repair patch material shall be used which characteristic shall be same or equivalent as original wrap round heat shrink sleeve used in pipeline string for HDD crossing.

- The contractor shall ensure that no any underground existing utilities / pipelines / cable etc. is damaged. It shall be responsibility of contractor to compensate any loss or damage while crossing. Contractor shall arrange all statutory permission from concerned authority before start of job. Contractor shall deploy only GAIL/ LEPL approved HDD agency and approval of agency shall be sought before deploying HDD agency.

- Where the pipeline route passes through forest / plantation areas, Contractor shall clear only the minimum width required for laying the pipeline as per Owner approved procedure for pipeline construction. Number of trees / plants to be felled down shall be restricted to a minimum.

- Clean-up and restoration of ROW and other conveniences like road, rail, canals, cultivable land etc. to original conditions as per specification and drawings to the entire satisfaction of OWNER and / or authorities having jurisdiction over the same, including disposal of surplus construction materials to a location identified by CONTRACTOR approved by local authority without causing any disturbance to environment, location and to the entire satisfaction of OWNER.

- Upon restoration of ROU the Contractor shall furnish documentary evidence in support of acceptance of he same duly signed by land Owner without any extra cost.

- Carrying out repair of all defects found during DCVG/CIPL survey etc.

- Carrying out cleaning, flushing, swabbing (as applicable), dewatering, testing and pre-commissioning of pipeline and associated facilities at Dispatch Station/SV-2 Tap-off and Receipt Station up to the respective battery limits. Locating all major and minor leaks during hydro testing if any.

- Repair of any leaks / burst occurring during testing of main pipeline. In case of failure during hydrotest the entire section shall be re-hydro tested.

- Tie- in with the pipeline at rail, road and other crossings including cutting of test headers as required and tie-in with terminal piping & with existing facilities as applicable.

- Idle time preservation of the pipeline (if required) for the specified period by filling with nitrogen to a positive pressure of 1 bar (g) including supply of nitrogen etc. as required.

- Installation of carrier pipe in canal / road (NH / Express Highway) / railway crossings by boring / HDD / Trench less method, as directed by Company. Contractor to note that the minimum elastic bend radius to be adopted, shall be as per pipeline engineering design basis enclosed with the tender.

- All incidental and associated works not specifically listed herein but are required to be carried out to complete entire work related to pipelines and the associated facilities and making the entire pipeline system ready for operation.

- The contractor shall be responsible for taking over of the material and subsequent handling, hauling, transportation to the actual work site(s) / fabrication yards(s) and storage & safe keeping of the materials.

- The Contractor shall inspect all Company supplied free issue materials at the time of taking over form the Company and defects noticed, if any, shall be brought to the notice of Company / Company representative and jointly recorded. Once the material has been taken over by the Contractor, all the responsibility for safe keeping of the materials and repair of damage / defects to pipe & pipe coating shall rest with the Contractor.

- Removal of dents in bevels less than 1 mm in depth shall be carried out by Contractor ahead of welding in the field at no extra cost to Company.

- <u>Pipe off cut</u>

The contractor shall keep a detailed inventory of the pipes received, per type of pipe & a note of their location. The contractor shall provide summary of the above to the owner.

The pipes off-cut can still be used in the life time of the contract. Before the end of leak test the contractor shall provide the owner with an inventory of the surplus pipes.
The term" surplus pipe" defined as "Any pipe that can immediately be reused (undeformed, numbered, coating & is in good condition) bearing individual pipe number, stamp of the recognized inspection agency, origin, type & length".
Only complete lengths of pipe element will be taken back by the owner. All other pipe surplus is the responsibility of contractor. Before termination of leak tests the contractor will draw up a final account of the pipes & transmit to owner as per following settlement formula.

Settlement Formula

X = Tr – (Tp + Tc + Cr + Lr)
Where,
Tr = Length of the pipes delivered & accepted on the working sites and issued to contractor.
Tp = Length of the pipes effectively laid.
Tc = Permitted loss (=0.3% of effective length of the pipe laid)
Cr = Length of the returnable pipe (2m & above)
Lr = Length of defective pipes element rejected for reasons which are not attributable to contractor.
X = Length involved to the contractor.

- **Returnable minimum length of pipe:**

Minimum length of pipe to be returned shall not be less than 2m. All pipe elements shall
bear the individual pipe number, stamp of the recognized inspection agency, original typeand length.

- **Returning the Surplus Material**

Only the material supplied by the owner as free issue material should be returned in good conditions and while returning, should be accompanied by all needful certificatory. If the free issue material is damaged or misused by the contractor, he will be charged twice the cost of the material. The contractor shall be solely responsible for any damage or misuse of the material supplied by him and no extra compensation either by way of time or cost shall be admissible.

- On completion of the work contractor shall submit to the company, an account for the material issued to the Contractor in the Performa prescribed by Engineer – in – Charge.

All such works which are not indicated here but otherwise required to complete the work in all respect in accordance with the specifications, drawings & other requirements of bid package shall also form part of Bidder's / Contractor's scope of work.

- Carrying out temporary and permanent cathodic protection works as defined in the bid package.

- Loading, unloading, handing over and transportation of all surplus Company supplied free issue line pipe after completion of works Company's designated warehouse as directed by Engineer-in-Charge and stacking the same. Stacking of surplus pipe shall be inclusive of supplying of sand bags etc. at Company store for proper stacking.

4.2 TERMINAL PIPING WORKS

- Receiving and Taking-over" Company supplied free issue Filter, Metering and PRS skid from designated warehouse, loading, transportation, unloading, at Contractor's worksite(s)/ workshop till the skid is installed in permanent installation. The contractor shall make his own arrangement of crane for lifting of all free issue material.

- Supply, fabrication and erection of pipe/ equipment supports (for all sizes/ thickness) including shoes, pipes, cradles, turn buckles, T-posts for all types of guides, anchors, all necessary equipment, consumables, labour etc. for completing all works including supply of bolts, nuts, washers, U-clamps, wooden blocks etc. as required for supporting.

- Hook-up of piping with skids, equipment"s & vessels, with the existing facilities, with the pipeline and at the battery limit with the facilities installed by others by welding or by flanged connection including cutting, fit-up, welding, NDT, radiography, interface/coordination as required with other Contractor(s)/Agencies.

- Painting of all equipment's, structural steel elements for pipe supports, above ground piping and all related miscellaneous items as per company specification enclosed with the bid document. Application thickness shall be as per painting Specification.

- Protective coating of 500 micron thick two component epoxy (achieved by application of three coats) duly approved by Company for all underground piping, valves, fittings,etc.asper specifications including supply of all materials.

- Hydro testing, dewatering, flushing & pre-commissioning activities of piping system of allsizes as per specifications enclosed including supply of all materials and manpower that are required during pre-commissioning and all associated works. Identification of leaks during hydrotesting & repair of defects.

- Final clean up and restoration of site, facilities etc. as per the requirement of Company/Engineer-in-Charge.

- Preparation of General Arrangement Drawings (GAD), isometrics and/or fabrication drawings required for the purpose of fabrication during execution of work.
- Preparation of as-built drawings, documents and project records as per instructions of Engineer-in-Charge.

- Co-ordination as required with other Agencies/Sub-Contractor(s) till the time thecommissioning operations are complete.

- Any other works not specifically listed herein but required for completion of the works in allrespects.

4.3 CIVIL / STRUCTURE WORKS

The scope of civil / structural and Architectural works under this Contract shall include Residual Engineering, detailing, supply and construction of all relevant civil / structural and Architectural works as per Design Basis, Specifications, standards, Addendums and Drawings enclosed with the bid document.

Major Civil / Structural and Architectural works involved shall include but not be limited to the following:

a. Topographical Survey & Geotechnical investigation of soil and submission of Recommendations for review.

b. Site Clearing / Grading

c. RCC /Paver Block pavements, Roads, Footpath.

d. Boundary wall / Chain Link fencing & Entry Gate, etc.

e. Approach Road for Station

g. Foundations for equipment viz. Pig Launcher / Receiver, Metering skid, Filtration skid, Letdown area, Pig trolley etc.

h. Architectural & Structural works in R.C.C./Structural steel.

i. Pits & Cable Trenches for underground works.

j. Pipe Sleepers / Supports and Valve foundations.

k. Valve Operating Platforms and Crossovers.

l. Pile Foundation wherever required as per Geo-tech recommendations.

m. Dewatering during excavation, if required.

n. Painting of Buildings & Structural steel works.

o. Preparation of fabrication drawings for all structural steel works and bar bending schedules for all RCC works

p. Breaking and making good the existing roads; pipe/electrical/instrumentation cable crossings etc.

q. Dismantling of existing masonry, concrete and steel structures, road, fence & otherrelated civil structures.

s. As built drawings / documents of all station.

t. For scope of other Civil Structural works, Pipeline, Instrumentation, Mechanical and Electrical scope of works shall also be referred to.

u. Any other civil and structural works required/directed by Engineer-in-charge for thesatisfactory and successful completion of the project shall be included in the lump sumcost and at no extra cost to the owner.

FACILITIES ENVISAGED AT STATIONS

Generally, Part or All the following facilities are to be developed at Stations

a. Foundation for equipment's like (Skids, Pig Launcher and Receiver, Pig Trolley).

b. Development / extension of process area,roads, foot path, boundary wall, Chain Link Fencing, cable trenches & pipe sleepers etc.

c. Pipe / valve supports, crossovers & valve operating platforms

d. Dismantling of existing masonry, concrete and steel structures, road, fence & other related civil structure whenever required.

All items in the S.O.R. shall be inclusive of all material, labour, constructional infrastructures like scaffolding/ staging, finishing, cleaning, cutting chases/holes etc. in brick work/ RCC work and making good the same and rectification of any damaged work shall be applicable for all heights and locations.

The Contractor shall obtain all necessary approvals from statutory authorities such as factory inspector, tariff advisory committee (TAC), local municipal or development authorities for the design and construction.

The procurement and supply of all materials, consumablesand non-consumables, and hardware etc. including necessary tools and tackles required for satisfactory completion of the job shall be the responsibility of Contractor within the quoted rates.

Note:- For all free issue material, Installation, Erection, Inter-connection with mainline, inter connection with skid component, required Civil foundation and Structural work, Loading and Unloading from GAIL store location to site, crane and other accessories required for successful commissioning shall be in contractor's scope.

4.5 ELECTRICAL WORKS

The scope of work shall include Design, residual engineering, Sizing, Supply, Installation, Field inspection, testing and commissioning of all electrical installation including all equipment / items:

- Design, Supply, installation, testing and commissioning of outdoor lighting fixtures, lighting control DB's, light poles, Wiring/cabling, Solar Light fixtures, Glanding & terminations,wiring for outdoor lightings etc. complete in all respects.

- Design, Supply, installation, testing and commissioning of for Hazardous area outdoor lighting fixtures, lighting control DB's, light poles, Wiring/cabling,Glanding & terminations for outdoor lighting fixtures complete in all respects suitable for Hazardous area.

- Design, Supply, installation, testing and commissioning of all earthing system at Station, comprising of copper plate & GI Pipe earth electrodes, Copper & GI strip, Lugs, connection wires of all Electrical, instrumentation/communication equipment, metering skid, piping, gate etc to the earth grid.

- Design, Supply, laying (in trenches, buried cable trenches, pipes, road crossings, pipe-racks etc). & termination of all Control & power cables (all incoming & all Outgoing feeders) as per cable schedules, & directions of engineer-in-charge, as per attached standards and recommended practices.

- Design, Supply, installation, testing and commissioning of all other items required to complete the job and hand over a fully functional system of the Works described in SOW/SOR are included in the scope of supply of the Contractor.

- Only Main equipment's estimated quantities are indicated in SOR. Unit rates quoted against each SOR item shall be applicable for any addition items required to complete the job also included in scope of works.

- Any modification/rectification required in existing Electrical power system/panels/DB's to complete the new job also included in scope of works.

- Providing as built documentation for all work done including old systems where any integration has been done. All documentation to be provided as printed documents and computer files compatible with MS Office and AutoCAD.

- All materials shall be approved by GAIL or its authorized representative before use by the Contractor**.**

- Any other works not specifically listed herein but required for completion of the works in all respects.

4.6 CATHODIC PROTECTION

Scope is including Design, Engineering, supply, installation, field inspection, testing, commissioning of TCP & PCP system.

- Preparation of Design package of TCP and PCP.

- Issued for Construction drawings and documents and As-built drawings and documents.

- Supply, installation, pre-commissioning and commissioning and monitoring TCP/PCP till handover to owner.

- Checking and Mitigation of any AC/DC interferences on pipeline.

- TCP/PCP of Pipeline as applicable as per approved design document during detailed engineering.

- All equipment and materials including cables, CPTR/CPPSM units, various types of test stations, junction boxes, anodes, grounding equipment/items/anodes, polarization cells, polarization, coupons, surge diverters, spark gap arrestors, bonding stations along with diodes, shunts and variable resistors etc. as required for Temporary cathodic protection & Permanent cathodic protection system of pipelines in line with standard specification, design basis and datasheet are included in the scope of supply of the contractor.

- Installation, Commissioning & monitoring of TCP till commissioning of PCP for main pipeline.

- Post commissioning surveys as per defined in standard specifications of Cathodic Protection system.

- Pipeline is passing through many foreign lines & other utilities either parallel or diagonal, CP interferences shall be mitigated in permanent measures.

- Any other work not specifically mentioned above, but required for the proper execution of the cathodic protection.

4.7 INSTRUMENTATION WORKS

The scope of work & supply shall generally be as follows, however Contractor to The scope of work & supply shall generally be as follows, however contractor to provide all materials/instrumentation, install & commission them as per P&IDs and other data provided in tender to complete the work in all respects.

- Supply, installation, testing and commissioning of field instruments as per P&IDs, Data sheets, Technical standard / specs.

- Installation of valve junction boxes for actuated valves followed by testing and commissioning of actuated valves;

- Installation and commissioning of free issue instruments and systems such as metering panel (flow computer panel), in field or in control room;

- Supply, installation, testing and commissioning of gas detectors;

- Supply, installation and commissioning of Telemetry Interface Cabinet (TIC) inclusive of supply of serial communication cable to interface with GAIL SCADA at respective terminal;
- Supply, laying and termination of I&C cables between field instruments, detectors, valves JBs and respective cabinet in control room complete with glanding, termination, ferruling, dressing etc. at both ends and commissioning assistance;

- Supply, laying and termination of I&C cables from skid JB to metering panel and /or GC panel/TIC and metering panel and /or GC panel to RTU complete with glanding, termination, ferruling, dressing etc. at both ends and commissioning assistance;

- Making of cable trench (if applicable), complete with excavation, restoration of trench, supply and installation of sand, suitable tiles/bricks, warning tapes, concrete cable markers, pipes at all the crossings etc.;

- Grouting of skid, arrangement of nitrogen cylinders (for skid testing), PSV testing (through authorized agency);

- Supply of Fire fighting system i.e. fire extinguishers as per PNGRB / OISD requirement.

- Installation, Testing and commissioning of USM/RPD/Turbine type check flow metering skid (free issue by GAIL) consisting of filtration, metering, pressure reduction, gas chromatograph and flow control valve;

- Preparation of design documents, procedures, manuals, drawings etc. as required;

- Preparation of Material Take-off (MTO) for the entire system other than those materials supplied by Company shall be including at all the terminals;

- As-built drawings and final documents etc.

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

5. CONTRACTOR'S RESPONSIBILITIES

Contractor's responsibilities, besides the scope of work to be performed by him defined earlier, shall also include the following:

a. Appraisal and taking cognizance of site-conditions, pipeline route, Central Government,Maharashtra State Government rules and regulations/ bye-laws, applicable Indian Standards and Codes, authorities having jurisdiction over the work site(s), environmental and pollution concerns including conditions/ stipulations laid down by the concerned authorities etc. The Contractor is deemed to have recognized any restrictive

features and constraints of the site(s), pipeline route and /or specific requirements of the work and madedue allowance for it in the work to be performed by him.

b. Company shall provide the available information and survey data along pipeline route and crossings. Company gives no guarantee or warranty as to the accuracy or completeness of the information provided. It is the Contractor's sole responsibility to obtain sufficient information / data along pipeline route and crossings to allow safe and sound design and installation of the proposed pipeline. Wherever company's survey Alignment & crossing drawings are not available, Contractor shall survey for Pipeline Alignment & all crossings and collects all information to submit in the form of Pipeline Alignment and crossing drawings as per engineering standards. Contractor also carryout Topographic and soil investigation survey for the terminal plot within 7 days from LOI date and submit to company for finalisation of Plot Plan and foundation drawings to start the construction work.

c. Interpretation and verification of data/information furnished by Company in respect of pipeline route surveys, crossing details, contained in the bid package. Any additional information/data/surveys etc. required by Contractor for detailed engineering and execution of the works shall be obtained by him. Company may assist him in obtaining such information/ data by issuing recommendatory letters.

d. Residual engineering including drawings and installation procedures,engineering for procurement & fabrication, engineering for installation including drawings,QA/QC procedures, etc performed by the Contractor shall be reviewed and approved by Company. Contractor shall submit engineering documents, drawings, procedures in hard copy to Company before start of construction work at site. All works shall be executed based on approved documents only.

Contractor shall prepare general arrangement drawing, isometric drawing & bill of materials, HDD design & drawing, Crossing drawings, Pipeline Alignment sheet including detour portion(wherever applicable), Topography & Geotechnical survey, CP design, vendor engineering drawing & documents etc. and submit the same from Owner/ consultant's approval/ record. Contractor shall prepare drawing for utilities line as required as per SOR and submit the same for Owner/ Consultant's approval /record.

e. Provide office and office support services/facilities for Company's Personnel at Contractor's design office for residual design review and approval of documents as per the requirement of the bid package.

f. Review and approval of Contractor's entire work(s) or approved IFC drawing provided by Company shall in no way relieve the Contractor of his sole responsibility for safe and efficient design, engineering, installation and subsequent operation of pipeline system.

g. Furnishing and mobilizing at site(s) of all construction equipment, manpower, tools and tackles, construction spreads, fully equipped and fully manned with other required support facilities etc. commensurate for spreads needed for successful execution of the works.

h. Contractor shall depute independent third-party inspector for carrying out radiographic inspection/ UT and interpretation of radiograph/ UT of welds. Third party inspector shall be approved by Company.

i. Pre-commissioning/ commissioning of entire pipeline/piping system.

j. Preparing and furnishing calculation books, pipe books, material/ purchase requisitions, final purchase orders including specifications, Vendor's data books (including Guarantees),

fabrication and construction drawings, all survey reports, inspection and testing reports, as-built records for all phases of work.

k. The Contractor is cautioned to exercise extreme care and take necessary precautions to prevent damage to the existing pipeline(s), facilities, electrical and other cables during execution of the entire works. Restoration/reconstruction of all structures/ facilities affected during pipeline construction shall be carried out by Contractor.

l. Wherever Contractor comes across water lines/open channels/drains in the fields used for cultivation, suitable arrangements similar to or higher specs than the existing type shall be made by the Contractor for ensuring water supplies across the fields and maintain the same till construction is completed in that stretch. Any claims arising out of noncompliance to the above requirements, as granted by competent authorities shall be to Contractor's account.

m. Contractor shall carry out all testing and inspection of materials, equipment etc. in independent testing institutions, laboratories, if so desired by Company.

n. Disposal and treatment of treated hydro-testing water, excavated materials, surplus materials etc. as per local authority's requirements.

o. All works shall be carried out by Contractor strictly in accordance with the drawings/documents/specifications indicated in the list of attachment document.

p. Any other work not specifically listed but required for successful completion of entire pipeline system.

- **AS BUILT DOCUMENT**

On successful completion of hydrostatic testing, the Contractor shall prepare As Built drawings / reports for entire pipeline/piping system as specified in scope of work. All "As Built" drawings / reports shall be submitted as below.

a. Main Pipeline

- As laid alignment sheets and crossing drawings/details.
- As built HDD crossing details, as applicable.
- All Inspection, Testing and NDT records. Radiographs/ UT of all weld joints packed kilometre wise in separate card board boxes in one set.
- Pipe and calculation books/records.
- All WPS and WQT
- All NOC from authority
- All inspection & testing documents.
- All purchase specification & procurement documents.

b. Dispatch/SV-2 and Receiving Stations etc.

- All piping GA drawings and supports at terminals.
- All piping line history sheets
- Installation and testing reports.
- All Test reports, IRN's for procured materials

- All purchase specification and procurement documents.

After completion of construction & commissioning of Terminal, contractor shall incorporate All the correction in drawings, prepare and issue all the “As-built drawings“ to the owner as final submission of drawings.

- For Mainline, pipeline alignment sheet, all X-ing details, all CP drawings, pipe book etc
- For Terminal, P &ID, layout drawing, Piping GAD, Isometric, all electrical and instrumentation drawings, all civil drawings.

For final submission only 4 sets of document plus the original transparencies shall be handed over by the contractor. Any construction done by the contractor without duly approved by the drawings shall be wholly at risk and cost Contractor shall also submit soft copy of pipe book in excel along with hard copy. Soft copy of all as-built drawings shall be also submitted in AutoCAD. Videography/ photograph of all major activities/ milestone achieved shall also be arranged and submitted by the contractor. For details of documentation to be submitted for mainline and terminal refer “Specification for pipeline construction” enclosed elsewhere with tender.

GAIL INDIA LIMITED

CONSTRUCTION OF STEEL PIPELINE AND ASSOCIATED FACILITIES ON LMC TO M/S CARBORUNDUM UNIVERSAL LTD., HOSUR

VOLUME II OF II (TECHNICAL) – B

PROCESS

E-TENDER REF :

(BID DOCUMENT NO - 034/LEPL/GAIL/15-R0)

Lyons Engineering Pvt. Ltd.

PMC:	DCI For LMC to M/s Carborundum Universal Ltd.	Doc No.	CLIENT:
		GAIL-ENG-GN-DOC-DL-001	
		Rev. 0	

Sr. No.	Description	Document / Drawing No.	Rev. No.
B	**PROCESS**		
	P&ID		
i)	P&ID Legend Sheet	GAIL-ENG-PR-DWG-PID-001	0
ii)	P&ID for Despatch station(LMC to M/s Carborundum Universal Ltd.)	GAIL-034054-PR-DWG-003	0
iii)	P&ID for Receiving station(LMC to M/s Carborundum Universal Ltd.)	GAIL-034054-PR-DWG-004	0
	SCHEMATIC DIAGRAM		
iv)	Schematic Layout(LMC to M/s Carborundum Universal Ltd.)	GAIL-034054-PL-DWG-002	0

SYMBOLS

PIPING VALVES

- PRESSURE SAFETY VALVE(PSV)
- INDICATES FLANGED VALVE (TYPICAL FOR ALL TYPES)
- INDICATES SCREWED OR SOCKET WELD VALVE (TYPICAL FOR ALL TYPES)
- BALL VALVE (FULL BORE)
- NC — NORMALLY CLOSED BALL VALVE
- CHECK VALVE
- AUTOMATIC RECIRCULATION VALVE
- GATE VALVE
- GLOBE VALVE
- PLUG VALVE
- NEEDLE VALVE
- BUTTERFLY VALVE
- MANUAL THREE WAY VALVE

ACTUATED VALVES

- GOV/SV — GAS OVER OIL ACTUATED VALVE
- HOV — HYDRAULIC ACTUATED VALVE
- GEAR/LEVER OPERATED VALVE
- PRESS.REDUCING REGULATOR (FLANGED)
- BACK PRESSURE REGULATOR (FLANGED)
- CONTROL VALVE (FLANGED) PNEUMATIC ACTUATOR WITH POSITIONER
- CONTROL VALVE (FLANGED) PNEUMATIC ACTUATOR WITH POSITIONER WITH HANDWHEEL
- SOLENOID VALVE
- INLET SIZE, INCHES
- ORIFICE CODE, LETTER
- OUTLET SIZE, INCHES
- SET PRESS. Barg
- PSV
- TAG NO.

PIPE FITTINGS

- 'T' TYPE STRAINER
- 'Y' TYPE STRAINER
- TS — TEMPERORY STRAINER
- CONE TYPE STRAINER
- BASKET TYPE STRAINER
- FILTER
- ANCHOR BLOCK
- SPACE/SLIP BLIND
- SPECTACLE BLIND (CLOSED)
- SPECTACLE BLIND (OPEN)
- REDUCER (CONCENTRIC)
- REDUCER (ECCENTRIC)
- CAP (THREADED OR SOCKETWELD)
- PLUG (THREADED OR SOCKETWELD)
- UNION
- INSULATING FLANGES
- HOSE CONNECTION
- BLIND FLANGE
- PIPE CAP
- SWAGE NOZZLE
- ANCHOR FLANGE

PIPE COMPONENTS

- FLAME ARRESTOR
- RESTRICTION ORRIFICE
- VENT FLAPPER
- EXPANSION JOINT
- FLEXIBLE HOSE
- SPOOL PIECE
- INSULATING JOINT
- FLOW TEE

MISCELLANEOUS

- SLOPE
- TP — TIE–IN POINT
- XXX — SPEC. BREAK
- XXX — CONTINUATION SYMBOL XXX = DRAWING NUMBER

LINE SYMBOLS

- PROCESS LINE
- UTILITY / SECONDARY LINE
- EXISTING
- MATCH, VENDOR & SKID LINE
- CONN. TO PROCESS MECHANICAL LINK OR INSTRUMENT SUPPLY
- DATA BUS
- GUIDED ELECTROMAGNETIC/ SONIC/OPTICAL SIGNAL
- INSULATED LINES/EQUIPMENT
- SOFTLINK OR DATA LINK
- PNEUMATIC SIGNAL LINE
- HYDRAULIC SIGNAL LINE
- WIRELESS SIGNAL
- ELECTRICAL SIGNAL LINE
- CAPILARY TUBING
- B — BURIED PIPELINE
- ELECTRIC HEAT TRACED LINE
- VENDOR LIMIT

INSTRUMENT SYMBOL

- LOGIC IN SCADA
- CONTROLLER
- ESD — EMERGENCY SHUTDOWN LOGIC
- SP — SPECIALITY ITEM
- PSE — RUPTURE DISC FOR PRESSURE RELIEF
- PSE — RUPTURE DISC FOR VACUUM RELIEF
- PSE — TURBINE METER
- HS — HAND SWITCH
- R — LOCAL RESET
- I — INTERLOCK
- E — ESD INTERLOCK
- AVAILABLE IN CONTROL ROOM
- TURBINE METER
- ORIFICE METER
- FE — PD METER
- FE — VORTEX METER
- FE — ANNUBAR OR PITOT TUBE
- FE — ULTRASONIC FLOW METER
- FE — AVERAGING PITOT
- FE — CORIOLIS METER
- FE — CALIBRATED METER RUN WITH QUICK CHANGE FITTING
- PI — PRESSURE INSTRUMENT WITH INTEGRAL DOUBLE BLOCK & BLEED
- INSTRUMENT CONNECTION WITH DIAPHRAGM SEAL
- INSTRUMENT CONNECTION WITH DIAPHRAGM SEAL AND BLEED CONNECTION
- FE — FLOW ELEMENT (ORIFICE) c/w PLATE
- FQI — FLOW INTEGRATING INDICATOR
- FI — FLOW INDICATOR (ROTAMETER TYPE)
- RO — RESTRICTION ORIFICE c/w PLATE
- SY — SOLENOID VALVE ATTACHED TO ACTUATOR

GENERAL ABBREVIATION

- HOV – HAND OPERATED VALVE
- GOV – GAS OVER OIL ACTUATED VALVE
- LTCS– LOW TEMPERATURE CARBON STEEL
- AG – ABOVE GROUND
- UG – UNDER GROUND
- BDV – BLOW DOWN VALVE
- BL – BATTERY LIMIT
- BV – BALL VALVE
- GV – GLOBE VALVE
- ESD – EMERGENCY SHUT DOWN VALVE
- FB – FULL BORE
- FC – FAIL CLOSED
- FO – FAIL OPEN
- FL – FAIL LOCKED (LAST POSITION)
- GS – GAS SUPPLY (INSTRUMENT)
- IDB – INTERMEDIATE DOUBLE BLOCK & BLEED
- ISBL – INSIDE BATTERY LIMIT
- OSBL– OUTSIDE BATTERY LIMIT
- LC – LOCKED CLOSED
- LO – LOCKED OPEN
- NC – NORMALLY CLOSED
- NO – NORMALLY OPEN
- OWS – OILY WATER SEWER
- PB – PUSH BUTTON
- HS – HAND SWITCH
- PCV – PRESSURE CONTROL VALVE
- RTU – REMOTE TELEMETRY UNIT
- SDV – SHUT DOWN VALVE
- SOV – SOLENOID VALVE
- SV – SECTIONALIZING VALVE(GOV–UNDER GROUND)
- TOP – TAP–OFF POINT
- UC – UTILITY CONECTION
- VAC – VACCUM
- VF – VENDOR FURNISHED
- XXL – PIG SIGNALLER ALARM (SIGNAL TO LOCAL PANEL/RTU)
- XXS – PIG SIGNALLER INDICATOR
- ZSH – POSITION SWITCH OPEN
- ZSL – POSITION SWITCH CLOSED
- GDPE – POINT TYPE GAS DETECTOR ELEMENT
- GDOE – OPEN PATH TYPE GAS DETECTOR ELEMENT

EQUIPMENT SYMBOL

PIG LAUNCHER/RECEIVER

PRESSURE INSTRUMENTS

- PG – PRESSURE GAUGE
- PT – PRESSURE TRANSMITTER
- PI – PRESSURE INDICATOR
- PR – PRESSURE RECORDER
- PIC – PRESSURE INDICATOR CONTROLLER
- PS – PRESSURE SWITCH
- PA – PRESSURE ALARM
- DPG – DIFFERENTIAL PRESSURE GAUGE
- DPT – DIFFERENTIAL PRESSURE TRANSMITTER
- DPI – DIFFERENTIAL PRESSURE INDICATOR
- DPIC – DIFFERENTIAL PRESSURE INDICATOR CONTROLLER
- DPR – DIFFERENTIAL PRESSURE RECORDER
- DPV – DIFFERENTIAL PRESSURE CONTROL VALVE
- PV – PRESSURE CONTROL VALVE
- PCV – SELF ACTUATED PRESSURE REGULATOR
- DG – DRAFT GAUGE
- PSV – PRESSURE SAFETY VALVE
- CRV – CREEP RELIEF/SAFETY VALVE
- DPSH – DIFFERENTIAL PRESSURE SWITCH HIGH

FUNCTIONAL SYMBOLS

- FIELD MOUNTED INSTRUMENT
- LOCAL PANEL INSTRUMENT
- REAR LOCAL PANEL INSTRUMENT
- CENTRAL PANEL MOUNTED INSTRUMENT
- REAR CENTRAL PANEL MOUNTED INSTRUMENT
- I — INTERLOCK FUNCTION
- RUNNING LIGHT (LOCAL)
- RUNNING LIGHT (CENTRAL PANEL)
- INDICATING LIGHT MOUNTED ON LOCAL PANEL (LOCAL CONTROL PANEL)
- RUNNING LIGHT (SCADA)
- RTU — REMOTE TELEMETRY UNIT
- DIAPHRAGM
- PROCESS CONTROL SHARED DISPLAY INSTRUMENTATION (SCADA)
- SHARED DISPLAY DEVICES WITH, LIMITED ACCESS TO ADJUSTMENTS LOCATED IN FEILD.
- AUXILLIARY OPERATORS INTERFACE DEVICE FOR EXAMPLE, BACK UP CONTROLLER OR MANUALSTATION.
- COMPUTER COMPONENTS NOT ACCESSIBLE TO OPERATOR LIKE I/O INTERFACE, BLIND CONTROLLER OR A SOFTWARE CALCULATION BOX.
- INDICATOR/CONTROLLER/RECORDER OR ALARM NORMALLY ACCESSIBLE TO OPERATOR THROUGH 'VIDEO DISPLAY'
- AUXIALLARY COMPUTER COMPONENT NORMALLY ACCESSIBLE TO OPERATOR
- SEQUENCTIAL LOGIC CONTROL LIMITED ACCESS TO OPERATOR.
- SEQUENCTIAL LOGIC CONTROL ACCESSIBLE TO OPERATOR.

TEMPERATURE INSTRUMENTS

- TG – TEMPERATURE GAUGE
- TI – TEMPERATURE INDICATOR
- TR – TEMPERTURE RECORDER
- TE – TEMPERATURE ELEMENT
- TIC – TEMPERATURE INDICATOR CONTROLLER
- DTIC – DIFFERENTIAL TEMPERATURE INDICATING CONTROLLER
- DTI – DIFFERENTIAL TEMPERATURE INDICATING
- D TR– DIFFERENTIAL TEMPERATURE RECORDER
- T JI – MULTIPOINT TEMPERATURE INDICATOR
- T JR– MULTIPOINT TEMPERATURE RECORDER
- TW – THERMOWELL
- TA – TEMPERATURE ALARM
- TCV – TEMPERATURE CONTROL VALVE
- TT – TEMPERATURE TRANSMITER
- FCV – FLOW CONTROL VALVE

LINE SERVICE IDENTIFICATION

- D – DRAIN
- CI – CHEMICAL INJECTION
- DW – DRINKING WATER
- FL – FLARE
- FW – FIRE WATER
- NG – NATURAL GAS
- N – NITROGEN
- OD – OPEN DRAIN
- PR – PRESSURE RELIEF
- V – VENT

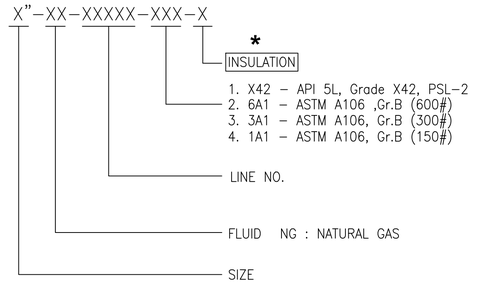
REV.	DATE	REVISION	BY	CHKD	APPD.
0	14.01.19	ISSUED FOR TENDER	VKS	MM	UNU

CLIENT : GAIL (INDIA) LIMITED

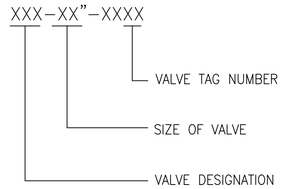
PMC: LYONS ENGINEERING PVT. LTD. NEW DELHI

TITLE:	P&ID LEGEND SHEET		
SIZE:	A2	DRAWING NO.	REV.
SCALE:	NTS	GAIL–ENG–PR–DWG–PID–001	0
SHEET:	1 OF 2		

LINE IDENTIFICATION

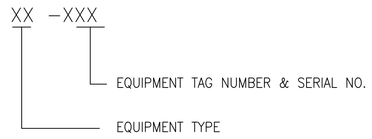


VALVE NOMENCLATURE



VALVE DESIGNATION

EQUIPMENT NOMENCLATURE



EQUIPMENT DESIGNATION

PL – PIG LAUNCHER
PR – PIG RECEIVER
FL – FILTER
H – HEATER

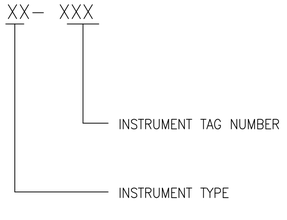
IDENTIFICATION LETTERS

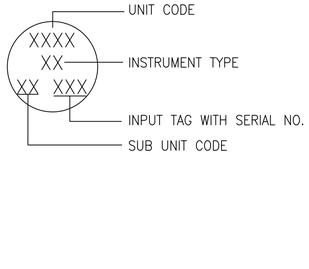
	FIRST LETTER				
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION				
C	–			CONTROL	
D	DENSITY	DIFFERENTIAL			
E	VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F	FLOW RATE	RATIO (FRACTION)			
G	–		GLASS VIEWING DEVICE		HIGH
H	HAND				
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	–	MOMENTARY			MIDDLE INTERMEDIATE
N	–				
O	–				
P	PRESSURE, VACUUM		ORIFICE, RESTRICTION, OPERATED		
Q	QUANTITY	INTEGRATE. TOTALIZE	POINT (TEST) CONNECTION		
R	RADIATION				
S	SPEED, FREQUENCY	SAFETY	RECORD	SWITCH	SELECTOR
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE VIBRATION. MECHANICAL		MULIFUNCTION	MULIFUNCTION	MULTIFUNCTION
V	ANALYSIS			VALVE, DAMPER LOUVER	
W	WEIGHT, FORCE				
X	UNCLASSIFIED	X AXIS	WELL	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT. STATE OR PRESENCE	Y AXIS	UNCLASSIFIED	RELAY, COMPUTE CONVERT	
Z	POSITION, DIMENSION	Z AXIS		DRIVER, ACTUATOR UNCLASSIFIED FINALCONTROL ELEMENT	

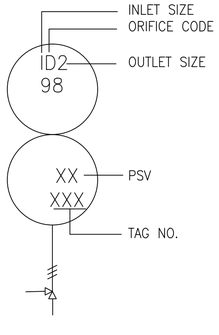
* INSULATION

C – COLD
H – HOT
A – ANTI FREEZE
PP – PERSONAL PROTECTION
N – NON–INSULATION
P – PAINTED
U – UNDERGROUND

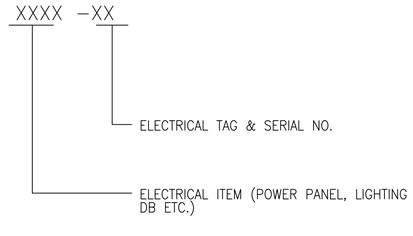
INSTRUMENT NOMENCLATURE







ELECTRICAL NOMENCLATURE



REV.	DATE	REVISION	BY	CHKD	APPD.
0	14.01.19	ISSUED FOR TENDER	VKS	MM	UNU

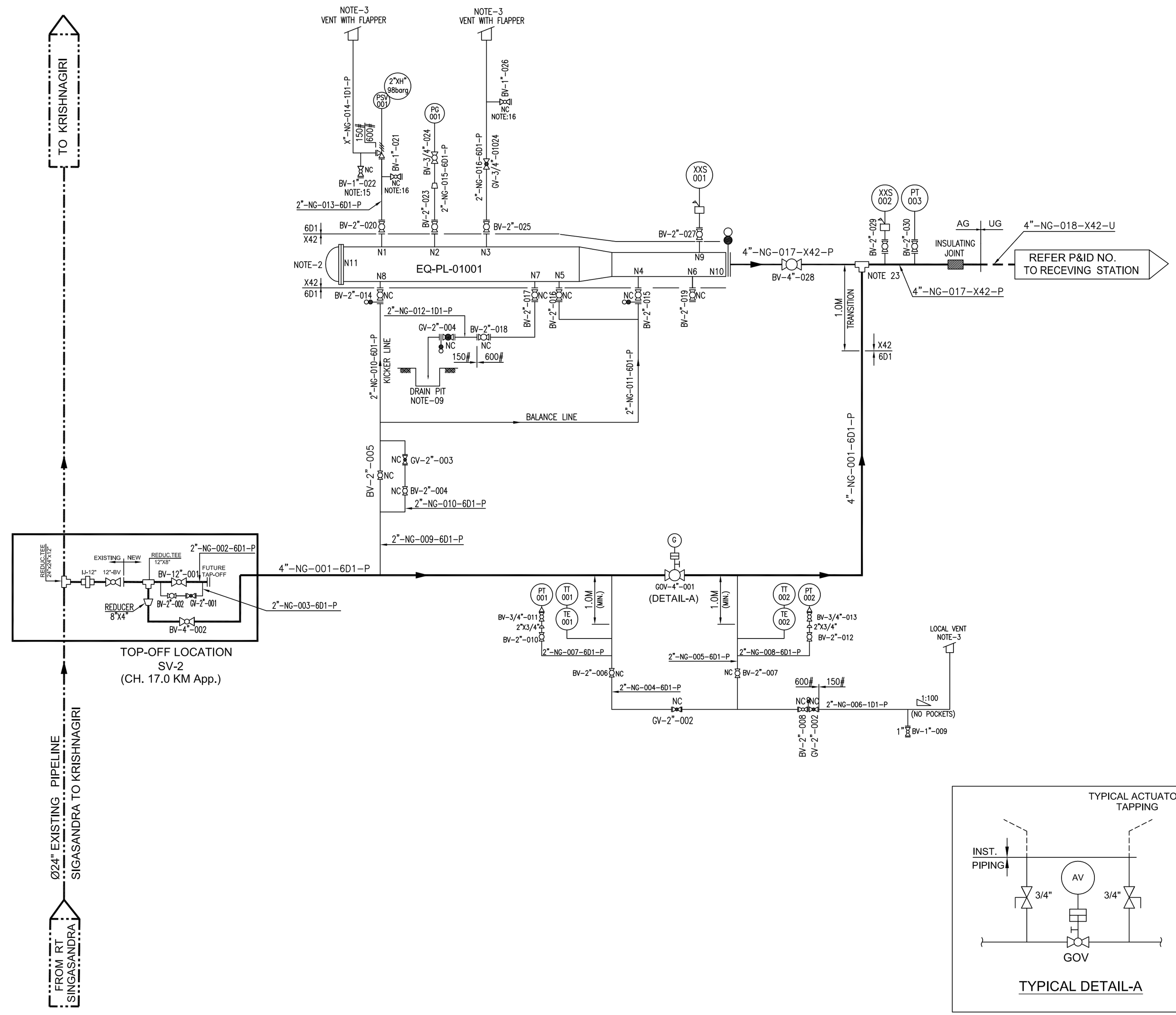
CLIENT: GAIL (INDIA) LIMITED

EC: LYONS ENGINEERING PVT. LTD.
NEW DELHI

TITLE: P&ID LEGEND SHEET

SIZE:	A2	DRAWING NO.	REV.
SCALE:	NTS	GAIL–ENG–PR–DWG–PID–001	0
SHEET:	2 OF 2		

EQ-PL-01001
(PIG LAUNCHER)
DESIGN PRESSURE: 92 Kg/cm2g



NOTES:-

1. GAS OVER OIL ACTAUTED VALVE (GOV) SHALL BE PROVIDED.
2. QUICK OPENING END CLOSURE ON THE DOOR.
3. ALL VENT LINES SHALL BE HAVE ELEVATION 3 METERS FROM THE HIGHEST OPERATING PLATFORM OR NEARBY STRUCTURE WITHIN 15 METERS WHICHEVER IS HIGHER NON SPARKING (BRASS)& FLAPPER TYPE VENT CONNECTION SHALL BE PROVIDED.
4. ANY OTHER INSALLATION IS REQUIRED TO ISOLATE THE INSTRUMENTS & CABLES FROM MAINLINE CP SYSTEM TO BE SUITABLY CONSIDERED & PROVIDED BY CONTRACTOR.
5. DURING ACTUAL CONSTRUCTION AT SITE, CONTRACTOR SHALL TAKE CARE TO DESIGNATE THE TAG NOS.(INST,VALVE ETC.) & LINE NOS. AS PER THIS P&ID.
6. PIG SIGNALER SHOULD BE SUITABLE FOR BI-DIRECTIONAL FLOW.
7. PSV OUTLET SHALL BE CONFIRMED AFTER FINALIZATION OF PSV SIZE BY CONTRACTOR.
8. ALL PT,TT & GOV Etc. SHOULD BE CONNECTED TO RTU.
09. LAUNCHER DRAIN SHALL BE AS PER EXTENDED & OPENED IN DRAIN (1.0X1.0X1.0 MTS) WITH CHEQUER PLATE .
10. STATION PIPING MATERIAL SHALL BE AS PER PIPING MATERIAL SPECIFICATION.
11. PIG LAUNCHER SHALL BE SUITABLE FOR CALIPER & INTELLIGENT PIGGING.
12. DRAIN PIT SHALL BE COVERED UNDER HAZARDOUS ZONE-1, GROUP-II A/B.
13. ALL MAINLINE AND STATION PIPELINE4" SHALL BE API 5L GR X42.
14. THE PIG INDICATOR (INTRUSIVE TYPE) WITH POTENTIAL FREE CONTACT SHALL BE SUPPLIED WITH SCRAPPER PACKAGE.
15. LOW POINT DRAIN SHALL BE PROVIDED ON DEPRESSURIZATION LINE AT MIN. DISTANCE FROM RISER PIPE OF VENT.
16. ALL BALL VALVES SHALL BE FULL BORE VALVES.
17. VALVES UP TO 4" SHALL BE LEVER OPERATED TYPE & ABOVE 4" SHALL BE GEAR OPERATED TYPE.
18. METERING SKID + PRS SHALL BE FREE ISSUE BY GAIL(INDIA).
19. TEMPERATURE GAUGE (TG) - SKIN TYPE.

LEGENDS:-

- ACTUATED VALVE
- FLANGED GLOBE VALVE (GV)
- FLANGED BALL VALVE (BV)
- BUTT WELDED GLOBE VALVE (GV)
- BUTT WELDED BALL VALVE (BV)
- SOCKET WELDED BALL VALVE
- FLANGED NON-RETURN VALVE (NRV)
- INSULATING JOINT
- ABOVE GROUND PIPELINE
- UNDER GROUND PIPELINE
- EXISTING PIPELINE

TYPICAL DETAIL-A

REV.	DATE	DESCRIPTION	PREP.	CHKD.	APPD.
0	30.11.19	ISSUED FOR BID	VKS	SR	TR

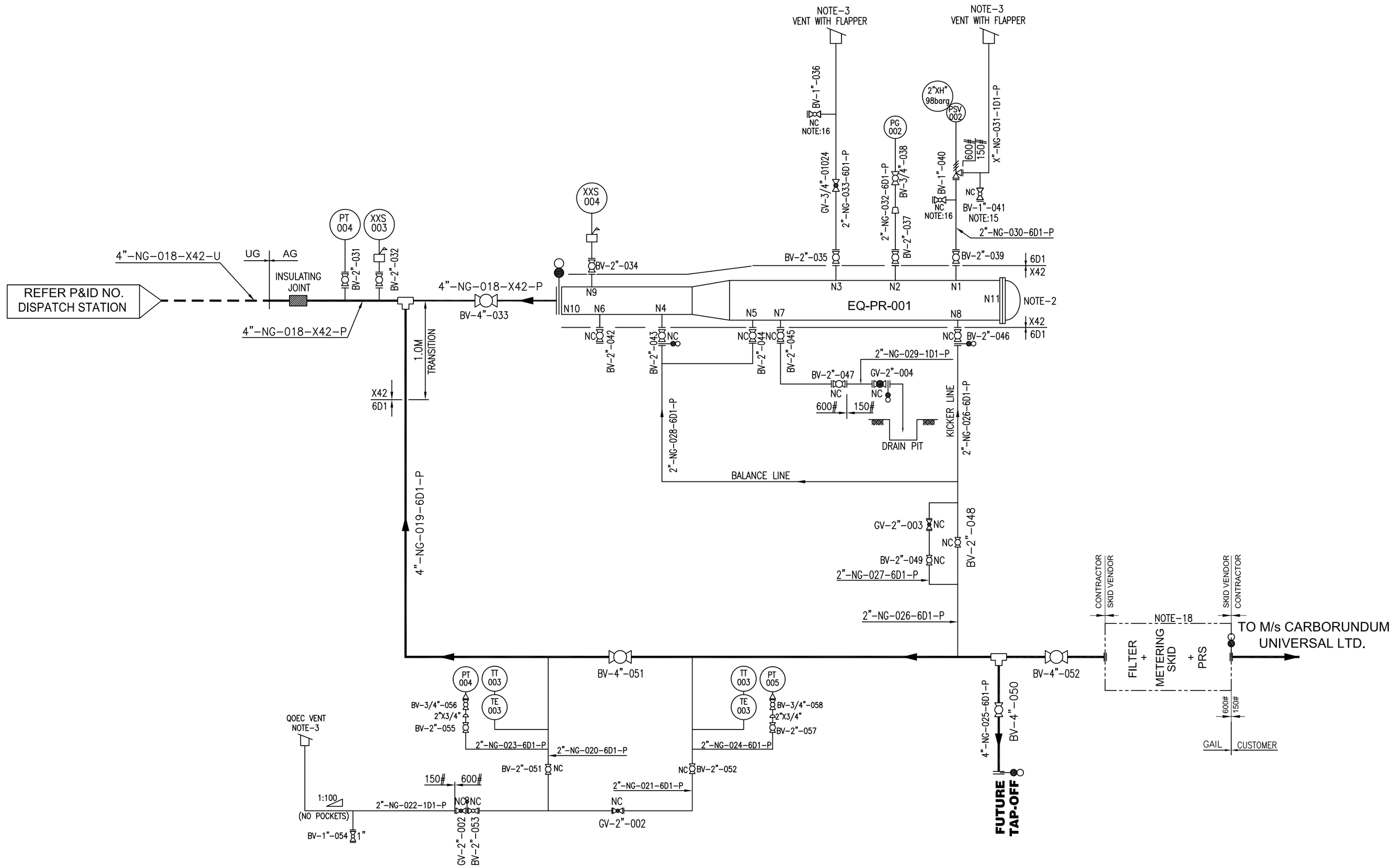
CLIENT: GAIL (INDIA) LIMITED

PMC: LYONS ENGINEERING PVT. LTD.

PROJECT: LMC TO MS CARBORUNDUM UNIVERSAL LTD. AT KRISHNAGIRI, TAMILNADU

SCALE	TITLE: P & ID FOR DISPATCH TERMINAL (LMC TO MS CARBORUNDUM UNIVERSAL LTD.)			
N.T.S.				
SIZE	JOB NO.	DRAWING NUMBER	SHEET	REV.
A2	034	GAIL-034054-PR-DWG-003	1 OF 1	0

EQ-PL-01001
(PIG LAUNCHER)
DESIGN PRESSURE: 92 Kg/cm2g



NOTES:-

1. GAS OVER OIL ACTAUTED VALVE (GOV) SHALL BE PROVIDED.
2. QUICK OPENING END CLOSURE ON THE DOOR.
3. ALL VENT LINES SHALL BE HAVE ELEVATION 3 METERS FROM THE HIGHEST OPERATING PLATFORM OR NEARBY STRUCTURE WITHIN 15 METERS WHICHEVER IS HIGHER NON SPARKING (BRASS)& FLAPPER TYPE VENT CONNECTION SHALL BE PROVIDED.
4. ANY OTHER INSALLATION IS REQUIRED TO ISOLATE THE INSTRUMENTS & CABLES FROM MAINLINE CP SYSTEM TO BE SUITABLY CONSIDERED & PROVIDED BY CONTRACTOR.
5. DURING ACTUAL CONSTRUCTION AT SITE, CONTRACTOR SHALL TAKE CARE TO DESIGNATE THE TAG NOS.(INST,VALVE ETC.) & LINE NOS. AS PER THIS P&ID.
6. PIG SIGNALER SHOULD BE SUITABLE FOR BI-DIRECTIONAL FLOW.
7. PSV OUTLET SHALL BE CONFIRMED AFTER FINALIZATION OF PSV SIZE BY CONTRACTOR.
8. ALL PT,TT & GOV Etc. SHOULD BE CONNECTED TO RTU.
09. LAUNCHER DRAIN SHALL BE AS PER EXTENDED & OPENED IN DRAIN (1.0X1.0X1.0 MTS) WITH CHEQUER PLATE .
10. STATION PIPING MATERIAL SHALL BE AS PER PIPING MATERIAL SPECIFICATION.
11. PIG LAUNCHER SHALL BE SUITABLE FOR CALIPER & INTELLIGENT PIGGING.
12. DRAIN PIT SHALL BE COVERED UNDER HAZARDOUS ZONE-1, GROUP-II A/B.
13. ALL MAINLINE AND STATION PIPELINE4" SHALL BE API 5L GR X42.
14. THE PIG INDICATOR (INTRUSIVE TYPE) WITH POTENTIAL FREE CONTACT SHALL BE SUPPLIED WITH SCRAPPER PACKAGE.
15. LOW POINT DRAIN SHALL BE PROVIDED ON DEPRESSURIZATION LINE AT MIN. DISTANCE FROM RISER PIPE OF VENT.
16. ALL BALL VALVES SHALL BE FULL BORE VALVES.
17. VALVES UP TO 4" SHALL BE LEVER OPERATED TYPE & ABOVE 4" SHALL BE GEAR OPERATED TYPE.
18. METERING SKID + PRS SHALL BE FREE ISSUE BY GAIL(INDIA).
19. TEMPERATURE GAUGE (TG) - SKIN TYPE.

LEGENDS:-

- FLANGED GLOBE VALVE (GV)
- FLANGED BALL VALVE (BV)
- BUTT WELDED GLOBE VALVE (GV)
- BUTT WELDED BALL VALVE (BV)
- SOCKET WELDED BALL VALVE
- FLANGED NON-RETURN VALVE (NRV)
- INSULATING JOINT
- ABOVE GROUND PIPELINE
- UNDER GROUND PIPELINE

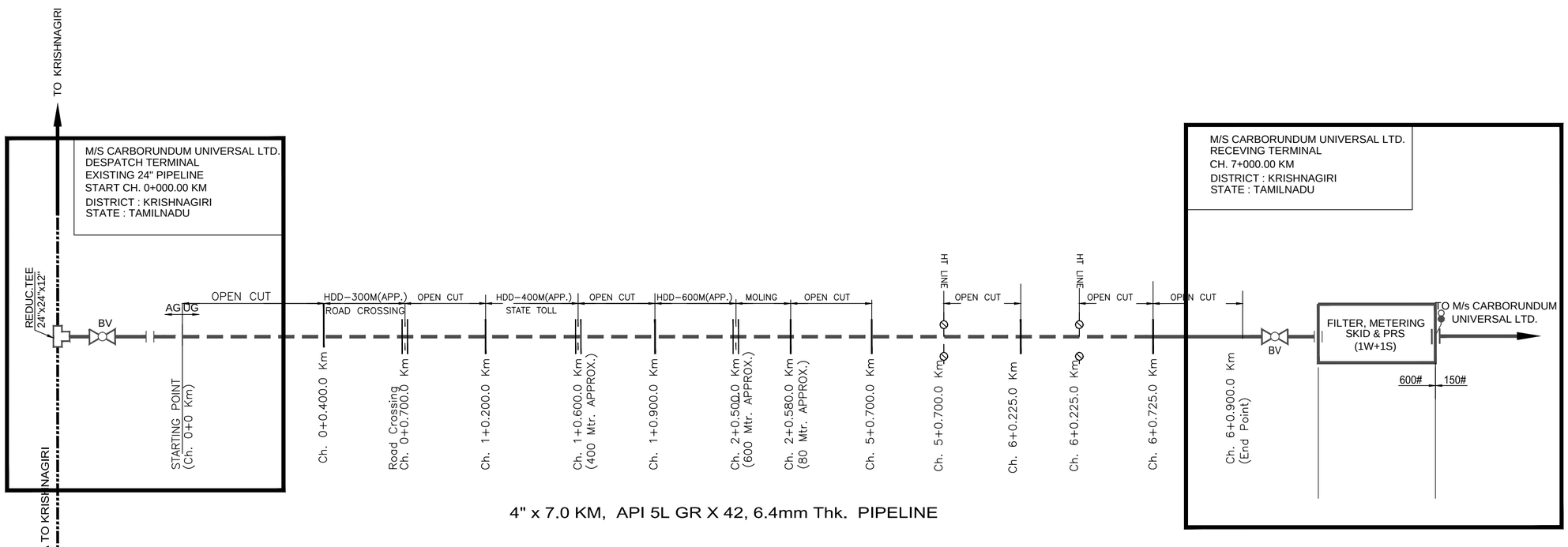
REV.	DATE	DESCRIPTION	PREP.	CHKD.	APPD.
0	30.11.19	ISSUED FOR BID	VKS	SR	TR

CLIENT: GAIL (INDIA) LIMITED

PMC: LYONS ENGINEERING PVT. LTD.

PROJECT: LMC TO MS CARBORUNDUM UNIVERSAL LTD.
AT KRISHNAGIRI, TAMILNADU

SCALE	TITLE: P&ID FOR RECEIVING STATION (LMC TO MS MS CARBORUNDUM UNIVERSAL LTD.)			
N.T.S.				
SIZE	JOB NO.	DRAWING NUMBER	SHEET	REV.
A2	034	GAIL-034054-PR-DWG-004	1 OF 1	0



NOTES

1. SURVEY PLAN HAS BEEN PREPARED AS PER THE JOINTLY SITE VISIT DONE BY GAIL & LEPL.

LEGEND:-

- ROAD CROSING
- HT (POWER LINE) CROSING
- EXISTING LINE
- UNDER GROUND (UG)
- ABOVE GROUND (AG)
- FLOW DIRECTION

GAS PIPELINE DETAILS	
PIPELINE SIZE	4"
DESIGN PRESSURE	92 kg/cm2g
MATERIAL	API 5L GR.X 42
WALL THIKNESS	6.4mm
EXTERNAL COATING	3LPE COATED
PIPELINE LENGTH	7.0 KM

PIPELINE SURVEY DETAILS :			
S.No.	Item Description	Total Qty.	Remarks
1.	HDD in RM	1300 Mtr.	
2.	HDD in Nos.	07 Nos.	
3.	Moling	80 Mtrs.	
4.	H.T Line Crossing	02 Nos.	
5.	Open Cut	5470 Mtrs.	

REV.	DATE	DESCRIPTION	PREP.	CHKD.	APPD.
0	10.12.19	ISSUED FOR REVIEW	VKS	SR	TR

CLIENT: GAIL (INDIA) LIMITED.

CONSULTANT: LYONS ENGINEERING PVT. LTD.

PROJECT: LMC TO MS CARBORUNDUM UNIVERSAL LTD. AT KRISHNAGIRI, TAMILNADU

SCALE	TITLE			
N.T.S.	PIPELINE ROUTE SURVEY PLAN			
SIZE	**JOB NO.**	**DRAWING NUMBER**	**SHEET**	**REV.**
A1	034	GAIL-034025-STD-DWG-001	1 OF 1	0

GAIL INDIA LIMITED

CONSTRUCTION OF STEEL PIPELINE AND ASSOCIATED FACILITIES ON LMC TO M/S CARBORUNDUM UNIVERSAL LTD., HOSUR

VOLUME II OF II (TECHNICAL) – C

PIPELINE

E-TENDER REF :

(BID DOCUMENT NO - 034/LEPL/GAIL/15-R0)

Lyons Engineering Pvt. Ltd.

PMC:	DCI For LMC to M/s Carborundum Universal Ltd.		CLIENT:
C	**PIPELINE**		
Sr. No.	**Description**	**Document / Drawing No.**	**Rev. No.**
1	Pipeline Design Basis	GAIL-STD-PL-DOC-DB-001	0
	TECHNICAL SPECIFICATION - PIPELINE		
2	Technical Specification for onshore pipeline construction	GAIL-STD-PL-DOC-TS-001	0
3	Technical Specification for onshore pipeline welding for Gas Transportation	GAIL-STD-PL-DOC-TS-002	0
4	Technical Specification for Concrete Weight Coating.	GAIL-STD-PL-DOC-TS-003	0
5	Technical Specification for pipeline crossing, rail, road and minor water ways	GAIL-STD-PL-DOC-TS-004	0
6	Technical Specification for field joint coating	GAIL-STD-PL-DOC-TS-005	0
7	Technical Specification for Casing Insulators and Casing End Seals.	GAIL-STD-PL-DOC-TS-006	0
8	Technical Specification for Long Radius Bends	GAIL-STD-PL-DOC-TS-007	0
9	Technical Specification for Inspection and Testing of Production Weld.	GAIL-STD-PL-DOC-TS-008	0
10	Technical Specification for Drying and Cleaning of Pipes.	GAIL-STD-PL-DOC-TS-009	0
11	Technical Specification for Major Crossing by Horizontal Directional Drilling.	GAIL-STD-PL-DOC-TS-010	0
12	Technical Specification for Pipeline Markers	GAIL-STD-PL-DOC-TS-011	0
13	Technical Specification for Hydro testing of pipelines	GAIL-STD-PL-DOC-TS-012	0
14	Technical Specification for Caliper Pigging	GAIL-STD-PL-DOC-TS-013	0
15	Technical Specification for Intelligent Pigging	GAIL-STD-PL-DOC-TS-014	0
16	Technical Specification for Documentation of Pipeline Construction	GAIL-STD-PL-DOC-TS-015	0
17	Technical Specification for pre-commissioning & Commissioning	GAIL-STD-PL-DOC-TS-016	0
18	Technical Specification for ERW Line Pipe	GAIL-STD-PL-DOC-TS-017	0
19	Technical Specification for 3LPE Coating for Line Pipe	GAIL-STD-PL-DOC-TS-018	0
20	Technical Specification for major water crossing (conventional trenching)	GAIL-STD-PL-DOC-TS-019	0
21	Assorted Valve	GAIL-STD-PL-DOC-TS-020	0
	STANDARD DRAWING - PIPELINE		
22	Pipeline Symbols	GAIL-STD-PL-DWG-TP-001	0
23	Topographical Symbols	GAIL-STD-PL-DWG-TP-002	0
24	Overhead Power Line Crossing	GAIL-STD-PL-DWG-TP-003	0
25	Typical Existing Pipeline Crossing	GAIL-STD-PL-DWG-TP-004	0
26	Rain Cap	GAIL-STD-PL-DWG-TP-006	0
27	Cased Crossing Pipeline - Road / Highway	GAIL-STD-PL-DWG-TP-007	0
28	Typical Trench Details	GAIL-STD-PL-DWG-TP-008	0
29	ROU for Forest Area	GAIL-STD-PL-DWG-TP-009	0
30	Pipe Line Warning Sign	GAIL-STD-PL-DWG-TP-010	0
31	Direction Marker	GAIL-STD-PL-DWG-TP-011	0
32	Typical Right of Use for Pipeline	GAIL-STD-PL-DWG-TP-012	0
33	Typical KM Post Markers	GAIL-STD-PL-DWG-TP-013	0
34	Test Station with Foundation Details	GAIL-STD-PL-DWG-TP-014	0
35	Areial Marker	GAIL-STD-PL-DWG-TP-015	0
36	Navigabale Waterway Pipeline Crossing Warning Sign	GAIL-STD-PL-DWG-TP-016	0
37	Typical ROW Boundary Marker	GAIL-STD-PL-DWG-TP-017	0
38	Detail of Casing Vent and Drain	GAIL-STD-PL-DWG-TP-018	0
39	Typical Waterway Crossing (Open Cut)	GAIL-STD-PL-DWG-TP-019	0
40	Cased Crossing Pipeline - Canal	GAIL-STD-PL-DWG-TP-020	0
41	Typical Slope Braeker Details	GAIL-STD-PL-DWG-TP-021	0
42	Bank Protection Details for Water Crossing	GAIL-STD-PL-DWG-TP-022	0
43	Typical Details for Railway Crossing	GAIL-STD-PL-DWG-TP-023	0
44	Trench Dimensions and Cohesionless Select Backfill for Pipeline Seismic Zone	GAIL-STD-PL-DWG-TP-024	0
45	Protection Detail at Hilly Terrain	GAIL-STD-PL-DWG-TP-026	0
46	Typical cross section for ROU preparation in hill areas	GAIL-STD-PL-DWG-TP-027	0
47	Existing Underground Pipe Crossing	GAIL-STD-PL-DWG-TP-028	0
48	Underground Cable Crossing	GAIL-STD-PL-DWG-TP-029	0
49	Casing Pipe Details	GAIL-STD-PL-DWG-TP-031	0
50	Typical Road Crossing (Open Cut)	GAIL-STD-PL-DWG-TP-032	0
51	Typical Details of Canal Crossing (Open Cut)	GAIL-STD-PL-DWG-TP-033	0

PMC:	DCI For LMC to M/s Carborundum Universal Ltd.		CLIENT:
52	Typical Concrete Slab Details for Mechanical Protection	GAIL-STD-PL-DWG-TP-034	0
53	Typical HDD River Crossing Showing Max. Scour Level & Min. Cover for Pipe	GAIL-STD-PL-DWG-TP-035	0
54	Typical Temperature Connections Details	GAIL-STD-PL-DWG-TP-036	0
55	Typical Pressure Connections Details	GAIL-STD-PL-DWG-TP-037	0
56	Typical Drawing For U-Clamp Support	GAIL-STD-PL-DWG-TP-038	0
57	Typical Drawing for Supportive Arrangement for Angle & Relief Valves	GAIL-STD-PL-DWG-TP-039	0

ENGINEERING STANDARD

GAIL INDIA LIMITED

PIPELINE DESIGN BASIS

GAIL-STD-PL-DOC-DB-001

0	24.11.19	Issued for Bid	SR	TR	SB	
Rev	**Date**	**Purpose**	**Prepared By**	**Checked By**	**Approved By**	

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6.0	**DESIGNDATA**
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ANNEXURE-A	**LISTOFCODESANDSTANDARDS**

1.0 INTRODUCTION

GAIL (India) Limited, is India's flagship Natural Gas company, integrating all aspects of the Natural Gas value chain and its related services. In a rapidly changing scenario, GAIL is spearheading the move to a new era of clean fuel industrialization, creating a quadrilateral of green energy corridors that connect major consumption center in India with major Gas Fields, LNG terminals and other cross border gas sourcing points. GAIL is also expanding its business to become a player in the International Market. M/s. GAIL (India) Limited envisages to strengthen local gas grid network in various parts of India.

M/s GAIL (India) Ltd. proposes to cater to the demand of M/s Carborendum Universal Ltd., Lyons Engineering Private Limited has been appointed as Engineering Consultant by GAIL for the project.

2.0 SCOPE

This document establishes minimum design parameters and basis for design and detailed engineering of the Pipeline and Associated facilities covered under this project as defined briefly here in below.

3.0 DESIGN CODES AND STANDARDS

Pipelines and terminal facilities envisaged shall be designed and engineered primarily in accordance with the provisions of the latest edition of Code ASME B 31.8: Gas Transmission and Distribution Piping Systems and OISD 226: Natural Gas Transmission Pipelines and City Gas Distribution Networks and PNGRB guidelines. In addition, requirements, as applicable to gas service of following codes /standards shall be complied with.

OISD Std.138	Inspection of Cross Country Pipelines-Onshore
ASME B31.3	Chemical Plant & Petroleum Refinery Piping
API Std.1102	Steel Pipeline Crossing Railways & Highways
API Std.1104	Standard for Welding Pipelines and Related Facilities
ISO 13623	Petroleum & natural gas industries–Pipeline transportation systems
PNGRB	Petroleum &Natural Gas Regulatory Board

In addition to above, codes and standards listed in Annexure-A shall also be referred.

In case of conflict between the requirements of ASMEB31.8/ OISD226 and other codes/ Standards referred above, requirement of ASMEB31.8/ OISD226 shall govern. In case of conflict between requirements of B31.8/ OISD226 and this document, requirements of this document shall govern.

4.0 DESCRIPTION OF FACILITIES

Details of facilities shall be as per P&ID's, process design basis, datasheets, line schedule etc. covered in the process package.

The typical pipeline facilities envisaged as a part Work of LMC are given at the end of this document as Enclosures

4.1 Dispatch Station

Facilities at Dispatch Station are Pig launcher complete with associated piping with Blow down Facility for Depressurizing the Pipeline.

4.2 Main Pipeline

Pipeline facilities are schematically indicated in Schematic attached with tender.

4.3 Receiving Station

Facilities at Receiving Station for the Pipeline shall consist of Pig Receiver complete with associated piping, Filtering, PRS in and Metering Skid, Blowdown Facility for Depressurizing.

4.5 Other Intermediate Installations

5.0 PIPELINE ROUTE

5.1 Pipeline Route &Terrain Details

Most of the areas the Pipeline shall be laid along the road and residential area. The ROU shall be restricted in all along the pipeline Route. Most route comes under either in Class III or Class IV.

6.0 DESIGN DATA

6.1 pipeline shall be designed for conditions as follows:

Max.DesignTemperature,0 C i. Above ground section ii. Underground section	-29 to 65.0 -29 to 60.0
Operating temperature, °C	7 to 35
Economic Design Life, years	35
Corrosion Allowance, mm	0

All terminal facilities (equipment and associated piping) shall be designed for design and operating conditions given in the process package.

7.0 PIPELINE AND ASSOCIATED FACILITIES DESIGN

7.1 General

Pipeline and pipeline stations to be installed as a part of this project shall be designed and engineered in accordance with the standards/ codes referred in section 3.0 of this document.

7.2 Pipeline

7.2.1 Pipeline shall be designed in accordance with requirements of ASME B 31.8 and OISD 226 & PNGRB guidelines. The pipeline shall with stand all installation, testing and operating condition/ loads. All

necessary calculations shall be carried out to verify structural integrity and stability of the pipeline for the combined effect of pressure, temperature, bending (elastic), soil/ pipe interaction, external loads and other environment al parameters as applicable during all phases of work from installation to operation. Allowable stress limit shall be as per ASME B 31.8. Such calculations shall include, but are not limited to following:

- Buoyancy control and stability analysis for pipeline section to be installed in areas subjected to flooding/ submergence. Unless specified, specific gravity of installation in such area shall be at least 1.2.
- Stress analysis at crossing of rail and high way etc.
- Crossing analysis of rivers by HDD as applicable.
- Pipeline expansion and its effect on station piping (above ground/ below ground).

7.2.2 Pipeline shall also be checked for adequacy against anticipated earthquake loading and any special measures such as increase in wall thickness/ grade/ select back fill etc. as required to ensure safety and integrity of the pipeline system shall be implemented.

7.2.3 Main line shall be provided with pigging facilities (wherever specified) suitable for handling all types of pigs including intelligent pigs.

7.2.4 Pipeline and its associated facilities shall be designed using the applicable design code and as modified below.

The pipeline shall be designed to meet the Location Class as defined in ASME B 31.8, except as modified below.

Location Class	Type of Facility	Design Factor
All	Station Piping	0.5
Class1	River/ Stream Crossings	
	•Drilled/ Bored/ Inaccessible/open cut	0.6
	•Others	0.72
	•HDD	0.5
	Cased/ Uncased Crossings or Parallel Encroachments on ROW of Hard Surfaced Roads, Public Streets and Highways	0.6
	Rail Crossings	0.5
	River/ Stream Crossings	
	•Drilled/ Bored/ In accessible/ open cut	0.5
	•Others	0.6

Class2	•HDD	0.5
	Cased/ Uncased Crossings or Parallel Encroachments on ROW of Hard Surfaced Roads, Public Streets and Highways	0.5
	Rail Crossings	0.5
Class3	All	0.5
Class4	All	0.4

7.3 Station Piping

7.3.1 Station piping to be provided at all stations shall be designed in accordance with OISD226/ ASME B 31.8 and utility piping (if required) to be provided at these locations shall be designed in accordance with the provisions of ASME B 31.3.

7.3.2 All piping shall be designed for combined effects of pressure, weight and temperature during operating conditions without over stressing the piping, valves or equipment. All piping shall be adequately supported, guided or anchored so as to prevent un due vibration, deflection or loads on connected equipment such as filters, meters etc.

7.4 Materials

Pipeline and its appurtenances shall be provided with carbon steel materials suitable for the intendedservice, as detailed in subsequent paragraphs

7.4.1 Line pipe for mainline

Line pipe shall conform to API 5L and Company specifications. Type of line pipe to be used shall be EW/ HFW/ Seamless/ LSAW/ HSAW. Line pipe size, material grade shall be as per wall thickness calculation for that particular class and Zone.

7.4.2 Other Materials

All other materials and equipment's including scraper traps (if required), flow tees, insulating joints, ball valves, plug valves, globe valves, check valves, pig signaler's, flanges and fittings shall be carbon steel suitable for the service conditions and shall be compatible with the line pipe material.

7.5 External/ Internal corrosion coating

7.5.1 Pipeline to be installed below ground shall be protected against external corrosion by a combination of high integrity externally applied coatings and permanent impressed cathodic protection system. Externally applied coating shall be three layer side extruded poly ethylene coating.

7.5.2 In addition, pipeline shall be provided with minimum 40 micron thick liquid epoxy internal coatingconforming to ISO 15741/ API RP 5L2.

7.5.3 All above ground piping and structures shall be painted to prevent atmospheric corrosion. Painting of above ground piping and structures shall be as per SSPC-SP-10, P-6 and F-6 shall be provided suitable for mention temperature application as per company specification enclosed with the bid document. Application

thickness shall be as per painting Specification GAIL-STD-PI-DOC-TS-004. Painting shall be suitable for normal corrosive environment/ corrosive environment, as applicable, as defined in Painting Specification for all stations and terminals.

7.6 Insulating joints

Insulating joints shall be provided to electrically isolate the buried pipeline from above ground pipeline. Insulating joints shall be monolithic type and shall allow smooth passage of pigs. Insulating joints shall be installed in above ground portion of the pipeline, immediately after the buried/ above ground transition at the scraper stations.

Wherever pressure/ temperature transmitters are used on cathodically protective pipeline the same shall be electrically isolated by providing insulating joints/ flanges.

7.7 Pipeline Burial

The pipeline shall be buried normally to depth of 1.0 meter below natural ground level except river/ rail/ road/ canal/ waterways crossing where minimum cover shall be as given below or as per the requirements of statutory/ local authorities whichever is more stringent. Increased cover shall be provided at critical locations and crossings.

Sl. No.	Location	Minimum Cover(m) (refernote1)
1.0	Industrial, commercial and residential area	1.0
2.0	Flat terrain	1.0
3.0	Minor water crossing/ canal/ drain/ nala/ waterways	1.5
4.0	HDD crossing of canals(below bed)	2.5
5.0	River crossings for which scour depth is defined (below scour)	1.5
6.0	Other River/ water crossings(Below Bed)	2.5(For normal soil) 1.5(For rocky strata)
7.0	Cased/ uncased road crossing	1.2
8.0	Cased railway crossing	1.7
9.0	Drainage, ditches at roads/railway crossings	1.2
10.0	Marshy land /Creek area	2.5

Note:-1

Additional soil cover other than specified above shall be provided at locations indicated by statutory/ local authorities or in areas likely to have an increased risk of impact damage or third party interference as per agreements between COMPANY and authorities. Incase, any privatewelling, industrial building or place of public assembly falls within 15m of pipeline, additional cover of minimum 300mm shall be provided over and above the cover indicated in the above table.

7.8 Marshy Areas/ Areas Prone to Flooding

Wherever marshy areas/ areas prone to flooding are encountered along the pipeline route, pipeline shall be provided with anti-buoyancy measures viz. continuous concrete coating/ Geo textile gravel filled bags. Unless specified otherwise in AFC drawings, specific gravity of installation in such areas shall be at least1.2.

7.9 Pipeline in common ROW

The location of new underground pipeline, when running parallel to an existing underground pipeline in same ROU/ ROW shall be laid at minimum clear distance of 5.0m from the existing underground pipeline. This distance may be reduced to 3.0m after assessment of construction methodology which do not result in unsafe conditions during construction.

7.10 Back filling

In normal cross-country areas, the pipeline trench shall be back filled with excavated soil. Select rock fill/ slope breakers shall be provided in the trench in steep areas (slope generally 10% and more) to prevent erosion. In case of rivers/ water bodies prone to scour and erosion, the safety cover shall be provided below the predicted scour level. In addition to the cover, anti-buoyancy measures (concrete coating) shall be provided at river crossings.

Contractor shall keep top 150mm of excavated top soft soil (free of gravels) a side, which shall be back filled in the end as top layer.

Select back fill shall be provided at approaches to terminal up to transition point (below ground/ above ground) inside terminal.

Select back fill shall also be provided as applicable for areas prone to seismic activity.

In rocky/ pebbles, marram areas, the trench bottom shall have sand/ soft soil padding of 150mm. After laying of pipeline, sand/ soft soil padding shall be placed around and on top of the pipe so that thickness of compacted padding on top of pipe corrosion coating shall be at least 150mm.

Disposal of debris and surplus material to designated disposal areas or designated place(s), as the case may be and as directed by Engineer-in-charge shall be carried out.

8.0 OTHER TECHNICAL REQUIREMENTS

8.1 Scraper Stations (whenever required)

Scraper traps shall be provided at the Dispatch & Receiving terminals. The scraper traps shall be capable of handling intelligent pigs and other cleaning pigs. The launching and receiving barrels shall be designed in accordance with the requirements of ASME B 31.8 and it send closure shall be designed and fabricated according to ASME Section VIII, Div.1. Adequate arrangements for launching, retraction, handling and lifting of cleaning and instrumented pigs shall be provided at the scraper stations. Traps shall be accessible by

walkway/ road for movement of equipment, pigs etc. These stations shall be provided with access road from the nearest metaled road.

Corrosion resistant coating shall be provided on the pipeline up to a minimum length of 500mm after it comes above ground/ before it gets buried underground at terminals and scraper stations.

The diameter of barrel of the launcher cum receiver shall be three nominal sizes larger than the pipeline nominal size. Center line elevation of scraper trap shall be at suitable height from grade level. Suitable arrangements shall be provided for handling &lifting of pigs.

The piping system at the terminals and intermediate stations shall be designed to have sufficient flexibility to prevent pressure and thermal expansion or contraction from causing excessive stresses on the connected equipment. The piping shall be designed/ fabricated as defined in clause 8.3.

As far as possible, pipeline expansion shall be absorbed by allowing the scraper traps to move on supports. Installation of anchor block in the underground pipeline is not permitted. If required adequate length of trench in approaches to stations shall be provided with a select back fill to ensure flexibility.

8.2 Piping

8.2.1 General

This section describes the design requirements of piping applicable for Dispatch station, intermediate pigging stations, sectionalizing valve stations and receiving station.

All piping and equipment shall be designed as per ASME B 31.8. All piping materials shall be as per Piping Material Specification (PMS).

Utility piping (if required) to be provided shall be designed in accordance with the provisions of ASME B 31.3.

Design shall provide consideration for all loadings like weight, temperature etc., significantly affecting the pipe material stresses in addition to fluid pressure.

8.2.2 Piping flexibility/ stress analysis

All piping shall be designed for thermal expansion under start up, operating and shut down conditions without over stressing the piping, valves or equipment. Provisions for expansion shall normally be made with bends and off sets.

All piping shall be adequately supported, guided or anchored so as to prevent un due vibration, deflection or loads on connected equipments. Equipment's/ valves requiring periodical maintenance shall be supported in such away that the valves and equipment can be removed with minimum temporary pipe supports.

8.2.3 Piping layout

-Piping will be located above-ground wherever possible within the terminals.

-Piping shall be designed considering skin temperature of piping material under empty conditions as 65ºC or design temperature of pipeline whichever is higher.

-Piping stress analysis shall be carried out to determine allowable pipe movement and support requirements wherever felt necessary.

-Buried piping inside the terminal area will have a minimum depth of cover of 1.2m.

-Where buried pipes come out of the ground, the underground coating on the pipe will continue for a distance of 500mm above ground.

- Platforms, crossovers shall be provided for ease of operation and maintenance.

- Painting above ground piping and structures shall be as per specifications

8.3 Welding

Welding shall be carried out in accordance with API 1104, specification for welding. Butt welds shall be 100% radiographed/ for all pipelines.

8.4 Hydrostatic Testing

After installation, the entire pipeline system shall be hydrotested with inhibited water. The water shall tested, as applicable prior to using for hydrotesting. The minimum hydrostatic pressure in any section shall be as per ASME B 31.8 for gaseous hydrocarbon pipelines. The maximum hydrostatic test pressure at any location of the pipeline shall not exceed the pressure required to produce a hoop stress equal to 90% of SMYS of the pipe material based on minimum wall thickness in the test section. The test duration shall be minimum 24 hours. Hydrostatic testing of terminals shall be carried out separately. Terminals as well as other intermediate facilities shall be tested at 1.5 times the design pressure. The test duration shall be 6 hours. Main line valves shall be installed after successful completion of hydrotesting.

8.5 Dewatering and swabbing

Dewatering, swabbing and pre-commissioning operations shall be carried out after hydrotesting and prior to commissioning of the pipeline as per Project specifications. Swabbing shall be carried out prior to installation of sectionalizing valves. After swabbing operation the pipeline sections shall be dried.

8.6 Crossings

8.6.1 Water Crossings

All water crossing shall be installed by open cut or may be crossed by Horizontal Directional Drilling (HDD)/ Micro Tunneling method. The requirement shall be finalized at site based on permission available and as advised by Engineer In-Charge.

8.6.2 Rail Crossing

Pipeline at rail crossings shall be provided with casing pipe. The casing pipe shall be three nominal pipe sizes larger than carrier pipe (unless advised otherwise by concerned authorities) and shall be installed by boring/ jacking. The rail crossing shall comply with the requirements of API 1102 and Indian Railway Authorities. The crossing angle shall be as close to 90º as possible. It should be noted that the extent of casing pipe generally specified by Railway sis 14.0m beyond center line of the outer most tracks on either side or 0.6meter beyond the ROU limits of Railways on either side, whichever is more. Carrier pipe shall be electrically insulated from the casing pipe and casing ends shall be sealed using durable, electrically non-conducting materials. The crossing drawing shall be subject to approval of concerned Railway Authorities prior to implementation.

8.6.3 Road Crossing

Road crossings shall comply with the requirements of API 1102 and the requirements of the concerned road authorities. Unless otherwise required by concerned Authorities, casing pipe shall not be used. However at national highway road crossings pipeline shall be provided with casing pipe, which shall extend min. 600mm

beyond Road ROW on either side. The casing pipe shall be installed by trenchless method like ramming/ boring/ jacking/ Micro Tunneling. Provision of casing at locations other than national highways shall be decided based on type of road crossing and as per requirements of local authorities if necessary. The casing pipe shall be three nominal pipe sizes larger than carrier pipe. The crossing angle shall be as close to 90º as possible. Casing insulators and end seals shall be provided to ensure electrical isolation of carrier pipe and casing pipe.

8.6.4 **Existing Pipeline Crossing/ Other utility Crossing**

The specific requirements of Owner/ operator of existing pipeline shall generally be followed. The minimum clearance between the lines shall be 500mm unless specified otherwise. A Concrete slab shall be provided 300mm above the new Pipeline or below in case new Pipeline is laid above existing utilities. In both the cases, the cover over Pipeline shall not anyway less the requirements

8.7 Valves

8.7.1 Application of various types of valves shall be as follows:

Valve type	Typical application
Globe	Throttling
Ball	On/off, Isolation (on mainline)
Plug	On/off, Isolation (in the terminals)
Check	Uni-directional flow

All pipeline valves shall comply with the requirements of API 6D/ relevant PMS. In order to minimize potential leak sources, valves used in mainline shall be with butt-weld ends. Valve installed within the terminal to isolate the mainline/ pipeline shall also be provided with butt welding ends. However terminal valves shall be flanged ends. Flanges may be used where frequent access or removal of equipment is required.

Wherever underground valves are provided, valves shall be provided with a stem extension in such away that the center line of the rim of the hand wheel on a horizontal shaft or centre of power actuators approximately 1.0m above the finished ground level.
Minimum size of any tapping from the underground pipeline shall be 2" NB and shall be provided with an isolation ball valve located at a minimum distance from the pipeline.

8.8 Branch Connections

All branch connections or side tap on the piggable lines wherever the branch line diameter is approx. 40% or more of the mainline size, shall be provided with flow tees to enable smooth passage of all types of pigs. Flow tees for this purpose shall have an internal pipe housed in a tee.

8.9 Pipeline Bends

In order to accommodate changes in vertical and horizontal alignment in piggable section of pipeline, elastic bends/ cold field bends/ hot formed long radius bends shall be used. Miter bends shall not be used for change in direction. Minimum bend radius shall be as follows:

Minimum Bend Radius			
Pipeline	Cold Field Bend Radius	LR Bend Radius	Remarks
4”	R=30D	R=6D	For Non-piggable lines 3D LR bend
8”	R=30D	R=6D	
12”	R=30D	R=6D	May be used

8.10 Pig Signaler’s (Whenever Required)

8.10.1 Pig signalers shall be installed as a minimum at the following locations:

Down stream of Pig launcher, & up stream of Pig Receiver &One location on the line.

8.10.2 Pig signaler shall be with trigger mechanism, suitable for maintenance with pipeline under operating pressure.

8.11 Specifications

All procurement of materials shall be as per Piping Material Specification (PMS) and specifications indicated in PMS.

ANNEXURE-A

LIST OF CODES AND STANDARDS

In addition to the codes/ standards mentioned in Para3.0, the latest edition of the below listed equivalent codes and standards shall also be used for design of proposed pipeline. The listing includes, but is not limited to, the following:

1. Line Pipes

API 5L	Specification for line pipe
API 5L1	Recommended practice for railroad transportation of line pipe
API 5LW	Recommended practice for transportation of line pipe on barges and marine vessels

2. Valves

API 6D	Specification for pipe line valves (Steel Gate, Plug, Ball and Check Valves)
API 602	Compact Steel Gate Valves-Flanged, Threaded, Welding & Extended body ends
ASTM A694	Forgings, Carbon & Alloy steel for Pipe Flanges, Fittings, Valves & parts for High Pressure Transmission Service.
MSS-SP-6	Finishes for Contact Faces of connecting End Flanges of Ferrous Valves and Fittings.
MSS-SP-25	Standard Marking System for Valves, Fittings & Unions
BS 5351	Steel Ball Valves for the Petroleum, Petrochemical and Allied Industries

2. Flanges & Fittings

MSS-SP-44	Steel Pipeline Flanges
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI 16.20	Ring-joint Gaskets & Grooves for Steel Pipe Flanges
ASTM A105	Forgings, Carbon Steel for Piping Components
ASTM A193	Carbon & Alloy Steel Bolts & Studs for High Temperature Service
API 601	Standards for Metallic Gaskets for Raised-Face Pipe Flanges & Flanged Connections
ANSI B16.9	Factory Made Wrought Steel Butt Welding Fittings
ANSI B16.11	Forged Fittings, Socket Welded & Threaded
ANSI B16.26	Butt Welding Ends
ASTM A234	Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures

ASTM A694	Forgings, Carbon & Alloy Steel for Pipe Flanges, Fittings, Valves & Parts for High Pressure Transmission Service.
MSS-SP-75	Specification for High Test Wrought Butt Welding Fittings
MSS-SP-97	Integrally Reinforced Forced Branch Outlet Fittings – Socket Welding, Threaded and Butt Welding Ends.
PFI-ES-24	Pipe Bending Methods, Tolerances, Processes & Material Requirements

4. Testing & Welding

ANSI/AWS D1.1	Structural Steel Welding
API 1104	Standard for Welding Pipelines and Related Facilities
AWS A3.0	Welding Terms and Definitions
AWS A5.1	Welding Electrodes
AWS A5.5	Specification for Low Alloy Steel Covered Arc Welding Electrodes
ASTM E165	Liquid Dye Penetrant Inspection of Pipeline Welds
ASTM A370	Standard Methods and Definitions for Mechanical Testing of Steel Products.
ASTM E18	Standard Hardness Test for Metals
ASTM E23	Standard for Impact Test for Metals
ASTM E84	Standard Test Method for Micro-hardness of Metals
ASTM E92	Standard Test Method for Vickers Hardness of Metallic Materials
ASTM E110	Standard Test Method Indentation Hardness for Metallic Materials by Portable Hardness Testers
ASTM E709	Standard Guides for Magnetic Particle Examination
MSS-SP-53	Quality Standard for Steel Casting & Forging-Magnetic Particle Method
MSS-SP-54	Quality Standard for Steel Casting & Forging-Radiographic Examination
MSS-SP-55	Quality Standard for Steel Castings & Forgings-Visual Method.

5. Surface Preparation, Painting and Coating

SIS-05-59	Pictorial Surface Preparation Standards for Painting Steel Surfaces
SSPC-SP-01	Solvent Cleaning
SSPC-SP-03	Power Tool Cleaning
SSPC-SP-05	Joint Surface Preparation Standard: White Metal Blast Cleaning

SSPC-SP10	Structural Steel Painting Council – Joint Surface
NACE No.2	Preparation Standard - Near-White Metal Blast Cleaning
SSPC-PA-02	Measurement of Dry Paint Thickness and Magnetic Gauges
ASTM E12	Measurement of Pipeline Dry Film Coating Thickness
ASTM-G6	Abrasion Resistance of Pipeline Coating
ASTM G8	Cathodic Disbonding of Pipeline Coatings
NACE-RP-0274	High Voltage Electrical Inspection of Pipeline Coatings Prior to Installation
IEC 454 – 2	Specification for Pressure-Sensitive Adhesive Tapes for Electrical Purposes
	CSA Z245.20-02 External Fusion Bond Epoxy Coating for Steel Pipe

6. Safety Systems

IP Model Code of Safe Practice in the Petroleum Industry parts 3, 6 and 9.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR ONSHORE PIPELINE CONSTRUCTION

GAIL-STD-PL-DOC-TS-001

0	29.01.19	Issued For Tender	AP	JR	SB	
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1.0 SCOPE

1.1 This specification defines the minimum requirements for the various activities to be carried out by Contractor for the construction of onshore pipelines.

1.2 The various activities covered in this specification include all works during the following stages of pipeline construction :

- Clearing, grubbing and grading of Right-Of-Way
- Staking of the pipeline route ;
- Handling, hauling, stringing and stacking/storing of all materials ;
- Trenching ;
- Field – bending of line pipe ;
- Lining-up and Welding
- Pipeline laying ;
- Backfilling ;
- Tie-in ;
- Hydrostatic testing, dewatering and drying
- Installation of auxiliary facilities and appurtenances forming a part of pipeline installation;
- Pre-commissioning and commissioning
- Clean-up and restoration of right-of-way
- Maintenance during defects liability period

1.3 CONTRACTOR shall submit detailed work procedures including drawings, calculations, as required equipment and manpower deployment details for the all pipeline activities to Owner for approval. Entire work shall be carried out as per approved procedures and to the satisfaction of Owner.

1.4 CONTRACTOR shall, with due care and diligence, execute the work in compliance with all laws, by-laws, ordinances, regulations etc. and provide all services and labour, inclusive of supervision thereof, all materials, excluding the materials indicated as "Owner Supplied materials" in the CONTRACT, equipment, appliances or other things of whatsoever nature required in or about the execution of the work, whether of a temporary or permanent nature.

1.5 CONTRACTOR shall be deemed to have obtained all necessary information regarding risks, contingencies and all other circumstances, which may influence the WORK.

1.6 CONTRACTOR shall be deemed to have inspected and examined the work area(s) and its surroundings and to have satisfied himself so far as practicable as to the form and nature thereof, including sub-surface conditions, hydrological and climatic conditions, the extent and nature of the WORK and materials necessary for the completion of the WORK, and the means of access to the work area(s).

1.7 CONTRACTOR shall, in connection with the WORK, provide and maintain at his own costs, all lights, guards, fencing, watching etc., when and where necessary or required by OWNER or by any duly constituted authority and/ or by the authorities having jurisdiction thereof for the protection of the WORK and properties or for the safety and the convenience of public and/ or others.

1.8 CONTRACTOR shall take full responsibility for the stability and safety of all operations and methods involved in the WORK.

1.9 For Design Data, Pipeline Design Stress Analysis, Seismic Design Criteria, HDD & Wall Thickness Selection Refer Doc No. GAIL-STD-PL-DOC-DB-001 (Pipeline Design Basis)

2.0 ABBREVIATIONS:

AFC : Approved For Construction

API : American Petroleum Institute

ASME : American Society For Mechanical Engineers

ASTM : American Society for Testing & Materials

DP : Dye Penetration

FOS : Factor of Safety

HDD : Horizontal Directional Drilling

MP : Magnetic Particle

NB : Nominal Bore

OD : Outside Diameter

OISD : Oil Industry Safety Directorate

ROU : Right of Use

ROW : Right of Way

U/G : Under Ground

A/G : Above Ground

3.0 CODES AND STANDARDS

3.1 Reference has been made in this specification to the latest codes, standards and specifications:

a.) ASME B31.8 - Gas Transmission and Distribution Piping systems

b) API 1104 - Standard for Welding Pipelines and related facilities

c) API 5L - Specification for Line pipe

d) OISD 141 - Design construction requirements for cross-country hydrocarbon pipelines.

e) OISD 226 - Natural Gas Transmission Pipelines and City Gas Distribution Networks.

f) PNGRB , Regulations 2009 - T4S Regulation, Petroleum and Natural Gas Regulatory Board

g) ASME SECTION IX - Welding qualification

h) DIN 30670 - Polyethylene Coating for Steel Pipes and Fittings

i) API 1102 - Recommended Practice for Steel Pipelines Crossing Railroads and Highways.

J) P&MP Act, 1956 & Land Acquisition Act, Water & Gas ROU (Acquisition) Act, 2000.

k) Railways/Highways/Forest/Other Pipelines – Statutory Regulations, Terms & Conditions as applicable. Petroleum Rules.
l) Basic Laws – Codes – Rules & Standards, mandatory by law in India and in the state of Rajasthan & Punjab.

The complete set of Specifications and standards, which are part of the present technical volume.

In general the pipeline and stations have to be built in accordance with the best state of engineering practice and commonly used by the worldwide gas industry.

In case of any conflict in the requirements of above codes and this specification, the most stringent requirement shall be followed.

4.0 RIGHT-OF-WAY (ROW)

4.1 General

CONTRACTOR shall, before starting any clearing operations, familiarise himself with all the requirements of the Authorities having jurisdiction over the Right of Way for work along the pipeline route or in connection with the use of other lands or roads for construction purpose.

Contractor shall notify Owner well in advance during the progress of work, the method of construction for crossing road, railways, canal ,cable, river, pipeline and other existing installations, services and obstacles.

The right of ingress and egress to the ROW shall be limited to points where such ROW intersects public roads, Arrangements for other access required by the CONTRACTOR shall be made by him at his own cost and responsibility, and for such access, and the conditions of this specification shall also apply.

Where the ROW comes within the area of influence of high voltage electrical installations, the special measures shall be taken.

Where row comes within the 30 meters of existing lines or facilities. Contractor shall propose and provide methods to safeguard the existing line or facilities, no work allowed in such areas without company prior approvals.

This distance depends on the voltage carried. For individual pipelines the minimum distance of the pipeline from the footing of the transmission line shall depend on the voltage. The following shall be the minimum Owner requirement for the clearance from power transmission lines:

Additional measures for work to be done at a distance less than 50 m from the centre of high voltage system.
If work is to be done at a distance less than 50 m from the centre of the high voltage system,the measure indicated below must be complied .

Range of Voltage	Minimum Clearance
0 - 50 KV	3 m
51 - 200 KV	5 m
201 - 380 KV	8 m

All necessary precautions shall be taken to prevent excavating and hoisting equipment from approaching high voltage lines to within above distances.

A minimum clearance of 500 mm shall be ensured when pipelines are to be laid parallel along underground power and/or communication cables, conductors or conduit. When such clearance cannot be maintained due to unavoidable reasons extra precautions shall be taken as approved by the Owner.

The Right-of-Way (ROW) will be handed over to Contractor by Owner as the work progresses. The Contractor is required to perform his construction activities within the width of ROW set aside for construction of pipeline, unless he has made his own arrangements with the land Owner and/or tenant for using extra land. Variation in the width of ROW caused by local conditions or installation of associated pipeline facilities or existing pipelines will be identified in the field or instructed to the Contractor by Owner.

The Right-of-Way boundary lines shall be staked by the Contractor, so as to prepare the strip for laying the pipeline. Contractor shall also establish all required lines and grades necessary to complete the work and shall be responsible for the accuracy of such lines and grades.

4.2 Staking

Prior to clearing operations Contractor shall carry out the following:

- Install bench marks, intersection points and other required survey monuments.

- Stake markers in the centerline of the pipeline at distances of maximum 100 meters for straight line sections and maximum 10 meters for horizontal bends.

- Stake two ROW markers at boundaries at least at every 100 meters.

- Install distinct markers locating and indicating special points, such as but not limited to:

  Contract limits, obstacle crossings, change of wall thickness, including corresponding chainage etc.

- All markers shall be of suitable materials so as to last till replacement with permanent markers and shall be colored distinctly for easy identification. Type, material and coloring of stake markers shall be subjected to approval of Owner. Any deviation from the approved alignment shall be executed by Contractor after seeking Owner's approval in writing prior to clearing operations.

- Contractor shall be responsible for the maintenance and replacement of the reference line markers until the permanent pipeline markers are placed.

4.3 Fencing

If Owner demands, Contractor shall install temporary fencing on either side of ROW wherever it is required to ensure safety and non-interference with others. For convenience of construction, Contractor shall install temporary gates to the fencing as per Owner's guidelines.

4.4 Clearing and Grading

4.4.1 Clearing of Obstacles

Any obstacle, which may hinder the construction and laying of the pipeline along the approved pipeline route and for a strip of land of the size provided shall be removed.

4.4.2 Clearing of Vegetation

All grubbed stumps, timber bush, undergrowth and roots shall be cut and removed from the ROW and shall be disposed off in a method satisfactory to Owner and authorities having jurisdictions. ROW cross fall shall not exceed 10%.

4.4.3 Uprooting of Trees

All trees which may hinder the construction of the pipeline along the approved pipeline route that belong to the protected green belt, reserved forest and other areas demarcated by the government authorities and any other tree in the opinion of the Owner requiring relocation/ re-plantation shall be relocated and replanted by the Contractor at an alternate location as recommended by the jurisdiction authorities / Owner. All such uprooting and re-plantation of trees shall be carried out by the Contractor in a manner that is satisfactory to the jurisdiction authorities/ Owner.

Contractor shall submit a procedure for uprooting and replanting of trees to the Owner for approval.

Trees that are required to be uprooted and not specified / recommended for re-plantation by the jurisdiction authorities / Owner shall be disposed of as debris and cleared from the ROW/ Project site by the Contractor.

4.4.4 Grading of ROW

Contractor shall grade the pipeline ROW as required for proper installation of the pipeline, for providing access to the pipeline during construction, and for ensuring that the pipeline is constructed in accordance with the most up-to-date engineering and construction practices. During entire period of pipeline construction and testing, Contractor shall maintain the ROW in motor-able condition. Final cleared & graded ROW shall be subjected to approval of Owner.

4.5 Approach roads

Grading operations should normally be carried out along the Right-of-Way (ROW) with mechanical excavators or manually. In certain areas, grading may have to be resorted exclusively by blasting.

In plain, rough or steep terrain, Contractor may have to grade access roads and temporary bypass roads for its own use. Where such access roads do not fall on the Right-of-way, Contractor shall obtain necessary written permission from land owners and tenants and be responsible for all damages caused by the construction and use of such roads at no extra cost to Owner. Where rocky terrain is encountered, grading shall be carried out in all types of solid rocks which cannot be removed until loosened by blasting, drilling or by other recognized methods of quarrying solid rocks. In certain areas where restricted ROU is available, contractor shall have to manage and follow other approaches to complete the job.

4.6 Provision of detours

Contractor shall be responsible for moving his equipment and men across or around watercourses and road crossings. This may require the construction of temporary bridges or culverts. Contractor shall ensure that such temporary works shall not interfere with normal water flow, avoid overflows, traffic, keep the existing morphology unchanged and shall not unduly damage the banks of water courses. No public ditches or drains shall be filled or bridged for passage of equipment until Contractor has secured written approval of the authorities having jurisdiction over the same. Contractor shall furnish Owner a copy of all such approval.
Contractor at his own cost shall furnish and maintain watch detours, lanterns, traffic light, barricades, signs, wherever necessary to fully protect the public.

4.7 Off right-of-way damages

Any damage to property outside ROW shall be restored or settled to the Contractor's account.
Contractor shall promptly settle all off right of use damage claims. if contractor fails to do so, company shall give written notice to contractor that if contractor does not settle the such claims within seven days after such notice. Company shall have the authority to settle claims from the account of contractor.

5.0 HANDLING, HAULING, STRINGING AND STORING OF MATERIALS

5.1 General

Contractor shall be fully responsible for all materials and their identification until the time such that the pipes and other materials are installed in permanent installation.

Contractor shall be fully responsible for arranging and paying for stacking/storage areas for the pipeline materials. However, method of stacking/ storage shall be approved by Owner.

5.2 Line pipes

The Contractor shall load, unload, transport and stockpile the bare/coated pipes using approved suitable means and in a manner to avoid damage to the pipe and coating. Contractor shall submit to Owner a complete procedure indicating the manner and arrangement used for handling, transportation and stacking of bare/coated pipes for Owner's approval prior to commencement of handling operations.

Stacks shall consist of limited number of layers so that the pressure exercised by the pipes own weight does not cause damage to the coating. Contractor shall submit the stacking height calculations as per API RP 5L1 to Owner for approval. Stacks of different diameters, wall thickness and damaged rejected pipe shall be separately segregated and identified properly. The pipes shall be stacked at a slope so that driving rain does not collect inside the pipe.

The ends of pipes during handling and stacking shall be protected with bevel protectors. Supports shall be provided for at least 10% of the pipeline length. These supports shall be lined with rubber protection. The second layer and subsequent layers shall be separated from each other by material such as straw in plastic covers or mineral wool strips or equivalent.

Materials excluding line pipes shall be stored in sheltered storages.

5.3 Stringing of pipe

Pipes shall be unloaded from the stringing trucks/trailers and lowered to the ground by means of boom tractor or swinging crane or other suitable equipment using lifting devices. Dragging or sliding of pipe shall not be permitted. Special precaution shall be taken during stringing of corrosion coated pipe as per the special requirements of previous paragraph. Stringing of pipe shall only be carried out in daylight and after clearing and grading operations have been completed. Pipes shall not be strung directly on the ground and shall be adequately supported with the help of sand bags or other soft material support in order to avoid damage to the pipe coating. Pipe shall not be strung on the Right-of-Way (ROW) in rocky areas where blasting may be required, until all blasting is complete and the area is cleared of all debris. Contractor shall submit to Owner for approval a complete procedure for stringing of line pipes.

5.4 Repair of damaged pipes

After the pipe has been strung on the Right-of-Way (ROW), it shall be inspected by the Contractor and the Owner and all defective pipes & pipe ends shall be repaired. Defective pipe shall be repaired or rejected as the Owner may direct as per the requirements of specification.

5.5 Identification

CONTRACTOR shall provide all pipes, bends, etc. greater than 2" with serial numbers as soon as possible and measure their length and state is on the pipes, etc. Pipes to be bent shall be measured prior to bending. Identification (i.e. letter, number and length) shall be indelible.
All serial numbers shall be recorded in a list, which shall also state appurtenant pipe numbers.

Besides recording the stamped - in pipe numbers, length of pipe and painted-on serial numbers, the stamped-in numbers of T-pieces, bends, valves, etc. and the batch numbers of bends, T-pieces, valves, etc. and the make of valves, shall also be recorded in said list.

Before a pipe length, pipe end, etc. is cut the painted serial number and stamped-in pipe number shall be transferred with the help of low stress punch by CONTRACTOR in the presence of OWNER to either side of the joint which is to be made by cutting, and the changes shall be recorded in the above mentioned list stating the (new) length. The results shall be such that all pipes, pups, etc. of diameter greater than 2" bear clear marks punched with a low stress punch.

CONTRACTOR shall explicitly instruct his staff that parts which cannot be identified must not be removed, except after permission by OWNER.

As a general rule parts must be marked as described above before being moved. In no conditions may unmarked parts be incorporated into the WORK.

6.0 TRENCHING

6.1 Contractor shall excavate and maintain the pipeline trench on the stacked centre line of the pipeline taking into account the curves of the pipeline.
In case of common ROU the Centerline of trench shall be established from the location of the existing pipeline. In case of independent ROU centre line of the trench shall be established from edge of the centre line.

6.2 Excavation

6.2.1 Contractor shall, by any method approved by Owner, dig the pipeline trench on the cleared and graded Right-of-Way (ROW).

6.2.2 In cultivated land the arable soil shall be properly prescribed and same to be replaced at original place during backfilling as advised by Owner.

Care shall be exercised to see that fresh soil recovered from trenching operation, intended to be used for backfilling over the laid pipe in the trench, is not mixed with loose debris or foreign material. The excavated material shall never be deposited over or against the strung pipe.

6.2.3 In steep slope areas or on the hillside, before commencing the works, proper barriers or other protection shall be provided to prevent the removed materials from rolling downhill.

6.2.4 In certain sloppy sections, before the trench cuts through the water table, proper drainage shall be ensured both near the ditch and the right-of-way in order to guarantee soil stability.

6.2.5 If pipeline passes through the edge of small lined drain, required restoration shall be carried out after completion of laying works. Prior approval need to be taken regarding construction and restoration procedure from Owner / Owner representative.

6.2.6 Contractor shall use cable/pipe locator before starting of the excavation to identify the existing utilities specially inside RIICO areas. Contractor to take proper precautions to avoid any damage to existing utilities.

6.3 Blasting

6.3.1 Contractor shall execute the blasting as per approved procedures, which will also detail out safety precautions to safe guard the existing pipelines.

6.3.2 No blasting is allowed within 15m of any existing pipeline or structures (either above or below ground).

Where blasting is to be carried out, between 50m and 15m away from any existing pipelines or structures (either below or above ground), the Contractor shall submit a procedure for controlled blasting e.g. break-holes, slit trench etc. Contractor shall perform a trial blast for Owner's approval.

6.4 Normal covers and trench dimensions

The trench shall be excavated to a minimum width maintaining clearance on both sides of the installed pipeline and to a depth to maintain the cover of the pipeline as indicated in the other contract documents or approved procedure.

Pipeline shall be laid with at least 500mm free clearance from the obstacles or as specified in the drawings or wherever it is required by concerned authorities.

The following minimum cover shall be maintained:

Location		Minimum Cover (M)
1	Area of agricultural & horticultural activity and of limited or no human activity	1.2
2	Industrial, Commercial & Residential areas	1.2
3	Rocky Terrain	1.0
4	Minor water crossings/ canals / drain / nala / ditches	1.5
5	Submerged river crossings 1. When Scour depth is known (below scour level) 2. When Scour depth is not known (below lowest bed level)	1.5 m 2.5 m
6	River with rocky bed (below scour level)	1.5
7	Water course crossing by HDD	2.5 m below scour level or lowest bed level (whichever is lower)
8	Uncased/ Cased Road Crossings/ Station approach	1.2
9	Cased railway crossing	1.7
10	Drainage, ditches at roads / railway crossings	1.2
11	Marshy land and creek area	1.5
12	Areas of brick kiln	1.5 (from the current level or below predicted excavation level, whichever is more

Note:

a) In case pipeline is located within 15 m from any dwelling unit, the cover shall be increased by 300 mm over and above that specified.
b) The above-mentioned minimum cover requirements shall be valid for all class locations.
c) Minimum depth of cover shall be measured from the top of pipe coating**/** casing pipe to the top of undisturbed surface of the soil, or top of graded working strip whichever is lower.
d) In case of rivers, which are prone to scour and erosion, adequate safe cover (min.2.5m) shall be provided below the predicted scour profile during the lifetime of pipeline. Contractor shall establish the scour level based on data provided by authorities.

At points where the contour of the earth may require extra depth to fit the minimum radius of the bend as specified or to eliminate unnecessary bending of pipe or where deeper trench is required at the approaches to crossings of roadways, streams etc. contractor shall excavate such additional depths as may be necessary at no extra cost to Owner.

6.5 Negative buoyancy to the pipe

Contractor shall dewater if necessary, using well point system or other suitable systems, and then install the pipe in the trench and backfill the trench. All underground utilities shall be located and protected as per the guidelines of jurisdiction authority/ Owner.

Contractor shall check if up-floating danger for the pipeline is present in open trench. If such danger of up-floating is present, Contractor shall take appropriate measures to prevent up-floating such as applying soil dams and dewatering of trench or temporary filling of water into the line (in exceptional cases) as approved by Owner. Contractor shall furnish details of all negative buoyancy calculations to the Owner for approval. Contractor shall carry out any anti buoyancy measures only after obtaining Owner's approval for such calculations.

In case of presence of water on the ditch bottom when the pipeline is being laid, the ditch shall be drained to the extent and for the time required to make a visual inspection of the ditch bottom. After such inspection, the presence of water will be allowed provided its level does not cause sliding of the ditch sides and pipe floating before backfilling.

Wherever up-floating of the pipeline after backfilling is indicated, anti-buoyancy measures shall be provided by Contractor for areas indicated in the drawings or as may be encountered during construction using the following method:

- Applying a continuous concrete coating around the pipe

Any other anti-buoyancy method adopted by the Contractor shall require prior written approval from the Owner.

The above provisions shall be in accordance with the relevant specifications and/or approved procedures / drawings and to the satisfaction of Owner.

6.6 Padding

In all cases where rock or gravel or hard soil is encountered in the bottom of the trench, extra padding shall be provided by Contractor as per Owner's instructions. The thickness of the compacted padding shall not be less than 150mm. In those areas that are to be padded, the trench shall be at least 150mm deeper than otherwise required, and evenly and sufficiently padded to keep the pipe when in place, at least 150mm above bottom of excavated trench.

The thickness of compacted padding on top of pipe shall be at least 150mm.Exact extent of trench padding shall be as per Owner's instructions. Padding materials that are approved by Owner shall be graded soil / sand and/or other materials containing no gravel, rock, or lumps of hard soil.

Contractor shall keep the trench in good condition until the pipe is laid.

7.0 BENDING

Contractor shall preferably provide for changes of vertical and horizontal alignment by making elastic bends. Contractor may provide cold field bends, at his option for change of direction and change of slope. Owner at his option may authorize factory made induction hot bends (LR bends) for installation at points where in Owner's judgments the use of such bends is unavoidable.

Over bends shall be made in such a manner that the centre of the bend clears the high points of the trench bottom. Sag bends shall fit the bottom of the trench and side bends shall conform and leave specified clearance to the outside wall of the trench.

7.1 Cold field bends

The minimum radius of cold field bends shall be as follows:

Nominal Pipe Size (NPS)	Minimum Radius of Cold Bend
Less than 12"	21D
14 " - 16"	30D
Greater than 16"	40D

Spiral SAW line pipes shall not be used for fabrication of cold field bends.

Contractor shall use a bending machine and mandrel and employ recognized and accepted methods of bending of coated pipe in accordance with good pipeline construction practice. However, bending machines shall be capable of making bends without wrinkles, buckles, stretching and with minimum damage to the coating.

7.1.1 Contractor shall, before the start of the work, submit and demonstrate to Owner a bending procedure, which shall conform to the recommendations of the bending machine manufacturer. The procedure shall include amongst other steps – lengths, maximum degree per pull and method and accuracy of measurement during pulling of the bend. This procedure and the equipment used shall be subjected to Owner's approval.

7.1.2 For welded pipes, longitudinal seam shall be suitably placed as per approved procedure so that the weld seam shall not be overstressed.

7.1.3 The ends of of each bend length shall be straight and not involved anyway in the bending. The length of the straight section shall permit easy joining. In no event shall the end of the bend be closer than 1.0m from the end of a pipe.

7.1.4 The ovality used on each pipe by bending shall be less than 1.6mm at any point. Ovality is defined as the reduction or increase in the internal diameter of the pipe compared with the nominal internal diameter. A check shall be performed on all bends in the presence of Owner by passing a gauging pig / buckle detector consisting of two discs with a diameter equal to 95% of the nominal internal diameter of the pipe connected rigidly together at a distance equal to 300mm.

7.1.5 Cold bend pipes on site shall have the corrosion coating carefully checked with the aid of a holiday detector for cracks in the coating down to the pipe wall. It must also be checked whether the coating has been disbanded from the pipe wall during bending by beating with a wooden mallet along the outer radius. Any defects or disbanding of the coating caused during bending shall be repaired at the Contractor's expense in accordance with Owner's approved procedures.

7.2 Elastic Bends

The minimum allowable radius for elastic bends in the buried pipeline including that for continuous concrete weight coated pipe shall be in accordance with relevant job standards. The elastic bend shall be continuously supported over its full length. A radius smaller than permitted in elastic bending shall require a cold bend.

Basis of Elastic bend refer Doc. No. GAIL-ENG-PL-DOC-CAL-001, Annexure -3 (Pipeline Wall Thickness Calculation)

7.3 Miter and Unsatisfactory Bends

All bends showing buckling, wrinkles, cracks or other visible defects or which are in any way in disagreement, in whole or in part, with this specification shall be rejected.

No miter bends shall be permitted in the construction of the pipe line. CONTRACTOR shall cut out and remove any bend or bends which do not meet the specifications and shall replace the same with satisfactory bends at no additional cost to the OWNER.

In the event the CONTRACT provides for supply of line pipe by OWNER, the pipes required for replacement will be furnished by OWNER, but the cost of replacement of such pipes shall be borne by CONTRACTOR. Cutting of factory made bends and cold field bends for any purpose are not permitted.

8.0 LINING UP AND WELDING

Each length of pipe shall be thoroughly examined internally and externally to make sure that it is free from visual defects, damage, severe corrosion (sea water pitting), dirt, animals or any other foreign objects. Each length of the pipe shall be adequately swabbed, either by use of canvas belt disc of proper diameter or by other methods approved by the Owner. Damaged/ corroded pipes shall be kept separate. Each length of pipe shall be pulled through just before being welded. Contactor shall submit a detail procedure for Lining of line pipe to Owner for approval.

Contractor shall align and weld together the joints of pipe so as to construct a continuous pipeline. All welds in the pipeline made by Contractor shall be of strength equal to that of pipe. All welding shall conform to Company's welding specifications enclosed with the Contract.

8.1 Pipe defects and repairs

8.1.1 Acceptability of defects in the pipe detected during inspection at the work site shall be determined in accordance with approved procedures or Code ASME B31.8/ API 5L whichever is more stringent.

8.1.2 Repair on line pipe shall be executed as specified in specification or Code ASME B31.8/ API 5L whichever is more stringent.

8.1.3 Repair of damaged pipe ends by hammering and/or heating is not allowed. Contractor shall submit detailed procedure for pipe defects and repairs to Owner for approval

8.2 Spacing Between Pipe and Skid

8.2.1 A strip of soft material shall be placed in between skid and pipe to protect the external coating of pipe from any damage.

8.2.2 The pipes shall be maintained from skids at the minimum distance of 500mm above ground.

8.3 Night Caps/ Temporary Caps

After each day's work or when work is interrupted, the open ends of the welded strings of pipes shall be capped with a securely closed metal cap as approved by Owner.

9.0 LAYING OF PIPE

9.1 Lowering in trench

9.1.1 Lowering shall follow as soon as possible, after the completion of the field joint coating of the pipeline. In the case of parallel pipelines, laying shall be carried out by means of successive operations, if possible without interruption. Contractor shall submit a detail procedure for lowering of pipeline to Owner for approval.

9.1.2 Before lowering in, a complete check by a full circle holiday detector for pipe coating and for field joint coating shall be carried out and all damages repaired as agreed by Owner at Contractor's cost. All the points on the pipeline where the coating has been in contact with either skids or with lifting equipment shall be properly checked. Where water is present in the trench, no laying shall be permitted until the ditch has been drained.

9.1.3 The pipeline shall be lifted and laid using, for all movements, necessary suitable equipment of non-abrasive material having adequate width for the fragility of the coating. Care shall be exercised while removing the slings from around the coated pipe after it has been lowered into the trench. Any damage caused to the coating shall be promptly repaired. Lowering in utilizing standard pipe cradles shall be permitted if Contractor demonstrates that pipe coating is not damaged. No sling shall be put around field joint coating.

9.1.4 The portion of the pipeline between trench and bank shall be supported by as many side-booms as required and approved by Owner for holding the line in gentle S-curve maintaining minimum elastic bend radius as specified in approved procedure. Lowering in and back filling shall preferably be carried out at the highest ambient temperature.

In laying parallel pipelines in the same trench, the minimum distances between the pipelines indicated in the approved drawings shall be maintained.

9.1.5 Over-head sections

a) The following works shall be completed before proceeding with the assembly and laying of overhead pipelines :

- Construction of the pipe support structures or of mounts on supports.
- Paints and/or coating of the pipe work, as indicated in the engineering specification.

b) The erection of the supports shall be carried out taking care that the elevation and alignment is in accordance with the drawings.

In the case of metal work supports, pre-fabrication and/or assembly shall take into account the maximum allowed free span and the supports shall not interfere with the pipeline welds.

c) In case roller supports are used, the rollers shall be lubricated, and then checked for smooth rotation. In case of seizure, the defect shall be repaired or roller shall be replaced. In the case of overhead section where the pipeline is slanting, the alignment of the end supports shall be made after placing the pipeline in position. Before installation of the pipe section, all the rollers shall be perfectly centered acting on the seat of the support plates.

The above alignment operations shall be carried out before connecting the overhead section with the ends of the buried section.

d) Lifting, moving and laying of the pipeline shall be carried out in accordance with the provisions of this specification.

An insulation sheet shall be installed to isolate the pipe from the support or support from the earth.
The sheet shall be hard polyethylene at least 5mm thick.
It shall extend to at least 25 mm outside the saddles or clamps.

e) Moving supports, if any shall be centered on their support and allow for a movement of at least 300mm in both directions.

f) A comprehensive report / method statement on the laying operation to be used shall be submitted to the Owner well in advance for approval. The report as a minimum shall include, but not limited to the following:

- Method of installation by lifting (as a preferred method).
- Pulling method and related calculations, whenever lifting method cannot be used.
- Pulling device and its characteristics.
- Method of anchoring the pulling device
- Characteristics of the pulling rope
- Braking device, if any.
- Pipeline assembly system.

10.0 BACK-FILLING

10.1 Backfilling shall be carried out immediately after the pipeline has been laid in the trench, inspected and approved by the Owner, so as to provide a natural anchorage for the pipeline, thus avoiding long exposure of coating to high temperature, damaging actions of adverse weather conditions, sliding down of trench sides and pipe movement in the trench. If immediate back filling is not possible, a covering of at least 200mm of earth shall be placed over and around the pipe coatings. Contractor shall submit to Owner/Consultant the detailed procedure for backfilling for approval.

10.2 Warning sheet / mat made of Polyethylene with fluorescent colour shall be laid after top padding of 300 mm. Prior to use, approval of the same shall be taken from Owner/Consultant.

10.3 As directed by Client/ Consultant, wherever hard rocks/ soil are encountered, padding and rock shield shall be provided across the pipe to cover all exposed pipe area to avoid any possible damages during back filling of hard materials like rock, gravel, lumps of hard soil etc.

10.4 When trench has been dug through roads, all back fills shall be executed by sand or suitable material as approved by Owner and shall be thoroughly compacted. In certain cases, special compaction methods, such as moistening or ramming of the backfill in layer may be required as advised by Owner.

10.5 In areas prone to soil erosion, back filling shall be carried out as per approved procedures, carefully and to the satisfaction of the Owner/authorities having jurisdiction.

10.6 Contractor shall furnish materials and install breakers in the trench in steep areas (slope generally 10% and more) for the purpose of preventing erosion of the backfill. The type of breakers installed shall be as per the approved drawings. Separate detailed procedure with sketch shall be prepared and get approved by owner / authority.

10.7 Company any public or private authority having jurisdiction over a road, street or drive way may require that the surface of the backfill be gravelled with crushed rock or some other purchased material and the road shall be repaved. In such instances, Contractor shall comply with said requirements at no extra cost to company.

10.8 Contractor shall leave the pipe uncovered at certain locations to allow Company to survey the top of the pipe and the level of the pipeline in the backfield trench. Within 48 hours after backfilling, Company shall have carried out such survey and informed Contractor of any realigning, if required. Thereafter Contractor shall compact the backfill.

The maximum allowable deviation from the centreline for land sections as staked out by Company and as referenced by Contractor after backfilling is limited to following:

Pipeline dia upto and including 600 NB : 200 mm

Pipeline dia greater than 600 NB : 300 mm

10.9 Stabilization of backfill shall be carried out by the Contractor in sandy areas and other such places, as Directed by the Company. Contractor shall carry out the stabilization to have a consolidated cover over the pipeline at no extra cost to Company.
The backfill shall be stabilized preferably with 150 mm layer of marl, mattresses of gatch other than straw or other stable materials. The width stabilization shall be at least 3.0 meters on either side of the pipeline, plus one meter for every 10 meters height of dune (where the line passes through the dune areas)

Temporary markers shall be installed during backfilling and the survey the pipeline axis. These markers shall then be replaced with permanent pipeline markers.

In certain areas like U/G pipeline crossing, overhead power cable crossing etc. special care to be taken by putting concrete slab /plastic grating before backfilling. Size and thickness of concrete slab/plastic grating shall comply applicable job standard and approved by Company.

11.0 TIEING-IN

11.1 The unconnected sections of the pipeline at various locations have to be tied in after the sections are coated, lowered and backfilled. The sections to be connected shall have at the ends – sections of over lapping, uncovered pipe of sufficient length to absorb, without including excessive stresses in the steel, small displacements necessary for perfect alignment and connection of the ends.

11.2 If a pup end cannot be avoided for tie-in, the minimum length that shall be added is 1.0 meters and two or more such pups shall not be welded together. All cut-off lengths greater than 1.0 meters shall be moved ahead in order to be welded into the pipeline at a suitable location. Tie-in with two or more pups may be used provided that they each have minimum length of 1.0 meter and are

separated by an entire length of pipe. In no case more than three (3) welds shall be permitted on a 10 meter length of pipeline.

11.3 Tie-in shall preferably be carried out at ambient temperatures corresponding to the average operating temperature in the case of a pipeline conveying fluids at normal temperatures and at the maximum ambient temperature in the case where the pipeline is carrying fluids at high temperature.

11.4 Contractor shall carry out tie-in-welding (including necessary cutting, bevelling, grinding of pipe weld seams and line-up etc.) cleaning, priming, coating and backfilling for the tie-in portion as per relevant specifications. CONTRACTOR shall also excavate the required bell-holes for the connection. Bell-holes made to facilitate welding shall provide adequate clearance to enable the welders to exercise normal welding ability and skill. All tie-in welds shall be radio-graphically examined.

11.5 The tie-in should be done in such a way as to leave a minimum of strain in the pipe. If necessary, with respect to the trench, realigning of the pipe shall be done to eliminate force or strain in the pipe by the CONTRACTOR at no extra cost to OWNER.

11.6 For tie-in of adjacent sections of pipeline already pressure tested, the pup used for tie-in shall be of single length or off-cuts of pipe which have already been hydrostatically tested. CONTRACTOR shall take care that sufficient number of pretested pipes with different wall thicknesses are readily available.

11.7 Contractor shall carry out tie-in-welding (including necessary cutting, bevelling, grinding of pipe weld seams and line-up etc.) cleaning, priming, coating and backfilling for the tie-in portion as per relevant specifications. Contractor shall also excavate the required bell-holes for the welding. Bell holes made to facilitate welding shall provide adequate clearance to enable the welders to exercise normal welding ability and skill. All tie-in welds shall be radio graphically examined.

11.8 Tie-in shall preferably be carried out at ambient temperatures corresponding to the average operating temperature in the case of a pipeline conveying fluids at normal temperatures and at the maximum ambient temperature in the case where the pipeline is carrying fluids at high temperature.

12.0 CROSSINGS

Pipe line sections at all major crossings like State and National Highways, Railways, major canals and lined canal / distributaries shall be laid by boring with casing pipe complying with all other statutory requirements. All other crossings shall be executed by open cut method unless otherwise specified in the Contract or specified by statutory authorities.

13.0 SPECIAL INSTALLATION OF THE PIPELINE

13.1 Installation of Insulating Joints

13.1.1 Insulating joints shall be installed at the locations shown in the drawings. Contractor shall obtain approval from the Owner before installation of the insulating joints.

13.1.2 Handling and installation of the insulating joints shall be carried out with all precautions required to avoid damage and excessive stresses and that the original pup length is not reduced.

13.1.3 The insulating joints and the welded joints shall be protected by external coating as per the relevant specifications issued for the purpose.

13.**72** **Welded Connections**

Where the ends of the piping components being welded have an internal surface misalignment exceeding 1.6 mm , the wall of the component extending internally shall be trimmed by machining so that the adjoining internal surfaces will be approximately flush. All welding shall be performed in accordance with Specification No. GAIL-STD-PL-DOC-TS-002 (Technical specification for onshore pipeline welding for Gas Transportation) and other applicable Job Specification.

Tie-ins between fixed points shall be made at maximum ambient temperature.

13.3 **Civil Work**

Civil work shall be performed in accordance with Specification issued for the purpose.

13.4 **Coating of buried installations**

All buried valves , insulating joints, flow tees , bends, other in-line fittings and appurtenances shall be coated with 100% solid high build epoxy (minimum 500 micron thk.) or any other equivalent suitable Company approved coating at no extra cost to Company. For buried pipes and LR bends, heat shirnk sleeves /cold applied tapes conforming to Specification No. GAIL-STD-PL-DOC-TS-005 (Technical Specification for Field Joint Coating) , shall be used. Contractor shall submit to Company a report regarding the method of application and the materials used along with all test certificates. Only after obtaining written approval from the Company, Contractor shall commence the work of coating.

14.0 CLEAN-UP & RESTORATION OF RIGHT-OF-WAY

14.1 After all required tests have been concluded satisfactorily Contractor shall clean up the site as laid down in the specifications issued for the purpose. The site finish shall be graded in accordance with the approved drawings.

14.2 Contractor shall restore the ROW and all sites used for the construction of pipelines, water crossings and other structures in accordance with Owner's instructions, and deliver them to the satisfaction of Owner.

14.3 For Company supplied materials, after completion of WORK, the Contractor shall return all surplus materials at Company,s designated areas.

The reconciliation of surplus free issue line pipes shall be as per the requirement of commercial condition of contract.

15.0 PIPELINE MARKERS

15.1 Contractor shall submit detailed drawings for pipeline markers to the Owner for approval. After approval, all markers shall be installed along the pipeline route as advised by Owner. As a minimum the markings shall be provided at intervals / spacing as follows:

Marker Type	Minimum Spacing Requirement
Kilo Meter Post	One marker every one kilometer
Aerial Marker	One marker at every five kilometers
Navigable Water ways/ Notice board	One each on either bank of the navigable water way
Boundary Markers	One each on either side of the boundary of the ROW at intervals of 250 m.
Direction Markers	One at the centre of curvature of the turning point. One each at a distance of 200 m on either side of the alignment.
Warning Signs: All road / railroad crossings Water course, nala, canal	One no. on either side of the road / railroad a) One no. for width less than 15m b) Two nos. on either side of the crossing for width greater than 15 m and all cased crossings

16.0 MAINTENANCE DURING DEFECTS LIABILITY PERIOD

If such defect shall appear or damage occur, OWNER shall forthwith inform CONTRACTOR thereof stating in writing the nature of the defect or damage.

If any such defect or damage be not remedied within a reasonable time, OWNER may proceed to execute the work at CONTRACTOR's risk and expense, provided that he does so in a reasonable manner. Such defect or damage can be, but is not limited to:

- Clean up of ROW, including water courses

- Sagging or sinking of site level or pipe supports

- Sliding of ditch banks

- Repair of fencing or removal of construction fencing

- Repaving of pavements, repair of pavements, repair of coating, painting

- Realigning markers, signs

- Leak/burst of pipe, leaking flanges, washouts

- Short-circuit in casings

- Construction defects such as dents, ovality, welding offsets/defects, etc. detected during intelligent pigging survey etc.

CONTRACTOR shall finish the work, if any outstanding, at the date of completion as soon as possible after such date and shall execute all such work.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR ONSHORE PIPELINE WELDING FOR GAS TRANSPORTATION

GAIL-STD-PL-DOC-TS-002

0	12.01.19	Issued For Tender	AP	JR	SB

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1.0 SCOPE

The requirements stated herein as minimum shall be applicable for the fabrication and erection of all types of welded joints of carbon steel pipeline, related station facilities.

The basis of this document is ASME B31.8/API 1104 latest edition. However, this document shall supersede ASME B31.8/API 1104 latest edition in case of conflict.

Any approval granted by the OWNER shall not relieve the CONTRACTOR of his responsibilities and guarantees.

The CONTRACTOR is free to and solely responsible to conduct any other tests which is required and deemed necessary for the guarantee and the integrity of the pipeline.

The CONTRACTOR shall be responsible for arranging all resources and facilities required for fulfilling his obligations for this specifications and instructions of the OWNER whether specifically mentioned herein or not, but required to fulfill the intended purpose of this specification.

2.0 CODES AND STANDARDS

The related, standards referred to herein and mentioned below shall be of the latest editions prior to the date of the purchaser's enquiry:

a)	ASME B31.8	:	Gas Transmission and Distribution Piping Systems.
b)	API 1104	:	Standard for welding of Pipelines and Related Facilities.
c)	ASME Sec. II C	:	Specification for welding Electrodes and Filler Materials.
d)	ASME Sec. V	:	Non Destructive examination.
e)	ASME Sec.VIII Div. I	:	Boiler and Pressure Vessel Code: Pressure Vessels.
f)	ASME Sec. IX	:	Boiler and Pressure Vessel Code: Welding and Brazing Qualification.
g)	ASTM E23	:	Notched Bar Impact Testing of Metallic Material.
h)	ASTM E92	:	Test Method for Vickers Hardness of Metallic Materials.
i)	ASTM E709	:	Practice for Magnetic Particle Examination.
j)	ASTM A370	:	Standard Test Methods and Definitions for Mechanical Testing of Steel Production.
k)	ASNT-SNT-TC-1A	:	Standard for Personnel Qualification and Certification in Nondestructive Testing
l)	PNGRB T4S	:	Technical Standards & Specifications including Safety Standards

3.0 CONFLICTING REQUIREMENT

In the event of any conflict in the requirements of this standard specification, job specification, datasheets, statutory regulations, related standards, codes etc., the most stringent requirement shall be followed:

4.0 WELDING PROCESS AND CONSUMABLES

4.1 This specification lays down minimum requirements for welding of various materials using Shielded Metal Arc Welding process (SMAW) with the approval of the Owner/ Consultant. Any other process of welding shall require prior approval from the Owner/ Consultant.

4.2 Welding consumables

4.2.1 The welding electrodes/ filler wires supplied by the Contractor shall conform to the class specified in the approved welding procedure specification. The materials shall be of the make approved by the Owner/ Consultant/TPI.

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.

The certificates shall have as minimum, information such as batch number, date of manufacture, consumable cast number, consumable chemistry, weld metal chemical analysis, weld metal mechanical properties including Charpy impact energy.

Electrode Qualification test records shall be submitted as per relevant code requirements by the Contractor for obtaining the approval of the Owner/consultant. The following details shall be provided in qualification test records. All weld tensile test, base material used, pre-heat and post weld heat treatment details, visual examination results, radiographic examination results, tensile test results (incl. UTS, and elongation), impact test values, chemical analysis report, fillet weld test results, other tests like transverse tensile tests and guide bend test results. The contractor shall give prior intimation to owner/ consultant regarding EQT. Each EQT shall be witnessed by owner/ consultant's inspector.

4.2.2 The electrode shall be suitable for the production welding process recommended and the base metal used. Physical properties of the welds produced by the electrode & brand recommended for the welding of particular base metal shall not be lower than the minimum values specified for the base metal unless otherwise specified in approved Welding Procedure Specification (WPS). The choice of electrode shall be made after conducting the required tests on the electrodes as per relevant standards, and acceptance shall be the sole prerogative of the Owner/Consultant.

4.2.3 All electrodes shall be purchased in sealed, containers and stored properly to prevent deterioration. Electrodes shall be kept in oven, if required, at all conditions as per manufacturer recommended temperature. Different grades of electrodes shall be stored separately. The electrodes used shall be free from rust, oil, grease, earth and other foreign matter, which affect the quality of welding.

4.2.4 The composition and purity of shielding gas when required by the welding processes other than shielded metal arc welding, when permitted by the Owner/Consultant shall be submitted to the Owner/Consultant for approval.

4.2.5 Contractor shall supply all necessary equipments such as welding equipment current and voltage meters, temperature measuring instruments, fluxes, gases, filler metals and testing equipment for satisfactory completion of all the work.

4 A) EQUIPMENT AND ACCESSORIES

1. The CONTRACTOR shall have sufficient number of welding and cutting equipment, auxiliaries and accessories of sufficient capacities to meet the target schedule.

2 . All the equipment for performing the heat treatment including transformers, thermocouples, pyro-meters, automatic temperature recorders with suitable calibration arrangements, etc. shall be provided by the CONTRACTOR, at his own expenses and these shall bear the approval of the COMPANY. Adequate means of measuring current and voltage shall be available.

3 . Redoing of any work necessitated by faulty equipment or operation used by the CONTRACTOR, will be done at his own expense.

4 B) BEVEL CLEANING AND BEVEL INSPECTION

Line pipe supplied by COMPANY shall have bevel ends as specified in the applicable specification for line Pipe attached with the Bid Package. Any modification thereto, if required by CONTRACTOR due to his special welding technique shall be carried out by the CONTRACTOR at his own cost.

Before welding, all rust and foreign matter shall be removed from the bevelled ends by power operated tools. This shall be effected inside and outside and for a minimum distance of 25mm from the edge of the weld bevel. The bevels shall be thoroughly inspected at this stage. If any of the ends of the pipe joints are damaged to the extent that, in the opinion of COMPANY, satisfactory weld spacing cannot be obtained and local repair by grinding cannot be successfully done, the damaged ends shall be cut and re-bevelled to the satisfaction of the COMPANY, with an approved bevelling machine. Manual cutting and weld repairs of bevels is not allowed. Should laminations, split ends or inherent manufacturing defects in the pipe be discovered, the lengths of pipe containing such defects shall be removed from the line to the satisfaction of COMPANY. On pipes which have been cut back, a zone extending 25mm back from the new field bevel, shall be ultrasonically tested to the requirement of the line pipe specification to ensure freedom from laminations. The new bevel shall be subjected to 100% visual and 100% dye penetrant/ MPI tests. A report shall be written for all testing and records kept.

5.0 WELDING PROCEDURE SPECIFICATION

5.1 Contractor shall submit the welding procedure specification indicating the proposed welding process to Owner/consultant for approval. Any deviation desired by the Contractor shall be obtained through the express consent of the Owner/Consultant.

5.2 A combination of different welding processes or a combination of electrodes of different classes/makes could be employed for a particular joint only after duly qualifying the welding procedures to be adopted and obtaining the approval of the Owner/Consultant.

Welding procedure qualification shall be carried out in accordance with the relevant requirements of API 1104 and other applicable codes and other job requirements by the Contractor. The Contractor shall submit the welding procedure specifications as per the formats given in API 1104 within one month after the receipt of the order indicating details of welding consumables, welding process, welding position, welders, destructive test sample positions, pre-heating requirements, voltage, current, heat input etc. The pipeline of maximum diameter and wall thickness shall be used for

welding procedure qualification. Inter pass temperature shall be considered as an essential variable in the procedure qualification.

5.3 Owner/Consultant's representative will approve the welding procedure submitted and shall release the procedure for qualification tests. The Contractor shall carry out under field conditions at their own expense the procedure qualification test. A complete set of test results shall be submitted to the Owner/consultant representative Inspector for approval immediately after completing the procedure qualification test and at least 2 weeks before the commencement of actual work. All tests shall be carried out as per provisions of these specifications.

5.4 Radiography of the entire weld shall be carried out using the same source of radiation, radiographic technique and exposure time as that to be used for production weld.

6.0 QUALIFICATION OF WELDERS

6.1 Welders shall be qualified in accordance with the API 1104 and other applicable specifications by the Contractor at their expense. The butt weld test pieces of the welder qualification tests shall meet the visual and the radiographic test requirements of this specification. The welder qualification tests shall be carried out using the welding procedure and the equipment that will be utilised during production welding. The welder qualification shall be done only on project line pipe. The Owner/Consultant representative inspector shall witness the test and certify the qualification of each welder separately. Only those welders who have been approved by the inspector shall be employed for welding. Contractor shall submit the welder qualification test reports and obtain express approval, before commencement of the work. It shall be the responsibility of Contractor to carry out qualification tests of welders. Guided bend tests shall also be conducted for welders to be qualified for station pipe welding. Retesting of a welder who has failed the qualification test shall be done only after approval of the Owner/ Consultant who shall decide on the training requirements.

6.2 The welders shall always have in their possession the identification card and shall produce it on demand by the Owner/Consultant representative. It shall be the responsibility of the Contractor to provide the identity cards after it has been duly certified by the Owner/Consultant. No welder shall be permitted to work without the possession of identity card.

7.0 ALIGNMENT

7.1 Immediately prior to line-up, the CONTRACTOR shall inspect the pipe ends inside and outside for damage, dents, laminations etc. Pipe for welding shall be set up correctly with proper spacing for the temperature changes during welding. Incorrect alignment shall in no circumstances be allowed at the position. Temporary attachments of any kind shall not be welded to the pipe. Welds joining the sections of the pipeline, valve installation or similar welds classified as tie-in welds shall be made in the trench. Otherwise, the alignment and welding shall be made alongside the ditch with the pipe supported on skids and pack pads or other suitable means approved by OWNER, at least 500 mm above the ground unless approved by the OWNER in specific cases.

7.2 For welded pipes, longitudinal weld seams of adjoining pipes shall be staggered such that a minimum distance of 150 mm is maintained along the circumference and both longitudinal welds are at top 90º quadrant of the pipeline (Except for bends). A longitudinal joint shall pass an appurtenance of a structural element at a minimum distance of 50 mm. However these shall not be applicable in case of a seamless pipe.

7.3 For pipe of same nominal wall thickness the off-set shall not exceed 1.6 mm. The off-set may be checked from outside using dial gauges. The welding shall be so located that the toe of the weld shall not come within 50mm of any other weld. Cold dressing is permissible only in cases of slight misalignment and may only be carried out with a bronze headed hammer. Hot dressing shall not be permitted.

7.4 The root gap shall-be accurately checked and shall conform to the qualified welding procedure. The use of internal Line-up Clamps is mandatory for pipe diameters 8" and above. However, in some cases (tie-in welds. flanges, fittings, small section etc.) where it is impossible to use internal Clamps, an external line-up clamp may be used.

7.5 The internal line-up clamp shall not be released before the entire root pass has been completed.

7.6 When an external line-up clamp is used, all spaces between bars or minimum 60% of the root pass length shall be welded before the clamp is released. The remaining pipe shall be adequately supported on each side of the joint.

Segments thus welded shall be equally spaced around the circumference of the pipe. Slag, etc. shall be cleaned off and the ends of the segments shall be prepared by grinding, so as to ensure continuity of the weld head.

8.0 JOINT PREPARATION

8.1 Before welding, all rust and foreign matter shall be removed from the bevelled ends by power operated tools at inside and outside edges for a minimum distance of 25mm from the edge of the weld bevel. Joints shall be swabbed with canvas belt or leather if required as per Owner/ Consultant's discretion. If any ends of the pipe joints are damaged to the extent that, in the opinion of Owner/ Consultant, satisfactory weld spacing cannot be obtained, and local repair by grinding cannot be successfully done, then the damaged ends shall be cut and bevelled to the satisfaction of the Owner/ Consultant, with an approved bevelling machine.

8.2 Manual cutting and repairing of bevels by welding is not allowed. In case laminations, split ends or inherent manufacturing defects are discovered in the pipe, then length of the pipe containing such defects shall be removed to the satisfaction of Owner/ Consultant. On pipes, which have been cut back, a zone extending 25 mm back from the new field bevel, shall be 100 % ultrasonically tested to the requirement of the line pipe specification to ensure freedom from laminations. The new bevel shall be 100% visual and 100% dye penetrate / MPI tested 100% UT. A report shall be made and records maintained for all testing. The re-bevelled pipe heat number identification shall be maintained by transferring information to the new pipe end. Where the pipe is to be field cut and welded, the shop-applied coating shall be neatly peeled and grounded for a distance of 100 mm from the weld.

8.3 The parts and joints being welded and the welding personnel shall be adequately protected from rain and strong winds. In the absence of such a protection no welding shall be carried out. All completed welding work shall be protected from bad weather conditions.

9.0 PRODUCTION WELDING

Production welding shall be performed as per qualified welding procedure. If any change in essential variables is made then a new welding procedure has to be established and qualified.

9.1 Welding Passes

a) Root pass is a critical welding activity, which shall be carefully carried out by the Contractor as per approved WPS. Root pass shall be made with branded electrodes/filler wires recommended in the qualified WPS. The size of the electrodes used shall be as per the approved welding procedure. It is recommend that immediately after the root pass the first hot pass is completed. However, Owner/Consultant's engineers at site can make this requirement mandatory as per site conditions.

b) Position or roll welding may be permitted. Separate procedures shall be submitted and qualified for up-hill, down-hill, vertical down and roll welding. Downhill welding shall be used when internal clamp is used. The vertical up method of welding shall be used for the root pass of the tie-ins, special crossings, fittings and special parts, fillet welds, repairs and when an external line up clamp is used. The downhill welding may be used for root run welding of tie-ins and special crossings when (i) the edges are machined or have equivalent preparation (ii) line up clamps are used and the fit up is geometrically and mechanically similar to one of the ordinary line welding without misalignment or unevenness.

c) Weld projection inside the pipe shall not exceed 2 mm.

d) Any deviations desired from the recommended welding technique and electrodes indicated in the WPS shall be adopted only after obtaining express approval of the Owner/Consultant.

e) Welding shall be continuous and uninterrupted during root pass. On completion of each run, craters, welding irregularities, slag, etc. shall be removed by stringing wire brush and chiseling. While the welding is in progress care shall be taken to avoid any kind of movement of the components, shocks, vibration and stresses to prevent occurrence of weld cracks.

f) The weld reinforcement shall not be in excess of 1/16” but the weld crown shall not be below the outside surface metal of the pipe.

g) Two welds shall not be started at the same location.

9.2 Joint completion

a) In general, single welder shall be used for welding of 6” pipe. The welding sequence shall be as per the qualified welding procedure specification. Once the deposit of the first pass has been started, it must be completed as rapidly as possible, reducing interruptions to the minimum. The welding and wire speed shall be approximately same as that established in the qualified welding procedure specification.

b) The interruption between completion of the first pass and starting the second pass shall be as stated in the procedure specification, normally not exceeding four minutes.

c) The time lapse between second and third pass shall be as stated in the procedure specification, normally not exceeding five minutes. Welding can be suspended, so as to allow the joint to cool down, provided that the thickness of the weld metal deposited is at least 50% of the pipe thickness. Upon restarting, preheating to at least of 100°C shall be carried out. Subsequent passes to weld completion shall be protected to avoid rapid cooling, if meteorological conditions so dictate. Cleaning between passes shall be done carefully so as to reduce the possibility of inclusions.

d) Electrode starting and finishing points shall be staggered from pass to pass. Arc-strikes outside the bevel on the pipe surface are not permitted, Arc-strike or arc-burn on the pipe surface outside the weld, which are caused accidentally by electrical arcs between the electrode, electrode holder,

welding cable or welding cable round and the pipe shall be removed by grinding in accordance with a procedure approved by Owner/Consultant and the repair checked by ultrasonic, radiographic, magnetic particle or dye penetrate tests which the Owner/Consultant feels necessary. The pipe wall thickness after grinding shall not be less than the minimum thickness limit permitted for the pipe. Repair of arc strikes by welding is prohibited.

e) Tie-in weld shall be completed without delays and shall not be left incomplete overnight.

f) All Fillet weld and branch connections shall be as per ASME B 31.8. Pipes of equal diameter but unequal wall thickness shall be welded either with the help of transition piece or per weld design for unequal thickness as specified in ASME B 31.8. The completed weld shall be carefully brushed and cleaned and shall appear free from spatters, scales, etc.

g) During welding operation the coating shall be protected from weld spatter burning either by using a 600mm wide asbestos blanket or by Owner/Consultant approved procedures. The protection device shall be placed 50mm from the weld centre.

10.0 HEAT TREATMENT

10.1 Preheating

a) Preheating requirement for the various materials shall be as per the welding specification chart.

b) Preheating shall be performed using resistance, induction/heating methods.

c) Preheating shall extend uniformly to at least three times the thickness of the joint, but not less than 50mm, on both sides of the weld. Preheating temperature shall be maintained over the whole length of the joint. During welding, temperature indicating crayons or other temperature indicating devices shall be provided by the Contractor to check the temperature.

d) Maximum interpass temperature shall be 250°C.

e) Pre-heating is also required prior to attachment of any branch connections or fittings on the line.

f) Asbestos blankets may be placed with the welds to slow the cooling rate as per procedure.

10.2 Post-weld heat treatment

a) The Heat treatment of welded joints shall be carried out as per the requirements laid down in ASME B.31.8 and other special requirements mentioned in approved WPS.

b) Post weld heat treatment shall be done by using an electric resistance or induction heating equipment, as decided by the Owner/Consultant.

c) While carrying out local post weld heat treatment, technique or application of heat must ensure uniform temperature attainment at all points on 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 as that specified in the relevant applicable standards/codes.

d) Throughout the cycle of heat treatment, the portion outside the heat 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 of the pipe shall not be allowed to exceed 400°C.

e) Contractor shall submit detailed procedure for post-weld heat treatment specifying the temperature measurement, minimum no. of thermocouples to be used, details of the equipment to be used, method of execution etc. for approval.

f) Automatic temperature recorders that have been suitably calibrated shall be employed. The calibration chart of each recorder shall be submitted to the Owner/ Consultant prior to starting the heat treatment operation and its approval shall be obtained.

g) Immediately on completion of the heat treatment, the post weld heat treatment charts/records along with the hardness test results on the weld joints (whenever required as per the welding specification chart) shall be submitted to Owner/ Consultant for approval.

h) Proper identification of weld joint shall be maintained and same shall appear on the corresponding post weld heat treatment charts and in corresponding radiography films.

i) Hardness of the heat affected zone as well as of the weld metal, after heat treatment shall be measured using a suitable hardness tester by Vickers or Brinnel and shall not exceed the maximum hardness specified in the specification. The weld joint shall be subjected to reheat treatment, when hardness measured exceeds the specified Limit by the Contractor at his own expense.

11.0 INSPECTION & TESTING

11.1 Welding Procedure Qualification

For welding procedure qualification tests, standard tests as specified in the API 1104 shall be carried out in all cases. In addition to these tests, other tests like radiography, macro/micro examination, hardness tests, Dye penetrate examination, Charpy V-notch etc. shall be carried out on specimens as per this specification. It shall be the responsibility of the Contractor to carry out all the tests required to the satisfaction of the Owner/consultant Inspector. The destructive testing of welded joints shall be as per Annexure-1.
Contractor shall proposed WPS and Procedure qualification test to be carried out as per API 1104.

Only approved make electrodes to used.

11.2 Visual inspection of the weld joint

Inspection of all welds shall be carried out by Owner/Consultant as per the latest editions of the applicable codes and specifications. All finished welds shall be visually inspected for alignment, excessive reinforcement, concavity of welds, shrinkage, cracks, under-cuts, dimensions of the weld, surface porosity and other surface defects. Under-cutting adjacent to the completed weld shall not exceed the limits specified in the applicable standard/code.

11.3 Non Destructive Examination

a) The non-destructive examination shall mainly consist of Radiographic examination and Ultrasonic Testing of the weld as detailed in Annexure-2.

b) Radiographic examination of all girth welds with 100% coverage of the weld shall be done as per requirement. All welds shall meet the criteria as set forth in API 1104 and as modified in this specification below

Cracks	Cracks of any type size and shape including crater cracks are not acceptable.
Incomplete root penetration	Not acceptable
Lack of fusion at the root	Not acceptable
Burn through	Not acceptable
Excess weld penetration (internal)	> 2mm Not acceptable
Excess weld reinforcement (External)	> 3mm Not acceptable

c) Any weld which as a result of radiographic and/or ultrasonic examination in the opinion of Owner/Consultant exhibits imperfections greater than the limits stated in API-1104 latest edition or as superseded in this specification above shall be considered defective and shall be marked with an identification paint marker.

d) The Contractor shall make all the arrangements for the radiographic examination of work covered by the specification at his expense.

e) The Owner/Consultant will review all the radiographs of welds and inform the Contractor regarding unacceptable welds. The decision of the Owner/Consultant shall be final and binding in this regard.

f) Ultrasonic inspection is required when 20mm or more are cut from the pipe. The pipe end as supplied shall be ultrasonically inspected for an additional length of 50 mm to assure no lamination exists.

i) In addition, ultrasonic inspection may be required for certain critical welding of the pipeline (i.e. tie-ins, welding of valves, flanges) randomly selected at Owner/Consultant's discretion. All tie-in welds shall be ultrasonically tested in addition to RT. All fillet and groove welds other than those, which are not radio graphically or ultrasonically examined, shall be examined by Dye Penetration or Magnetic Particle inspection techniques.

j) In case of gas cutting of pipe end, ultrasonic inspection shall be done for lamination/ checking before welding of Tie-in joints.

k) The Owner/ Consultant must approve all non-destructive test systems used for inspecting welds.

l) Suitable records shall be maintained by the Contractor as desired by the Owner/Consultant on the day-to-day work done on welding radiography and ultrasonic testing. The Contractor shall present the records to the Owner/Consultant on a day-to-day basis and whenever demanded for approval.

11.4 Destructive testing

a) The COMPANY has the authority to order the cutting of up to 0.1% of the total number

of welds completed for destructive testing at no extra cost of COMPANY.

b) If one production weld fails to conform to the specified requirements, the Contractors shall cut two additional weld joints from either side of the failed one and shall carry destructive testing as per the specification requirement. If both the joints fail the destructive examination, the entire length of pipeline under investigation shall be removed and the entire weld has to be cut and re-weld to the satisfaction of the OWNER/ CONSULTANT after conducting a root cause analysis.

c) Along with production weld destructive testing, base metal from same location shall also be removed and tested for all properties (Chemical and Mechanical) which are already performed in pipe mill except DWTT for verification, validation and acceptance.

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12.0 REPAIRS OF WELDS

12.1 With the prior permission of Owner/Consultant welds which do not comply with the standards of acceptability, shall be repaired or the joint cut out and re-welded.

A separate welding procedure specification sheet shall be formulated and qualified by Contractor for repair welds simulating the proposed repair to be carried out. Separate procedures are required to be qualified for (a) through thickness repair (b) partial thickness repair. The root pass, for repairs opening the root, shall be replaced by the vertical uphill technique. The procedure shall be proven by satisfactory procedure tests pertaining to AP1-1104 including the special requirements of the specification, and shall also be subjected to metallographic examination, hardness surveys and Charpy tests to determine the effects of repair welding on the associated structure.

Root sealing or single pass repair deposit shall not be allowed. Internal root defects shall be grounded thoroughly and welded with a minimum of two passes. However, while grinding for repairs, care shall be taken to ensure that no grinding marks are made on the pipe surface anywhere. LPT shall be carried out to confirm removal of repair before welding.

The repair weld shall be subjected, as a minimum requirement, to the same testing and inspection requirements as the original weld, the entire joint shall be re-radiographed. A 100% ultrasonic inspection shall be done at the repaired area externally. Any repaired area that is wide, irregular or rough shall be rejected and a full cut out shall be done. The repair welding shall have a minimum preheat of 100ºC and shall be preheated for at least 150 mm on either side of repair.

Welds not meeting the specification after one repair shall be cut out. A report of all repairs shall be maintained by Contractor. All repairs shall be carried out on the day after initial radiography or earlier. A full report of all repairs made shall be submitted every day to the Owner/Consultant.

12.2 Elimination of repairs

Only one attempt for repair of any region is permitted. Repairs are limited to a maximum 30% of the weld length. For internal repairs or external repairs which open the weld root, only 20% of the weld length may be repaired. Repairs opening the root must only be carried out in the presence of Owner/Consultant. The minimum length of a repaired area shall be 100mm as measured over the-recapped length. Welds containing cracks shall be cut out and rebevelled to make joint. Owner/Consultant shall authorize all repairs.

12.3 Weather condition

Welding shall not be done in open areas during blowing sands, dust storms, high winds, rains or where relative humidity is higher than 75%. Welding at ambient temperature below 5ºC shall be done only with specially qualified procedure with controlled heating and cooling practices.

12.4 Marking

The Contractor according to the numbers assigned to the welders shall mark all welds on the top quarter of the pipe adjacent to the weld. Metallic dies shall not be used to mark on the pipe. Contractor shall furnish to Owner/ Consultant with all records of welder numbers and Joint numbers.

ANNEXURE – 1

1.0 DESTRUCTIVE TESTING OF BUTT WELDED JOINTS

1.1 Preparation

After the visual and the non-destructive inspection, the test weld shall be subjected to mechanical test.

After satisfactory completion of all visual and non-destructive testing the procedure test weld shall be set aside for a period not less than 72 hour. No further work on the test weld and no cutting of test specimens from the weld shall be performed until a period or at least 72 hours has expired.

Weld specimens shall be taken from the positions as per approved WPS. In addition to API 1104 tests the following tests of minimum numbers to be carried out as tabulated low:-

Type and Number of Test Specimens for Procedure Qualification Test and Production Welds

PIPE SIZE, OUTSIDE DIAMETER-INCHES	**NUMBER OF SPECIMENS**		
	MACRO	**HARDNESS**	**IMPACT**
Wall thickness- under ½ inch			
Under 2.375	0	0	0
2.375 to 4½	0	0	0
Over 4½ less than 12¾	2	2	12
12 3/4 and over	2	2	24
Wall thickness-over ½ inch			
4-½ and smaller	0	0	0
Over 4 1/2 less than 12¾	2	2	12
12¾ and over	2	2	24

Macro and hardness shall be carried out, generally at the top and bottom of the joint suitably as per approved WPS.

The test shall be carried out at laboratories approved by the Owner/Consultant. The specimens shall be prepared in accordance with the relevant standard code requirements.

1.2 Tensile strength

Specimens shall be taken from the position as per approved WPS. The test shall be carried out in accordance with API 1104. Acceptance Criteria shall be as per API 1104.

1.3 Nick-break test

Specimens for nick-break test with notches, thus worked, can break in the base metal, instead of in the fusion zone; therefore an alternative test piece may be used after authorization by the Owner/ Consultant with a notch cut in the reinforcement of outside weld head to a maximum depth of 1.5 mm, measured from the surface of the weld head.

Acceptance Criteria shall be as per API 1104.

1.4 Macroscopic Examination

Specimens shall be taken from the positions as indicated in the approved WPS and shall be prepared in accordance with ASTM E2 and E3. One of the specimens shall be taken from the T-intersection at the line pipe seam weld.

The width of the macro-section has to be at least three times the width of the weld. The section is to be prepared by grinding and polishing and etched to clearly reveal the weld metal and heat affected zone.

Specimens shall be carefully examined under the microscope, with a magnification of at least 25 (25:1).

Owner/Consultant reserves the right to ask for a micrograph with 5 times (5:1) magnification, for Documentation purposes.

Under macroscopic examination, the welded joints shall show good penetration and fusion, without any defect exceeding the limits stated in the evaluation criteria of the Nick Break test.

1.5 Hardness Test

The prepared macro-section is to be used for hardness testing using the Vickers method (HV10). Test shall be made on selected specimen of weld joint. These series of reading shall be extended from unaffected base metal or one side across the weld to unaffected base metal on the other side. Three transverse shall be made as follows - first 2 mm from the outer edge, the second across the centre and third 2 mm from the inner edge. The specimen between the hardness impressions shall be 0.75 mm. The hardness impression nearest the fusion line shall be within 0.5 mm.

Hardness value shall not exceed 235 HV10 or as specified in approved WPS.

All the hardness values contained from the heat affected zone shall not exceed 40 HV with respect to the average hardness values obtained for the base metal. If these additional tests give hardness within the specification limit the slightly higher value may be accepted.

1.6 Charpy-V-notch Impact test

Specimens shall be taken from the position as per approved WPS. The test shall be carried out in accordance with ASTM-370.

Five test specimens shall be taken from each sample and they shall be cut and worked so that their length is transverse and perpendicular to the weld bead with the notch position. The notch shall be perpendicular to the rolled surface. The test specimen width shall depend upon the pipe wall nominal thickness as following:

Nominal wall thickness in mm	Test specimen width in mm
6.4	2.5

The test shall be carried out as in accordance with ASTM-370.

Test pieces shall be immersed in a thermostatic bath and maintained at the test temperature for at least 15 minutes. They shall then be placed in the testing machine and broken within 5 seconds of their removal from the bath.

The test temperature shall be 0º and -20 °C.

The acceptable values of the impact energy shall be as follows:

Temp (° C)	Average of three specimens (Note 2) Joules (Minimum)	Any single value (Note1) Joules (Minimum)
0	100	80
-20	35	28

Note:

1. These values are specified for resistance to brittle fracture only. Where additional requirements are specified by Owner/Consultant, the same shall be followed.

2. Two samples of the highest and lowest values shall be discarded.

1.7 Bend test requirements

The Bend test Specimens shall be made and tested as per the requirements of API 1104.

The acceptance criteria shall be as per API 1104.

ANNEXURE-2

1.0 ULTRASONIC INSPECTION

Ultrasonic inspection is required to be performed on the pipeline field welds as per conditions listed in this specification. This section concerns manual ultrasonic Inspection. However ultrasonic inspection by automatic equipment shall be used only with Owner's/consultant's approval.

1.1 Equipment and Operators

The operators shall be qualified by a Third Party Inspection Authority. All operators shall be qualified as per AST-SNT-TC-1A minimum level II.

The Owner/Consultant has the option of checking the ability of personnel employed for ultrasonic testing by means of qualification tests.

1.2 Specification for Ultrasonic Testing Procedure Qualification

Before work begins, the Contractor shall present a specification describing the proposed procedure qualification and calibration methodology.

This specification shall state, as an indication only but not limited to the following information:

- Type of UT equipment used
- Details for calibration
- Type and dimensions of transducers
- Frequency range
- Coupling medium
- Inspection technique
- Record details
- Reference to the welding procedure where it is intended to adopt the weld location.
- Temperature range of the joints to be inspected.

The ultrasonic inspection procedure shall be approved by the Owner/ Consultant. The Contractor shall make welds (according to the same production procedure) having typical defects which are intended to be detected by ultrasonic testing.

This test shall be conducted in the presence of the Owner/ Consultant. The Ultrasonic inspection procedure shall be approved by the Company.

1.3 Test procedure

Circumferential welds shall be inspected from both sides using angled probes.

If, during the test, echoes of doubtful origin appear, it shall be necessary to inspect a convenient area on the pipe surface, close to the weld, with a straight beam transducer in order to check whether any manufacturing defects are present which could have interfered with the ultrasonic beam.

The equipment shall include but not be limited to the following:

– Ultrasonic equipment and coupling medium

– Sample sections for calibration of instruments
– Equipment for cleaning of surface to be examined
– Rules calibrated in centimeters for exact location of the position of defects.

1.4 Reference Blocks

The efficiency of the equipment used, the effective refraction angle of the probe, and the beam output point, shall be checked using a V_1 and V_2 sample block, IIW type or the calibration block ASTM E-428.

1.5 Amplification during production testing

The amplification during production testing shall be obtained by adding 2-6 dB (according to the surface condition of the pipe and its cleanliness) to the reference amplification.

1.6 Qualification of Ultrasonic Testing Operators

At any time during the project, Owner/ Consultant may ask for a qualification test for the ultrasonic equipment operator. Minimum qualification of the operator shall be ASNT-Level–II.

1.7 Evaluation of indications given by ultrasonic tests

Each time that echoes from the weld head appears during production testing, the instrument amplification shall be altered to coincide with the reference amplifications and the probe shall be moved until maximum response is obtained, paying attention all the time to the probe-tube coupling.

If under these conditions, the height of the defect echo is equal to or greater than that of the reference echo, the defect shall be evaluated according to section 15.4 of this specification. If the detect has also been detected by the radiographic and/or visual examination, the dimensions shall be judged according to the type of examination which detects the greater defect. Returns which are less than 50% of the reference echo will not be considered. If returns are above 50% but lower than 100% of the reference echo, and if the operator has good reasons to suspect that the returns are caused by unfavorably oriented cracks, he shall inform the Owner/Consultant. Moreover, when there is a defect to be repaired, such defect shall be removed for a length corresponding to the one where no more return echo is given.

1.8 Other equipment

The use of rules calibrated in centimeters, attached if possible to the probe, for the precise location of the position of welding defects, is recommended. Defect location is effected by measuring the projection distance between the probe output and the reflecting surface.

The operators carrying out the tests shall have, besides the probing instrument, tools for cleaning the pipe surface (tiles, brushes, etc.) as well as the coupling liquid or paste appropriate for the temperature of the section to be examined.

2.0 RADIOGRAPHIC TESTING

2.1 Proposed Radiographic examination procedure shall be submitted by the Contractor for approval.

2.2 The procedure of radiographic examination shall be qualified to the entire satisfaction of Owner/Consultant prior to use. It shall include but not be limited to the following requirements

i) Only Lead foil intensifying screens, at the rear of the film shall be used for all exposures.

ii) Type 2 and 3 films as per: ASTM E-94 shall be used.

iii) A densitometer shall be used to determine film density. The transmitted film density shall be between 2.0 and 3.5 throughout the weld. The unexposed base density of the film shall not exceed 0.30.

iv) Radiographic identification system and documentation for radiographic interpretation reports and their recording system.

v) Film type and brand, film processing methods, exposure conditions (kV, mAmin, Cmin).

vi) Type of penetrameters, Radiographic technique and number of exposures.

vii) Type of radiation source (power, local spot size etc).

viii) Diameter and thickness of pipe to be inspected and weld/welder numbering system,

2.3 The Contractor shall qualify each procedure in the presence of the Owner/Consultant prior to use.

2.4 All the girth welds of mainline shall be subjected to 100% radiographic examination. Each weld shall be clearly and permanently numbered adjacent to weld or down stream side.

2.5 When the radiation source and the film are both on the outside of the weld and located diametrically opposite each other, the maximum acceptable length of film for each exposure shall not exceed the values given in API 1104. The minimum film overlap, in such cases, shall be 40mm. The ellipse exposure technique may be used on nominal pipe sizes of 2 inch and smaller provided that the source of film distance used is a minimum of 12 inch. When such a procedure is used exposure of 90º to each other shall be obtained.

Penetrameters shall be placed on both source and the film side. The sensitivity level achieved shall be satisfied by penetrameter on the source side.

2.7 Films shall have no fogs, spots or makes and shall not be exposed to back scatter radiation. All weld spatter, debris, foreign matter and other detects which interferes with the interpretation of the radiograph shall be removed from the weld area.

2.8 Three copies of each acceptable radiographic procedure and three copies of radiographic qualification records shall be supplied to Owner/Consultant. One set of the qualifying radiographs on the job shall be kept by the Contractor's authorized representative to be used as a standard for the quality of production radiographs during the job. The other two sets shall be retained by Owner/Consultant for its permanent record.

2.9 Three copies of the exposure charts relating to material thickness, kilo voltage, source of film distance and exposure time shall also be made available to Owner/Consultant by the Contractor.

2.10 The Contractor shall provide all the necessary facilities at site, such as a dark room with controlled temperature, film viewer etc. to enable the Owner/Consultant to examine the radiographs.

2.11 The Contractor, if found necessary, may modify the procedure of radiographic examination suiting to the local conditions prevailing. This shall, however, be subject to the approval of the

owner/Consultant. Owner/Consultant shall have live access to all the Contractor's work facilities in the field.

2.12 Any approval granted by the Owner/Consultant shall not relieve the Contractor of his responsibilities and guarantees.

2.13 Radiation source

Radiographic examination shall be carried out using X-radiation's. Radiographic examination by Gamma rays may be allowed, at the discretion of the OWNER, in ease of inaccessible joints. X-ray equipment shall have sufficient power (voltage and current) for the diameter and thickness of the pipeline to be inspected.

2.14 Level of quality

The quality level of Radiographic sensitivity required for radiographic inspection shall be 2%.

2.15 Penetrameters

The image quality indicator (abbreviation: IQI) shall be used for the qualification of the welding procedure and during normal line production. Radiographic sensitivity shall be measured with the wire image quality indicator (Penetrameter). The penetrameter shall be selected according to DlN54109 or IS01027. The placement of the penetrameter shall be as per approved procedures.

The sensitivity limit may be considered to have been reached when the outline of the IQI, its identification number and the wire of the required diameter show up clearly on the radiograph.

The Owner/consultant may authorize use of types of IQI other than those planned, provided that they conform to recognized standards and only if the Contractor is able to demonstrate that the minimum sensitivity level required is obtained. For this demonstration, a test shall be carried out comparing the lQI specified and the Contractor's to show up the identification number and other details of the proposed IQI, which must be visible in the test radiograph.

2.16 Film Identification Markers

All films shall be clearly identified by lead numbers, letters, and/or markers. The image of the markers shall appear on the films, without interfering with the interpretation. These markers positions shall also be marked on the part to be radio graphed and shall be maintained during radiography.

2.17 Protection and Care of Film

All unexposed films shall be protected and stored properly as per the requirements of API 1104 standard and ASTM E.94.

The exposed and unexposed film shall be protected from heat, light, and dust and-moisture. Sufficient shielding shall be supplied to prevent exposure of film to damaging radiation prior to and following the use of the film for radiographic exposure.

Film processing (development, fixing, washing etc.) shall comply with supplier’s requirements and as per ASME Section V SE-94.

2.18 Re-Radiography

The weld joints shall he re-radiographs in ease of unsatisfactory quality of the radiographs, at the expense of the Contractor.

All the repaired weld joints shall be re-radio graphed at no extra cost to the Owner/Consultant in the same manner to that followed for the original welds. In addition, the repaired weld areas shall be identified with the original identification number plus the letter R to indicate the repair.

When evaluating repair film, radiographers shall compare each section (exposure) of the weld wall the original film to assure repair was correctly marked and original defect removed.

The Owner/Consultant will review prior to any repair of welds, all the radiographs of welds which contain, according to the Contractor's interpretation unacceptable defects. The final disposition of all unacceptable welds shall be decided by the Owner/Consultant.

2.19 Qualification of Radiographers

Pipeline radiographers shall be qualified in accordance with the requirement of API 1104 and to the full satisfaction of Owner/Consultant and as per AST-SNT-TC-1A Level II.

Certification of all the radiographers, qualified as per above, shall be furnished by the CONTRACTOR to the Owner/Consultant before a radiographer will be permitted to perform production radiography. The certificate record shall include:

The radiographers shall be required to qualify with each radiographic procedure they use, prior to performing the work assigned to him in accordance with the specification.

2.20 Preservation of Radiographs

The radiographs shall be processed to allow storage of films without any discoloration for at least three years. All the radiographs shall be presented in suitable folders for preservation along with necessary documentation.

All radiographs shall become property of the Owner/ Consultant.

2.21 Equipment and Accessories

Contractor shall make necessary arrangements at his own expense, for providing the radiographic equipment, radiographic films and all the accessories for carrying out the radiographic examination for satisfactory arid timely completion of the job. The Contractor shall be responsible for obtaining necessary permits regarding, holding use and transport of sources.

2.22 Radiation Protection

Contractor shall be responsible for the protection and personnel monitoring of every man with or near radiation sources.

The protection and monitoring shall comply with local regulations. Contractor shall be responsible for complying with all rules and regulation set forth by Atomic Energy Commission or any other Government of India agencies in this regard and Owner/Consultant shall not be responsible. Owner/Consultant shall be kept indemnified at all times by the Contractor.

2.23 Safety Instructions

The safety provisions shall be brought to the notice of all concerned by display on a notice board at prominent place at the work spot. The person responsible for the "safety" shall be named by the Contractor.

3.0 MAGNETIC PARTICLE & DYE PENETRANT TESTING

3.1 For welded joints and for detection of surface defects that cannot be radio graphed or ultrasonic tested either dye penetrant or magnetic particle inspection shall be called out after approval of the Owner/consultant.

3.2 The procedure for magnetic particle examination shall contain as a minimum the following information for approval by the Owner/consultant.

- Type and size of material to be examined.
- Type of magnetization and equipment
- Type of ferromagnetic particles used
- Method of surface preparation
- Magnetization current
- Type of ferromagnetic particle used.

3.3 The area being examined shall be magnetized in at least two direction perpendiculars to each other. The non-fluorescent particles (wet order) shall have sufficient contact with respect to the surface to be examined.

3.4 The surface to be examined shall be made free of grease, dirt, oil, scale, oxides, etc.

3.5 MPE shall not be performed on parts whose temperature exceeds 300°C.

3.6 Magnetic particle operators and dye penetrant shall be qualified to ANSI-SNT-TC-1A Level II or equivalent as approved by Owner/ Consultant.

3.7 Dye penetrant examination procedure shall also be submitted to Owner/ Consultant for approval.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR CONCRETE WEIGHT COATING

GAIL-STD-PL-DOC-TS-003

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1.0 SCOPE

This specification defines the minimum technical requirements for the materials, workmanship, application, inspection, handling and other activities for anti-buoyancy measures using external concrete weight coating of pipeline.

2.0 CODES AND STANDARDS

Reference has been made in this specification to the following codes and standards:

a)	PNGRB Regulation	:	T4S Regulation, Petroleum and Natural Gas Regulatory Board
b)	ASTM A-185	:	Specification for Steel Welded Wire Reinforcement, Plain for Concrete Reinforcement
c)	ASTM C-642	:	Test Method for Specific Gravity, Absorption and Voids in Hardened Concrete
d)	ASTM C-138	:	Test Method for Unit Weight, Yield and Air Content of Concrete
e)	ASTM C-309	:	Specification for Liquid Membrane Forming Compounds for Curing Concrete
f)	ASTM A-82	:	Specification for Steel Wire, Plain, for Concrete Reinforcement
g)	ASTM C-39	:	Test Method for Compressive Strength of Cylindrical Concrete Specimens
h)	IS - 269	:	Indian Standard Specification for Ordinary and Low Heat Portland Cement (1959; Reaffirmed1999)
i)	IS – 456	:	Plain and Reinforced Concrete – Code of Practice (3rd Revision – 2000)
j)	IS – 6909	:	Indian Standard Specification for Super Sulphated Cement (1990; Reaffirmed 1997)
k)	IS-8112	:	Indian Standard Specification for Ordinary Portland Cement
l)	IS-383	:	Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete
m)	IS-2386 (PART I thru' VIII)	:	Indian Standard Methods of Test for Aggregates for Concrete
n)	IS-516	:	Method of Test for Strength of Concrete
o)	IS:1566	:	Indian standard for Hard-drawn steel wire fabric for concrete reinforcement

3.0 MATERIALS

The Contractor shall supply all the materials necessary for the performance of the work.

All materials supplied by the Contractor, which in the opinion of Owner, do not comply with the appropriate specifications shall be rejected and immediately removed from site by Contractor at his own expense.

All materials for concrete coating shall comply with following requirements.

3.1 Cement

3.1.1 Portland Cement (conforming to IS-269), or High Strength Ordinary Portland Cement (conforming to IS-8112) shall be used. Cement which has hardened or partially set or has become lumpy shall not be used. Test certificates from the cement Manufacturer shall be supplied to the COMPANY for all cement delivered to site.

3.1.2 Super sulphated Cement shall be (conforming to IS 6909) used wherever the soil is corrosive.

3.1.3 Cement which is more than six months old shall not be acceptable.

3.1.4. Test Certificates from the cement Manufacturer shall be supplied to the GAIL /GAIL representative for all batches of cement delivered to site.

3.1.5. In case concrete weight coating is to be provided at location affected by seawater tidal flats etc. Portland cement in accordance with ASTM C-150 Type III shall be used.

3.2 Aggregates

3.2.1 Aggregate shall comply with the requirements of IS: 383 and shall be tested in accordance with IS:2386. Aggregates shall be clean and free from injurious amounts of salt, alkali, deleterious substances or organic impurities.

3.2.2 Fine Aggregates

'Fine Aggregates' shall mean any of the following, as defined in IS: 383:

i) Natural sand;
ii) Crushed stone sand;
iii) Crushed gravel sand;

Sand shall be well-graded from fine to coarse in accordance with Table 4 of IS: 383.

3.1.3 Coarse Aggregates
Use of coarse aggregates shall be subjected to Owner's approval.

3.3 Water

The water shall be fresh and clean and shall be free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. It shall not contain chlorides, sulphates, and magnesium salts. Water from each source shall be tested by the Contractor before use and the test reports shall be submitted to the GAIL /GAIL representative for approval.

Water from source shall be tested by the Contractor at his own expense before use and the test reports shall be submitted to the Owner's representative for approval.

3.4 Reinforcement

Concrete coating shall be reinforced by a single layer or multiple layers of steel reinforcement according to the provisions hereinafter described. Reinforcement shall be Fe 415.

3.4.1 Reinforcement shall consist of welded steel wire fabric manufactured in rolls (ribbon mesh) or in flat sheets and shall conform ASTM A-185. Steel wires in the ribbon mesh shall conform to ASTM A-82.

3.4.2 Steel wires shall be galvanized at finished size. The diameter of the wire and wire spacing (mesh) dimensions shall be selected according to the following criteria.

3.4.2.1 Wire fabric manufactured in rolls (ribbon mesh) shall be 25 x 50 mm of 14 gauge U.S. steel wires (2mm wire). The above dimensions will be applied unless otherwise specified by Owner.

3.4.2.2 Wire fabric manufactured in flat sheets shall be 50 x 100mm max. steel wire mesh, 13 gauge 2.5mm thickness. As a rule wire fabrics (sheets) shall be used when concrete coating is applied by casting method, while ribbon mesh (rolls) shall be used when concrete coating is applied by impingement method.

4.0 COATING REQUIREMENTS

Pipes shall be concrete coated to a thickness as specified in the relevant drawings and as per the design documents. CONTRACTOR shall be permitted to select any proportioning of materials to achieve the specified requirements of concrete density and weight by doing mix

design and trial tests.

Concrete shall conform to the following standards:

Property	Minimum Acceptable Value
Concrete Density	2400 Kg/m^3
Compressive Strength (After 7 Days)	170 Kg/cm^2
Compressive Strength (After 28 Days)	250 Kg/cm^2

5.0 APPLICATION METHOD

Concrete coating shall be applied by casting or impingement method. Any alteration or modifications to the method described in the specification shall be submitted to the Owner for approval. The application method shall however ensure the basic characteristics of concrete coating in compliance with the minimum requirements of this specification. To avoid slippage between the concrete and the anti-corrosion coating, precaution shall be taken, contractor to submit the detailed procedure.

Contractor shall submit to the OWNER, prior to commencement of work, the procedure of concrete application for approval.

Wherever practical, the specified total thickness of concrete coating shall be applied in a single pass.

6.0 EQUIPMENT

The equipment used for performing the concrete coating shall be capable of doing so with a reasonable degree of uniformity with respect to density, thickness and strength. The proportioning equipment and procedure shall be of the type to ensure consistently proportioned materials by weight. Concrete shall be mixed in a mechanical mixer, which shall ensure thorough mixing of all materials. Any equipment that tends to separate the ingredients shall not be used.

7.0 MEASUREMENTS & LOGGING

Contractor shall submit detailed methodology in their procedure for measurement and logging. All Measurements as mentioned below shall be taken during the work stages and clearly logged in a proper logbook. A special logbook shall be used for recording tests and trial results. A logbook shall refer to pipe lengths having the same nominal diameter, and wall thickness.

7.1 The logging methodology shall include minimum the following details:

a) Line pipe

1) Field identification number
2) Mill serial Number
3) Length (m)
4) Average outside diameter (mm)
5) Weight (Kg)

b) Corrosion Coating

1) Type of coating
2) Thickness of coating (mm)
3) Weight of coated pipe (kg)
4) Date of corrosion coating application

c) Concrete Weight Coating

1) Batch identification number
2) Date of placing of concrete coating.
3) Average concrete coating thickness.
4) Wet weight of coated pipe (weight and date of weighing)
5) "Dry weight" of concrete coated pipe
(Weight and date of weighing or related weight 28 days after placing of concrete and so identifiable).
6) "Unit dry weight" of concrete coated pipe.
7) "Negative buoyancy" (unit) of concrete coated pipe

7.2 No concrete placing shall be done before items 1 to 5 listed in 7.1(a) have been logged. In addition, each batch / shift shall be identified and logged against cube samples taken for compressive strength and dry density.

8.0 PROCEDURE QUALIFICATION

Before commencement of the work, Contractor shall perform all tests, either in the laboratory or in field to properly select type of mix, which meets the requirements of section 5.0 of this specification.

8.1 The type of mix, i.e., the correct combination of the cement, aggregates and water which results in the desired properties of concrete shall be first determined. For each mix the following shall be accurately checked and recorded:

i) Proportions and weights of the respective materials used
ii) The water/ cement ratio
iii) The grading of the aggregates.

8.2 Samples shall be prepared and tested in accordance with ASTM C-642 to determine the dry specific gravity (28 days after placing).

8.3 When the results of the above tests do not meet the requirements, the mix shall be modified and concrete samples tested until a proper mix has been determined.

8.4 The mix so determined shall then be used for sampling of concrete to be submitted to compressive strength tests as per IS 516.

8.5 Frequency of sampling for tests for density and compressive strength of concrete shall be as follows:

Quantity* of Concrete (m^3)	**Number of Samples**
Up to 25	3
26 to 50	4
51 and above	4 samples and one additional sample for each additional 50 m^3 or part thereof.
* Quantity is the volume of concrete to be used for each qualified mix.	

9.0 APPLICATION OF REINFORCEMENT AND CONCRETE COATING

9.1 Two test cubes each per day shall be obtained from batches and tested at the end of 7 days after coating, for compressive strength and specific gravity. Additional samples may be required at the discretion of Client/Consultant/TPI for various purposes such as to determine the strength of concrete at the time of striking the formwork, or to determine the duration of curing or to check the testing error.
Additional samples may also be required for testing samples cured by accelerated methods as described in IS 9103. The specimen shall be tested as described in IS S16.

9.2 The moisture content of the aggregates used shall be such as to maintain a satisfactory control on the water / cement ratio of the concrete mix.

9.3 To maintain the water / cement ratio constant at its correct value, determination of moisture contents in both fine aggregates and coarse aggregates (if used) shall be made as frequently as possible. Frequency for a given job shall be determined by the Owner according to weather conditions.

9.4 Reinforcement application

9.4.1 Prior to placing of reinforcement, the protective coating of each pipe length shall be carefully inspected visually and by holiday detectors. If damages are found, they shall be repaired before start of the work. Foreign matters, if any, shall be removed from the surface of the protective coating.

9.4.2 Reinforcement shall be placed around the pipe in such a way as to cover whole pipe length or sections to be concrete coated. The reinforcement shall protrude a minimum 75 mm from the finished concrete coating at the pipe ends.

9.4.3 Splices and attachments shall be done by binding with steel wire having 1.5mm diameter.
Circular and longitudinal joints of wire fabric in sheets shall be lapped at least for one mesh. The spiral lap shall be one mesh while the spliced lap shall be three meshes.

9.4.4 Reinforcement shall rest on synthetic resin spacers forming a "Crown" whose number shall be such as to avoid contact of the steel reinforcement with the pipe's protective coating. Spacing between the two consecutive 'crown' centres shall be 500 to 1000 m.

9.4.5 One layer of reinforcement steel shall be provided for concrete thickness up to 60 mm. The reinforcement steel shall be embedded approximately midway in the concrete coating thickness. For concrete thickness above 60mm two layers of reinforcing steel shall be provided. If application method requires more than one pass of concrete, one reinforcement layer for each pass is to be applied irrespective of the concrete coating thickness.

9.5 Concrete placing

9.5.1 Concrete shall be placed within a maximum of 30 minutes from the time of mixing (adding water to mix) and shall be handled in such a way so as to prevent aggregate segregation and excessive moisture loss. Concrete containers shall continuously be kept clean and free from hardened or partially hardened concrete.

9.5.2 Placement of concrete shall be up to the specified thickness in one continuous course, allowance being made for splices of reinforcement and providing reinforcement in the right location.

9.5.3 No passes shall be stopped for more than 30 minutes. Before placing fresh concrete against the joint, the contact surfaces shall be carefully cleaned and wetted to obtain a good bond between the fresh material and the previously placed material.

9.5.4 All pipes shall be kept clean and free from cement, concrete and grout either inside or outside of the uncoated sections.

9.5.5 The coatings at each end of the pipe shall be bevelled to a slope of approximately two-to-one (2:1).

9.5.6 Bevel protectors shall be kept in place throughout the coating application and even after the coating is complete.

Suitable means shall be provided to ensure that the temperature of the concrete, when placed, does not exceed 32°C.

9.6 Winter concrete coating

9.6.1 In ambient temperatures below 4 °C concrete must be protected from the effects of frost by warming the aggregates and / or warming of the mixing water and additionally ensuring an air temperature of 6 °C in the vicinity of the concrete.

9.6.2 Storing and curing of coated pipe shall not take place at temperatures below 1.5 °C, until the concrete has aged sufficiently to have achieved a crushing strength of at least 10 N/mm^2.

9.7 Reclaimed concrete

9.7.1 Use of reclaimed rebound shall be done only with the written permission of the Owner and to the satisfaction of the Owner's inspector.

9.7.2 When use of reclaimed rebound is permitted by the Owner, this material shall be added to and thoroughly intermixed with freshly batched concrete in a secondary mixture of a type, acceptable to the Owner's representative.

9.7.3 The amount of reclaimed material used shall not exceed 5% of the total mix by weight and shall only be added in an even flow during a continuous coating operation.

9.8 Cut back on concrete coating

Both ends of each joint for the distance of 250mm or as specified in the Contract document shall be completely free of concrete to facilitate field joints.

9.9 Handling after application

Contractor shall take precautions to prevent detrimental movement of pipe after coating and to minimize handling stresses whilst concrete is hardening and curing.

Identity of each pipe shall be preserved during and after the coating process by transfer of pipe information to and outside of concrete coating at each end of the all pipes.

9.10 Curing

9.10.1 Immediately after concreting, the exposed surfaces of the concrete shall be protected during hardening from the effects of sunshine, drying winds, rain, etc., and then after the initial set has taken place, the concrete coating shall be properly cured. The coated pipe section shall be handled gently by suitable means to prevent undue distortion.

9.10.2 Curing shall be performed by application of an approved curing membrane using sealing compounds and shall meet the requirements of ASTM C-309. The curing compound material shall be stored, prepared and applied in strict conformity with the instructions of the Manufacturer. The ingredients of any such compound shall be non-toxic and non-inflammable and shall not react with any ingredient of the concrete, the reinforcement, the anti-corrosion coating or steel pipe. The application of the curing compound shall be done immediately after the coating is completed and preferably before the pipe is removed from the concrete coating apparatus. The surface of the concrete shall be lightly sprayed with water before applying the curing compound. The membrane curing period shall not be less than 4 days, during which period the freshly coated pipes shall not be disturbed. The pipe surface shall be kept wet during daylight hours for seven days after application of the concrete coating. The concrete coating shall not be allowed to dehydrate.

Before handling and hauling of the concrete coated pipes, a check shall be made to make sure that the concrete coating is properly cured. Stacking and shipment of the coated pipes shall be initiated only after seven days provided that the concrete coating suffers no damage.

10.0 TOLERANCES

10.1 Contractor shall maintain a surface tolerance of $\pm$ 6mm on outside diameter of the coated pipes measured by diameter tape. The diameter of each coated pipe shall be obtained at five (5) points, spaced at equal intervals between end points.

10.2 The acceptance weight tolerance for any single pipe shall be limited to (-) 2% to (+) 5% of the calculated theoretical weight. The theoretical weight shall be calculated using total weight of the pipe with concrete and corrosion coating.

10.3 Acceptable weight tolerance from the approved mix, during production shall be as follows:

i) $\pm$ 3% for each type of aggregate

ii) $\pm$ 2% for aggregate as a whole

iii) $\pm$ 3% for the total quantity of water

iv) $\pm$ 3% for cement

11.0 WEIGHING

11.1 The test specimen shall be selected at equal intervals during the course of production.

11.2 Contractor shall weigh each pipe when dry prior to shipment and 28 days after placing of concrete and mark the weight with paint on the inside of the pipe

12.0 INSPECTION AND TEST

12.1 After curing, every length of concrete coated pipe shall be non-destructively tested by suitable means such as "ringing" to determine if any suspected defects are present. In case this indicates faulty coating, cores shall be removed from coating and inspected. When defective coating appears from cores, the concrete coating shall be removed from the pipe lengths.

12.2 Every length of concrete coated pipe shall be checked to verify insulation between steel reinforcement and pipe by means of a megger or equivalent device. For this purpose provisions should be made during placing of concrete such as to leave at least a point of exposed steel reinforcement whenever the latter shall terminate inside of concrete coating.

12.3 During the tests above and before transporting of concrete coated pipes, every pipe length shall be visually inspected to detect whether any damages and/or defects are present. Possible damages and/or defects with their allowable limits are described at following section. Repairable concrete coating shall be clearly marked while the non-repairable ones shall be removed from the pipe lengths.

13.0 COATING OF FIELD WELDS

13.1 The CONTRACTOR shall coat the uncoated pipe surface at field welds in accordance with methods approved by OWNER. CONTRACTOR shall submit a detailed procedure for joint coating for OWNER's approval.

13.2 The reinforcement for the field welds shall be same as that for line pipe coating with the same number of layers and the same space between layers as for the existing coating. The edges of this netting must be carefully secured with galvanized wire to the reinforcement extending from the existing coating.

The reinforcement shall not make direct /electrical contract with the pipe.

Synthetic resin spacer blocks shall be used to keep the reinforcement away from the corrosion coated pipe surface.

13.3 The composition of the concrete shall be the same as that of the reinforcement free from the pipe coating.

13.4 When moulds are used, the CONTRACTOR shall prevent air being trapped by applying mechanical vibrators or by striking the outside of the moulds with suitable sticks.

14.0 REPAIRS

The following are repairs that will be permitted to coating due to unavoidable damage in handling and in storage (This applies only to concrete that has set).

14.1 Spalling due to compression or shearing caused by impact against other objects. Spalling is defined as damage, which causes a loss in concrete of more than 25 percent of the total thickness of the coating at the point of damage.

14.2 Damage due to spalling of an area of less than 0.1 m^2 (1 square foot) where the remaining concrete is sound will be accepted without repairs.

14.3 Damage due to spalling of an area of more than 0.1 m^2 and less than 0.3 m^2 shall have the concrete remaining in place over that area removed as necessary to expose the reinforcing steel throughout the damaged area. Edges of the spalled area shall be under-cut so as to provide a key lock for the repair material. A stiff mixture of cement, water and aggregate shall be trowelled into and through the reinforcement and built up until the surface is level with the coating around the repair. The pipe shall then be carefully laid with the repaired area at the top. The repaired area shall be moist cured for a minimum of thirty six (36) hours before further handling.

14.4 Should the damaged area be more than 0.3 m^2, coating shall be removed around the entire damaged area. A repair shall be made by satisfactorily restoring the reinforcement, forming the area with a metal form and pouring a complete replacement of materials similar to that from which the coating was made. The mixture shall be one (1) part of cement to three (3) parts of aggregate and the necessary water to produce a slump not to exceed 100 mm (four inches). The resulting coating shall be equal in weight, density, uniformity, thickness, strength and characteristics to the originally applied coating. The pipe shall then be carefully laid in a position where it shall be allowed to remain for a minimum of 36 hours before further handling.

14.5 CRACKING DUE TO PIPE DEFLECTIONS

Cracks that are in excess of 1/16th inch in width and extend over 180 Deg circumferentially around the pipe or longitudinal cracks over 12 inch in length shall be repaired. Repair shall be done by chiseling the crack out to a width not less than 1 inch throughout length upto coating thickness. The crack shall be repaired with materials similar to form with coating materials.

15.0 MARKING

15.1 Every concrete coated pipe length shall be clearly marked by a suitable type of paint (i.e., red and/or white lead paint). Markings out of concrete coating shall be made inside of pipe close to bevel end, in such a way that the area involved by welding operations is not affected by paint.

15.2 For each concrete coated pipe length, at one of the two ends, the field identification number and the date of concrete placing shall be marked, while the dry as well as the wet weight along with number of days after coating shall be marked at the other end.

16.0 UNLOADING, TRANSPORTATION, STORING AND HAULING

16.1 During loading, transport, unloading and hauling of inert aggregates, any contact and mixing with mud, earth, grease and any other foreign material shall be carefully avoided. Precautions shall be taken to prevent contamination, to maintain the cleanliness and against effects of hot or cold weather or other adverse climatologically condition.

16.2 During the operations of loading, unloading and stock-piling, the pipe sections shall be handled in such a way so as to avoid damages to pipe ends, protective and/or concrete coating.

16.3 Stacks shall consist of a limited number of layers such that the pressure exercised by the pipes' own weight does not cause damages to coating. Stacking with more number of layers shall be agreed upon with the OWNER provided that each pipe section is separated by means of spacers suitably spaced so as to avoid stresses and compressed points of contact on the coated surface.

16.4 Materials other than pipes and which are susceptible of deteriorating or suffering from damages especially due to humidity or other adverse weather conditions, shall be suitably stored and protected.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR PIPELINE CROSSING RAIL, ROAD AND MINOR WATER WAYS

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1.0 SCOPE

1.1 This Specification defines the minimum technical requirements for the various activities to be carried out by Contractor for the installation of pipelines at rail, roads, minor waterways and other service crossings.

The provisions of this specification are not applicable for pipelines crossing water courses, which are specifically designated as "Major Water Courses" in the CONTRACT.

2.0 CODES AND STANDARDS

Reference has been made in this specification to the latest edition/ revision of the following codes, standards and specification.

a) ASME B 31.8 : Gas Transmissions and Distribution Piping System

b) API RP 1102 : Steel Pipeline Crossing Railroads and Highways

c) RDSO report no. BS-105 : Guidelines on Pipeline Crossings under Railway Track

d) PNGRB REGULATION 2009 :T4S Regulation, Petroleum and Natural Gas Regulatory Board

3.0 GENERAL

3.1 Laying of pipeline at crossing of roads, railroads, buried services, canals and minor watercourses is allowed only after obtaining approval from the authorities having jurisdiction. Contractor shall make suitable arrangements for safeguarding the roads, etc., and the verges and/or banks thereof and the buried services with appropriate provisions.

3.2 Highways, main-roads and railroads and their verges and banks of water crossings are not allowed to be used for loading, unloading or stacking of materials and/ or equipment. For secondary roads, such loading/ unloading is permitted only after prior approval from the concerned authorities CONTRACTOR is not allowed to close or divert roads or water courses without prior approval from the COMPANY and the concerned authorities. CONTRACTOR shall never unnecessarily hamper the users of the roads, railroads, buried services and/ or water courses. The water flow shall not be obstructed in any way.

3.3 The Owner/ Consultant reserves the right to demand a detailed report including the following information for individual crossing for approval:-

Time Schedule

Working methodology

Equipment and Manpower deployment

Test Procedure

Soil Investigation

Detailed calculations for crossings

Manpower deployment schedule and details.

3.4 Pipeline sections for crossings of roads, railroads, canals and rivers etc., shall be hydrostatically pre-tested at-site, prior to joint coating and post tested after installation, whenever:

3.4.1 Crossing is executed by boring/ HDD.

3.4.2 Crossing is installed in casing pipe.

3.4.3 River crossing pipes which are to be continuously concrete weight coated (to be tested prior to concrete coating).

3.4.4 Whenever, in OWNER's opinion, the repair of pipeline at crossing, in case of a leak during final hydrostatic testing, would require inordinate amount of effort and/ or time.

3.4.5 Whenever pretesting is insisted upon by the Authorities having jurisdiction over the utility crossed.

3.5 Cased crossings (rail/road) and rivers crossing sections shall be pressure tested before and after installation for a period of at least four (4) hours. Such sections shall be retested along with completed mainline sections. Minimum and maximum hydro test pressure as per Pipeline Design Basis (Doc. No.GAIL-STD-PL-DOC-DB-001)

3.6 Pipeline sections at all major crossings like State/ National Highways, railways, major canals and lined canals/distributaries shall be laid by boring with casing pipe complying with all other statutory requirements.

3.7 Contractor shall take suitable measures for the protection of pipeline from overhead high tension power lines by providing plastic gratings/concrete slabs as per approved drawings/ job standards.

4.0 ROAD AND RAIL ROAD CROSSINGS

4.1 The work under crossing shall include necessary clearing, grading and trenching to required depths and widths, welding of casing (when required) and carrier pipes, coating, lowering-in, backfilling, clean-up, restoration to the original condition and further strengthening and protective works, testing, installation of assemblies, insulators and seals and temporary works such as sheet pilling, bridges, etc.

4.2 The work shall be carried out in accordance with the approved drawings/ job standards, as directed by Owner/Consultant and to the satisfaction of Owner/Consultant and the authorities having jurisdiction over the facility crossed. The work carried out for road and railroad crossings shall meet the minimum requirements of API RP 1102, latest edition.

4.3 Before the installation work of crossing commences the Contractor shall provide suitable barricade, temporary bridge/bypass work (especially where roads are open-cut) with railing, if required by Owner/Consultant for safety of traffic. Adequate traffic warning signals and/or traffic lights and suitable diversions shall be provided as directed by Owner/ Consultant or authorities

having jurisdiction over these areas. Such diversions shall not cross the pipeline where it has already been installed, unless proper safeguarding at Owner's/ Consultant's opinion is ensured.

4.4 Prior approval from the statutory authorities shall be obtained to lay the pipeline across highways/ roads either by boring or by open-cut method. Installation of the crossing shall be by the method (i.e., boring/ open-cut) approved by Authorities having jurisdiction. Railroad crossings shall always be bored/ jacked.

4.5 Pipeline can cross the road with open cut method without any casing pipe if there is no specific instruction in concerned authority's permission. In such a case, crossing section shall be laid on soft soil/ sand bed of trench at specified required depth. The section shall be back filled with sand only. Subsequently the road shall be repaired/ constructed by appropriate methods to avoid sand erosion during monsoon. It shall be ensured that the road has been restored to it's original condition to the entire satisfaction of owner/ consultant and the authority having jurisdiction over the road.

4.6 Boring/ jacking of carrier pipes for crossings is allowed only if the pipes for boring/ jacking are provided with a suitable corrosion coating and CONTRACTOR remains liable for the suitability of the pipe and weld-coating of carrier pipes to be bored and for which coating and method of application are anyhow to be authorised by COMPANY without prejudice to CONTRACTOR's liability. In all other cases the carrier pipes shall be cased.

4.7 Before start of the boring/ jacking CONTRACTOR shall execute a soil investigation and determine the ground water table. Based on these investigations CONTRACTOR shall prepare a construction drawing and submit to COMPANY for approval including time schedule and soil investigation report. The CONTRACTOR shall submit for approval of COMPANY the method of boring / trenchless to be carried out, depending on the nature of soil conditions, nature of crossing, local requirements etc.

4.8 During the execution of boring the ground water table over the length of the boring shall be lowered up to at least 0.50 M below bottom of the pipeline. This water table is to be regularly inspected and maintained by CONTRACTOR and reported to COMPANY. To safeguard the stability of the bore pit, CONTRACTOR shall, if necessary in COMPANY's opinion, use a closed sheet piling which shall extend at least over 50% of the length in undisturbed soil. The length of the boring shall be in accordance with the length of the ROW of the crossing (road, railroad, etc.) with minimum 0.6 m extra on either side.

4.9 In approaches to the crossing, CONTRACTOR shall eliminate unnecessary bending of pipe by conforming to the contour of the ground by gradually deepening the ditch at such approaches as directed by the OWNER.

4.10 The bottom of the trench and/ or the pit for at least twelve (12) metres at the approach to each end of a casing shall be graded and if necessary backfilled with clean sand and compacted to an elevation that will provide sufficient and continuous support to the pipeline so that the pipeline remains correctly aligned at the casing ends during and after backfilling.

4.11 The diameter of the hole for a bored section shall have a hole diameter as close as practicable to the outside diameter of the carrier or casing pipe. If excessive void or too large hole results, or if it is necessary, in the opinion of OWNER, to abandon the bored hole, prompt remedial measures such as filling the hole with suitable material shall be taken to the entire satisfaction of the OWNER and Authorities having jurisdiction thereof at no extra cost to

OWNER. Equipment used for installation of casing pipe shall be of the type approved by OWNER.

4.12 An installation consisting of hydraulic jacks shall be provided with easily readable pressure gauges (in bar) and sealable pressure limits. Their proper operation shall be demonstrated before the work is started. COMPANY can request that the maximum pressing force be limited.

4.13 At the front of the pipe there may be a cutting ring which may be 12mm larger than the outside diameter for the pipe or casing. A lubricating pipe can also be used in jacking, the nipples of which shall not protrude from the cutting edge. Said lubricating pipe shall not be fixed to the pipe casing. When jacking, only biologically degradable lubricants shall be used

4.14 Removal of soil from the pipeline during jacking shall be done mechanically by means of a standard, locked auger, which has to be safeguarded against jacking ahead of the pipe.

4.15 During jacking the progress of the pipe to be jacked and the cutting capacity of the auger shall be mutually adjusted, by regulating the speed of the auger, to prevent the road from bulging (rpm too low) or cave-ins (rpm too high). In any case no more soil shall be removed than the volume of the pipe. The auger drive shall be provided with a clutch.

4.16 The progress in the work, the readings of the gauge pipes, the jacking pressures observed, etc., shall be recorded in a log book, to be shown to OWNER upon request. All information shall be supplied to OWNER on completion of the work.

4.17 If the jacking fails, the casing shall not be withdrawn. It shall be filled with sand and plugged at either end. The diameter of the casing pipe shall conform to API RP 1102 recommendations or as directed by the Engineer – in - charge.

4.18 OWNER reserves the right to inspect certain lengths of pipes to assess damages, if any, to the corrosion coating of the carrier pipe used for boring. CONTRACTOR shall weld additional lengths of pipe and pull the required extra lengths of OWNER 's inspection. If during inspection any defects are noticed, CONTRACTOR, in consultation with OWNER, shall carry out the remedial measures required.

4.19 While welding of the casing and vent/ drain pipes, internal high or low is not allowed.

4.20 Welding of casing and vent/ drain pipes need not be radio-graphed, however, only normal visual checks shall be carried out. Before welding, the single length of pipe shall be inspected in order to check that there is no out of roundness and dents. When such defects are noticed, these must be completely removed before joining the pipes. If these defects cannot be repaired, the defective section shall be cut out.

4.21 In the case of crossing where excavation has been authorised, the welding for the casing pipe and for a continuous section of the pipeline corresponding to the expected length shall be carried out in the proximity of the crossing. Casing must be laid immediately after the trenching. Casing pipe must be laid with a single gradient in order to allow for an easy insertion and, if necessary at a future date, to allow for the removal or replacement of the pipeline, leaving the casing undisturbed.

4.22 The assembly of vent pipe units as approved by OWNER shall be carried out by direct insertion and welding to the ends of the casing pipe before introducing the carrier pipe. The operation of assembling and extending the vent pipe shall be carried out in such a way that there is no contact with the carrier pipe. The painting/ coating of the vent pipes shall be applied before backfilling as per relevant specifications.

4.23 The casing pipe shall be considered ready for installation of the carrier pipe, after careful inspection and internal cleaning with the removal of soil, mud, stones and other foreign materials.

4.24 Insulators, as approved by OWNER, shall be securely fastened (cadmium plated) to the pipe with all bolts and fixtures firmly tightened. The number of insulators and spacing shall be as shown in the drawings or at 2.5m intervals (whichever is more stringent). At the end of both sides of the casing, a double set of insulators shall be installed.

4.25 Care must be taken in pushing or pulling carrier pipe into the casing so that the pipe is aligned correctly in the casing and that the pushing or pulling force is evenly and constantly applied to avoid damages to the insulators. A nose piece having a diameter equal to that of the pipe shall be welded on the front and back end of the carrier pipe to facilitate installation of the carrier pipe properly in the casing and to keep it dry and clean.

4.26 After installation of the carrier pipe section, the casing and the appurtenances, but prior to making tie-in welds and backfilling, an electrical test shall be conducted by the CONTRACTOR in the presence of the OWNER, to determine the resistance between the casing and the carrier pipe or the carrier pipe and the soil. After backfilling and compaction, additional tests shall be conducted to determine if the casing is electrically shorted to the pipe. If the installation is found to be shorted, CONTRACTOR shall make the necessary corrections and repairs at his cost, until a test to the satisfaction of the OWNER is obtained.

5.0 CROSSING OF BURIED SERVICES

5.1 The pipeline under construction may pass above or below the existing buried facilities such as pipelines, cables, etc. Type of crossing shall be such that a minimum depth of cover, as required in the drawings and specifications, is guaranteed. The minimum clearance required between pipeline and the existing facility shall be 500mm unless otherwise specified.

5.2 Whenever buried services in the ROW are to be crossed by Contractor, Contractor shall safeguard the buried facilities and the required protecting precaution shall be executed as approved by Owner/Consultant of the buried service.

For buried services to be crossed by boring /jacking, the provisions of relevant Operator specification shall be followed.

6.0 MINOR WATER WAYS

6.1 Minor water crossing are crossings of (future) ditches, distributaries, canals, water courses, rivers, streams, etc., whether the bed(s) contain(s) water or not, and not being specified as 'Major Water Crossing' in the Contract.

6.2 Whenever minor water crossings in the ROW are to be crossed, Contractor shall install suitable temporary bridges as advised by Owner/consultant / Authority jurisdiction and further comply with the provision as laid down in this specification.

6.3 Before executing the work, Contractor shall carry out detailed survey to determine the nature of flow rate of the watercourse with the object of determining what precautions are necessary to be taken care during period of execution.

6.4 In the case of crossings of watercourses for which no special methods of laying are required, crossing spool piece shall be assembled and subsequently laid. Bends shall be of cold field type.

6.5 Whenever required by Owner/Consultant, Contractor shall, before start of construction, execute a soil investigation. Based on such soil investigation he shall prepare construction drawings, work method, Equipment and Manpower deployment and time schedule for approval by Owner/Consultant.

6.6 The depth of the existing bottom of a minor watercourse crossing shall be determined in relation to the adjacent ground level by taking the average of four measurements.

6.7 Contractor shall take special care to check with the concerned authorities for special conditions applying to working on, over, under or through minor water crossing and Contractor shall comply with all such conditions. Written arrangements with authorities shall be drawn up in co-operation with Owner/Consultant.

6.8 The minimum cover over the pipe shall be as specified in the relevant approved drawings and specifications.

6.9 For crossings beneath the bed of watercourses, the pipe section shall be made in such a way that it conforms to the existing or future bed as indicated in the approved drawings. In crossings for which an individual drawing has not been prepared, the minimum cover of the pipeline shall not be less than that indicated in the standard drawings for a similar type of crossing.

6.10 Whenever the crossing requires a straight section of pipe between the lower bends coinciding with the riverbed, this section shall be laid at a single horizontal level.

6.11 For crossing of ditches, canals, banked channels, etc., by boring, the pipe section shall be prepared, laid and tested in accordance with the applicable provisions of Section 3.0 of this specification.

6.12 The Contractor shall arrange temporary installation on diversion as may be necessary; to ensure the effective functioning of watercourses to be crossed, to the entire satisfaction of the concerned local authorities as well as the Owner.

6.13 Banks and trenches of minor water crossings shall be backfilled with soil which is to be approved by Owner/Consultant and shall be thoroughly compacted to prevent soil and bank erosion as per the drawings and standards to the satisfaction of authorities having jurisdiction thereof and Owner/Consultant.

6.14 Whenever boulders, rock, gravel and other hard objects are encountered, they shall not be placed directly on the pipe. Sufficient earth, sand or other selected and approved backfill material shall be placed initially around and over the pipe to provide a protective padding or cushion extending to a minimum thickness of 30 centimeters around the pipe before backfilling remainder of the trench with excavated or other material as per approved drawings and standards.

6.15 After the trench has been backfilled and during the clean-up works, the minor water crossing shall be cleaned at least across the whole width of the ROW.

6.16 When specified in the Contract, Contractor shall repair the ditch/ river/ stream bank with materials to be supplied by him. The excavation shall be backfilled with well compacted soil, followed by a

minimum 0.25m thick layer of properly shaped boulders (75mm to 150mm) encased in a net of galvanized iron wire of dia. 3mm spaced at a maximum distance of 50mm to be laid over the backfilled, compacted and graded banks.

6.17 The crossing of any embankments shall be carried out strictly in accordance with approved drawings.

6.18 No drilling work on embankments shall be permitted without prior written approval from the relevant Authorities.

7.0 CASED CROSSING

7.1 Jacking of line pipe for crossing are not allowed at any circumstances. Whenever boring is to be carried out, casing pipe shall be used.

Before start of the boring/jacking, Contractor shall carry out a soil investigation and determine the ground water table. Based on such investigations, Contractor shall prepare construction drawing, methodology, equipment and manpower deployment details and submit the same to Owner/Consultant for approval which shall also include work schedule and soil investigation report.

During the execution of the boring the ground water table over the length of the boring shall be lowered up to at least 0.50m below bottom of the pipeline. This water table is to be regularly inspected and maintained by Contractor and reported to Owner/Consultant.

To safeguard the stability of the bore pit, Contractor shall, if necessary in Owner/Consultant's opinion, use a closed sheet piling, which shall extend at least over 50% of the length in undisturbed soil. The length of casing pipe shall extend to the crossing (road, railroad, etc.), minimum 0.6m extra on either side of the crossing (Road, railroad, etc.).

In approaches to the crossing, Contractor shall eliminate unnecessary bending of pipe by conforming to the contour of the ground by gradually deepening the ditch at such approaches.

7.2 The bottom of the trench and/or the pit for at least twelve (12) meters at the approach to each end of a casing shall be graded and if necessary backfilled with clean sand and compacted up to at least 95% Proctor density to an elevation that will provide sufficient and continuous support to the pipeline so that the pipeline remains correctly aligned at the casing ends during and after backfilling.

7.3 The diameter of the hole for a bored section shall have diameter as close as practicable to the outside diameter of the carrier or casing pipe.

Equipment proper operation shall be demonstrated before the work is commenced to the satisfaction of Owner/Consultant.

Removal of soil from the pipeline during jacking shall be done mechanically by means of a standard, locked augur, which has to be safeguarded against jacking, ahead of the pipe. If, in the opinion of the Owner/Consultant, fluid sand may arise, an inner pipe with funnel shall be used.

7.4 During boring/jacking the progress of the pipe to be jacked and the cutting capacity of the auger shall be mutually adjusted, by regulating the speed of the augur, to prevent the road from bulging (rpm too low) or cave-ins (rpm too high). In any case no more soil shall be removed than the volume of the pipe. Augur drive shall be provided with a clutch.

7.5 During the progress of the work, readings of the gauge pipes, jacking pressure observed etc. shall be recorded in a logbook which should be presented to Owner/Consultant upon request. All information shall be supplied to Owner/Consultant on completion of the work.

7.6 Owner/Consultant reserves the right to inspect certain lengths of pipes to assess damages, if any, to the corrosion coating of the carrier pipe used for boring. Contractor shall weld additional lengths of pipe and pull the required extra lengths for Owner's inspection. If during inspection any defects are noticed, Contractor, in consultation with Owner/Consultant, shall carry out the remedial measures required.

7.7 All the execution of the work, loading/unloading of material shall be carried out within the proximity of the crossing as allotted by Owner/Authorities. Casing must be laid with a single gradient in order to allow for an easy insertion and, if necessary at a future date, to allow for the removal or replacement of the pipeline, leaving the casing undisturbed.

7.8 Welding of casing and vent/drain pipes need not be radiographed, however, only normal visual inspection shall be carried out. Before welding, the single length of pipe shall be inspected in order to check that there is no out of roundness and dents. If these defects cannot be repaired, the defective section shall be cut out.

7.9 The assembly of vent pipe units as approved by Owner/Consultant shall be carried out by direct insertion and welding to the ends of the casing pipe before introducing the carrier pipe. The operation of assembling and extending the vent pipe shall be carried out in such a way that there is no contact with the carrier pipe. The painting/coating on the vent pipes shall be applied before backfilling as per relevant specifications/approved procedures.

7.10 The casing pipe shall be considered ready for installation of the carrier pipe, after careful inspection and internal cleaning with the removal of soil, mud, stones and all other foreign materials.

7.11 Insulators, as approved by Owner/Consultant, shall be securely fastened to the carrier pipe with all bolts and fixtures firmly tightened. The number of insulators and spacing shall be as shown in the project drawings or at 2.5 meters whichever is more stringent. At the end of both sides of the casing, a double set of insulators shall be installed. Casing insulators and end materials are to be conformed as per Section 8.0 & 9.0 of this specification.

7.12 Care must be taken in pushing or pulling carrier pipe into the casing so that the pipe is aligned correctly in the casing and that the pushing or pulling force is evenly and constantly applied to avoid damages to the insulators. A nose piece having a diameter equal to that of the pipe shall be welded on the front and back end of the carrier pipe to facilitate installation of the carrier pipe properly in the casing and to keep it dry and clean.

7.13 After installation of the carrier pipe section, but prior to making tie-in welds and backfilling, an electrical test shall be conducted by the Contractor in the presence of the Owner/Consultant, to determine the resistance between the casing and the carrier pipe or the carrier and the soil. These tests shall show at least a resistance of 100000-ohm/m^2 after backfilling and compaction. Additional tests shall be conducted to determine, if the casing is electrically shorted to the pipe. If the installation is found to be shorted, Contractor shall make the necessary corrections and repairs, until a test to the satisfaction of the Owner is obtained.

8.0 CASING INSULATORS

Pipeline insulators shall be used to support the carrier pipe inside the casing pipe and electrically isolate the carrier pipe from the casing pipe at the cased crossings.

Manufacturer shall obtain prior approval from Owner/ Consultant on drawing/design of casing insulators.

8.1 It shall be made in segments duly held together with cadmium plates. Bolts and nuts are to be supplied with casing insulators.

The number of segments shall be two for pipe diameters up to 12" (generally). For larger diameters, the number of segments may be more than two, but their number shall be kept minimum.

Casing insulators shall be made of injection moulded high density polyethylene or other material equivalent or superior as approved by Owner/Consultant and shall meet the requirements given in Table-1.

TABLE – 1: MATERIAL PROPERTIES FOR CASING INSULATORS

PROPERTY	VALUE	ASTM TEST METHOD
Dielectric Strength	450-500 Volts/Mil	D-149
Compressive Strength	3200 psi	D-695
Tensile Strength	3100-5000 psi	D-638, D-651
Impact Strength	4 ft.lb./inch of notch	D-256
Water Absorption	0.01%	D-570

9.0 CASING END-SEALS

Casing end seals are intended to be used for sealing the annular space between casing pipe and carrier pipe at casing ends so as to prevent ingress of moisture and water.

Manufacturer shall obtain approval from Owner/Consultant on design/ drawing of end seals.

The seals shall be suitable for the casing and carrier pipe diameter as applicable for each case.

The casing end-seal shall be flexible to cater for the expansion and contraction of carrier and casing pipes and shall be able to tolerate both angular and concentric misalignment of casing pipe without loss of sealing efficiency.

The casing end-seals shall be made of heat shrink high density radiation cross linked polyethylene with an adhesive having a melt point suitable for the pipeline service temperature and ambient temperature foreseen during construction. End-seals material shall be resistant to heat, cold, vibration, impact, abrasion, corrosive fluids, disbanding, organic and bio-deterioration.

Material for casing end seals shall meet the requirements given in Table-2.

TABLE – 2: MATERIAL PROPERTIES FOR CASING END SEALS

PROPERTY	VALUE	ASTM TEST METHOD
Backing (Sleeve and closure patch) Tensile Strength Ultimate Elongation Heat Shock	 2200 psi 400% No visual cracks, flow or drips (at 250°C, 4 hours)	 ASTM D-638 ASTM D-638 ASTM D-2671
Adhesive Ring and Ball softening point Lap Shear	 90°C 60°C – 25 psi 23°C – 250 psi (2 inch/min.)	 ASTM E-28 ASTM D 1002
System Peel strength (to casing and carrier pipe and closure patch)	 5 psi (10 inch/min.)	 ASTM D-1000

9.1 Inspection And Testing For Insulator & End Sealings:

Manufacturer/ contractor shall furnish material test certificates of the components used in the assembly of casing insulators and end seal.

The manufacturer / contractor shall replace, at no extra cost, any material not conforming to the material and performance requirements of this specification.

Manufacturer / contractor shall submit detailed specification of the materials used in the assemblies, along with instructions for handling, use and installation of the material for OWNER approval prior to procurement.

9.2 Documentation

Manufacturer shall submit documentation for Casing insulators and End seals, which shall include the following as minimum:

a. General Arrangement Drawings
b. Test and material certificates of all components used in the assembly of casing insulators and end seals.
c. Application Procedures / Manuals

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR FIELD JOINT COATING

GAIL-STD-PL-DOC-TS-005

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1.0 SCOPE

This specification establishes the minimum requirements of materials, equipment and installation of field joint anti-corrosion coating of buried onshore pipelines factory coated with three layer polyethylene or three layer polypropylene by heat shrink wraparound sleeves conforming to DIN EN 12068 class C– "Cathodic Protection – External Organic Coatings for the Corrosion Protection of Buried Steel Pipelines". Unless modified / replaced by this specification, all requirements of DIN EN 12068 shall remain fully applicable and complied with.

This specification shall be read in conjunction with the conditions of all specifications and contract documents between Owner/ Consultant/ TPI and Contractor.

2.0 CODES AND STANDARDS

Reference has also been made to the latest edition (edition enforce at the time of floating the enquiry) of the following standards, codes and specifications:

a)	PNGRB Regulation 2009	:	T4S Regulation, Petroleum and Natural Gas Regulatory Board
b)	ISO 8502 – 3	:	Preparation of Steel Substrates before Application of Paints and Related Products – Part 3 - Assessment of Dust on Steel Surfaces Prepared for Painting (Pressure Sensitive Tape Method)
c)	ISO 8503 – 1	:	Part 1: Specification and definitions for ISO surface profile comparator for the assessment of abrasive blast cleaned surfaces.
d)	ISO 8503 – 4	:	Part 4: Methods for calibration of ISO surface profile comparator and for the determination of surface profile – Stylus instrument procedure.
e)	SIS-055900	:	Pictorial Surface Preparation Standard for Painting Steel Surfaces
f)	SSPC-SP1	:	Steel Structure Painting Council.
g)	DIN EN12068	:	Cathodic Protection – External Organic Coatings for the Corrosion Protection of Buried Steel Pipelines
h)	DIN 30672	:	Coating of corrosion protection tapes and heat shrinking products for pipelines
i)	ASTM D-638	:	Standard method of test for tensile properties of plastics.

j) ASTM D-149 : Standard Test Methods of Dielectric Breakdown voltage and Dielectric strength of solid electrical insulating materials at commercial frequencies.

k) ASTM D-257 : Standard Test Methods for D-C Resistance or conductance of insulating materials.

l) ASTM D-570 : Standard Method of Test for Water Absorption of Plastics.

In case of conflict between the requirements of this specification and that of above referred documents, the most stringent requirements shall be followed.

3.0 MATERIALS AND EQUIPMENT

Contractor shall supply joint coating materials, all equipment and manpower required for a skillful and adequate application of coating in the field in accordance with the specifications.

Contractor shall submit and demonstrate to Company proposed materials and works procedures for applying field coating and repair procedures for same. These proposed procedures and all materials, equipment and tools used in the work shall be subject to Owner's approval.

3.1 Field Joint Corrosion Coating Material

Field joint anti-corrosion coating material shall be either heat shrinkable wraparound sleeve or cold applied tape suitable for a maximum operating temperature of (+) 65°C (T_{max}) and shall conform to designation EN 12068 – C HT 60 UV. In addition the field joint anti-corrosion coating shall comply the requirements specified in para 3.3 of this specification. Also suitable coating material shall be applied for 3LPP coated pipes (if any) subject to the owner's approvals, other than Dirax sleeve for HDD crossings.

3.2 Heat Shrinkable Wraparound Sleeves

Heat shrinkable wraparound sleeve shall consist of radiation cross-linked, thermally stabilized, ultraviolet resistant semi-rigid polyolefin backing with a uniform thickness of high shear strength thermoplastic/ co-polymer hot melt adhesive. The joint coating system shall consist of a solvent free epoxy primer applied to the pipe surface prior to sleeve application. The backing shall be provided with suitable means (thermo- chrome paint, dimple, or other means) to indicate the desired heat during shrinking in field is attained. The sleeve shall be supplied in pre-cut sizes to suit the pipe diameter and the requirements of overlap.

The total thickness of heat shrinkable wraparound sleeve in the as applied condition shall be as follows:

Pipe Size (Specified Outside Diameter)	**Thickness (mm)**	
	On Pipe Body (Min.)	**On Weld Bead (Min.)**
4" (114.3 mm) to 10" (273.0 mm)	2.5 mm	2.0 mm
12" (323.9 mm) to 18" (457.2 mm)	2.5 mm	2.0 mm

20" (508.0 mm) to 30" (762.0 mm)	3.0 mm	2.5 mm
≥ 32" (812.8 mm)	3.0 mm	2.5 mm

The heat shrink wraparound sleeve shall have the required adhesive properties when applied on various commercial pipe-coating materials. The pre-heat and application temperatures required for the application of the shrink sleeve shall not cause loss of functional properties of the pipe coating.

The Contractor shall propose the specific grade of field joint coating system meeting the requirements of this specification from manufacturers. In case the Contractor proposes to supply heat shrinkable wraparound sleeve then the Contractor shall propose only those coating systems that have been previously used in pipelines of same or higher than the size indicated in tender and above in a single project for similar operating conditions.

3.3 Functional Requirements of Field Joint Coating

3.3.1 Properties of the PE backing shall be as follows:

Sl. No.	Properties	Unit	Requirement	Test Method
a.	Tensile Strength @+25ºC	N/mm^2	> 12	DIN EN 12068
b.	Ultimate Elongation @+25ºC	%	> 250	DIN EN 12068
c.	Dielectric withstand with 1000 Volts/ sec	KV	> 30	ASTM D 149
d.	Water absorption, @+25ºC for 24 hours	%	<0.05	ASTM D 570
e.	Volume Resistivity @+25ºC	Ohm-cm	> 10 15	ASTM D 257

NOTE: Thermal Ageing Resistance is as per DIN EN 12068.

3.3.2 Functional Properties of Joint Coating System (As applied) As applied field joint coating system shall comply the requirements of DIN EN 12068, Table 1 and 2 corresponding to designation DIN EN 12068 – C HT 60 UV, except as modified below :

Cathodic Disbondment Resistance at T_{max} i.e. (+) 60°C shall be 20 mm when tested as per Annexure K of DIN EN 12068. Test shall be carried out at (+) 60°C

Peel Strength shall be as follows:

Peel Strength	**Temp**	**Unit**	**Requirement for Mech. Resistance Class C (minimum)**	**Test Method as per DIN EN 12068**
Inner to Inner + Outer to Inner	@ 23ºC	N/mm	1.5	Annexure B
	@T max	N/mm	0.3	
Outer to Outer	@ 23ºC	N/mm	1.5	
	@T max	N/mm	0.3	
To Pipe Surface	@23ºC	N/mm	3.5	Annexure C
	@T max	N/mm	0.5	
To Factory Coating	@23ºC	N/mm	3.5	
	@T max	N/mm	0.5	

Contractor shall obtain prior approval from Owner/Consultant regarding the Manufacturer of the joint coating material and the specific grade of the joint coating system. Complete technical details along with test certificates complying with the requirements of clause 3.2.1 and 3.2.2 shall be submitted to Owner/ Consultant for this purpose. The Contractor shall furnish test certificates from an independent DIN recognized/approved laboratory for all the properties required for the specified EN designation of field joint coating and the requirements of this specification.

3.4 The materials shall not be older than their period of validity at the time of application by Contractor. Deteriorated/decomposed material shall be disposed off and replaced by Contractor at his own expense.

Contractor shall ensure that the coating materials supplied by him are properly packed and clearly marked with the following:

Manufacturer's name

Material qualification

Batch number

Date of manufacturing and date of expiry

CONTRACTOR shall be responsible for arranging all equipment and manpower required for application, testing and inspection of coating and all required materials for field joint coating in accordance with this specification.

3.5 Contractor shall ensure that the Manufacturer has carried out all quality control tests on each batch and manufacturer shall provide test certificates to certify that the supplied materials meet the manufacturer's specifications as indicated in the purchase order and as approved by Owner/Consultant. Certificates and data sheets certifying the qualities of the coating materials shall be submitted by Contractor to Owner/Consultant prior to application. Owner/Consultant reserves the right to have the materials tested by an independent laboratory.

3.6 Materials shall be stored in sheltered storage in the manufacturer's original packing and away from direct sunlight and in accordance with manufacturer's instructions.

3.7 Contractor shall provide and maintain mobile facilities which contain all necessary equipment and its spares for cleaning, coating, repairs, inspection and tests.

3.8 Contractor shall furnish sufficient number of the following equipment and the required spares as a minimum for inspection and test purposes for each crew:

a) Fully automatic full circle adjustable holiday detector with a visible and audible signal system for inspection of coatings.

b) Thickness gauge for measuring thickness.

c) Contact type temperature recording thermometer.

d) Roughness profile measuring (Stylus) instrument

4.0 APPLICATION PROCEDURE

4.1 General

4.1.1 The application procedure shall be in accordance with manufacturer's instructions and the minimum requirements specified below, whichever are the most stringent and shall be demonstrated to and approved by the Owner/Consultant. Manufacturer's expert shall supervise the application and shall be available at site upon request during qualification of application procedure and during construction at Contractor's cost.

4.1.2 Operators for coating application shall be given necessary instructions and training before start of work, by the Contractor. To verify and qualify the application procedures, all coating applied during the qualification test shall be removed for destructive testing as detailed subsequently in this specification. Contractor shall only utilize those operators who have been approved/pre-qualified by the field joint coating manufacturer.

4.1.3 Oil, grease and salt shall be removed from steel surface by wiping with rags soaked with suitable solvents such as naphtha or benzene. Kerosene shall not be used for this purpose.

4.1.4 Each field joint shall be blast cleaned using a closed cycle blasting unit. Steel or chilled shot and iron grit shall be used and Garnet material with the second one. During blast cleaning the pipe surface temperature shall be simultaneously more than 5°C or more than 3°C above ambient Dew Point, while the ambient Relative Humidity shall not be greater than 85%. Prior to surface cleaning the surfaces shall be completely dry. The surface shall be cleaned to a grade Sa 2½ in accordance with Swedish Standard SIS-055900 with a roughness profile of 50 – 70 microns. Surface roughness profile shall be measured using an approved profile comparator in accordance with ISO 8503-1 and shall be calibrated prior to the start of the work in accordance with ISO 8503-3 or ISO 8503-4. The blast cleanliness shall be checked on every joint and the roughness profile shall be checked for 1 out of every 10 joints.

Dust, girt or foreign matter shall be removed from the cleaned surface by a suitable industrial cleaner. The dust contamination allowed shall be of a rating max 2 as per ISO 8502 -3. The frequency of checking for dust contamination shall be 1 out of every 10 joints.

Blast cleaned field joint shall be coated within 2 – 4 hours according to the conditions below :

- Relative Humidity (RH) > 80 % - 2 hours
- Relative Humidity (RH) 70 - 80 % - 3 hours
- Relative Humidity (RH) < 70 % - 4 hours

Pipes delayed beyond this point or pipes showing any visible rust stain, shall be blast cleaned again.

4.1.5 The field joint surface shall be inspected immediately after blast cleaning and any feature of the steel surface such as weld spatter, scabs, laminations or other imperfections considered injurious to the coating integrity made visible during blast cleaning shall be reported to the Owner/Consultant and on permission from Owner/Consultant, such defects shall be removed by filing or grinding. Pipes affected in this manner shall be then re-blasted cleaned if the defective area is larger than 50 mm in diameter.

4.1.6 The ends of existing pipe protective coating shall be inspected and chamfered. Unbounded portions of the coating shall be removed and then suitably trimmed. Portions where parent coating is removed shall be thoroughly cleaned as specified. The adjacent chamfered areas of the line pipe coating shall be cleaned and abraded, to expose a clean uniform fresh surface of uncontaminated factory applied coating.

4.1.7 All steel joint surfaces shall be thoroughly examined before the application of the coating in order to ensure the surfaces are free of oil, grease, rust, mud, earth or any other foreign matter. All these substances shall be removed before coating, to the procedures herein described.

4.1.8 Protection coating shall be applied on the joints immediately after the completion of cleaning operation.

4.2 Application Procedure for Heat Shrink Wraparound/Sleeves

In addition to the requirements stated above, following shall be complied with:

4.2.1 The wrap around sleeve shall be of a size such that a minimum overlap of 50 mm is ensured (after shrinking) on both sides of the yard applied corrosion coating of pipes.

In the cases where carrier pipe is installed by direct boring/jacking, the overlap on the mill coating for the leading edges of the joints shall be minimum 200 mm. When this extra overlap is achieved by providing an additional patch of heat shrink tape/wraparound, it shall be applied in such a manner that the square edge of the patch on the joint coating is in the direction opposite to the direction of boring / jacking.

4.2.2 Before centring the wraparound sleeve, the bare steel surface shall be preheated either with a torch moved back and forth over the surface or by induction heating. The minimum pre-heat temperature shall be as recommended by manufacturer and shall be checked by means of contact type temperature-recording thermometer. Temperature indicating crayons shall not be used. Pre-heat temperature shall be checked on every joint. Care shall be taken to ensure that the entire circumference of the pipe is heated evenly. Temperature measuring instruments shall be calibrated immediately before the start of the works and thereafter at intervals recommended by the manufacturer of the instrument.

4.2.3 Upon pre-heating, the pipe surface shall be applied with two pack epoxy primer of wet film thickness 200 microns or as per manufacturer's recommendation whichever is higher, to cover the exposed bare metal of the welded field joint and 10 mm min. onto the adjacent pipe coating if recommended by the manufacturer. The wet film thickness of the primer shall be checked on every joint with a wet film thickness gauge prior to installation of sleeve. Thickness gauge shall be calibrated once per shift.

4.2.4 Immediately after application of epoxy primer, the wraparound sleeve shall be entirely wrapped around the pipe within the stipulated time recommended by the manufacturer. Sleeve shall be positioned such that the closure patch is located to one side of the pipe in 10 or 2 O'clock position, with the edge of the undergoing layer facing upward and an overlap of min. 50 mm. Gently heat by appropriate torch the backing and the adhesive of the closure and press it firmly into place.

4.2.5 A heat shrinking procedure shall be applied to shrink the sleeve in such a manner to start shrinkage of the sleeve beginning from the centre of the sleeve and heat circumferentially around the pipe. Continue heating from the centre towards one end of the sleeve until recovery is completed. In a similar manner, heat and shrink the remaining side. Shrinking has been completed when the adhesive begins to ooze at the sleeve edges all around the circumference.

Visual appearance and void after installation on the body, area adjoining the weld and area adjoining the factory applied coating. (To establish voids adjoining the weld and factory coating, a strip of 50 mm wide and 200 mm long shall be stripped and examined.)

Owner/Consultant shall witness the tests and inspection. Regular application of field joint coating shall commence only upon successful completion of the procedure qualification testing. Only Qualified coater shall execute the job.

After successful completion of the pre-qualification testing as above, the entire field joint coating shall be removed, the pipe surface re-blasted and field joint coating re- applied as per the requirements of this specification.

4.3 Pre-Qualification of Field Joint Coating System

The field joint coating system materials and the procedures proposed by the Contractor shall be pre-qualified during the sleeve installation start-up phase. Five joints (5) shall be coated with the requirements of this specification and then inspected and tested in accordance with the requirements of this specification with respect to the following:

- Surface preparation, cleanliness, roughness profile and dust contamination
- Pre-heat temperature (as applicable)
- Primer thickness
- As applied coating thickness
- Holiday detection

Peel test at (+) 23°C & (+) 80°C on pipe surface & factory applied coating and at over laps (as applicable). If required to achieve the temperature of (+) 80°C, suitable thermal blanket may be used.

Visual appearance and void after installation on the body, area adjoining the weld and area adjoining the factory applied coating. (To establish voids adjoining the weld and factory coating, a strip of 50 mm wide and 200 mm long shall be stripped and examined.)

Owner/ owner's representative shall witness the tests and inspection. Regular application of field joint coating shall commence only upon successful completion of the prequalification testing.

After successful completion of the pre-qualification testing as above, the entire field joint coating shall be removed, the pipe surface re-blasted and field joint coating reapplied as per the requirements of this specification.

4.4 Application Procedure for Cold Applied Tapes

4.4.1 Cold applied joint protection tape shall be of the type, which can be applied by spiral wrapping on the pipe.

4.4.2 Immediately after the completion of surface preparation, the approved primer of wet film thickness 150 microns or as per manufacturer's recommendation whichever is higher, to cover the exposed bare metal of the welded field joint and 10 mm min. onto the adjacent pipe coating if recommended by the manufacturer. Any dirt on the primed surface shall be removed. If the primer is damaged, the damaged area shall be cleaned and re-primed.

4.4.3 Approximately 100 mm of inner wrap interleaving paper shall be peeled back and inner wrap shall be applied with the thicker adhesive side to the pipe. Whilst continuously removing the interleaving paper, the tape shall be spirally applied through a machine to provide a minimum of 55% overlap. Sufficient

tension shall be applied to ensure good conformity, avoiding air pockets and also continuously smooth out as the wrapping proceeds. The wrapping shall start and finish to give a minimum 50 mm overlap on to the adjoining yard applied coating. Outer wrap shall also be applied in similar method.

5.0 INSPECTION AND TESTING

5.1 Visual Inspection

Visual inspection of the as applied coating shall be carried out on every joint, for the following:

- Mastic extrusion on either ends of the sleeve shall be examined
- There shall be no sign of punctures or pinholes or bend failure. The external appearance of the sleeve shall be smooth, free of dimples, air entrapment or void formation. All sleeves shall be tested for the presence of voids by knocking on the sleeves. A hollow sound compared to the remainder of the sleeve may indicate the presence of voids under the sleeve. Such sleeve shall be tested for adhesion at the discretion of the Owner/ Consultant.
- Weld bead profile shall be visible through the sleeve
- Visual indicator provided on the backing and the closure patch showing desired heat is achieved.

5.2 Holiday Inspection

The entire surface of each joint shall be inspected by means of a full circle holiday detector approved by Owner/Consultant set to a DC voltage applicable as per the requirements of factory applied mainline coating specification of Owner/ Consultant. Inspection of the sleeves shall be conducted only after the joint has cooled below 50°C. The holiday detector used shall be checked and calibrated daily with jeep meter. The detector electrode shall be in direct contact with the surface of coating to be inspected.

No field joint shall be covered or lowered in the trench until it has been approved by the Owner/Consultant.

5.3 As-applied Coating Thickness

Coating thickness shall be checked by non-destructive methods for each field joint. Average thickness of the as-applied coating on pipe body shall be established based on measurements at min. eight locations i.e. four measurements on either side of the girth weld at 3, 6, 9 & 12 O'clock positions. To establish the minimum thickness on the girth weld, four measurements shall be taken on apex on the weld at 3, 6, 9 & 12 O'clock positions. All such measurements shall be recorded. Owner/ Consultant reserves the right to ask for additional measurements at any location on the field joint coating, whenever doubt arises.

5.4 Peel Strength Testing

5.4.1 One out of every 50 joint coatings or one joint coating out of every day's production, whichever is stringent, shall be tested to establish the peel strength on steel and factory applied coating. Contractor shall carry out such testing in the presence of Owner/Consultant.

5.4.2 From each test sleeve selected as above, one or more strips of size 25 mm x 200 mm shall be cut perpendicular to the pipe axis and slowly peeled off.

The required peel strength shall meet the requirements of this specification as applicable for (+) 23°C or (+) 80°C whichever is feasible. This test shall be conducted between wrapping & metal and mill coating & between layers at overlap with joint coating (wherever applicable). After removal of strip, the bulk of adhesive shall remain adhered to the pipe showing no bare metal, otherwise, test shall be considered failed. The adhesive layer that remains on the pipe surface shall generally be free of voids resulting from air or gas inclusion. In case the peel strength test at a different temperature than that specified is warranted due to the ambient site conditions, then the peel strength shall comply the recommendation of the manufacturer. Manufacturer shall be asked to furnish peel strength values corresponding to various expected temperatures, prior to start of the works.

5.4.3 If the sleeve does not meet the requirements of above clause 5.4.2, the adjacent two sleeves shall also be tested. If the adjacent two sleeves are acceptable the test rate shall be increased to one sleeve every twenty five until Owner/Consultant's is satisfied. The test rate can then be reduced as per clause 5.4.1. If either or both of the adjacent two sleeves do not meet the requirements of clause the field coating shall be stopped.

5.4.4 Owner/Consultant reserves the right of 100% removal of sleeves if he is not convinced that the requirements of clause 5.4.2 are achieved.

6.0 REPAIRS

6.1 If a field joint is detected to be unacceptable after testing as per section 6.0 of this specification the Contractor shall, at his own cost:

- determine the cause of the faulty results of the field coating.
- mobilise the expert of manufacturer, if required.
- Test to the complete satisfaction of the Owner/Consultant, already completed field coatings
- stop field coating until remedial measures are taken against the causes of such faults, to the entire satisfaction of the Owner/Consultant.

6.2 Contractor shall replace all joint coating found or expected to be unacceptable as per section 6.0 of this specification.

6.3 Contractor shall, at his own cost repair all areas where the coating has been removed for testing by the Owner/Consultant.

6.4 After the coating work on welded joints and repairs to the coating have been completed the coating as a whole shall be tested with a spark-tester before lowering or jacking the pipeline.

6.5 Owner/Consultant shall be entitled to check the coating on buried pipelines or parts of pipelines with equipment such as the "Pearson Meter" and the resistance meter. If coating defects are established, the Contractor shall be responsible for excavation at such points, repairing the coating, spark testing and backfilling the excavations without extra charge.

7.0 DOCUMENTATION

7.1 Prior to procurement of coating materials, Contractor shall furnish the following information for qualification of the Manufacturer and material:

a. Complete information as per clause 3.1, DIN EN 12068 along with descriptive technical catalogues.
b. Test certificates and results of previously conducted tests, for all properties listed in clause 3.2 of this specification.
c. Reference list of previous supplies, in last 5 years, of the similar material indicating the project details such as diameter, quantity, operating temperature, year of supply, project name, contact person and feedback on performance.
d. Once the Owner/Consultant's approval has been given, any change in material or Manufacturer shall be notified to Owner/Consultant, whose approval in writing of all changes shall be obtained before the materials are manufactured.

7.2 Prior to shipment of materials from the Manufacturer's Works, Contractor shall furnish the following documents:

a. Test certificates/results as per Manufacturer's Quality Control Procedure for each batch of materials.
b. Specific application instructions with pictorial illustrations.
c. Specific storage and handling instructions.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR CASING INSULATORS AND CASING END SEALS

GAIL -STD-PL-DOC-TS-006

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1.0 SCOPE

This specification covers the minimum requirements of design, material, installation and supply of casing insulators and end seals intended to be used for cased pipeline crossings.

2.0 CODES AND STANDARDS

The related, standards referred to herein and mentioned below shall be of the latest editions prior to the date of the purchaser's enquiry:

a) ASME B 31.8 : Gas Transmission and Distribution Piping System

b) API 1102 : Steel Pipeline Crossing Railroads and Highways

c) PNGRB , Regulations 2009 : T4S Regulation, Petroleum and Natural Gas Regulatory Board

3.0 FUNCTIONAL REQUIREMENTS

3.1 Casing Insulators

Pipeline insulators shall be used to support the carrier pipe inside the casing pipe and electrically isolate the carrier pipe from the casing pipe at the cased crossings.

The Casing insulators shall have the following properties:

- Resist cold flow and will not soften at design temperature.
- Resist mechanical damage while being pulled into the casing
- Resist corrosion.
- Have high electrical insulating value and low water absorption, thus preventing leakage and maintain electrical isolation between carrier and casing pipes.
- Have high compressive strength in order to ensure a permanent support to the carrier pipe.
- Have low friction, to offer less resistance to carrier pipe movement

Contractor shall obtain prior approval from the Owner on casing insulator manufacturer, design, drawings, quality assurance and application methods.

3.2 Casing end-seals

Casing end seals are intended to be used for sealing the annular space between casing pipe and carrier pipe at casing ends so as to prevent ingress of moisture and water.

Contractor shall obtain prior approval from the Owner on casing end seals manufacturer, design, drawings, quality assurance and application methods.

4.0 DESIGN REQUIREMENTS

4.1 Casing Insulators

It shall be made in segments duly held together with cadmium/ xylan plated bolts and nuts, to be supplied with casing insulators.

The number of segments shall be two for pipe diameters up to 12" (generally). For larger diameters, the number of segments may be more than two but shall be kept to minimum.

The skid height shall be obtained by the following formula & shall be ≥ 2 inch (min):-

$$\frac{\text{Casing Internal Dia - Carrier Outer Dia}}{2}$$

Double insulators shall be installed at ends and shall be located at 300 mm from the end of the casing. Another insulator shall be placed at a distance of approx. 1250 mm (max) from the double insulators. The remaining insulators shall be installed at an equal spacing of approx. 2500mm (max.) each (Refer Fig. 2 attached at the end for installation details). The support point of successive collars shall be regularly staggered.

Material:

Casing insulators shall be made of injection moulded high density polyethylene or other material equivalent or superior as approved by Owner and shall meet the requirements given in Table-1.

Table 1 : Material Properties for Casing Insulators

Property	Value	ASTM Test Method
Dielectric Strength	450-500 Volts/Mil	D-149
Compressive Strength	3200 psi	D-695
Tensile Strength	3100-5000 psi	D-638, D-651
Impact Strength	4.0 ft.lb./inch of notch	D-256
Water Absorption	0.01%	D-570

4.2 Casing end seals

The seals shall be suitable for the casing and carrier pipe diameter as applicable for each case. The casing end-seal shall be flexible to cater for the expansion and contraction of carrier and casing pipes and shall be able to tolerate both angular and concentric misalignment of casing pipe without loss of sealing efficiency.

The design of the casing end seal shall permit easy installation of the seal to the cased pipeline crossing. It shall provide moisture-proof seals when installed for the entire anticipated life of the buried pipeline

Material:

The casing end-seals shall be made of heat shrink high density radiation cross linked polyethylene with an adhesive having a melt point suitable for the pipeline service temperature and ambient temperature foreseen during construction. End-seals material shall be resistant to heat, cold, vibration, impact, abrasion, corrosive fluids, disbonding, organic and bio-deterioration. The manufacturer shall confirm compatibility of end seals with carrier pipe coating.

Material for casing end seals shall meet the requirements given in Table-2.

Table 2 : Material Properties for Casing end Seals

Property	Value	Test Method
Backing (Sleeve and closure patch) Tensile Strength Ultimate Elongation Heat Shock	 2200 psi 400% No visual cracks, flow or drips (at 250 °C, 4 hours)	 ASTM D-638 ASTM D-638 ASTM D-2671
Adhesive Ring and Ball softening point Lap Shear	 90 °C 60 °C - 25 psi 23 °C - 250 psi (2 inch/min.)	 ASTM E-28 ASTM D 1002
System (as applied) Peel strength (To casing and carrier pipe and closure patch)	 5 pli (10 inch/min.)	 ASTM D-1000

5.0 DOCUMENTATION

Manufacturer shall submit documentation for Casing insulators and End seals, which shall include the following as minimum.

i) General Arrangement Drawings

ii) Test and material certificates of all components used in the assembly of casing insulators and end seals as per section 4.0 of this specification.

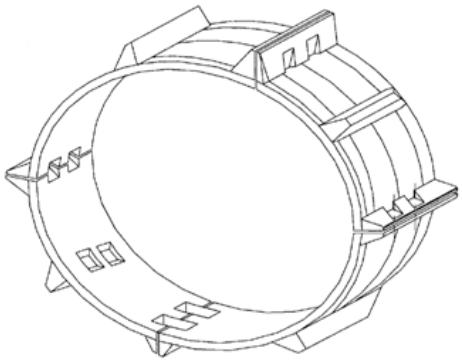
iii) Application Procedures / Manuals

iv) Inspection and Testing

6.0 SUPPLEMENTARY REQUIREMENTS

6.1 The manufacturer shall replace, at no extra cost, any material not conforming to the material and performance requirements of this specification.

6.2 Manufacturer shall submit all the documents, test reports, records and other information to the OWNER for record after approval.



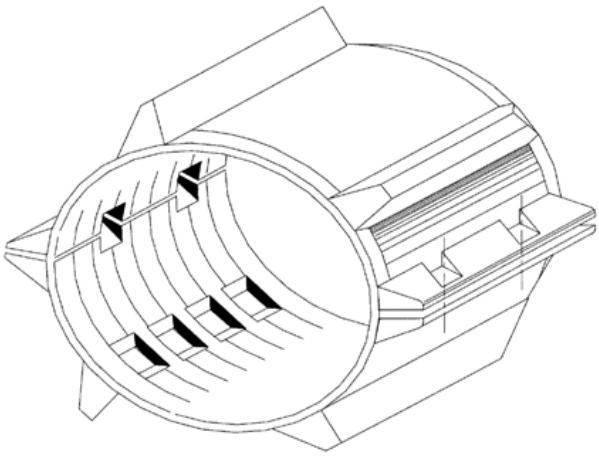
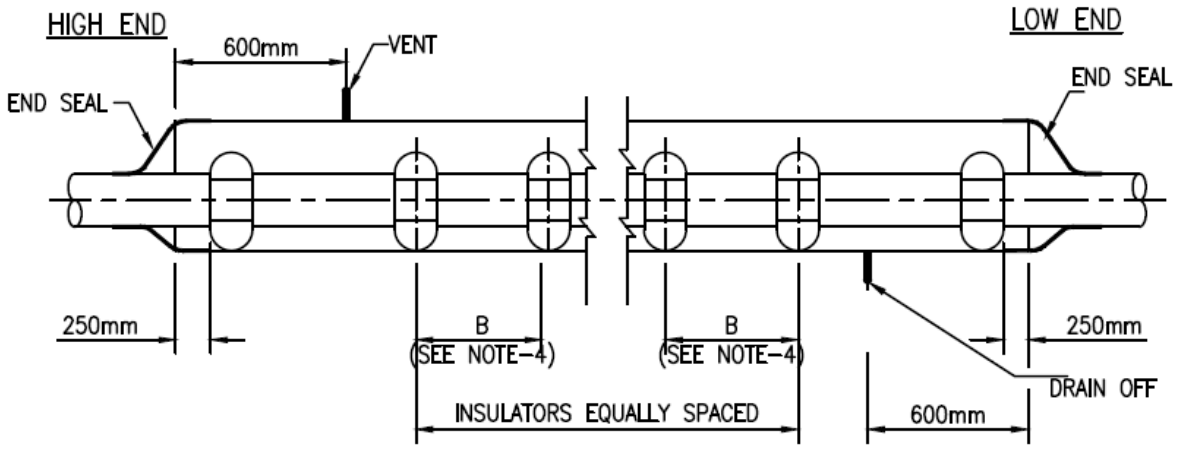


Fig 1: Casing Insulators



Refer standard drawing for casing pipe details.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR LONG RADIUS BENDS

GAIL-STD-PL-DOC-TS-007

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1.0 SCOPE

This Specification defines the minimum requirements for design, manufacture, inspection, testing, transportation and supply of Long Radius Bends made from carbon steel line pipes for use in onshore gas pipeline systems.

2.0 CODES AND STANDARDS

The manufacturer shall perform work in accordance with the latest edition of the following codes, standards and specifications:

a)	ASME Sec. V	:	Method for non-destructive examination
b)	BS EN 10204	:	Metallic Products- Types of inspection documents
c)	ASME B 31.8	:	Gas Transmissions and Distribution Piping System
d)	BS EN ISO 6507-1	:	Methods for Vickers Hardness Test – Testing of Metals
e)	MSS-SP-75	:	Specification for High Test Wrought Weld Fitting
f)	API-5L	:	Specification for Line Pipe
g)	API RP 5L1	:	Recommended Practice for Rail Road Transportation of Line Pipes
h)	ASME Sec. II Part A	:	Ferrous Material Specification
i)	ASME Sec VIII Div 1 & 2	:	Boiler and Pressure Vessel Code.
j)	ASME B 16.49	:	Factory made wrought steel Butt-welding Induction Bends for Transportation and Distribution Systems
k)	ASTM A370	:	Standard Test Methods and Definitions for Mechanical Testing of Steel Products.
l)	ISO 15590-1	:	Petroleum and natural gas industries- induction bends, fittings, and flanges for pipeline transportation system- Part 1: Induction Bends

In case of conflict between the requirements of this specification and the reference documents, the requirement whichever is more stringent shall prevail.

3.0 MATERIALS

Bend shall be fabricated from bare steel line pipe of heaviest thickness available. Pipes with positive wall thickness shall be used for fabrication of bends. The type of pipe to be used in fabrication of bends shall be ERW API 5L Gr. X-52 or as indicated in the purchase order.

Unless specified otherwise in Purchase Order, the Line pipes for fabrication of bend shall be provided by the CONTRACTOR. Only pipes with positive wall thickness shall be used for fabrication of bends.

All mechanical properties of the bends after finishing shall be same as pipe specification.

One additional bend for each heat, nominal diameter and wall thickness shall be made by the manufacturer for test purposes. Each test bend shall be bent to an angle of 90º. All examination and test shall be performed on the test bends after final stress relieving. The result of all tests shall be in accordance with the requirements of this Specification. The following tests shall be conducted:

a) The bend shall be non-destructively tested in accordance with 6.2 of this specification.
b) The dimensions of the bends shall meet the requirements of section 7.0 of this specification.

c) The bend shall be hydrostatically tested in accordance with Section 6.1 of this specification.

d) Tensile tests shall be performed in accordance with API-5L on transverse and longitudinal specimens one each taken from the inner and outer radius and from the stop and start transition areas of the bend. Tensile properties shall be in accordance with the Specification.

e) One transverse weld tensile test shall be performed by the Manufacturer to determine the yield and tensile strengths. Such test shall be performed as per API-5L.

f) One set of three Charpy V-notch impact test specimens shall be taken from each of the inner and outer radii and from the stop and start transition areas of the bend. Impact test shall be carried out as per ASTM 370 at -20 & 0 °C and impact energy shall be in accordance with the specification / approved QAP.

g) One set of three Charpy V-notch impact test specimens shall be taken from each of the following locations for Welded Pipe Bend (for seamless Pipe, bend as per coupon):

Centre of the weld
Fusion line
2mm from fusion line
5mm from fusion line
Min. impact energy value at -20 °C shall be 35 J Avg. and 28 J Ind. and 100 J Avg & 80 J Ind. for testing at 0 °C

h) One full wall macro section taken parallel to the longitudinal axis of the bend shall be removed from the inner and outer radii and from the stop and start transition areas in the body of the bend. The macro sections shall be polished and Vickers hardness tested in accordance with BS EN ISO 6507-1 shall be performed.

i) For bends manufactured from SAW pipes one face and one root guided bend test shall be performed. For bends manufactured from EW pipes, reverse bend test shall be carried out .

j) The fracture toughness test shall be determined by manufacturer at 0º C & -20 ºC.

k) Hardness test shall be carried out for each heat of steel. Hardness shall not exceed 248 HV10.

l) Metallographic examination (X200 & X400) shall be carried out as per material / manufacturing specification. The grain size shall be 8 or finer as per ASTM E 112. Optical microphotograph shall be provided along with final documentations.

4.0 PROCESS OF MANUFACTURE

4.1 Manufacturing Procedure Specification

The Manufacturer shall submit a manufacturing procedure specification (MPS) which shall meet all the requirements of these specifications. The MPS shall include but not limited to a complete and detailed procedure for the manufacture of high frequency induction bends and shall include all proposed operations, in the correct sequence, together with all appropriate parameters and methods by which the manufacturer proposes to monitor the parameters as listed below:

a. Sequence of operations;
b. Description of equipment and instrumentation;
c. Bending speed (mm/min);
d. Bending load;
e. Bending temperature;
f. Dimensional Control Procedure;
g. Hydrostatic Testing Procedure;
h. Quench variables (including flow rate);
i. Stress Relieving procedure;
j. Mechanical testing and inspection procedures;
k. Marking details;
l. Handling, transport and storage

Bidder has to submit work procedure with QA/QC plan for approval. Work shall commence after approval from Owner/Consultant.

Failure of any of the qualification tests listed above shall cause rejection of the MPS and all induction bends. Owner / Consultant reserve the right to demand re-qualifications in the case of any changes to the Owner / Consultant approved MPS or interruptions in the production of induction bends.

4.2 Manufacturing Procedure Qualification

Manufacturer shall perform the Manufacturing Procedure Qualification to demonstrate that the procedure will produce bends with the requirements set forth in this specification. Test bends shall be provided by Manufacturer for qualification of the MPS. Owner / owner representative reserves the right to select the test bends.

Once the bending operation has commenced any stoppage of the activity shall not be permitted until the entire bending process is completed.

Post bend stress relieving shall be applied over the entire bend and tangent lengths.

5.0 MANUFACTURE OF PRODUCTION BENDS

5.1 Bends shall be manufactured in accordance with the Owner / Consultant approved MPS. Any deviations from the MPS or any changes in the bend forming parameters used for the Manufacturing Procedure "Qualification Test Bend shall be cause of rejection of MPS" or the performance of additional test bends for re-qualification of the MPS at Manufacturer's expense.

5.2 All bends shall be manufactured by hot bending of the pipe by using high frequency induction heating and forming.

5.3 All bends manufactured by induction welding shall be subject to post bend stress relieving by tempering. Post bend heat treatment procedure including temperature and time shall be included in the bend manufacturing procedure.

5.4 All bends shall be manufactured by using a type of bending equipment approved by the Owner/ Consultant.

5.5 The longitudinal weld seam shall be located at approximately 10º from the neutral zone, measured from the outside of the bend made with welded pipe. Manufacturer shall provide a drawing which shows the orientation of weld seam.

5.6 The Manufacturer shall, at no additional expense to the Owner / Consultant, furnish and use an internal bending mandrel to achieve smooth and undistorted bends.

5.7 All bends having a difference between the maximum and minimum outside diameters in excess of 2.0% of the nominal outside diameter of the pipe, or having buckles, shall be rejected.

5.8 The minimum wall thickness of the pipe after bending shall not be less than the required nominal design wall thickness of the pipeline.

5.9 Bends shall not have any circumferential joints.

5.10 All bends shall be provided with tangent length at both ends. Tangent length shall be 500 mm or pipe OD whichever is more.

5.11 The Manufacturer shall supply all the bends with machined bevel at both ends in accordance with API-5L. Bend angle and bend radius shall be as indicated in the Material/Purchase requisition. All bends shall be non-destructively examined in accordance with the requirements of Section 6.2 of this specification.

5.12 Each bend shall be tested using a gauging pig consisting of 2 gauging plates. The diameter of the gauging plates shall be 95% of the nominal internal diameter. The gauge plates shall be mounted 2D or 300 mm (whichever is more) apart on each end of the gauging pig. Details of the gauging pig shall be submitted to the Owner / Consultant for approval.

5.13 No repair by welding shall be allowed on any part of the bends.

5.14 Maximum allowable ripple in any section of the bend shall not exceed 1.0% of the outside diameter of the pipe.

5.15 Any bend that is buckled or gouged by the bending operation shall be rejected.

5.16 ERW type pipe shall be used for fabrication of bends.

6.0 INSPECTION AND TESTING

The Manufacturer shall perform all inspection prior to shipment and tests as per the requirement of this specification at his works prior to shipment. Inspection/ Material certificate shall confirm to EN 10204 3.2 certification.

6.1 Hydrostatic testing

All induction bends shall be hydrostatically tested at the Manufacturer's works in accordance with the requirements of API-5L. The test pressure shall be 100% SMYS with a hold time of 30 min.

The Manufacturer shall submit hydrostatic test pressure calculations to the Owner / Consultant for approval.

All gauges used for measurement of pressure during hydrostatic testing of bends shall be calibrated against a dead weight tester to the satisfaction of the Owner / Consultant before and after the test. All pressure gauges used shall have an upper range of 1.5 to 2 times the minimum test pressure.

All hydrostatic pressure tests shall be chart recorded. The identification number of the induction bends being tested shall be clearly recorded on the hydrostatic pressure charts.

Orientation of the weld seam of the pipe bends fabricated from welded pipes shall be such that any pin hole leak in the seam area shall be clearly visible to hydrostatic testing operators and inspection personnel.

6.2 Non-destructive examination

6.2.1 Manufacturer shall submit a detailed procedure for all non-destructive Tests to be performed on the bend. The NDT procedure shall, as a minimum, include the following:

a) Equipment Details and Calibration Techniques
b) Qualification of NDT operators (shall be minimum ASNT-TC-1A level 2)
c) Scanning Techniques (100% coverage)
d) Examination Techniques
e) Testing evaluation method
f) Preparation of Reports

6.2.2 All bends shall be subjected to non-destructive testing in accordance with the requirements of specification.

6.2.3 Non destructive examination shall be performed on all bends that have passed the hydrostatic testing.

6.2.4 The surface of the bends to be examined shall be clean and smooth, free from dirt, paint or any other foreign matter which would affect/influence the results of testing.

6.2.5 The entire outer surface of each bend and bevels shall be inspected for laminations and cracks by Magnetic Particle Inspection in accordance with ASME Section V, article 7.

6.2.6 The Manufacturer shall ultrasonically examine the weld areas of all induction bends for defects. Also full body surface shall be examined ultrasonically for bends made by SMLS / welded pipes.

6.2.7 The full circumference of both ends of each bend after beveling shall be ultrasonically tested for laminations over a length of 25 mm and acceptance limits shall be as per specification as referred in Clause 2.0 of this specification.

6.2.8 Acceptance levels for MPI, UT and RT inspections shall be in accordance with specification.

6.2.9 The entire outer surface included extrados surface of each bend and bevel ends shall be inspected for lamination by MPI in accordance with ASME Sec V.

6.3 Residual Magnetism

Manufacturer shall use a digital or analogue gauss meter with directional probe with an accuracy of 0.1 Gauss to determine the residual magnetism of the induction bend.

No residual magnetism in either longitudinal or transverse direction to the pipe axis shall be greater than 15 Gauss.

Demagnetization shall be applied if the magnetic measurement shows values greater than the acceptable limit of 15 Gauss.

The Manufacturer shall include the procedure for degaussing in the Manufacturing Procedure Specification.

6.4 Surface Finish

Any irregularities in the surface contour of the bend caused by the bending operation shall be rejected.
Manufacturer shall include a description of how surface irregularities shall be avoided and the methods proposed to inspect such irregularities in the MPS.

6.5 Inspection by Owner/ Consultant

Owner/ Consultant's representative reserves the right to perform stage wise inspection and witness tests on all bends as indicated in 6.1 and 6.2 at manufacturer's work, prior to shipment.

Manufacturer shall give reasonable notice of time and shall provide without charge reasonable access and facilities required for inspection to the Owner / Consultant.

7.0 DIMENSIONAL REQUIREMENTS

All induction bends shall be of a minimum radius as specified in Purchase Order.

All bends shall be supplied to the dimensional tolerance specified in this specification and relevant data sheets.

Tolerances

The finished bends shall conform to the following dimensional tolerances in addition to MSS-SP-75 requirements. However the ends of the tangent length of the finished pipe bend shall meet the dimensional tolerances of the relevant line pipe specification referred in Section 2.0.

7.1 Bend Angle : (±) 0.5º
Bend Radius : (±) 0.5% of nominal bend radius.

7.2 The manufacturer shall check the wall thickness of the pipe ultrasonically before bending of 6D bend (for piggable line) both the inside and outside rail, at approximately 15 degree intervals or 300mm whichever is less. The wall thickness shall be measured ultrasonically after bending at the same locations measured before bending. These measurements shall be taken at four equally spaced locations around the pipe circumference at both welding ends of the bend. The measured wall thickness shall be at least equal to the pipeline nominal wall thickness specified in the purchase requisition.
If the pipes are free issue, the thickness of the finished bend shall comply with the requirement of cl. no. 7.2.

7.3 Ovality in any plane in the finished bend shall not exceed 1.6 mm at any point. Ovality shall be calculated using the following formula:

$$\text{Ovality} = \frac{2(OD_{max} - OD_{min})}{OD_{nom}}$$

Where
OD max- Maximum Outside Diameter
OD min - Minimum Outside Diameter
OD nom- Nominal Outside Diameter

The measurements shall be made over the circumference of the bend either at distances approximately equal to pipe diameter or 300mm whichever is less. Minimum three measurements shall be taken for each bend.

7.4 **Off Plane**

Off plane of bends shall not exceed (θ/90) x 10mm, where θ is the bend angle in degree or the tolerance limit specified in MSS-SP-75, whichever is less. The measurement shall be in accordance with MSS-SP-75.

7.5 Any type of repair and sizing is not acceptable until unless approved by owner/ owner's representative.
Bevel and squareness of bend ends shall comply with the requirements of relevant company specification referred in Clause 2.0.

8.0 MARKING, PACKING AND SHIPMENT

8.1 Material of 6D and 3D bends shall be as per pipeline material and shall be marked as per MSS-SP-75 standard .

8.2 The original pipe number and bend suffix shall be marked by die stamping at both ends on the bevel of all bends. No die stamping shall be permitted on any other part of the bend.

8.3 As a minimum, for each bend, following markings are stenciled at both ends internally with indelible paint.

8.4 Pipe original individual identification number and bend suffix heat number and original pipe number

a) Purchase order/Item number
b) Bend angle
c) Heat number
d) Owner/Consultant name
e) API-5L material grade
f) Specified wall thickness, outside diameter, bend angle, bend radius
g) Heat treatment
h) Measured weight
i) Any other information required by API-5L.

8.5 All loose and foreign material such as rust, grease etc. shall be removed from inside and outside of the bend.

8.6 All bends except bevelled ends shall be coated internally and externally with a thin film of zinc chromate red oxide paint for protection against corrosion during transit and storage. The coating shall be easily removable in the field. Manufacturer shall furnish the details for the same

8.7 Both ends of the bends shall be suitably protected to avoid any damage to the bevel during transit by means of metallic or high impact plastic bevel protectors.

8.8 Package shall be marked legibly with indelible marking ink to indicate the following:

a) Order Number
b) Tag Number
c) Manufacturer's Name
d) Size (Inches) and wall thickness (mm)
e) Radius of bend (mm) and bend angle

9.0 DOCUMENTATION

Documentation relating to the supply of goods shall be provided by the Manufacturer. All documents shall be reviewed and approved by the Owner / consultant.

Full certification of the procedure and results of bending, inspection and testing shall be provided by the Manufacturer.

Certification shall cover all results required by this specification. All certificates shall be marked with sufficient information to enable full traceability to the items it represents and the relevant specifications and procedures.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR INSPECTION & TESTING OF PRODUCTION WELD

GAIL-STD-PL-DOC-TS-008

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1.0 SCOPE

This Specification defines the minimum technical requirements for the various activities to be carried out by Contractor for Inspection & Testing of Production Weld.

2.0 CODES AND STANDARDS

The following specifications shall apply in conjunction with the following (all latest editions) codes and standards:

i) API 1104
ii) ASME B31.8
iii) ASTM E94

iv) ASTM E 142

v) ASNT, recommended practice no. SNT-TC-IA supplement A.
vi) ISO R 148
vii) ASTM A370
viii) ASME Sec. V

Except otherwise stated by the Owner / Consultant for the number of field butt welds selected for non-destructive examination, the provisions of ASME B 31.8 shall govern.

The Owner/ Consultant shall determine the non-destructive examination method applicable and their specific field application.

The Owner/ Consultant shall supervise and inspect the welding activities in accordance with the provisions laid down in the Codes.

The Owner/ Consultant are also exclusively responsible for its personal interventions and decisions as supervisor and inspector of the welding activities.

Except otherwise stated by the Owner and the Consultant. The inspection and testing of production welds will be carried out in accordance with the provisions of the ASME B 31.8 code and the standard mentioned in this chapter.

3.0 TESTING OF WELDED JOINTS AND ACCEPTANCE CRITERIA

Production weld test is for mainline shall be tested prior to painting or coating.

3.1 Non – Destructive testing

3.1.1 Visual Inspection

Inspection of all welds shall be carried out by owner/ consultant 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, under-cuts,

dimensions of the weld, surface porosity and other surface defects. Undercutting adjacent to the ted weld shall not exceed the limits specified in the applicable standard/ code.

The visual inspection shall be interpreted in accordance with API 1104 with the following additional requirements:

- Arc ignition Points
- o ≤ 0.5 mm: acceptable if ground out
- o > 0.5 mm: unacceptable and cut out
- Clamp Crates
- o ≤ 0.5 mm: acceptable if ground out
- o 0.5 to 1.5mm = Acceptable if ground out and welded according to repair procedure and also specify above 1.5 = unacceptable and cut out.

3.1.2 Radiographic Testing

3.1.2.1 Test method and acceptance criteria

Radiographic testing with X rays or gamma rays shall be carried out in accordance with the provisions of API 1104. All butt welded joints of mainline as well as of station piping shall be 100% radiographic tested irrespective of the class location.

3.1.3 Ultrasonic Testing

3.1.3.1 Test Method and Acceptance criteria

The ultrasonic testing shall be carried out in accordance with ASME V-Art. 5 and API 1104.

The number of field joints welds selected for ultrasonic examination is specified by the Owner / Owner representative.

3.1.3.2 Scope of the Test

a) Minimum test planned

- For the stations and valves stations all welds shall be inspected by ultrasonic testing.
- Welded joints (e.g. tie-in welds) shall be 100% ultrasonically tested.
- If any pipe end is cut by more than 50 mm, the re-bevelled end shall be ultrasonically tested for any lamination.

b) Supplementary Tests

Further to a decision by the Owner / Consultant (for example in the event of cracks) all the welds carried out in the course of that day may be tested with ultrasonic testing and if necessary this inspection may be extended to all welds. If these tests bring to light any defective welds, the Contractor shall carry out the repairs at his own expense.

3.2 Other test method

As well as the non-destructive tests describe above, the Owner / Consultant, may decide to carry out additional destructive or non-destructive tests, such as:

- Magnetic Particle Test
  - All tie-in weld & Fillet weld shall be 100% Magnetic particle tested.
  - All re-bevelled pipe end shall be magnetic particle tested.
  - All repair areas shall be verified by either LPT / MPT as directed by site in-charge

- Liquid Penetratrant Test
  - All repair areas shall be verified by either LPT / MPT as directed by Owner/ Owner's representative.
- Weld Sampling
- Any other destructive or non – destructive test methods

The acceptance criteria for the magnetic partial test and liquid penetrant test are defined on the basis of the following standards:

- Magnetic particle test
  - Method: ASME V-Art 7
  - Acceptance criteria ASME VIII Div I – App. 6 and API 1104.
- Liquid penetratant test
  - Method: ASME V-Art 6
  - Acceptance criteria ASMEVIII – Div I – App. 6 and API 1104

The acceptance criteria for the weld samples shall be the same as for the welding procedure qualification.

3.3 Destructive test

At least one production weld (to be chosen by Owner) will be cut out during the first week of welding production for each thickness and sent for destructive testing. 5 test specimens of impact test shall be carried out for production weld. One highest and one lowest energy value out of 5 test specimens to be discarded. Finally 3 test specimens of impact test shall be considered. In case of production weld failure, two (2) more additional joints has to be conducted for same days, same welders and same thickness for which production joint failed.

Other production welds (cut out) to be sent for destructive testing shall be minimum one no. out of every 1000 welding joints & any additional tests deemed necessary by Owner in view of inconsistent quality of production welds, % of weld repair and performance track record of qualified welders. The location of Production welds for carrying out Destructive Testing will be chosen by Owner/Owner's representative Contractor will not be entitled for any compensation for any destructive test deemed necessary by Owner.

The destructive tests must be carried out in accordance with section 5.6 of API 1104. All tests will be carried out in laboratory approved by Owner.

Contractor will not be entitled for any type of compensation for any destructive test deemed necessary by Owner/ Consultant.

The destructive testing shall be carried out in accordance with annexure of welding specification. All tests shall be carried out in Owner /Consultant approved laboratory.

3.4 Identification of incompetent welders

Welding joints shall be identified as failed if following non destructive testing concludes results as follows;

a. If radiography fails in two consecutive welds.
b. If UT shows defects in two consecutive welds.

4.0 IMPLEMENTATION OF THE NON-DESTRUCTIVE TESTS

Radiographic tests will be carried out daily after the completion of the welding on the day's welding pipeline stretch.

No tests shall be carried out on strings, which are still being welded even if the usual deadlines are compromised as a result.

Ultrasonic tests shall in principle be carried out 24 hours after welding.

5.0 ANNOUNCEMENT OF TEST RESULTS

The NDT results shall be sent to contractor by Owner / Owner representative/ TPI during normal working hour in the following day as agreed with Owner.

5.1 Welding of tie-ins and repairs

5.1.1 Radiographic Testing

Subject to the approval of the Owner / Owner representative, in urgent cases, TPI shall inform the Contractor verbally of the provisional test results within the hour following the photograph by interpreting the wet film.

The results shall not be definitive until the dry firm has been examined.

The deadline for verbal communication of the definitive results shall be twelve hours following the announcement of the results when they have been interpreted from the wet film.

5.1.2 Visual and ultrasonic Testing

The results of these tests shall be given verbally at the time of the test.

Written communication of the results shall be by means of inspection test report.

6.0 INSPECTION OF FILMS BY CONTRACTOR

Before carrying out any repairs, the Contractor may inspect the relevant film himself. The film remains the property of the Owner.

7.0 LOCAL REPAIRS AND CUT OUT DEFECTIVE WELDS

The Contractor shall be obliged to repair welds or re-weld or cut out welds which are deemed defective by the owner/ consultant/ TPI. This shall be carried out within normal working hours.

Each repair of defective weld, whether local or total, shall be carried out within two working days following the announcement of the results by owner/ consultant/ TPI.

Section 10 of API 1104 is applicable with the following requirements.

- All cracks other than carter cracks or star cracks (ref 9.3.10 of API 1104) shall not be repaired by welding. The cracks must be removed by cutting out the weld.
- All other defects except superficial defects detected by NDT can only be repaired by welding after approval by owner/ consultant/ TPI on site.
- Superficial defects can be removed by grinding provided min. thickness of pipe is respected. After grinding, the ground area will be inspected by liquid penetrant test or magnetic particle test.
- The weld repairs shall be tested by X-rays, UT and / or MT as required by owner/ Owner representative / TPI at site.
- A second repair on weld is not acceptable and weld must be cut out if defects are detected in repair.
- In case of cut out of weld, & zone of at least 5 cm of the pipe material shall be removed on both side of the weld. The new bevel should be checked by penetrant test in the absence of defect.
- The cut out welds shall be preserved in the weld number for further investigation.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR DRYING AND CLEANING OF PIPELINE

GAIL-STD-PL-DOC-TS-009

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1.0 SCOPE

This Specification defines the minimum technical requirements for the various activities to be carried out by Contractor for Inspection & Testing of Production Weld.

2.0 CODES AND STANDARDS

The related, standards referred to herein and mentioned below shall be of the latest editions prior to the date of the purchaser's enquiry:

ASME B 31.8	:	Gas Transmission and Distribution Piping System
OISD	:	Natural Gas Transmission Pipelines and City Gas Distribution Networks
PNGRB, Regulation 2009		T4S Regulation, Petroleum and Natural Gas Regulatory Board

3.0 DRYING ACTIVITIES

The contractor shall perform the following for drying the pipeline:

DEWATERING - Removal of hydrotest water from pipelines

SWABBING - Reducing the amount of remaining water in the pipeline, left after dewatering operations, and spreading it as a thin film on the inside wall on the pipeline

DRYING - Drying the gas pipeline to the required degree of dryness

PURGING - Purging or filling the pipeline with nitrogen (as applicable) and keeping it under positive pressure if commissioning is delayed

Contractor shall develop procedure accordingly and carry out applicable activities after obtaining owner's approval for the same.

4.0 DEWATERING AND SWABBING OF PIPELINE

4.1 Dewatering

Dewatering shall be performed to remove major amount of test water from the pipeline using a propellant and a pig train.

The dewatering operation shall consist of at least two dewatering runs when air is used as propellant for pig trains. In case the propellant is the product that the pipeline will ultimately carry, only one dewatering run is required.

The contractor shall propose the minimum speed and back pressure of the pigs in order that continuous operation will be performed without the pig getting stuck. Necessary calculations shall be submitted by CONTRACTOR in this regard. CONTRACTOR shall also submit a contingency plan for retrieval of stuck pigs if any.

Contractor shall provide a suitable compressor for oil-free air with sufficient capacity and pressure.

The pigs shall be removed immediately by the CONTRACTOR in the presence of OWNER Representative upon arrival at the receiving end. CONTRACTOR shall ensure that the bulk of the water has been removed from the pipeline before taking up the next stage of the drying operations. CONTRACTOR shall specify when the dewatering phase is to be considered complete and shall take approval of the OWNER before proceeding further.

As a minimum the CONTRACTOR shall continue the dewatering operation till majority of water is removed from the pipeline.

4.2 Swabbing

The swabbing operation consists of running several pig trains through the pipeline. During the swabbing operation, the remaining water in the pipeline shall be reduced and spread out in the form of a thin water film over the pipeline wall to obtain a more efficient drying operation.

The CONTRACTOR shall submit the detailed procedure and the duration of the swabbing operation and obtain OWNER approval before starting the operation.

The pig velocities during the complete swabbing operations shall not exceed 7.0km/hr. CONTRACTOR may use polyurethane cup pigs followed by foam pigs for the swabbing operation.

If dewatering pigs are used, the minimum speed and the backpressure of the pigs to maintained during dewatering operation shall be proposed by the contractor to do continuous operation and without pig getting stuck.

CONTRACTOR shall weigh and measure the pigs prior to launching and on arrival of the pigs at the receiving end.

Contractor shall ensure that the pipeline shall be free from dust and debris after swabbing operation and final cleanliness of the pipeline shall be subject to approval of the OWNER.

Acceptance criteria

Acceptance criteria of the swabbing operation-Difference in weights of pig before and after passing through the pipeline shall be limited to 5% of its original weight.

Before proceeding to the next stage of operations, the contractor shall ensure that bulk of the water has been removed from the pipeline system and swabbing is done to meet the requirement of EGP.

Note-1: After dewatering and swabbing of the main pipeline segment , electronic geometry pigging (EGP) of the pipeline shall be done by the contractor as applicable.
Note-2: Ideally, EGP shall be followed by commissioning activities of the pipeline as applicable. If subsequent to EGP activities, commissioning activities of the pipeline is taken up after long time delay then adequate measures should be taken to inertize the pipeline during this idle period so that internal corrosion does not occur. Suitable inertizer should be introduced in the pipeline and the pipeline should be kept bottled up with this inertizer inside it.

Note-3: All the pigs including bi-directional pigs required during pre-commissioning to be arranged by contractor as applicable.

6.0 DRYING

In order to remove the remaining water after swabbing at low points in the pipeline and in body cavities of valves, instruments, and in other connected piping, drying of the pipeline system shall performed. The CONTRACTOR may choose any of the following methods of drying as applicable.

Digital dew point meter shall be used for checking the dryness. Wet bulb with dry ice is not acceptable.

The CONTRACTOR may choose any of the following methods of drying as applicable:

6.1 Vacuum Drying

The residual water in the pipeline left after the swabbing operation shall be removed by means of boiling the water below the vapor pressure in the pipeline. The vapor shall be drawn from the pipeline until the specific dryness has been achieved.

The vacuum drying operation shall commence as soon as possible after the swabbing is completed but not later than 30 hours after the swabbing operation has been completed. The vacuum drying operation shall consist of four stages i.e., evacuation stage, boiling stage, air purge dryness test and the final reduction of line pressure.

During air purge dryness test the dew point measured at the suction end shall not deviate by more than 1 °C from the dew point measured at the inlet end during the 24 hour test period. If it is more than 1 °C it is implied that the pipeline still contains free water.

The pipeline shall be dried up to a dew point of at least (-) 8 °C at atmospheric pressure.

The dew point at the input and output ends shall be measured to ensure that required dew point is achieved. As a final acceptance the dew point stated above shall be maintained for a period of 48 hours.

Upon completion of the drying operation CONTRACTOR shall submit evidence to substantiate that the pipeline has been dried to the required dryness level. This evidence shall consist of data related to the following stages of the operation.
- A rapid decrease of pressure at the end of the boiling stage
- A conclusive result of the air purge dryness test
- A steep pressure drop rate during the final draw down, which shall correspond with a calculated rate.

If any of the aforementioned criteria do not give a conclusive result that the pipeline has been dried to the required level, CONTRACTOR shall repeat the vacuum drying operation by continuing the boiling stage followed by the air purge test and the final draw down, until a conclusive result of the required dryness of the pipeline has been established and proven to the satisfaction of OWNER.

6.2 Super Dry Air Method

The residual water in the pipeline left behind after the swabbing shall be removed by means of absorption of the water into dry air blown through the pipeline.

Contractor shall specify the procedure and duration of the air drying method, which shall be approved by owner.

The air drying operation shall commence as soon as possible but not later than 24 hours after the swabbing is completed.

The air drying operation consists of two stages namely, the pigging stage and the air purge dryness test. Oil free and dry air shall be used.

The air shall have dew point below the required dew point in the pipeline. The pipeline shall be dried up to a dew point of (-) 8 °C at atmospheric pressure.

The dew point at the inlet and outlet ends shall be monitored to ensure that the required dew point is achieved.
As a final acceptance, the dew point stated above shall be maintained for a minimum period of 48 hours.

7.0 PURGING

During the purging operation the air left in the pipeline shall be replaced by dry nitrogen before admitting the hydrocarbon that the pipeline will ultimately carry.

The purging operation shall start as soon as possible after the drying operation has been completed and approved by the owner. If nitrogen purging is carried out after the 24 hours of completion of drying CONTRACTOR to re-perform the air dryness test prior to commencement of the purging operation.

Contractor may use dry nitrogen instead of dry air for drying operation and obtain desired drying level corresponding to -8 ^{0}C air dew point at exit end and oxygen below 2% (v/v).

The purging operation procedure may vary as per the drying procedure. CONTRACTOR shall submit the detailed purging procedure for approval of the OWNER prior to its implementation.

8.0 ACCEPTANCE OF WORK

Upon completion of the dewatering, swabbing, drying and purging operations written approval shall be obtained from the OWNER to terminate the operations.

Approval for such termination shall be given only after completion of the following conditions:

- The required accuracy of measuring equipment and records has been demonstrated.
- All data, records, calculations and duly completed forms have been submitted.

- The drying criteria as specified and detailed in the approved procedures in terms of residual water, required dew point and/or other requirements established have been satisfactorily attained.

The work shall only be considered to be completed after receipt and approval of the final report.

The CONTRACTOR shall repeat part or the whole of the dewatering, swabbing, drying operations under any of the following circumstances as determined by the OWNER.
- The accuracy of the measurements is considered to be insufficient.

- The submission of data, records, calculations, and other documentation is considered to be insufficient or inconclusive.

-The acceptance criteria established for the drying and purging operations have not been met to the satisfaction of the OWNER.

9.0 DOCUMENTATION

Final report shall be submitted to the OWNER not later than 30 days after acceptance of the work.

CONTRACTOR shall submit to the OWNER for approval the complete description, detailed procedure and time schedule of all the dewatering, swabbing drying and purging operations.
CONTRACTOR shall ensure that the documents are related to the as-built conditions of the pipeline.

All documents, procedures, calculations, schedules and details of the equipment shall be in SI units. Documents shall also contain all safety plans procedures to be followed while carrying out the activities.

Upon successful completion of the work CONTRACTOR shall prepare a final report of the work which shall include necessary charts, diagrams, graphs, calculations, recordings/daily logs, measurements and details of the operation etc. Report shall also include all certificates of calibration of instruments required together with records of calibration performed at site just prior to the start of operation.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR MAJOR CROSSING BY HDD

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1.0 SCOPE

1.1 This specification defines the minimum technical requirements for the various activities to be performed by the Contractor for the engineering, design and construction of pipeline at major crossings using horizontal directional drilling technique.

1.2 This specification shall be read in conjunction with the requirements of specification and other documents included in the CONTRACT between owner and Contractor.

1.3 Contractor shall, execute the work in compliance with laws, by laws, ordinance and regulations. Contractor shall provide all services, labour, inclusive of supervision thereof, supply of all materials (excluding "Owner supplied Material), equipment, appliances etc.

1.4 Contractor shall take full responsibility for the stability and safety of all operation and methods involved in the work.

1.5 Contractor shall be deemed to have inspected and examined the work area and its surroundings and to have satisfied himself as far as practicable with the surface conditions, hydrological and climatic conditions, the extent and nature of the work and materials necessary for the completion of the work, and the means of access to the work area.

1.6 Contractor shall be deemed to have obtained all necessary information with regard to risks, contingencies and all other circumstances, which may influence the work.

1.7 Contractor shall, in connection with the work, provide and maintain at his own costs all lights, guards, fencing, as necessary or directed by Owner or their representative.

2.0 CODES AND STANDARDS

Reference has been made in this specification to the latest edition/ revision of the following codes, standards and specification.

a) ASME B 31.8 - Gas Transmission and Distribution Piping System.

b) API RP 1102 - Steel pipeline crossing railroads and highways

c) OISD 226 - Natural Gas Transmission Pipelines and City Gas Distribution Networks

d) PNGRB T4s - Technical Standards & Specifications including Safety Standards

In the event of conflict between any of the above specification/standard or between any standard and this specification, the more stringent shall apply.

3.0 DESIGN & ENGINEERING

3.1 The limits of each crossing shall be determined by the Contractor on the basis of crossing profile based on survey drawings, design, equipment, installation technique and site condition. Detail engineering for the crossing shall be prepared by contractor and get approved from owner/consultant.

3.2 Within the entire limits of crossing, the minimum cover to top of coated pipe shall be as specified in the pipeline design basis document.

However, wherever the drilled length for a crossing includes the crossings of obstacles such as roads, railroads, canals, streams, etc. The following minimum requirements of cover to the pipe shall be satisfied unless specified otherwise in pipeline design basis.

In case the pipeline crosses other utilities, viz., other pipelines, sewers, drain pipes, water mains, telephone conduits and other underground structures, the pipeline shall be installed with at least 500 mm free clearance from the obstacle or as specified in the drawing or such greater minimum distance as may be required by authorities having jurisdiction. Also in all cases, the minimum covers specified above shall be maintained within the entire limits of crossing.

3.3 The entry and exit points of the pipeline at ground level shall not come within the limits of crossing as defined in the crossing drawings.

3.4 Level of the pipeline considering the Geo-technical hydrological data provided by the owner for basic route detail. However, detailed survey data shall be collected by the Contractor before execution of work.

3.5 Contractor shall carry out calculations for determining the maximum permissible overburden on pipe, to check that the empty pipeline is safe from collapse at any point along the drilled crossing section. Contractor shall submit these calculations to Owner for approval.

The minimum requirements of limits of each river crossing shall be as defined in the preliminary drawings furnished by Owner/Consultant. Contractor may change the limits slightly to suit his requirement and installation technique, with prior written approval from Owner/Consultant and authorities having jurisdiction.

3.7 Pipeline Axis

The plane containing the pipeline route axis shall be perpendicular to the horizontal plane. There shall be no bending of the pipeline route axis at depths shall lower than 2 meters below ground level.

3.8 Back-reamed hole and Pipeline Interface

3.8.1 Contractor shall derive combination of:

- Back-reamed hole diameter
- Bentonite density
- Pipeline submerged weight in bentonite (and means to achieve that weight) to optimise the crossing design in terms of pipeline stresses and power requirement

3.8.2 Contractor shall indicate what maximum shear stress in the pipeline coating will result due to above parameters and other characteristics described in this section.

3.8.3 Contractor shall furnish all calculations for Owner's approval. If shear stress in pipe coating is, in the opinion of Owner, beyond the permissible limits, Contractor shall revise his choice of parameters to reduce shear stress on pipe coating to permissible value.

3.9 Contractor shall determine in the minimum allowable elastic bend radius for pipe from the following consideration:

3.9.1 Maximum longitudinal stress during installation

Total maximum longitudinal stress in the pipeline due to tension and bending at any location shall not exceed 90% of the SMYS of the pipe material.

Contractor shall, in order to check this requirement, evaluate the maximum tensile forces to which the pipeline is subjected to at any phase of its installation during the pulling operation.

Contractor shall, evaluate the maximum tension forces to which the pipeline is subjected for following phase of its installation during the pulling operation

a) Stress in the pipe at the beginning of the pull

b) Stress in the pipe upon finish of the pull-in

c) Stress in the pipe due to over-bend

3.9.2 Maximum Equivalent Stress during Final Hydrostatic Test

After installation, the pipeline shall be hydrostatically tested to a minimum test pressure equal to 1.5 times the design pressure or at a pressure stipulated in the Special Conditions of Contract whichever is higher. However, during hydrostatic testing, the combined equivalent stress in the pipeline due to bending and test pressure shall not exceed 90% of the SMYS of pipe material.

3.9.3 Maximum Equivalent Stress during Service

Permissible values of maximum equivalent stress during services shall be governed by the requirements of ASME B 31.8. The details of pipeline operating parameters are provided in the Special Conditions of Contract.

3.9.4 The minimum allowable radius of curvature for the pipeline shall be the highest value of the minimum pipeline elastic radius as computed from the considerations outlined above after correction for drilling inaccuracies or multiplication by the factor 1.85, whichever results in the highest permissible value of minimum elastic bend radius.

3.9.5 Contractor shall submit all calculations for Company's approval along with procedure.

3.10 Pipeline Configuration along the Support String before Entry Point

3.10.1 Contractor shall determine the required pipeline configuration in order to allow smooth pull in the crossing entry point and admissible stress in the supported pipeline string.

Pipeline combined stress shall not exceed 90% of the specified minimum yield strength for line pipe material.

3.10.2 Contractor shall furnish all calculation and specify the number of required supports, description of the supports, their co-ordinates and capacity in metric tons.

3.10.3 Contractor shall also furnish a drawing of the launching ramp indicating the pipeline configuration.

3.10.4 The distance between each roller shall also be specified and justified.

3.11 Contractor shall, based on result of design and engineering carried out by him, prepare construction drawings for the crossing and shall submit the same for Owner's approval.

Construction drawings shall indicate the pipeline profile with levels furnished at sufficient intervals for proper control during construction. Other relevant details viz., entry & exit point co-ordinations details, Bore hole location as wells as survey details to be included in the Drawings.

Contractor shall also submit the following details:

a. Plan drawings showing drill axis, co-ordinates of entry/ exit point, north direction, existing utilities close to the drilled hole, obstacles, shortest distance between the drill axis and obstacles, minimum radius of curvature, planned work area for rig site and pipe string site, and markers and signage.

b. Profile drawing showing entry/ exit angle, horizontal and effective length of drilling, elevations of drill profile at sufficient intervals, scour profile where applicable, cover, minimum radius of curvature, obstacles and pipe data.

c. Work area preparation drawing on the rig and pipe side showing location of various drill rig components (rig, cabin, pump, etc.), method of anchoring the rig, location and size of the drill fluid storage pit and access roads shall also be provided.

d. Pipe roller supports/ trench line drawing showing the number of rollers/ supports, location of rollers in plan and elevation, pipe string configuration on launch ramp and detailed drawing of the roller support.

e. Bundle drawing showing cross section of the bundle, diameters of individual pipes, method of securing the bundle.

f. Pipe break-over entering into the hole.

g. Arrangement of accessibility to rig and pipe side.

Contractor shall also calculate the total length of pipeline required as well as the maximum tension required on the pull head of the rig.

3.12 All construction works shall be carried out in accordance with the construction drawings approved by Owner.

3.13 Before commencement of any field work, Contractor shall furnish for Owner's approval all design calculations and construction drawings as stipulated in the above clauses.

4.0 CONSTRUCTION

The method of Construction shall comply with all the conditions and requirement issued by Authorities having jurisdiction in the area where the work is to be performed.

If no public road exists, Contractor shall arrange for access to his work area at no extra cost to Owner/consultant.

4.1 Installation Procedure

HDD shall be done by approved / registered HDD contractor in GIGL vendor list. Contractor shall take approval from PMC / Owner in case of an unapproved HDD contractor.

HDD contractor shall submit Site organogram to PMC / Client before starting the work at site.

The installation procedure as a minimum shall include the following:

a. Project Manpower deployment at site and co-ordination office.

b. Time schedule for construction.

c. Details of equipment: Contractor shall furnish the complete list of all equipment to be deployed for preparation of pipe string and installation of crossing including technical characteristics and capacity of each equipment including instrumentation, monitoring and control equipment.

d. Preparation of fabrication yard and launching areas.

e. Pipeline string preparation (hauling, stringing, welding, etc.).

f. Pre & Post hydrostatic test procedure.

g. Method of installation covering all stages of construction, viz. Rig up, Pilot Hole, Back-reaming, Pulling Rig Down, Back filling, etc.

h. Calculations for maximum pulling force on the rig.

The time schedule shall be in accordance with overall time schedule for the project.

Approval by Owner/Consultant of the methods used by Contractor shall in no way relieve Contractor from the sole responsibility for safe and satisfactory installation of the crossing.

4.2 R.O.W. Preparation

Contractor shall arrange additional land required for pipeline string preparation, rig set-up and launching operations without any cost to owner. Contractor shall clear and grade the length of ROW required for installation of the land portion and drilled river-crossing portion. Contractor shall do such grading on ROW as is necessary and properly to perform the pipeline construction operations, to provide access to the pipeline construction and to ensure safe construction of pipeline.

Contractor shall ensure that his construction activities shall not cause inconvenience to public nor shall there be any undue interference with the normal use of the land and watercourses.

The ROU clearing and grading operations shall in no case involve damage/changes of embankment/structure of nay type and class without prior approval of the authorities having jurisdiction over the same.

4.3 Handling, Hauling, Storing and Stringing Of Pipes and Other Materials

Contractor shall be fully responsible for arranging and paying for storage areas. Contractor shall load, unload, transport and stock-pile the coated pipes using approved suitable means and in a manner to avoid damage to the pipe and coating. Transportation and handling of coated pipes shall also comply with requirements of API RP 5L-1 & 5LT. Contractor shall be fully responsible for the pipe and pipe identification marking until such time the pipes are installed in permanent installation.

4.4 Pipe String

Complete pipe string shall be prepared as a single string for pulling.

4.5 Installation

4.5.1 Installation shall be taken in accordance with approved installation procedures.

4.5.2 The lateral offset of the actual exit point of the pilot hole from the calculated and theoretical exit point shall not exceed +/- 2% of the length of the crossing, however the actual exit point shall not come outside the ROU limits of the pipeline.

The length tolerance shall not exceed +/- 1% of the crossing length, subject to the condition that the actual exit point shall be within the limits of crossing as defined in the approved drawings.

4.5.3 Back reaming shall be done separately from the pipeline pulling operation. The size of the back-reamed hole shall be adequate (approximately 1.5 times the pipeline diameter) to allow enough clearance for smooth pull-back of the pipeline.

4.5.4 Contractor shall be responsible for maintaining the drilled hole till such time the pipeline is pulled in.

4.5.5 During pulling operation, the buoyancy of the pipeline shall be controlled by suitable approved methods so as to maintain the buoyancy as close as possible to zero during pull-back in order to reduce friction forces of the pipeline in the hole.

Bentonite slurry of specified viscosity shall be pumped into the hole, preventing the wall from collapsing and protecting the pipeline coating.

4.5.6 Contractor shall provide suitable facilities to Owner/consultant's personnel to witness all stages of construction.

4.5.7 Contractor shall be responsible for the integrity of the corrosion coating and shall apply necessary approved protective coatings.

Coating inspection of the pipeline after completion of pulling operation shall be made by:

a. Pulling the pipe to the extent possible with normal rig set tip at the exit point;

b. Excavating the adjacent portion tip to and including the first held joint.

The pipeline and joint coating shall be examined visually and with holiday detectors for defect. The length to be inspected shall, as a minimum, be one pipe length and one joint coating. In case damages/holidays are detected in the first pipe length/ joint, the subsequent pipe length / joint shall be exposed and coating integrity checks shall be made. If found acceptable by Owner/consultant, the first pipe length/ joint shall be repaired and/or replaced as directed by Owner/consultant. If the coating of second pipe length/ joint is also found damaged, Contractor shall propose further course of action and Owner/consultant's instructions shall be followed. All such works shall be done at no extra cost to Owner/consultant.

4.5.8 Before final hydrostatic testing, Contractor shall prove the diameter of the pipeline by passing a gauging (caliper) pig through the pipeline. The gauging pig shall have a diameter equal to 95% of the nominal internal diameter of the pipe. Contractor shall supply and install all temporary scraper launchers/ receivers and other equipment, piping and materials and consumables for the purpose.

4.5.9 Contractor shall obtain plans and full details of all existing and planned underground services from the relevant Local Authorities and shall be responsible for location and protection of the same. Contractor

shall execute the work at the crossings as per guidelines of the authorities having jurisdiction and to the satisfaction of the Owner/consultant.

4.5.10 After pulling the pipeline across the drilled crossing, Contractor shall cut the extended portion of the pipeline at the entry and exit points. Thereafter, the drilled portion of the pipeline shall be cut at suitable location/depth and extended on either bank by installing a cold field bend with minimum bend radius as specified in the relevant specification and a straight pipe length of 12m, such that at the ends the top of the pipeline is minimum 1.2 m below the natural ground level.

4.6 Hydrostatic Testing

4.6.1 Pre- testing

Contractor shall hydrostatically pre-test the complete pipe string of each river crossing before installation as per approved procedure.

The section of the pipeline corresponding to the river/major water crossing shall, before installation, be subjected to min. 1.5 times of design pressure, the combined equivalent stress in pipeline due to bending and test pressure shall not exceed 90% to 95% of SMYS of pipe material for 6 hours. At any cost highest pressure shall not be exceeding the maximum mill test pressure and recorded by manothermograph. During the test, Contractor shall check all welds for leakage. Failure, if any, during the test shall be rectified by the Contractor to the satisfaction of Owner/consultant at no extra cost. The method adopted for pre-hydro testing shall be in accordance with Specification.

4.6.2 Post-testing

Post hydro test shall be carried out for HDD portion of the pipeline at a pressure not less than 1.5 times the design pressure. After the temperature has been stabilized, the pressure shall be maintained for at least 24 hours and shall be recorded.

Contractor to refer document number GIGL-STD-PL-DOC-TS-012 (Technical specification for hydro-testing of pipelines) for hydro testing procedure.

4.6.3 De-watering, Cleaning, Drying

Once the tests have been declared satisfactory, the pipeline shall be de watered and properly cleaned and dried as per Specification No. ENG-STD-PL-DOC-TS-009.

The disposal of the water shall be performed such that no harm is done to the environment and the dewatering procedure, to be submitted by the pipeline contractor for Company/Company's representative's approval, should indicate this safe disposal methodology.

4.7 Final Clean Up

4.7.1 After completion of construction, Contractor shall clear the sites of all balance material and debris to the satisfaction of owner/consultant and authorities having jurisdiction.

The ground occupied during the work shall be reinstated to its original condition as quickly as possible after the completion of work.

Contractor shall take due care in disposing off inhibitor added water so that it doesn't cause any adverse affect on the surrounding environment.

4.7.2 The contractor shall give procedure for "surplus soil, bentonite slurry and corrosion inhibited tested water disposal" to client/consultant/TPI for approval

4.8 Markings

The location of the pipe shall be clearly marked by suitable means: conventional yellow markers, overhead markers, sign etc.

5.0 DOCUMENTATION

5.1 In addition to the documents specified elsewhere in this specification, Contractor shall submit to the Owner/consultant six copies each of the following documents/records.

5.2 During the course of execution of the crossing contractor shall generate/compile the following data. It shall be obligatory on part of the Contractor to furnish this data to Owner/consultant for the event it is required for.

Detailed drilling log and down hole data, including but not limited to, the following:

a) Torque and pulling/pushing force

b) Data on drilling fluid consisting of the following:

c) Density

d) Type of mud and additive employed

e) Mixing, pumping & cleaning.

Wash and drill pipe data, viz.

a) Dimension and material properties,

b) Data on APT classification,

c) Type of inspection previously carried out on these pipes.

d) Topics of the permits obtained from authorities having jurisdiction for the various works.

e) Detail profile of the drilled hole along with the water level variations.

f) Records of hydrostatic pre-testing and final testing

g) Record of Non Destructive Testing of welds.

h) Clearance certificates from the land Owner/consultant, authorities having jurisdiction regarding satisfactory clean-up and restoration of pipeline ROU and work areas.

5.3 After completion of construction, contractor shall prepare and furnish six sets of copies and two sets of reproducible of As-Built drawings for the crossings. As built drawings shall, as a minimum include the following information:

– True profile of the river bed and banks along the pipeline;

- True profile of the pipeline as installed;
- Depth of cover to top of-pipe at regular intervals;
- Location of entry and exit points and angles of entry and exit, along with lateral offset of exit point from the original pipeline alignment;
- Location and angle of field bends;
- Location of pipeline markers.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR PIPELINE MARKERS

GAIL-STD-PL-DOC-TS-011

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1.0 SCOPE

This specification covers the minimum requirements for supply, fabrication and erection of pipeline markers to be installed by Contractor at various locations along the route of cross-country pipeline.

2.0 REFERENCE CODES

Reference has been made in this specification to the latest revision of the following code:

API RP 1109 : Recommended practice for marking liquid petroleum pipeline facilities

PNGRB , Regulations 2009 : T4S Regulation, Petroleum and Natural Gas Regulatory Board

ASME B31.8 : Gas Transmission and Distribution Piping systems

3.0 GENERAL

3.1 Contractor shall supply, fabricate and install the pipeline markers along the pipeline route. The locations of markers as indicated in the approved drawings shall be treated for guidance purposes only and the exact location of the markers shall be based on AS- BUILT drawing and as directed by the Owner.

3.2 The pipeline markers shall be fabricated, painted (painting shall be done as per LEPL standard specification) and installed in accordance with the standard drawings included herein. Before start of fabrication of the markers, Contractor shall prepare and submit for Owner's approval the detailed scheme for the marker plates as applicable for the project.

3.3 The pipeline markers shall be installed, as far as possible, at locations such that they do not cause any hindrance to the regular use of the land or to the traffic.

4.0 AERIAL MARKERS

Aerial markers shall in general be installed along the pipeline at every five (5) kilometers intervals and at places specified by Owner. Refer Standard Drawing no. **GAIL-STD-PL-DWG-TP-015** for more details.

5.0 KILOMETER MARKERS

Kilometer markers shall in general be installed along the pipeline between the aerial markers at every one (1) kilometer interval. Markers shall indicate cumulative chainage in kilometers from the reference station, as directed by OWNER. A kilometer marker is not required if the relative length between its location and any pipeline warning sign is less than 200 meters. Refer Standard Drawing no. **GAIL-STD-PL-DWG-TP-013** for more details.

6.0 PIPELINE WARNING SIGN

Pipeline Warning Sign shall in general be installed at

- National, State Highway & Other Road Crossings (above 15m width) : 2 Nos.
- Other Road Crossings (less than 15m width) : 1No.
- Railway Crossings : 2 Nos.
- Water Crossings (less than 15m width) : 1No.
- Water Crossings (above 15m width) : 2No.
- SV Stations & TOP Station : 1No.
- And at any other location of importance as observed by Owner /Owner's Representative during construction.

Pipeline Warning Sign shall identify the existence of the pipeline and display the name of the Company, with an emergency telephone number, as shown in Standard Drawing no. **GAIL-STD-PL-DWG-TP-010**.

7.0 ROW BOUNDARY MARKERS

Right-of-Way boundary markers shall be fabricated and installed as per the drawings at every 250 metres interval along the entire pipeline route. These shall be installed on either side of the pipeline route to define the ROW boundary limits. These shall also be installed at pipeline turning points to maintain the continuity of the ROW limits. Refer Standard drawing No. **GAIL-STD-PL-DWG-TP-017** for details.

8.0 DIRECTION MARKERS

Direction Markers as shown in Standard Drawing no. **GAIL-STD-PL-DWG-TP-011** shall be installed to identify the significant turning points of the pipeline during serial traverse. One direction marker shall be installed at each turning point along the pipeline alignment. Two more directional markers shall be installed along the Pipeline alignment on either side of the Turning Point at 200 m from Turning Point of the pipeline route.

9.0 NAVIGABLE WATERWAY PIPELINE CROSSING WARNING SIGN

The Navigable Waterway Pipeline Crossing Warning Sign shall be fabricated in accordance with Standard Drawing No. GAIL-STD-PL-DWG-TP-016. Such Warning Sign shall be installed one on each bank of navigable water courses at the pipeline crossing location, in lieu of the Pipeline Warning Sign described in clause 6.0 of this specification.

10.0 SPECIAL MARKERS

As directed by Company, Special Marker shall be installed at Location where the following changes take place:
- Change in pipeline diameter and wall thickness.
- Change in type of pipe.
- Change in class locations for pipeline conveying gas.

The above data may be provided on other types of marker (except RoU boundary marker), if the relative distance between the two does not exceed 100 m.

ENGINEERING STANDARD

TECHNICAL SPECIFICATION FOR HYDRO TESTING OF PIPELINES

GAIL-STD-PL-DOC-TS-012

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1.0 SCOPE

1.1 This specification defines the minimum technical requirements for supply, works and operations to be performed by Contractor for hydrostatic testing of pipelines .

2.0 CODES AND STANDARDS

a) ASME B31.8 : Gas transmission and distribution piping system

b) API RP1110 : Pressure testing of liquid petroleum pipelines

c) ASME Sect. VIII : Boiler & Pressure Vessel code Div. 1

e) PNGRB T4S : Technical Standards & Specifications including Safety Standards

3.0 GENERAL

3.1 Hydrostatic test shall be performed on the entire length of the pipeline. Hydrostatic test shall be performed in accordance with approved test diagrams with clearly indicating the no. of test sections and min. /max. test pressure for each test section. The maximum length of each test section shall not exceed 50 kilometers. The hydrostatic testing shall exclude all the facilities that are installed as a part of the scrapper station. For hydrostatic testing, temporary test headers shall be provided and the pipeline section between the headers shall be tested as per approved procedure. The test shall not commence until the pipeline has been cleaned, gauged and flooded as per this specification.

Wherever pipeline is installed through casing or by HDD, the pipe strings/sections, shall be pre-tested and post-tested. Hydrostatic test shall include all those sections, which have been previously tested i.e. rail, road and water crossings.

3.2 Hydrostatic testing of the mainline shall be done only after completion of all mechanical and civil works i.e., all welds have been accepted and the pipeline has been laid and backfilled according to the specifications. Further, the test shall commence only after the pipeline has been cleaned, pigged, gauged and flooded as per this specification. Contractor shall perform all works required for testing after obtaining written approval from the Owner/consultant. All pipe work in test sections shall be adequately supported to hold loads imposed by weight of water.

3.3 Corrosion Inhibitor

If considered necessary by Owner/Consultant the Contractor shall provide corrosion inhibitor to the water to be used for hydrotesting.

Contractor (not the inhibitor manufacturer) shall get the inhibitor tested for corrosion inhibition and microbiological control efficiency from competent Govt./ PSU Laboratory. The test report shall be submitted to company for approval prior to undertaking hydrotesting works.

The dosage as recommended by inhibitor supplier shall only be adopted.

Contractor is to ensure that the numbers of golden welds that are a minimum. The hydrotest for the total pipeline system indicating the estimated number of subsections, which will hydrotested, shall be part of the procedure. The consecutive test sections shall be constructed with adequate overlap and planning so that tie-in can be carried out with a single weld. If tie-in cannot be carried out with a single weld, then that length of pipe shall be pre-tested at the specified test pressure for duration not less than six hours. All golden tie-in welds shall be welded and subjected to radiographical and ultrasonic inspection. Further in case of golden tie-ins, DPT or MPT shall be performed after completing root/ hot pass.

3.4 The maximum variation in altitude within the test sections shall be restricted as far as possible within 60 meters. However, contractor shall ensure that the test pressure shall not exceed 100% of SMYS at the lowest portion of the test section due to altitude difference.

3.5 Contractor shall prepare a detailed test procedure and submit for Owner/Consultant's approval at least one month before the scheduled commencement of tests. The procedure shall strictly comply with the requirements of this specification. The procedure shall include all temporary materials and equipment, but not limited to the following items:

a) A test diagram indicating all fittings, test ends, vents, valves test headers, temporary connections, instruments, thermocouples, relevant elevations and ratings. The diagram shall also indicate injection location and intake and discharge lines. The P&ID and pipeline drawings shall be marked up showing the battery limit of the test section.

b) The hydrostatic test diagram shall also indicate pipeline wall thickness, length of test sections, Specified minimum test pressure, points of maximum and minimum elevations and their relationship to the pressure at the test point.

c) Estimated amount of test water, water sources, results of test sample, including required concentration of corrosion inhibitors and additives, procedure for inhibitor injection and control of concentration.

d) Cleaning, gauging, filling and flushing procedures, including a complete description of all proposed equipment and instruments (including spares), their location and set-up.

e) The type, no of pigs and sequence of pigs and the pig tracking system for cleaning and removal of air pockets. Drawings of pigs, pig inspection procedures, including procedures to be followed.

f) Pressure testing procedure including a complete description of all proposed equipment and instruments (including spares), their location and set-up, and proposed system for observation and recording of data during the pressure test.

g) Procedure for filling, pressurization and residual air volume determination.

h) Procedure for thermal stabilization and pressure and temperature monitoring during stabilization and hold period.

i) Theoretical pressure volume and pressure temperature curves including calculating steps.

j) Procedure for detection and location of leaks.

k) Procedure for depressurization, dewatering the pipeline section after testing, including a

complete description of all proposed equipment and instruments (including spares), their location and set-up, the type and sequence of pigs and the pig tracking system if required along with the pig specification.

l) Formats for recording the test data, calculation sheets etc.

m) HSE requirements during filling, hydro testing, water disposal, use of chemicals, etc.

n) An emergency procedure in the event of a test failure through rupture.

o) Contingency procedure for removal of stuck pig/ blocked pigs in pipeline.

3.6 Equipment and Instrumentation

The Contractor shall furnish all necessary equipment for performing the work as stated in cleaning, flushing, filling, leveling, stabilizing, testing and dewatering procedures.

This shall include, but not be limited to the following equipment and instruments.

1) Pigs for filling, cleaning and gauging of the pipeline include:
- Cleaning pigs with spring loaded steel wire brushes except for internal coated pipes. In this case pigs to be provided with nylon / polyurethane brushes.
- Four cup batching pigs, Gauging pigs fitted with gauge plate.

Contractor shall provide sufficient no. of pigs including spares.

2) Air compressors for cleaning, gauging & dewatering of minimum 3000 Nm^3/h capacity 0-100 bar.

3) Calibration of all measuring instruments in Owner/ Consultant approved laboratory.

4) Fill pumps: The Contractor shall determine the type and number of fill pumps in order to guarantee the following:

a) Differential head 20% greater than the maximum required.

Flow rate - Minimum 400 m^3/h

Maximum 1000 m^3/h

If a single pump is used, a standby unit must be available. The stuffing boxes of the pumps must be sealed to prevent air from entering the internals of the pump.

5) Variable speed positive displacement pumps equipped with a stroke counter to pressurize the line with a known volume per stroke and capable of exceeding the maximum test pressure by at least 20 bar.

6) Breakwater tanks with filters for water filling and chemical dosing.

7) Two positive displacement meters and/or turbine flow meters with flow straightners to measure the volume of water used for filling the line. These meters shall be provided with a calibration certificate not older than six months. However all instruments used for measurement of volume of water added for pressurization shall have calibration certificates not older than one month.

8) Pressure recording instruments with pressure sensors and 24-hour charts. These shall be calibrated against dead weight tester.

9) Dead weight testers with an accuracy of 0.01 bar measuring in increments and sensitivity of 0.05 bar shall be provided with a calibration certificate no older than one month. The pressure range of the dead weight tester shall be 1.5 times the hydrotest pressure.

10) Large diameter (6" Minimum) Bourdon Pressure gauges of suitable pressure range (1.5 x test pressure to be measured) and accuracy of $\pm$ 0.1% of the full-scale value. These shall be calibrated at site with dead weight tester. Its calibration shall be checked at the beginning, end and during the hydrotest period. The pressure gauges shall be installed at both ends of the test section.

11) Two temperature recorders for fill water with an accuracy of $\pm$ 1% of full-scale range. The scale range shall be 0°C to 60°C and the sensitivity shall be 0.1°C. The temperature shall be recorded throughout filling stage.

12) Thermocouples for measuring the pipe wall temperature with an accuracy of $\pm$ 0.2°C.

13) Ambient/Environmental temperature shall be recorded throughout hydrotest duration from the beginning of pressurization. The recorder shall have a range of 0°C to 60°C and shall have an accuracy of $\pm$ 1% of full-scale range. Two recorders one at each end shall be used.

14) A barograph with an accuracy of $\pm$ 0.8 millibar and measuring increments of 1 mbar.

    Two laboratory thermometers (thermocouples based) of 0°C to 60°C range, with an accuracy of $\pm$ 0.1°C to be used in thermowells. The temperature measuring instruments shall be provided with NPL calibration certificate not older than one month. These shall be used for calibration of the temperature recorders.

15) Portable tanks of sufficient size to provide a continuous supply of water to the pump during pressurizing.

16) Means to measure the volume of water necessary to drop the line pressure by 0.5 bar (container on scales or graduated cylinder). Resolution shall be 0.0005% of fill volume of the pipeline.

17) Injection facilities to inject additives for anti-corrosion, oxygen scavenger and bactericides into the test medium in the required proportions.

18) The temporary test headers shall be installed according to the testing sections fixed in the test procedure manual. Proper piping and valve arrangements shall be available to allow launching and receiving of each pig independently. The test heads, manifolds etc., shall be pre-tested for four hours at a pressure equal to 110% of maximum test pressure. The manifolds, test heads, end closures and other temporary testing equipment shall be designed as per recognized codes and shall be either flange/bolted or welded to the pipeline section.

19) A good and well laid out test cabin shall be located at a safe distance and shall have sufficient space to house all instruments and record of data.

20) Communication equipment suitable for a continuous connection between the beginning and the end of the test section and with the inspection team along the line, in accordance with the requirements of Local Authorities.

21) Thermocouples shall be attached on the external surface of the pipe after removal of external coating and shall be adequately protected by padding with minimum 500 soil. After successful testing , the thermocouples shall be removed and damaged coating shall be repaired as per applicable coating repair procedure, approved by company. For soil temperature measurements, the thermocouple shall be buried at pipe centerline depth at a distance of 500 mm from the pipe wall.

22) All instruments used for measurement shall be certified for accuracy, repeatability and sensitivity.

23) The temperature along the pipeline section shall be measured prior to start of water filling, during filling, during thermal stabilization, and during hydrotest. The recording frequency shall be in terms of every four hours or lesser based on site condition or as directed by the Owner.

In addition to above, Owner/Consultant reserves the right to demand installing more thermocouples as per site conditions.

Thermocouples shall be attached on the external surface of the pipe after removal of external coating and shall be adequately protected. Owner/Consultant coating instruction shall be followed.

4.0 TEST DURATION AND PRESSURE

4.1 The duration of hydrostatic test shall be minimum 24 hours after stabilization and the test pressure shall be as indicated in approved hydrostatic test diagram.

4.2 Unless otherwise specified in the Contract, natural gas pipelines shall be tested at a minimum test pressure of 1.5 times the design pressure irrespective of the class location. However, the maximum test pressure at the lowest point of the test section or at the section with the least wall thickness shall be limited to hoop stress resulting in 100% of SMYS.

4.3 Pre-testing:

Pre-testing of pipe shall be carried out of carrier pipes in case of cased crossings, pipe strings in case of HDD, pipe before concrete coating and as specified elsewhere in the tender document at a test pressure limited to hoop stress resulting in 100% of SMYS.

The test duration shall be 6 hours and shall be properly recorded.

5.0 PROCEDURES

The test medium shall be soft non-aggressive water. The water to be used shall be filtered, potable and free from sand or silt. The water shall be free of dissolved substances, harmful chemicals, bacteria etc., which could be harmful to the pipe or which could form internal deposits in the pipeline. The water quality shall correspond to filtration through a 50 micron filter and the average content of suspended matter shall not exceed 20g/m^3. Contractor shall submit laboratory test reports of water used for testing.

Contractor shall provide Owner/ Consultant approved corrosion inhibitors, oxygen scavengers and bactericides to be added to the test water as required. The Contractor shall furnish and install all temporary piping which may be necessary to connect from source of water to its pumps and manifolds/tankages. All temporary piping shall be adequately supported during the pressure test. Pressure hoses used shall be properly armoured and shall have a safe working pressure at least equal to twice the hydrostatic test pressure. The hoses shall be anchored to prevent pipe whip and shall not be used inside the test cabin. All hoses shall be pre-tested at least for one hour at their rated working pressure.

5.1 Cleaning & Gauging

Before filling operation the Contractor shall clean the pipeline by air driven pigs to remove all mill scale, rust/sand, weld debris and other metallic particles from the internal of pipe sections. The finishing touch shall be executed with pigs provided with air jet holes or nozzles to keep the internal dust in turbulence ahead of the pigs. Contractor to ensure that the cleaning pigs does not damage pipeline components and facilities. The number of pig runs shall depend upon the cleaning results and shall be determined by the Owner/ Consultant Representative at site. In case of stuck/ blocked pigs, contractor to submit detail action plan at site for Owner's approval before proceeding with any remedial measures. Pig train speed shall be maintained between 0.5 m/sec to 1 m/sec. Progress of pig train shall be monitored. Contractor has to furnish detailed procedure including placement of pig locators on the line.

During filling the pigs used shall be capable of providing positive air/water interface and minimize air entertainment. All spaces in which air could be entrapped such as valve bodies; bypass pipe work etc. should be vented and sealed. The cleaning fluids shall remove chemical particles and organisms. The cleaning and gauging train design, number of pigs, train velocity etc., shall be based on pipeline size and gradient along pipeline route. Care should be taken in downhill pipe sections where air pressure shall be maintained to ensure that pigs do not move ahead of line fill resulting in air pockets being trapped at the uphill. The pressure produced by downhill point of water column on the pig shall be balanced by sufficient back pressure.

After cleaning the pipeline by using air and acceptance by Company, gauging shall be carried out by using gauging pig. The gauge plate diameter shall be equal to 95% of inside diameter of the heaviest wall pipe in the test section. While computing the ID of heaviest wall pipe, pipe manufacturing tolerances shall not be considered. A 10 mm thick aluminium plate shall be used for making the gauge plate.

After receipt of gauging pig at the other end, the gauge plate shall be inspected in the presence of Company representative. A deformed, bent or severally nicked plate or damaged pig shall be evidence of gauging pig run failure and the same shall not be acceptable to COMPANY. In such cases the Contractor shall repair and rectify the line and repeat the gauging pig run to the satisfaction and approval of the Company Representative. Any obstruction and/or faults such as dents, buckles, flat spots, etc. analysed and noted during gauging pig run shall be located and any necessary repair work shall be performed to rectify the same to the satisfaction of the Company. A written approval shall be obtained from Company regarding successful completion of gauging pig run.

After acceptance of gauging operation, air header shall be cut and removed. Pre-tested test headers loaded with three numbers of four cup batching pigs shall be welded to test section.

The drawing of the test headers shall be submitted along with hydrotest procedure for approval. All fittings and flanges to be used in the test header fabrication shall be at least one ANSI rating higher

than the line rating. The headers shall be pretested at line hydrotest pressure for duration of minimum 4 hours. The record shall be kept and shall be part of the final hydro test report.

After cleaning, pipeline will be flushed with minimum 1 km of pipeline volume and water shall be filled with corrosion inhibitor by propelling minimum 2 pigs with water column of 100 meters.

5.2 Thermal Stabilization

After a check has been made to confirm whether the pressure has attained at least 1 bar (g) on the highest section, the thermal stabilization can be started.

Thermal equilibrium between the pipeline and environment shall be checked through the thermocouples installed on the pipeline.

Pipe to soil temperature readings shall be taken at every 2 hour intervals. Thermal stabilization shall be done for 24 hours and shall be considered to have been achieved when a difference not higher than 1ºC is attained between the average values of the last two readings. Owner/Consultant shall approve thermal stabilization completion before pressurization.

5.3 Pressurization

The pressurization rate shall not be more than 2 bar/ min. Pressure shall be recorded by using a dead weight tester and confirmation shall be done with pressure gauge on the same header. Water volume shall also be recorded with respect to pressure.

- Each 5 bar increments upto 80% of test pressure as recorded by the dead weight tester.
- Each 2 bar increment between 80% of test pressure as recorded by the dead weight tester.
- Each 0.5 bar increments between 90% of the test pressure up to full test pressure as recorded by dead weight tester.

Pressure cycling and Air volume ratio calculations requirements:

i) Pressurise to 50 % of test pressure, hold pressure for 1 hour, and collect water for air volume calculations. Check for any leaks.

ii) Drop pressure to static head of test section at test head.

iii) Re-pressurise to 75% of test pressure, hold pressure for 1 hour and check for any leakage

iv) Drop pressure to static head of test section at the test head.

v) Re-pressurise to test pressure and hold for stabilization.

vi) During the pressurisation to each test pressure, two tests shall be carried out for the calculation of air volume in the pipeline under test at 50% and 75% of test pressure.

In case, during the hold pressure periods indicated above, a decrease in pressure in observed, the above operations shall not be repeated more than twice, after which the line shall not be considered capable of test, until the Contractor has isolated and eliminated the cause for the lack of water tightness.

5.4 Air Volume Calculation

In order to check the presence of air in the pipeline, two separate consecutive pressure lowering of 0.5 bar shall be carried out.

For calculation of air in the pipeline the second pressure lowering shall be used, and the relevant drained water shall be accurately measured (V_1). This amount measured shall be compared to the

theoretical amount (V_2) corresponding to the pressure lowering that has been carried out, by using the procedure outlined in the specification.

If no air is present in the length under test:

$$\frac{V_1}{V_2} = 1$$

The above ratio is acceptable, provided it shall not differ from '1' by more than 2% (i.e. 1.02).

If ratio is found to be above within limits, then pressurization can proceed. If not, water refilling shall be carried out by another run of batching pigs after depressurizing the pipeline.

Simultaneously contractor shall also construct a plot of pressure volume from the initial stage of pressurization until a definite linear relationship is obtained. The theoretical P/V plot shall also be plotted on the same graph. Once 50% of test pressure is reached, the linear curve shall be extrapolated backwards to cut the volume axis. The measured air volume and its percentage of pipeline test section volume shall be calculated. On completion of the air inclusion P/V plot, a separate P/V plot should commence and continue until the test pressure is reached. The slopes of the actual P/V plot and theoretical P/V plot shall be compared and all calculations and graphs shall be submitted to Owner/Consultant for information.

Percentage of air = (volume of air / volume of line) X 100

Air content shall not exceed 2 % of the line volume. In case, air content exceeds the limit, testing shall be terminated. The test section should be emptied and refilled at the discretion of the Owner/ Consultant.

5.5 Testing (pressure holding test)

After the section has been pressurized and the air column test has given acceptable results the test pressure shall be held for a minimum of 24 hours after stabilization. After temperature and pressure are stabilized, the injection pump shall be disconnected and all connections at the test heads shall be checked for leakage. The pressure and temperature recorders shall then be started once again with the charts in a real time orientation for continuous recording throughout the test duration. No further pumping is permitted during the test period.

During the testing period the following measurements shall be recorded/ reported:

- Every one-hour pressure measurements from dead weight testers.

- Every two hours the ambient temperature and the pipe temperature at the thermocouples and fill water temperature.

- Barometric pressure for every one hour.

All data shall be recorded on appropriate formats attached to the hydrostatic test procedure manual. Care shall be taken that the maximum test pressures are not exceeded.

6.0 ACCEPTANCE

The hydrostatic test shall be considered as positive if pressure has kept a constant value throughout the test duration, except for change due to temperature effects. Such changes shall be evaluated as described below.

The pressure change value as a function of temperature change shall be algebraically added to the pressure value as read on the meters. The methodology for calculation of pressure change due to temperature shall be as per section 8.0 of this specification. The pressure value thus adjusted shall be compared with the test and shall be considered as acceptable if the difference is less than or equal to 0.3 bar of test pressure. In case of doubt or if for any reason the test pressure has been reduced other than for bleed-off excess pressure, the test duration shall be extended by 24 hours.

If test section doesn't meet the above requirement, Contractor shall determine by search the location of leakage or failure. All leaks and failures within the pipe wall or weld seam shall be repaired by replacement of entire pipe or pipes in which leakage or failure occurs. In those cases, where leaks occur in circumferential welds the Owner/ Consultant shall determine the method of repair. Contractor shall comply with instructions of the Owner/ Consultant's representative whether to replace a section of the line pipe that includes the line leak or whether to repair the circumferential weld. The repair shall be carried out as per specifications. Where failures occur in pipeline field bends, bends shall be replaced with same degree bends. After completion of repairs, the hydrostatic test shall be repeated as a complete cycle, as per this specification. All repairs and retesting shall be carried out at the expense of the Contractor. All work of reinstalling line pipes to replace failed pipes shall be carried out as per specifications. For Owner/Consultant verification, all failed pipes shall be stored, marked, and tagged indicating date and location of failure and pressure at which failure occurred. The failed areas shall be greased to prevent corrosive action.

A. The cost of repairs or replacements, followed by refilling & repressurising the line, due to poor workmanship, shall be borne by the contractor. In the event of leaks or failures resulting from faulty company furnished materials, contractor shall be reimbursed as per provision of the contract. All work of reinstalling of line pipe, to replace failures, shall be done in accordance with the relevant specifications included in the contract.

B. Contractor shall haul and stockpile all damaged and defective pipes to storage location designed by the company. All Cracks and splits resulting from failure shall be coated with an application of grease to preserve the characteristics of failure from corrosion. joint of failed pipes shall be marked with paint, with the tag indicating failure details date and location failure and pressure at which failure occurred. Failed pipes shall have pipe nos. and heat no. clearly marked on the outside surface along with warning sign to prevent usage.

7.0 TERMINATION

After the positive results of testing and all the data have been gathered, the test shall be terminated upon written approval given by Owner/Consultant.

The pipeline shall be slowly depressurized at a moderate and constant rate as instructed by Owner/Consultant. Subsequent operation such as caliper pigging, swabbing, drying, purging , inertising and commissioning shall be carried out as per applicable specifications enclosed with the contract.

Dewatering shall be carried by using four cup pigs and foam pigs driven by compressed air. The detailed dewatering procedure shall be deployed by the Contractor in such a way as to provide adequate control of pigs during dewatering. Pigs and equipment required for dewatering the line shall be furnished by Contractor and shall be approved in advance by the Company. Four cup pigs shall first be passed through the line to displace the water. Then foam pigs shall be passed in order to complete the line dewatering. Contractor shall use a number of foam pigs each in different colours/numbered for this purpose. The line shall be considered dewatered when a negligible amount of water is flushed out by the last foam pig.

Before the start of dewatering and disposal of hydro test water, a procedure for treatment of inhibited water to prevent pollution shall be submitted by Contractor to Company for review and approval. During dewatering, care shall be taken to properly dispose off the discharged water in order to avoid pollution, damages to field under cultivation and /or existing structures and interference with traffic.

All thermocouples installed on the line shall be removed and coating repaired to satisfaction of the client. All piping and instrument connections shall be blanked, plugged or capped as per requirements.

Water measurement, pressure measurement, temperature measurement to be included with accuracy, duration of measurement, scale, fee rate etc.

8.0 CALCULATIONS

The theoretical water amount that is necessary for filling the section to be tested shall be obtained from the geometrical volume of the section considering the pipe tolerances.

The theoretical water amount that is necessary for pressurizing the section shall be calculated by means of the following formula:

$$Vp = (0.884\ r_1/t+A) \times 10^{-6} \times V_t \times \Delta P \times K$$

Where:

Vp = Computed water amount required to raise the pressure by 'ΔP' in the section to be tested (m^3)

Vt = Geometrical volume of the section (m^3)

ΔP = Pressure rise (bar)

r_1 = Nominal inner radius of the pipe (mm)

t = nominal pipe thickness (mm)

A = isothermal compressibility value for water at the pressurization temperature in the P range (bar^{-1}).

K = a dimensionless coefficient that is equal to a value of 1.02 for Longitudinally welded pipe, and 1.0 for seamless pipe.

The pressure change due to a water temperature change shall be calculated through the following formula:

$$\Delta P = B * \Delta T / \{ (0.884 r1 / t)+ A \}$$

Where;

ΔP = Pressure change resulting from a temperature change (bar).

ΔT = Algebraic difference between water temperature at the beginning of the test and water temperature as measured at the end of the test (ºC).

B = Value of the difference between the thermal expansion of water at the pressure and temperature as measured at the end of the test and that of Steel (ºC). Refer Table-1.

A = Isothermal compressibility value of water as estimated at the pressure and temperature values obtained at the end of test (bar^{-1}). Refer Fig-1.

r_1 = Nominal inner radius of the pipe (mm).

t = Nominal pipe thickness (mm).

9.0 TEST REPORT / DOCUMENTATION

A complete report signed by Contractor and the Owner/ consultant Representative shall be submitted upon completion of the hydrostatic testing operations for each test section.

The report shall contain as minimum:

- Cleaning, flushing, filling and testing procedure used
- Schematic layout of cleaning, filling and testing facilities
- All Instruments calibration certificates
- A profile of the pipeline that shows the test sites, all instrument and injection connections.
- Pipe filing logs and records.
- Hydrotest chemicals specification, dosage, injection records specifications and certificates.

- Pig specifications
- Pigging records including details of pig runs.
- Pressurization and stabilization records and charts with all information specified.
- Pressure and temperature recording charts with appropriate information inscribed thereon.
- Dead weight tester logs and recordings
- Air volume calculations and plots
- Pressure – temperature change calculations
- Profiles of pipelines with elevations
- Environmental data, barometric data
- Depressurisation logs and records
- Disposal method of test water
- Records and photograph of all leaks/failure, location of failure and method of repair
- Schematic isometric drawing of test header with all auxiliaries.
- Daily log of events.

10.0 PRECAUTIONS DURING THE TEST

In addition to all that has been expressly described in the procedures for carrying out the test, the following requirements shall also be complied with.

10.1 During the hydrotest, no other activities shall be performed on or near pipeline being tested. Further, the test sections shall be kept under continuous surveillance by regular petrolling during test and with continuous communication.

10.2 Signs stating “PIPE UNDER TEST – KEEP OFF” shall be placed where the test ends are located. Such areas shall be suitably guarded throughout the duration of the test. In case pressurizing is done from the shore end, the entire operational area shall suitably be fenced to prevent entry of unauthorized personnel. The warning sign shall also be in Local Language.

10.3 All personnel working on the hydrotest spread shall be instructed on the possible dangers connected with the high-pressure test operations. During the testing, operations, unauthorized personnel shall not be allowed near by the test head location. Test cabin shall be at least 10 m away from the pipeline so that it is not affected by any pipeline failure.

10.4 All precautions pertaining to handling and disposal of chemicals shall be as per manufacturer’s standards.

10.5 All pumps shall have overprotection devices set @ 5 bar above test pressure.

10.6 The pressure shall be reduced to a safe level of 1 bar before any work is permitted on the pipeline section.

10.7 All crossing areas and areas of public access should be patrolled during test.

10.8 Contractor to ensure that all safety precautions comply with statutory and other national/state and local regulations and shall give notice to the concerned authorities regarding the intention to carry out the test.

10.9 Contractor to ensure that a hydrotest organization chart is made and all personnel are fully aware of their responsibilities and scope of work.

Table 1

Difference between the water thermal expansion factor and the steel thermal expansion factor ($^oC^{-1}$) (10^{-6})

°C Bar	1	2	3	4	5	6	7	8
0.98	-98.62	-79.89	-61.81	-44.34	-27.47	-11.14	4.66	19.98
10	-95.55	-76.94	-58.99	-41.65	-24.89	-8.67	7.02	22.23
20	-92.15	-73.68	-55.86	-38.64	-22.01	-5.92	9.65	24.74
30	-88.74	-70.4	-52.72	-35.63	-19.14	-3.16	12.29	27.26
40	-85.32	-67.12	-49.58	-32.62	-16.24	-0.41	14.93	29.78
50	-81.9	-63.84	-46.43	-29.6	-13.36	2.36	17.57	32.31
60	-78.47	-60.55	-43.27	-26.58	-10.46	5.15	20.23	34.85
70	-75.03	-57.25	-40.1	-23.54	-7.56	7.92	22.89	37.39
80	-71.6	-53.96	-36.94	-20.51	-4.65	10.7	25.55	39.94
90	-68.16	-50.66	-33.77	-17.47	-1.73	13.5	28.23	42.5
100	-64.72	-47.35	-30.6	-14.43	1.18	16.29	30.9	45.05
110	-61.28	-44.05	-27.43	-11.38	4.1	19.08	33.58	47.61
120	-57.84	-40.74	-24.26	-8.34	7.02	21.88	36.26	50.18
130	-54.4	-37.44	-21.08	-5.29	9.95	24.68	38.94	52.75
140	-50.96	-34.13	-17.9	-2.25	12.87	27.49	41.63	55.32
150	-47.53	-30.83	-14.73	0.8	15.79	30.29	44.31	57.89
160	-44.1	-27.53	-11.56	3.85	18.72	33.1	47	60.46
170	-40.67	-24.23	-8.4	6.89	21.64	35.9	49.69	63.04
180	-37.24	-20.94	-5.23	9.94	24.56	38.7	52.37	65.62
190	-33.83	-17.65	-2.06	12.98	27.48	41.51	55.06	68.19
200	-30.42	-14.37	1.09	16.01	30.4	44.3	57.75	70.77
210	-27.02	-11.09	4.25	19.04	33.31	47.1	60.43	73.34
220	-23.63	-7.82	7.4	22.06	36.22	49.9	63.12	75.9
230	-20.24	-4.56	10.54	25.08	39.13	52.69	65.8	78.48
240	-16.87	-1.3	13.67	28.1	42.03	55.48	68.48	81.05
250	-13.58	1.94	16.79	31.11	44.92	58.26	71.15	83.61
260	-10.14	5.17	19.9	34.12	47.81	61.04	73.81	86.81
270	-6.8	8.39	23	37.11	50.69	63.8	76.48	88.73
280	-3.48	11.6	26.11	40.09	53.56	66.57	79.14	91.29
290	-0.17	14.8	29.19	43.07	56.43	69.33	81.78	93.83
300	3.13	17.98	32.27	46.03	59.29	72.06	84.83	96.38

Table 1

Difference between the water thermal expansion factor and the steel thermal expansion factor ($^oC^{-1}$) (10^{-6}).

°C Bar	9	10	11	12	13	14	15
0.981	34.82	49.22	63.2	76.78	89.99	102.83	115.34
10	36.97	51.26	65.15	78.64	91.75	104.51	116.93
20	39.36	53.55	67.33	80.71	93.72	106.39	118.71
30	41.76	55.84	69.51	82.79	95.7	108.26	120.49
40	44.18	58.14	71.7	84.87	97.68	110.14	122.28
50	46.6	60.45	73.9	86.96	99.68	112.04	124.07
60	49.02	62.76	76.1	89.07	102.67	113.93	125.88
70	51.44	65.08	78.32	91.17	103.68	115.84	127.69
80	53.88	67.4	80.53	93.29	105.69	117.76	129.5
90	56.32	69.73	82.75	95.41	107.7	119.67	131.32
100	58.77	72.07	84.98	97.53	109.73	121.59	133.15
110	61.21	74.41	87.22	99.66	111.75	123.52	134.98
120	63.67	76.74	89.45	101.79	113.79	125.46	136.82
130	66.12	79.09	91.69	103.93	115.83	127.39	138.67
140	68.58	81.45	93.93	106.07	117.67	129.34	140.51
70	71.05	83.8	96.18	108.21	119.9	131.2	142.37
160	73.51	86.15	98.43	110.36	121.96	133.74	144.22
170	75.97	88.51	100.68	112.51	124.01	135.19	146.08
180	78.44	90.87	102.94	114.66	126.06	137.15	147.94
190	80.91	93.23	105.19	116.82	128.12	139.11	149.81
200	83.37	95.59	107.45	118.97	130.17	141.07	151.68
210	85.84	97.95	109.71	121.13	132.24	143.03	153.55
220	88.3	100.31	111.97	123.29	134.29	144.99	155.42
230	90.67	102.67	114.23	125.45	136.36	146.96	157.3
240	93.22	105.03	116.48	127.6	138.42	148.93	159.18
250	95.69	107.39	118.74	129.76	140.48	150.9	161.05
260	98.14	109.74	121	131.92	142.54	152.87	162.93
270	100.6	112.1	123.25	134.08	144.61	154.84	164.81
280	103.05	114.44	125.5	136.24	146.67	156.84	166.69
290	105.5	116.79	127.75	138.39	148.73	158.78	168.57
300	107.94	119.13	130	140.54	150.79	160.75	170.45

Table 1

Difference between the water thermal expansion factor and the steel thermal expansion factor ($^oC^{-1}$) (10^{-6}).

^oC / Bar	16	17	18	19	20	21	22	23
0.981	127.52	139.41	151	162.31	173.37	184.18	194.75	205.08
10	129.02	140.83	152.36	163.58	174.56	185.3	195.79	206.07
20	130.71	142.42	153.85	165	175.9	186.55	196.96	207.16
30	132.4	144.02	155.35	166.42	177.23	187.8	198.14	208.26
40	134.1	145.62	156.87	167.85	178.58	189.07	199.33	209.37
50	135.8	147.24	158.39	169.85	179.93	190.34	200.52	210.49
60	137.51	148.86	159.92	170.73	181.29	191.62	201.72	211.61
70	139.22	150.49	161.46	172.18	182.66	192.91	202.93	212.74
80	140.95	152.11	163	173.64	184.03	194.2	204.14	213.88
90	142.67	153.75	164.56	175.1	185.41	195.5	205.36	215.03
100	144.42	155.4	166.11	176.58	186.8	196.8	206.59	216.17
110	146.15	157.04	167.66	178.05	188.2	198.12	207.82	217.33
120	147.9	158.7	169.24	179.54	189.59	199.44	209.06	218.49
130	149.65	160.36	170.81	181.02	191	200.75	210.31	219.66
140	151.4	162.03	172.39	182.51	192.41	202.09	211.56	220.84
70	153.16	163.7	173.98	184	193.82	203.42	212.81	222.02
160	154.93	165.37	175.56	185.51	195.24	204.76	214.08	223.2
170	156.69	167.05	177.15	187.02	196.66	206.1	215.34	224.39
180	158.47	168.73	178.75	188.53	198.09	207.45	216.61	225.55
190	160.24	170.42	180.35	190.05	199.52	208.8	217.89	226.79
200	162.01	172.1	181.95	191.57	200.97	210.16	219.17	227.99
210	163.8	173.8	183.55	193.09	202.4	211.53	220.46	229.2
220	165.58	175.43	185.16	194.62	203.85	212.89	221.74	230.41
230	167.36	177.19	186.78	196.14	205.3	214.26	223.04	231.63
240	169.16	178.89	188.39	197.68	206.75	215.63	224.33	232.85
250	170.94	180.59	190.01	199.21	208.2	217	225.63	234.08
260	172.73	182.3	191.63	200.75	209.66	218.4	226.93	235.31
270	174.53	184	193.25	202.29	211.12	219.77	228.24	236.54
280	176.32	185.7	194.88	203.83	212.59	221.16	229.55	237.77
290	178.11	187.42	196.5	205.37	214.05	222.54	230.86	239.01
300	179.9	189.13	198.13	206.92	215.51	223.93	232.18	240.26

Table 1

Difference between the water thermal expansion factor and the steel thermal expansion factor ($^oC^{-1}$) (10^{-6})

°C Bar	24	25	26	27	28	29	30
0.981	215.22	215.14	234.88	244.41	253.79	263	272.03
10	216.13	225.99	235.66	245.13	254.44	264.27	272.57
20	217.15	226.94	236.53	245.94	255.18	264.59	273.18
30	218.18	227.88	237.41	246.75	255.93	264.95	273.8
40	219.21	228.85	238.3	247.58	256.69	265.64	274.42
50	220.25	229.82	239.2	248.4	257.45	266.33	275.07
60	221.3	230.79	240.11	249.24	258.22	267.04	275.7
70	222.35	231.78	241.02	250.08	258.99	267.75	276.35
80	223.42	232.77	241.94	250.93	259.78	268.47	277.01
90	224.48	233.76	242.87	251.79	260.57	269.19	277.66
100	225.56	234.76	243.79	252.66	261.36	269.92	278.33
110	226.64	235.78	244.73	253.53	262.17	270.77	279.01
120	227.73	236.79	245.68	254.4	262.98	271.41	279.69
130	228.82	237.81	246.63	255.28	263.69	272.16	280.38
140	229.92	238.84	247.59	256.18	264.62	272.92	281.08
150	231.03	239.87	248.55	257.07	265.44	273.69	281.78
160	232.14	240.91	249.52	257.97	266.28	274.46	282.49
170	233.26	241.96	250.49	258.88	267.12	275.23	283.2
180	234.38	243.01	251.47	259.79	267.97	276.01	283.92
190	235.51	244.06	252.46	260.71	268.82	276.8	284.64
200	236.64	245.12	253.45	261.63	269.67	277.59	285.37
210	237.77	246.18	254.45	262.5	270.54	278.39	286.11
220	238.91	247.26	255.45	263.49	271.4	279.19	286.85
230	240.06	248.33	256.46	264.43	272.28	280	287.59
240	241.21	249.41	257.46	265.37	273.16	280.82	288.35
250	242.36	250.49	258.48	266.31	274.04	281.63	289.11
260	243.52	251.58	259.49	267.27	274.92	282.46	289.86
270	244.68	252.66	260.52	268.23	275.82	283.29	290.64
280	245.84	253.76	261.54	269.18	276.71	284.12	291.4
290	247.01	254.86	262.57	270.15	277.61	284.95	292.18
300	248.18	255.96	263.6	271.11	278.51	285.79	292.95

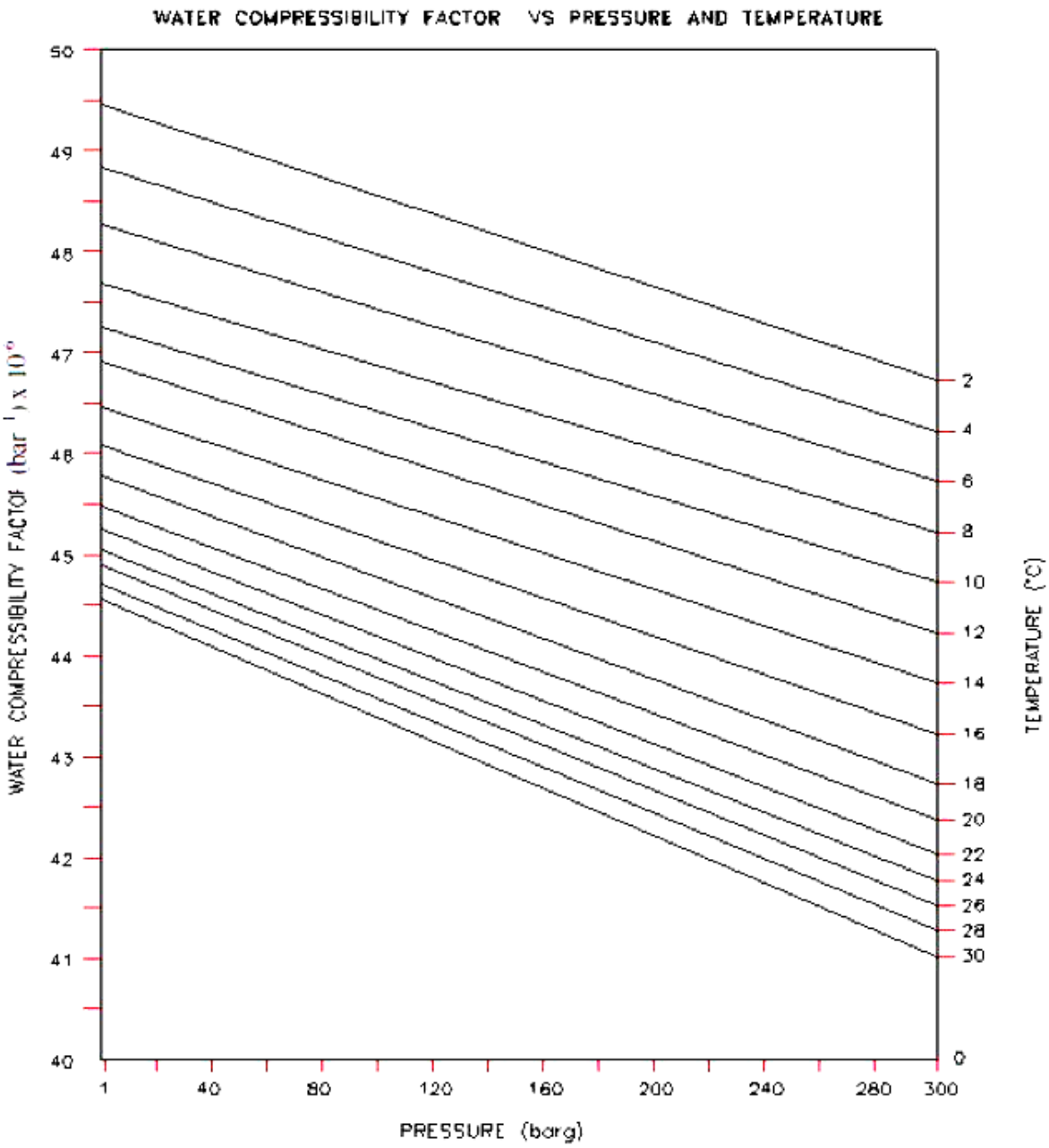

Fig.1 Water Compressibility Factor

ENGINEERING STANDARD

TECHNICAL SPECIFICATION FOR CALIPER PIGGING

GAIL-STD-PL-DOC-TS-013

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1.0 SCOPE

This specification covers the minimum requirements for carrying out the electronic geometry pig run after successful completion of pipeline laying work. After dewatering and swabbing of the main pipeline segment, magnetic and electronic geometry pigging (EGP) of the pipeline shall be done by the contractor. The basic purpose is to detect geometry defects and pipeline features by running electronic calliper pigs preceded by magnetic cleaning pig to clean the pipeline to acceptable level.

2.0 OBJECTIVE

The objective of the present pigging programme is to assess the internal geometry of the pipelines and detect geometry defects if any, of the pipeline.

3.0 SCOPE OF WORK

Scope of work of the contractor shall consist of running EGP through 100% pipeline length. The EGP run shall be done after successful completion of hydro-test of the pipeline. In case permanent launcher and receiver are not ready, contractor shall carry out the EGP with temporary launcher and receiver which shall be arranged by the contractor at no extra cost and time to Owner. All facilities/services numerated herein under (not limited to) which the contractor deems necessary to fulfil the work shall have to be arranged by the contractor at no extra cost and time to owner.

Mobilization of all equipment by the contractor e.g. electronic geometry pigs, air compressors, pig locating and pig tracking devices, temporary launcher and receiver, spares, consumables, communication system, transportation and adequate qualified personal for completion of entire work within contract price without depending turnaround time of bringing the pig received from previous run from receiver station to launch station, as such no turn period shall be allowed. It is expressly understood that this does not limit the scope of work of the contractor in any way. The quantities to be mobilised for different equipment (pigs, pig tracking device) accessories, spares, and consumables need to be carefully evaluated taking in to the consideration that geometry inspection of each segment should be carried out without any constraint. Contractor shall submit operation manual/procedure manual and data sheets for pigs before commencing the job for owner approval.

Transportation of the tools and personnel by the contractor at the site from one pigging section to another as per availability of the work front. Contractor shall organize placement pigs into launcher and retrieval of the pig from the receiver including launching and receiving operations.

The contractor shall submit the details of each type of pig including foam, gauge and caliper for approval of OWNER / CONSULTANT/ TPI, which he proposes to use. Pigs shall be launched in the pipeline only after their design and size has been approved by OWNER / CONSULTANT/ TPI. Due care shall be taken not to damage internal coating by the contractor, while proposing the pigs for internally coated pipeline.

The detailed scope of work shall also include, but not limited to

- Placement of marker devices along the Row over the pipeline.
- Identification of defects in the field
- Preparation of work reports.

4.0 REFERENCE CODES AND STANDARDS

Relevant recommended practise/standards/specifications are indicated below which shall be used in conjunction with this specification

1. API STD 1163: In-line inspection system qualification standard
2. NACE SP 102: In-line inspection of pipelines
3. NACE PUBLICATION 35100: In-line non-destructive inspection of pipelines
4. ASNT ILI-PQ: In-line inspection personnel qualification and certification
5. ASME B 31.8S: Managing system integrity of gas pipelines
6. PNGRB T4S: Technical standards and specifications including safety standards

In the event of conflict between any of the above specification/standard or between any standard and this specification, the more stringent shall apply.

5.0 VELOCITY OF DIFFERENT PIGS

Contractor shall be required to maintain velocities of propelling medium in such a way that the objective of each pig run shall be achieved.

6.0 FOAM PIG RUN

Contractor to carry out adequate number of foam pigs runs in each pipeline covered under Scope of Work prior to running of cleaning pigs to make a final assessment of the line pig- ability to the satisfaction of the Contractor and provide detailed daily site report for each run in the approved format before commencing the subsequent run. Contractor to select size of the foam pigs in such a way that the objective shall be achieved.

7.0 GAUGE PIG RUN

Contractor to carry out adequate number of gauging pig runs in each pipeline covered under Scope of work including pig tracking for pipeline to assess any internal restriction in the pipeline that may restrict the passage of cleaning and caliper pig. Contractor to provide detailed daily site report for each run in the approved format before commencing the subsequent run Gauge pig shall be equipped with a gauge plate made of Aluminium having its diameters 95% of minimum pipeline Internal Diameter (I.D.). The gauge pig should be able to pass over or negotiate lateral tees or bends on the pipeline.

8.0 CLEANING PIG RUN

8.1 Pipelines with Internal Coating

Contractor to carry out adequate number of cleaning pig runs by running suitable cleaning pigs in the pipelines including pig tracking till the time owner/ owner's representative is satisfied about the degree of cleanliness of pipeline. The contractor shall provide detailed daily site report for each run in the approved format before commencing the subsequent run. Choice of the type of cleaning pig has been left to the contractor. The contractor shall assure that the pigs, which are proposed to be used, are adequately soft and they do not damage internal coating under any circumstances. The brushes and scrappers used shall be of non-metallic/ plastic material. However, the details of these pigs including their construction details of brushes, scrappers etc. (if applicable) shall be submitted to OWNER / CONSULTANT/TPI for approval before their usage.

8.2 Pipelines without Internal Coating

CONTRACTOR to carry out adequate numbers of cleaning pig runs by running suitable cleaning pigs in pipeline including pig tracking till such time CONTRACTOR is satisfied with himself about the degree of cleanliness of pipeline and provide detailed daily site report for each run in the approved format before commencing the subsequent run. Choice of the type of cleaning pig has been left to the contractor. Contractor may deploy brush cleaning pig, magnetic cleaning pig, combination of brush and magnet, scrapper pig etc. the cleaning pigs should be able to pass over negotiate lateral tees or bends on the pipeline.

9.0 CALIPER PIG RUN

CONTRACTOR to carry out adequate number of electronic geometry (caliper) pig runs each pipeline including pig tracking for each pipeline decided after findings of gauging pig run to generate valid and interpretable geometry data of the pipeline and analysis of data of the caliper survey to detect the nature, extent and location of geometry defect. Contractor to provide detailed daily site report for each run in the approved format before commencing the subsequent run. The caliper should be capable of inspecting entire length of the pipeline i.e. from launcher to receiver in single run. Battery life should be adequate to commensurate with the run time required to travel the pipeline length. The electronic recorder system should have requisite data storage capacity. The drive cups should have requisite resistance to wear and tear to maintain effective seal throughout the entire run time.

The measurement shall cover the entire 360° of internal pipe wall circumference using properly oriented and sufficient quantity of sensors. For internally coated pipelines adequate care shall be taken by using soft cups so that no damage takes place to the internal coating of pipe. The tool shall be capable to identify and locate the following features as minimum.

- Individual Girth weld
- Dent, ovality, buckles, or any other out of roundness, change in pipeline I.D. and difference of thickness.
- Bend with bend radius and degree of bend.
- Valves or any partially closed valves.
- Tees/ off-takes.

Caliper Pig shall be calibrated on predetermined dent on same size and thickness of the pipeline to be examined and witnessed by Owner/ Consultant/TPI.

10.0 PIG TRACKING

The movement of any type of pig (Except, foam pig) put into the line during caliper pigging shall be required to be monitored along the pipeline length. The Contractor shall detail out the complete methodology of pig tracking proposed to be deployed by him including complete technical details of the equipment, device proposed and minimum parameters for tracking devices e.g. alarm (sound), time of detection & location of detection shall be used for this purpose.

It is proposed that pig tracking would be done in a discrete manner at regular intervals (Max 5 km) on each pipeline. The exact KM chainage of these locations shall be decided at site in consultation with the Contractor and Owner / Consultant/TPI.

11.0 MARKER DEVICES

The contractor shall submit the details of marker devices, which he proposes to place for relocating the defect accurately in the field, when the same has been identified as a result of Caliper survey.

The contractor shall be responsible for placing these devices (Marker Magnets or Locator coils or any other device) at suitable interval so that the defect can be easily located in the field with

minimum above ground measurement. It may be noted that placement of marker devices, their retrieval and locating the identified defect in the field shall be the responsibility of the contractor. The liquidation of defects, if any, is however, not included in the scope of work of the contract.

12.0 DEFECT VERIFICATION AND RECTIFICATION

At the discretion of the Owner/ Consultant/ TPI at least two locations for each pipeline shall be identified from the recorded data and the contractor shall provide Owner / Consultant /TPI to precisely locate it at site.

The contractor shall depute his representative during such verification work at verification sites for establishing that filed log detected anomalies conform to actual sizing including linear and circumferential positions at site

All anomalies found beyond acceptable limit shall be verified and rectified. After completion of necessary fabrication/rectification, contractor shall carry out repeat run and submit results to owner/consultant for acceptance

13.0 ABNORMAL SITUATIONS

The objective of this section is to write down foreseeable abnormal circumstances for taking appropriate measures, should such a condition arise during implementation of project.

The following abnormal condition has been foreseen by the Owner. However, if the Contractor foresees any other abnormal condition, he is free to make a mention.

13.1 Tool Failure

Contractor is required to get valid interpretable and verifiable data for pipeline. In case Contractor's equipment fails to perform electronic geometry inspection to generate valid data for any of the pipeline, Contractor will make extra runs of pigs to get valid and physically verifiable data.

13.2 Stuck-Up Tool

The Contractor shall details out a contingency plan as proposed by him in case any of the pigs get stuck up. The plan shall identify procedure for exactly locating the stuck up pig, detail procedure for retrieval of pig, equipment, including support facilities required to retrieve the pig.

If pig does not move from stuck up location, by any measure, then the pipeline section shall have to be cut for retrieval of Pig. Necessary erection, fabrication and modification of pipe with new pipe piece after retrieval of pig shall be done by Contractor. The cost for this works shall be borne by Contractor on actual. After fabrication & erection, pigging contractor shall run Gauge pig to check internal restriction, if any. Locating the stuck up pig and its retrieval shall be the responsibility of the Contractor.

14.0 WORK REPORT

The work report shall be prepared and submitted in hard copy (sets) and Soft Copy.

The work report shall consist of following as a minimum.

- All field activities.

- Equipment description

- List of installations

- List of significance with feature information and installation reference.

- Survey log and enlargement areas of special interest to suitable scale.

-XYZ MAPPING

XYZ mapping data acquisition shall be part of the tool specification. XYZ mapping measurement shall cover the entire 360 degree of internal pipe circumference using properly oriented and by sufficient quantity of sensors. The tool shall be capable to identify and locate the following features as a minimum.

a) Individual girth weld, weld joints
b) Dent, ovality, dent with ovality, buckles, wrinkles/ripples or any other out of roundness, change in pipeline I.D. and difference of thickness.
c) Tap-off Valves or any partially closed valves

-TOOL PERFORMANCE

Tool shall have capabilities as under.

a) Minimum detection level for dent (at the specified accuracy) : 2% of ID
b) Measurement accuracy for dent : 25% of the value in mm measured by the tool
c) Minimum detection level for Ovality : 3 mm (for 16", 12", 8" & 6" lines)
d) Measurement Accuracy for Ovality : +/- 2% of ID
e) Location Accuracy Axial: +/- 1 M from the reported anomaly chainage
f) Circumferential location accuracy : +/- 15 degree
g) The tool shall be capable of negotiating 6D bend at maximum thickness and 15% reduction in Pipe ID.

Any deformation existing on the weld (circumferential or longitudinal) is to be reported.

15.0 FINAL REPORT

The contractor shall include in his offer the most appropriate reporting procedure envisaged. However, report shall include but not limited to the following:

a) Detailed report about running of the electronic geometry pig including but not limited to the operational and functional details.

b) Details describing the type, size and location of individual mechanical defects. The location of each defect shall be suitably listed wi th reference to permanent pipeline features, circumferential location, girth weld no., relative and absolute distance.

c) A detailed report in respect of each defect for which sizing has to be done indicating its length, depth and axial as well as circumferential location suitably referenced.

d) Preliminary site report for each pipe segment for each running of electronic geometry pig runs stating comments/observations of each run, pig condition, operating parameters, and total time required.

e) Velocity plot of the electronic geometry pig along the length of the segment.

f) Photographs of defects along with captions as observed during verification.

g) All data to be given shall be in graphical and Microsoft Excel format also. All the formats / software / software outputs to be in line with Pipeline Open Data Standard (PODS) stipulations.

h) List of anomalies and the pipe tally shall be compatible with excel files.

The format of the above report shall be mutually agreed upon between the contractor and owner/consultant. The above report shall be submitted in four copies of bound volume. All raw and final processed inspection log along with the operating software necessary for review/analysis of the data shall also be submitted in 4 nos. CDs (master copy including copies). This is required to facilitate selection of significant defects, their chainage and sizing. The software should be user friendly

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECNICAL SPECIFICATION FOR INTELLIGENT PIGGING

GAIL-STD-PL-DOC-TS-014

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1.0 SCOPE

This specification covers the minimum requirements for carrying out the on-line inspection of the pipelines. This requirement is not intended to be all inclusive and use of guidelines set-forth does not relieve the contractor to his responsibility to carry out all activities successfully to obtain valid, interpretable and physically verifiable data from the intelligent pig runs about the condition of the pipeline.

2.0 TECHNIQUE FOR INTELLIGENT PIGGING

The Corrosion Detection tool used for on line Inspection should be High resolution inspection tool based on **Magnetic Flux leakage (MFL) Technology**.

3.0 PIG DIAMETER AND VELOCITY CRITERIA

Irrespective of the gas flow velocity, it is desired that MFL tool maintains the velocity which is required to maintain accuracy specified by the tool owning agency for various defect categories. Contractor shall collect the flow data from the owner before starting ILI run. The minimum diameter negotiable for MFL shall be 95% of minimum ID of the pipeline. Contractor shall be required to maintain the velocities of different pigs in such a manner that normal flow through the pipeline while particular pig is travelling is not required to be altered.

The normal flow rate and pressure for pipeline are given in design basis enclosed in tender document.

4.0 REFERENCE CODES AND STANDARDS

Relevant recommended practise/standards/specifications are indicated below which shall be used in conjunction with this specification

1. API STD 1163: In-line inspection system qualification standard
2. NACE SP 102: In-line inspection of pipelines
3. NACE PUBLICATION 35100: In-line non-destructive inspection of pipelines
4. ASNT ILI-PQ: In-line inspection personnel qualification and certification
5. ASME B 31.8S: Managing system integrity of gas pipelines
6. PNGRB T4S: Technical standards and specifications including safety standards

In the event of conflict between any of the above specification/standard or between any standard and this specification, the more stringent shall apply.

5.0 PRE-INSPECTION ACTIVITIES

Following activities are envisaged prior to running of high resolution intelligent pig. The sequence shown here is indicative which may vary during execution as per agreed schedule between Owner and Contractor.

4.1 Magnet marker installation

Contractor to supply adequate numbers of permanent magnet markers for installation of the same on the pipeline at 1.0 (one) Km interval irrespective of permanent pipeline installations. These permanent magnet markers shall not be retrieved back after completion of inspection work and shall not be taken back by Contractor. Contractor to supply these permanent magnet markers in advance so that same can be installed by him before commencement of inspection works. Contractor to deploy magnet markers of adequate strength so that same shall be detected by high resolution inspection pig during inspection at above coating thickness and gas velocities. Contractor to take all adequate precautions so that pipeline and coating is not damaged during installation of magnet markers. Contractor has to submit to the Owner the sketch containing reference of magnet marker location with respect to permanent features/installation available in the vicinity.

4.2 Procedure document and Operation Manual

Contractor shall submit operation manual for pigs and procedure document for execution of the field activities for the various pipelines covered under scope of work before commencing the job for Owner/Consultant/TPI approval. The document shall include as a minimum data sheets of pigs deployed at site, list of items to be mobilized, launching & receiving procedure, pig tracking procedure, reporting formats for each type of pig run, format for preliminary report , specific considerations to be observed during pigging etc.

4.3 Pull through Test

Contractor is required to pre-calibrate the inspection tools (Intelligent pig) perform the pilot/loop test at his inspection Centre before mobilization of these inspection tools to SITE. Company/Consultant at its discretion reserves the right to witness and / or to appoint its authorized agency to witness the above pre-calibration / pilot / loop tests to ascertain the diagnostic capability, mechanical performance requirements, reliability etc. of the inspection tools to be deployed at SITE. During pull through test, the Owner/Consultant representatives shall be allowed to share the technical information related to the Corrosion Detection Pig including test pipe data, tool velocity, magnetization level achieved and metal loss inspection performance achieved during testing. However, it is clearly and expressly understood by the Contractor that such association of the Company/Consultant for witnessing the pre-calibration/pilot/loop tests shall in no way absolve the responsibility of the Contractor either for the performance of the inspection tools or his obligations under the Contract. Company/Consultant shall bear the expenses of there own representative /

authorized agency related to travel, (to and fro) boarding, lodging and other incidentals during the period of their stay for witnessing above tests of inspection the above tests of inspection tools at the inspection Centre of the Contractor. Pull through test report for each size of Corrosion Detection pig shall be submitted within seven days of performing the test.

4.4 Pre-Inspection Pig runs

Contractor shall complete all activities required to establish piggability and adequate cleanliness of pipeline to the satisfaction of the Contractor and to verify the internal geometry of the pipeline with relation to ovality, dent etc. and to ensure that internal bore restriction at any location does not exceed the limitation of proposed tools to be used subsequently.

4.4.1 Gauge Pig run

Contractor shall run a gauging pig with the gauging plate made of Aluminum and its diameter should be 95% of minimum pipeline internal diameter. Contractor's cleaning and gauging pig assemblies should be able to pass over or negotiate lateral tees or bends of sizes or radii given in the tender document. The cups/disc should have requisite resistance to wear and tear to maintain effective seal throughout the entire run time.

4.4.2 Cleaning Pig runs

Contractor shall carry out at least one run of brush cleaning pig and magnet cleaning pig to decide the number of cleaning runs required and the choice of the cleaning pig for subsequent cleaning runs as suitable for the purpose to obtain internal condition adequately clean so as to obtain valid and interpretable inspection data from the intelligent pig and to safeguard caliper and intelligent pig against damage due to debris.

A single cleaning run is not expected to produce any conclusive information. Performance of each cleaning pig run shall be assessed from the debris quantity, debris quality and physical condition of pig.

The cleaning pigs for successive cleaning pig runs including configuration of each pig shall be selected by the Contractor in such a manner that effective cleaning is achieved with minimum number of runs and then the same should not get lodged into the pipeline.

5.0 INSPECTION PIG RUNS

5.1 Electronic Geometry (CALIPER) Pig run

The electronic geometry (caliper) pig should be capable of recording the entire length of each segment i.e. from launcher to receiver in one single run and therefore its electronic recorder system should have requisite data storage capacity. Battery life therefore should be adequate to commensurate with the run time required to travel the pipe length of each segment and the drive cups should have requisite resistance to wear and tear to maintain effective seal throughout the entire run time.

The measurement shall cover the entire 360^0 of internal pipe wall circumference using properly oriented and sufficient quantity of sensors. The tool should be capable to identify and locate the following features as a minimum.

- Individual Girth weld
- Dent, ovality, buckles, or any other out of roundness, change in pipeline I.D. and difference of thickness.
- Bend with bend radius and degree of bend.
- Valves or any partially closed valves.

5.2 Intelligent Pig run

Upon completion of all preceding activities (foam, cleaning, gauging, caliper runs) and based on their results Contractor shall intimate about his readiness for running the high resolution corrosion

detection pig. OWNER/Consultant shall indicate the exact time of launching the corrosion detection pig in consultation with Contractor.

Marker devices should be placed at approximately 1.0 KM interval as mentioned at clause 4.1 prior to running of Intelligent Pig.

The intelligent pig proposed by the Vendor should be capable of identifying the following anomalies keeping in view the defect significance detailed out at para 6.0 below:

- Metal loss (internal and external)
- Axial and circumferential slotting
- Location of girth welds, valves, lateral joints.
- Circumferential cracks.
- Proximity of any ferrous object to pipeline.
- Manufacturing defects
- Dent.
- Estimated strain in dent as per ASME B31.8 appendix R.
- Metal loss in dents
- Arc strike, Pin holes
- Artificial defect.
- Scabs, Slivers.
- Buckle.
- Corrosion cluster
- Grinding
- Girth weld crack
- Girth weld anomaly.
- HIC (hydrogen induced cracking).
- Lamination.
- Longitudinal seam weld crack.
- Longitudinal weld anomaly.
- Ovality Pipe mill anomaly.
- Pipe mill anomaly cluster.
- SCC (Stress corrosion cracking).
- Spiral weld crack (for HSAW Pipes)
- Spiral weld anomaly (for HSAW Pipes).
- Wrinkle, etc.

- 100% length of the pipeline shall be inspected by running MFL tool to generate valid and physically verifiable data and submit the detailed report for the entire length.

6.0 DEFECT SIGNIFICANCE

The following information/performance is expected out from the Geometry survey.

The electronic geometry pig/Caliper pig deployed by Contractor should be able to perform inspection of pipelines as per following detection and sizing specifications.

Dent	:	2% of outer diameter (O. D.)
Ovality	:	5% of outer Diameter (O. D.)
Location accuracy	:	Axial ± 0.2m (Within pipe)
		Axial ± 1.0m (from marker)
Circumferential	:	± 5°

(For dents, ovalities and pipeline feature as detailed above).

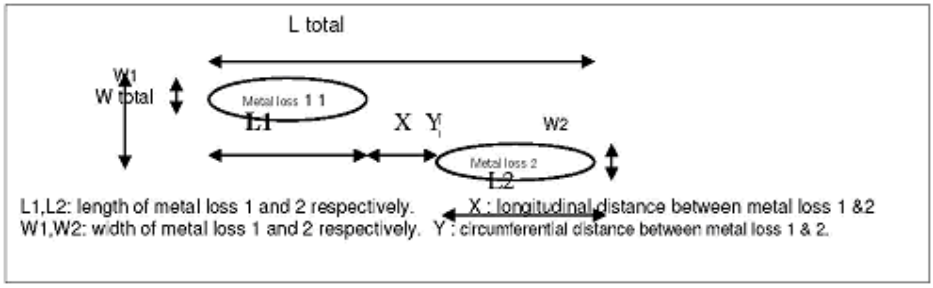
6.2 The following information/performance is expected out of the intelligent pig inspection:

6.2.1 The external or internal metal loss/mechanical defects should be identified, discriminated, sized (L x B x D) and suitably reported in a mutually agreed manner.

6.2.2 Inspection of entire length of each segment to be completed in one single run.

6.2.3 To check the effect of inter-active corrosion if a cluster of pits are identified close to each other, values of L1, L2 ...W1, W2.....should be reported (refer sketch below) and the location of each pit cluster is to be identified with reference to permanent pipeline feature.

Flaws are considered interacting if they are spaced longitudinally for circumferentially from each other within a distance of 3 times the wall thickness (3t). Interacting flaws should be evaluated as a single flaw combined from all interacting flaws.



6.2.4 Any metal loss in the heat affected zone of the weld should be specifically highlighted in the report but may not be sized.

6.2.5 ACCURACY OF DEFECTS

The best accuracy offered and guaranteed by the Contractor for each category of defect should be clearly spelt out. The Contractor must define the "pitting corrosion", general corrosion and the accuracy offered by him in each case for a) depth of corrosion b) axial and circumferential location of corrosion and c) length of corrosion.

CONFIDENCE LEVEL AND PROBABILITY OF DETECTION

A confidence level of 80% is acceptable in defect sizing accuracy (i. e. guaranteed accuracy is acceptable for equal to or more than 80% metal loss features reported) with 90% Probability of Detection (POD).

The intelligent pig should have as a minimum, the following capabilities with 80% confidence level and 90% probability of detection (POD).

DETECTION CAPABILITY AND SIZING ACCURACY

IDENTIFICATION/ CHARACTERISATION DEFECT	MINIMUM DETECTION CAPABILITY OF DEPTH AT 90% POD	SIZING ACCURACY AT 80% CONFIDENCE LEVEL	
		DEPTH	LENGTH & WIDTH
GENERA L CORROSION ([W ≥ 3t] AND [L ≥ 3t])	0.1t	±0.1t	±20 MM

PITTING CORROSION A < 1t X 1t B >1tX1t<2Tx2t C >2t X 2t < 3t X 3t	Detectable 0.4t 0.2t	---- ±0.2t ±0.2t	----- ±t OR ±15 MM WHICH EVER IS MORE ±t OR ±15 MM WHICH EVER IS MORE
AXIAL GAUGING [W ≥ 3t AND L ≥ 3t]	0. 20t	±0.20t	±20 MM
CIRCUMFERENTIAL GAUGING W ≥ 3t	0.15t	±0.15t	±20 MM

L: Axial length of the defect
W: Width of the defect.
t: wall thickness of pipeline

LOCATION ACCURACY		
A	AXIAL WITHIN PIPE FROM MARKER	 ±0.20 M ±1.0 M
B	CIRCUMFERENTIAL	±5 DEGREE

7.0 PIG TRACKING

The movement of any type of pig put into the line during pre-inspection or intelligent pigging shall be required to be monitor along the pipeline length from launcher to receiver trap. The pig tracking system should be capable of working under Over head high voltage transmission lines. Bidder to propose a tracking system which shall be able to detect pig passage in the existing pipe cover. The transmitter should have adequate battery life so that stuck up pig can be located within reasonable time frame. The pig tracking system should be capable of locating the stuck up pig in the range of ±15 Meter. The BIDDER shall detail out the complete methodology of pig tracking proposed to be deployed by him including complete technical details of the equipment and device proposed to be used for this purpose.

It is proposed that pig tracking would be done in a discrete manner generally at 2 to 3 KM interval at pre-selected locations. The exact KM chainage of these locations shall be decided at site in consultation with the CONTRACTOR and OWNER/CONSULTANT/TPI

8.0 PRELIMINARY REPORT AND DEFECT VERIFICATION

Contractor on completion of the corrosion detection pig run, to furnish a preliminary inspection report indicating all detected defects including sizing of defects, chainage of defects, circumferential location, distance from magnet marker/pipeline feature, pipe joint length etc . The preliminary inspection report shall also include information about the data quality, general pipeline conditions and major observations during inspection.

The preliminary report shall be submitted within three weeks from the date of completion of High resolution MFL pig run.

OWNER/CONSULTANT/TPI shall identify a maximum of five verification points from the preliminary report/recorded data and contractor to provide CONSULTANT/OWNER/TPI the facilities to locate those points at site. Verification shall be done by OWNER within four weeks from the date of receiving the information on dig site verification.

All defects recorded by the High Resolution tool shall be reported in the Contractors report. However, while selecting the defects for verification purpose, following guidelines shall be observed:

- A maximum of 5 numbers of most injurious verifiable metal loss defects to be identified in the segment having any one or combination of following.
- General Corrosion defects with length and width greater than 3t x 3t and metal loss depth 20% of wall thickness or more.
- Pitting corrosion defects with length and width greater than 2t x 2t and metal loss depth 40% of pipe wall thickness or more.
- Mill defects and other manufacturing defects which threaten the pipeline integrity.
- Geometry defects with metal loss.
- Any other critical defect at the discretion of OWNER.

In case there is a mismatch in the reported defects and those measured at site during verification then the contractor shall depute his representative to observe verification by non destructive testing at given sites for proving that field log detected anomalies conform to wall thickness loss and sizing within the limits of tolerance as per provision of technical specification in Bid Document. The data

can be reviewed by the Contractor based on the witnessed NDT results and a revised report can be given. Again OWNER/CONSULTANT/TPI shall select five defects from the revised report for verification in the field. In case of non compliance of these defects to the tender requirements, the run shall be considered as unsuccessful. In case physically verifiable defects are not found, the Contractor shall explicitly indicate this situation in his preliminary report.

9.0 VENDOR DATA REQUIREMENT

Following information is required to be furnished by vendor in his documents:

a. Direction of magnetization (axial/circumferential) and polarity of magnetic field.
b. Required minimal magnetic field strength H in kA/m at the inner surface of the pipe to meet the given POD and accuracy.
c. The magnetic field strength H in kA/m as function of wall thickness and pig speed & grade, at the inner surface of the pipe.
d. Required minimal induced magnetic flux density B in Tesla in the pipe wall to meet the given POD and accuracy.
e. Nominal circumferential distance of ID/OD discriminating sensors (if present)

10.0 DATA ANALYSIS

CONSULTANT/COMPANY shall participate in the analysis of the recorded data together with the engineering and other personnel of CONTRACTOR. This analysis shall be carried out at Bidder's Analysis Centre to achieve the following objectives:

a) To identify the locations of internal or external defects likely to jeopardize the normal safety and operation of the pipeline.

b) To arrive at general methodology of repair to be followed.

c) Short-term measures to be taken in view of potentially hazardous defects, if found in any of the pipelines.

Contractor shall provide all raw and processed data and his software package along with his compatible hardware. The software package shall be user friendly.

11.0 FINAL WORK REPORT

The Contractor shall include in his offer the most appropriate reporting procedure envisaged for the subject pipeline. This will have to be mutually agreed between the successful BIDDER and CONSULTANT/COMPANY.

However, any reporting system shall include but not limited to the following:

- Preliminary site report for each pipe segment for each running of foam, cleaning, caliper, intelligent pig runs stating comments/observations of each run, pig condition, operating parameters and total time required.
- A detailed report in respect of each pipe segment of running each of the preinspection tool such as cleaning pig, caliper pig.
- A detailed report on the geometry survey of each pipeline segment incorporating the following supplemented with raw/processed data logs.

➢ List of installations

➢ List of Significances with

• Feature information

• Feature type

• Feature description

• Feature log Distance

• Feature Clock orientation

• Feature length

• Feature depth (Change in ID)

➢ Installation references

• Distance from next Installation

• Installation Distance

• Installation type

- Velocity plot of EGP
- Temperature Plot if applicable.
- Survey Log and enlargement areas of special interest
- Detailed report about running of the intelligent pig including but not limited to the operational and functional details.
- Details describing the type, size, internal/external discrimination and location of individual metal loss defects. The location and orientation of each defect should be suitably listed with reference to permanent pipeline features, girth weld no., relative and absolute distance and severity of the defect.
- A detailed report in respect of each defect for which sizing has to be done indicating its length, width, depth, axial and circumferential location suitably referenced.
- Depth based feature distribution against pipe length of all metal loss features.
- Severity analysis for all metal loss features having metal loss greater than 20% for all detected features. -Individual evaluation feature report in great detail for 5 nos. significant metal loss features of each segment.

- Suitable histograms between absolute distance of pipeline and no. of defects.
- Report on inter-active corrosion due to clustering of pits.
- Velocity of the intelligent pig along the length of the segment.
- The format and pro forma of the above report shall be mutually agreed upon between the successful Contractor and CONSULTANT/COMPANY.
- All the data generated by the CONTRACTOR shall be compiled in a floppy disk and CD having user friendly operation on an IBM Compatible PC along with the software necessary for review/analysis of data.. This is required to facilitate selection of significant defects, their chainage and sizing. This floppy disk and CD will be submitted by CONTRACTOR, as a part of report. Contractor to provide three sets of CD/Floppy consisting all generated data along with compatible operating software.

12.0 CONTINGENCY WORKS

BIDDER to write down in his offer all foreseeable abnormal circumstances during the execution of the project for enabling the COMPANY/CONSULTANT to take appropriate measures in time, to be prepared should such a condition arise during the implementation of the project.

In the event of pig getting stuck in the pipeline during pigging activity CONTRACTOR shall assist the COMPANY in the retrieval of the tool. This assistance will be limited to his providing advice on the operation methodology to be adopted for salvaging the tool and in putting back the pipeline in normal operating condition. Also refer clause no. 12.2 of this section for details.

13.0 ABNORMAL SITUATIONS

The objective of this section is to write down foreseeable abnormal circumstances for taking appropriate measures, when such a condition arises during implementation of Project. The following abnormal conditions have been foreseen by the COMPANY. However, if the Contractor foresees any other abnormal condition, he is free to make a mention of the same and alongwith necessary provision to counter the same:

13.1 Tool failure

CONTRACTOR is required to get valid interpretable and physically verifiable data for pipeline covered under scope.

In case CONTRACTOR'S equipment fails to perform electronic geometry pre inspection and/or intelligent pigging inspection to generate valid data for any of the segment, CONTRACTOR will make extra runs of Pigs to get valid and physically verifiable data.

The replacement/repair/modification of the CONSTRUCTIONAL PLANT AND EQUIPMENT shall be decided by the CONTRACTOR. In case the CONTRACTOR decides to take the CONSTRUCTIONAL PLANT AND EQUIPMENT or any of its components for repair/modification from the site, then he shall be permitted to do so provided he furnishes an additional bank guarantee for an amount equal to payments made to him by the COMPANY for the respective group of pipelines up to this stage. The Bank Guarantee so furnished shall be valid for a period of six months. The CONTRACTOR shall be responsible for all costs including but not limited to transport from/to India, re-export duty/ Custom duty for Import/re-Import of the replaced/modified/ repaired CONSTRUCTIONAL PLANT AND EQUIPMENT without any additional payment from the COMPANY on this account. In case CONTRACTOR fails to re-mobilize for completion of the WORKS, the above additional bank guarantee shall be liable to be invoked by the COMPANY without any prejudice to other remedies and provisions of the CONTRACT.

13.2 Stuck-up tool

The Contractor shall detail out a contingency plan in his BID as proposed by him in case any of the pigs get stuck up. The plan shall identify procedure for exactly locating the stuck up pig, equipment, including SPREAD and support facilities required to retrieve the pig and maintain the flow with minimum loss of time and optimum efforts.

In the event of the pig getting stuck in the any segment of the pipeline during any Pigging activity CONTRACTOR shall assist the COMPANY and his CONSULTANT and CONTINGENCY CONTRACTOR or other authorised agencies of the COMPANY in retrieval of the tool. The assistance in the field will be limited to his providing advice. After retrieval of the pig, decision to continue with the next phase of activities shall be taken by COMPANY/CONSULTANT/TPI. Locating the Stuck up pig shall be the responsibility of the CONTRACTOR.

Reverse flow is not possible. Pressure surges may be possible which need to be critically planned in consultation with COMPANY, CONSULTANT and CONTINGENCY CONTRACTOR. If Pig do not move from stuck up location, by any measure, then the pipeline section shall have to be cut for retrieval of Pig. Hot tapping, bypass loop installation, Pipe cutting etc. before pig retrieval and Necessary erection, fabrication and modification of pipe with new pipe piece after retrieval of pig shall be done by owner. If Gauge pig get stuck due to some anomaly/reduction in diameter of pipeline then cost of replacement will be borne by Owner. However, locating the stuck pig is responsibility of Pigging

Contractor with an accuracy of +/- 3 M. After fabrication & erection and resumption of flow, pigging Contractor shall run Gauge pig to check internal restriction, if any.

12.3 Mismatch of inspection results with actual defects during site verification

In case of variance between the results of physical defect verification and the results reported by the contractor on the basis of intelligent pigging (after considering the tolerance as provided in the contract) even after allowing extra runs, COMPANY shall review the entire case in consultation with the contractor.

ANNEXURES

FOR

INTELLIGENT PIGGING

ANNEXURE – I

PROFORMA FOR GUAGING PIG, BRUSH CLEANING PIG, MAGNET CLEANING

PIG DETAILS

Sr. No.	Description	Bidders Details
1.0	**GAUGE PIG**	
1.1	Minimum % of ID that the GAUGE pig pass without damaging pig and pipe	
1.2	Number of modules and length of tool	
1.3	Weight of gauge pig	
1.4	Bend radius able to negotiate	
1.5	% diameter of Aluminium Gauge plate	
1.6	Schematic sketch of foam pig enclosed indicating Configuration.	
2.0	**BRUSH CLEANING PIG**	
2.1	Minimum % of ID that the BRUSH CLEANING pig pass without damaging pig and pipe	
2.2	Number of modules and length of tool	
2.3	Weight of Brush cleaning pig	
2.4	Bend radius able to negotiate	
2.5	Number of brushes mounted on pig	
2.6	Schematic sketch of BRUSH pig indicating configuration.	
3.0	**MAGNET CLEANING PIG**	
3.1	Minimum % of ID that the MAGNET CLEANING pig pass without damaging pig and pipe	
3.2	Number of magnets mounted on pig	
3.3	Number of modules and length of tool	
3.4	Weight of pig	
3.5	Bend radius able to negotiate	
3.6	Schematic sketch of magnet pig enclosed indicating configuration.	

ANNEXURE – II

PROFORMA FOR ELECTRONIC GEOMETRY PIG DETAILS

Sr. No.	Description	Bidder Details or (Yes / No.)
ELECTRONIC GEOMETRY PIG		
1.0	Weight of tool	
2.0	Number of Modules of tools and length of tool	
3.0	Principle of operation	
4.0	Capability of inspecting Maximum length in single run.	
5.0	Pressure range	
6.0	Temperature range	
7.0	Battery life	
8.0	Capability of detecting 2% dent	
9.0	Able to carry inspection at gas velocities mentioned in bid document	
10.0	Speed range for data generation	
11.0	Frequency or distance of sampling	
12.0	Capability to identify following as a minimum	
12.1	Individual girth weld	
12.2	Dent and Ovality	
12.3	Out of roundness	
12.4	Valves or any partially closed valve	
13.0	Minimum % of ID that the EGP pig pass without damaging pig and pipe	
14.0	Axial accuracy of locating defect from reference marker/pipeline feature	
15.0	Accuracy of measurement (% of ID)	
16.0	Bend radius the tool is able to negotiate	
17.0	Schematic sketch enclosed indicating configuration	
18.0	Any other tool specific information	

ANNEXURE – III

PROFORMA FOR HIGH RESOLUTION MFL INSPECTION PIG DETAILS

Sr. No.	Description	Bidders Details or (Yes / No.)
1.0	Bidder to confirm that the MFL inspection tool is of High Resolution tool	
2.0	Bidder to confirm that the HR MFL inspection tool is owned by him	
3.0	Wall thickness range in MM	
4.0	Magnetization level to be achieved in the different pipe thickness. OR Enclose graph indicating relationship between magnetic field strength and wall thickness.	
5.0	a) Speed range in m/s for data generation as per bid specification.	
	b) Maximum speed m/s at which the tool can be operated.	
6.0	Device if proposed for pig speed control to achieve valid, interpretable and quality data as per detection and sizing specifications of tender document.	
7.0	Temperature range	
8.0	Maximum pressure	
9.0	Maximum pressure	
10.0	Minimum pressure for gas pipelines	
11.0	Number of Modules of tools and total tool length	
12.0	Bend radius able to negotiate	
13.0	Capability of inspecting Maximum length in single run	
14.0	Axial sampling rate (frequency or distance)	
15.0	Circumferential sampling rate	
16.0	Total number of primary sensors	
17.0	Total number of secondary sensors	
18.0	Data storage capacity	
19.0	Battery life	
20.0	Maximum limit on adjacent sensors damage during the run in order to generate data as per bid specification.	
21.0	Maximum % of primary and secondary sensors damage permissible during the run in order to generate the data as per bid specification.	

22.0	Minimum % of ID that the MFL inspection pig pass without damaging pig and pipe	
23.0	Capability to identify following as a minimum	
23.1	General corrosion	
23.2	Pitting corrosion	
23.3	Circumferential gouging	
23.4	Axial gouging	
23.5	Location of girth weld, valves and lateral joints	
23.6	Circumferential crack	
23.7	Proximity of any ferrous object to pipeline	
23.8	Manufacturing defects	
24	capability of MFL inspection tool	
24.1	Axial accuracy of locating defect from reference marker/pipeline feature	
24.2	Axial accuracy of locating defect within pipe from upstream weld joint.	
24.3	Circumferential Accuracy	
24.4	Shall be able to discriminate between external & internal defects	
24.5	Able to size (LXBXD) all defects having depth 0.10t and more in case of General Corrosion defect.	
24.6	Shall be able to detect minimum 0.10t wall thickness loss with an accuracy ±0.1t with 90% probability of detection and confidence level of 80% in sizing in case of general corrosion defect.	
24.7	Shall be capable of completing the intelligent pigging in one continuous single run for segment covered under Scope of Work	
25.0	Any other specific information	
26.0	Schematic sketch of HR MFL inspection tool.	

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR DOCUMENTATION OF PIPELINE CONSTRUCTION

GAIL-STD-PL-DOC-TS-015

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1.0 SCOPE

1.1 This specification covers the minimum requirements of the various records, reports and drawings for all aspects of pipeline construction to be prepared by Contractor and submitted to the Owner at intervals as described in this specification and as directed by Owner.

1.2 All documents required to be prepared and submitted by Contractor as per this specification shall be in addition to the various reports, records, methodology statements, calculations, drawings etc. to be submitted by the Contractor for Owner's record, review or approval as per the requirements of all other specifications included in the Contract between the Owner and the Contractor.

1.3 This specification shall be read in conjunction with the condition of all specifications and documents included in the Contract between Owner and Contractor.

1.4 The EPC Contractor will develop establish and maintain an effective Planning & Monitoring system for successful implementation of the project. The Contractor will deploy qualified and experienced Planning Engineers construction site.

1.5 The system will be capable of accurate and timely prediction of trend, evolution of adequate preventive actions for likely slippages, and formulation of suitable catch-up schedules for delay, if any.

1.6 This document shall be read in conjunction with other documents forming part of RFP for the EPC work, such as Table of Content, Scope of Work, Design Basis, Schedule of Rates, Specifications, Standards, Drawings of all disciplines and other Documents forming part of Tender Document.

2.0 RECORDS

Contractor shall submit daily, weekly, monthly progress report and after completion to the Owner various records and reports, for Owner's documentation purposes during and immediately after the construction. This shall as a minimum include, but not limited to the following:

2.1 Daily Progress Report

- Planning Sheet
- Separate progress reports of all crews
- Daily welding results and repairs
- Actual weather conditions
- Application for variations, if any
- Accidents
- Damages
- Activities required from OWNER at short notice.
- Materials Receipts
- Urgently required materials etc

2.2 Weekly Progress Report

- Up-to-date list of confirmed site instructions issued by OWNER
- Materials procured
- Material defects and repairs
- Outstanding activities of Owner
- List of installed markers, chainage

- Required approvals from Owner
- Progress planned
- Report of manning of all crews, equipment and plant
- Report of equipment and plant
- Report of accidents
- Report of damages
- Report of acquired releases, permits
- Priced variations
- Required materials for next month etc.

2.3 Monthly Progress report

- Progress report for payment, safety report, report of accidents, security report, health and environment report, material balance, approved variations.

2.4 Further Contractor shall supply (for approval, if required, to the Owner with documents such as but not limited to:

- Organogram for the construction of the work.
- Bio-data of key personnel (including foremen).
- List of addresses of personnel in particular of medical staff, safety and security officers.
- List of approved codes.
- List of approved sub-contractors.
- Time schedule.
- Acquired permits and/or approvals from authorities, endowments, if any.
- Minutes of meeting with Owner with comments, if any.
- Material certificates, material receipts, etc.
- Guarantees from Vendors and Sub-contractors
- Calculations, temporary works, buoyancy, blasting, etc.
- Drawing issued by Contractor
- Vendor drawings
- As-built drawings of route maps, profile drawings, detail drawings and isometric drawings.
- Procedures such as surveying, staking, fencing etc.
- Welder procedure qualification record, radiographic procedure qualification, Welder qualification.
- Coating procedure.
- Installation of crossings.
- Hydrostatic testing procedure,
- Blasting procedure.
- Radiographic report along with original radiographs.
- Pipe and welding book
- Material records and accounting book

- **Reports:**
  - Materials tests (coating, welding, painting, etc.)
  - Computerized Potential Logging Test
  - Water samples
  - Cleaning, pigging report before hydrostatic test
  - Hydrostatic test
  - Calibration test
  - Rock blasting trials
  - Equipment certificates (dead weight tester, instruments, vessels, equipment, etc.)
  - Manuals

- Major water crossings
- Releases.

2.5 Contractor shall prepare the document control index for the construction.

2.6 Contractor shall submit the final documentation procedure.

2.7 Contractor shall submit to owner color photographs of various construction activities/ operations at regular intervals. Size, number and frequency of the photographs shall be mutually agreed upon at a later stage. Also contractor shall make video recordings of all operations right from the start of construction till the completion of works, covering to the extent as instructed by owner and submit to the owner.

2.8 PROJECT SCHEDULE

Schedules to be prepared and submitted by contractor to Owner/PMC for review & approval. Detail Master Schedule and Milestones are to be prepared and submitted by the EPC. Contractor for review and approval of Owner/ PMC.

2.9 Overall Project Schedule

Major milestones for each unit will be depicted at the beginning of the network. The project schedule will be developed for contractual duration and/ or target duration decided with Owner/PMC. Grace period, if any as per contract will not be considered for schedule. The schedule will be reviewed by Owner/PMC and the comments if any will be incorporated and the schedule will be issued for implementation within one week from the receipt of comments. This schedule once approved by Owner/ PMC will not be revised without the prior written permission of Owner/ PMC.

2.10 **Functional Schedule**

Unit wise "S" curves for schedule progress will also be submitted along with the functional schedules. The schedule will be reviewed by Owner/PMC and comments, if any, be incorporated and issued for implementation within one week from receipt of comments. The Schedule "S" curves will remain firm during the execution of the project.

Contractor will also ensure preparation, submission and updating of all functional schedules as described herein including that for all sub contracted packages.

2.11 Ordering Schedule

The Contractor will submit a Unit wise schedule for all ordering activities. This will include all MRs (Material requisitions) listed in Engineering Schedule.

2.12 Construction Schedule

The Contractor will prepare and submit a Detailed Construction Schedule for Owner/PMC review. The Contractor will describe resources (manpower and machinery) required to be mobilized. The schedule will have interface with Engineering, Ordering and Manufacturing & Delivery activities and also interface required from Owner/PMC. The Contractor will also define construction quantity for each activity. Contractor will finalize discipline wise Construction "S" Curves.

2.13 Overall "S" Curves

The Contractor will prepare unit wise and Overall "S" curves showing cumulative schedule progress taking into consideration "S" curves for Detailed Engineering, Ordering, Manufacturing & delivery and Construction "S" Curves.
The overall "S" curves will be updated immediately after finalization of construction schedule.
The overall "S" curves will be submitted for Owner/PMC review, with necessary backups and will form part of monthly progress report.

2.14 Pre Commissioning / Commissioning Schedule

Contractor will prepare unit wise / system wise pre-commissioning/ commissioning micro-level schedule. Contractor to Owner/ PMC will submit these schedules for review two months before the Mechanical Completion milestone or one month before starting pre-commissioning activities, whichever is earlier.
The schedules will be developed after considering the pre- commissioning/ commissioning priorities and interface requirements and identify requirement of vendor's representatives' stay at site. The description of system mentioned in the schedule will be as agreed with Owner/ PMC.

2.15 Catch up Plan

The Contractor will generate and submit catch-up schedule for completion of all balance activities without change in contractual completion date with detailed resource reinforcement as and when asked by Owner/ PMC. The catch-up schedules will be submitted to Owner/ PMC for review. Accordingly the "S" curves for catch-up schedules will be made and shown along with the original schedules and actual "S" curves. During updating of overall project schedule, the catch-up schedules will be shown in bar charts along with the original schedule.

2.16 PROGRESS REVIEW MEETING

The Contractor will present project status, project highlights, delays, areas of concern etc. and action plan as applicable at various review meetings described below. The presentation materials will be submitted by Contractor to Owner/PMC at least two days before the date of the meeting for management level review meetings and Monthly/ Fortnightly review meetings.
Owner/PMC will decide venue and timing of the meeting. Frequency of Meeting (Monthly or Fortnightly) will also be decided by Owner/PMC, based on criticality of the project status.

2.17 Management Review Meeting

Level of participation : Senior management of Owner, PMC, TPIA and Contractor.
Agenda frequency and venue : To be decided by Owner/PMC.

13.0 "AS-BUILT" DRAWINGS AND PIPE BOOK

13.1 General

Contractor shall prepare "as-built" drawings of all by or on behalf of Owner issued drawings and of all Contractor work drawings including Vendor drawings, such as but not limited to:

For pipeline section:

- Route maps

- Profile maps
- Alignment Sheets
- Detail drawings (road, railway, minor water crossings, major water crossings, etc.)
- Isometric drawings of installations
- Special installations, etc.

Further Contractor shall prepare a pipe and weld book.

13.2 "As-Built" Drawings

Contractor shall prepare a complete set of "as-built" drawings. From the start of construction, Contractor shall daily process any changes into two sets of drawings. Deleted parts shall be indicated in red, new parts in blue, remarks in green and unchanged parts in yellow. Said drawings shall be kept in site and be available to Owner at all times. Contractor shall prepare "as-built" drawings based on these data and as laid down hereafter. One set of these drawings with data shall be sent to Owner before taking over of the work, while the other set shall be handed to Owner at the same time. On completion of the work, one revised film transparency of all drawings made "as-built" by Contractor containing the "as-built" information shall be handed to Owner as well as one complete set of microfilms of same as will be specified by Owner. Contractor shall prepare and submit a specimen of the layout of the drawings for Owner approval.

Contractor shall provide soft copy of all documents for uploading on PIMS.

The required measurements for "as-built" drawings shall be executed by Contractor by experienced, qualified surveyors.

The surveyors shall daily take care of all measurements required such as but not limited to:

- Horizontal location of the pipeline with regard to deviations and permanent grid pillars.
- Vertical levels with regard to Mean Sea Level of pipeline and grade.
- Location and type of bends, fittings etc. and grades, points of intersections, etc.
- Changes of wall thickness, materials.
- Location and details of valves, insulating flanges, fencing etc.
- Location and details of buried services.
- Location and details of road, railway, water crossing etc.
- Location and details of casing pipes, vents etc.
- Location and type of coating
- Location and type of weighting, anchoring
- Location and type of markers.
- Location of further appurtenances (pig– signalers, etc.)
- Location of ROW and of pipeline with respect to ROW.
- Type of soil
- Type of rock.
- Type of blasting or ripping
- Sand padding.
- Type of road pavement
- Details of bank protection, number of insulators, seals etc.

Contractor shall also prepare isometric drawings of all installations (facilities) etc. for which the data as mentioned in or required for the pipe and welding book can be identified as such and which drawings can also be used for material accounting.

13.3 Nameplates of equipment

All permanent equipment supplied and installed by CONTRACTOR shall be provided with nameplates by CONTRACTOR. All texts size of the plate shall be submitted to OWNER for approval before plates may be manufactured.

13.4 Pipe Book

Every page of the pipe and welding book shall mention.

- Data relevant to the project and section thereof.
- Sequential number
- Length brought forward (for pipes and other materials)
- Length to bring forward (for pipes and other materials).

Alignment sheet number and at least the location thereon of two welds on every page of the pipe book.

Further,

- Diameter of pipeline
- Length of each pipe
- Wall thickness
- Pipe number
- Heat number, certificate number
- Cut and re-numbered pipe ends
- Date of stringing
- Data of welding
- Direction of working
- Weld number
- Welder number
- Type of welding, electrode, diameter
- Weld treatment (if any)
- NDT report no, date & result
- Coating
- Pre & post hydro details
- Backfilling details
- Crossing details
- TCP details
- Restoration details
- Limits of valve stations, water crossings, etc
- Test pressure, data and test (hydrostatic)
- Length of section per page in line separated in the pipes including field bends and factory bends and/or other inline fittings.
- Length to bring forward (pipes and other materials)
- Length brought forward (pipes and other materials)

In order to achieve this CONTRACTOR shall identify all pipe elements. Sample format of pipe book shall be submitted for Owner/ Consultant approval.

13.5 As-Built Documents

Contractor shall prepare all documents in the prescribed format as indicated below.

In addition to the hard copies, softcopies of final documents shall also be submitted in electronic media i.e. CD / DVD format.

Software used for the preparation of these documents shall be as follows:

Type document		**Software**
a) Reports/ Documents	-	MS Office
b) Drawings	-	Auto CAD

For the purpose of preparation of as-built drawings, Contractor shall update the "Issued for construction" drawings issued by the Company. It shall be the Contractor's responsibility to convert the drawings furnished by the Company in hard copy into CAD drawings including scanning, digitising and converting the drawings into a suitable format compatible with the AutoCAD and above. As-built drawings shall be prepared only on AutoCAD drawings.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECNICAL SPECIFICATION FOR PRECOMMISSIONING & COMMISSIONING OF PIPELINE SYSTEM

GAIL-STD-PL-DOC-TS-016

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1.0 SCOPE

The specification covers the minimum technical requirements for testing and commissioning of entire pipeline facilities including commissioning activities such as pre-commissioning checks, dewatering, swabbing, flushing/blowing, leak testing etc.

2.0 GENERAL

The scope of work for testing & commissioning including Pre – Commissioning actives shall include but not limited to the manpower, machinery & equipments, detailed Procedures, Materials & Consumable, Communications etc. to perform the work satisfactorily .

Contractor shall prepare detailed procedures for piping, dewatering, swabbing, pigging & commissioning of the pipeline, covering all aspects of work for owner's approval.

Contractors shall design & supply all temporary line connections Valves, Instruments, as required during the various operations.

In the event of any details which are not fully addressed, it is warranted by Contractor that work shall be performed in accordance with the specification & the best recognized practices in the onshore pipeline industry.

3.0 RESPONSIBILITY OF CONTRACTOR

The pipeline contractor shall be responsible for all the pre-commissioning and commissioning activities that need to be carried out for the project.

3.1 Mechanical Completion

Mechanical Completion of systems shall mean that all installation works of the facilities (or a specific part thereof where specific parts are mentioned in the bidding document) have been completed and hydro-tested in accordance with approved construction drawings, approved specification, applicable codes as defined in the bid document, accepted international good engineering practices and all the activities have been completed physically and structurally in a comprehensive manner and made fit for use in all aspects as per the scope in bid document including safety and quality aspects by the Contractor.

This shall include following as the minimum:

i. Pipeline has been installed, non-destructively tested and accepted, restoration of entire pipe line including crossings, flushed clean, cleaned by Magnetic Pigging, hydrostatically tested, dewatered, swabbed, successful completion and acceptance of Caliper run (EGP) and XYZ mapping for entire section from launcher to Receiver including restoration of entire pipe line and crossings and pre – dried up to 0 degree Centigrade (Dew point Temperature).

ii. Piping and Associated Facilities – piping systems , mechanical equipment and their supporting structure are installed, non-destructively tested and accepted, hydrostatically tested, flushed clean including cardboard blasting (as applicable), dewatered, blown by compressed air to remove residual water to the maximum possible extent.

iii. Stations/ terminals are ready in all respect including first to final layers of painting and complete painting below the supports, the entire piping systems are pneumatically tested.

iv. Piping stress analysis completed & detailed engineering stage HAZOP recommendation complied.
v. Calibration & installation of all field mounted instruments, local panel mounted receiver instruments completed.
Vi Installation of permanent cathodic protection systems for entire pipeline system is completed.
viii. Walk Patrolling Survey of the entire pipe line, OFC installation in all respect and testing to be completed.
vii. Installation of all facilities like pig launcher/ receiver, line connections, Spool pieces, Pigs and requisite accessories, valves, instruments, manpower etc. as required during various operations.

viii. Preparation of detailed procedures, activity schedules, bar charts, schemes etc. This shall include preparation of detailed procedures for dewatering, swabbing, electronic geometric pigging and shall address the sequence and methodology describing all operations, data on materials, equipments, instruments, consumables (e.g. Pigs and associated items), detailed time schedule and organization chart.

ix. Availability and arrangement of temporary pigging facilities have to be done by EPC contractor at site as per P&IDs.

3.2 Pre-commissioning

In order to execute and perform pre-commissioning activities, the pipeline contractor shall be responsible for (but not limited to) the following:-

- Carrying out pre-commissioning checks of the pipeline system including Tap-off Stations/Receipt Stations, Sectionalizing Valve (SV) Stations and their associated facilities under the scope of work to ascertain that the project has been mechanically completed in all respects.

- Checking of field instruments, laying out survey of pipeline, checking of communication system, checking of Electrical, Instrumentation system, controls & interlock etc.

- Dewatering of Pipeline and above ground piping, flushing/air-blowing and leak testing of piping i.e. piping and equipments under their scope of work.

- Supply and supervision of manpower for pre-commissioning.

- Operation of machinery and equipment for pre-commissioning.

- Supply and use of materials/consumables as required for the pre-commissioning activities.

- Erection of all temporary facilities like pig launcher/receiver, line connections, spool pieces, pigs and requisite accessories, valves, instruments, manpower etc. as required during various operations.

- Preparation of detailed pre-commissioning procedures, activity schedules, bar charts, schemes etc.

This shall include preparation of detailed procedures for dewatering, electronic geometric pigging / caliper pigging (By other Contractor), idle time preservation (if applicable), removal of idle time preservers (if applicable, flushing/blowing, leak testing and shall address the sequence and methodology describing all operations, data on materials, equipments, instruments, consumables (e.g. Pigs and associated items), communication systems, necessary calculations, detailed time schedule and organization chart.

- All necessary work to perform the job successfully including all modifications that would be required at various stages.

The pipeline contractor shall demonstrate to the Owner / Consultant /TPI (for approval) the successful completion of all the above mentioned activities.

In the event of any detail, which is not fully addressed, the pipeline contractor should warrant that work shall be performed in accordance with the relevant codes, Owner/Consultant's specifications and the best recognized engineering guidelines and practices being followed in the on-shore gas pipeline industry.

3.3 Commissioning

In order to execute and perform commissioning related activities, the pipeline contractor shall be responsible for providing all support/assistance required for commissioning under the overall guidance and supervision of Owner/Consultant/TPI. Contractor shall submit a detailed commissioning procedure for Owner / Consultant approval.

The pipeline contractor shall be also responsible to coordinate with the Composite Contractor(s), who is responsible for commissioning of the cathodic protection of the entire pipeline so that the commissioning process can be proceed uninterruptedly in a harmonious manner for the entire project.

Commissioning assistance broadly covers the following activities:

- Commissioning checks including Safety Review prior to start of commissioning activities to achieve 'Ready for commissioning' status for pipeline
- Surveillance of pipeline and attending leaks and operation of SVs and metering station (at Dispatch Station/Tap-Off Station/Receipt Stations, IDS whenever required).
- Supply and supervision of manpower for commissioning. Manning of SV and Tap-Off Station/Receipt Stations for pig tracking, pig receiving and other activities.
- Supply and operation of machinery and equipment for commissioning, if required.
- Supply of Nitrogen and its associated accessories for purging required for carrying out commissioning.
- Supply and use of materials/consumables as required for the commissioning activities.
- Any other assistance required by Owner / Consultant/ TPI.

- Erection and supply of all temporary line connections, spool pieces, strainers, valves, instruments, manpower etc. as required during various operations.

- Ensuring all communication facilities is in place and in proper working condition prior to start of commissioning activities of the pipeline system.

- Stabilization and total system operation for 72 hrs with all instruments controls & interlocks working satisfactorily at normal operating conditions. On completion of this stage one month operating run period will start.

- All necessary work to perform the job successfully including all modifications that would be required.

In the event of any detail, which is not fully addressed, contractor should warrant that work should be performed in accordance with the relevant codes, Owner's specifications and the best recognized engineering guidelines and practices being followed in the onshore pipeline industry.

3.4 Pre-commissioning Activities

3.4.1 Pre-commissioning Checks

Pre-commissioning checks shall be carried out for the pipeline system to ascertain that the pipeline system has been mechanically completed in all respect. **These checks shall cover all the facilities of the main pipeline, including Metering Stations, tap-Off Stations, Receipt Stations, Sectionalizing Valve Stations, as applicable**. The pre-commissioning checks shall include the following:

A) **System Checks**

The entire facilities shall be checked against the latest P&ID's, Engineering and Vendor Drawings/Documents and other design specifications. Any shortcoming observed shall be listed down in the form of punch lists and these should be duly attended or liquidated. The pipeline contractor should check the stations systems from the angle of pre-commissioning and commissioning and spell out any additional requirement of vents/drains, temporary arrangement/modification etc. that may be required during the pre-commissioning and commissioning activities and arrange for the same in consultation with the Owner / Consultant / TPI representative.

B) **Checking of Field Instrument**

All the field instruments like actuated valves, shutdown valves, transmitters, solenoid valves, shut down switches, alarms etc. shall be checked physically and also for their intended application by simulating the actual conditions. It will also include checking of different meters, gauges, action of actuated valves, control valves, shutdown valves etc.

C) **Survey of the Pipelines**

This shall be performed to confirm that proper fittings/supports, Cathodic protection system, route markers, warning signs, fencing around SV stations, etc. have been installed along the pipeline.

D) **Checking of Communication System**

This is to check that there is proper communication with adequate back-up power to ensure uninterrupted communication.

E) **Checking of Electrical Distribution System**

This is to ensure safety and also to ensure an uninterrupted power supply during start-up and normal pipeline operation.

F) **Checking of Instrument, controls & Interlocks**

This is to check that instrument controls and interlocks are functional as per the normal operating conditions.

G) **Checking of Utilities**

This is to check that utilities like power system, etc. are available prior to start-up.

H) **Any other checks as may be considered necessary.**

3.4.2 Pre-commissioning works for the above ground piping (Dispatch Station, Metering Stations, Receipt Stations etc. under the scope of work)

3.4.2.1 Dewatering (Hydro Test Water)

General

Dewatering of a piping system shall be done subsequent to the hydro-test of the respective piping section. During the dewatering operation, the major quantity (to the maximum extent possible) of hydro-test water shall be removed from the main interconnecting piping work in the stations. A standard blind shall be arranged and provided at the inlet and outlet nozzles of pumps and sump tank to avoid entry of debris/dirt/mud etc., before start-up of pre-commissioning activities.

Operational Requirements

The dewatering operation of the piping work in the stations shall consist of physically draining the water content in the piping work by opening low point drains and/or end flanges. If required, air shall be used to push-off water from the pipes. The pipeline contractor shall arrange suitable compressor for such purposes.

Flushing/Blowing of Aboveground Piping in the Terminal

Flushing/blowing of the above ground piping with water/air to remove debris/dirt/mud from within the piping has to be performed by the pipeline contractor. Subsequent to water flushing, to ensure complete cleanliness of the piping work, air blowing/cardboard blasting method has to be adopted. All instruments, control valves, orifice plates etc. to be dismantled from the piping work and any gap produced should be bridged with suitable temporary spool. Proper supporting of the piping, during such flushing/blowing activities is to be ensured by the pipeline contractor.

The pipeline contractor has to make arrangement of clean water/air for these flushing / blowing activities.

The pipeline contractor should submit a plan/methodology for carrying out such activities detailing out each aspect/step.

Acceptance Criteria

The pipeline contractor shall specify when flushing/air blowing is completed to the satisfaction of the Owner/Consultant/TPI, and shall obtain approval of the Owner/Consultant/TPI before proceeding to the next step.

3.5 Commissioning Related Activities

Safety Review Prior to Start of Commissioning Activities

A pre-start-up safety review of the cross-country pipeline system shall be arranged by the pipeline contractor, involving all concerned in the commissioning. The Owner/Consultant/TPI shall also participate in the pre-start-up safety review. The pipeline contractor shall generate all requisite formats to record the findings of such Safety Review.

Ready for Commissioning

After completion of pre-commissioning activities and Owner approved safety start-up review followed by liquidation of review punch list points, the pipeline contractor shall notify the Owner/Consultant/TPI that the pipeline systems in totality are ready in all respects for hydrocarbon-in. 'Ready for commissioning status' shall be jointly assessed by Owner/Consultant TPI, composite work contractor, Pipeline contractor. After such joint assessment, if all the criteria are met, it will then be declared by the Owner that the entire pipeline system has reached a stage of 'Ready for Commissioning'.

'Ready for commissioning status' shall be jointly reviewed by Company and Contractor and final clearance for start-up shall be given by the Company. After such joint assessment, if all the criteria are met, it will then be declared that the pipeline system has reached a stage of 'Ready for Commissioning'.

Commissioning and Stabilization

The pipeline contractor shall be responsible for providing all necessary assistance to carry out commissioning activities under the overall guidance and supervision of Owner/Consultant/TPI for the entire pipeline system.

Acceptance Criteria

The system shall be considered to be commissioned successfully when the pipeline system including the underground pipeline and the above ground piping at dispatch and receipt stations, SV stations and hook-up / tap-off points is charged with natural gas, is free of leaks and run successfully at stable operating conditions with instrumentation / control systems process utilities and support systems taken on line for a minimum period of 72 hours.

The commissioning of pipeline system shall include commissioning of branch lines, if any, and associated facilities including auxiliary facilities and aboveground piping.

4.0 DOCUMENTATION

The pipeline contractor shall submit the complete description, detailed procedures and time schedule for all of the following activities for approval of the Owner/Consultant/TPI.

- Pre-commissioning Checks
- Dewatering
- Swabbing
- Flushing / Blowing
- Low Pressure Leak Test with Air
- Drying
- Idle Time Preservation (if applicable), including Removal of Preservers

All these documents should be prepared covering all aspects of HSE, quality assurance and quality control plans.

The pipeline contractor shall ensure that his documents are related to “as-built” conditions of the pipeline, equipment and structures involved.

Documents shall also contain all safety plans, procedures to be followed while carrying out the activities.

Upon successful completion of the work, the pipeline contractor shall prepare a final report of the work which shall include necessary charts, diagrams, graphs, calculations, recordings, daily logs, measurements, details of the operation etc. Report shall also include all certificates of calibration of instruments required, together with records of calibration performed at site prior to the start of any operation and the approved pre-commissioning and commissioning formats and check sheets.

5.0 SPARES AND CONSUMABLES

The pipeline contractor shall identify and arrange for supply of manpower, spares, tools, tackles and consumables as required for pre-commissioning and commissioning activities.

6.0 SAFETY

The pipeline contractor shall follow the safety practices during execution of pre-commissioning and commissioning works as detailed in the scope of work. The pipeline contractor shall also maintain and follow all safety practices equivalent or better than those being practiced by the industry during pre-commissioning and commissioning activities. A dedicated safety department from the pipeline contractor’s side should be available for the job.

7.0 OTHERS

The pipeline contractor, along with his bid documents, is required to submit the following:

- Execution plan and method statement for pre-commissioning and commissioning activities.

- Past experience of pre-commissioning and commissioning activities carried out for a similar pipeline system / network.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR BARE (ERW) LINE PIPES

GAIL-ENG-PL-DOC-TS-017

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1 INTRODUCTION

1.1 SCOPE

This specification establishes the minimum requirements for the manufacture of longitudinal seam electric welded steel line pipe in accordance with the requirements of API (American Petroleum Institute) Specification 5L, Forty fifth edition and makes restrictive amendments to API Spec 5L. Unless modified and/ or deleted by this specification, the requirements of API Spec. 5L shall remain applicable.

Manufacturer shall supply the line pipe size,grade & quantity as per Material requisition (MR). The transportation for line pipe (3LPE/ Bare) up to Owner designated store is under Manufacturer scope.

All applicable supplementary requirements for PSL-2 are mandatory. Manufacturer shall produce the line pipes only at the authorized mills at authorized locations as per attached vendor list. No mill other than the authorized mill shall be engaged for manufacturing the line pipes even if it is in the same premises of the authorized mill. Sub-contracting of line pipe manufacturing to any other vendor is not permitted. Testing for product analysis and mechanical properties shall be carried out for each heat during regular production of pipes at manufacturer's test facility, however during First Day production Test all testing shall be carried out at manufacturer's test facility and external NABL laboratory and all results at both the testing facilities shall comply with the specification requirements.

External lab shall be approved by National Accreditation Board for Testing and Calibration Laboratories (NABL) for India and for outside of India external laboratory approved by equivalent national authority/board of Pipe Manufacturer's country.

The vendor shall have implemented or will implement a tracking system able to trace back all manufacturing and inspection steps. The vendor tracking system shall be described in a written procedure. Information and data to be traced back shall be part of the information and data to be submitted every shift/ day to the Owner Representative at the vendor premise. A format to transfer the information and data shall be submitted by vendor for Owner approval at the Pre-production Meeting.

First day production test shall be witness by OWNER's representative/ Consultant/TPIA.

The complete production cycle shall be supervised by OWNER's representative/ Owner's approved Third Party Inspection Agency (TPIA).

TPIA shall be appointed by Manufacturer. TPIA agency shall be finalized from vendor list with prior permission from OWNER.

Extent of inspection shall be minimum as per QAP enclosed; however the manufacturer shall ensure that pipes are in 100% conformances to latest API 5L and this specification.
In case of inconsistency / discrepancy / mismatch, if any, between QAP, addendum and/or this Specification, the stringent one shall apply.

The coverage by this specification is limited to line pipe to be used in onshore high pressure Natural Gas pipelines transporting non-sour hydrocarbons.

The Manufacturer shall have a valid license to use API Monogram in accordance with the requirements of API Spec 5L, Forty fifth edition.

1.2 PRODUCT SPECIFICATION LEVEL (PSL)

Line pipe supplied to this specification shall conform to Product Specification Level PSL2.

1.3 PIPE SIZE & GRADES

This specification is applicable to PSL 2 line pipes size of 4” to 12” NB & grade X52 to X65.

2 CONFORMITY

2.1 UNITS OF MEASUREMENT

Data is expressed in both SI units and USC units. For a specific order item, unless otherwise stated, only one system of units shall be used, without combining data expressed in the other system.

2.2 ROUNDING

In this International Standard, to determine conformance with the specified requirements, observed or calculated values shall be rounded to the nearest unit in the last right-hand place of figures used in expressing the limiting value, in accordance with ISO 80000-1/Cor1:2011.

For Purpose of determining conformance with this specification, the specified limits for YT/UTS ratio are absolute limits, as defined in ASTM E 29, for using significant digits in test data to determine conformance with specification in this regard (YS/UTS ratio).

3 NORMATIVE REFERENCES

The latest editions (editions enforce at the time of issue of enquiry) of following additional references are included in this specification.

ASTM E 92	:	Test Method for Vickers Hardness of Metallic Materials.
ASTM E 112	:	Standard Test Methods for Determining Average Grain Size.

4 TERMS AND DEFINITIONS

For this specification the following definitions shall apply:

OWNER/PURCHASER	-	GAIL INDIA LIMITED
CONSULTANT	-	LYONS ENGINEERING PVT. LTD
MANUFACTURER/ VENDOR	-	Manufacturer of the pipes
SHALL/ MUST/ IS TO BE	-	A mandatory requirement
SHOULD recently Amended	-	A non-mandatory requirement, advisory or

Third Party Inspection Agency (TPIA) - An independent agency approved by OWNER/CONSULTANT doing witness, review and monitoring of entire line pipe production /testing and also responsible for certifying compliance to specification and API 5L codes on behalf of OWNER/CONSULTANT and shall be appointed by manufacturer/vendor.

5 SYMBOLS & ABBREVIATED TERMS

Symbols and abbreviated terms shall be as defined in API 5L, 45th edition.

6 PIPE GRADE, STEEL GRADE & DELIVERY CONDITION

6.1 PIPE GRADE AND STEEL GRADE

The pipe grade for PSL 2 pipe shall be according to Table 1 of API 5L, 45th Edition and as mentioned elsewhere in the bid document. Following shall be applicable from Table 1 of API 5L with regards to starting material.

Product Specification Level	:	PSL 2
Delivery Condition	:	Thermo mechanical-rolled coil
Pipe Grade	:	API 5L Gr. X52M to X65M

The QAP for steel HR coils shall be prepared by the Manufacturer as per actual requirements (New) specified in the bid document, line pipe specification & QAP. The same shall be submitted for Owner/ Consultant's approval. Testing of raw material (Steel HR Coils) at steel mill shall be witness by TPIA as per approved steel QAP.

Manufacturer shall engage the same TPIA for pipe mill and steel mill for witness of all testing.

The TPIA shall report directly to OWNER/CONSULTANT in all technical and QA/QC matters related to the manufacturing and supply of line pipe as per this specification. TPIA shall submit Daily progress report to Owner for steel, pipe and coating as per approved DPR format.

6.2 DELIVERY CONDITION

Following shall be applicable from Table 1 of API 5L with regards to starting material.

Product Specification Level	:	PSL 2
Delivery Condition	:	Thermo mechanical-rolled coil
Pipe Grade	:	API 5L Gr. X52 to Gr. X65

However, in addition to this delivery condition(s) shall be in accordance with the purchase order as specified elsewhere in the bid document.

7 INFORMATION TO BE SUPPLIED BY THE PURCHASER

GENERAL INFORMATION

The purchase order shall include the following information:

a) Quantity (e.g. total mass or total length of pipe);
b) PSL -2
c) Type of pipe (Refer table 2 or 3 of API 5L, 45th edition)
d) Steel grade
e) Outside diameter & wall thickness Length and type of length Confirmation of applicability of individual annexes.

8 MANUFACTURING

8.1 PROCESS OF MANUFACTURE

The pipes shall be manufactured in accordance with the applicable requirements and limitations given in Table 2 & 3 of API 5L, 45th edition.

Type of pipe	: Electric Welded
Type of pipe end	: Plain
Pipe Grade	: PSL 2
Starting Material	: Quenched and tempered or controlled rolled or combined rolled and accelerated cooled to impart fine grain structure to the furnished steel or normalised/ normalising-rolled
Pipe forming	: Cold Forming Electric welding shall be performed with a minimum welder frequency of 250 kHz. The welding system shall have an integrated control in which following data as a minimum shall be monitored: - Time - Welding speed - Current and Voltage - Heat treatment temperature
Pipe heat treatment	: Normalising
Delivery condition	: M

A Manufacturing Procedure Specification (MPS) as described in Annexure B of this specification shall be prepared and submitted to Purchaser for approval prior to start of production.

The weld seam and the entire heat affected zone (HAZ) shall be heat treated so as to stimulate a normalizing heat treatment in order to control the structure so that no unhampered marten site remain in the weld seam and the HAZ, and the mechanical properties of heat treated zone approximates that of the parent metal. The quality of the longitudinal weld shall be such to provide weld joint efficiency factor of 1.0.

MILL SPEED:

The speed of the mill set at the time of procedure qualification shall be maintained within a permitted variation of +/- 15 %. The mill speed shall be declared at the beginning of each shift and any fluctuation of more than permitted limit of +/- 15 % shall warrant re-qualification of entire procedure.

PARAMETER CONTROL:

The current & voltage supplied to the welder along with welding temperature shall be monitored on-line and recorded both in text and graphical mode. Provision for auto control of voltage, current and temperature shall be available in the mill. Electric welding shall be performed with a minimum welder frequency of 250 kHz. The permissible range of welding temperature, Voltage and Current shall be finalized during first day production. Any fluctuation in these parameters beyond permissible shall actuate spray painting system and all such pipes subject to such variation in welding temperature limits shall be painted, pipe number recorded and pipes declared as rejected. Permanent graphical and textual record of all these parameters shall be produced for inspection at the end of each shift.

STEEL PROPERTIES

The steel used for manufacturing of pipes shall be fully killed and the grained with a grain size of ASTM 8 or finer as per ASTM E 112. All the heats of steel should be subject to chemical, mechanical, impact test at –20ºC & 0ºC under third party inspection agency. Pipe shall have longitudinal seam, manufactured using electric induction or electric resistance welding process utilizing high frequency electric supply (Bidder shall maintain minimum 250 KHz frequency during the welding process subject to coverage of all size, grade and thickness ranges as provided in the tender). The system shall have an integrated control in which following data a minimum shall be monitored.

- Time
- Welding speed
- Current & Voltage.
- Welding temperature
- Heat treatment temperature

8.3 STARTING MATERIAL

- The line pipe furnished to this specification shall be made from steel produced in basic oxygen or electric arc furnace. Steel shall preferably be made by continuous casting only. All the heats of steel should be subjected to chemical, mechanical, impact test at -20°C and 0°C under witness of TPIA.

- Steel manufacturer shall be as per Owner Vendor list.

- MPS & detail QAP of steel to be prepared by steel manufacturer and submit the same for Owner/Consultant approval.

- All testing requirement of steel shall be as per tender QAP of steel.

- For PSL 2 pipe, the steel shall be fully-killed and made according to fine grain practice with a grain size of ASTM 8 or finer as per ASTM E 112.

- The width of the coil used for the manufacture of pipe shall not be less than 1.5 times or more than 3.0 times the specified OD of the pipe.

- Central slitting of coils are not permitted.

- The strip or plate used for the manufacture of PSL 2 pipe shall not contain any repair welds.

8.8 TREATMENT OF WELD SEAMS IN ERW PIPES

PSL 2 HFW PIPE

The weld seam and the entire heat affected zone (HAZ) shall receive a normalizing heat treatment in order to control the structure so that no un-tempered martensite remain in the weld seam and the HAZ, and the mechanical properties of heat treated zone approximate that of the parent metal. The quality of the longitudinal weld shall be such to produce weld joint efficiency factor of 1.0.

SEAM NORMALIZING

The weld seam and the Heat Affected Zone (HAZ) shall undergo normalizing heat treatment to get a fine grain structure of similar characteristics to the base material. The heat treatment shall consist of heating by induction the weld area and HAZ to achieve complete austenitisation followed by air- cooling until temperature is below 350°C. Before normalizing, the weld seam shall be allowed to cool below 600° C. The longitudinal seam shall be normalised between 800-900° C. Graphical & textual recording of normalizing temperature is mandatory. The plant shall be equipped with automatic control of current, voltage and normalising temperature. The normalising temperature fluctuation permitted is +/- 70° C. Any fluctuation beyond the above range shall be recorded in the pipe by means of a paint spray. The pipes painted for variation in temperature beyond limits shall be taken out of

production line and shall be declared rejected. Grain size of the post-heated microstructure shall be 7 (as per ASTM E 112) or finer.

8.9 COLD SIZING AND COLD EXPANSION

Pipe furnished to this specification shall not be cold-expanded.

8.11 JOINTERS

Jointers on pipes are not permitted.

8.13 TRACEABILITY

The Manufacturer/Purchaser shall establish and follow documented procedures for maintaining heat and test unit identity traceability of all coils/ pipes as per requirement of API Spec. 5L and as modified in this specification. The same shall be submitted for Owner/ Consultant approval before implementation. The pipe mill shall have internal tracking system for their pipe traceability-inline production to reduce manual introversion. SAP base system is preferred.

9 ACCEPTANCE CRITERIA

9.2 CHEMICAL COMPOSITION

The chemical composition of each heat of steel on product analysis shall be in accordance with Table 5 and notes given below. Table 5 of API Spec 5L stands modified as below:

Table – 5: PSL 2 Chemical Requirements for Heat and Product Analyses by Percentage of Weight

Element	Product Analysis (percent)
C	0.16 max. (For Grade X52 & X56) 0.12 max. (For Grade X60 & X65)
Mn	1.40 max. (For Grade 52 & X56) 1.60 max. (For Grade X60 & X65)
Si	0.15 min, 0.45 max.
S	0.015 max.
P	0.02 max.
Al	0.07 max.
Nb	Note m (i) (For Grade X52 to X65)
V	Note m (i) (For Grade X52 to X65)
Ti	Note m (i) (For Grade X52 to X65)
Cr	0.20 max.
Mo	0.10 max. (For Grade X52 to X65)
Cu	0.35 max.
Ni	0.20 max.
N	0.012 max.

B	0.0005 max.

Note: m

i. V+Nb+Ti shall not exceed 0.12% (for Grade X52 to X65)
ii. Cu+Ni shall not exceed 0.50%
iii. Al/N shall be min. 2

Note: n
If alloying elements other than those specified in Table 5 above are added to the steel, the limits of the additional components shall be agreed with the Purchaser.

Note: o
Minimum for "Si" is not applicable for Al killed steel.

- **Carbon Equivalent (PSL 2 Only)**

For PSL2 pipes of all grades, size and wall thickness, Carbon Equivalent shall comply with the following limits:

CEPCM ≤ 0.20 %

Boron content shall be considered in CEPCM formula even if it is less than 0.0005%.

For PSL2 pipes of all grades, size and wall thickness, Carbon Equivalent shall comply with the following limits:

CE IIW ≤ 0.40 %

The CE IIW limit shall not apply if C≤0.12%

- **Elements Analyzed**

For heat analysis and product analysis, all the elements listed in Table 5 of this specification shall be analyzed and reported, even if those are not purposely added but are present as residuals only and same shall be certified 3.2 in accordance with EN 10204 by TPIA.

9.3 TENSILE PROPERTIES

The finished pipes shall conform to the requirements of Table 7 of API Spec 5L 45th edition and as modified herein.

The ratio of body yield strength and body ultimate tensile strength of each test pipe on which body yield strength and body ultimate tensile strength are determined, shall not exceed 0.90.

The ultimate tensile strength of the weld shall be equal to or better than the specified minimum ultimate tensile strength of the base metal.

The minimum elongation of base metal shall be determined in accordance with the formula given in foot note (f) of Table 7 of API 5L, 45th Edition. However elongation in no case shall be less than 25%.

9.4 HYDROSTATIC TEST

Test pressure shall be held for a minimum period of 15 seconds for all sizes and grades of pipes. The pressure shall be recorded on charts for each pipe and shall submit for inspection agency for review on shift basis. Each pipe shall undergo hydrostatic test at pressure corresponds to hoop / fibre stress generated equal to minimum 100% SMYS and witnessed by OWNER / CONSULTANT / TPIA.

- **VERIFICATION OF HYDROSTATIC TEST**

The pressure gauge used for hydrostatic testing shall have a minimum range of 1.5 times and maximum range of 2 times the test pressure. The pressure gauge shall be calibrated by means of a “Dead Weight” tester only. In presence of TPIA and the records shall be maintained. Each pipe shall undergo hydrostatic test at pressure corresponds to hoop / fibre stress generated as per API Spec 5L Para 10.2.6.5.

Calibration of pressure gauge shall be done at start of each shift & calibration of hydro tester with 1.6 mm TDH to ensure the sensitivity of pressure recorder chart shall be carried out at beginning of each shift. Hydrostatic test shall be witnessed by OWNER/CONSULTANT/TPIA and pressure shall be recorded on charts for each pipe and shall submit to inspection agency for review on shift basis.

In order to ensure that every length of pipe is tested to the required test pressure, each tester, except those on which only continuous welded pipe is tested, shall be equipped with a recording gauge that can record the test pressure and the test duration for each length of pipe, or shall be equipped with some positive and automatic or interlocking device to prevent pipe from being classified as tested until the test requirements (pressure and duration) have been met. Such records or charts shall be available for examination at the manufacturer’s facility by the purchaser’s inspector. The test-pressure measuring device shall be calibrated by means of a dead-weight tester, or equivalent, no more than four months prior to each use. Test pressures that are higher than required may be used.

- **TEST PRESSURE**

The test pressure for all sizes and grades of pipe shall be such that hoop stress generated is equivalent to 100 % of SMYS.

- **CYCLIC HYDRO TEST**

Cyclic hydrotest shall be carried out for only one pipe during first day production.

Test frequency shall be one pipe for any one thickness/Size/Grade.

Acceptance criteria for Cyclic Hydro test shall be as follows:

1) Cyclic hydro shall be carried out for one hr at 50% of htp, one hr at 75% of HTP & 24 hr at 100% HTP.
2) An automatic continuous recording on graph (time / pressure) shall be done.
3) Pressure shall be drop up to static head +1 bar as per spec requirement per cycle.

- **Burst Test**

Burst test shall be carried out on one pipe during first day production for lowest thickness per grade per size per steel supplier. One pipe tested for entire campaign shall be subjected to burst test and burst pressure and location shall be noted. Burst pressure shall be more than 130 % of specified minimum yield strength. If the burst pipe fails below 130% of SMYS then the manufacturer shall investigate and submit a report to the Client before re-testing and re-starting of the regular production.

9.6 FLATTENING TEST ACCEPTANCE CRITERIA

During regular production 6 Sample per coil (2 samples each from first & last accepted pipe of the coil 2 Sample from middle pipe of coil.) The sample shall be flattened at 0º & 90º. In case of weld stop, a sample from each crop end shall be tested at 3 o'clock position only. Flattening test shall be carried out after hydro test for first day production.

Acceptance criteria for flattening tests shall be as follows:

Flattened to ½ original OD without weld opening, continue flattening to 1/3 of specified OD without cracks other than in weld and continue flattening until opposite wall of pipe meet and no lamination on material on full flat. Dye Penetrate testing may be used to positively confirm the presence of crack, break or opening.

9.5 REVERSE BEND TEST

Reverse bend test shall be carried out as per PNGRB Guideline G.S.R. 808(E) Annexure III. Ring Specimen of width 100 mm to 115 mm shall be taken from the pipe and tested in accordance with the procedure given below and Fig 2 of this specification. Two reverse bend test specimen shall be removed after hydro test and tested.

- **Selection of Mandrel**

The reverse bend test shall be carried out with a mandrel, whose radius (R), or width (A) shall be calculated for any combination of diameter, wall thickness and grade with the following formula:

$$A = 2R = \frac{1.4\,(D - t)\,t}{e\,(D - 2t) - 1.4\,t} - t$$

Where

D	-	Specified outside diameter of pipe, mm
t	-	Specified wall thickness of pipe, mm
1.4	-	Peaking factor
e	-	Strain

Minimum value of 'e' shall be as follows:

Grade of Steel	Min 'e' value
Gr. B	0.1425
X-42	0.1375
X-46	0.1325
X-52	0.1275
X-60	0.1225
X-65	0.1175

- **Procedure**

The mandrel shall be plunged into the specimen, with the weld in contact with the mandrel, to such a depth that the angle of engagement between mandrel and specimen reaches 60^0 (Ref. Fig 2 of this specification). If the combination of diameter and wall thickness of pipe and radius of mandrel is such that the angle of engagement does not reach 60^0 the mandrel shall be plunged into the specimen until opposite walls of the specimen meet.

- **Acceptance Criteria**

A specimen which fractures completely prior to the specified engagement of mandrel and specimen, or which reveals cracks or ruptures in the weld or heat affected zone longer than 4 mm, shall be rejected. Cracks less than 6 mm long at the edges of the specimen shall not be cause for rejection. Dye penetrate testing may be used to positively confirm cracks or openings.

9.8 CVN IMPACT TESTS FOR PSL 2

The Charpy V notch impact test shall be carried out at -20°C and 0°C. The minimum all heat average full size absorbed energy value (based on a set of three specimens) for transverse body specimen, weld and HAZ shall be as per below table.

Impact testing shall be carried out at Base Metal, Weld & HAZ location of pipe. A one set shall consist of 3 specimen.

	Test Temperature	Minimum Average Value (for 3 specimen)	Minimum Single Value
Base Metal	-20°C	35 J	28 J
Base Metal	0°C	100 J	80 J
For Weld &HAZ	-20°C	27 J	22 J
For Weld &HAZ	0°C	40 J	32 J

The specimen shall be full sized or largest obtainable sub size in case pipeline diameter and thickness does not permit full size specimen. In case it is not feasible to obtain transverse specimen, a longitudinal specimen may be taken upon approval from Purchaser.

Shear fracture area for base metal: For pipes of all sizes and wall thicknesses, the minimum (set of 3 test specimens) shear fracture area for each test shall be at least 85% average & 80% individual, based upon a test temperature of at -20°C and 0°C.

9.9 DWT TEST FOR PSL 2 WELDED PIPE

- **Drop Weight Tear Test (DWTT):** DWT Test in accordance with API Spec 5L and as modified in this specification shall also be performed for all pipe size, grade and wall thickness. DWT test shall be carried out for a set of two test pieces at -20°C. The average shear fracture area shall be ≥ 85% and individual area shall be ≥ 80% based upon test temperature of -20 °C.

  DWTT test shall be carried out at -20 °C and minimum test frequency shall be one set/heat/ thickness/size/grade (one set shall consist two sample). Sample shall be remove from base in Transverse Direction.

- **DWTT Transition curve:** Full transition curve shall be established for minimum one heat out of three heat during first day production test.

  During PQT one pipe (2 sample per Temp.) shall be tested at different temperatures –46°C, –20°C, -10°C, 0°C & 10°C for shear area(testing at different temperature is only to establish transition curve) however Average shear fracture area shall be ≥ 85% at –20°C out of above referred temperature.

9.10 SURFACE CONDITIONS, IMPERFECTIONS AND DEFECTS

Cracks, Sweats, Slivers, Mechanical damages and Leaks are not permitted

- **ARC BURNS**

  Arc burns produced during the manufacturing of pipes are injurious defects and shall be disposed off in accordance with the requirements of API Spec 5L (c) or (d) of E10 (Annex- E). As a reference method for conforming the existence of an arc burn, the area shall be buffed with wire brush or sanding disc and etched with 5 % nital solution. However, arc burns can be considered for acceptance, in case the same is recrystallized by seam heat treatment. In such case, the Manufacturer shall demonstrate the recrystallization to Purchaser by taking a sample as per this specification.

- **LAMINATIONS**

  Any lamination or inclusion either extending into the face or face of bevel & pipe body with in manual UT portion or present within 50mm from pipe ends is considered defect and pipe containing such defects shall be cut back until such defects are eliminated.

  The disposition of lamination and other type of defects on the skelp/pipe shall be as per Annex-E of API Spec 5L and as modified in this specification.

- **CRACKS:**

  Sections of the pipes containing cracks shall be rejected and kept outside in one definedplace. NCR's shall be prepared for all such rejected pipes and segregated /stacked separately and kept available till completion of order or as agreed by inspection agency.
  All the rejected pipes shall be kept at designated location and shall not be disposed off until the order is completed. Bidder shall put a request to GAIL for dispatch of such NCR's noted on line pipes. Finally, GAIL shall intimate to TPIA & Bidders for clearance.

- **GEOMETRIC DEVIATIONS**

  For other than dents, geometric deviations from the normal cylindrical contour of the pipe (e.g. flat spots and peaks) that occur as a result of the pipe forming process or manufacturing operations and that exceed 1.6 mm (0.063 in) in depth, measured as the gap between the extreme point of the deviation and the prolongation of the normal contour of the pipe, shall be considered defects and shall be treated in accordance with C.3 (b) or (C) of Annexure C.

- **Dent**

  Allowable dent size shall be as per API Spec 5L and as modified in this specification as below:

a) Dent, 3.2 mm sharp bottom gouges are not acceptable.
b) 6 mm dents without any gouges (smooth end) are acceptable.
c) Any dent with gouges is not acceptable.
d) Dents on weld and heat affected zones (HAZ) are not acceptable
Grinding / jacking work shall not be allowed on pipe to remove the dent.

- **HARD SPOTS**

Any hard spot having a minimum dimension greater than 2 in. (50.8 mm) in any direction and hardness greater than 248 HV10 shall be rejected. The section of pipe containing the hard spot shall be removed as a cylinder.

- **OTHER SURFACE IMPERFECTIONS**

Other surface imperfections found by visual inspection shall be investigated, classified and treated as follows:-

a) Imperfections that have a depth ≤ 5% t and do not encroach on the minimum permissible wall thickness shall be classified as acceptable imperfections and shall be treated in accordance with Clause C.1 or C.2, as applicable (Annexure C).

b) Imperfections that have a depth > 5% and do not encroach on the minimum permissible wall thickness shall be classified as defects, and shall be disposed-off in accordance with clause C.3 of API Spec. 5L. (Annexure C).

c) Imperfections that encroach on the minimum permissible wall thickness implies that the portion of the wall thickness that is beneath the surface imperfection is less than the minimum permissible/Specified wall thickness.

9.11 TOLERANCE FOR DIAMETER, WALL THICKNESS, LENGTH AND STRAIGHTNESS

- **Pipe Length**

All pipes shall be supplied with length between 11.5 m and 12.5 m. The minimum average length of the entire order shall be 12.0 m. API 5L Table 12 shall not be applicable. Pipe used for sampling may be accepted for a length between 10 to 11.5 m. The minimum overall length tolerance shall be (-) zero and (+) one pipe length to complete the ordered quantity.

Each pipe shall be measured for conformance to above requirements and all measurements shall be recorded.

- **Wall thickness**

In addition to API requirements, the wall thickness of each pipe shall be checked, measured and recorded along the circumference at both ends of pipe body & mid

location of pipe body at 12 o'clock, 3 o'clock, 6 o'clock and 9 o'clock positions. The wall thickness tolerance shall comply with the requirements of this specification. Min. 8 nos. of readings per pipe shall be taken to cover both ends & middle of pipe body. Written record of the same shall be submitted with final documentations.

The tolerance on normal wall thickness shall be +10% and -0%. API Spec 5L Table 11 stands modified accordingly.

- **Diameter Tolerance**

  - **Pipe Body**

The outside diameter of pipe body, as determined by taping the circumference, shall not deviate by more than the values given below.

Size	Tolerance
≥ 4 ½ and ≤ 12	± 2 mm

  - **Pipe Ends**

Diameter tolerances for the pipe ends indicated in API Spec 5L, Table 10 shall be applicable on outside diameter for pipe size ≤ 12".

The inside diameter, based on circumferential measurement, over a length of 100 mm from the end shall comply with the tolerances specified in API Spec 5L/ISO 3183. Inside diameter is defined as ID = (OD-2WT.) where ID, OD & WT are the inside diameter, specified outside diameter and specified wall thickness respectively.

- **Out of Roundness Tolerance**

Out of roundness on pipe except the end, shall not exceed the following:

  - **Pipe body**

The outside diameter of pipe body, as determined by taping the circumference, shall not deviate by more than the values given. API Spec 5L Table 10 stands modified accordingly.

Pipe Size	Tolerance
≥4 ½ and < 12	± 2 mm (within 100 mm from both the ends)

  - **Pipe end**

Out of Roundness i.e., the difference between the maximum and minimum diameter (outside diameter for pipe size ≤ 12") at pipe ends, shall not exceed the following:
Size Tolerance
≤ 10 ¾: 2 mm
≥ 12 ¾: 3 mm

Out of roundness tolerance indicated in API Spec 5L, Table 10 stands deleted. Out of roundness tolerances apply to maximum and minimum diameters as measured with a bar gauge, caliper or device measuring actual maximum and minimum diameter.

Each pipe shall be measured for conformance to above requirements. All dimensions and tolerances shall be measured and recorded at least 3 times per operating shift (12 hrs. maximum).

- **Straightness**

The deviation from a straight line for all diameters shall not exceed 1mm per meter but max 10mm. Each pipe shall be checked for conformance to above requirements. Straightness shall be measured and recorded after hydrostatic testing for each pipe. The local deviation from a straight line at each pipe end (1000mm portion) specified in clause "b" (API 5L) shall not be allowed. Straightness shall be measured and recorded at least 3 times per operating shift (12 hours maximum).

9.12 FINISH OF PIPE ENDS

- **PLAIN END**

Pipes shall be furnished with plain ends. Unless specified otherwise, the pipe ends shall be bevelled as per API Spec. 5L.
In removing the inside burrs at the pipe ends, care shall be taken not to remove excess metal and not to form an inside cavity or bevel. Removal of excess metal beyond the minimum wall thickness as indicated in para 9.11.3.2 of this specification, shall be a cause for re-bevelling. In case root face of bevel is less than that specified, the pipe ends shall be re-bevelled and rectification by filing or grinding shall not be done.

Both pipe ends of each pipe shall be provided with metallic bevel protectors as per Manufacturer's standard. Bevel protectors shall be of a design such that they can be re-used by coating applicator for providing on externally anti-corrosion coated pipes subsequent to coating of line pipe.

- **RADIAL OFFSET OF STRIP / PLATE EDGES**

All pipes shall be checked for offset of skelp edges and it shall be measured and recorded. In case, there is any change in the bevel tool/ machine, test shall be repeated for at least one pipe or till the offset is within acceptable limits and only then regular production shall be restarted. Offset shall be measured and recorded at least 3 times per operating shift.

- **HEIGHT OF FLASH OR WELD/BEAD REINFORCEMENT**

All pipes shall be checked for conformance of height of flash (+0.7 mm, - 0 mm) and shall be measured and recorded at least 3 times per operating shift (12 hours maximum).

Height of Flash shall apply as follows:

a) The outside flash shall be trimmed to an essentially flush condition.
b) The wall thickness at the trim shall not be less than the minimum permissible wall thickness.

10 INSPECTION

10.1.3 INSPECTION DOCUMENTS FOR PSL 2 PIPE

Manufacturer shall issue inspection certificate 3.2 in accordance with EN 10204 for each dispatched steel and pipe.

10.2.1.2 INSPECTION FREQUENCY

The frequency of Inspection and testing shall be as per tender QAP.

- **Heat Analysis:**

Where the steel mill is not a part of an integrated pipe mill, heat analysis shall be reported by the Manufacturer prior to start of pipe production.

- **Product Analysis:**

Two samples per test unit shall be analysed. The test unit shall be 50 pipes per heat per size. Pipes selected shall be such that one at the beginning of the heat and one at the end of the heat are also represented.

- **Tensile Test Frequency (For Pipe body & Weld):**

Tensile tests shall be made at the frequency of two (02) set per inspection test unit per heat per size as per QAP. Set shall consist of two samples one for weld one for body:

Test unit shall consist of 50 pipes that are made to the same size and the same specified wall thickness by the same process, from the same heat and under the same manufacturing conditions.

- **Charpy Impact Test:**

The minimum test frequency shall be one set per 50 pipes per heat per temp. Per combination of pipe size and specified wall thickness. The set shall consist of three specimens each from Body, weld & HAZ in transverse direction.

- **Metallographic Examination:**

A test specimen for metallographic & hardness examination shall be taken transverse to the Longitudinal weld, from one finished pipe from each test unit of 50 pipes per heat or at least once per operating shift (12 hrs maximum) and whenever changes of grade, diameter or wall thickness are made and whenever significant excursions from operating heat treatment conditions are encountered.

The Hardness test shall be conducted for 1 sample per 50 pipes per heat during regular production.

- **Dimensional measurements:**

Each pipe shall be measured for following:

Visual inspection, pipe diameter & out of roundness, wall thickness, pipe weight, length etc. as per API 5L and as modified in this specification. All dimensions and tolerances shall be measured and recorded at least three times per operating shift (12 hrs max.)

API 5L Table 18 shall be considered applicable for the tests which are not covered in this specification.

10.2.2 SAMPLES AND TEST PIECES PREPARED

- **SAMPLES AND TEST PIECES FOR PRODUCT ANALYSIS**

Samples shall be taken, and test pieces prepared, in accordance with ISO 14284 or ASTM E1806. Two pipes per heat per size per lot of 50 pipes shall be analyzed (One at start of heat and one at end of heat of pipe). Sample used for product analysis shall be taken from finished pipes. Sample used for mechanical tests shall be taken from finished pipes.

10.2.3 SAMPLES AND TEST PIECES FOR MECHANICAL TESTS

- **TEST PIECES FOR THE TENSILE TEST**

The transverse tensile tests shall be carried out on flattened rectangular specimen only. Rectangular test pieces, representing the full wall thickness of the pipe, shall be taken in accordance with ISO 6892 or ASTM A 370 and as shown in Figure 3 (a & b) of API 5L 45th edition; transverse test pieces shall be flattened.

Two transverse base metal specimens per 50 pipes per heat and two transverse weld metal specimens per 50 pipes per heat for tensile test shall be tested. Weld beads shall be ground flush and local imperfections shall be removed.

- **TEST PIECES FOR THE CVN IMPACT TEST**

The test pieces shall be prepared in accordance with ASTM A 370 & the required striker radius shall be 8 mm. The axis of the notch shall be perpendicular to the pipe surface.

In addition to the specimen taken from the body of the pipe, three transverse specimens each from Weld and HAZ shall also be taken. When either full size or sub-size transverse specimen as per API Spec 5L, Table 22 is not possible to obtain, transverse specimen of either ⅓ Size or ¼ Size, whichever is maximum possible, may be obtained. When such sub-size specimens are used, the acceptance of the individual/average absorbed energy values shall be established as per this specification.

The minimum test frequency shall be one set per 50 pipe per heat at 0'C & -20'C (a set of three specimens each for body, Weld and HAZ) per combination of pipe size and specified wall thickness.

For pipe weld and HAZ tests, each test piece shall be etched prior to notching in order to enable proper placement of the notch.

For test pieces taken in the weld of HFW pipe, the axis of the notch shall be located on, or as close as practical to, the weld line.

- **TEST PIECES FOR DWT TEST**

The test pieces shall be prepared in accordance with API RP 5L3.

- **TEST PIECES FOR THE FLATTENING TEST**

The test pieces shall be taken in accordance with ISO 8492 or ASTM A 370.

Minor surface imperfections may be removed by grinding.

10.2.5 MACROGRAPHIC AND METALLOGRAPHIC EXAMINATION

For pipe that is required to be seam-heat-treated, it shall be verified by metallographic testing that the entire HAZ has been appropriately heat treated over the full wall thickness.

A test specimen for metallographic & hardness examination shall be taken transverse to the longitudinal weld, from one finished pipe from each lot of 50 pipes per heat or at least once per operating shift (12 hrs maximum) whichever is occurring more frequently and whenever changes of grade, diameter or wall thickness are made and whenever significant excursions from operating heat treatment conditions are encountered. The specimen shall be suitably ground, polished and etched to reveal the macro-structure. The specimen shall be visually examined using a minimum 10X magnification to provide evidence that heat treatment of weld zone is adequate and to provide evidence that proper fusion has been obtained for the full thickness, and texture of weld zone. In case imperfections

or defects are observed, it will become a cause for re-evaluation of welding parameters as deemed necessary by OWNER/CONSULTANT/Consultant and/or TPIA. Optical micro photographs of the 200 X & 400 X magnifications for visual-examination of the specimen shall be submitted to OWNER/CONSULTANT/Consultant along with the MTC for each heat. It will become a cause for re-evaluation of welding parameters and heat treatment as deemed necessary by Purchaser's Representative.

In Metallographic test, no un-tempered martensite remains & uniformly distributed ferritic structure shall be established & fusion line shall be clearly visible. The ASTM grain size no. shall be 8 or finer as per ASTM E 112.

- **HARDNESS TEST**

Vickers hardness tests shall be carried out on each specimen taken for metallographic examination in accordance with ASTM E-32, at locations indicated in Fig. 4 at of this Specification. Indentation in the Heat Affected Zone shall start as close to the fusion line as possible. The resulting Vickers hardness value at any point shall not exceed 248 HV10. The maximum difference in hardness between the base metal and any reading taken on the weld or heat affected zone shall be less than 80 HV_{10}.

10.2.6 HYDROSTATIC TEST

Test pressure shall be held for a minimum period of 15 seconds for all sizes and grades of pipes. Each pipe shall undergo hydrostatic test at pressure corresponds to hoop / fibre stress generated equal to minimum 100% SMYS.

The pressure gauge used for hydrostatic testing shall have a minimum range of 1.5 times and maximum range of 4 times the test pressure. The pressure gauge shall be calibrated by means of a "Dead Weight" tester only.

The test pressure for all sizes and grades of pipe shall be such that hoop stress (fibre stress) generated is equivalent to 100% of SMYS, computed based on the formula mentioned in API Spec 5L Para 10.2.6.5.

Calibration of pressure gauge shall be done at start of an each shift (12 hours max.) & calibration of hydrotester with 1.6 mm TDH shall be carried out at beginning of shift.

10.2.7 VISUAL INSPECTION

Each pipe shall be visually inspected to detect surface defects, with an illuminance of at least 300 lx (28 fc). Such inspection shall be over the entire external surface and shall cover as much of the internal surface as is practical and shall be free of defects in the finished condition.

10.2.8 DIMENSIONAL TESTING

The diameter of each pipe shall be measured. Unless a specific method is specified in the purchase order, diameter measurements shall be made with a circumferential tape, ring gauge, snap gauge, calliper or optical measuring device.

The out-of-roundness of each pipe shall be determined. The out-of roundness shall be determined as the difference between the largest outside diameter and the smallest outside diameter, as measured in the same cross-sectional plane.

Each length of pipe shall be measured for conformance to the specified wall thickness requirements. Wall thickness measurements shall be made with a mechanical calliper or with a properly calibrated non-destructive inspection device of appropriate accuracy. In case of dispute, the measurement determined by use of the mechanical calliper shall govern.

In addition to API requirements, the wall thickness of each pipe shall be checked along the circumference at both ends and at the mid location of pipe body at 12 o'clock, 3 o'clock, 6 o'clock and 9 o'clock positions. The wall thickness tolerance shall comply with the requirements of this specification.

Test frequency and acceptance criteria shall be as per QAP.

10.2.10 NON-DESTRUCTIVE INSPECTION

Non destructive inspection shall be accordance with Annexure E

10.2.12 RETESTING

In the event any analysis / test fails to conform to the specified requirements, manufacturer shall either reject the lot/test unit involved or test two additional lengths from same test unit. If both of the new tests conform to the specified requirements, then all the lengths in that test unit shall be accepted, with the exception of original selected length. If one or both of the retest samples fail to conform to the specified requirements, the purchaser or purchaser's representative reserves the right to either test remaining lengths in that test unit or reject the whole lot/test unit.

Recheck analyses

Modalities of recheck Product analysis shall be as per API Spec 5L as applicable to the lot being tested. However, during individual testing, each pipe shall be fully analyzed to meet the requirements of this specification.

11 MARKING

Marking specified in API Paragraphs and otherwise specified in the Purchase Order shall be in English language and international system (SI) of units. Marking shall comply with

Clause 11 of API Spec 5L and as modified in this specification. Marking shall Manufacturer's Name, API Monogram, API License No., Nominal OD, Wall thickness, Grade PSL, "HFW", Pipe Number, Heat Number, Actual Length in meter & weight, ASL No. etc. Marking procedure shall be prepared by manufacture and submitted to owner/ consultant for approval.

- **STENCILING MARKING:**

Marking shall be paint stencilled on each length of the pipes at right angles to the pipe axis approximately 200mm from both end. Stencil marking shall be placed on the one inside & one outside surface of each length.

Paint used for stencil marking shall withstand a temperature up to 250°C expected to be experienced during further external anti-corrosion coating operations of line pipe by coating applicator.

Stenciling procedure shall be prepared by manufacturer & submitted to Owner /Consultant for approval.

- **DIE STAMP:**

Additionally, the pipe number shall be placed by cold rolling or low stress dot marking on the outside surface of the pipe at an approximate distance of 50 mm from both ends. In case of non-availability of either cold rolling or low stress dot marking Facility in pipe mill, an alternative marking scheme of a permanent nature may be proposed by the Manufacturer.

- **BAR CODE:**

Bar code shall be applied on the inside & outside surface of the pipe in addition to stencilling. Bar code shall be provided as per the requirements of specified in Annexure R.

Bar coding procedure shall be prepared by manufacturer & submitted to Owner /Consultant for approval.

Bar code scanner required at pipe mill for scanning all detail of dispatched pipe and generate excel file and submit along with dispatch documents.

- **COLOR CODE:**

A colour code band shall be marked on inside surface of finished pipe for identification of pipes of same diameter but different wall thickness, as indicated in the Purchase Order.

The colour code band shall be 50 mm wide and shall be marked at a distance of 150 mm from the pipe ends. Thickness wise Colour code shall be finalized by manufacturer.

12 COATING AND THREAD PROTECTORS

- **BEVEL PROTECTORS**

Both pipe ends of all pipes shall be provided with metallic or high impact metallic bevel protectors as per Manufacturer's standard. Bevel protectors shall be of a design such that they can be re-used by coating applicator for providing on externally anti-corrosion coated pipes subsequent coating of line pipe. Type of bevel protectors shall be approved by inspection agency. Three layer external PE coating (3LPE) shall be provided as per coating specification

13 RETENTION OF RECORDS

In addition to the records indicated in clause 13 of API Spec 5L, Records of the following inspections, if applicable, shall be retained by the manufacturer and shall be made available to the purchaser, upon request, for a period of five years after the date of purchase from the manufacturer. Total records shall be produced in form of Compact Disc (CD) including the IR/IRN/MTC/Photographs and the same shall be handed over to OWNER/CONSULTANT.

a) Heat and product analyses;

b) Tensile tests;

c) Bend tests;

d) CVN tests;

e) DWT tests;

f) Hydrostatic-tester recorder charts or electronic methods of record storage;

g) Radiographic images for pipe inspection;

h) Non-destructive inspection by other methods where applicable;

i) Qualifications of non-destructive inspection personnel;

j) Radiographic images for jointer welds;

k) Repair welding procedure tests;

l) Records of any other test as specified in the Annexure or the purchase order or

QAP, including all welding procedure specifications (WPS) and welding-procedure qualification test records (WPQT/PQR).

In addition to the records indicated in API Spec 5L, the Manufacturer shall retain the records of all additional tests/calibration records mentioned in this specification including the hard copy records of ultrasonic testing carried out on pipe/skelp as well as pipe ends.

- **PRODUCTION REPORT**

All data related to the Manufacturing process of Steel and pipe shall be submitted to OWNER/CONSULTANT / OWNER/CONSULTANT representative by the Purchaser/ Manufacturer on day to day basis in English language. The Manufacturer shall provide 2 hard copies & 2 soft files in scanned & excel format of production report in English language indicating at least the following for each pipe. International system of units (SI) shall be adopted.

- Pipe number
- Heat number from which pipe is produced
- Pipe length and weight.
- Pipe grade

The Manufacturer shall provide 2 set of hard copies and 2 set of soft (CD) copies of acceptance certificates which shall include the results of all tests required as per this specification and performed on delivered material giving details of, but not limited to, the following:

- All test certificates mentioned in clause 10.2.4 of API 5L and QAP
- Records of qualification of welders and procedures for repair welding
- Certified reports of dimensional, workmanship and defects inspection.
- Data on test failures, rejected heats/lots, etc.
- All other reports, results and records required which includes but not limited to all NDT reports, thickness measurement report, etc. as per this specification.

The certificates shall be valid only when signed by the Purchaser & endorsed by OWNER/CONSULTANT TPIA. Only those pipes, which have been certified by the Purchaser & endorsed by OWNER/CONSULTANT TPIA, shall be dispatched from the pipe mill.

In the event of small quantities of pipes supplied against this specification, like those for bends and other similar applications, as specifically called out in the Purchase Order, the production report may consist of only test certificates required as per API Spec 5L and other test reports/results required as per this specification.

- **LINEPIPE TRACKING DATA**

The line pipe data shall be provided in portable document format in CD/DVD. However packing list shall be provided in excel format also. The specific data to be recorded shall be agreed between Purchaser and the Manufacturer and shall include, but not limited to, the following:

- All marking information
- Date of plate and pipe manufacture
- All mechanical properties from test results
- All dimensional records
- Final inspection and release date
- Description and disposition of repairs
- Load-out despatch date
- Destination
- Consignment details.

14 PIPE LOADING

The manufacturer shall be responsible for the shipment of pipe, the manufacturer shall prepare and follow loading diagrams that detail how the pipe is to be arranged, protected and secured on trucks, railcars, barges or ocean-going vessels, whichever is applicable. The loading shall be designed to prevent end damage, abrasion, peening and fatigue cracking. The loading shall comply with any rules, codes, standards or recommended practices which are applicable.

Transportation & handling procedure of 3LPE/ Bare pipe shall be prepared by manufacture and submit to client/consultant for approval as per detail describe in Annexure Q of this specification.

15 DISPOSAL OF REJECTED PIPES

NCR's shall be prepared for all rejected pipes. All rejected pipes segregated and Stacked/ stored separately and kept available till completion of order or as agreed by OWNER/CONSULTANT.

All rejected pipes are clearly marked with suitable marking / identification system which is approved by OWNER/CONSULTANT.

All the rejected pipes shall be kept at designated location and shall not be disposed off until the order is completed. Bidder shall put a request to OWNER/CONSULTANT for dispatch/ disposal of such NCR's noted on line pipes.

16 REJECTION

If OWNER/CONSULTANT / TPIA rejects pipes repeatedly for any recurring cause, this shall be adequate reason to refuse final inspection of subsequent pipes until the cause has been investigated and corrective action taken by the Manufacturer. If required an independent agency may be engaged to investigate the root cause, at the cost of Manufacturer.

17 PLANT ACCESS

The inspector representing the purchaser shall have unrestricted access, at all times while work of the contract of the purchaser is being performed, to all parts of the manufacturer's works that will concern the manufacture of the pipe ordered. The manufacturer shall afford the inspector all reasonable facilities to satisfy the inspector that the pipe is being manufactured in accordance with this specification. All inspections should be made at the Place of manufacture prior to shipment, unless otherwise specified on the purchase order, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

ANNEXURE - B: MANUFACTURING PROCEDURE QUALIFICATION (PQT) FOR STEEL/PIPE

Manufacturing Procedure Specification (MPS):

A Manufacturing Procedure Specification (MPS) outlining the successive steps and associated inspection procedures from steelmaking to finished line pipe shall be prepared and submitted to Owner / Consultant for approval prior to start of production. Manufacture of steel/pipe shall start only after the approval of Manufacturing Procedure. The approved Manufacturing Procedure shall be strictly followed in all phases of the production of steel/pipe.

PQT of Steel:

Before steel production commences, Manufacturing Procedure Specification (MPS) for manufacturing of steel and Statistical process control charts shall be prepared by steel manufacturer and submitted for approval of Owner / Consultant.

In addition to the requirements indicated in API 5L, MPS shall also include all testing requirements as per steel QAP. During steel production in steel mill, All testing shall be witnessed by TPIA as per QAP.

Control rolling process shall be Random witnessed by TPIA. Owner reserve the right to witness of control rolling process at steel mill during steel production.

PQT of Pipes:

Before pipe production commences, Manufacturing Procedure Specification (MPS) for manufacturing of pipes and Statistical process control charts shall be prepared by pipe manufacturer and submitted for approval of Owner / Consultant.

Minimum 3 different heat to be selected out of which at least 2 pipes per heat to be selected for testing for first production of line pipe.

These first day's production tests shall be repeated upon any change in the manufacturing procedure as deemed necessary by Purchaser’s Representative. The first day production tests shall be carried out on pipes for each diameter and each grade of steel.

Note: In the event of small quantities of pipes ordered against this specification, like those for bends and other similar/specific applications, as specifically called out in the Purchase Order, the first day production test shall not be carried out. Pipes in such case shall be accepted based on regular production tests.

First day production shall be carried out as per approved welding procedure specification. Mill parameters established during first day shall be followed in regular production.

First day production shall be witnessed by owner representative/ Consultant and third party inspection agency (TPIA). Manufacturer shall give mandatory prior notice at least (7) seven working days in advance to owner representative/ Consultant and TPIA. The first day production shall be carried out on pipes for confirmation of product and continuation of regular pipe production

The manufacturer shall submit to purchaser a report giving the results of all tests mentioned below. The report shall be signed and agreed by Inspection agency and same report shall be submitted to owner for approval of starting regular production.

The various tests to be conducted as a minimum on each pipe shall be as follows. The test method and acceptance values shall be as per this specification and QAP unless specified differently in this Annexure.

a. Visual Examination

All pipes shall be examined visually for dimensional tolerances and apparent surface defects.

b. Ultrasonic Examination

All pipes shall be examined by automatic Ultrasonic equipment as per Annexure E of this specification. Coil/ Plate UT acceptance criteria shall be as per QAP. The weld seam of all pipes shall be examined 100% ultrasonically. 100% surface area of the plate/body of pipe shall be subject to U.T.

c. Radiographic Examination

The weld seam of all pipes shall be examined radio-graphically for the entire length. Manufacturer has to retain films up to 5 years.

d. Product Analysis (Spectro)

Two (02) samples per pipe shall be tested for chemical analysis as per this specification.

e. Mechanical Properties

The mechanical properties of all pipes shall be tested and shall meet the requirements of this specification and QAP. Purchaser Representative will select the locations on the pipe from where the test specimen shall be removed.

The following tests shall be conducted:

i. **Flattening test:** 2 samples (test at 0°& 90°) from each pipe shall be removed. In case of weld stop 1 sample from each crop end shall be tested at 3 O'clock position. Flattening test shall be carried out after hydro test for first day production.

Acceptance: no opening in weld at 1/2 of OD, no opening in material at 1/3 of OD. Continue full flattening for lamination check.

ii. **Tensile test:** Two transverse base metal specimen and two transverse weld specimen for tensile test shall be tested for each pipe.

iii. **Metallographic Examination (Macro & Micro):** 6 sample / pipe. Six (6) weld cross-section specimen, three (3) from each end of the pipe joint, shall be taken.

iv. **Hardness Test:** Two samples per pipe shall be tested for hardness at room temperature after etching. Hardness test shall be conducted on selected pipes as per requirement of para 10.2.4 of this specification.

v. Fracture Toughness Test:

One set per pipe shall be tested at -20°C and 0°C each from body, weld & HAZ in transverse orientation. A one set shall be consist of 3 specimens.

Shear fracture area for base metal: For pipes of all sizes and wall thicknesses, the minimum (set of 3 test specimens) shear fracture area for each test shall be at least 85% average & 80% individual, based upon a test temperature of at -20°C and 0°C.

vi. **Reverse bend test (RBT):** 2 samples / coil (one from first & one last accepted pipe of the coil) In case of weld stop one sample from each crop end.

vii. Drop Weight Tear Test (DWTT): DWT Test in accordance with API Spec 5L and as modified in this specification shall also be performed for all pipe size, grade and wall thickness. DWT test shall be carried out for a set of two test pieces at -20°C. The average shear fracture area shall be ≥ 85% and individual area shall be ≥ 80% based upon test temperature of -20 °C.

DWTT test shall be carried out at -20 °C and minimum test frequency shall be one set/heat/ thickness/size/grade (one set shall consist two sample). Sample shall be remove from base in Transverse Direction.

DWTT Transition curve: Full transition curve shall be established for minimum one heat out of three heat during first day production test.

During PQT one pipe (2 sample per Temp.) shall be tested at different temperatures –46°C, –20°C, -10°C, 0°C & 10°C for shear area(testing at different

temperature is only to establish transition curve) however Average shear fracture area shall be ≥ 85% at –20°C out of above referred temperature.

f. Burst Test:

One pipe for each size and grade on lowest thickness per steel supplier shall be subjected to burst test. Burst test pressure shall be such that hoop stress generated is at least equivalent to 130% of SMYS. Burst test pressure & location shall be recorded. If burst pipe fails below 130%of SMYS then manufacture shall investigate the root cause & submit the report to the client before retesting & restarting of the regular production.

g. Cyclic Hydro test:

Cyclic hydro test shall be carried out for 1 hour at 50% of highest test pressure (HTP), 1 hour at 75% of HTP & 24 hours at 100% of HTP. Automatic continuous recording on the graph (time/pressure) shall be carried out. Pressure shall drop up to static head +1 bar per cycle. Test shall be carried out for any one thickness per size per grade.

h. External Lab Testing

During the first day production one pipe out of three heat shall be selected for testing at external NABL laboratory under TPIA's witness for following tests.

1. Product Analysis (2 sample)
2. Tensile Test (4 sample)
3. Impact Test (one set at -20’ C & 0’ C for base, weld & HAZ)
4. Hardness Test (2 Sample)
5. Metallographic (6 Sample)

All testing shall be conducted at Manufacturer’s facility and at an external NABL lab simultaneously to establish the acceptance of the product.

External Lab Testing shall be required during the first day production only for one thickness per size per grade. No requirement on regular production.

The cost of external lab testing shall be borne by manufacturer. Both tests i.e. external (NABL approved laboratory) and internal (at manufacturer’s facilities) shall comply with the specification requirements.

i. Retest criteria for first day production test

If the above tests do not meet the requirements of this specification, the Purchaser shall have the right to intensify control and normal production which may require other supplementary tests in order to identify anomalies of production without prejudice to the right to reject production in the event of serious anomalies.

In the event any analysis / test fails during first day production test to conform to the specified requirements. Manufacturer shall retest as per Clause no 10.2.12 of this specification.

ANNEXURE – C: TREATMENT OF SURFACE IMPERFECTIONS AND DEFECTS

C.1 Treatment of surface imperfections

Surface imperfections not classified as defects may remain in the pipe without repair or may be cosmetically dressed-out by grinding.

C.2 Treatment of dressable surface defects

Complete removal of defects shall be verified by local visual inspection and by suitable non-destructive inspection. To be acceptable, the wall thickness in the ground area shall be in accordance with 9.11.3.2 and as modified in this specification.

C.3 Treatment of Non-dressable surface defect

Pipes that contains non dressable surface defect shall be given one or more of the following dispositions.

a) Deleted

b) The section of the pipe containing the surface defects shall be cut off, within the limits on length.

c) The entire pipe length shall be rejected.

ANNEXURE – E: NON-DESTRUCTIVE TESTING

1. Qualification of Personnel

All personnel performing NDT activities shall be qualified in the technique applied, in accordance with latest edition of ISO 11484 or ASNT No. ASNT-TC-1A or equivalent.

All NDT shall be performed in accordance with written procedures prepared by level III inspector. These all procedures shall be reviewed by TPIA prior to start the first day production.

Acceptable qualification for NDT inspectors shall be as specified below:

(i) For UT

For UT, at least one level III qualified inspector shall be available to the mill for overall supervision. A level II inspector is required for shift supervision, manual weld inspection and calibration of all systems (both manual and automated).

(ii) For all other NDT methods

Evaluation of indications: Level I, II, III inspector
Supervision: Level II or Level III inspector (in case evaluation is by Level I inspector)

Note: Levels 1, 2 and 3 is ISO 11484 corresponds to levels I, II and III in ASNT SNT-TC-1A

2. Methods of Inspection

Location of NDT equipment in the manufacturer's facility shall be such that final inspection of weld seam of pipe shall be performed after hydrotesting.

2.1 AUT of HR Coil / Pipe Body

AUT of HR Coil / Pipe Body shall be as per the requirement of ISO 10893-9 & the level of acceptance shall be U2. The entire width and length of the HR coil shall be 100% ultrasonically inspected including trimmed HR coil edge. HR coil shall be ultrasonically tested for laminations using an oscillating or straight running pattern of probes, so as to provide inspection coverage of at least 100% of the HR coil surface uniformly spread over the area.

Alternatively the pipe may be tested after welding of longitudinal seam by rotary ultrasonic testing of the pipe body. The coverage area shall be 100%. Acceptance limit, Calibration standard & Calibration frequency shall be as per QAP.

Locations showing indications above the acceptance limits may be re-examined by manual ultrasonic method. If no defects are located during re-examination, the original findings may be ignored. Additional scanning may be requested by Purchaser's Representative to check questionable areas.

2.2 Inspection of EW Weld Seam

AUT of Weld:

The full length of EW seam of each pipe after hydrotest shall be AUT tested in order to detect defects in EW seam. Locations showing indications above the acceptance limits shall be re-examined by manual ultrasonic method. Acceptance limit, Calibration standard & Calibration frequency shall be as per QAP.

Radiography (X-Ray) of weld:

The weld of the pipe shall be inspected by X-Ray method to detect defects as per API 5L. For first day production the frequency shall be 0.1% of each pipe of total weld length (Minimum 200 mm). During Regular production the frequency shall be 0.1% of the total weld length (Minimum spot length200 mm). The pipes for radiographic examination shall be randomly selected such that they suitable cover as many heats / lots. Owner's Representative / TPIA reserves the right to select the pipes for radiographic examination. The radiographic technique and acceptance criteria shall be as per API 5L.

Eddy current Test of weld:

The eddy current examination shall be carried out on each pipe for detecting significant imperfections during first day and regular production. Reference standard shall be one "1.6 mm radially drilled hole" at the centre. Calibration shall be performed twice in the shift (12 hours). Acceptance criteria shall be 100% reference standards.

2.3 Inspection of Pipe Bevel End

Manual UT of Pipe End:

The weld at any pipe ends not covered by automatic ultrasonic equipment shall be inspected by manual ultrasonic equipment with same sensitivity and capability as automatic equipment.

Full circumference of both ends of each pipe shall be 100 % manual ultrasonically tested over a circumferential width of at least 100 mm with angular probes to detect cracks.

Magnetic Particle Test of Pipe End:

All finished weld bevels face shall be MPI tested. Any imperfection detected on the weld bevel shall be cause for re-bevelling and the bevel re-inspected by 100% MPI.

The OD of the weld seam 100mm from both end shall be wet magnetic particle tested for surface breaking defects at a frequency of 10 pipe per shift (12 hours). If no indications are noted in the testing, then this frequency will be reduced to 5 pipe per shift.

Acceptance criteria & calibration standards for Magnetic Particle Test shall be as per API 5L.

Residual Magnetism

Measurement of residual magnetism shall be made using a Hall-Effect Gauss-meter or other type of approved calibrated instruments. The Gauss-meter shall be operated in accordance with the written instructions demonstrated to give accurate results. The accuracy shall be verified at least once each day of working.

Measurements shall be made on each end of a pipe.

As a minimum one reading shall be taken at each end of the pipe. It should be Maximum 15 gauss (Average of 4 readings) with no individual reading shall exceed 20 Gauss. Any pipe that does not meet the requirements stated above shall be rejected. Manufacturer shall be responsible for carrying out de-magnetization of any pipe, which shows residual magnetism in excess of the 25 gauss to the satisfaction of the owner‘s representative/ TPIA.

3. Ultrasonic and Electromagnetic Inspections

3.1 Equipment

All automatic ultrasonic equipment shall have an alarm device, which continuously monitors the effectiveness of the coupling. The equipment for the automatic inspection shall allow them localization of both longitudinal and transverse defects corresponding to the signals exceeding the acceptance limits of the reference standard. The equipment shall be fitted with a paint spray or automatic marking device and alarm device for areas giving unacceptable ultrasonic indications and probe de-coupling. All ultrasonic testing equipment shall be provided with recording device. In addition, an automatic weld tracking system shall be provided for correct positioning of the probes with respect to weld centre.

3.2 Ultrasonic and Electromagnetic Inspection Reference Standards

Reference Standards for weld seam:

The reference standard (calibration pipe) shall have the same specified diameter and wall thickness as specified for the production pipe being inspected and shall be of sufficient length to permit calibration of ultrasonic inspection equipment at the speed to be used in normal production. The reference standard (calibration pipe) shall also be of the same material, type and have the same surface finish as the pipe being inspected.

The reference standard for weld seam UT shall contain machined notches (Total 6 nos notch) /holes and as given below:

- One longitudinal inside notch of type N5 at the center & each edge of weld seam.
- One longitudinal outside notch of type N5 at the center & each edge of weld seam.
- Three 1.6 mm radially drill hole one at center & one at each edge of the weld.

Acceptance criteria for weld seam shall be 100% of reference standards.

Reference standards for coil / coil edge / pipe body:

The reference standard for coil body / pipe body shall contain machined slot width 6 mm & depth 0.5 t. slot shall be prepared for HR coil in full width and for pipe circumferential.

Reference standard for the ultrasonic inspection of coil edges (area adjoining weld seam) / pipe ends shall have 6.4 mm diameter FBH of a depth 0.5 t, where `t' is the specified wall thickness.

Acceptance criteria for coil / coil edge / pipe body shall be 100% of reference standards.

Calibration frequency for coil/ pipe body/ weld seam:

The calibration shall be performed at following intervals for UT of coil/ pipe body/ weld seam.

a. At the beginning of each operating shift (12 hours maximum).
b. At every four hours during each operating shift (12 hours maximum).
Or Every 50 pipes whichever is earlier.
c. Every time the running of the system gives rise to doubts on its efficiency.

If during the above calibration verification, it is found that the equipment has not functioned satisfactorily in the opinion of the Purchaser's Representative, all the pipes or skelp already inspected after the previous verification shall be inspected again at Manufacturer's cost.

4. Laminar imperfections in the pipe body of EW pipes

For EW pipe, ultrasonic inspection shall be used to verify that the the pipe body is free of laminar imperfections greater than those permitted by

a) ISO 10893-9 acceptance level U2, if such inspection is done prior to pipe forming
or
b) ISO 10893-8 acceptance level U3, if such inspection is done after seam welding

5. Disposition of pipes containing defects

The pipes having a thickness less than the minimum allowed in accordance with this specification, after repair by grinding shall be treated for disposition in accordance with clause (e) or (f) of E10 (annex –E) of API Spec 5L.

ANNEXURE – Q: PROCEDURE FOR HANDLING, STORAGE & TRANSPORTATION OF BARE & COATED PIPES

Manufacturer shall submit his handling, loading and unloading procedure for Owner/Consultant approval prior to production (number of layers, number of lateral supports etc.). All handling, storage, loading unloading shall be done in such a manner so as to prevent mechanical damage and corrosion. Loading onto or into rail, trucks, ships shall be done as per API RP5L1, API RP 5LW and API 5LT as applicable. The pipes stored or transported shall at all times be well supported to prevent deformation and give protection to pipe ends. The transportation for line pipe up to owner designated store is under Manufacturer scope as per API 5L.

1.0 HANDLING

Pipes shall be handled in safe & careful manner by skilled workmen to avoid damage due to impact/ jarring. The Manufacturer shall be responsible for any damage occurring to the pipes from unloading to reloading on the relevant transportation means.

• A description with calculation of the handling, storage and transportation procedures during the total manufacturing cycle (including pipe transportation to the final delivery on the site) shall be submitted by the manufacturer;

• Manufacturer shall also submit a description with calculation of long period (> 6months) strips storage procedure, including the number and spacing of bearing and the number.

1.1 Handling Equipments

Vacuum cranes, Mobile crane, Hydra, EOT cranes equipped with spreader bars, suitable slings, shackles and hooks lined / padded by Teflon/ rubber/ other cushioning material excluding brass, copper, bronze & any other copper alloy shall be used for handling/ transportation of pipes.

Spreader Bars, I-Beams and Hangers

I-Beams must be of adequate capacity & placed at the centre of the pipe i.e.20-28 Ft. (Approx. half the length of the pipe). Side hangers must be 8 to 12 Ft. long with eye holes to hook the slings. Hangers should be fixed to the barter beam with quarter pin to provide flexibility at the time of lifting.

Wire Slings / Webbing Slings

Wire Slings of sufficient length from the cranes hooks to the bars shall be at angle not less than l0° and not more than 45°. Alternatively, webbing slings of adequately capacity may be used.

Hooks

Portion of the hook's jaw clamping the bevelled edge of pipe shall be lined/ padded/ Bare with Teflon/ rubber/ other cushioning material excluding brass, copper, bronze & any other copper alloy.

Bevel End Protector

The bevelled end of pipes will be protected by metallic bevel end protector. The thickness of end protector ranges from 0.8 mm to 1.6 mm.

2.0 STACKING OF PIPES IN THE PIPE STORAGE YARD OF MANUFACTURER

a) Pipe should be stacked on sand rows covered with plastic sheet of thick gauge, sand to be free from stones and necessarily covered. Stacking should not be on bare ground.

b) Alternatively, pipes may be stacked on wooden sleepers.

c) No of support (Bearing) shall be minimum 2 rows.

2.1 Stacking Pattern

Stack should be slightly slopping to drain off rain water.

Stack should be in trapezoidal from to avoid collapsing.

Stack should be in a staggered pattern so that each pipe in the stack supported by full length of two pipes in the lower row. Minimum 2 nylon ropes will be applied on bare/coated pipes at both end of pipe. The diameter of nylon rope will be minimum 12 mm.

2.2 Stack Height

The pipe stack height in the yard is depended on pipe size & grade of steel pipe. This is calculated as per recommendation of API RP 5L1.

The static load stress is calculated by following equation:

$$\sigma_s = 0.2\sqrt{D}\,\frac{(nL)}{B}\,\frac{D}{t}\,ln\left(\frac{D}{2t}\right) \quad \text{for USC units}$$

$$\sigma_s = 9.05 \times 10^{-4}\sqrt{D}\,\frac{(nL)}{B}\,\frac{D}{t}\,ln\left(\frac{D}{2t}\right) \quad \text{for SI Units}$$

n = Stacking load factor which is the number of rows in the pipe load, whether provided with separator strips or nested,

L = maximum length of individual Pipe, ft (m).
B= effective number of bearing strips
D= specified OD of pipe, in. (mm),
t = specified wall thickness, in (mm)
$\ln\left(\frac{D}{2t}\right)$ = Natural logarithm of D/2t

Pipe stacking pattern on sand rows at pipe yard:
a. Width of the sand rows - 0.8 meter minimum
b. Distance between 2 sand rows- 20 feet minimum
c. Height of sand rows - 0.5 meter minimum
d. Width at bottom of sand raw - 1.0 M Min.

3.0 TRANSPORTATION

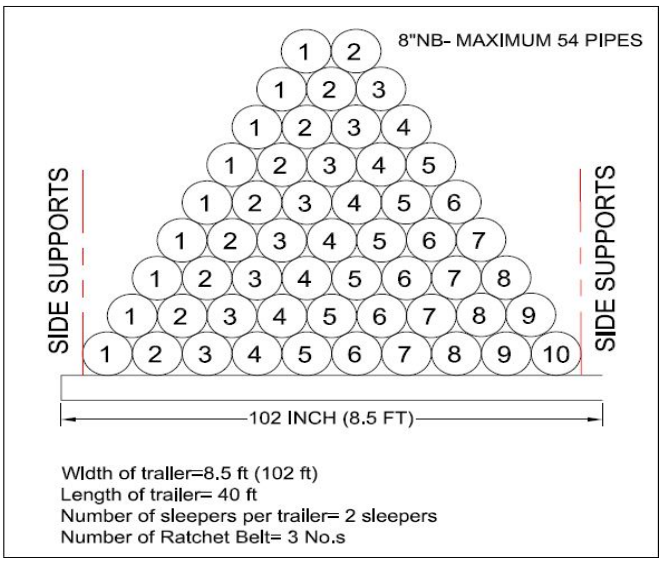
3.1 Trailers

3.1.1 Ideally low-bed trailers shall be used. In case of semi-low beds trailers, an even platform shall be created by placing a single block or log on the lower end of the trailer bed. Trailer should have a stopper facility.

3.1.2 The approximate size of the wooden sleepers shall be of 8.5' length x 6' width x 4' height or 8.5' length x 5' width x 4' height.

3.1.3 Number of Pipes loaded on each trailer shall be dependent upon the size and grade of steel pipe as per API 5L1.However same shall be proposed by Manufacturer i.e (trapezoidal/square) and same shall be finalized during approval of document

A typical stacking arrangement drawing has been shown below:



3.1.4 Safety procedure for transportation

a. If the manufacturer is responsible for the shipment of pipe, the manufacturer shall prepare and follow loading diagrams that detail how the pipe is to be arranged, protected and secured on trucks. The loading shall be designed to prevent end damage, abrasion, peening and fatigue cracking.

b. The trailer to be used for transportation must have provision of support on both sides and it should not be overloaded than its capacity.

c. The second layer and all following layers shall be separated from the other with adequate number of separating layers of protective material such as straw in plastic covers or mineral wool strips or equivalent, to avoid direct touch between the coated pipes.

d. Wooden dunnage shall be laid at approximately same interval. Soft material such as rubber sheet should preferably be applied between pipe and wooden dunnage.

e. The rubber protection must be free from all nails and staples where pipes are in contact.

f. Slings or non-metallic straps shall be used for securing loads during transportation. They shall be suitable padded at the contact points with the pipe.

g. Pipe shall be handled in a manner to prevent damage to the pipe and its coated surfaces. End hooks suitably radiuses and lined with plastic or similar approved material. A spreader bar shall be used between lifting lines. During handling, the pipe shall be prevented from impacts or jars.

h. Wire ropes shall not be used in direct contact to lift pipes. Minimum 3 ratchet belts or tube chains will be placed.

3.1.5 Dispatch Clearance Procedure

Seller shall obtain dispatch clearance from the Owner/Consultant prior to each dispatch.

Copy of Inspection Release note, Dispatch Clearance and Statement showing the name of vessel, description and weight of material and shipping mark etc. to be submitted along with the documents.

ANNEXURE - R: REQUIRMENTS OF STENCILING MARKING & BAR CODE FOR 3LPE / BARE PIPE

1.0 PURPOSE

The purpose of this annexure is to ensure the identification of pipes through barcode label

2.0 SCOPE

This procedure defines to identify the pipes through barcode label scanning. This procedure covers the application of 2D type bar code and pipe marking on Bare Pipe and 3LPE coated pipes after the final coating of bare pipes. Bar code to be applied after clearance from TPIA upon final acceptance of external coated pipes/Bare pipe. Barcode should have pipe NO. Type (3LPE /ERW), Coat No., Dia., Unit, Length, Wall thickness, heat No. and item code. TPIA shall verify barcode with hand held barcode reader during inspection of pipe for final dispatch at pipe mill.

3.0 METHOD

3.1 Procedure For Bar Coding of Bare Line Pipe and Externally Coated ERW Line Pipe.

3.1.1 On Bare / External 3LPE Coated Pipes

Pipe marking (stencil) shall be made from both end (one inside & one out side) of the pipe opposite to the weld line. Pipe no shall be printed on barcode at the bottom. Manufacturer has to ensure physical correction of the pipe as per stencil & barcode before applying barcode. One 2D type barcode sticker shall be pasted at an angle of 180° from the stencil side at a distance of 200 mm from the cutback area.

1. For details refer figure-A for pipe marking and bar coding procedure on the outside pipe surface.
2. In case any unfit pipes found for coating or for any reason pipes are cut, the actual length of pipe shall be given in barcode sticker.

3.1.2 Printing of Barcode Labels

The barcode labels will be printed at the time of final inspection (label size 2”x 4”) and will be printed by using printer. The pipe number and other details will be taken from the Final Visual and Dimension inspection report system. The label shall have details as per Client/TPIA. The barcode and item code as per sample attached. The label details contains PIPE No, Coat No .ASL No, Item Code up-to 10 Digit Max.

SAMPLE PIECE OF BARCODE LABEL PIPE NO : XXXXXXXXXX TYPE : 3LPE/ERW HEAT NO : XXXXXXX

COAT NO : XXXXXXXXXX DIA : XX INCH LENGTH : 12.05 M W. THICKNESS : XX MM ITEMCODE : XXXXXXXXXX

The barcode standard is symbology and the paper material used is 2D and tear-able.

3.1.3 Fixing Of Labels on Pipes

Ensure that the surface area in which labels are pasted should be clean, dry and free from dust. For each pipe four (2) labels shall be fixed, one for each end at one inside & one outside (fixed approx. 200 mm from the cutback / bevel area and 180° on each end). All bar code shall be oriented perpendicular to the weld seam. The barcode label shall be put on completely finished pipe. Barcode label should not be overlapped with stencilling or any other marking outside coated pipe. (i.e. external coated pipe surface).

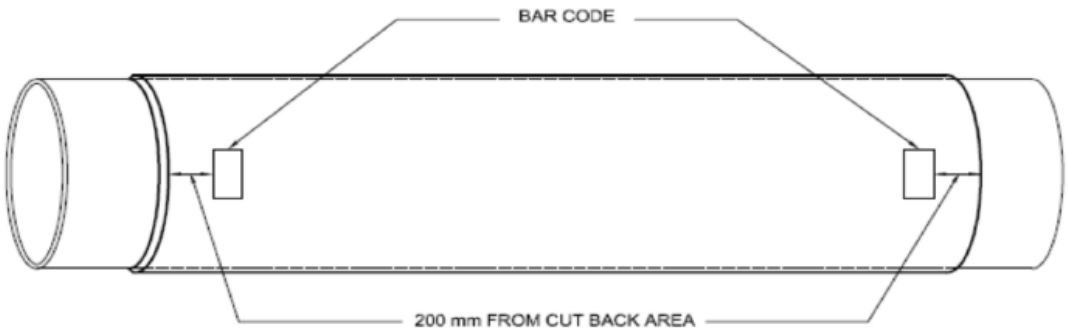
3.1.4 Verification of Barcode Labels

At the time of dispatching of pipes, QC personnel shall verify the barcode labels visually. If the barcode labels found damaged, missing or illegible for the purpose same shall be replaced by new one and applied as described in clause 3.1.1 & 3.1.2.

3.1.5 Scanning Of Barcodes

The barcode can be read by scanning the codes by scanner provided by supplier at pipe mill. When the code is scanned the pipe number will be visually seen on the scanners monitor and same will be saved in its memory. The full details of the pipe can be obtained by connecting the computer with the scanner having database for these pipes.

FIGURE –A (OUTSIDE SURFACE –ON EXTERNAL COATED PIPE)



FIGURES

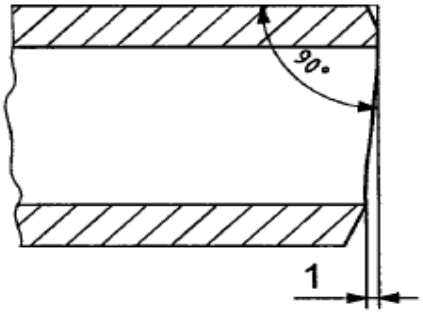


FIG 1: OUT OF SQUARENESS

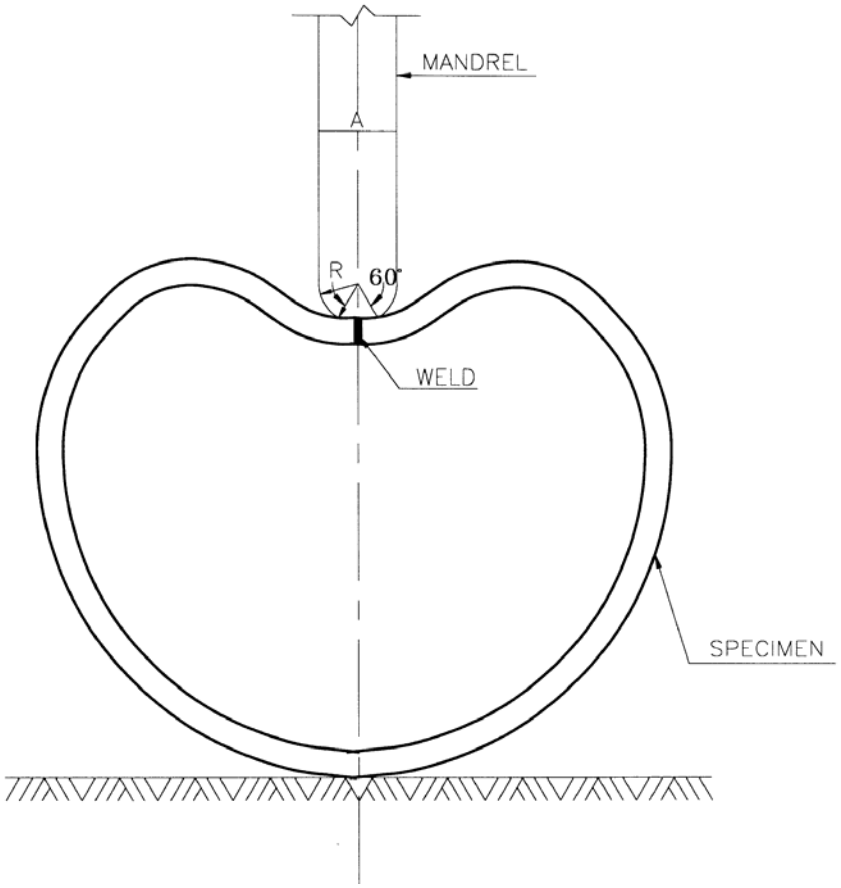
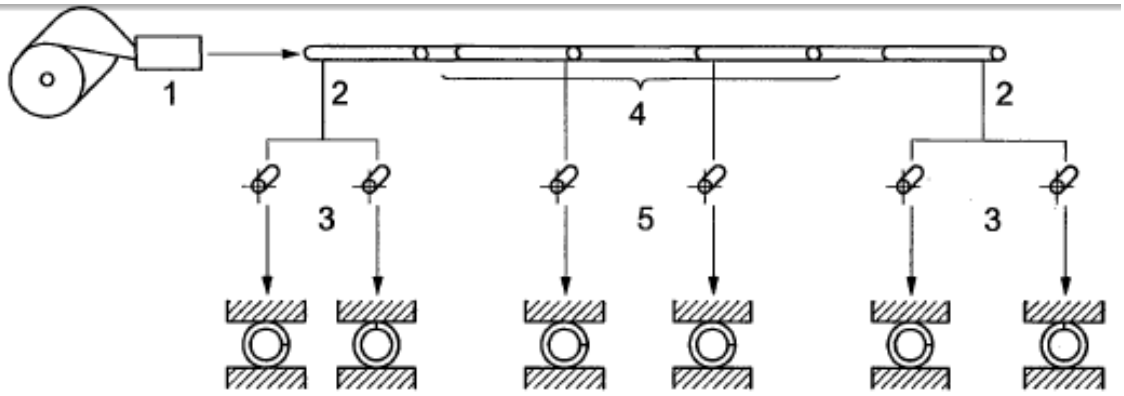


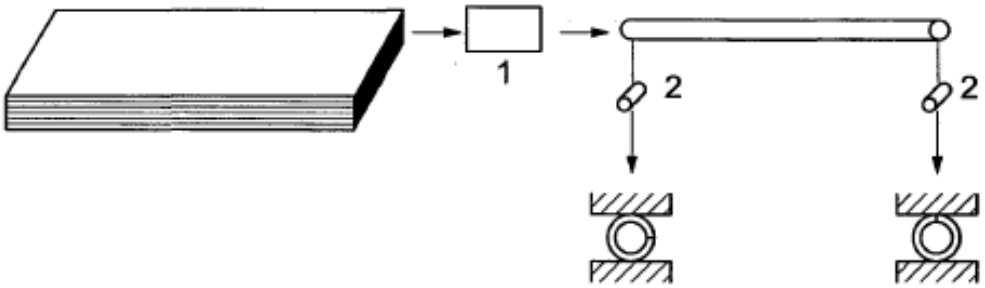
FIG 2 : REVERSE BEND TEST



Key

1 welding
2 coil end
3 two test pieces from each coil end
4 weld stop
5 two test pieces, one from each side of the weld stop

a) EW pipe in grades ⩾ L245 or B and LW with D < 323,9 mm (12.750 in) — Non-expanded, produced in multiple lengths



Key

1 welding
2 two test pieces, one from each pipe end

b) EW pipe in grades ⩾ L245 or B — Non-expanded, produced in single lengths

Key

1 test unit of ⩽ 50 tonnes (55 tons) of pipe
2 one test piece, from one pipe end

c) EW pipe in grades L175, L175P, A 25 or A 25P with D ⩾ 73,0 mm (2.875 in)

Key

1 test unit of ⩽ 100 lengths of pipe
2 one test piece, from one pipe end

d) EW pipe in grades ⩾ L245 or B and LW pipe with D < 323,9 mm (12.750 in) — Cold expanded

FIG 3: FLATTENING TEST

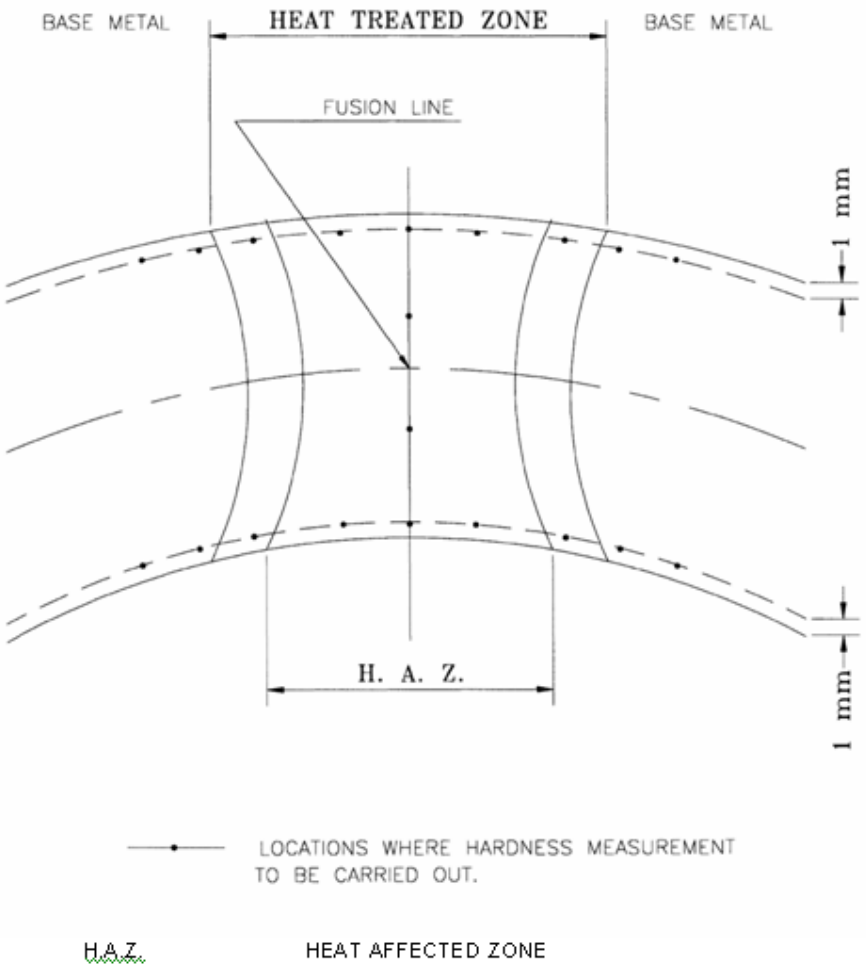


FIG 4: LOCATIONS FOR HARDNESS MEASUREMENT

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR 3LPE COATING FOR LINE PIPE

GAIL-STD-PL-DOC-TS-019

0	13.01.2019	Issued for Tender	AP	IR	SB

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1.0 GENERAL

- **Definitions**

  For this specification the following definitions shall apply:

  OWNER/PURCHASER - GAIL INDIA LIMITED

  CONSULTANT - Lyons Engineering Pvt. Ltd

  CONTRACTOR–Line pipe Manufacturing Company.

  SHALL/MUST/IS TO BE - A mandatory requirement

  SHOULD - A non-mandatory requirement, advisory or recently Amended

- **Abbreviations**

  ASTM - American Society for Testing and Materials

  BS - British Standards

  DIN - Deutsche Industry Norman

  FBE - Fusion Bonded Epoxy

  ISO - International Organization of Standardization

  NACE - National Association of Corrosion Engineers

  SSPC - Steel Structures Painting Council

2.0 SCOPE

This specification defines the minimum technical requirements for the application of three layerpolyethylene coating (3LPE) to the external surface of the pipe for buried service which operates under design temperature from -20°C to +65°C. The extruded polyethylenecoatingshall be confirming to DIN 30670 (latest edition).
In case, Applicator/ Contractor feels more stringent testing shall be followed to meet all testing requirements of this specification, then Applicator/ Contractor is free to do such stringent testing including equipment calibration etc.

3.0 CODES, REGULATIONS AND STANDARDS

The latest edition of the following codes and standards shall establish the minimumstandards for the work.

- DIN 30670 Polyethylene Coatings for Steel Pipes and Fittings

- ISO 21809-1:Petroleum and Natural Gas Industries-External Coatings for buried and submerged pipeline transportation systems-Part 1:Polyolefin Coatings
- ISO 21809-2: Petroleum and Natural Gas Industries-External Coatings for buried and submerged pipeline transportation systems-Part 2: Fusion bonded epoxy coatings
- API 5L Specification for line pipe.
- API RP 5L1 Recommended Practice for Railroad Transportation of Line Pipe
- ASTM D 638 Test Methods for Tensile Properties of Plastics
- ASME B31.8 Gas Transmission and Distribution Piping Systems
- ASTM D-257 Standard Test Methods for D-C Resistance or conductance of insulating materials.
- ASTM D-543 Standard method of Test for Resistance of Plastics to Chemical Reagents
- ASTM D-570 Standard Method of Test for Water Absorption of Plastics
- ASTM D-792 Standard Test method for Specific Gravity and Density of Plastics by Displacement.
- ASTM G95 Test Method for Cathodic Disbonding of Pipeline Coatings
- ASTM D-1603 Standard Test Method for Carbon Black Content in Olefin Plastics
- ASTM D-257 Standard Test Methods for DC Resistance or Conductance of Insulating Materials
- ASTM D-792 Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
- ASTM G42 Tentative Methods for Cathodic disbonding of Pipeline Coatings Subjected to Elevated or Cyclic Temperatures.
- ISO 9001:2015 Quality Management System
- ISO 8501-1 Preparation of Steel Substrates before Application of (Part 1) Paints and Related Products – Rust Grades and preparation grades uncoated steel substrates and of steel substrates after overall removal of previous coatings.
- ISO 8502–3 Preparation of steel substrates before application of paints and relatedproducts Tests for the assessment of surface cleanliness - Part 3: Assessment of dust on steel surfaces prepared for painting (pressuresensitive tape method)
- ISO 8503-1 Preparation of steel substrates before application of paints and related products Surface roughness characteristics of blast-cleaned steel substrates Part 1: Specifications and definitions for ISO surface profile comparators for the assessment of

abrasive blast-cleaned surfacesEN 10204 Test Certificates for Stainless Steel ProductsSIS 055900 Preparation of Steel Substrates before Application of Paints and Related Products – Visual Assessment of Surface Cleanliness.

- BS 5750 Specification for Final Inspection and Testing (Part 3)
- DIN 53735 Testing of Plastics: Determination of Melt Index of Thermoplastics
- CSA Z245.20 External Fusion Bond Epoxy Coating for Steel Pipe

The Manufacturer shall be familiar with the requirement of these documents and shall make them readily available at the coating plant to all persons concerned with carrying out the works specified in this specification.

4.0 DOCUMENT PRECEDENCE

In case of inconsistency/ discrepancy/ mismatch, if any, between QAP, RFP and/ or addendum,reference codes/standards and this specification, more stringent shall prevail and as directed byowner shall be adopted. However, the requirements specified in final approved QAP for quantum of check, acceptance criteria for tests shall be followed.

5.0 PLANT SCALE AND INSTALLATION

Coating plant(s) geometry and dimensions are such as to allow the execution of a continuouswork schedule. Vendor shall install requisite equipment and plant in roofed and adequately weather - protected areas. Plant equipment, machinery and other facilities shall be in first class operating condition to at least meet the job requirements of quality and production. Worn out and improvised plants are not acceptable.

Vendor shall have fully equipped laboratory and test facilities with adequate inventory to carry out tests required for the procedure qualification and during regular production. However during PQT in addition to internal lab testing, all batches raw materials per manufacturer shall be tested at external NABL laboratory or equivalent laboratory and will submit the test results for review of owner / consultant.

Manufacturer shall, at his own responsibility and cost, provide and prepare all necessary area for the storage of bare and coated pipe and all other materials, for coating yard, stock- piling and other temporary installation. For each area, manufacturer shall provide necessary agreements as required with the land owner(s)/relevant Authorities, and, on work completion, to clean and pay settlement and claims for damages, as applicable.

Manufacturer shall at its own responsibility and cost, provide for water and power supply and other utilities and consumables and obtain authorization regarding access roads and other permits required for the execution of works conforming to all the requirements of the governing Authorities.The Contractor shall be fully responsible for adherence to all statutory regulations applicable for handling and disposal of the hazardous chemicals during the coating works.

6.0 MATERIALS AND APPLICATION

The Contractor shall submit a detailed written description of the coating equipment, procedure and materials for OWNER's / CONSULTANT's review. The description shall be accompanied by full details and results of tests on similar coating, or trials performed by Contractor. Such test results and / or trails shall demonstrate, to the satisfaction of OWNER / CONSULTANT. Contractor's equipment, procedures and materials shall provide a finished coating, meeting the requirements of this specification. The 3LPE coating system shall comprise of a powder epoxy primer, polymeric adhesive and a polyethylene topcoat. Coating materials shall be suitable for the service conditions and the pipe sizes involved. The coating materials i.e. epoxy powder; adhesive and polyethylene compound shall have proven compatibility. The coating system and materials shall be pre-qualified and approved by Owner/Consultant in accordance with provision of **Annexure-I**&**Annexure-II** of this specification.. Manufacturer shall obtain prior approval from Owner for the coating system and coating materials.

Contractor shall choose brand of epoxy powder, adhesive Polyethylene as per **Annexure-II** that will achieve the functional requirements and properties of coating system as specified in this specification.

In addition to Manufacturer’s certificate, the Contractor shall draw two samples for following properties from each batch of epoxy, adhesive and polyethylene per manufacturer in the presence of Owner/ClientRepresentative. One sample for internallab andone sample for external NABL laboratory or equivalent laboratory to establish compliance with the Manufacturer’s test certificates. Testing in internal lab & external lab shall be witness by TPIA and the test result will submit toowner / consultant for review. External lab testing of Raw material is only required for PQT.

A. EPOXYPOWDER:

i. GelTime
ii. Curetime
iii. Moisturecontent
iv. Thermal Characteristics (Tg1, Tg2, H)
v. Density

B. ADHESIVE:

i. SpecificGravity
ii. Melt FlowRate
iii. Vicat SofteningPoint
iv. Moisturecontent

C. POLYETHYLENE:

i. Melt FlowRate
ii. SpecificGravity
iii. Vicat SofteningPoint
iv. MoistureContent/Water absorption (24h at +25’C)
v. Oxidative InductionTime
vi. Hardness
vii. Tensile strength
viii. Ultimate Elongation

In case of failure of any of the above tests in a batch, that batch of material shall be tested for all other tests required as per Clause no 8.1 8.2 & 8.3 including the tests which failed. If all tests pass, the batch shall be accepted for coating. If any of the tests fail, entire batch of material shall be rejected and shall not be used for the coating.

All packages of powder shall be marked with the following data as a minimum.

- Manufacturer
- Material identification
- Type of Material and Data sheet
- Shelf life
- Receiving Inspection Acceptance
- Instruction of application procedure with key parameters
- Batch number
- Place and date of manufacture
- Expiry date
- Healthy safety and environment instructions
- Storage instructions

Material not supplied with the above information shall not be used.

Manufacturer shall ensure that all coating materials are properly stored in accordance with the Manufacturer's recommendation at all times, to prevent damage and deterioration in quality prior to use.

Manufacturer shall be required to use all materials on a date received rotation basis, i.e. first in -first used basis.

7.0 FUNCTIONAL REQUIREMENTS

The coating shall be able to withstand a maximum in service operating temperature of (+) 65°C and shall conform to 'S' Type of coating as per DIN 30670. In addition, in open storage the coating must be able to withstand a temperature of at least (+) 80°C, without impairing its serviceability and properties specified.

The coating materials used shall be fully stabilized against influence of ultraviolet radiation(i.e. sunlight), oxygen in air and heat (due to environmental temperature as specified above).No appreciable changes shall occur during exposure to such environment for service life of40 years. The Contractor / Vendor shall submit certificate from Manufacturer in this regard.

The topcoat polyethylene used shall be a black readymade compound, fully stabilized against influence of ultraviolet radiation (i.e. sunlight), oxygen in air and heat (due to environmental temperature as specified above). No appreciable changes shall occur during exposure to such environments up to at least a period of 6000 hours. The coating manufacturer shall submit certificate from Manufacturer in this regard.

The manufacturer's trade name and data sheets for each coating material proposed by thecontractor shall be submitted for OWNER / CONSULTANT approval prior to the placing of any order for coating work.

All materials noted to be without above identification shall be deemed suspect and shall berejected by Owner. Such materials shall not be used for coating and shall be removed fromsite and replaced by manufacturer at his expense.

8.0 PROPERTIES

Properties of coating system and coating material shall comply the requirements indicated in subsequent paragraphs. In case the coating / material properties are tested as per test methods/standards other than specified herein below, the same may be accepted provided the test procedures and test conditions are same or more stringent than the specified.

8.1 EPOXY POWDER

Contractor shall choose brand of epoxy powder and adhesive as per **Annexure-II** that will achieve the functional requirements and properties of coating system as specified in above clauses of this specification.

Each Epoxy batch shall be accompanied by a certificate (EN 10204 TYPE 3.2) stating thefollowing tests have been carried out on every batch and results are in accordance with the manufacturer's product specifications:

- Sieve analysis
- Gel time
- Infrared scan
- Density
- Moisture content
- Thermal analysis
- Cure Time

8.2 ADHESIVE

The adhesive layer shall be polyethylene copolymer, which shall provide sufficient adhesion between the FBE corrosion coating and the polyethylene coating. The adhesive layer shall have the following characteristics:

Sl. No.	Properties	TEST METHOD	UNIT OF MEASUREMENT	LIMITS
a.	Melt Flow Rate (190°C / 2.16 kg)	ASTM D 1238	G/10 min.	1.0 (Min.)
b.	Vicat Softening Point	ASTM D 1525	Deg. C	100 min.
c.	Tensile yield strength at 23eg.C.	ASTM D 1238	Mpa	>8
d.	Ultimate elongation at 23Deg. C	ASTM D 638	%	≥600
e.	Specific Gravity at 25'C	ASTM D 792	G/cm3	0.926 min.
f.	Melting Point	ASTM D-3417	°C	>127
g.	Moisture content	ISO 15512	%	≤0,1
h.	Hardness			As per manufacturer recommendation

8.3 POLYETHYLENE MATERIAL

The polyethylene shall be suitable for use up to design temperatures of the pipeline and suitable for a 3-layer coating system, and shall match the following properties.

Sl. No.	Properties	Unit	Requirement	Test Method
a.	Tensile Strength @ + 25 °C	N/mm^2	17 min.	ASTM D 638
b.	Melt Flow Rate (190°C / 2.16 kg)	g/10 minutes	0.25 min.	ASTM D 1238 or DIN 53735
c.	Specific Gravity @ + 25 °C	-	0.941 min.	ASTM D 792
d.	Hardness @ + 25 °C	Shore D	55 min.	ASTM D 2240
e.	Water Absorption, 24 hours, @ + 25 °C	%	0.05 max.	ASTM D 570
f.	Volume Resistivity @ + 25°C	Ohm-cm	10^{15} min.	ASTM D 257
g.	Dielectric withstand, 1000 Volt/secrise @ + 25 °C	Volts/mm	30,000 min.	ASTM D 149
h.	Vicat Softening Point	0 C	110 min.	ASTM D 1525
i.	Elongation at 25+-2 °C	%	600 min.	ASTM D 638
j.	Oxidative Induction Time in Oxygen at 220°C, Aluminum pan, no screen	Minutes	10	ASTM D3895
k.	Environmental Stress Crack Resistance (ESCR) (for F_{50}) Medium Density [Condition"C"] High Density[Condition"B"]	Hours	 300 300	ASTM D1693
l.	Carbon Black Content	%	2 min.	ASTM D 1603
m.	UV resistance and thermal ageing resistance	%	ΔMFR ≤ 35	DIN 30670
n.	Melting Point	°C	125	ASTM D 2117
o.	Moisture Vapour Transmission	gm/24 hrs./sq.m.	0.8 maximum	ASTM E-96

Test Certificate from PE manufacturer shall be submit for No appreciable changes due to Ultraviolet radiation, Oxygen in air and heat for at least 6000 Hours.

8.4 COATING SYSTEM

Sl. No.	Properties	Unit	Requirement	Test Method
a.	Bond Strength (using Type 2 Test Assembly i.e. Dynamometer) @ 20 +/-5°C @ 65 +/-5°C	kg/cm	 8.0min 5.0min	DIN 30670
b.	Impact Strength (Min. of 30 impacts on body alongthe length. No breakdown allowed when tested at 25 KV)	Joules per mm of coating thickness	7 min	DIN 30670
c.	Indentation Hardness @ 23 +/-2°C @ 70 +/-2°C	mm	 0.2 max 0.3 max	DIN 30670

d.	Elongation at Failure	%	300 min.	DIN 30670
e.	Coating Resistivity (*)	Ohm – m^2	10^8 min.	DIN 30670
f.	UV resistance& Thermal ageing resistance	-	ΔMFR ≤ 35	DIN 30670
g.	Cathodic Disbondment @ +23 °C after 28days:-1.5 V @ +65 °C after 48hrs: -3.5V	mm radius of disbondment (**)	≤ 7mm	DIN 30670
h.	Flexibility		No cracking at an angle of 2°per pipe perdiameter length.	ISO 21809-1 Annexure I
i.	Holiday Detection at 25kV		No Holiday	
j.	Hot water Immersion test	mm	Average ≤ 2 And maximum ≤ 3	ISO 21809-1 Annexure M
k.	Degree of Cure of Epoxy Percentage Cure, Tg	% °C	95 ≤ 5	DIN 30670 ISO 21809-1

Notes:

(*) Test carried out in an independent laboratory of national/international recognition on PE topcoat is also acceptable.

(**) Disbondment shall be equivalent circle radius of total unsealed area as per ASTMG42.

9.0 MEASUREMENT AND LOGGING

Contractor shall maintain records in computer using MS ACCESS database Software containing all the relevant data of individual pipe and pipe coating including pipe number, heat number, diameter, length, wall thickness, defects, coating number, batches of materials, sampling, testing, damages, repairs, rejects and any other information that Owner/ Client considers to be relevant and required for all incoming bare pipes and Owner/ Client approved outgoing coated pipes as applicable. Contractor's documentation shall be designed to ensure full traceability of pipe and coating materials through all stages of coating and testing. Contractor shall submit this information in the form of a report at the agreed intervals. The above data shall also be provided in MS ACCESS format as well as in excel format and 2 Nos Compact Disc (CD)/ USB drive. Contractor shall provide one Computer Terminal to Owner/ Client Representative for monitoring/tracking of the above. The Contractor shall also submit the material balance details to Owner/ Client for information at the end of eachshift.

10.0PIPE SURFACE PREPARATION

Unless specified otherwise, the pipes shall be supplied free from mill applied oils but may be subject to contamination occurring during transit.

Prior to cleaning operation, Contractor shall visually examine the pipes and shall ensure that all defects, flats and other damages have been repaired or removed. The manufacturer shall also remove marking stickers, if any, present within the pipe. Record shall be kept of such marking on the stickers to ensure traceability of pipe after coating.

Any oil, grease, salt or other contaminants detrimental to the formation of a good coating bond or coating quality shall be removed prior to coating application. Contaminants may be removed by the use of non-oily solvents. Gasoline or kerosene shall not be used for this purpose. Visible oil and grease spots shall be removed by solvent wiping. Solvent cleaning shall be in accordance with SSPC-SP1. Steel surface shall be allowed to dry before abrasive cleaning.

All pipes shall be preheated to a temperature of 65°C to 85°C prior to abrasive blast cleaning. The external surface of the pipe shall be cleaned using 2 no. dry abrasive blast cleaning units to achieve the specified surface cleanliness and profile.

The abrasive blast cleaning units shall have an effective dust collection system to ensure total removal of dust generated during blast cleaning from the pipe surface. During abrasive blast cleaning, the metallic abrasive shall be continuously sieved to remove “fines” and “contaminants” and the quality checked at every four hours. Abrasives used for blast cleaning shall comply ISO-11124.

Suitable plugs shall be provided at both pipe ends to prevent entry of any shot/grit into the pipe during blast cleaning operations. These plugs shall be removed after blast cleaning. Alternatively the Contractor may link the pipes suitably together to prevent the entry of any short/grit into the pipe.

Chemical Pre-treatment with Phosphoric Acid Solution

All pipes shall be provided chemical pre-treatment with phosphoric acid solution. 10% solution of phosphoric acid, Oakite 31 / 33 or equivalent, shall be used to remove all soluble salts and other soluble contaminants.

The Applicator/ Contractor shall provide data sheets and supporting documentation for the phosphoric acid to be used. The documentation shall verify that the phosphoric acid is suitable for the treatment of line pipe prior to the application of the specific fusion bonded epoxy powder being applied and the final coating will meet fully the requirements of this specification.

The pipe temperature immediately prior to the phosphoric acid treatment shall be in the range of 45 to 75 °C. Phosphoric acid treatment shall be followed immediately by washing with deionised water. De-ionised water used shall conform to the following requirements:

a. Turbidity NTU 1 max.

b. Conductivity µmho/cm 5 max.

c. Hardness - Nil

d. Total Alkalinity as CaCO3 mg/l 2 to 3

e. Chloride as Cl- mg/l 1 max.

f. Sulphate as SO4 = mg/l 1 max.

g. pH - 6.5 to 7.5

Tests to determine the above properties shall be carried out in accordance with “Standard Methods for the Examination of Water and Wastewater” published jointly by American Public Health Association, American Water Works Association and Water Pollution Control Federation.

Quality of the deionised water shall be monitored at the start of each shift and at every four hours interval. Non-compliance of de-ionised water w.r.t. the above requirements shall cause stoppage of the operations.

The pH of the pipe surface shall be determined both before and after the de-ionised water rinse initially on each pipe and in case of consistent results, the frequency may be relaxed to once per hour at the discretion of Owner's Representative. The measured pH shall be as follows:

Before de-ionised water wash: 1 to 2

After de-ionised water wash: 6 to 7

After the de-ionised water wash, the pipe shall be dried with dry air and preheated to a temperature of 65°C to 85°C.

The salt tests shall be carried out after de-ionised water rinse. One test shall be carried out at one end of each pipe. The acceptance criteria shall be 2µg/cm2. An approved salt meter (SCM 400 or equivalent) shall be used to carry out salt tests and shall be calibrated in accordance with the equipment manufacturer's recommendations.

All pipes shall be tested for salt contamination after blast cleaning unit. One test shall be carried out on one end of pipe. The acceptance criteria shall be 2 µg/cm². An approved salt meter (SCM 400 or equivalent) shall be used to carry out salt tests and shall be calibrated in accordance with the equipment manufacturer's recommendations. Any pipe having salt contamination exceeding 2 µg/cm² shall be either reblasted or deionised water washed and then rechecked for salt contamination. In case salt level less than 2µ g/cm² is consistently achieved, the frequency of salt contamination testing may be relaxed to at least one pipe per hour at the sole discretion of the Owner Representative.

Abrasive cleaning carried out shall be such that the resultant surface profile is not dished and rounded when viewed with 30X magnification. The standard of finish for cleaned pipe shall conform to near white metal finish to SA 2 ½ of ISO 8501-1. Surface of pipe after abrasive blast cleaning shall have an anchor pattern of 50 to 80 microns (RZ). This shall be measured for each pipe by a suitable instrument such as surface profile depth gauge. In addition the pipe surface after blast cleaning shall be checked for the degree of cleanliness (SA 2½), degree of dust and shape of profile. Degree of dust shall comply the requirements of ISO 8502 – 3. Acceptance limit shall be either quality rating 2 or Class 2. Tape used for assessment of degree of dust shall comply IEC 60454-2. Pressure shall be exerted on the applied tape using a 4 kg roller, prior to peeling-off to assess the degree of dust.

All pipes shall be visually examined for presence of any shot/grit/loose material left inside the pipe during blast cleaning. Suitable mechanical means (stiff brush) shall be employed to remove the same before the pipes are processed further. In addition, inside surface of the pipe shall also be visually inspected for presence of any foreign material or shots and grit (free or embedded/sticking to pipe inside surface). The pipe inside surface shall be examined using sharp floodlight focused at the middle of the pipe at one end while inspection is carried out visually from other end. Any foreign material or shots/grit present in the pipe shall be completely removed by mechanical brush, high pressure air jets, by tilting of pipe, etc.

At no time shall the blast cleaning be performed when the relative humidity exceeds 85%. The Contractor shall measure the ambient conditions at regular intervals during blast cleaning and coating operations and keep records of prevailing temperature, humidity and dew point.

The blast cleaned surface shall not be contaminated with dirt, dust, metal particles, oil, water or any other foreign material, nor shall the surface or its anchor pattern be scarred or burnished. All blast cleaned pipe surface shall be kept in dust free enclosure prior to coating. After blast cleaning, all surfaces shall be thoroughly inspected under adequate lighting to determine anchor pattern, quality of blasting and identify any surface defects prior to coating application.

All surface defects such as slivers, scab, burns, laminations, welds spatters, gouges, scores, indentations, slugs or any other defects considered injurious to the coating integrity made visible during blast cleaning shall be reported to the OwnerRepresentative and on permission from Owner Representative, such defects shall be removed by filing or grinding. After any grinding or mechanical repairs, the remaining wall thickness shall be checked and compared with specified thickness. Any pipes having thickness less than minimum specified thickness shall be kept aside and disposed off as per the instructions of Owner Representative. The method employed to remove surface defects shall not burnish or destroy the anchor pattern or contaminate the surface. Pneumatic tools shall not be used unless they are fitted with effective air/oil and water traps. Where burnishing results in destruction of anchor pattern, the anchor pattern shall be restored by suitable means. Pipes that have damages repaired by grinding and have ground areas more than 50mm in diameter shall be re-blasted.

Any dust or loose residues that have been accumulated during blasting and/or during filing/grinding operations shall be removed by vacuum cleaning.

If contamination of surface occurs, the quality of blast cleaning method and process shall be examined. If the surface roughness is outside the specified limit, the blast cleaning material shall be checked and replaced.

Upon Completion of the blasting operations, the quality control supervisor shall accept the pipe for further processing or return for re-blasting after removal of defects/imperfections. In case imperfections are considered detrimental to the coating quality, the same shall be reported to Owner's Representative for final decision on rejection or re- blasting/removal of defects. Re-blasting/removal of defects or returning pipe to the yard shall be at the Contractor's cost.

Owner's Representative, in additions, reserves the right to initiate any of the above actions during periodic inspections for oil, dust, salt, imperfections, surface defects, lack of white metal finish, etc.

In order to ensure that pipe with defects are not processed further, provisions shall be available to lift the pipes from inspection stand.

Chemical Pre-treatment with Chromate Solution

Following completion of abrasive blast cleaning, all pipe surface shall be chemically pre-treated with a 10% strength chromate solution.

The Applicator/ Contractor shall provide data sheets and supporting documentation for the chemical to be used. The documentation shall verify that the chemical is suitable for the treatment of line pipe prior to the application of the specific fusion bonded epoxy powder being applied and the final coating will meet fully the requirements of this specification.

The chemical pre-treatment shall be applied fully in accordance with the chemical suppliers' instructions and in a manner that ensures 100% uniform coverage of the pipe surface without introducing surface contamination.

The Applicator/ Contractor shall check that the concentration of the chemical pre-treatment solution remains within the range recommended by the chemical manufacturer for the pipe coating process. The concentration shall be checked at the make up of each fresh solution and once per hour, using a method approved by the chemical manufacturer. The Applicator/ Contractor shall also ensure that the chemical pre-treatment solution remains free from contamination at all times. Recycling of chemical pre-treatment solution is not permitted.

The Applicator/ Contractor shall ensure that the temperature of the substrate is maintained between 40°C and 80°C and the chromate solution temperature does not exceed 60° or as recommended by the manufacturer.

The chromate coating shall be smooth, even, free from runs, drips or excessive application and lightly adherent with no flaking of the coating. The chromate coated steel must be thoroughly dried immediately after application and shall be achieved by boiling off any residual solution on the surface.

The total allowable elapsed time between completion of the blasting operations and commencement of the pre-coating and heating operations shall be such that no detectable oxidation of the surface occurs. Relative humidity readings shall be recorded every half an hour during the blasting operations in the immediate vicinity of the operations. The maximum elapsed time shall not exceed the duration given below:

Relative Humidity %	Maximumelapsed time
> 80	2 hours
70 to 80	3 hours
< 70	4 hours

Any pipe not processed within the above time-humidity requirement shall be completely re- blasted. Any pipe showing flash rusting shall be re-blasted even if the above conditions have not been exceeded. The dew point shall be 3°C less than the pipe temp. & RH should be less than 85%.

Pipe handling between abrasive blasting and pipe coating shall not damage the surface profile achieved during blasting. Any pipe affected by the damage to the surface exceeding 200mm² in area and/or having contamination of steel surface shall be rejected and sent for re- blasting.

11.0COATING APPLICATION

The external surface of the cleaned pipe conforming to clause 10.0 of this specification shall be immediately coated with 3-layer extruded polyethylene coating in accordance with the procedures approved by Owner relevant standards and this specification. In general the procedure shall be as follows:

11.1 Pipe Heating

Immediately prior to heating of pipe, all dust and grit shall be removed from inside of the pipe by a combination of air blast, brushing and vacuum cleaning. Suitable arrangement shall be made to protect the bevel ends from getting damaged during the coating operation.

Induction heater or gas fired heating shall be used for heating the pipe. The method shall be capable of maintaining uniform temperature along the total length of the pipe, and shall be such that it shall not contaminate the surface to be coated. In case of induction heating, appropriate frequency shall be used to ensure 'deep heating' and intense skin heating is avoided. Gas fired heating system shall be well adjusted so that no combustion products are deposited on the steel surface. This shall be demonstrated on bare pipes prior to start of PQT. Oxidation of the cleaned pipe surfaces prior to coating (in the form of blueing or other apparent oxide formation) is not acceptable.

External surface of the pipe shall be heated to about 190 °C or within a temperature range (min. to max.) as recommended by the powder manufacturer. Required pipe temperature shall be maintained as it enters the coating chamber.

Temperature of the pipe surface shall be continuously monitored & recorded by using suitable instruments such as infrared sensors, contact thermometers, thermocouples etc. The recording method shall allow to correlate each linepipe. The monitoring instrument shall be able to raise an alarm/activate audio system (hooter) in the event of tripping of induction heater/gas fired heater or in the event of pipe temperature being outside the range recommended by the manufacturer. Any deviation from the application temperature range recommended by manufacturer shall be rectified. If immediate rectification is not feasible, the production shall be stopped until cause of deviation has been removed. Any pipe coated during the duration of temperature deviation shall be identified by marking and rejected. Such rejected pipes shall be stripped, re-cleaned and recoated.

Temperature measuring & monitoring equipment shall be calibrated twice every shift and/or as per OwnerRepresentative's instruction.

Manufacturer shall ensure that pipe surface emissivity variations are minimised during pipe heating. To avoid significant variance, more than once blasted joints should be coated at the same time and not mixed with joints blasted only once.

11.2 Pipe Coating

Subsequent to pipe heating, coating consisting of following layers shall be applied onto the pipe.

i. Electrostatic application of epoxy powder of minimum dry film thickness 200 micron, unless otherwise specified. The maximum thickness shall not exceed the epoxy thickness specified by epoxy powder manufacturer.
ii. Grafted co-polymer adhesive application by extrusion, minimum thickness 250 micron.
iii. Polyethylene application by extrusion.

The coated pipe shall be subsequently quenched and cooled in water for a period that shall sufficiently lower the temperature of pipe coating to permit handling and inspection.

Minimum total thickness of finished coating shall be as under:

Pipe Size (Specified Outside Diameter)	Minimum Coating Thickness (mm)
	Increased Type (v)
Up to 4" (DN 100)	2.5
Above 4" up to 10" (> DN 100 ≤DN 250)	2.7

Minimum 400 micron epoxy thickness shall be considered for ERW linepipe, which are required to be used for HDD crossings.

Coating materials shall be inspected in accordance with the manufacturer's recommendation prior to coating application and it shall be ensured that the materials are moisture free. In case the relative humidity exceeds 80%, the adhesive and polyethylene material shall be dried using hot dry air as per the directions of Owner/ Client Representative.

Prior to starting the application of fusion bonded epoxy powder, the recovery system shall be thoroughly cleaned to remove any unused powder remaining from a previous line pipe coating application. The use of recycled powder shall be permitted subject to:

Satisfactory qualification of the reclaimed system during PQT stage.The proportion of the reclaimed powder in the working mix does not exceed 20% at anyone time.The quality of the recycled powder being routinely checked during production, at a minimum frequency of once per shift and consistently meets the requirements stated in this specification.

Dry air, free of oil and moisture shall be used in the coating chamber and spraying system and filters, dehumidifier/dryer as required along with control & monitoring system shall be provided for this purpose. Dew point of air used to supply the fluidised bed, epoxy spray system and epoxy recycling system shall be at least (–) 40°C and this shall be shall be monitored during the regular production.

Air pressure in the epoxy spray guns shall be controlled, continuously monitored and recorded by using suitable instruments. The air pressure shall be controlled within the limits established during coating procedure qualification. The monitoring system shall be able capable of raising an alarm / activate audio system (hooter) in the event of change in air pressure beyond the set limits. Any deviation from the pre-set limits shall be rectified. If immediate rectification is not feasible, the production shall be stopped until cause of deviation has been removed. Any pipe coated during the duration of air pressure deviation shall be identified by suitable marking and rejected. Such rejected pipes shall be stripped and recoated.

Extruded adhesive layer shall be applied before gel time of the epoxy coating has elapsed and within the window recommended by the manufacturer. The Contractor shall establish, to the satisfaction of the Owner/ Client Representative, that the adhesive is applied within the gel time window of epoxy and at the temperature recommended by the adhesive manufacturer. The Contractor shall state the

minimum and maximum time interval between epoxy and adhesive application at the proposed pre-heat temperature and line speed.

Extruded polyethylene layer shall be applied over the adhesive layer within the time limit established during PQT stage and within the time/temperature range recommended by the manufacturer. The extrusion temperatures of the adhesive and polyethylene shall be continuously recorded. The monitoring instruments shall be independent of the temperature control equipment. The instruments shall be calibrated prior to start of each shift.

Contractor shall ensure that there is no entrapment of air or void formation along the seam weld (where applicable) during application of coating. Air entrapment below the coating and also along the coating overlap shall be prevented by forcing the coating on to the pipe using high pressure roller of suitable design during coating application. In case it is not adequately achieved, Contractor shall supplement by other methods to avoid air entrapment. The methods used shall be witnessed and approved by Owner/ Client.

Resultant coating shall have a uniform gloss and appearance and shall be free from air bubbles, wrinkles, holidays, irregularities, discontinuities, separation between layers of polyethylene & adhesive, etc.

Coating and/or adhesive shall terminate at the below mentioned distance from pipe ends:

Pipeline Size	Coating cut back length
4” NB to 10” NB	110 mm +10 mm / (-)0 mm

The adhesive shall seal the end of applied coating. Contractor shall adopt mechanical brushing for termination of the coating at pipe ends. Edge of the coating shall be shaped to form a bevel angle of 30° to 45°.

Failure to comply with any of the above applicable requirement and of the approved procedure shall be cause for the rejection of the coating and such coating shall be removed in a manner approved by Owner/ Client at Contractor's expense.

12.0 INSPECTION AND TESTING

12.1 General

The Manufacturer shall establish and maintain such quality assurance system as are necessary to ensure that goods or services supplied comply in all respects with the requirements of this specification. The minimum inspection and testing to be performed shall be as indicated subsequently herein. All the inspection & testing shall be performed under the supervision of NACE level-II certified inspector. Applicator`s QA/QC in-charge shall be an engineering graduate having at least 5 years of experience in 3LPE coating application.

12.2 Visual Inspection

Immediately following the coating, each coated pipe shall be visually checked for imperfections and irregularities of the coating. The coating shall be of natural colour and gloss, smooth and uniform and shall be blemish free with no dust or other particulate inclusions. The coating shall not show any defects such as blisters, pinholes, scratches, wrinkles, engravings, cuts, swellings, disbonded zones, air inclusions, tears, voids or any other irregularities. Special attention shall be paid to the areas adjacent to the longitudinal weld (if applicable), adjacent to the cut-back at each end of pipe and within the body of the pipe.

In addition inside surface of the pipe shall also be visually inspected for presence of any foreign material or shots and grit (free or embedded/sticking to pipe inside surface). The pipe inside surface shall be examined using sharp floodlight focussed at the middle of the pipe at one end while inspection is carried out visually from other end.

12.3 Coating Thickness

The coating thickness shall be determined by taking at least 10 measurements at locations uniformly distributed over the length and periphery of each pipe. In case of welded pipes, five of the above readings shall be made at the apex of the weld seam, uniformly distributed over the length of the coated pipe. All readings must meet the minimum requirements.

Thickness of epoxy and adhesive shall be measured at the beginning of each shift and whenever the plant re-starts after any stoppage for compliance. Coating of epoxy and adhesive on portion of pipe required for this purpose, stripping and recoating of such partly coated pipes shall be at Contractor’s expense.

Coated pipes not meeting the above requirements shall be rejected. Rejected coated pipes shall be stripped and re-coated in accordance with approved procedure, at Contractor's expense.

12.4 Holiday Detection

Each coated pipe length shall be checked over 100% of coated surface by means of a "holiday detector" of a type approved by Owner/ Client for detecting holidays in the finished coating.

The holiday detector shall be a low pulse D.C. full circle electronic detector with audible alarm and precise voltage control complying with DIN VDE 0433 Part 2. The set voltage for inspection shall be minimum 25 kV. Travel speed shall not exceed 300 mm/s.

Contractor shall calibrate the holiday detector at least once every 4 hours of production. Contractor shall have necessary instruments or devices for calibrating the holiday detector.

Any pipe coating shall be rejected if more than 1(one) holiday & area more than 100 cm^2 in size are detected in its length attributable to coating process.

Holidays, which are lesser in size than those mentioned in above, shall be repaired in accordance with a approved procedure and shall be at Contractor's expense.

All pipes leaving coating plant shall have sound external coating with no holiday or porosity on 100% of the surface.

12.5 Bond Strength Test

Contractor shall conduct bond strength test for composite coating as per Clause 8.4 (a) of this specification. A minimum of 65 mm length shall be peeled. First 20 mm and last 20 mm shall not be counted for assessment of bond strength.

The frequency of test for each cut back portions shall be one pipe in every fifteen (15) pipes coated and for middle of pipe shall be one pipe per shift. On each selected pipe, bond strength shall be performed for each specified temperature. Test shall be performed at each cut back portion and one in the middle of pipe. The system shall disbond/separate cohesively either in adhesive layer or in polyethylene layer. Majority of the peeled off area on the pipe shall show presence of adhesive. Disbondment/separation at epoxy to steel interface or epoxy / adhesive interface or adhesive / polyethylene interface shall not be permitted. The failure mode shall be recorded for each test.

In case the test fails to comply the specified requirement, the Contractor shall test the preceding and succeeding coated pipe. If both pipes pass the test, then the remainder of the pipe joints in that shift shall be deemed satisfactory. If either pipe fails to meet the specified requirements, all pipes coated during that shift shall be tested until the coating is proved acceptable. Rejected coated pipes shall be stripped and re-coated in accordance with approved procedure, at Contractor's expense.

The frequency of bond strength test as per above Para for each cut back portion may be reduced depending upon the consistency of result to one pipe in every fifty(50) instead of every fifteen (15) pipes, and for middle of pipe shall be one pipe per shift at the sole discretion of the Owner/ Client Representative.

12.6 Impact Strength

Impact strength test shall be conducted as per clause 8.4 (b) of this specification. Initially the frequency of test shall be two (2) coated pipes per shift as per approved QAP.

Minimum thirty (30) impacts located equidistant along the length of coated pipe shall be performed.

Immediately after testing, the test area shall be subjected to holiday detection at the same voltage as used prior to impact strength test. The pipe shall be rejected if any holiday is noted in the test area.

In case of test failure, retesting and disposal of coated pipe shall be as per Para 12.5 above.

12.7 Indentation Hardness

Indentation hardness test shall be as per clause 8.4 (c) of this specification. The frequency of test shall be initially 2 (two) coated pipes per shift as per approved QAP. Two samples for each temperature shall be taken from the cut back portion of coated pipe.

Indentation Hardness Test shall be carried out at every change in batch of PE.

In case of test failure, retesting and disposal of coated pipe shall be as per Para 12.5above.

12.8 Air Entrapment Test

Strips from bond strength tests or coated pipe may be used to help determine the porosity of the finished coating. Strip shall be also cut from longitudinal weld (if applicable) at cut back portion and examined for the presence of voids.

Bond strength strip shall be viewed from the side and at the failure interface. At the pipe bond strength test location, utility knife shall be used to cut the edge of the coating to a 45° angle and view with a microscope. Similar examination shall be done in the coating cut back area.

One sample each either on the bond strength strip or coated pipe and strip cut from the longitudinal weld (if applicable) shall be examined for air entrapment per shift. Strips shall be viewed from the side.

All examination shall done using a 30X magnification hand-held microscope. The polyethylene and adhesive layers shall have no more than 10% of the observed area taken up with air entrapment

(porosity or bubbles). Air entrapment shall not occupy more than 10% of the thickness in each case. Bubbles shall not link together to provide a moisture path to the epoxy layer.

In case of test failure, retesting and disposal of coated pipe shall be as per Para 12.5 above.

12.9 Degree of Cure

Epoxy film samples shall be removed from cut back portion of the coated pipe using hammer and cold chisel and the samples shall be taken for cure test using DSC procedure. Silicon coated sulphite paper shall be placed between the epoxy layer and adhesive layer immediately after epoxy application, to ensure physical separation of epoxy & adhesive as well as to prevent contamination of epoxy with adhesive layer, at a location from where the epoxy samples are to be removed for the test. Care shall be taken to remove the samples of full film thickness avoiding inclusion of steel debris. Glass transition temperature differential (ΔTg) and % cure (ΔH) shall comply the specified requirements.

Frequency of this test shall be once per shift. Pipe shall be selected randomly by Owner/ Client Representative during the middle of a shift. Suitable provisions/arrangements as per the instructions of Owner/ Client Representative shall be made by the Contractor for this purpose

In case of test failure, production carried out during the entire shift shall be rejected, unless the Contractor proposes a method to establish the compliance with the degree of cure requirements of all pipes coated during that shift.

12.10 Epoxy Layer Adhesion Test

Adhesion of epoxy layer shall be determined at ambient temperature by the “St Andrews Cross” method i.e. by cutting two straight lines through the epoxy layer with a sharp knife. The incisions shall intersect at an angle of 30°/150°. The epoxy coating shall resist disbondment from the steel when attempts are made to flick/lift the coating from the 30° angle with a sharp knife.

Frequency of this test shall be once per shift. The test shall be carried out at the cut back portion on the pipe from which the Degree of Cure test has been carried out as per Para 12.9 above.

In case of test failure, retesting and disposal of coated pipe shall be as per Para 12.5 above.

12.11 Cathodic Disbondment Test

CD test shall be carried out for 48 hrs at 65’C& 28 days at 23’C as per clause 8.4 (g) of this specification.

During regular production frequency of this test for inhouse lab for each temp shall be once in every two weeks or one test representing each batch of epoxy powder used, whichever is more frequent.

In case the test fails to conform to the specified requirement, at the option of the Contractor, all pipes coated after the previous acceptable test and prior to next acceptable test shall be rejected or the test shall be repeated using two additional samples taken from the same end of the affected pipe.

When both retests conform to the specified requirement, the lot of pipes shall be accepted. When one or both the retests fail to conform to the specified requirement, all coated pipes after previous acceptable test and prior to next acceptable shall be rejected. All rejected pipes shall be stripped, re-cleaned and re-coated. Owner/ Client may consider a further retest program to determine whether any of the affected pipe meet the criteria for acceptance upon written request by the Manufacturer.

12.12 Hot water immersion

Hot water immersion shall be carried out as per requirement of clause no. 8.4of this specification. The test method and acceptance criteria shall be as per annexure M of ISO 21809 Part 1-2011-Polyolefin Coatings.

The test frequency shall be once per batch of PE material.

In case the test fails to comply with the specified requirement, the Applicator/ Contractor shall test the two preceding and two succeeding coated pipe. If both pairs of pipes pass the test, then the remainder of the pipes in that day shall be deemed satisfactory. If any of these four (4) pipes fails to meet the specified requirements, all pipes coated in that day shall be tested until the coating is proved acceptable.

Rejected coated pipes shall be stripped and re-coated in accordance with approved procedure, at Applicator/ Contractor's expense.

Damages occurring to pipe coating during above tests shall be repaired in accordance with approved coating repair procedure.

Repairs occurring on account of the production tests are however excluded from above mentioned limitations at Para 12.4 above.

Owner reserves the right to perform inspection and witness tests on all activities concerning the pipe coating operations starting from bare pipe to finished coated pipe ready for despatch and also testing of raw materials. Contractor shall give reasonable notice of time and shall provide without charge reasonable access and facilities required for inspection to the Owner's representative. Inspection and tests performed or witnessed by Owner/ Client's representative shall in no way relieve the contractor’s obligation to perform the required inspection and tests.

In case rate of defective or rejected pipes and/or samples tests are 10% or more for a single shift (typically 12 hours), manufacturer shall be required to stop production and carry out a full and detailed investigation and shall submit findings to Owner for approval. Contractor shall recommence the production only after getting the written permission from Owner.

Under no circumstances any action or omission of the Owner/ Client's Representative shall relieve the Contractor of his responsibility for material and quality of coating produced. No pipes shall be transported from the coating plant unless authorised by Owner/ Client in writing.

All acceptance criteria & frequency of test and scope of TPIA during regular production shall be as per Quality assurance Plan (QAP).

13.0HANDLING, TRANSPORTATION AND STORAGE OF MATERIALS

The coating manufacturer shall be fully responsible for the pipe and for the pipe identification marking from the time of "taking over" of bare pipe until such time that the coated line pipes are `handed over' and/or installed in the permanent installation as the case may be according to the provisions of the CONTRACT.

At the time of "taking over" of bare pipes manufacturer shall inspect and record all the relevant details referred above including pipe defects in the presence of Owner/ Owner representative. All pipes shall be checked for bevel damages, weld seam height, dents, gouges, corrosion and other damages. Owner/ Client Representative shall decide whether pipe defects / damages are suitable for repair. Damage to the pipes that occur after the manufacturer has taken delivery such as dents, flats, or damage to the weld ends shall be cut off or removed and pipes rebevelled and repaired again as necessary. The cost of this work, as well as that of the pipe lost in cutting and repair shall be to the manufacturer's account. All such works shall be carried out after written approval of the Owner. Any reduction in length shall be indicated in the manufacturer's pipe tracking system.

The manufacturer shall unload, load, stockpile and transport the bare pipes within the coating plant(s) using suitable means and in a manner to avoid damage to pipes.

The manufacturer shall stockpile the bare pipes at the storage area of the coating plant. The manufacturer shall prepare and furnish to Owner/ consultant a procedure/calculationgenerally in compliance with API RP-5L1 5L1& API RP 5LT and prevailing guidelines/rules of statutory bodies (Road/ rail) for stacking of pipes of individual sizes, which shall be approved by Owner/ Consultant prior to commencement.

The manufacturer shall load, unload, transport and stockpile the coated pipes within the coating plant using approved suitable means and in a manner to avoid damage to the pipe and coating. The Ownershall approve such procedure prior to commencement of work.

Coated pipes may be handled by means of slings and belts of proper width (minimum 60 mm) made of non- abrasive/non-metallic materials. In this case, pipes to be stacked shall be separated row by row to avoid damages by rubbing the coated surface in the process of taking off the slings. Use of round sectional slings is prohibited. Fork lifts may be used provided that the arms of the forklift are covered with suitable pads, preferably rubber.

Bare/coated pipes at all times shall be stacked completely clear from the ground, at least 300 mm, so that the bottom row of pipes remains free from any surface water. The pipes shall be stacked at a slope so that driving rain does not collect inside the pipe. Bare/coated pipes may be stacked by placing them on ridges of sand free from stones and covered with a plastic film or on wooden supports provided with suitable cover. This cover can be of dry, germ free straw covered with plastic film, otherwise foam rubber may be used. The supports shall be spaced in such a manner as to avoid permanent bending of the pipes.

Stacks shall consist of limited number of layers such that the pressure exercised by the pipe's own weight does not cause damages to the coating. Contractor shall submit calculations for Owner/consultant approval in this regard. Each pipe section shall be separated by means of spacers suitably spaced for this purpose. Stacks shall be suitably secured against falling down and shall consist of pipe sections having the same diameter and wall thickness. The weld seam of pipes shall be positioned always in a manner so as not to touch the adjacent pipes.

The ends of the pipes during handling and stacking shall always be protected with bevel protectors.

The lorries used for transportation shall be equipped with adequate pipe supports having as many round hollow beds as there are pipes to be placed on the bottom of the flat bed type lorry/ Trailer.

Total width of the supports shall be at least 5% of the pipe length and min. 4 nos. support shall be provided. These supports shall be lined with a rubber protection and shall be spaced in a manner as to support equal load from the pipes. The rubber protection must be free from all nails and staples where pipes are in contact. The second layer and all following layers shall be separated from the other with adequate number of separating layers of protective material such as straw in plastic covers or mineral wool strips or equivalent, to avoid direct touch between the coated pipes.

All stanchions of lorries used for transportation shall be covered by non-abrasive material like rubber belts or equivalent. Care shall be exercised to properly cover the top of the stanchions and other positions such as reinforcement of the truck body, rivets, etc. to prevent damage to the coated surface. Slings or non-metallic straps shall be used for securing loads during transportation. They shall be suitably padded at the contact points with the pipe

Materials other than pipes and which are susceptible of deteriorating or suffering from damages especially due to humidity, exposure to high thermal excursions or other adverse weather conditions, shall be suitably stored and protected. Deteriorated materials shall not be used and shall be replaced at Contractor's expenses. These materials shall always be handled during loading, unloading and storage in a manner so as to prevent any damage, alteration and dispersion. When supplied in containers and envelopes, they shall not be dropped or thrown, or removed by means of hooks, both during the handling operations till their complete use. During unloading, transport and utilization, any contact with water, earth, crushed stone and any other foreign material shall be carefully avoided.

Manufacturer shall strictly follow Manufacturer's instructions regarding storage temperature and methods for volatile materials that are susceptible to change in properties and characteristics due to unsuitable storage. If necessary the Contractor shall provide for a proper conditioning.

In case of any marine transportation of bare/coated line pipes involved, the same shall be carried out in compliance with API RP 5LW. Contractor shall furnish all details pertaining to marine transportation including drawings of cargo barges, storing/stacking, sea fastening of pipes on the barges/marine vessels to the Owner/ Client for approval prior to undertaking such transportation works. In addition contractor shall also carry out requisite analyses considering the proposed transportation scheme and establish the same is safe and stable. On- deck overseas shipment shall not be allowed.

14.0REPAIR OF COATING

Manufacturer shall submit to Owner/ Consultant , its methods and materials proposed to be used for executing a coating repair and shall receive approval from Owner/ Consultant prior to use. In open storage the repair coating materials must be able to withstand a temperature of at least (+) 80°C without impairing its serviceability and properties. Coating manufacturer shall furnish manufacturer’s test certificates for the repair materials clearly establishing the compliance of the repair materials with the applicable coating requirements indicated in this specification.

All pipe leaving coating plant, shall have sound external coating with no holiday or porosity on 100% of the surface.

Defects, repairs and acceptability criteria shall be as follows:

- Pipes showing porosities or very small damage not picked up during holiday test and having a surface less than 0.5 cm^2 or linear damage (cut) of less than 3 cm shall be repaired by stick using material of samequality.

- Damages caused to coating by handling such as scratches, cuts, dents, gouges, not picked up during holiday test, having a total reduced thickness on damaged portion not less than 2 mm and an area not exceeding 20 cm^2 shall be rebuild by heat shrink patch only and without exposing to baremetal.

- Defects of size exceeding above mentioned area or holidays of width less than 300 mm shall be repaired with heat shrink repair patch by exposing the bare metal surface.

- Defects exceeding the above and in number not exceeding 1 per pipe and linear length not exceeding 500 mm shall be repaired using heat shrinkable sleeves of HTLP 80 orequivalent.

- Pipes with bigger damage shall be stripped andrecoated.

- No Circumferential sleeve (full encirclement) repair is permitted within 100 mm length of the coating cut back area.

Irrespective of type of repair, the maximum numbers of repair of coating shall be as follows:

- Holiday repair of size 100 cm^2 attributable to process of coating application shall be maximum one number perpipe.

- In addition to the above, defects to be repaired by heat shrink patch/sleeve shall be maximum 1 (one) perpipe.

Defects exceeding the above limits shall cause pipe coating rejection, stripping and recoating. The above is exclusive of the repairs warranted due to testing as per this specification.

All repairs carried out to coating for whatever reason shall be to the account of Contractor.

Cosmetic damages occurring in the polyethylene layer only need not be repaired by exposing up to steel surface, as deemed fit by the Owner/ Client Representative. In any case the Contractor shall establish his material, methods and procedure of repair that result in an acceptable quality of product by testing and shall receive approval from Owner/ Client prior to use.

Testing of repairs shall be in the same form as testing coating. All repairs shall result in a coating thickness no less than the parent coating thickness. Contractor shall test repairs to coating as and when required by Owner/ Client.

Repair procedures/ process shall be qualified during PQT.

Only qualified insulator shall allowed conducting the repair work and all repaired pipes shall be identified by indicating alphabet ‘R’ after the coating number.

15.0MARKING

Contractor shall place stencilling marking on the one inside and one outside coating of opposite surface ends along with barcode as per barcode specification on the coated pipe, and marking shall indicate, but not limited to the following information:

a. Pipe number, Heat number
b. Pipe diameter, material grade, length & wall thickness
c. Coated pipe number
d. Colour band
e. Any other information considered relevant by Owner.
f. Pipe Manufacturer Name
g Inspection Mark/Punch

Contractor shall obtain prior approval on marking procedure to be adopted from the Owner/ Client.

16.0QUALITY ASSURANCE

The Contractor shall have established within his organisation and, shall operate for the contract, a documented Quality System that ensures that the requirements of this specification are met in all aspects. The Quality System shall be based upon ISO 9001/2 or equivalent.

The Contractor shall have established a Quality Assurance Group within its organisation that shall be responsible for reviewing the Quality System and ensuring that it is implemented.

The Contractor shall submit the procedures that comprise the Quality System to the Owner/ Client for agreement.

The Contractor's Quality System shall pay particular attention to the control of Suppliers and Sub-contractors and shall ensure that the requirements of this specification are satisfied by the Suppliers and Sub-contractors operating Quality system in their organisation.

The Contractor shall, prior to the commencement of work, prepare and issue a Quality Plan (QAP) for all of the activities required satisfying the requirements of this specification. The plan shall include any sub-contracted work, for which the sub-contractors Quality Plans shall be submitted. The plan shall be sufficiently detailed to indicate sequentially for each discipline the requisite quality control, inspection, testing and certification activities with reference to the relevant procedures and the acceptance standards.

The Contractor's Quality system and associated procedures may, with due notice, be subject to formal audits. The application of quality control by the Contractor will be monitored by the Owner/ Client Representatives who will witness and accept the inspection, testing and associated work required by this specification.

The coating pipe mill shall have internal tracking system for their pipe traceability-inline production to reduce manual introversion. SAP base system is preferred.

ANNEXURE-I

1. COATING PROCEDURE QUALIFICATION TEST (PQT)

Upon award of the Contract, the Manufacturer shall submit within two (2) weeks, for Owner/ Consultant approval, a detailed report in the form of bound manual outlining, but not limited to, thefollowing:

- Details of plant(s), location(s), layout, capacity and production rate(s).
- Details of the equipment available to carry out the coating works including surface preparation, epoxy powder application and its recycling system, adhesive & polyethylene extrusion, moisture control facilities available for coating materials.
- Details of process control and inspection equipment required for the coating process such as temperature control, thickness control, holiday testers, etc.
- Facilities in the yard for unloading, handling, transport, production, storage, stockpiling, loading of bare and coated pipes and warehouses for storage of other coating materials.

- Plant Organization Chart and availability of manpower including coating specialist
- Details of utilities/facilities such as water, power, fuel, access roads and communication etc.
- Details of chemical pre-treatment facilities including process control, inspection equipment for phosphoric acid wash etc, de-ionized water wash, holiday testing etc.
- Solid/ liquid waste management system procedure and facility details for safe disposal of chemical and organic substances.

After Owner/ Client has given approval; no change in plant set-up shall be made. However, unavoidable changes shall be executed only after obtaining written approval from Owner/ Client.

At least Two (2) weeks prior to the commencement of production coating, a detailed procedure of the Contractor's methods, material proposed, etc., shall be formulated by the Contractor and submitted for Owner/ Client approval in the form of a bound manual. The procedure shall include, but not limited to, the following information andproposals:

a. Pipe inspection at the time of bare pipereceipt.
b. Steel surface preparation, including preheating, removal of steel defects, method of pipe cleaning, dust removal, abrasive blast cleaning and surface profile; methods of measurements andconsumables.
c. Pipe heating, temperatures and control prior to epoxyapplication.
d. Complete details of raw materials including current data sheets showing values for all the properties specified together with quality control and application procedure recommendations frommanufacturer(s).
e. Application of epoxy powder, adhesive and polyethylene, including characteristics, temperature, line speed, application window, curing time,etc.
f. Quenching and cooling, including time andtemperature.
g. Quality Assurance System, Quality Plan, Inspection and Test Plan and reporting formats, including instrument and equipment types, makes and uses,etc
h. Detailed method of repair of coating defects duly classified depending upon nature and magnitude of defects and repair thereof including coating strippingtechnique
i. Details of instrument and equipment calibration methods including relevant standards and examples of calibrationcertificates.
j. Complete details and inventory of laboratory and equipment for procedure qualification and regular production
k. Pipe handling and stock piling procedures including pipe tracking, traceability, pipe end protection and protection against adverse ambient conditions during storage.
l. Sample of recording and reporting formats, including laboratory reports, certificates and requirement as per clause of this specification.
m. Complete details of test certificates for raw materials including test methods and standards used.
n. Test certificates from PE compound manufacturer for tests for thermal aging, coating resistivity and aging under exposure to light. These test certificates shall not be older than three years.
o. Health, Safety and Environment Plans.
p. Storage details of coating materials and chemicals.
q. Continuous temperature monitoring at various stages of coating

Procedure Qualification Tests (PQT) shall be carried out only after obtaining written approval of the above procedure from Owner/ Client. No change in the procedure shall be made after the Owner/ Client has given approval. However, unavoidable changes shall be executed only after obtaining written approval from Owner/ Client.

Prior to start of production, the Contractor shall, at his expense, carry out a coating PQT for each

pipe diameter on any one wall thickness, for each type of pipe, for each coating material combination, and for each plant, to prove that his plant, materials, and coating procedures result in a quality of end product conforming to the properties stated in clause, relevant standards, specifications and material manufacturer's recommendations. Contractor shall give seven (7) working days notice to witness all procedures and tests.

A batch representing a normal production run, typically 25 pipes, shall be coated in accordance with the approved coating procedure and the coating operations witnessed by Owner/ Client Representative. Out of these pipes, at least one pipe at start and end of PQT shall be coated partly with epoxy and partly with both epoxy and adhesive layers.

At least 10 (ten) test pipes shall be selected by Owner/ Client Representative for coating procedure approval tests and shall be subjected to procedure qualification testing as described hereinafter. Owner/ Client Representative shall witness all tests. Out of 10 (ten) test pipes, 2 (two) pipe partly coated with epoxy and partly coated with both epoxy and adhesive layers shall be included. Remaining 8 (eight) test pipes shall have all three layers.

During PQT, the Contractor shall qualify various procedures forming a part of coating operations as detailed subsequently.

2. QUALIFICATION OF PROCEDURES

2.1 Epoxy Powder Application & Recycling

During pre-qualification, air pressure in the epoxy spray guns, satisfactory functioning of monitoring system, line speed v/s coating thickness, etc. shall be established. Dew point of air used to supply the fluidized bed, epoxy spray system and epoxy recycling system shall be recorded during the PQT.

Also, the Manufacturer shall remove samples of reclaimed powder from the reclamation system. These samples of reclaimed powder shall be subject to a detailed visual examination, thermal analysis and moisture content tests. The properties of the reclaimed powder shall be within the range specified by the Manufacturer of epoxy powder. In case the properties of the reclaimed powder are out of the range specified by the Manufacturer, Contractor shall not the use the reclaimed powder during the regular production.

2.2 Pipe Pre-heating

The manufacturer shall establish the temperature variation due to in-coming pipe temperature, line speed variation, wall thickness variation, emissivity, interruptions, etc. and document the same during the PQT stage. During PQT, proper functioning of pipe temperature monitoring and recording system including alarm/hooter shall be demonstrated to the Owner/ Client Representative.

2.3 Surface Preparation

The procedure to clean and prepare the pipe surface shall be in accordance with the requirements of this specification. The ratio of shot to grit shall be established during procedure qualification testing, such that the resultant surface profile is not dished and rounded. The qualification shall be performed through a visual inspection, measurement of roughness and check of the presence of dust on the abrasive blast cleaned pipe surface.

2.4 Chemical Pre-treatment

2.4.1 Phosphoric Acid Wash followed by De-ionised Water Wash

The procedure to apply the chemical pre-treatment viz. phosphoric acid wash followed by de-ionised water wash shall be in accordance with the recommendations of the manufacturer and shall result in intended cleaning requirements of this specification. Working solution preparation, maintaining concentration, application procedure including method of spreading, spreading rate, drying times, etc. depending upon the cleanliness/temperature of the incoming pipe and the line speed shall be established. Temperature of the chemical, pipe pre-heat temperature vs line speed vs dwell time, rinsing procedure, testing & control, rectificatory measures, drying procedure etc. shall be clearly established during PQT. Also the quality of the deionised water shall be established during PQT.

2.4.2 Chromate Treatment

The procedure to apply the chromate treatment shall be in accordance with the recommendations of the manufacturer. Working solution preparation, maintaining concentration, application procedure including method of spreading, spreading rate, drying times, etc. depending upon the temperature of the incoming pipe and the line speed shall be established. Temperature of the chemical, pipe pre-heat temperature vs. line speed, pipe heating after chromating and time limit within which the pipe to be heated, testing & control, rectificatory measures, shall be clearly established during PQT.

2.5 Coating Application

The Owner Representative will check the correctness of each coating application operation, values of the main parameters of each operation, pre-heating pipe surface temperature prior to epoxy powder application temperature, line speed, fusion bonded epoxy curing time, temperature and flow rate of co-polymer adhesive and polyethylene, etc. and the same shall be recorded. These values shall be complied with during regular production.

3. QUALIFICATION OF APPLIED COATING

3.1 Tests on pipe coated partly with epoxy and partly with epoxy & adhesive layers

a. Degree of Cure

Epoxy film samples (minimum 4 no.) shall be scrapped from the coated pipe and the samples shall be taken for cure test using Differential Scanning Calorimetry (DSC) procedure. Care shall be taken to remove the samples of full film thickness avoiding inclusion of steel debris. Glass transition temperature differential (ΔTg) and % cure (ΔH) shall comply with the specified requirements.

b. Epoxy Layer Thickness

Epoxy layer thickness shall be checked at every one metre spacing at 3, 6, 9 and 12 o'clock positions. The thickness shall comply with the specified thickness requirements. Adhesive layer Thickness

c. Adhesive Layer Thickness

Adhesive layer thickness shall be checked at every one metre spacing at 3, 6, 9 and 12'o clock positions. The thickness shall comply with the specified thickness requirements.

d. Holiday Inspection

Entire pipe shall be subject to holiday inspection and the test voltage shall be set to exceed 5 v/micron of epoxy thickness specified for the portion coated only with epoxy layer.

e. Dry Adhesion

Dry adhesion test shall be carried out for two pipe as per clause A.4 of ISO 21809-2 Fusion bondedepoxy coating. The rating obtained shall be either 1 or 2.

f. 24 hrs Adhesion Test

Adhesion Test (24 hrs) shall be carried out for two pipe on the epoxy coated pipe as per clause A.15 of ISO 21809-2 Fusion bonded epoxy coating. The rating obtained shall be from 1 to 3.

g. Cross-section & Interface Porosity Test

Cross section porosity and interface porosity tests shall be carried out on the epoxycoated pipe. Test method and acceptance criteria shall comply as per clause A.11 ofISO 21809-2 Fusion bonded epoxy coating

3.1 Tests on pipes coated with all three layers

a. Bond Strength:

Three test pipes shall be selected for bond strength tests. On each of the selected pipes, three bond strength test shall be performed for each specified temperature i.e. one at each end and one in the middle of the pipe and specified requirements shall be complied with, i.e. bond strength as well as mode of separation. Length of peel shall be minimum 65 mm. No failure either adhesive to fusion bonded epoxy primed surface or adhesive to PE, no disbanding between steel & epoxy. None of these samples shall fail.

b. Impact Strength:

Three test pipes shall be selected for impact strength test and the test shall meet the specified requirements as per clause no 8.4 (b)

C. Indentation Hardness

Two samples for eachtemperature from all pipes (8 pipes) shall be taken. If any one of thesesamples fails to satisfy the specified requirements, then the test shall be repeated on four more samples. In this case, none of the samples shall fail.

d. Elongation at failure

Six samples each from five coated pipes i.e. 30 samples in all shall be tested and the test shall comply the specified requirement. Only one sample per pipe may fail.

e. Specific electrical Resistance (Coating Resistivity) & UV Resistance & Thermal Ageing Resistance

The specific electrical resistance, UV resistance & thermal ageing resistance of the coating shall be measured in accordance with Annex-J, K & L of DIN 30670 respectively. Test certificates from PE compound manufacturer for tests for thermal aging, coating resistivity and aging under exposure to light. These test certificates shall not be older than threeyears and same shall be reviewed by Owner/ consultant during PQT.

f. Cathodic Disbondment Test

Cathodic disbondment test shall be carried out for two samples for inhouse lab (one at 23'C & one at 65'C) for the pipes having all three layers. One test shall be carried out at 23'C for 28 days duration and another test at 65'C for 48 hours duration. The tests shall comply with the specified requirement.

In addition to above one sample (at 23'C) for28 day Cathodic disbondment test shall be sent to independent NABL approved Lab or equivalent Lab and same shall be witness by TPIA. (Independent Lab testing only applicable for PQT).

g. Holiday Inspection

All the pipes shall be subject to holiday inspection at 25 KV with speed of maximum 300mm/sec.No Holiday shall be acceptable.

h. Coating Thickness Measurement

All pipes shall be subject to coating thickness measurements. The average coating thickness shallbe determine by measurement at five equidistant points along the apex of weld seam of the coated pipe & 10 measurements at location uniformly distributed over the length and periphery of each pipe all reading must meet the minimum requirements.

i. Air Entrapment

One sample from each pipe body (8 pipes) and on weld (if applicable) shall be taken from all coated pipes and the specified requirements shall be complied with.

j. Degree of Cure

Epoxy film samples after 3LPE coating shall be scrapped from one coated pipe and the samples shall be taken for cure test using Differential Scanning Calorimetry (DSC) procedure. Silicon coated sulphite paper shall be placed between the epoxy layer and adhesive layer immediately after epoxy application, to ensure physical separation of epoxy & adhesive as well as to prevent contamination of epoxy with adhesive layer, at a location from where the epoxy samples are to be removed for the test. Care shall be taken to remove the samples of full film thickness avoiding inclusion of steel debris. Glass transition temperature differential (ΔTg) and % cure (ΔH) shall comply with the specified requirements.

k. Hot Water Immersion

One test pipe shall be selected for hot water immersion test. The test method and acceptance criteria shall be as per annexure M of ISO 21809 Part 1-2011- PolyolefinCoatings.

l. Flexibility

One test pipe shall be selected for Flexibility test as per clause no 8.4 (h) of this specification. The test method and acceptancecriteria shall be as per annexure I of ISO 21809 Part 1-2011- Polyolefin Coatings.

m. Cyclic test

One pipe for total order shall be selected for Cyclic test after completion of coating followed by strip test of coating to locate any failure on disbondment. for cyclic test the pipe shall be pressurized to 1.5 times of design pressure and then dropped to 5% of design pressure and again re- pressurized to 1.5 times design pressure, continuously for about 100 cycles then checked for coating disbondment by stripping the pipe coating.

4. INSPECTION OF ALL TEST PIPES

All pipes shall be subject to the following inspections:

- Surface cleanliness, surface roughness measurements and dust control immediately after second abrasive blast cleaning and salt test.
- Visual inspection of finished coating, cut back dimension, internal/external cleanliness, end sealing and bevel inspection.
- Acceptance criteria for all inspection and testing shall be as specified in this specification.

After completion of the qualification tests and inspection, the Contractor shall prepare and issue to Owner/ Client for approval a detailed report of the above tests and inspection including test reports/certificates of all materials and coatings tested. Only upon written approval from Owner/ Client, Contractor shall commence production coating.

On successful completion of PQT, coating of all test pipes shall be removed and completely recycled as per the approved coating procedure specification, at Contractor's expense. Remaining pipes will be accepted by Owner/ Client provided they meet the requirements of this specification and need not be stripped and re-cycled.

All acceptance criteria & frequency of test and scope of TPIA during PQT shall be as per Quality assurance Plan (QAP).

The Contractor shall re-establish the requirements of qualification and in a manner as stated before or to the extent considered necessary by Owner/ Client, in the event of, but not limited to, the following:

- Every time there is a change in the previously qualified procedure.
- Every time there is a change in the manufacturer and change in formulation of any of the raw materials and change in location of raw material manufacture.
- Every time the coating yard is shifted from one location to the other or every time the critical coating equipments (induction heater, epoxy spray system, extruder, etc) are shifted.
- Any change in line speed during coating application.
- Any time when in Owner's opinion the properties are deemed to be suspect during regular production tests.

Owner reserves the right to conduct any or all the test required for qualification through an independent laboratory or agency at the cost of Contractor when in Owner's opinion, the results are deemed suspect. Owner's decision shall be final.

ANNEXURE-II

LIST OF ACCEPTABLE COMBINATIONS OF COATING MATERIALS

The following combinations of coating materials are considered acceptable. In case any of the combinations listed below are offered, details regarding properties of the offered materials need not be furnished with bid. However, In the event of award of contract, Contractor shall furnish the combination(s) proposed and re-confirmation of compatibility of the proposed combination (s) from the raw materialsManufacturers.

Epoxy Powder (Manufacturer)	**Adhesive (Manufacturer)**	**PE Compound (Manufacturer)**

CORRO-COAT EP-F 2001 (JOTUN)	FUSABOND 158D (DUPONT)	SCLAIR 35 BP HDPE (NOVACOR)
CORRO-COAT EP-F 2002HW (JOTUN) or SCOTCHKOTE 226N (3M)	LUCALEN G3710E (LYONDELLBASELL)	LUPOLEN 4552 D SW 00413 (LYONDELLBASELL)
PE 50-6109 (BASF) or CORRO-COAT EP-F 2001/ 2002HW/1003HW (JOTUN) or SCOTCHKOTE 226N (3M)	ME 0420 (BOREALIS)	HE 3450 (BOREALIS / BOROUGE)
CORRO-COAT EP-F 2001 (JOTUN)	LE – 149 V (HYUNDAI ENGINEERING PLASTICS)	ET 509 B (HYUNDAI ENGINEERING PLASTICS)

Although the above combinations would be acceptable to Company, the responsibility of suitability for application, performance and compliance to the coating system requirements shall unconditionally lie with theContractor.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECNICAL SPECIFICATION FOR MAJOR WATER CROSSINGS (CONVENTIONAL TRENCHING)
GAIL-STD-PL-DOC-TS-019

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ABBREVIATIONS:

ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing of Materials
API	American Petroleum Institute
OISD	Oil Industry Safety Directorate

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1.0 SCOPE

This specification covers the minimum requirements for the various activities to be performed by Contractor for the construction of pipeline major water crossings by conventional trenching method. Provisions of this specification are applicable only for "Major Water Crossing" specifically named as such in the contract.

This specification shall be read in conjunction with the condition of all specifications and documents include in the contract between company and contractor.

2.0 REFERENCES CODES, STANDARDS AND SPECIFICATIONS

The latest edition of following Codes and Standards are referenced in this specification and all provisions of these reference codes and standards shall be applicable.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

B31.4 : Pipeline Transportation system for liquid Hydrocarbon & other liquids.

B 31.8 : Gas Transmission and Distribution Piping Systems.

AMERICAN PETROLEUM INSTITUTE (API)

1102 : Steel Pipeline Crossing Railroads and Highways

1109 : Marking Liquid Petroleum Pipeline Facilities

1104 : Welding of Pipelines and Related Facilities

OIL INDUSTRY SAFETY DIRECTORATE (OISD)

Std. 141 : Design and Construction Requirements for Cross Country Hydrocarbon Pipelines.

Std. 226 : Natural gas Transmission Pipelines and city gas distribution network.

US DOT PIPE LINE SAFETY STANDARD

Part 192, Title 49 : Transportation of Natural and other Gases by Pipeline

Part 195 : Transportation of Liquid by Pipe Line

COMPANY STANDARD SPECIFICATIONS

Following Company specifications shall form integral part of this specification and shall be complied with when applicable to the works covered in the contract.

SS-PL-015	Standard Specification for Pipeline Construction
SS-PL-005	Standard Specification for Pipeline Concrete Weight Coating of Onshore Pipelines
SS-PL-012	Standard Specification for Hydrostatic Testing of Onshore Pipelines
SS-PL-016	Standard Specification for Pipeline Markers

In case of conflict between various requirements of this specification and reference standards mentioned above, more stringent requirement shall apply unless otherwise agreed by Company.

3.0 GENERAL REQUIREMENT

a. If specified, Contractor shall carry out all geotechnical and hydrological investigation as per relevant specification. Contractor shall also carry out scour calculation based on the above and submit all reports and calculation to company for review and approval.
b. Contractor shall comply with all the conditions and requirements issued by Authorities having jurisdiction in the area where the work is to be performed. Contractor shall, at his own responsibility, obtain necessary permits from the Authorities having jurisdiction, for performing its work.
c. Contractor shall take full responsibility for the suitability, stability and safety of all operations and methods involved in the work.
d. Contractor shall be deemed to have inspected and examined the work area and its surroundings and to have satisfied himself so far as practicable as to the form and nature thereof, including sub-surface conditions, hydrological and climatic conditions, the extent and nature of the work and materials necessary for the completion of the work, and the means of access to the work area.

e. Prior to start of any work, Contractor shall carry out a pre-construction survey of the major water crossings and. acquaint himself with site conditions and to collect any data regarding the water velocity and the tidal variation in the flow pattern and shall verify the suitability of his equipment and the method of construction.
f. Contractor shall, with due care and diligence, execute the work in compliance with all laws, by-laws, ordinances, regulation etc., and provide all services and labor, inclusive of supervision thereof, all materials, excluding the materials indicated as "Company Supplied Materials", equipment appliances or other things of whatsoever nature required in or about the execution of the work, whether of a temporary or permanent nature.
g. Contractor shall be deemed to have obtained all necessary information subject as above mentioned as to risks, contingencies and all other circumstances, which may influence the work.

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h. Contractor shall, in connection with the work, provide and maintain at his own-costs all lights, guards, fencing, watching etc., when and where necessary or required by company or by any duly constituted Authority for the protection of the work and properties or for the safety and the convenience of public and/or others.
i. If no public roads exist, Contractor shall arrange at his own for access to work areas at no extra time and cost to Company.
j. Before start of the field construction work, Contractor shall submit the following for approval of each major water crossing
   - Installation method.
   - Proposed time schedule indicating start and finish dates with detailed break-up showing critical activities.
   - Layout, location and other drawings / sketch of work area.
   - Details of equipment (including number and capacity of equipment deployed)
   - Proposed sub-contractors and / or vendors (if any) along with their scope of work.

The description of the installation method as a minimum shall include the following:

a. Preparation of fabrication yard and launching area along with proposed Layouts.
b. Pipeline construction details (including hauling, stringing, welding, NDT, concrete coating, etc.).
c. Study of water currents in relation to the method of launching (on bottom and on surface)
d. Calculations For stability of pipeline during launching and final test.
e. Buoyancy Studies.
f. Pre-test procedure.
g. Pulling or other installation method and related calculations / analysis including rope test, checking of winch/crane pulling capacity etc.
h. Pulling arrangement including launch way and anchoring and braking device.
i. Trench correction before launching / lowering.
j. Method of positioning and sinking / lowering of pipeline.
k. Method of rectification of damages to the pipeline / coating, during launching.
l. Method of backfilling and bank protection.
m. Final test procedure after backfilling. .
n. Safety system adopted

o. Communication system adopted during construction/testing/survey.
p. Abandonment and recovery procedures.
q. Dredging, anchoring requirements spoil deposit and trench survey method and Contractor's proposed methodology for execution of these activities.

Approval by Company of the methods used by Contractor shall in no way relieve Contractor from the sole responsibility for safe and satisfactory installation of the crossing
.

4.0 TRENCHING

4.1 EXCAVATION

Contractor shall dredge or excavate the trench for the water crossing in conformity with the approved drawings. Dredging of the trench shall be executed as accurately as possible.

The trench shall be excavated to such depth as, required to provide the minimum cover and the pipeline configuration as specified. The pipeline profile of the crossing shall be followed as accurately as possible. Before laying, the trench shall be cleaned and leveled. The trench shall be subject to inspection by Company prior to installation of the pipe.

Navigational traffic shall not be obstructed, unless permission has been given thereto. Contractor shall issue all necessary, publication according to the local requisitions.
Instructions given by Authorities shall be followed accurately and immediately, so that traffic encounters no hindrance.

Contractor will not be entitled for any compensation in terms of time and cost, if his work is hampered or delayed due to weather conditions, any obstacles / or any traffic on the spot, where work is executed.

Contractor is fully responsible for the execution of the blasting (wherever permitted), the dredging and excavation work, hopping of the spoil; transportation, dumping on land or in water, all to be executed in agreement with Authorities, land owners and Company.

Contractor maybe obliged to dredge or excavate a trench deeper or wider than indicated in the drawings. in order to-properly lay the pipeline in unstable (underwater) areas, or near and adjacent to the banks of water-courses. It shall be understood that Contractor is aware of such problems at the time of his Bid and that when such additional excavation is required, it shall be done by Contractor as part of the work and that he will install the necessary provisions and/or temporary works such as sheet-piling, special filling materials, etc. at no extra cost to Company.

During the execution of dredging work by Contractor, bearings, measurements and levels shall be taken by or on behalf of Company. Contractor shall render assistance for this purpose and make available for Company appropriate survey boats, fully manned and equipped, before the trench excavation work of the water crossing can be started- Contractor, if so desired by Company, shall make cross profiles at intervals of not more than 10.0 m of the bottom of the watercourse along the surveyed centerline of the water crossing. In such a case, horizontal measurements shall be taken by triangulation or tapping between known points and shall be made with such accuracy that the location of each vertical measurements is known with 1.0 m. Vertical measurements shall be taken with a sonic recording device, or with line and rod, as directed by Company and shall be taken with such an accuracy that each depth is known within 0.2 m. Vertical measurements shall be taken at points averaging not more than 5.0 m apart and no two measurements shall be more than 7.0 m apart. The cross profiles shall extend at least 10 m on both sides of the top of the trench.

All measurements shall be recorded by Contractor. Company may witness such measurements. The resulting profile, corrected to the elevation of the undisturbed watercourse, shall then be the reference profile. Said profile shall be plotted on a 1:200 vertical and horizontal scale.

Contractor shall keep the trench in good condition until the pipe is laid, and no claim is to be made to the Company by reason of its caving either before or after the pipe is laid. Contractor

shall do whatever is required to excavate the trench, install the pipe in it and backfill the trench in accordance with the specifications at no extra cost to Company.

Immediately before installation of the water crossing in the excavated trench, Contractor shall prepare a profile of the trench bottom along the surveyed center line of the water crossing for comparison with the reference profile. Contractor shall also make cross sections of the trench at intervals of not more than 50 m. All profiles and cross section measurements shall be taken as specified and, if required, shall be witnessed by Company. These data shall be submitted to Company for approval.

Contractor shall grade the trench in such a manner as to give the maximum amount of uniform support to the pipeline when it is lowered or pulled into place. The maximum unsupported span shall not exceed 10.0 m.

In submerged sections, where rock or gravel is encountered in the bottom of the trench, padding is required. The thickness of the padding under the concrete coated pipe shall at least be 0.5m and after installation at least 0.5 m around the pipe.
Blasting, if any, and padding shall be included in the Contractor's work.

4.2 DIKES, DAMS AND WEIRS

Contractor shall install temporary provision in the existing dikes, dams, etc. to prevent flooding of low areas.

Therefore in general, in existing dikes, dams, etc. a double substituting weir must be installed before start of excavation in the existing dike or dam. Such a double substituting weir can be a closed wall of sheet piling, supported by soil. The provisions shall be such that the underwater profile of the dredged trench, the water flow and water movement caused by boats/ ships etc. cause no slides / cave-ins of the dike or dam.

5.0 POLLUTION CONTROL MEASURES

Contractor shall take all necessary precautions not to pollute river water and banks during entire construction operation. Equipment deployed and, construction methodology adopted shall be-such, that minimum damage is caused to the existing environmental conditions. Union and State Government requirements concerning pollution control and environmental protection 'shall be fully complied with.

6.0 CONTINUOUS CONCRETE COATING

Contractor shall provide concrete coating over the pipeline including the bends in accordance with the specification issued for the purpose and approved procedure. Contractor shall coat the weld joints in order to arrive at the continuously concrete coated pipeline. However the concrete coating shall be applied after the hydrostatic pretest.

7.0 HYDROSTATIC PRE-TESTING

Contractor shall hydrostatically pre-test the pipe string of each water crossing before installation as per approved procedure.

Joint coating of the welds shall be done after this pre-test.
The section of the pipeline corresponding to the crossing shall, before installation, be subjected to a minimum hydrostatic test pressure equal to 1.4 times design pressure for gas pipeline and 1.25 times design pressure for liquid pipeline. The combined equivalent stress in the pipeline due to bending and test pressure shall not exceed 95% of the SMYS of the pipe material.

After the temperature has been stabilized, the pressure shall be maintained in the pipeline for at least six hours and recorded by manothermograph. During test, the Contractor shall check all welds for leakage. Failure, if any, during the test shall be rectified by the Contractor. If the

same is due to failure on account of any cause other than defect in materials supplied by Company, the repairs shall be done free of cost, to the satisfaction of Company.

8.0 INSTALLATION

Contractor shall submit a detailed scheme for the method, proposes to adopt for installing the pipeline to Company for approval. Contractor shall calculate all stresses in the pipeline while laying and check whether the stresses remain within permissible limits. A set of all calculations shall be submitted to Company for approval.

Contractor shall perform all work required to install the water crossings, including the possible appurtenances indicated in the drawings. The water crossings shall be installed in such a manner as to comply with the requirements and conditions stated by the Relevant Authorities issuing the permits. Contractor shall pay special attention to minimize any damage to embankments and dikes in the vicinity of water crossings.

The equipment for launching shall be arranged in such a way that the pipeline is laid without impact or jerking and is not subjected to stresses of any type other than those which are allowable. Minimum allowed radius of curvature shall be followed, particularly at the end of the launching way towards the water in the freely suspended section.

After the water-crossing section has been installed in place, Contractor shall fill this pipeline section including the pertaining land pipeline sections with water for the final testing.

Contractor shall check if the position and depth of the water crossing are in accordance with the approved drawing, by means of a profile of the pipeline, before and after the water crossing section is filled with water.

Prior to backfill the pipeline shall, when laid in the trench, conform to the bottom contour of the trench grade, so that it will be firmly, uniformly and continuously supported within the permissible limits of unsupported spans as specified in Para 4.1.

If the pipe does not properly fit the trench or does not rest at sufficient depth to satisfy the minimum requirements of cover as specified in approved drawings, the Contractor shall make necessary corrections to trench so that the pipe, when finally in position in the trench, shall fully meet the specification, failing which Contractor may be asked to remove the pipeline. This shall be done at no extra time and cost to the Company.

9.0 INSTALLATION OF PARALLEL PIPELINES

When parallel pipelines are required to be installed across major water crossing, Contractor shall further comply with the following requirements.

Depending on the diameter of the parallel pipelines, the characteristics of the crossing and the limitation of Contractor's equipment, Contractor may propose installation of the parallel pipelines either together in a combined operation or separately in a common trench.

If the pipelines are installed together, the minimum clear distance between the parallel pipelines (measured from the outside diameters of the concrete coated pipes) shall be 300 mm. Contractor shall provide spacers (at sufficient intervals along the length of the pipe sections), securely fixed to the pipes, or shall propose other suitable alternative methods, so as to ensure that the stipulated minimum clear distance is maintained. The buoyancy of the combined installation (pipes+spacers), shall be checked before installation. The spacers may be removed before the trench is backfilled.

Contractor shall furnish detailed drawings/calculations for the pipe assembly, showing the details of spacers/other arrangements for Company's approval before start of construction.

If the parallel pipelines are installed separately in a common trench, the minimum clear distance between the parallel pipelines in the trench shall be 5000 mm. Contractor shall ensure that this minimum spacing is maintained till the time the trench is backfilled.

Construction Equipment
All critical construction equipment deployed shall have a factor of safety of 2 (minimum) over the calculated loads/capacities.

10.0 BACKFILLING AND BANK PROTECTION

10.1 BACKFILLING

Backfilling of the water-crossing section shall be performed as described in the following clauses.

The bottom of the water way shall be reinstated to its original level by backfilling the trench in a manner and with suitable material and as prescribed and approved by the Authorities and Company. In case material other than the original spoil is required, this shall be supplied by Contractor.

Wherever boulders, rock; gravel and other hard objects are encountered, they shall not be placed directly on the pipe.

Sufficient soft earth, sand or selected and approved back fill material shall be backfilled initially around and over the pipe to provide a protective padding or cushion extending to a minimum thickness of 0.5 m around the pipe before backfilling remainder of the trench with excavated or other material.

Wherever required by Company, Contractor shall cover the nearly backfilled trench with a layer of rock boulders to be approved by Company over a width equal to the width of excavated trench with an extra of 5m on either side at no extra cost to Company.

Backfilling progress of the trench shall be checked continuously and a daily progress report shall be made in three-fold and handed over to Company.

All embankments and/or dikes, bed and banks shall be reinstated to their original state and levels, unless otherwise prescribed in the drawings or by the competent Authorities or Company.

All remaining spoil-deposits shall be cleaned by Contractor to the satisfaction of Company.

10.2 BANK PROTECTION

a. Trenches in banks of major water crossing shall be backfilled with soil approved by Company. The fill at the banks shall be compacted firmly and reinforced with sacked earth, rip-rap, or by other means as directed by Company to the satisfaction of Authorities having jurisdiction thereof. In areas where the backfilled soil is expected to be of loose type, which is prone to flow, the trench shall be backfilled with crushed rock of size approved by Company and pipe shall be provided with adequate padding of soil of a quantity approved by Company. Slope breakers if required shall be provided in both the banks. After the trench has been backfilled and during the cleanup works, the water crossing shall be cleaned across the whole width of RoU.

b. Unless stipulated otherwise by the Authority or by Company, Contractor shall protect the banks of the major water crossings by using gravel and boulders filled embankment mattresses of galvanized iron wire to be laid over the backfilled, compacted and graded banks. In case slope of the banks is 1:1 or more, bank protection shall be carried out using gabions. Bank protection works shall be carried out by Contractor in accordance with the relevant drawings. All materials required for such works shall be supplied by Contractor and all works carried out in accordance with specifications, approved drawings, instructions of Company and to the complete satisfaction of Authorities having jurisdiction at no extra cost to Company.

c. The width of the above protection shall be equal to the width of trench excavated and damage and further extending 3 m on either side. The width of the restoration on the slope shall be determined by the levels.

d. Before post installation hydrostatic testing, Contractor shall "prove" the Diameter of the pipeline by passing a gauging pig 95% of ID through the pipeline. The gauging pig shall be capable of locating and detecting defects permitted by governing code. Contractor shall supply and install all temporary test headers and other equipment, piping materials and other consumables for the purpose.

11 POST-INSTALLATION HYDROSTATIC TEST

The test pressure shall be same as adopted during pre-testing. The combined equivalent stress in the pipeline due to bending, static head and test pressure shall not exceed 95% of the SMYS of the pipe material. After temperature stabilization, pressure shall be retained in the pipeline for a minimum 24 hours and recorded by manothermograph. The hydrostatic testing shall be carried out in accordance with approved procedures.

12 POST-CONSTRUCTION SURVEY

After laying of the pipeline, Contractor shall carry out a post-construction survey jointly with Company. Any defects brought to the notice of Contractor shall be promptly corrected by Contractor at his own expense to the complete satisfaction of Company.

13 FINAL CLEAN-UP

After completion of construction, Contractor shall clear the site of all balance material and debris. All balance pipe lengths, in case supplied by company, shall be returned to Company's designated stock yard(s). Site shall be cleared to the complete satisfaction of Company and authorities having jurisdiction. All such works shall be done at no extra cost to Company.

14 DOCUMENTATION

In addition to the documents specified elsewhere in this specification, Contractor shall submit to the Company six copies of leach of the following documents/records.

i. Pipe book of the crossing.

ii. Copies of the permits obtained from Authorities having jurisdiction for the various works.

iii. Clearance certificates from the land owners and Authorities having jurisdiction regarding satisfactory clean-up and restoration of pipeline ROU and work areas.

iv. Pre and post installation Hydrotest Report.

v. True profile of the bed and banks of water crossing along the pipeline after backfilling

vi. True profile of the pipeline as installed and depth of cover at top of pipe at 10 m interval.

vii. Location and angle of sag bends and over bends.

viii. Cross section along the pipeline indicating nature and extent of backfill materials, thickness of concrete coating to pipe etc.

ix. Method and extent of bank protection.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR ASSORTED VALVES

GAIL-STD-PL-DOC-TS-017

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1. 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. REFERENCE DOCUMENTS

The following Standard includes provision which, through reference in this text constitute provision of this Standard. Latest revision of this standard shall be used unless otherwise specified.

API 1104	: Specification for Welding Pipelines and related facilities.
ASME 16.10	: Face to Face and End to End Dimensions of Valves
ASME 16.20	: Metallic gasket for pipe flanges – Ring joint or spiral wounds and jacketed.
ASME 16.21	: Non Metallic Gaskets for pipe flanges.
ASME B 16.5	: Steel Pipe Flanges and Flanged Fittings.
ASME B 16.34	: Valves - Flanged, Threaded and Welding Ends.
ASME B 16.5	: Steel Pipe Flanges and Flanged Fittings.
ASME B 31.3	: Process Piping.
ASME B 31.8	: Gas Transmission and Distribution Piping Systems.
ASME Sec VIII Div.I/Div.II	: Boiler and Pressure Vessel Code – Rules for Construction of Pressure Vessels.
ASTM A3 70	: Standard Test Methods and Definitions for Mechanical Testing of Steel Products.
ASTM B 733	: Auto catalytic Nickel Phosphorous Coating on Metals.
BS 6755-1	: Testing of Valves. Specification for production pressure testing requirements.
BS 6755-2	: Testing of Valves. Specification for fire type-testing requirement.
EN 10204	: Metallic Materials – Types of Inspection documents.
MSS-SP-6	: Standard Finishes for Contact Faces of Pipe Flanges and Connecting - end Flanges of Valves and Fittings.
MSS-SP-25	: Standard marking system for Valves, Fittings, Flanges and Union.
MSS-SP-44	: Steel Pipeline Flanges.
MSS-SP-53	: Quality Standard for Steel Casting and Forgings for Valves, Flanges and Fittings and Other Piping Components – Magnetic Particle Examination Method.
ISO 5208	: Industrial Valves – Pressure Testing of Valves
ISO 10497	: Testing of Valves – fire type testing requirements.

ISO 13623 : Petroleum & Natural Gas Industry – pipeline transportation system.

ISO 14313 : Petroleum & Natural Gas Industry. Pipeline transportation system – Valves.

SSPC-VIS-1 : Steel Structures Painting Council Visual Standard.

3. DEFINITIONS

Shall : This verbal form indicates requirements strictly to be followed in order to confirm to the standards and from which no deviation is permitted.

Should : This verbal form indicates that among several possibilities one is particularly suitable without mentioning or excluding others or that a certain course of action is preferred but not necessarily required.

May : This verbal form indicates a course of action permissible within the limits of this standard.

Can : This verbal form used for statements of possibility & capability, whether material, physical or casual.

4. MATERIALS

4.1 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.

4.2 Carbon steel used for the manufacture of valves shall be-fully killed.

4.3 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:

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

4.4 For valves specified to be used for Gas service or High Vapor 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 22J.

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.

4.5 When the ball of valve is manufactured out of C.S, it shall be subjected to 75µm/0.003"/0.075mm thick electroless nickel plating as per ASTM B733 with following classification SC2, type II, class-2 for Ball made of S.S material, ENP is not mandatory.

4.6 Valves shall be subjected to hardness test on base material for each heat for pressure containing parts. 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.

5. DESIGN AND CONSTRUCTION

5.1

a) Valve design shall be as per API 6D and suitable for the process conditions indicated in the 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 with 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 B16.34.

b) Corrosion Allowance for all valves to be used in sweet gas services shall be considered nil.

c) The manufacturer shall have valid license to use API monogram on valves manufactured as per API6D.

5.2 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
	150-250 (6-10)	Regular
	300 (12) & above	Venturi
600	50-250 (2-10)	Regular
	300 (12) & above	Venturi
900	50-250 (2-10)	Regular
	300 (12) & above	Venturi

5.3 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.

5.4 Cover shall be bolted to the body and screwed connections are not acceptable.

5.5 Soft seats to achieve a seal between plug and body are not permitted.

5.6 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.

5.7 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.

5.8 Valve design shall ensure repair of gland packing under full line pressure.

5.9 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 ASME B 16.5. For valve sizes up to DN 600 mm (24") excluding DN 550 mm (22") MSS-SP-44 shall be referred/ ASME B16.47Series A for DN 550 mm (22") and for DN 650 mm (26 inches) and above. Flange face shall be either raised face or ring joint type as indicated in Valve Data Sheet. In case of RTJ flanges, the groove hardness shall be minimum 140 BHN. All flanged face shall have concentric serration with 125 AARH finish

c) Butt welding end preparation shall confirm to ASME B 16.25. Incase of difference in thickness of valve body & mating pipelines, the bevel end of valve shall be as per ASME B 31.8. The end preparation shall take care of outside diameter of connecting pipe, wall thickness, material grade, SMYS & Special chemistry of welded material as indicated in the data sheet.

5.10 Valves shall be provided with plug position indicator and stops of rugged construction at the fully open and fully closed positions.

5.11 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.

5.12 Valves shall be suitable for either buried or aboveground installation as indicated in Valve Data Sheet.

5.13 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 centre line of the valve opening and the centerline of the rim of the hand wheel on a vertical shaft or centerline of the hand wheel on a horizontal shaft.

b) Vent, drain and sealant connections shall be terminated adjacent to the valve operator by means of suitable piping anchored to the valve body.

b) 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" or 1/2" NPT plugs at the top and bottom, for draining and filling with oil to prevent internal corrosion.

5.14 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 operate 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.

5.15 Repair by welding is not permitted for fabricated and forged body valves. However repair by welding as per ASME BI 6.34 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 4.6, 6.4 and 6.5 of this specification and shall meet the requirements as specified therein.

5.16 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.

5.17 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..

6. INSPECTION AND TESTS

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:

6.1 All valves shall be visually inspected.

6.2 Dimensional check on all valves shall be carried out as per the Purchaser approved drawings.

6.3 Chemical composition and mechanical properties shall be checked as per relevant material standards and this specification, for each heat of steel used.

6.4 Pressure containing parts of all valves such as body, bonnet, flange, welding ends and balls etc shall be subjected to impact test on each heat of base material as per API6D CL.3.7.

6.5 All Valves shall be impact tested at -20°C. The average energy absorbed shall be 35J and min. 28J.

6.6 Non Destructive Examination

a) 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. All castings shall be wet magnetic particle inspected 100% of the internal surfaces. Method and acceptance shall comply with MSS-SP-53.

b) Body castings of all valves shall be radio graphically examined as per ASME B16.34. Procedure and acceptance criteria shall be as per ASME B 16.34. For all sizes body casting shall be subjected to 100% radiography.

c) All 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 subject to wet magnetic particle inspection on 100% of the internal surfaces. Method and acceptance shall comply with MSS-SP-53

Bodies and bonnets made by welded assembly of segments of castings, forgings, combinations thereof shall be examined, as applicable, by methods of 6.6 (b) for cast components or 6.6 (c) for forged components and plates.

6.7 Full inspection by radiography shall be carried out on all welds of pressure containing parts. Acceptance criteria shall be as per ASME B 31.3 or ASME B31.8 as applicable and API 1104.

6.8 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 penetrate 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.

6.9 All valves shall be tested in compliance with the requirements of API 6D. 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. No leakage is permissible during hydrostatic testing. The body cavity self-relieving feature meeting the requirements of clause 5.8 of this specification shall also be checked.

6.10 A supplementary air seat test as per API 6D 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.

6.11 Valves shall be subjected to Operational Torque Test as per clause C4 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 5.22 (c) of this specification.

6.12 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. The 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.

6.13 Subsequent to successful testing as specified in clause 6.9, 6.10, 6.11 and 6.12 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 500 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 6.9 and 6.10.

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 prototype test of similar nature shall not be considered acceptable in place of this test.

6.14 Purchaser reserves the right to perform stage wise inspection and witness tests as indicated in clauses 6.1 to 6.13 above at Manufacturer's works prior to shipment. Manufacturer shall give reasonable access and facilities required for inspection to the Purchaser. 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.

7. 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 6.11, 6.12 and 6.13 of this specification.

e) All other test reports and certificates as required by API 6D, this specification and datasheets.

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.

8. PAINTING, MARKING AND SHIPMENT

8.1 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 coal tar epoxy resin with a minimum dry film thickness of 300 microns.

8.2 All valves shall be marked as per API 6D. The units of marking shall be metric except nominal diameter, which shall be in inches.

8.3 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.

8.4 All sealant lines and other cavities of the valve shall be filled with sealant before shipment.

8.5 Packaging and shipping instructions shall be as per API 6D and procurement documentation. All valves shall be transported with ball in the fully open condition.

8.6 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

9. SPARES AND ACCESSORIES

9.1 Manufacturer shall furnish list of recommended spares and accessories for valves required during start-up and commissioning.

9.2 Manufacturer shall furnish list of recommended spares and accessories required for two years of normal operation and maintenance of valves.

9.3 Manufacturer shall quote for spares and accessories as per Material Requisition.

10.0 DOCUMENTATION

10.1 At the time of bidding, Manufacturer shall submit the following documents:

a) Filled Data Sheet

b) 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.

b) Sectional drawing showing major parts with reference numbers and material specification. In particular a blow up drawing of ball-seat assembly shall be furnished complying with 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 centerline to bottom of support foot.

10.2 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 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. Manufacturer 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.

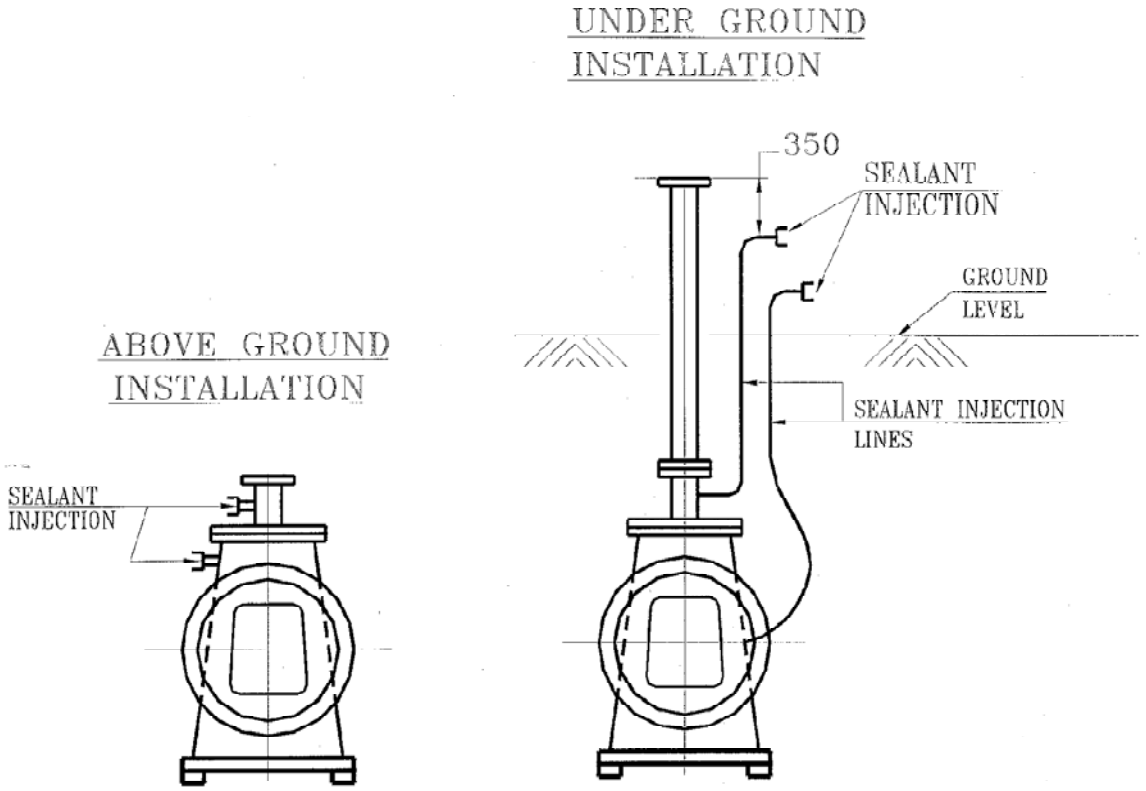
10.3 CD containing all docs in 10.2 & 10.4 shall be submitted within 30 days from the approval date, Manufacturer shall submit to Purchaser one reproducible and six copies of the approved drawings, documents and specifications as listed in clause 10.2 above.

10.4 Prior to shipment, Manufacturer shall submit to Purchaser one reproducible and six copies of the following:

a) Test certificates as per clause 7.0 of this specification.

b) Manual for installation, erection, maintenance and operation instructions including a list of recommended spares for the valves.

10.5 All documents shall be in English language only.


UNDER GROUND
INSTALLATION
350
SEALANT
INJECTION
GROUND
LEVEL
SEALANT INJECTION
LINES
ABOVE GROUND
INSTALLATION
SEALANT
INJECTION

CHECK VALVE

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 c-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:

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

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 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 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:

a) Swing Check Valve
b) Dual Plate Check Valve
c) 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 require 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 B 16.25. 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 B 31.3, 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. Inspection certification shall be confirmed to EN-10204-3.1b. 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) Wherever applicable, the body castings of valves shall be radio graphically 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	-	$\leq$ DN 400mm (16")	-	100%
		$\geq$ DN 450mm (18")	-	100%
ANSI Class 600	-	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:

a) Mil test certificates relevant to the chemical analysis and mechanical properties of the materials used for the valve construction as per the relevant standards.

b) Hydrostatic test certificates complete with records of timing and pressure of each test.

c) Test reports of radiograph and ultrasonic inspection, as applicable.

d) All other tests 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 :

a) Order Number

b) Manufacturer's Name and trade mark.

c) Valve Size and Rating

d) Tag Number.

e) Minimum & maximum operating temperature.

f) Body material designation.

g) Maximum operating pressure.

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 and Quality assurance plan (QAP).

c) Details of corrosion resistant paint proposed to be applied.

Reference list of similar supplies of check valves, including project, year, client, location, size, rating, the Manufacturer shall furnish services, etc. 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 change to the Purchaser as per the relevant clause of the bid document.

10.5 All expenses shall be to Manufacturer's account.

LYONS ENGINEERING PVT. LTD. NEW DELHI	PIPELINE SYMBOLS	DRAWING NO. GAIL-STD-PL-DWG-TP-001
		SHEET NO. 1 OF 1

PROPOSED PIPELINE

EXISTING PIPELINE

TP TURNING POINT

UNCASED CROSSING

CASED CROSSING

CNNTINUOUS CONCRETE WEIGHT COATING

GRAVEL FILLED GEO TEXTILE BAGS

OPTICAL FIBER CABLE INSIDE HDPE

OPTICAL FIBER CABLE INSIDE HDPE CONDUIT SUBDUCTED IN CS PIPE

INTERMEDIATE PIGGING STATION

SECTIONALISING VALVE (SV)/ BLOCK VALVE

EXISTING UNDERGROUND CABLE/PIPELINE/ STRUCTURE CROSSING

PUMP/ COMPRESSOR STATION

HOT INDUCTION BEND

INSULATION JOINT

K K.M. POST

W PIPELINE WARNING SIGN

A AERIAL MARKER

N NAVIGABLE WATERWAY PIPELINE WARNING SIGN

D DIRECTION MARKER

TEST STATION

CHAINAGE C.P.

TYPE INSTALLATION

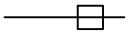
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	18.01.2019	ISSUED FOR TENDER	SS	VKS	JR

LYONS ENGINEERING PVT. LTD. NEW DELHI	TOPOGRAPHICAL SYMBOLS	DRAWING NO. GAIL–STD–PL–DWG–TP–002
		SHEET NO. 1 OF 1

METALLED ROAD

UNMETALLED ROAD

RAILWAY


BOUNDARY WITH MARKER

STREAM < 5 M WIDTH

STREAM < 5 m. WIDTH(DRY)

TIDAL RIVER

CANAL

DAM

WATER TANK, LAKE OR RESERVOIR

QUARRY

ROCKY SLOPES

TUBE WELL

WALL (DESCRIBED)

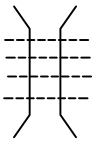
PLACE OF WORSHIP

MONUMENT

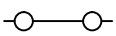
HUTS (TEMPORARY)

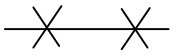
GRAVES

TREE


BRIDGE

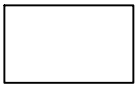
POWER LINE


TELEPHONE LINE


FENCE

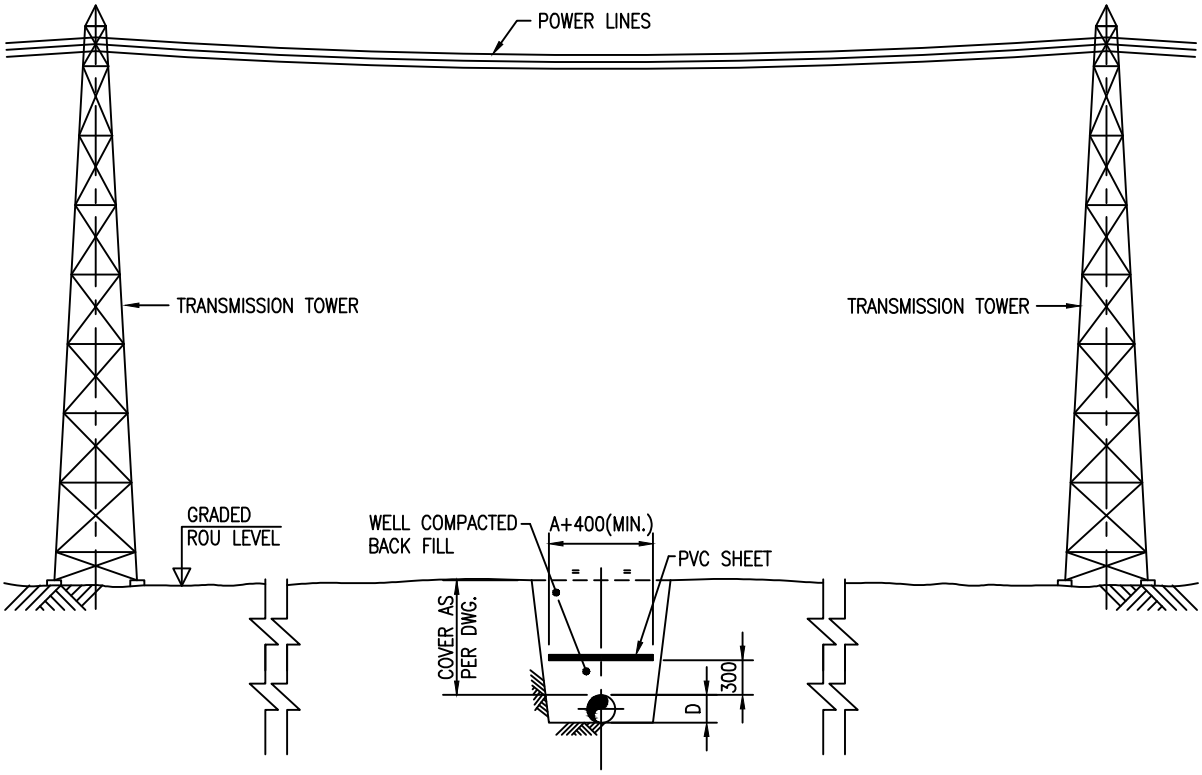
GROUND PROFILE

SWAMP OR MARSH/MUD

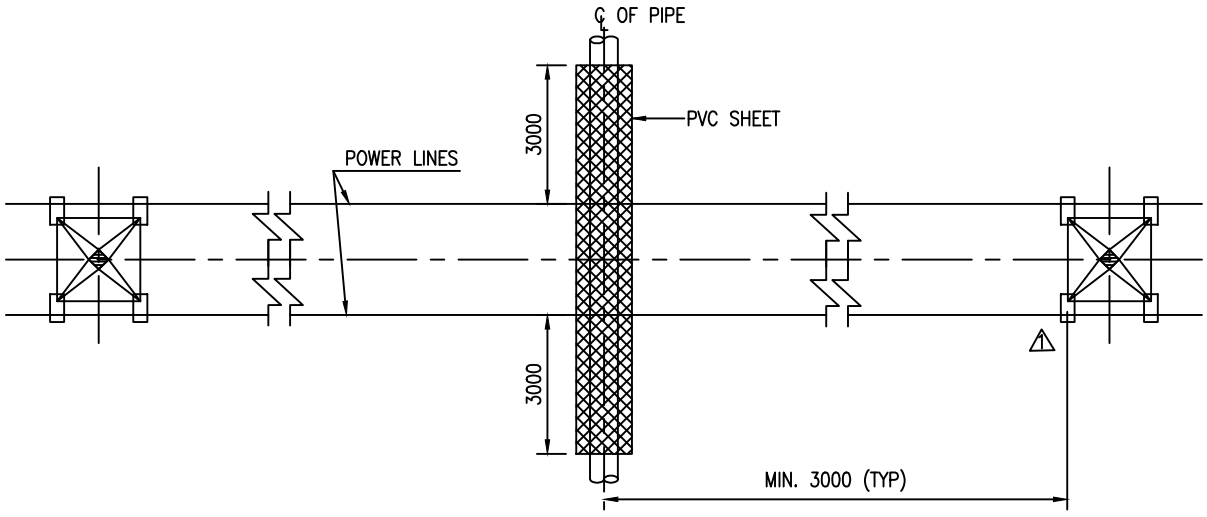

SAND DUNES

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	18.01.2019	ISSUED FOR TENDER	SS	VKS	AP

LYONS ENGINEERING PVT. LTD. NEW DELHI	OVERHEAD POWER LINE CROSSING	DRAWING NO. GAIL–STD–PL–DWG–TP–003
		SHEET NO. 1 OF 1



SECTION

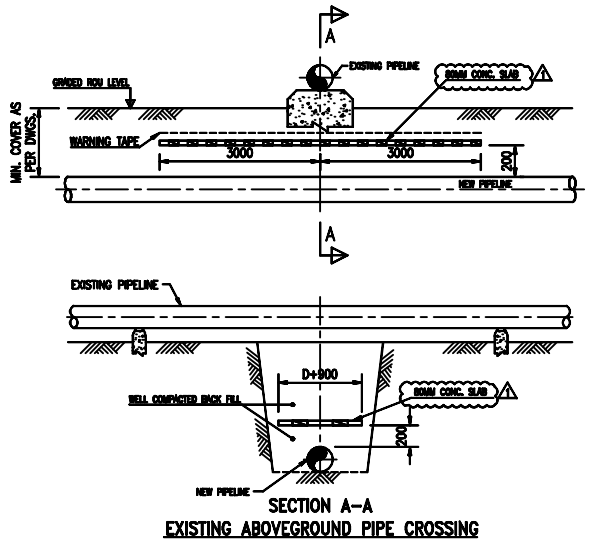


PLAN

NOTES:–

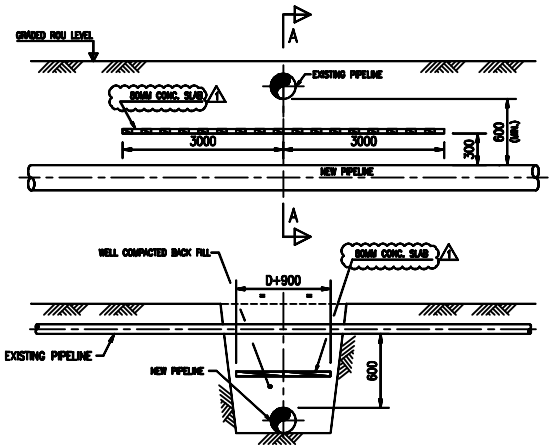
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE STATED.
2. HDPE 6MM thk. SHEET SHALL BE USED FOR POWER SUPPLY 11 KV AND 66 KV.
3. CONCRETE SLAB OF 100 MM SHALL BE PROVIDED FOR ABOVE 66 KV.
4. SUITABLE MEASURES SHALL BE TAKEN FOR THE PROTECTION OF THE LINE AND SECURITY OF PERSONNEL WHEREVER FOUND NECESSARY.
5. DIMENSION 'A' SHALL BE A=D+500MM.
6. APPROVAL OF THE CROSSING SHALL BE OBTAINED FROM CONCERNED AUTHORITIES.

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	18.01.2019	ISSUED FOR TENDER	SS	VKS	JR



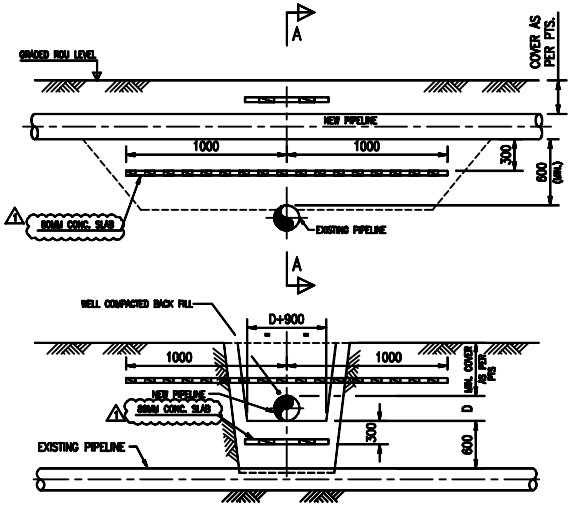
SECTION A–A

EXISTING ABOVEGROUND PIPE CROSSING



SECTION A–A

EXISTING UNDERGROUND PIPE CROSSING(TYPE–1)



SECTION A–A

EXISTING UNDERGROUND PIPE CROSSING(TYPE–1)

NOTES

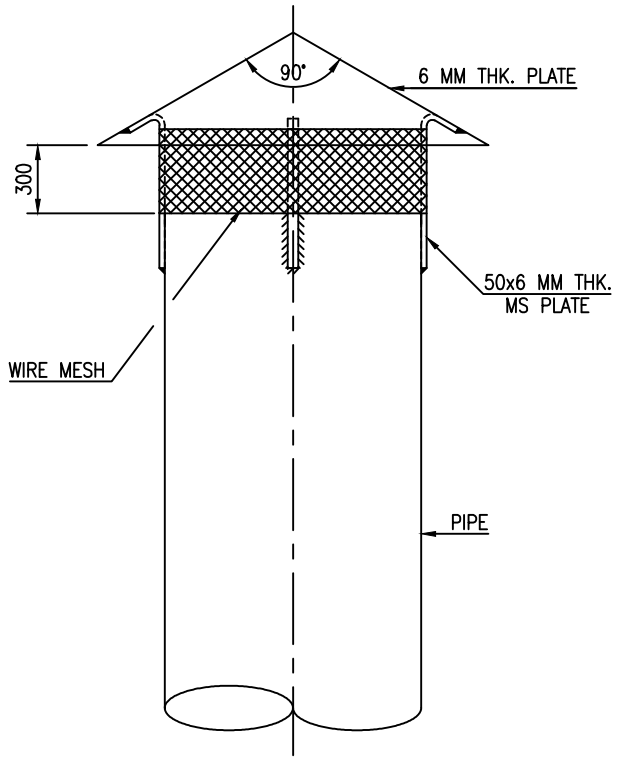
NOTES

1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE STATED.
2. A MODIFIED PIPELINE WARNING SIGN SHALL BE INSTALLED WHERE THE PIPELINE CROSSES AN EXISTING PIPELINE CARRYING HAZARDOUS FLUID.
3. FOR CONCRETE SLAB REFER DWG. No. GIGL–STD–PL–DWG–TP–034
4. SUITABLE CATHODIC PROTECTION BONDING SHALL BE PROVIDED BETWEEN CROSSING PIPELINES. IN SOME CASES THE NEW PIPELINE MAY REQUIRE ELECTRICAL ISOLATION.
5. TRENCH DIMENSIONS SHALL BE IN ACCORDANCE WITH RELEVANT STANDARDS/SPECIFICATIONS.
6. APPROVAL OF THE CROSSING SHALL BE OBTAINED FROM CONCERNED AUTHORITIES.

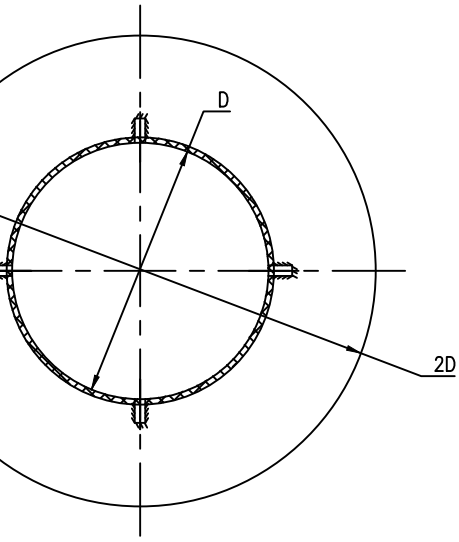
LYONS ENGINEERING PVT. LTD. NEW DELHI								TYPICAL EXISTING PIPELINE CROSSING	DRAWING NO.	REV.
	DWG. NO.	REF. DRAWING	0	18.01.19	ISSUED FOR TENDER	SS	WS	JR		
			NO.	DATE	REVISION	DRN	CHKD	APPD	GAIL–STD–PL–DWG–TP–004	0

LYONS ENGINEERING PVT. LTD. NEW DELHI	RAIN CAP	DRAWING NO.
		GAIL–STD–PL–DWG–TP–006
		SHEET NO. 1 OF 1

TYPE–I

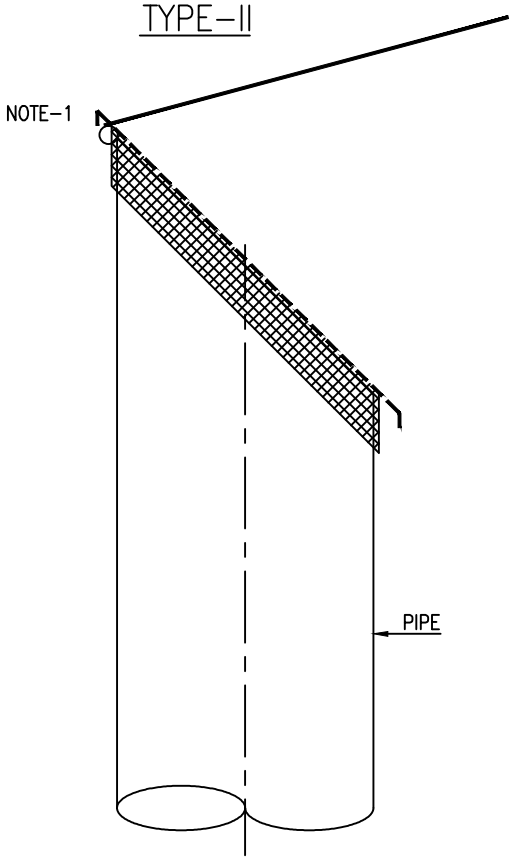


ELEVATION

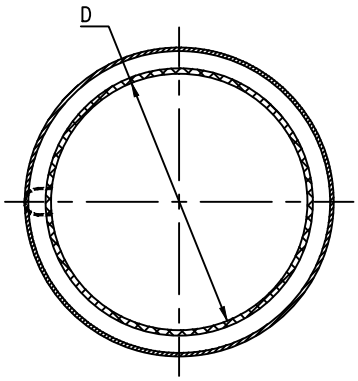


PLAN

TYPE–II



ELEVATION

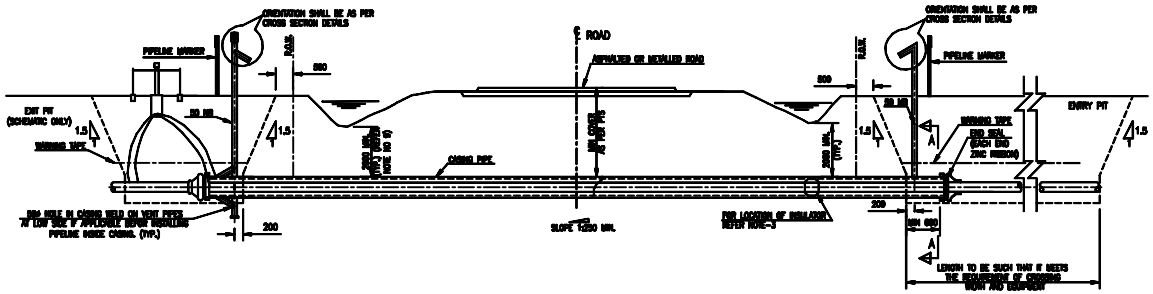


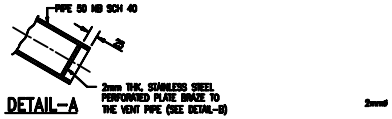
PLAN

NOTES:–

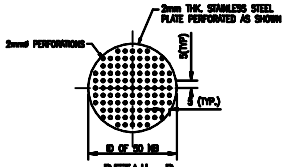
1. HINGE DETAILS TO BE DECIDED BY VENDOR.
2. MATERIAL OF CONSTRUCTION OF FLAP SHALL BE NON SPARKLING BRASS.
3. 1/2" CIRCULAR RING SHALL BE PROVIDED AROUND THE FLAP.
4. STOPPER TO BE PROVIDED SO THAT FLAPPER GO BACK TO ITS ORIGINAL POSITION AFTER COMPLETION OF VENTING.

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	18.01.2019	ISSUED FOR TENDER	SS	VKS	AP

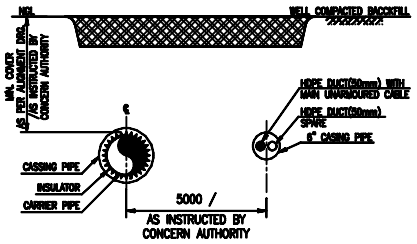




DETAIL-A

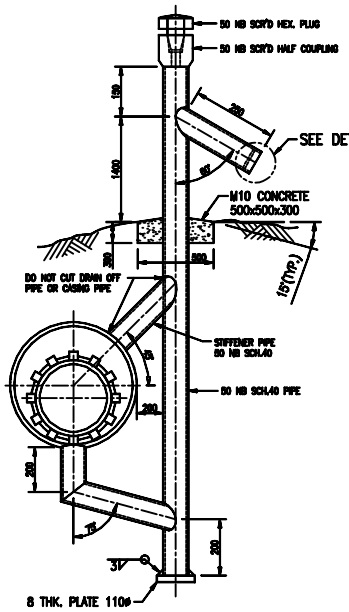


DETAIL-B

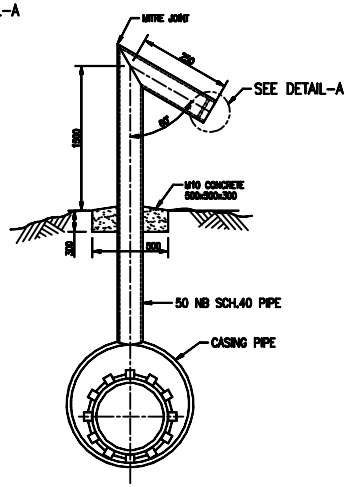


SECTION A-A

TYPICAL BORE PIT EXCAVATION



DRAIN OFF

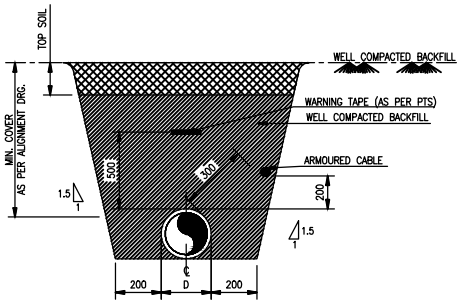


VENT

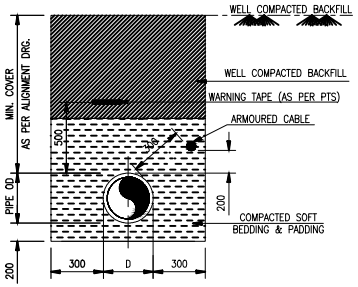
NOTES

1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. THE CROSSING WORKS SHALL BE EXECUTED IN ACCORDANCE WITH API RECOMMENDED PRACTICE 1102 LATEST EDITION.
3. 500mm AWAY FROM BOTH ENDS, TWO NOS. INSULATORS SHALL BE PLACED. IN BALANCE LENGTH MAX. SPACING OF INSULATORS SHALL BE 2000 mm.
4. ELECTRICAL INSULATION BETWEEN THE CASING AND CARRIER PIPE SHALL BE CHECKED WITH A SUITABLE MEGGER.
5. MATERIAL OF THE CASING INSULATORS SHALL BE HDPE. END SEALS SHALL BE HEAT SHRINKABLE TYPE, CONTRACTOR SHOULD TAKE PRIOR APPROVAL FOR MATERIAL OF CONSTRUCTION FOR END SEAL & SHALL SUBMIT MATERIAL CERTIFICATES TO OWNER/ CONSULTANT FOR APPROVAL.
6. 1:250 SLOPE TO BE PROVIDED FOR DRAINING DURING INSTALLATION OF CASING PIPE.
7. CASING PIPE SHOULD EXTEND MIN. 600mm BEYOND THE TOE OF THE SLOPE OR BASE GRADE, OR MIN 900mm BEYOND THE BOTTOM OF THE DRAINAGE DITCH, WHICHEVER IS MORE.
8. CONTRACTOR SHOULD SUBMIT DETAILED WORK PROCEDURE ALONG WITH SKETCHES AND MATERIAL TEST CERTIFICATES FOR APPROVAL.
9. THE CROSSING SHALL BE DONE ACCORDING TO THE GOVERNING DIMENSION OUT OF THESE DEFINED DIMENSIONS, AS THESE ARE ONLY GUIDING DIMENSIONS.
10. BENTONITE FILLING PROCEDURE SHALL BE DONE AS PER OWNER/ CONSULTANTS INSTRUCTIONS.
11. CROSSING MAY BE CARRIED OUT PRIOR TO MAINLINE ACTIVITIES ADDITIONAL ROU, IF REQUIRED, FOR APPROACH TO CROSSING, PIPELINE STRING, HYDROTESTING WORKING PIT FOR CROSSING TO AVOID CAVING OF SOIL SHALL BE PROCURED BY CONTRACTOR WITHOUT ANY COST IMPLICATION.
12. CATHODIC PROTECTION :- ALL CASING PIPES FOR CROSSING SHALL BE C.P. PROTECTED.
13. TEST STATION ON BOTH SIDE OF CROSSING.
14. THE LOCATION OF ENTRY AND EXIT PIT SHALL BE DECIDED AT SITE TO SUIT THE SITE REQUIREMENT.
15. AT EACH CROSSING, PIPELINE CROSSING WARNING SIGN SHALL BE INSTALLED ON EITHER SIDE OF CROSSING. THE WARNING PLATE MAY BE MOUNTED ON THE VENT/DRAIN OFF PIPE.
16. ALL CARRIER PIPELINE JOINTS SHALL BE RADIOGRAPHED.
17. PIPELINE SECTION SHALL BE PRETESTED HYDROSTATICALLY SEPARATELY FROM THE MAIN LINE TESTING WHEN REQUIRED BY CONCERNED AUTHORITIES OR AS DIRECTED BY CLIENT.
18. THE CASING PIPE SHALL BE PROVIDED WITH MINIMUM 50 MM DIAMETER VENT PIPE FOR FILLING BENTONITE. AFTER FILLING OF BENTONITE, VENT PIPE AT BOTH ENDS SHALL BE TRIMMED AND PLUGGED/SEALED WITH END CAPS.
19. IN ANY CASE, THE MINIMUM LENGHTH OF CASING PIPE SHALL BE 72M FOR NATIONAL HIGHWAY CROSSING, AND 60M FOR ALL STATE HIGHWAY/MDR CROSSING.

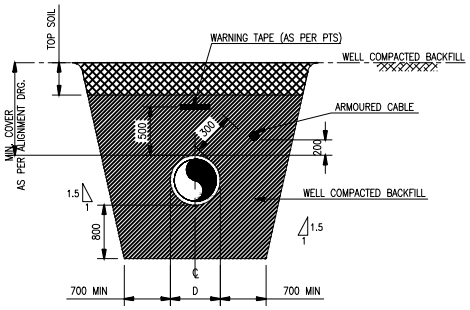
LYONS ENGINEERING PVT. LTD. NEW DELHI									CASED CROSSING PIPELINE ROAD / HIGHWAY	DRAWING NO.	REV.
	DWG. NO.	REF. DRAWING	0	18.01.19	ISSUED FOR TENDER	SS	VKS	JR		GAIL-STD-PL-DWG-TP-007	0
			NO.	DATE	REVISION	DRN	CHKD	APPD			



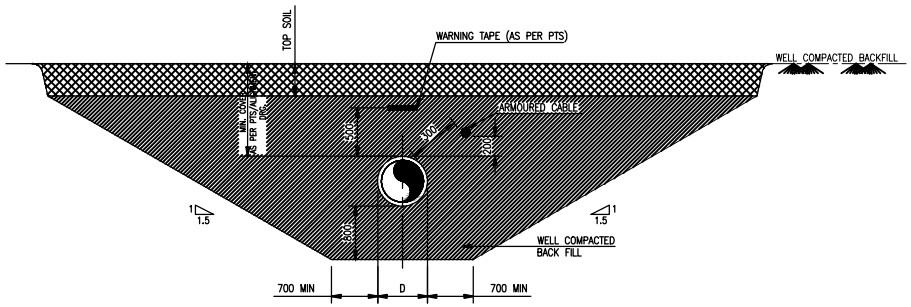
TYP. TRENCH DETAILS IN NORMAL SOIL
TYPE-1



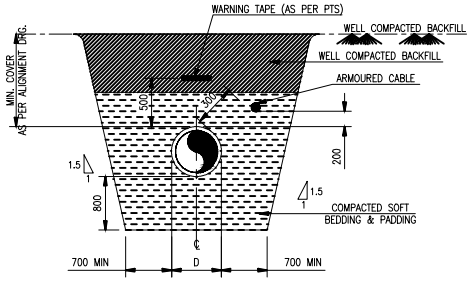
TYP. TRENCH DETAILS IN ROCK AREA
TYPE-2



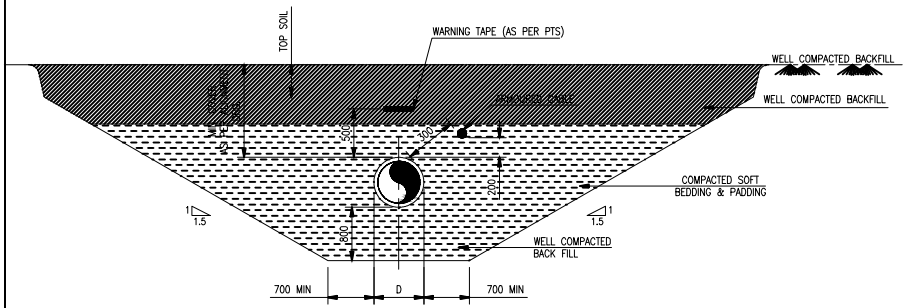
TYP. TRENCH DETAILS FOR REVERSE SLIP FAULT (IN NORMAL SOIL) AREAS
TYPE-3



TYP. TRENCH DETAILS FOR SLIP FAULT (IN NORMAL SOIL) AREAS
TYPE-4



TYP. TRENCH DETAILS FOR REVERSE SLIP FAULT (IN ROCK) AREAS
TYPE-5



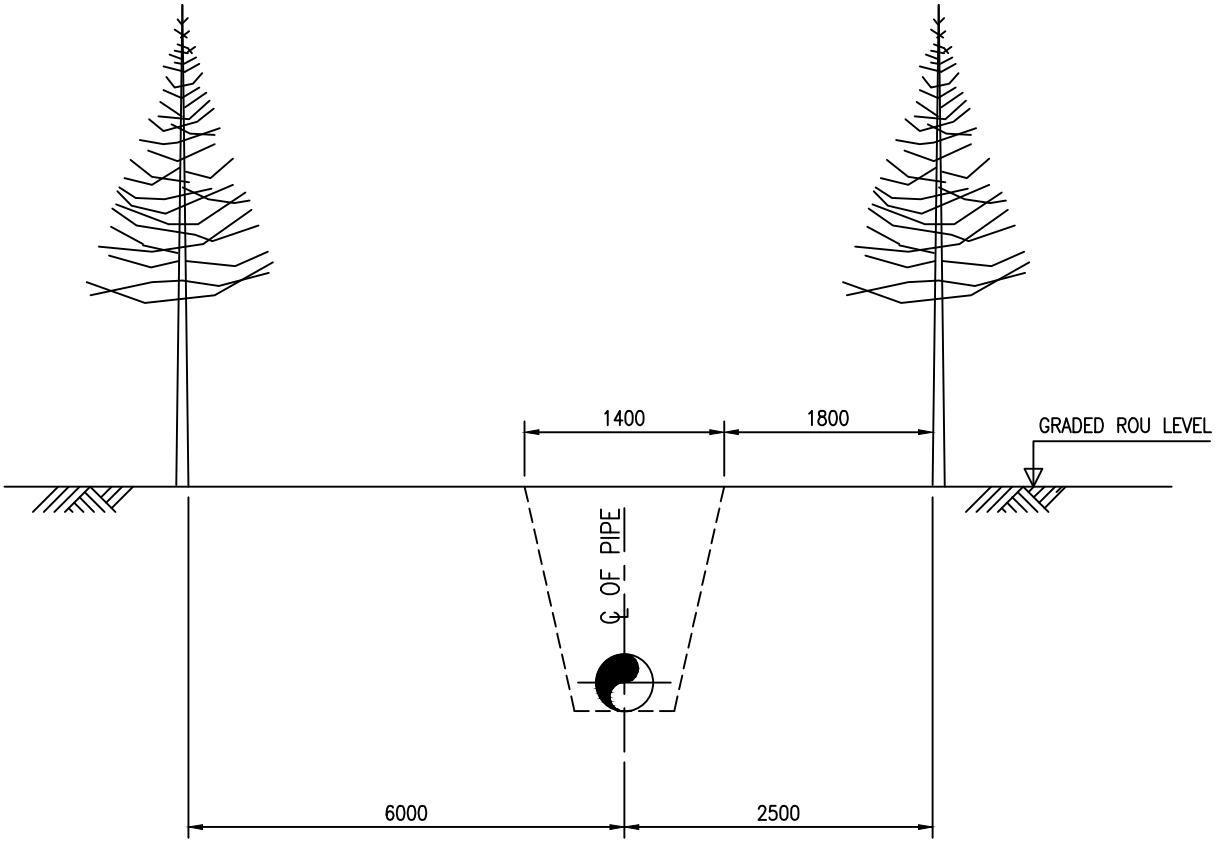
TYP. TRENCH DETAILS FOR SLIP FAULT (IN ROCK) AREAS
TYPE-6

NOTES

1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. MINIMUM COVER OVER LINE PIPE SHALL BE AS PER PTS AND REQUIREMENT OF CONCERNED AUTHORITY.
3. THIS SKETCH IS INDICATIVE ONLY.
4. TYPE OF TRENCHING TO BE USED SHALL BE AS PER PTS AND APPROVED PROCEDURE.
5. ALL TYP. CROSS SECTIONS MUST BE VIEWED LOOKING IN THE DIRECTION OF FLOW.

LYONS ENGINEERING PVT. LTD. NEW DELHI									TYPICAL TRENCH DETAIL	DRAWING NO. GAIL-STD-PL-DWG-TP-008
	DWG. NO.	REF. DRAWING	NO.	DATE	REVISION	DRN	CHKD	APPD		REV. 0
			0	18.01.19	ISSUED FOR TENDER	SS	WS	JR		

LYONS ENGINEERING PVT. LTD. NEW DELHI	ROU FOR FOREST AREA	DRAWING NO.
		GAIL–STD–PL–DWG–TP–009
		PAGE NO. Page 1 of 1

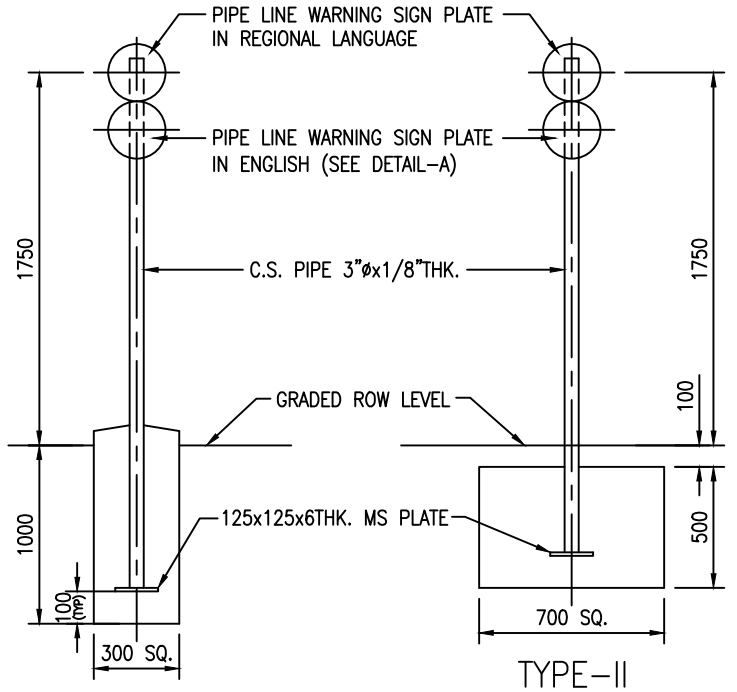


NOTES:–

ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE STATED.

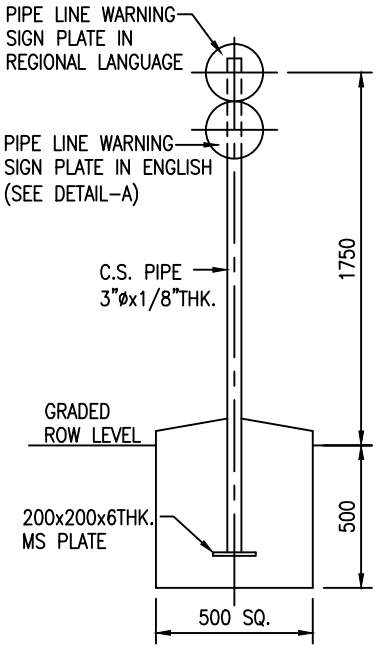
REV. NO.	DATE	SUBJECT OF REVISION	PREP	CHKD	APPD
0	10.01.2019	ISSUED FOR TENDER	SS	VKS	AP

LYONS ENGINEERING PVT. LTD. NEW DELHI	PIPE LINE WARNING SIGN	DRAWING NO. GAIL–STD–PL–DWG–TP–010
		SHEET NO. 1 OF 1

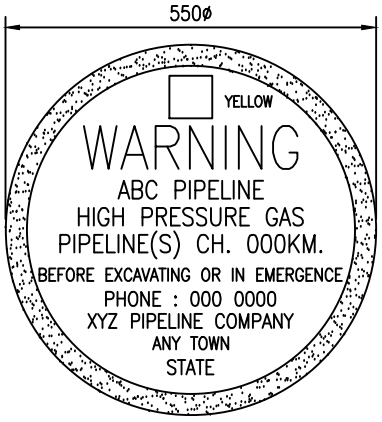


TYPE–I
FOR NORMAL SOIL

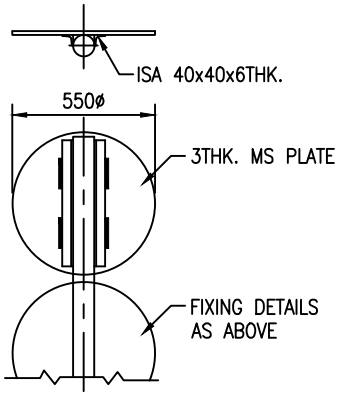
TYPE–II
FOR DRIFTING SAND SOIL



TYPE–III
FOR ROCKY AREAS



DETAIL–A



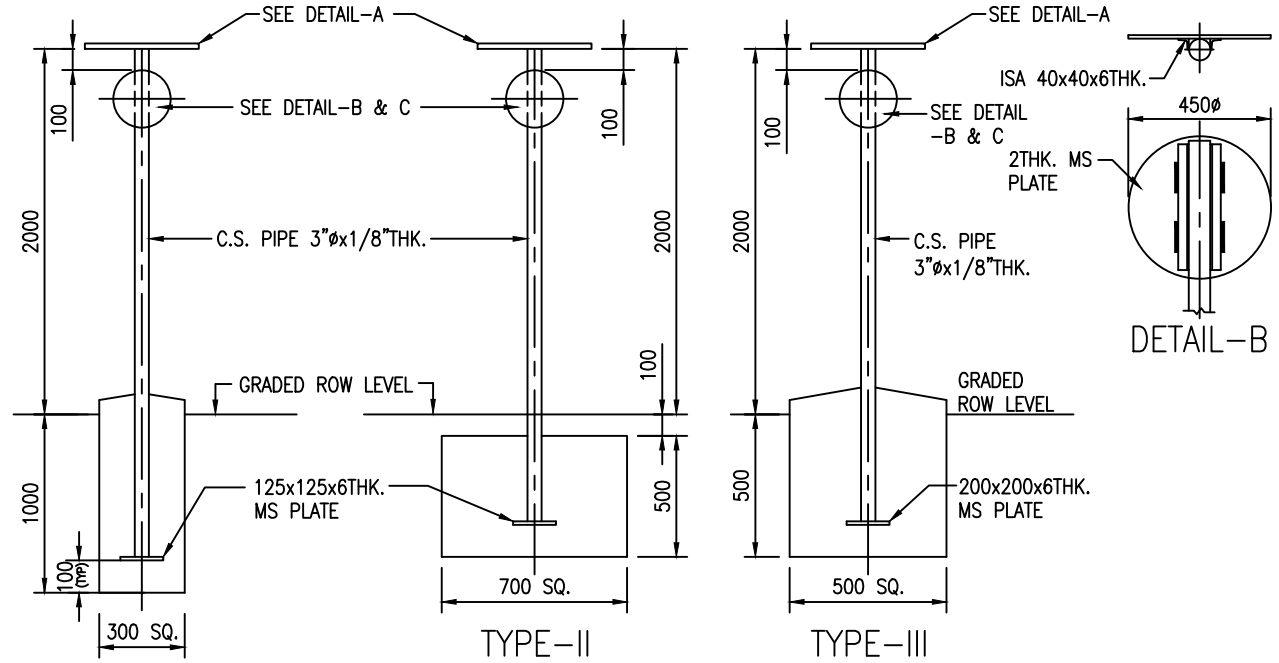
WARNING SIGN PLATE
FIXING DETAILS

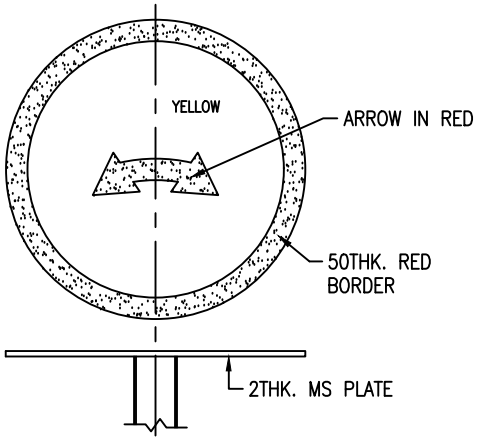
NOTES:–

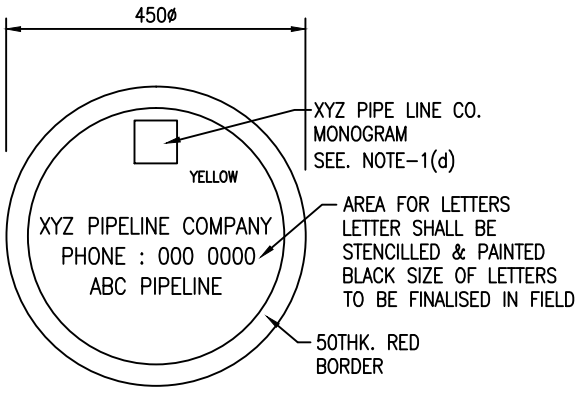
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE STATED.
2. SCHEME OF PAINTING & COLOURING
(a) UNDERGROUND STEEL STRUCTURE (EXCEPT THAT EMBEDDED IN CONCRETE), : COAL TAR EPOXY MIN. 300 MICRON THK.
(b) OVERGROUND STEEL STRUCTURE : ONE COAT OF PRIMER & TWO COATS SPECIFIED COLOUR PAINT.
(c) COLOUR SCHEME FOR XYZ PIPELINE CO. MONOGRAM SHALL BE AS DIRECTED BY OWNER.
(d) ALL LETTERS EXCEPT WARNING SHALL BE PAINTED BLACK.
(e) POST SHALL BE PAINTED WITH 250 WIDE ALTERNATE BANDS OF BLACK AND WHITE PAINT.
(f) ALL OTHER ABOVEGROUND STEEL SHALL BE PAINTED YELLOW.
3. LOCATION
(a) THE PIPE LINE WARNING SIGN SHALL BE INSTALLED IN ACCORDANCE WITH CONTRACT REQUIREMENTS AND AS DIRECTED BY OWNER IT SHALL BE INSTALLED TO THE LEFT OF THE PIPE CENTER LINE, VIEWING IN THE DIRECTION OF FLOW AT 300MM FROM PIPELINE O.D. AND THE WARNING SIGN PLATE SHALL FACE THE UTILITY BEING CROSSED.
(b) THE WARNING SIGN PLATE MAY BE MOUNTED ON VENT PIPES OR KM POST WHERE EVER POSSIBLE.
4. THE FOUNDATION SHALL BE MADE OF CONCRETE M20.
5. SIGN PLATE IN REGIONAL LANGUAGE SHALL BE PREPARED BY CONRACTOR ON SIMILAR LINES AND APPROVED BY THE OWNER.

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	18.01.19	ISSUED FOR TENDER	SS	VKS	AP

LYONS ENGINEERING PVT. LTD. NEW DELHI	DIRECTION MARKER	DRAWING NO.
		GAIL–STD–PL–DWG–TP–011
		SHEET NO. 1 OF 1







NOTES:–

1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE STATED.
2. SCHEME OF PAINTING & COLOURING

(a) UNDERGROUND STEEL STRUCTURE (EXCEPT THAT EMBEDDED IN CONCRETE) COAL TAR EPOXY MIN. 300 MICRON THK.
(b) OVERGROUND STEEL STRUCTURE : ONE COAT OF PRIMER & TWO COATS SPECIFIED COLOUR PAINT.
(c) FIGURES SHALL BE STENCILED ON BOTH SIDES OF THE POSTS IN BLACK.
(d) COLOUR SCHEME FOR XYZ PIPELINE CO. MONOGRAM SHALL BE AS DIRECTED BY OWNER.
(e) POST SHALL BE PAINTED WITH 250 WIDE ALTERNATE BANDS OF BLACK AND WHITE PAINT.
(f) ALL OTHER ABOVEGROUND STEEL SHALL BE PAINTED YELLOW.

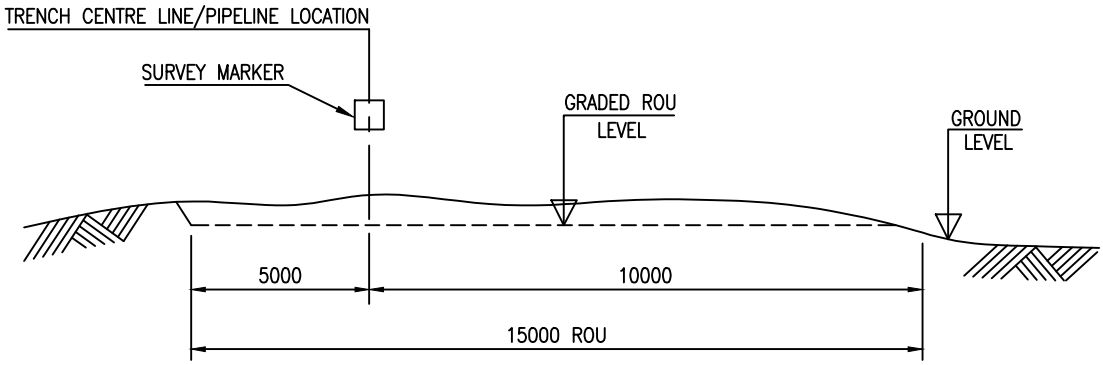
3. LOCATION

(a) DIRECTION MARKER SHALL BE INSTALLED AS PER SPECIFICATIONS AS DIRECTED IN APPROVED DRAWINGS AND AS DIRECTED BY OWNER.
(b) OWNER NAME PLATE SHALL FACE THE PIPELINE.
(c) DIRECTION MARKER SHALL BE INSTALLED 1000MM TO LEFT OF THE PIPE CENTER LINE/VIEWING TOWARDS THE DIRECTION OF FLOW AND AS INDICATED IN LOCATION SKETCH.

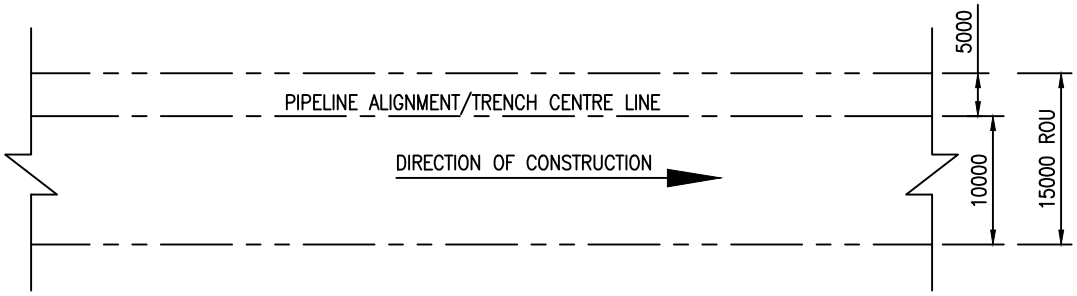
4. THE FOUNDATION SHALL BE MADE OF CONCRETE M20.
5. SIGN PLATE IN REGIONAL LANGUAGE SHALL BE PREPARED BY CONRACTOR ON SIMILAR LINES AND APPROVED BY THE OWNER.

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	18.01.19	ISSUED FOR TENDER	SS	VKS	JR

LYONS ENGINEERING PVT. LTD. NEW DELHI	TYPICAL RIGHT OF USE FOR PIPELINES	DRAWING NO.
		GAIL–STD–PL–DWG–TP–012
		SHEET NO. 1 OF 1



RIGHT OF USE DURING CONSTRUCTION



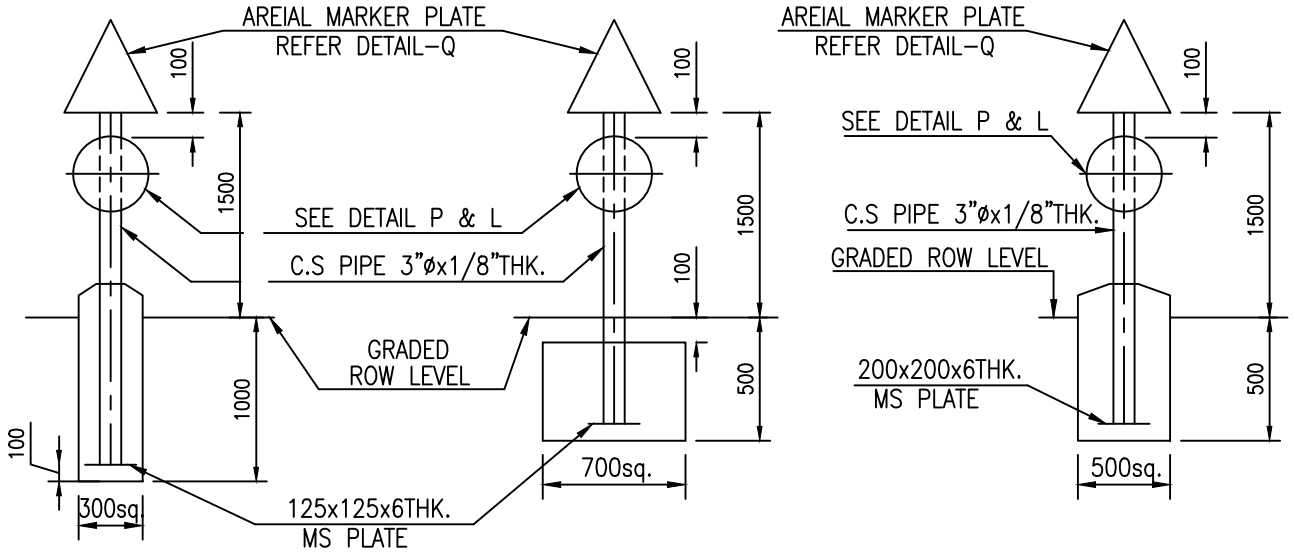
LOCATION OF PIPELINE IN ROU
WITH RESPECT TO DIRECTION OF CONSTRUCTION

NOTES:–

1. ALL DIMENSIONS ARE IN mm.
2. DIFFERENT ROU DIMENSIONS MAY BE ADOPTED BASED ON SITE CONDITION, CONSTRUCTION METHOD.
3. THE LOCATION OF PIPELINE IN ROU MAY BE CHANGED TO SUIT SITE CONDITIONS, AFTER OBTAINING WRITTEN APPROVAL FROM OWNER.
4. THE EXCAVATED LAYER OF FERTILE TOP SOIL (SEED STOCK) SHALL BE REINSTATED TO ITS ORIGINAL POSITION DURING BACK FILLING.
5. MINIMUM COVER OVER THE PIPE SHALL BE AS PER SPECIFICATION AND REQUIREMENT OF CONCERNED AUTHORITIES.

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	18.01.19	ISSUED FOR TENDER	SS	VKS	AP

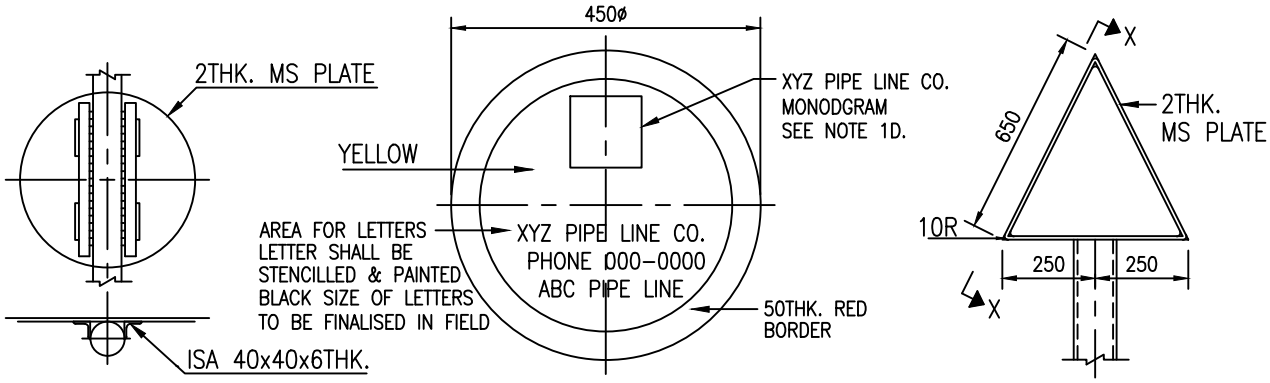
LYONS ENGINEERING PVT. LTD. NEW DELHI	TYPICAL K.M. POST MARKERS	DRAWING NO.
		GAIL–STD–PL–DWG–TP–013
		SHEET NO. 1 OF 1



TYPE–I
FOR NORMAL SOIL

TYPE–II
FOR DRIFTING SAND SOIL

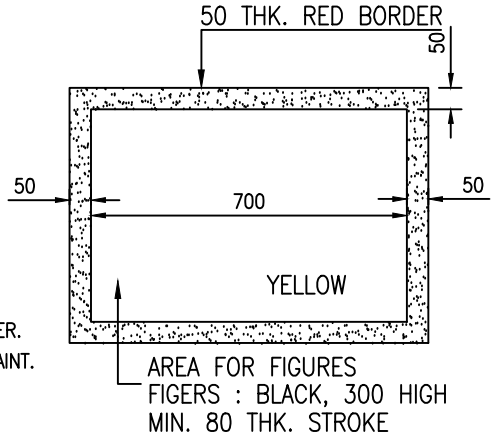
TYPE–III
FOR ROCKEY AREAS



DETAIL–P

DETAIL–L

DETAIL–Q



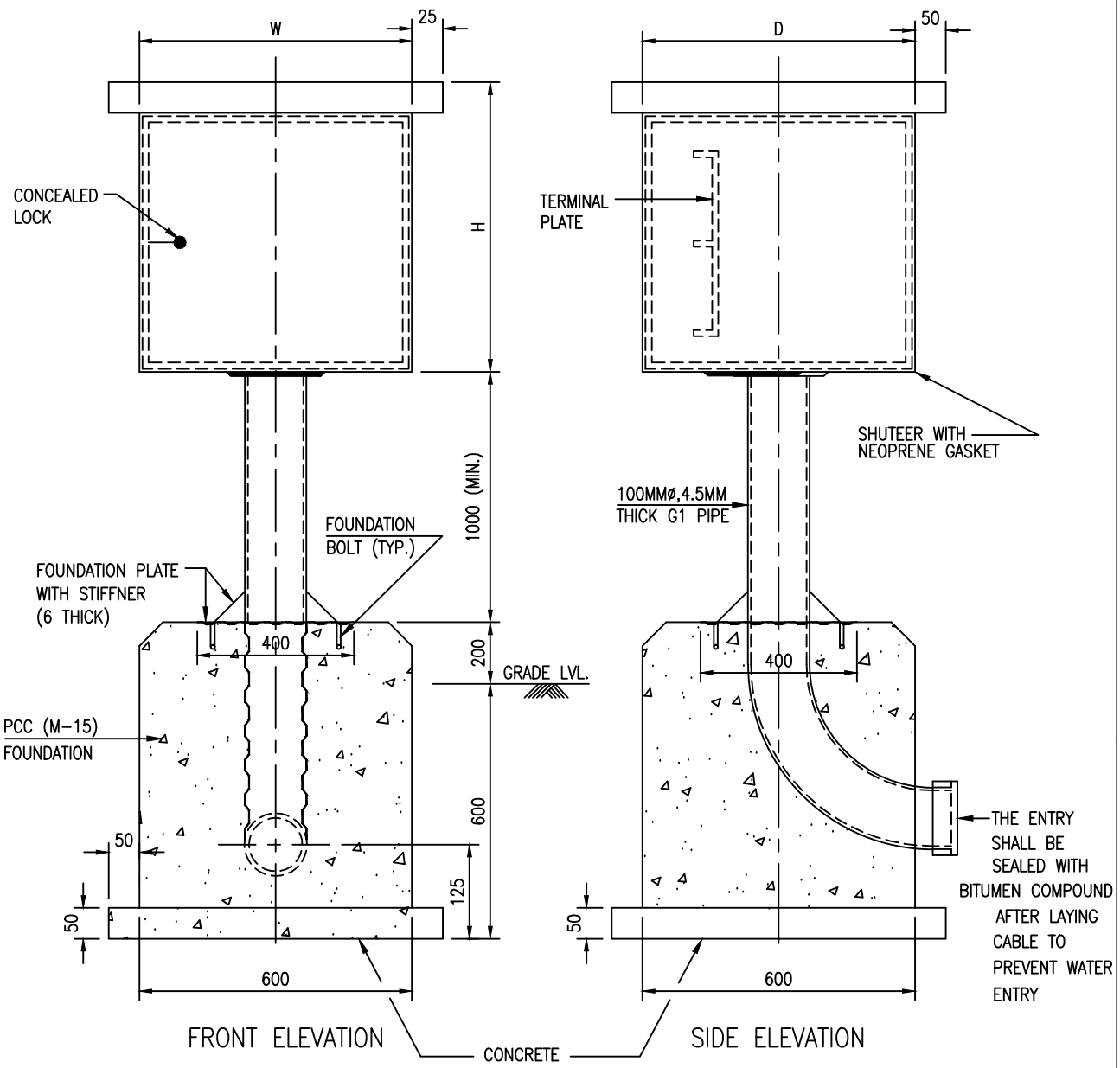
VIEW–XX

NOTES:–

1. SCHEME OF PAINTING & COLOURING
(a) UNDERGROUND STEEL STRUCTURE (EXCEPT THAT EMBEDDED IN CONCRETE) COAL TER EXPOXY MIN.300 MICRON THIK.)
(b) OVERGROUND STEEL STRUCTURE : ONE COAT OF PRIMER & TWO COATS SPECIFIED COLOUR PAINT.
(c) FIGURES SHALL BE STENCILED ON BOTH SIDES OF THE POSTS IN BLACK.
(d) COLOUR SCHEME FOR XYZ PIPLINE CO. MONOGRAM SHALL BE AS DIRECTED BY OWNER.
(e) POST SHALL BE PAINTED WITH 250 WIDE ALTERNATE BANDS OF BLACK AND WHITE PAINT.
(f) ALL OTHER ABOVEGROUND STEEL SHALL BE PAINTED YELLOW.
2. LOCATION
(a) K.M. POST SHALL BE INSTALLED AT EVERY KILOMETERS AS PER REQUIREMENTS OF CONTRACT AND AS DIRECTED BY OWNER.
(b) OWNER NAME PLATE SHALL FACE THE PIPELINE.
(c) K.M. POST SHALL BE 100MM TO THE LEFT OF THE PIPE CENTRE LINE VIEWING TOWARDS THE DIRECTION OF FLOW AND AS INDICATED IN SKETCH.
3. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE INDICATED.
4. THE FOUNDATION SHALL BE MADE OF CONRETE M20.
5. THE HEIGHT OF THE K.M. POST MAY BE VARIED TO SUIT FIELD REQUIREMENTS.

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	18.01.19	ISSUED FOR TENDER	SS	VKS	AP

LYONS ENGINEERING PVT. LTD. NEW DELHI	TEST STATION WITH FOUNDATION DETAILS	DRAWING NO.
		GAIL–STD–PL–DWG–TP–014
		SHEET NO. 1 OF 1

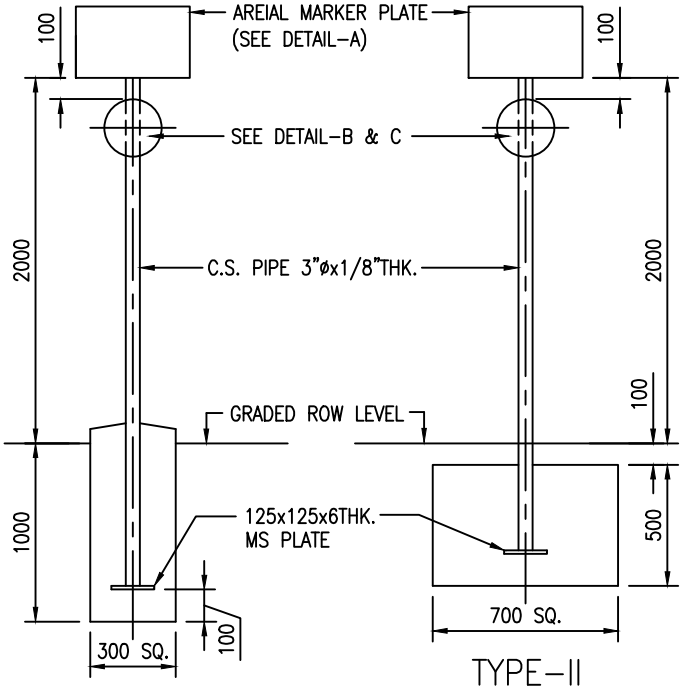


NOTES:–

1. THE SHUTTER SHALL BE HINGED TYPE WITH CONCEALED LOCK & SHALL HAVE DOOR GASKET TO MAKE THE TEST STATION WEATHER PROOF.
2. THE CHAINAGE OF TEST STATION SHALL BE WRITTEN WITH BLACK PAINT ON THE OUTER SIDE OF THE FRONT SHUTTER.
3. TEST STATION SHALL BE ERECTED WITH THEIR SHUTTERS PARALLEL TO THE LINE OF AXIS & FACING THE PIPE LINE.
4. THE INNER & OUTER SURFACE OF TEST STATION SHALL BE EPOXY PAINTED.
5. THE NAME PLATE SHALL BE OF ANODISED ALUMINUM WITH BLACK BACKGROUND & WHITE LETTERS: & SHALL BE FIXED TO THE INNER SIDE OF SHUTTER.
6. HEIGHT OF THE TEST STATION SHOWN ABOVE GROUND LEVEL IS MINIMUM ONLY. THE ACTUAL HEIGHT SHALL BE DECIDED BASED ON LOCAL FLOOD LEVELS TO BE ASCERTAINED.
7. ALL THE DIMENSIONS ARE IN MM.
8. CONTRACTOR SHALL FURNISH ALL THE DIMENSIONS OF THE TEST STATION.

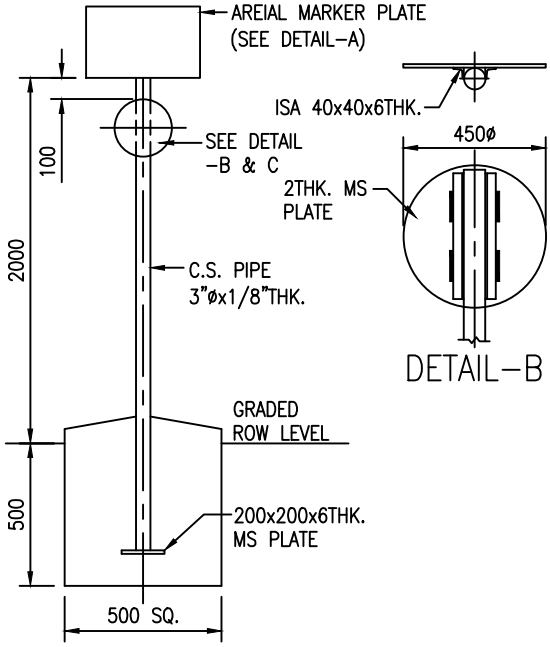
REV. NO.	DATE	SUBJECT OF REVISION	PREP	CHKD	APPD
0	10.01.2019	ISSUED FOR TENDER	SS	VKS	AP

LYONS ENGINEERING PVT. LTD. NEW DELHI	AERIAL MARKER	DRAWING NO.
		GAIL–STD–PL–DWG–TP–015
		SHEET NO. 1 OF 1

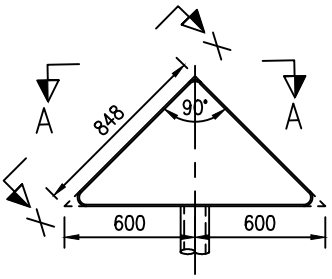


TYPE–I
FOR NORMAL SOIL

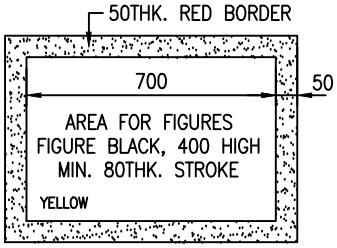
TYPE–II
FOR DRIFTING SAND SOIL



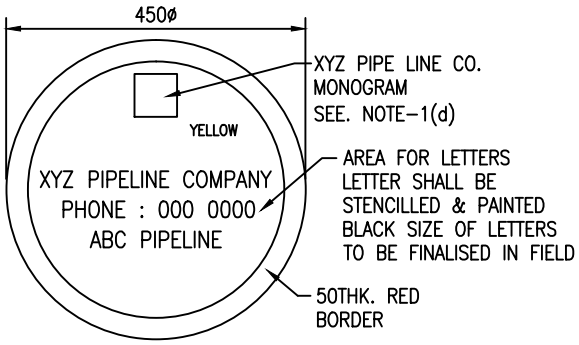
TYPE–III
FOR ROCKY AREAS



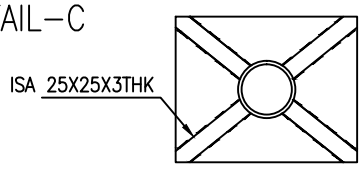
DETAIL–A



VIEW X–X



DETAIL–C



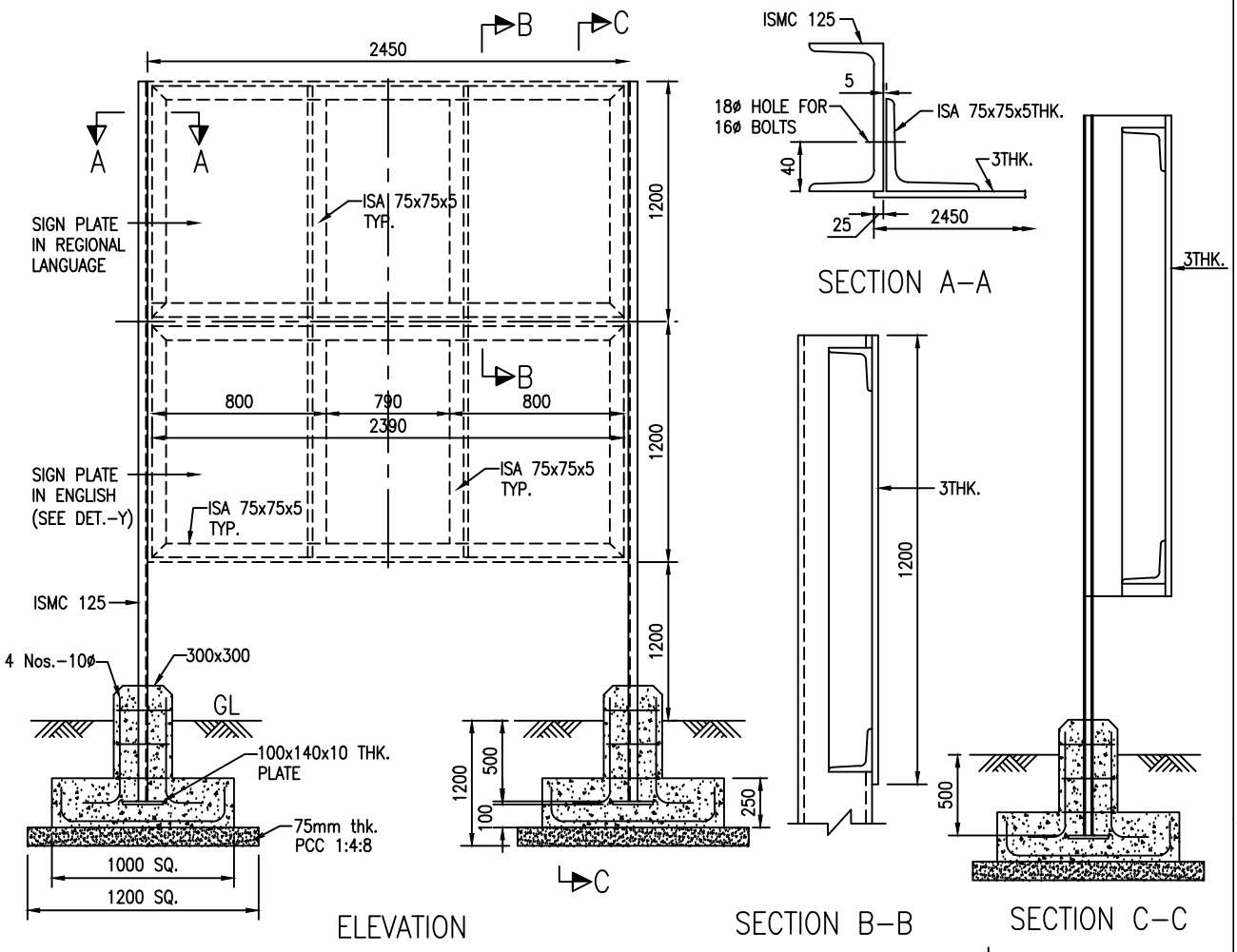
SECTION A–A

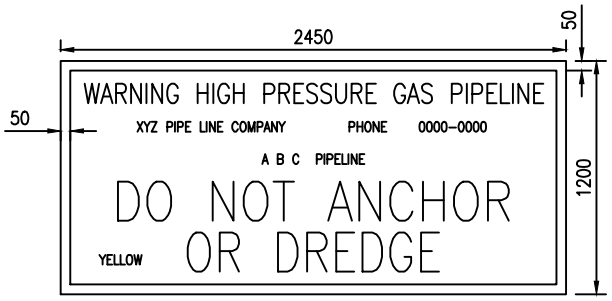
NOTES:–

1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE STATED.
2. SCHEME OF PAINTING & COLOURING
(a) UNDERGROUND STEEL STRUCTURE (EXCEPT THAT EMBEDDED IN CONCRETE) COAL TAR EPOXY MIN. 300 MICRON THK.
(b) OVERGROUND STEEL STRUCTURE : ONE COAT OF PRIMER & TWO COATS SPECIFIED COLOUR PAINT.
(c) FIGURES SHALL BE STENCILED ON BOTH SIDES OF THE POSTS IN BLACK.
(d) COLOUR SCHEME FOR XYZ PIPELINE CO. MONOGRAM SHALL BE AS DIRECTED BY OWNER.
(e) POST SHALL BE PAINTED WITH 250 WIDE ALTERNATE BANDS OF BLACK AND WHITE PAINT.
(f) ALL OTHER ABOVEGROUND STEEL SHALL BE PAINTED YELLOW.
3. LOCATION
(a) AERIAL MARKER SHALL BE INSTALLED AT EVERY 5 KM. AS PER REQUIREMENTS OF CONTRACT AND AS DIRECTED BY OWNER.
(b) OWNER NAME PLATE SHALL BE FIXED ON BOTH SIDES OF THE POST.
(c) AERIAL MARKER SHALL BE 3000MM TO THE LEFT OF THE PIPE CENTRELINE VIEWING TOWARDS THE DIRECTION OF FLOW AND AS INDICATED IN LOCATION SKETCH.
4. THE FOUNDATION SHALL BE MADE OF CONCRETE M20.
5. SIGN PLATE IN REGIONAL LANGUAGE SHALL BE PREPARED BY CONRACTOR ON SIMILAR LINES AND APPROVED BY THE OWNER.
6. ALL WELD SHALL BE 4 MM.

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	10.01.2019	ISSUED FOR TENDER	SS	VKS	JR

LYONS ENGINEERING PVT. LTD. NEW DELHI	NAVIGABLE WATERWAY PIPELINE CROSSING WARNING SIGN	DRAWING NO.
		GIGL-STD-PL-DWG-TP-016
		SHEET NO. 1 OF 1





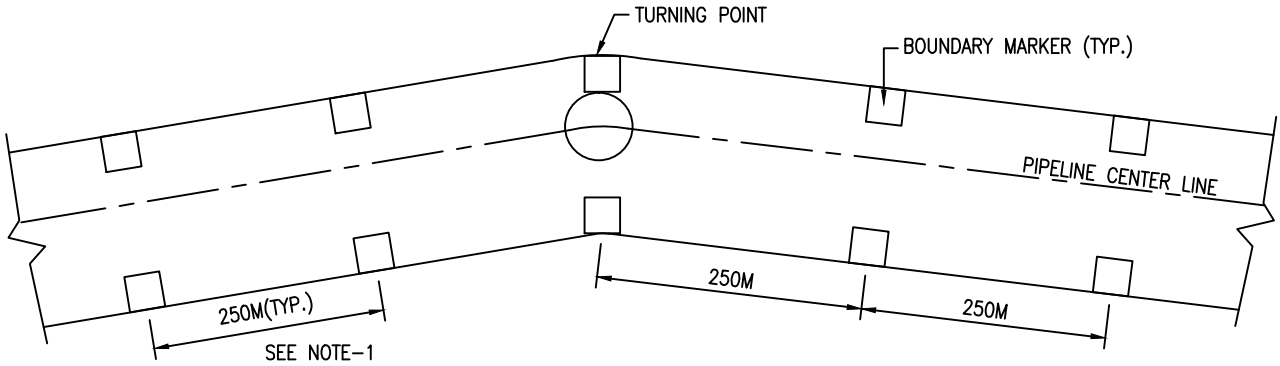
DETAIL-Y

NOTES:-

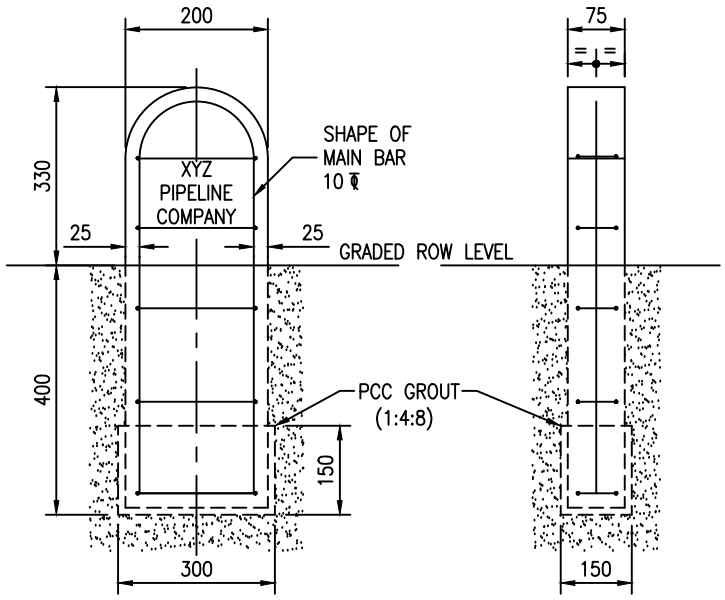
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE STATED.
2. SCHEME OF PAINTING & COLOURING
(a) UNDERGROUND STEEL STRUCTURE (EXCEPT THAT EMBEDDED IN CONCRETE) COAL TAR EPOXY MIN. 300 MICRON THK.
(b) OVERGROUND STEEL STRUCTURE : ONE COAT OF PRIMER & TWO COATS SPECIFIED COLOUR PAINT.
(c) COLOUR SCHEME FOR XYZ PIPELINE CO. MONOGRAM SHALL BE AS DIRECTED BY OWNER.
(d) POST SHALL BE PAINTED WITH 250 WIDE ALTERNATE BANDS OF BLACK AND WHITE PAINT.
(e) ALL OTHER ABOVEGROUND STEEL SHALL BE PAINTED YELLOW.
3. LOCATION
(a) THE NAVIGABLE WATER WAY WARNING SIGN SHALL BE INSTALLED ON BOTH THE BANKS & FACING THE WATER WAY AS CLOSE TO THE BANKS AS POSSIBLE.
(b) STRADDLING THE PIPE CENTER LINE
4. THE FOUNDATION SHALL BE MADE OF CONCRETE M20.
5. SIGN PLATE IN REGIONAL LANGUAGE SHALL BE PREPARED BY CONRACTOR ON SIMILAR LINES AND APPROVED BY THE OWNER.
6. ALL WELDS SHALL BE 4 MM.

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	08.01.2019	ISSUED FOR TENDER	SS	VKS	JR

LYONS ENGINEERING PVT. LTD. NEW DELHI	TYPICAL ROW BOUNDARY MARKER	DRAWING NO.
		GAIL–STD–PL–DWG–TP–017
		SHEET NO. 1 OF 1

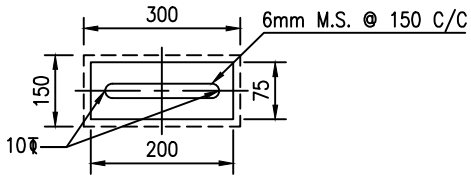


LOCATION PLAN OF BOUNDARY MARKER



ELEVATION

SIDE VIEW



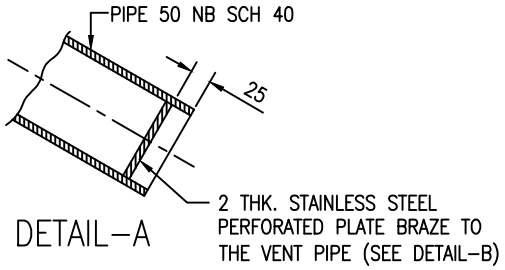
PLAN

NOTES:–

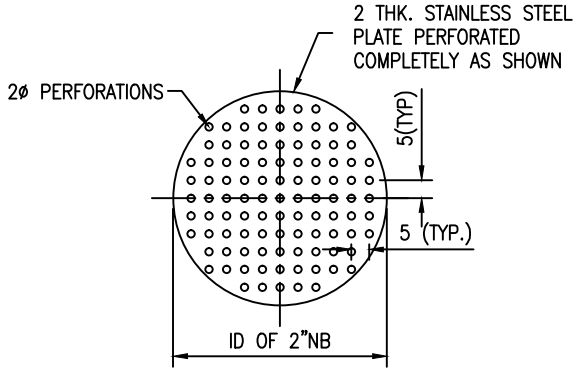
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE STATED.
2. BOUNDARY MARKERS SHALL BE INSTALLED AT THE ROW LIMITS ON EITHER SIDE AT 250M CENTERS AND ALSO AT ALL TURNING POINTS AS PER SPECIFICATIONS AND AS DIRECTED BY OWNER. BOUNDARY MARKERS SHALL PREFERABLY BE PLACED ON FIELD BUNDS/ UNCULTIVABLE AREAS.
3. ALL BOUNDARY MARKERS SHALL BE PRECAST AND INSCRIPTIONS SHALL BE ENGRAVED CENTRALLY IN THE MOULD ON THE FACE.
4. LETTERS SHALL BE 60 HIGH AND 5 DEEP.
5. INSCRIPTIONS SHALL FACE THE PIPE LINE.
6. CONCRETE FOR BOUNDARY MARKERS SHALL BE M20.
7. ABOVE GROUND PART OF BOUNDARY MARKERS SHALL BE PAINTED YELLOW WITH MIN. THREE COATS OF APPROVED QUALITY PAINT INSCRIPTIONS SHALL BE PAINTED BLACK.

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	18.01.2019	ISSUED FOR TENDER	SS	VKS	AP

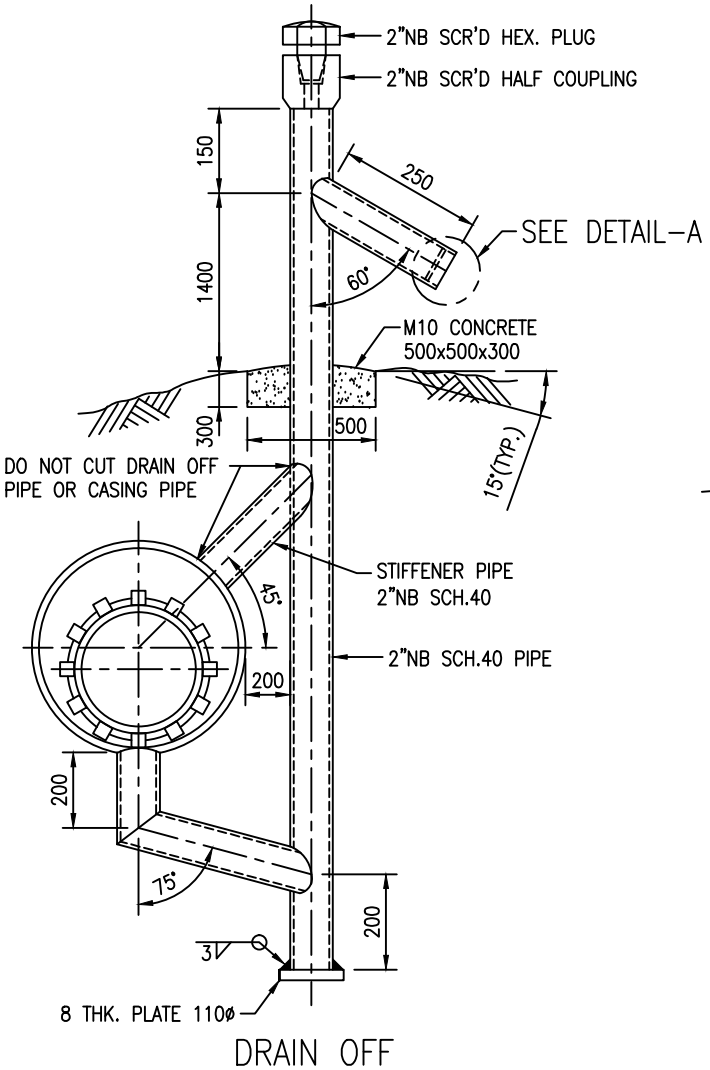
LYONS ENGINEERING PVT. LTD. NEW DELHI	DETAILS OF CASING VENT AND DRAIN	DRAWING NO. GAIL–STD–PL–DWG–TP–018
		SHEET NO. 1 OF 1



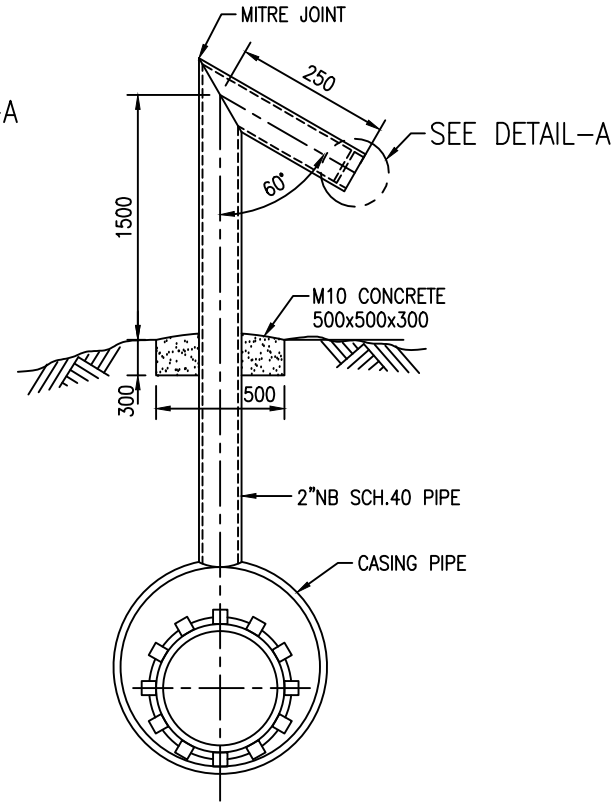
DETAIL–A



DETAIL–B



DRAIN OFF



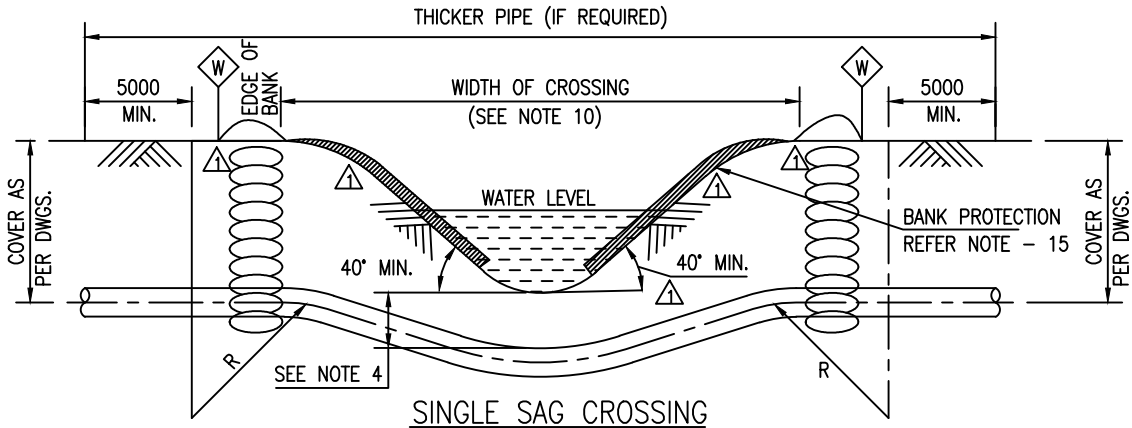
VENT

NOTES:–

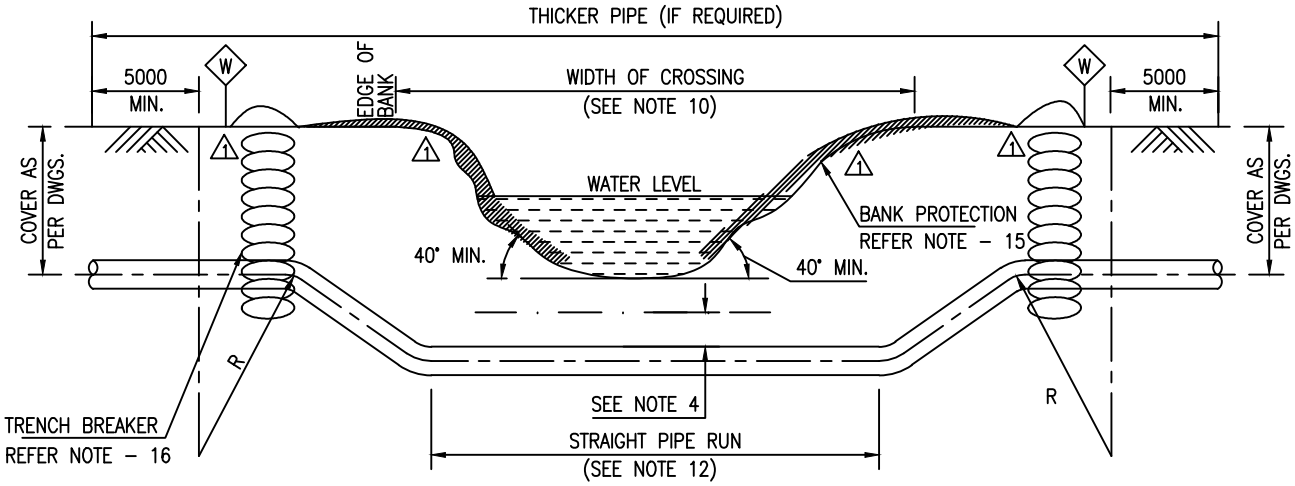
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE STATED.
2. VENT AND DRAIN OFF TO FACE LEFT WHEN LOOKING IN DIRECTION OF CONSTRUCTION AND SHALL BE PARALLEL TO CROSSING.
3. VENT AND DRAIN OFF PIPE SHALL BE API 5L Gr. B, SCH.40 OR EQUIVALENT.
4. PORTION OF VENT AND DRAIN OFF PIPES WHICH ARE UNDER GROUND OR WHICH MAY BE UNDER WATER ARE TO COATED WITH LIQUID EPOXY OF 500 MICRON THK. OF APPROVED QUAILITY. ABOVE GROUND PORTION SHALL BE GIVEN ONE COAT OF PRIMER AND TWO COAT OF ALUMINIUM PAINT.
5. AFTER FILLING OF BENTONITE, VENT PIPE AT BOTH THE ENDS SHALL BE TRIMMED AND PLUGGED/SEALED WITH END CAPS.

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	18.01.2019	ISSUED FOR TENDER	SS	VKS	AP

LYONS ENGINEERING PVT. LTD. NEW DELHI	TYPICAL WATERWAY CROSSING (OPEN CUT)	DRAWING NO. GIGL-STD-PL-DWG-TP-019
		SHEET NO. 1 OF 1



SINGLE SAG CROSSING
(SEE NOTE 1)



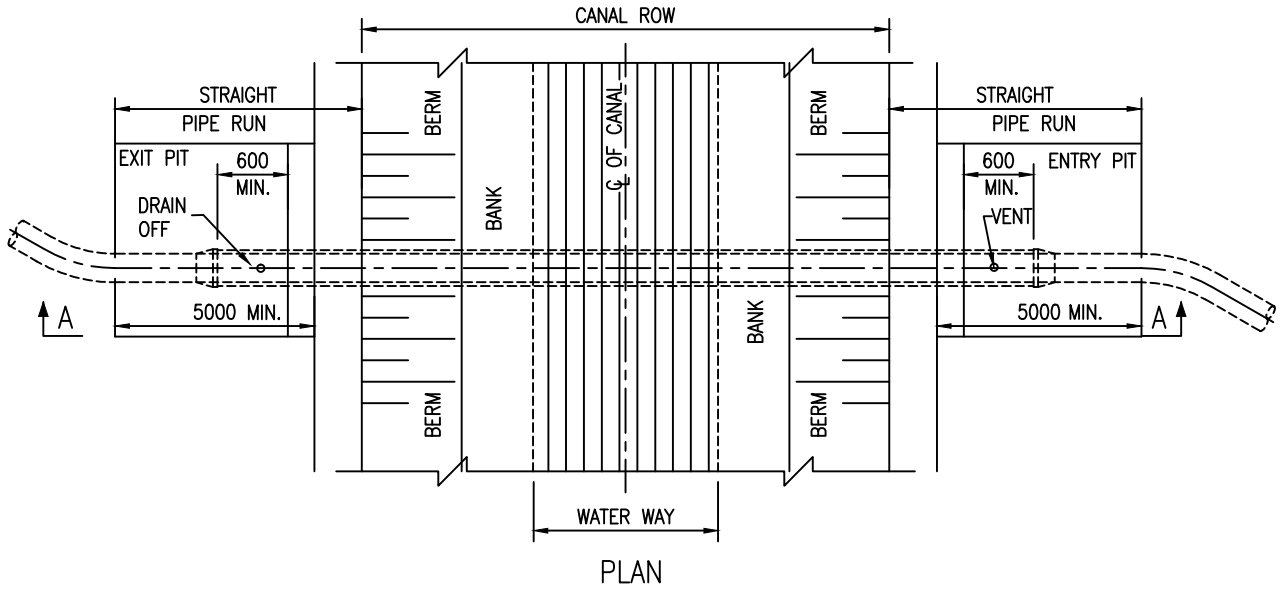
DOUBLE SAG CROSSING
(SEE NOTE 2)

NOTES:–

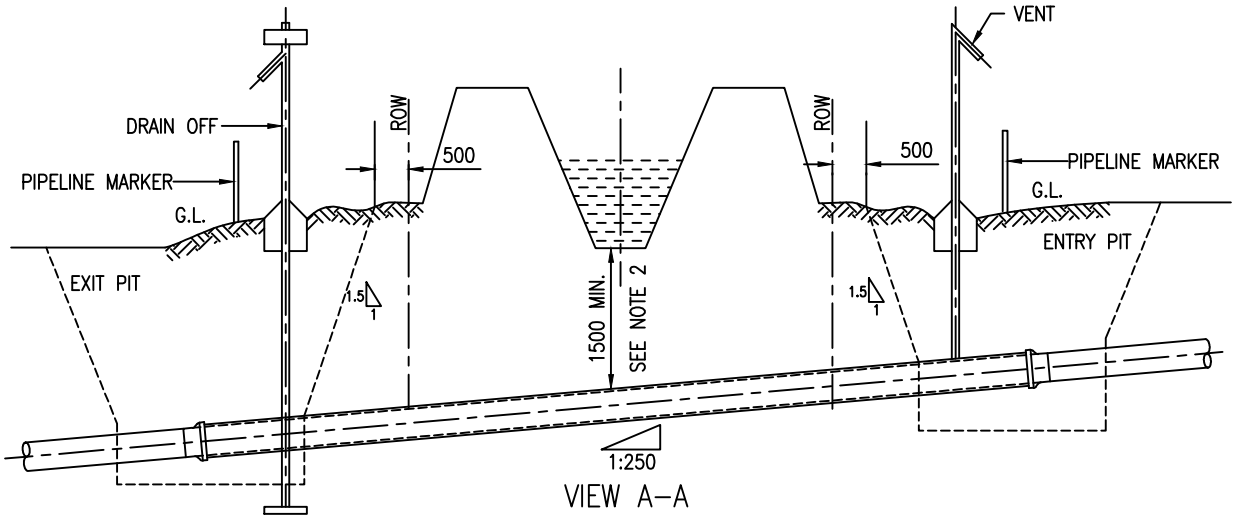
1. SINGLE SAG CROSSING SHALL NORMALLY BE USED WHERE THERE IS NO EVIDENCE OF EROSION OF BANKS AND SCOURING OR SHIFTING OF STREAM BOTTOM AND WHERE BED WIDTH DOES NT PROHIBIT ITS USE.
2. DOUBLE SAG CROSSING SHALL BE USED WHERE THERE IS EVIDENCE OF EROSION OF BANKS. SCOURING OR SHIFTING OF STREAM BOTTOM.
3. IN DOUBLE SAG CROSSING, GENERALLY COLD FIELD BENDS SHALL BE USED.
4. THE MINIMUM COVER OVER THE PIPE MEASURED BELOW THE MAXIMUM SCOUR DEPTH SHALL BE :–
   (a) 250 BELOW SCOUR LEVEL.
   (b) 1500 FOR ROCKY STREAM BOTTOM.
5. THE TYPE AND EXTENT OF BUOYANCY CONTROL MEASURES SHALL BE AS PER SPECIFICATION AND AS DIRECTED BY COMPANY FOR INDIVIDUAL CROSSING AND SHALL BE SHOWN ON THE ALIGNMENT SHEETS.
6. THE FILL AT THE BANKS SHALL BE TEMPED FIRMLY AND REINFORCED WITH SACKED EARTH, LEAN CONCRETE, RIP RAP OR BY OTHER MEANS AS DIRECTED BY COMPANY. ADDITIONAL BANK PROTECTION MEASURES AS PER SPECIFICATIONS SHALL BE ADOPTED WHEN THERE IS EVIDENCE OF EROSION AND SLUMPING OF BANKS OR WHEN THE BANKS ARE STEEP.
7. THE LOCATION OF CROSSING SHALL BE IN A LONG STRAIGHT STRETCH OF THE STREAM IF POSSIBLE.
8. EXACT POSITION AND ANGLE OF COLD BENDS SHALL BE DETERMINED IN FIELD.
9. AFTER INSTALLATION OF THE CROSSING, THE WATER COURSE SHALL BE RESTORED TO ITS ORIGINAL CONDITION TO THE ENTIRE SATISFACTION OF THE AUTHORITIES JURISDICTION OVER THE SAME. WHERE THE EXCAVATED MATERIAL IS UNSUITABLE , TRENCH SHALL BE BACKFILLED WITH MATERIAL APPROVED BY COMPANY.
10. WIDTH OF CROSSING SHALL BE THAT CORRESPONDING TO THE HIGHEST WATER LEVEL. THE HIGHEST WATER LAVEL SHALL BE DETERMINED BASED ON THE FOLLOWING: I) HISTORICAL RECORDS (TO THE EXTENT AVAILABLE)
    II) BANK CONDITION VIS–A–VIS EROSION, ETC.
    III) EVIDENCE OF EXTINCTION OF VEGETATION ALONG BANKS.
    IV) DISCUSSIONS WITH LOCAL PEOPLE.
11. THE NUMBER OF WARNING SIGNS SHALL BE a) 1 (ONE) FOR CROSSINGS LESS THAN 15 M WIDTH AT UP STREAM BANK
    b) 2 (TWO) FOR CROSSINGS ABOVE 15 M WIDTH.
12. STRAIGHT LENGTH OF PIPE SHALL BE USED AT LEAST FOR THE ENTIRE WIDTH OF CROSSING.
13. CONTRACTOR SHALL VERIFY THE ACTUAL DIMENSIONS WITH RESPECT TO SURVEY DETAILS FOR EACH CROSSING AS AND WHEN DIRECTED BY COMPANY. CONTRACTOR SHALL PREPARE DETAILED DRAWINGS FOR INDIVIDUAL CROSSINGS FOR COMPANY APPROVAL BEFORE COMMITMENT OF CONSTRUCTION.
14. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED.
15. BANK PROTECTION SHALL BE ACCORDANCE WITH GIGL-STD-PL-DWG-TP-022.
16. TRENCH BREAKER SHALL BE ACCORDANCE WITH GIGL-STD-PL-DWG-TP-021
17. PRE HYDROTESTING SHALL BE CARRIED OUT FOR NALAS/STREAM WIDER THAN 40 METER.

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	10.01.2019	ISSUED FOR TENDER	SS	VKS	JR

LYONS ENGINEERING PVT. LTD. NEW DELHI	CASED CROSSING PIPELINE–CANAL	DRAWING NO.
		GAIL–STD–PL–DWG–TP–020
		SHEET NO. 1 OF 1



PLAN



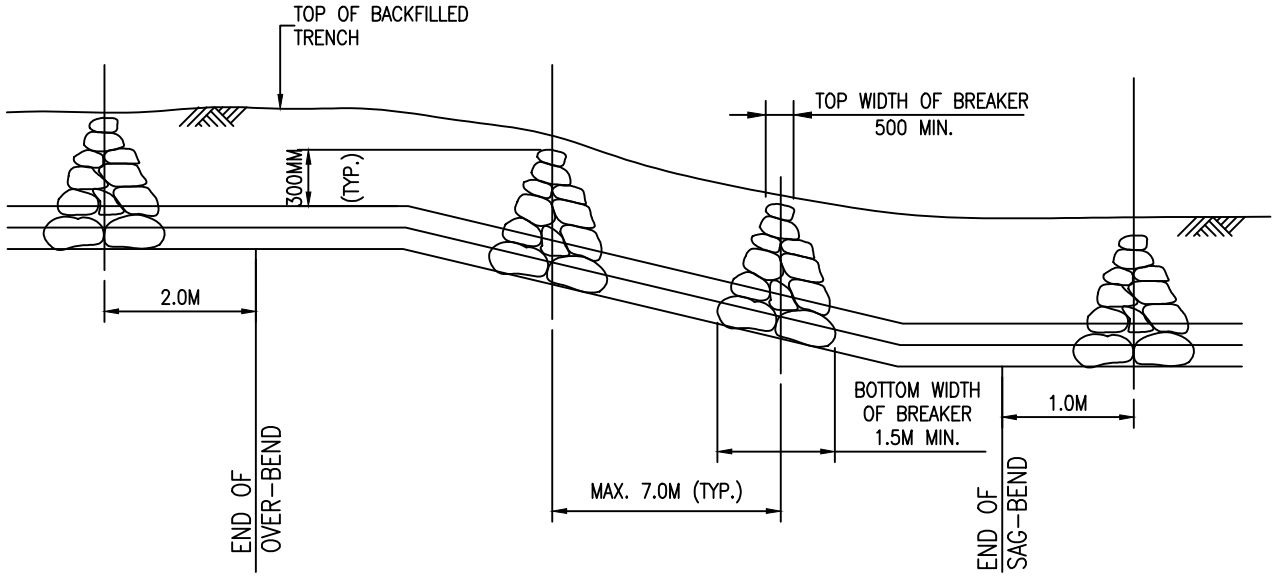
VIEW A–A

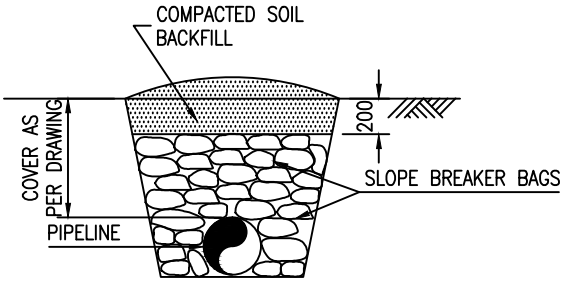
NOTES:–

1. ALL DIMENSIONS ARE IN MM, UNLESS OTHERWISE SPECIFIED.
2. THE MINIMUM 1.5M COVERAGE SHALL BE MAINTAINED BETWEEN UPPER GENERATRIX OF CASING PIPE AND LOWER LEVEL OF CANAL EXCEPT OTHERWISE STATED IN PTS OR REQUESTED BY CANAL AUTHORITES.
3. REFER API RP 1102 FOR OTHER DESIGN AND INSTALLATION REQUIREMENTS.
4. ANGLE OF INTERSECTION BETWEEN PIPELINE AND THE CANAL SHALL BE AS CLOSE TO 90° AS POSSIBLE BUT IN NO CASE < 30°.
5. AT EACH CROSSING, PIPELINE CROSSING WARNING SIGN SHALL BE INSTALLED ON EITHER SIDE OF CROSSING. THE WARNING PLATE MAY BE MOUNTED ON THE VENT/DRAIN OFF PIPE.
6. CONTRACTOR SHALL VERIFY THE ACTUAL DIMENSIONS WITH RESPECT TO SURVEY DETAILS OF EACH CROSSING AND PREPARE DETAILED DRAWINGS FOR INDIVIDUAL CROSSING FOR COMPANY/CONCERNED AUTHORITIES' APPROVAL BEFORE COMMENCEMENT OF CONSTRUCTION.
7. CATHODIC PROTECTION TEST LEAD TERMINAL BOX MAY BE MOUNTED ON VENT PIPE. FOR CP LEAD TERMINAL BOX DETAILS REFER RELEVANT STANDARD/SPECIFICATION.
8. ALL PIPELINE JOINTS SHALL BE RADIOGRAPHED.
9. ELECTRICAL INSULATION BETWEEN CASING AND CARRIER PIPES SHALL BE CHECKED WITH SUITABLE MEGGER.
10. AFTER INSTALLATION OF CASING AND CARRIER PIPES THE RESTORATION SHALL BE CARRIED OUT TO THE SATISFACTION OF CANAL AUTHORITIES.
11. PIPELINE SECTION SHALL BE PRETESTED HYDROSTATICALLY SEPARATELY FROM THE MAIN LINE TESTING WHEN REQUIRED BY CONCERNED AUTHORITIES/OR AS DIRECTED BY COMPANY.
12. BENTONITE FILLING PROCEDURE SHALL BE DONE AS PER OWNER/CONSULTANTS INSTRUCTIONS.
13. CROSSING MAY BE CARRIED OUT PRIOR TO MAINLINE ACTIVITIES ADDITIONAL ROU, IF REQUIRED, FOR APPROACH TO CROSSING, PIPELINE STRING, HYDROTESTING WORKING PIT FOR CROSSING TO AVOID CAVING OF SOIL SHALL BE PROCURED BY CONTRACTOR WITHOUT ANY COST IMPLICATION.
14. THE LOCATION OF ENTRY AND EXIT PIT SHALL BE DECIDED AT SITE TO SUIT AT SITE REQUIREMENT.
15. MATERIAL OF THE CASING INSULATORS SHALL BE HDPE. END SEAL SHALL BE HEAT SHRINKABLE TYPE(MAKE RAYCHEM OR EQUIVALENT), CONTRACTOR SHOULD TAKE PRIOR APPROVAL FOR MATERIAL OF CONSTRUCTION FOR END SEAL & SHALL SUBMIT MATERIAL CERTIFICATES TO OWNER/CONSULTANT FOR APPROVAL.
16. THE CASING PIPE SHALL BE PROVIDED WITH MINIMUM 50 MM DIAMETER VENT PIPE FOR FILLING BENTONITE, AFTER FILLING OF BENTONITE, VENT PIPE AT BOTH ENDS SHALL BE TRIMMED AND PLUGGED/SEALED WITH END CAPS.
17. CASING SHALL BE CATHOLICALLY PROTECTED, HENCE CONTRACTOR SHALL AVAIL NECESSARY APPROVAL BEFORE EXECUTING THE WORK.

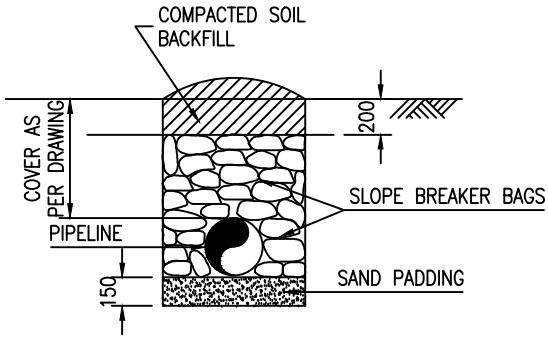
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	18.01.2019	ISSUED FOR TENDER	SS	VKS	JR

LYONS ENGINEERING PVT. LTD. NEW DELHI	TYPICAL SLOPE BREAKERS DETAILS	DRAWING NO.
		GAIL-STD-PL-DWG-TP-021
		SHEET NO. 1 OF 1





SECTION
(NORMAL SOIL AREA)

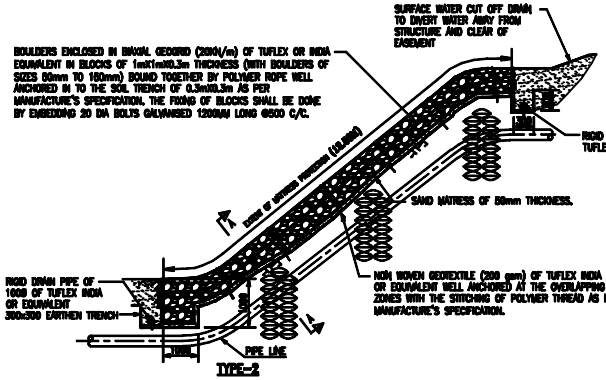


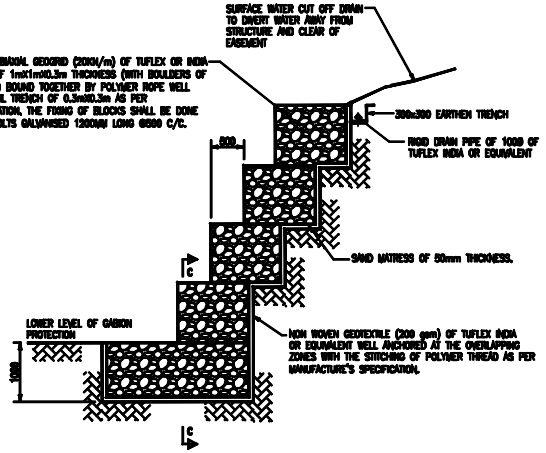
SECTION
(ROCKY AREA)

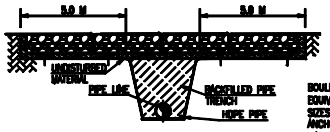
NOTES:-

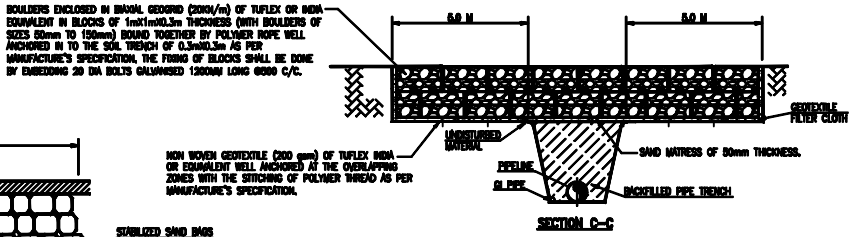
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE STATED.
2. DISTANCE"L" BETWEEN BREAKERS NUMBER OF LAYERS OF BAGS IN EACH SLOPE BREAKER SHALL BE DECIDED ON A CASE-TO-CASE BASIS DEPENDING ON SLOPE OF GROUND AND CHARACTERISTICS OF SOIL. BAGS SHALL BE PLACED IN SUCH A MANNER SO AS TO HAVE A STABLE ARRANGEMENT, HOWEVER DISTANCE "L" SHALL NOT EXCEED 7.0M.
3. BAGS TO BE PLACED VERTICAL IN THE TRENCH NOT 90° TO THE PLANE OF THE PIPE.
4. BREAKERS SHALL BE INSTALLED IN STEEP SLOPE AREAS (GENERALLY SLOPE 10% OR MORE), WHERE SHOWN IN DWG. AND WHEREVER INSTRUCTED BY OWNER / REPRESENTATIVE
5. TOP LAYER OF TRENCH SHALL BE BACKFILLED WITH SOIL OR CRUSHED ROCK (EXCAVATED MATERIAL)
6. THE REMAINING TRENCH AREA SHALL BE BACK FILLED AS REQUIRED BY SPECIFICATION.

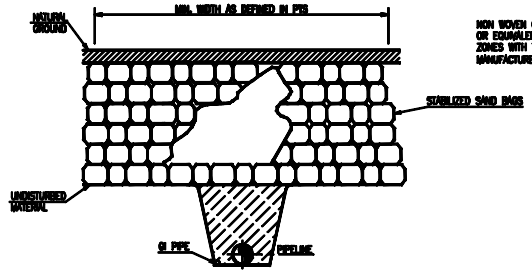
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	18.01.2019	ISSUED FOR TENDER	SS	VKS	AP



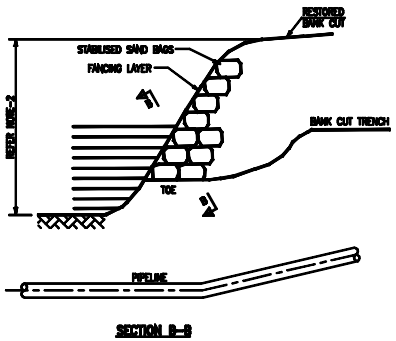


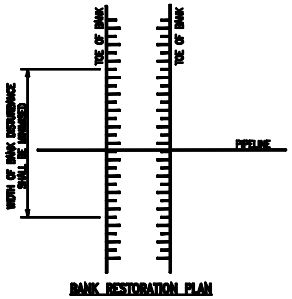






TYPE	DESCRIPTION
TYPE-3	IF SLOPE IS 1:1 (FOR RIVERS)
TYPE-2	IF SLOPE IS LESS THAN 1:1 (FOR RIVER)
TYPE-1	FOR NALAS IN WHICH BANKS ARE PRONE TO SCOUR

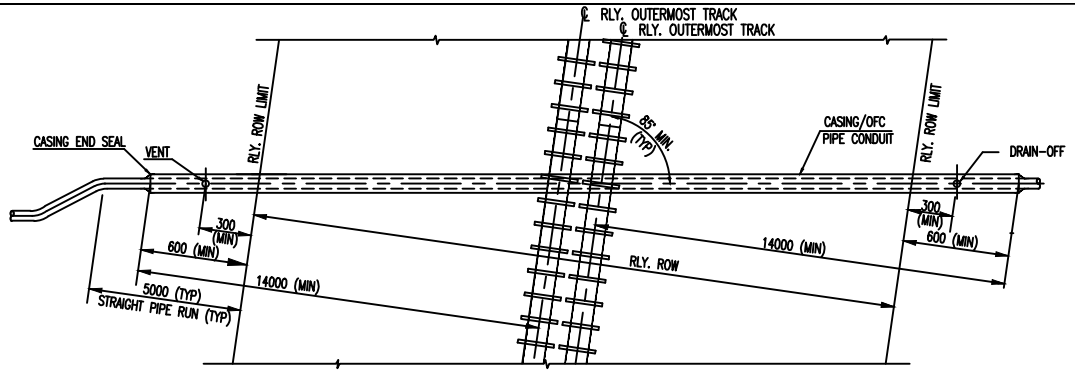




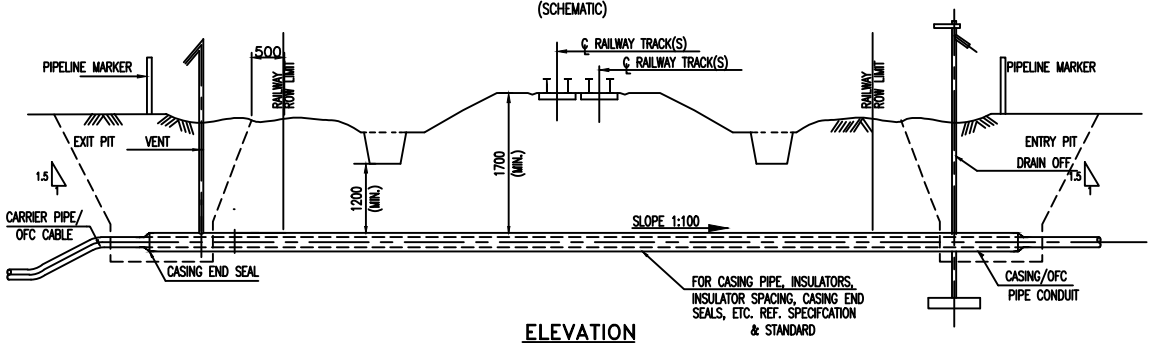
NOTES

1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. THE HEIGHT OF BANK PROTECTION SHALL EXTEND TO 2METER ABOVE ABOVE HFL OR UPTO THE BANK TOP.
3. STABLISED SAND BAGS SHALL BE LAID IN AN INTERLOCKING PATTERN.
4. GABIONS (GALVANISED MESH) INSTALLED IN ACCORDAINCE WITH MANUFACTURER'S SPECIFICATION.

LYONS ENGINEERING PVT. LTD. NEW DELHI									BANK PROTECTION DETAIL FOR WATER BODY	DRAWING NO.
										GAIL-STD-PL-DWG-TP-022
	DWG. NO.	REF. DRAWING	0	18.01.19	ISSUED FOR TENDER	SS	VKS	AP		REV.
			NO.	DATE	REVISION	DRN	CHKD	APPD		0



PLAN
(SCHEMATIC)



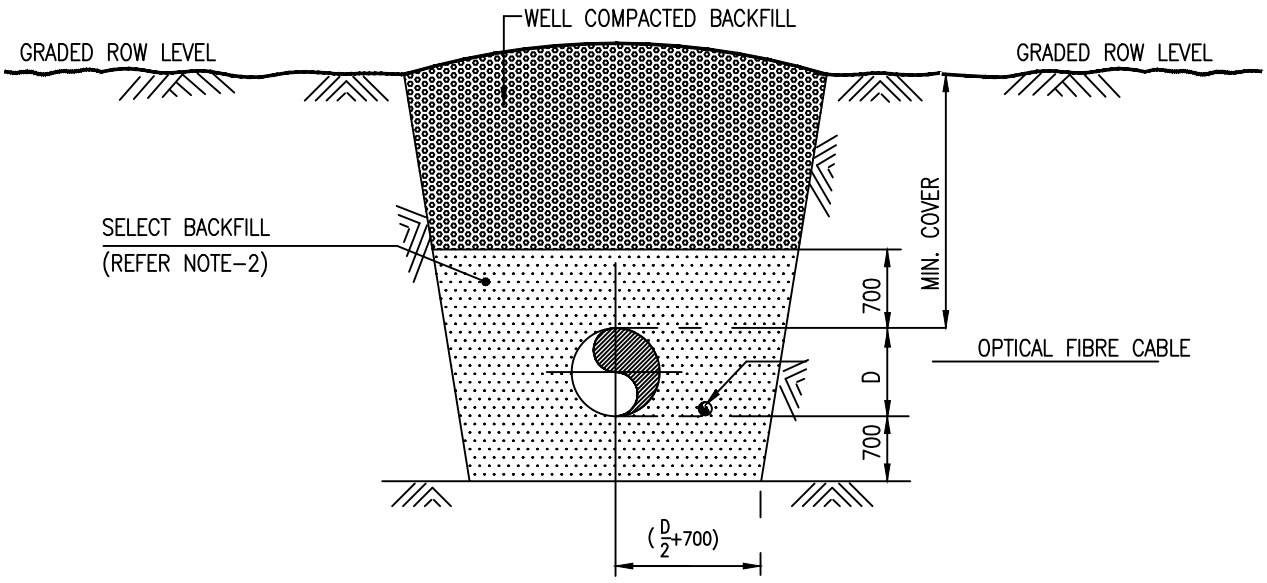
ELEVATION
(SCHEMATIC)

NOTES:-

1. ALL DIMENSIONS ARE IN mm UNLESS SPECIFIED OTHERWISE.
2. CATHODIC PROTECTION TEST LEADS TERMINAL BOX MAY BE MOUNTED ON THE VENT PIPE. FOR CP LEAD TERMINAL BOX DETAILS REFER RELEVANT STD./SPECIFICATION.
3. AT EACH CROSSING, A PIPELINE WARNING SIGN SHALL BE INSTALLED ON EITHER SIDE OF CROSSING. WARNING SIGN PLATE MAY BE MOUNTED ON THE VENT PIPE.
4. REFER API RP 1102 FOR OTHER DESIGN AND INSTALLATION REQUIREMENTS.
5. ELECTRICAL INSULATION BETWEEN CASING AND CARRIER PIPES SHALL BE CHECKED WITH SUITABLE MEGGER.
6. AFTER INSTALLATION OF CASING AND CARRIER PIPES, THE AREA SHALL BE RESTORED TO THE SATISFACTION OF THE CONCERNED AUTHORITIES/COMPANY.
7. DELETED.
8. CONTRACTOR SHALL VERIFY THE ACTUAL DIMENSIONS WITH RESPECT TO SURVEY DETAILS FOR EACH CROSSING AND PREPARE DETAILED DRAWINGS FOR COMPANY'S / CONCERNED AUTHORITY'S APPROVAL BEFORE COMMENCEMENT OF CONSTRUCTION.
9. PIPELINE SECTION SHALL BE PRE-TESTED HYDROSTATICALLY, SEPARATELY FROM THE MAIN LINE TESTING WHEN REQUIRED BY THE AUTHORITIES CONCERNED AND/OR AS DIRECTED BY THE COMPANY.
10. ANGLE OF INTERSECTION BETWEEN PIPELINE AND RAILWAY SHALL BE AS CLOSE TO 90° AS POSSIBLE BUT IN NO CASE LESS THAN 85°.
11. CASING PIPE SHALL BE EXTENDED FOR A DISTANCE OF UPTO 14.00m FROM CENTRE LINE OF OUTERMOST RAILWAY TRACK OR 0.6m BEYOND RAILWAY ROW LIMITS ON EITHER SIDE, WHICHEVER IS MORE.
12. JACKING / BORE THRU' TECHNIQUE SHALL BE USED FOR THE CROSSING.
13. SEPARATE C.S. CONDUIT FOR OFC SHALL BE INSTALLED AT MINIMUM DISTANCE FROM CASING FOR CARRIER PIPE. IF SPECIFIED.
14. ALL CARRIER PIPE JOINTS SHALL BE 100% RADIOGRAPHED.
15. COATING OF CASING PIPE SHALL BE AS PER REQUIREMENT OF AUTHORITIES.
16. CASING PIPE SHALL BE PROVIDED WITH MINIMUM 50 MM DIA VENT PIPE FOR FILLING BENTIONITE. AFTER FILLING BENTONITE, VENT PIPE AT BOTH ENDS SHALL BE TRIMMED
17. IN ANY CASE THE MINIMUM LENGTH OF CASING PIPE SHALL Be min. 60 M FOR ALL RAILWAY CROSSING.
18. ALL CASING PIPES SHALL BE CP PROTECTED.
19. CONTRACTOR SHALL SUBMIT DETAILED WORK PROCEDURE ALONG WITH SKETCHES AND MATERIAL TEST CERTIFICATE FOR APPROVAL.
20. BENTONITE FILLING PROCEDURE SHALL BE DONE AS PER OWNER/CONSULTANT INSTRUCTION.
21. CROSSING MAY BE CARRIED OUT PRIOR TO MAINLINE ACTIVITIES. ADDITIONAL ROU, IF REQUIRED, APPROACH TO THE CROSSING TO AVOID CAVING OF SOIL SHALL BE PROCURED BY THE CONTRACTOR WITHOUT ANY COST IMPLICATION.
22. CLASS 4 CARRIER PIPE SHALL BE USED ACROSS ALL RAILWAY CROSSING WITH LENGTH OF RISK RADIUS AS PER ASME B31.8.

LYONS ENGINEERING PVT. LTD. NEW DELHI									TYPICAL DETAILS OF RAILWAY CROSSINGS	DRAWING NO.	REV.
	DWG. NO.	REF. DRAWING	0	18.01.19	ISSUED FOR TENDER	SS	VKS	AP		GIGL-STD-PL-DWG-TP-023	0
			NO.	DATE	REVISION	DRN	CHKD	APPD			

LYONS ENGINEERING PVT. LTD. NEW DELHI	TRENCH DIMENSIONS AND COHESIONLESS SELECT BACKFILL FOR PIPELINE IN SEISMIC ZONE	DRAWING NO. GAIL–STD–PL–DWG–TP–024
		SHEET NO. 1 OF 1



SELECT BACK FILL FOR SEISMIC ZONE

NOTES:

1 ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED.

2 SELECT BACKFILL SHALL BE COHESSIONLESS SOIL (LIKE SAND, MURRUM, MIXED SOIL ETC.). THE ANGLE OF FRICTION OF COHESIONLESS SOIL SHOULD BE LESS THAN 35°. DENSITY OF SELECT BACKFILL SHALL NOT EXCEED 1.8 T/M^3 AFTER COMPACTION IN TRENCH.

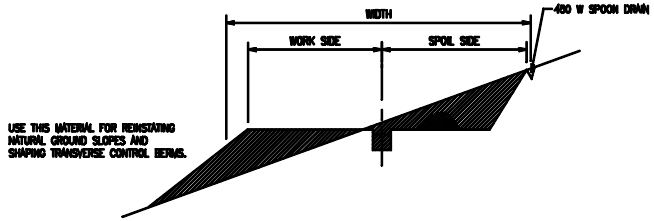
3 MINIMUM PIPELINE COVER SHALL BE 1200 mm. ANY EXTRA COVER REQUIREMENT SHALL BE IN ACCORDANCE WITH SPECIFICATIONS/ STANDARDS/ DRAWINGS.

4 MINIMUM COVER REQUIREMENT SHALL BE SUBJECT TO APPROVAL OF CONCERNED AUTHORITIES WHEREVER REQUIRED.

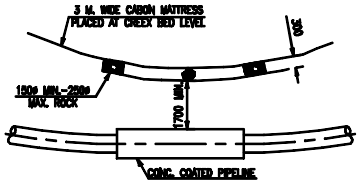
5 FOR MINIMUM COVER REQUIREMENT AT PIPELINE CROSSING ROADS, RAILWAY TRACKS, RIVERS, MARSHY AREAS ETC., REFER STANDARDS/ DRAWINGS.

6 TRENCH CROSS SECTION SHALL VIEWED IN THE DIRECTION OF FLOW.

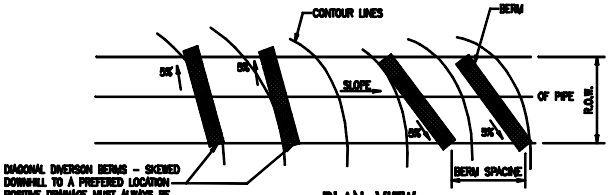
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	18.01.2019	ISSUED FOR TENDER	SS	VKS	JR



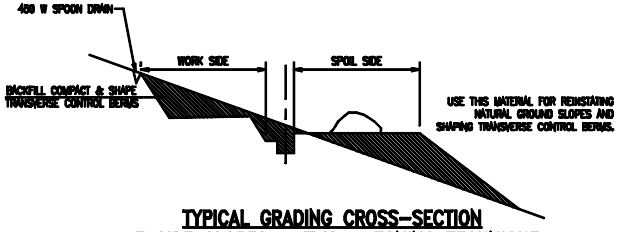
TYPICAL GRADING CROSS-SECTION AT SIDE SLOPES



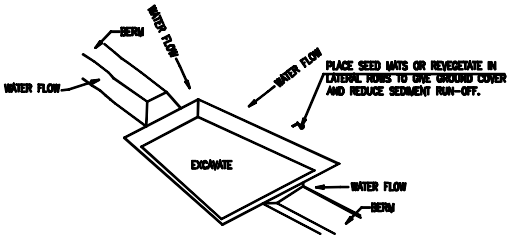
GABION MATTRESS DETAIL
(LOCATION SHOWN ON ALIGNMENT SHEET OR AS PER DIRECTION ON SITE)



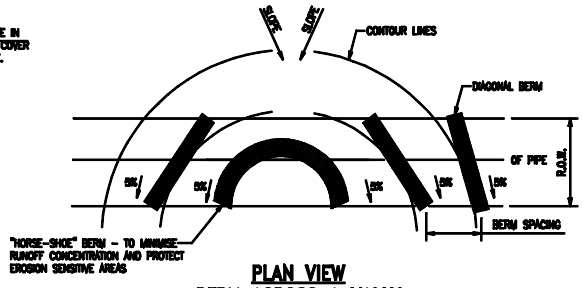
PLAN VIEW
BERM AT TRANSVERSE SLOPE



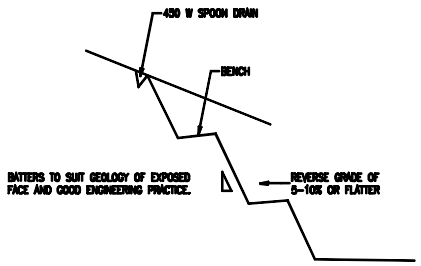
TYPICAL GRADING CROSS-SECTION
AT SIDE SLOPES - TWO - TONING TECHNIQUE



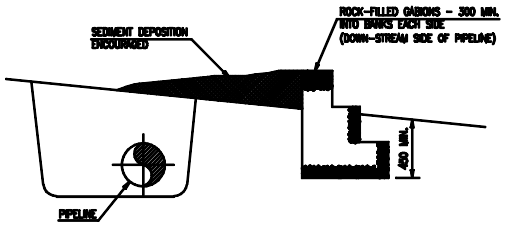
TYPICAL EXCAVATED EARTH OUTLET SEDIMENT TRAP



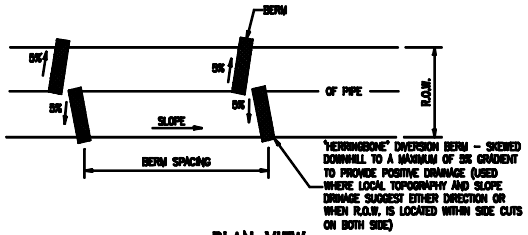
PLAN VIEW
BERM ACROSS A VALLY



TYPICAL TERRACES WITH BENCHES



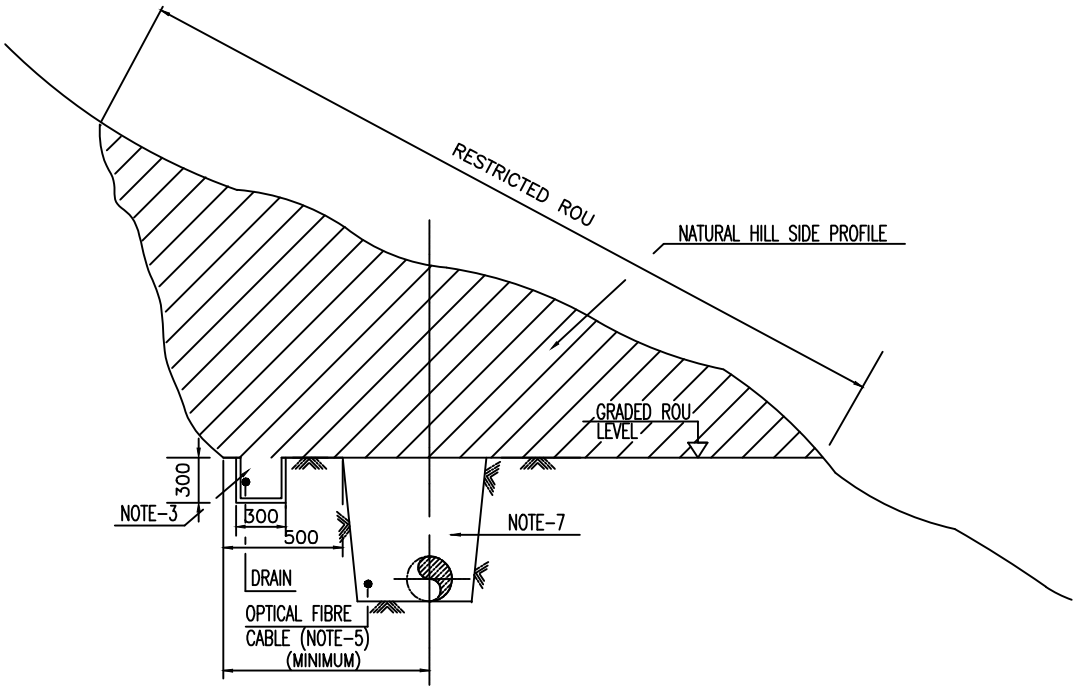
GABIONS USED FOR WATERWAY BED
STABILISATION & PREVENTION OF RIVER BED SCOUR



PLAN VIEW
"HERRINGBONE" DIVERSION BERMS

LYONS ENGINEERING PVT. LTD. NEW DELHI	DWG. NO.	REF. DRAWING	NO.	DATE	REVISION	DRN	CHKD	APPD	PROTECTION DETAIL AT HILLY TERRAIN	DRAWING NO.	REV.
			0	10.01.19	ISSUED FOR TENDER	SS	WS	AP		GAIL-STD-PL-DWG-TP-026	0

LYONS ENGINEERING PVT. LTD. NEW DELHI	TYPICAL CROSS SECTION FOR ROU PREPARATION IN HILL AREAS	DRAWING NO. GAIL–STD–PI–DWG–TP–027 SHEET NO. 1 OF 1

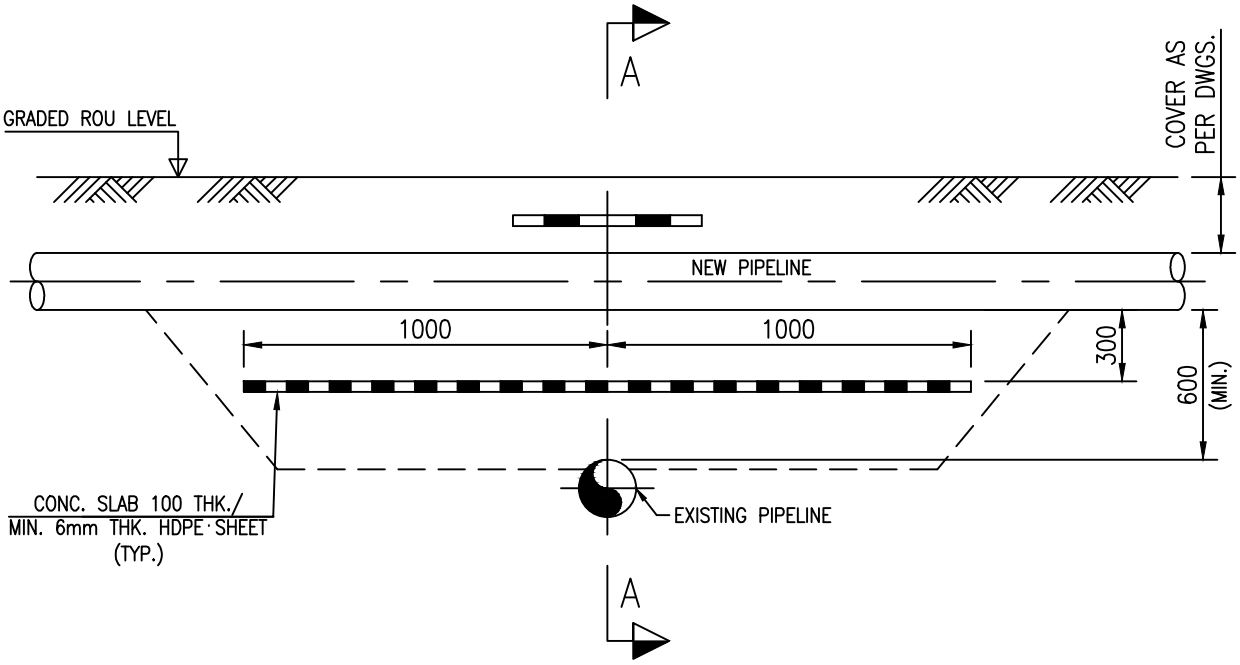


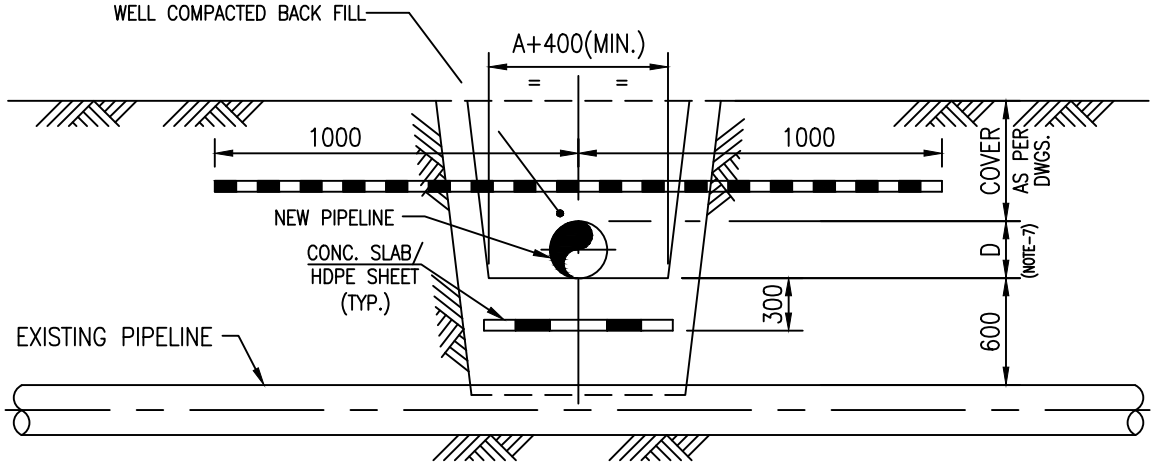
NOTES:–

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED.
2. A DRAIN SHALL BE PROVIDED TO DRAIN OFF WATER FROM ROU. THIS DRAIN SHALL BE CONNECTED TO THE NEAREST STREAM/NALA. CROSS DRAINS SHALL ALSO BE PROVIDED AT SUITABLE LOCATIONS AS PER INSTRUCTIONS OF ENGINEER–IN–CHARGE.
3. WHENEVER THE PIPELINE IS CROSSING ANY STREAM/ NALA, ENTIRE WIDTH OF SUCH STREAM/ NALA SHALL BE PROVIDED WITH A MINIMUM 100 MM THICK LAYER OF PCC TO PREVENT SOIL WASH OFF DURING RAINS. THE PCC LAYER SHALL COVER THE ENTIRE WIDTH OF PREPARED ROU.
4. REFER APPLICABLE STANDARD/ DRAWINGS FOR DETAILS OF OFC.
5. FOR TRENCH DETAILS REFER STD. DOC–00004–PL–PL–STD–023
6. THE BACKFILLING OF THE TRENCH AND OTHER TRENCH STABILIZATION MEASURES SHALL BE AS INDICATED IN APPROVED FOR CONSTRUCTION ALIGNMMENT SHEETS OR AS DIRECTED BY ENGINEER–IN–CHARGE.
7. RESTORATION OF ROU SHALL BE CARRIED OUT AS PER THE INSTRUCTIONS OF ENGINEER–IN–CHARGE.

REV. NO.	DATE	SUBJECT OF REVISION	PREP	CHKD	APPD
0	12.01.2019	ISSUED FOR TENDER	SS	VKS	JR

LYONS ENGINEERING PVT. LTD. NEW DELHI	EXISTING UNDERGROUND PIPE CROSSING	DRAWING NO. GAIL–STD–PL–DWG–TP–028
		SHEET NO. 1 OF 1





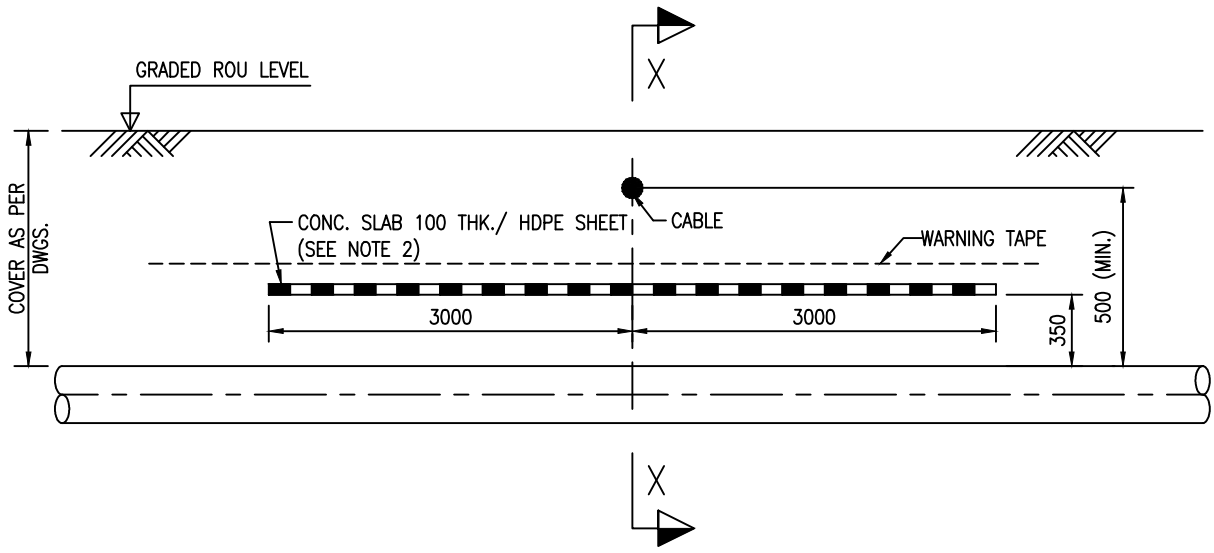
SECTION A–A

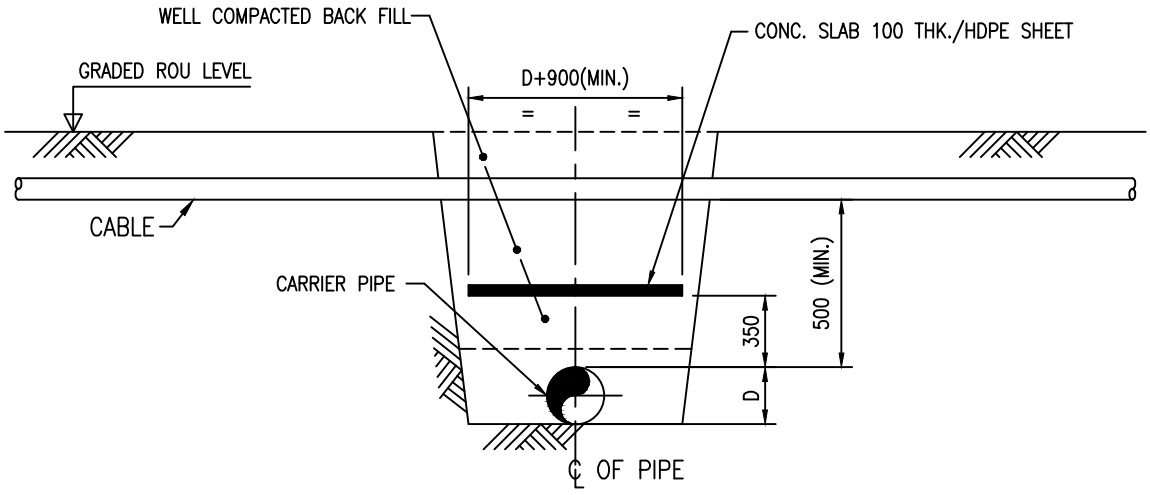
NOTES:–

1. A MODIFIED PIPELINE WARNING SIGN SHALL BE INSTALLED WHERE THE PIPELINE CROSSES AN EXISTING PIPELINE CARRYING HAZARDOUS FLUID.
2. CONCRETE SLAB PCC M15 AS PER IS 456 OR MIN. 6mm THK. HDPE SHEET SHALL BE PROVIDED.
3. CONC. SLAB NEED NOT TO BE PROVIDED BETWEEN AN EXISTING PIPELINE AND A NEW CASED PIPELINE.
4. SUITABLE CATHODIC PROTECTION BONDING SHALL BE PROVIDED BETWEEN CROSSING PIPELINES. IN SOME CASES THE NEW PIPELINE MAY REQUIRE ELECTRICAL ISOLATION. C.P. DETAILS ARE COVERED SEPARATELY.
5. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE STATED.
6. DIMENSION 'A' SHALL BE CALCULATED USING FORMULA A=(D1+D2+....Dn) + (n–1) x 500 WHERE D1, D2,.... Dn ARE THE DIAMETERS. OF PIPELINES IN mm IN THE SAME TRENCH AND 'n' IS NO. OF PIPELINES IN SAME TRENCH.
7. DIMENSIONS 'D' SHALL BE THE LARGEST DIAMETER OF THE PIPELINES LAID IN SAME TRENCH.
8. TRENCH DIMENSIONS SHALL BE IN ACCORDANCE WITH RELEVENT STANDARDS/SPECIFICATIONS.
9. APPROVAL OF THE CROSSING SHALL BE OBTAINED FROM CONCERNED AUTHORITIES.

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	18.01.2019	ISSUED FOR TENDER	SS	VKS	AP

LYONS ENGINEERING PVT. LTD. NEW DELHI	UNDERGROUND CABLE CROSSING	DRAWING NO.
		GAIL–STD–PL–DWG–TP–029
		SHEET NO. 1 OF 1



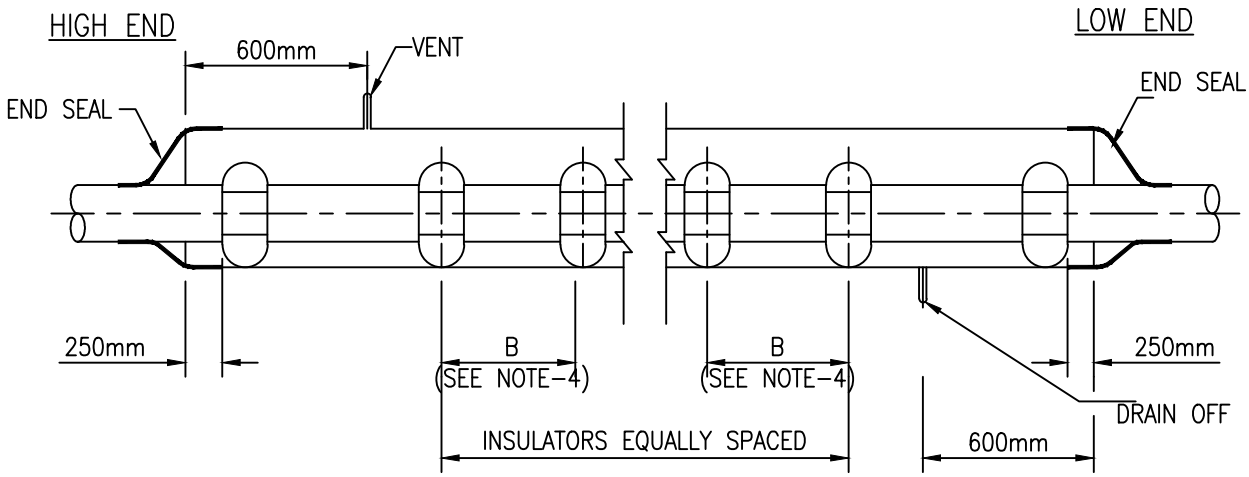


SECTION X–X

NOTES:–

1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE STATED.
2. CONCRETE SLAB SHALL BE PCC M15 AS PER IS 456, 100THK OR HDPE SHEET 6 MM THICK.
3. A MODIFIED PIPELINE WARNING SIGN SHALL BE INSTALLED CLOSE TO THE CROSSING.
4. IN CASE OF ARMOURED AC CABLE, C.P. BONDING IS TO BE PROVIDED BETWEEN PIPELINE AND CABLE ARMOUR. IN CASE OF UNARMOURED CABLE, ARRANGEMENT FOR SHIELDING (BY PROVIDING CASING ON EITHER SIDE OF THE PIPELINE OR CABLE) SHALL BE CONSIDERED.
5. DIMENSION 'A' SHALL BE A=D+500MM.
6. TRENCH DIMENSIONS SHALL BE IN ACCORDANCE WITH RELEVENT STANDARDS/SPECIFICATIONS.
7. APPROVAL OF THE CROSSING SHALL BE OBTAINED FROM CONCERNED AUTHORITIES.

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	18.01.2019	ISSUED FOR TENDER	SS	VKS	AP



NOTES:-

1. THE CASING PIPE SHALL BE DESIGNED IN ACCORDANCE WITH API RP 1102.
2. CASING PIPE IS NOT NORMALLY TO BE COATED BUT IN HIGHLY CORROSIVE AREAS THE CASING SHALL BE COATED, WRAPPED AND CATHODIC PROTECTION PROVIDED WITH SACRIFICIAL ANODES.
3. AT BOTH ENDS OF CASING PIPE A DOUBLE SET OF INSULATORS SHALL BE INSTALLED.
4. THE MAXIMUM SPACING OF THE INSULATORS SHALL BE AS PER MANUFACTURES RECOMMENDATIONS BUT IN NO CASE MORE THAN 2000MM.
5. ELECTRICAL INSULATION BETWEEN THE CASING AND CARRIER PIPE SHALL BE CHECKED WITH A SUITABLE MEGGER.
6. CASING INSULATORS AND END SEALS SHALL BE AS PER THE SPECIFICATION ISSUED FOR THE SAME.
7. END SEALS SHOWN HERE ARE ONLY INDICATIVE, POSSIBILITY OF PROVIDING OTHER TYPES OF FLEXIBLE END SEALS MAY BE CONSIDERED.
8. TO PREVENT DAMAGE TO COATING AND WRAPPING (IF APPLIED) TO CASING PIPE IN CASE OF BORED/JACKED CROSSING A PROTECTIVE COATING OF CONCRETE OR SUITABLE MATERIAL SHALL BE PROVIDED ON CASING PIPE.

REV.	DATE	SUBJECT OF REVISION	PREPD.		CHKD.		APPD.	
0	18.01.2019	ISSUED FOR TENDER	SS		VKS		AP	

LYONS ENGINEERING PVT. LTD. NEW DELHI	CASING PIPE DETAILS	DRAWING NO. GAIL-STD-PL-DWG-TP-031
		SHEET NO. 1 OF 1

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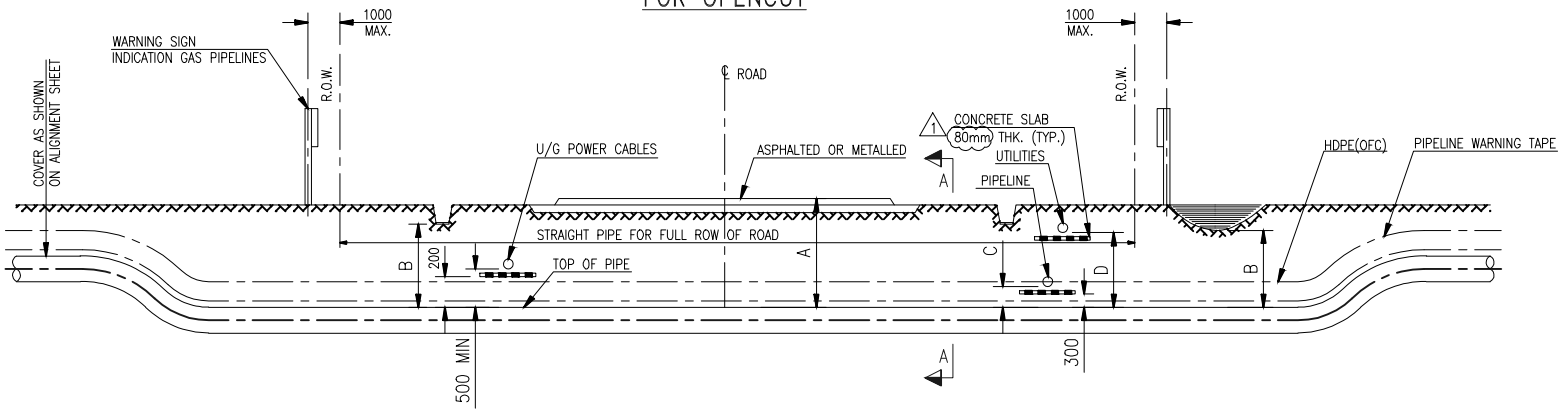
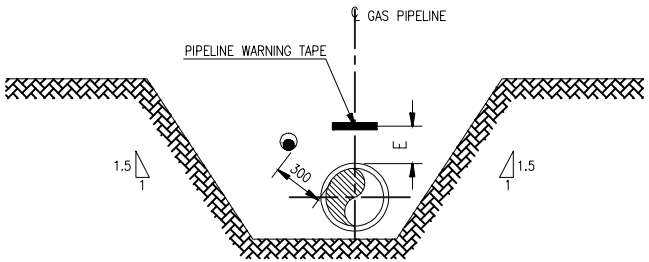
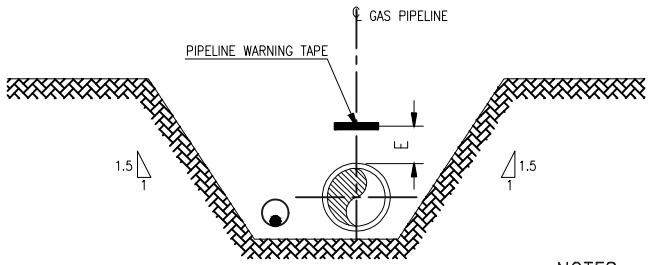




SECTION A–A TYPE–1



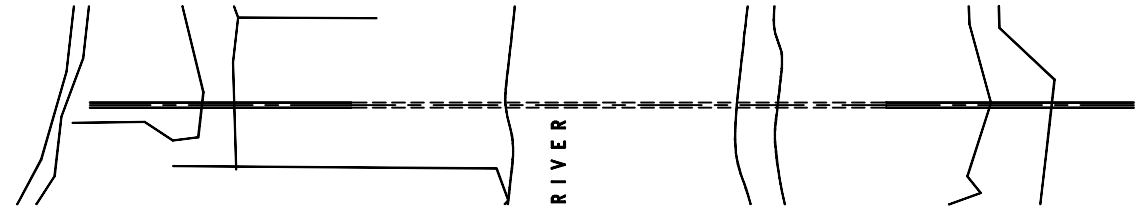
SECTION A–A TYPE–2

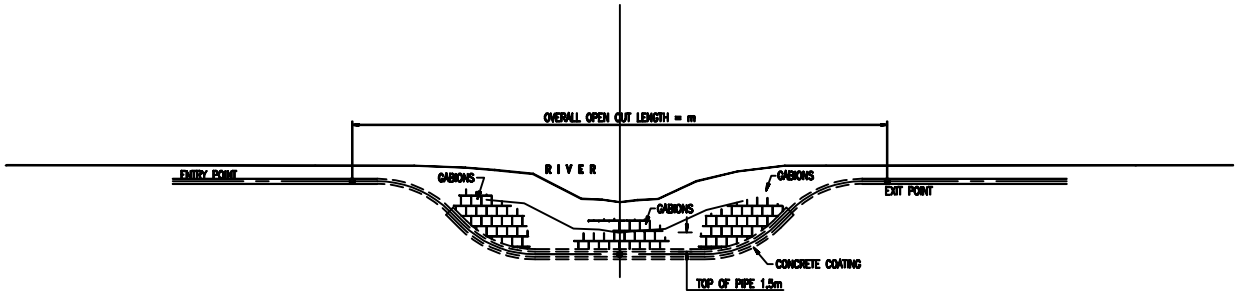
	A	B	C	D	E
ASPHALTED OR METALLED ROAD	1500 (MIN.)	2000 (MIN.)	600 (MIN.)	650 (MIN.)	500 (MIN.)

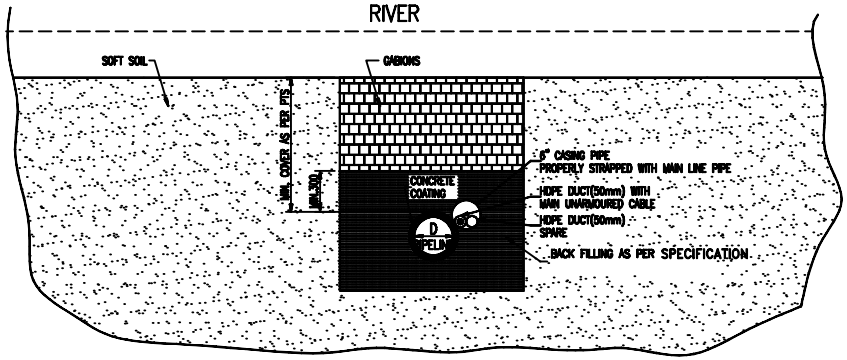
NOTES

1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. ROAD/HIGHWAY CROSSING SHALL BE RESTORED TO ORIGINAL CONDITION TO THE ENTIRE SATISFACTION OF OWNER AND CONCERNED AUTHORITIS HAVING JURISDICTION.
3. REFER API RP 1102 FOR OTHER DESIGN AND INSTALLATION REQUIREMENTS.
4. ANGLE OF INTERSECTION BETWEEN PIPELINE AND THE ROAD/HIGHWAY SHALL BE AS CLOSE TO 90° AS POSIBLE BUT IN NO CASE < 30°.
5. IN CASE PIPELINE COATING IS LIABLE TO DAMAGE WHILE BORING/JACKING, A PROTECTIVE COATING OF CONCRETE OR ANY OTHER SUITABLE MATERIAL SHALL BE PROVIDED ON CARRIER PIPE IN ACCORDANCE WITH PTS & AS DIRECTED BY OWNER/OWNER'S REPRESENTATIVE.
6. CONTRACTOR SHALL VERIFY THE ACTUAL DIMENSIONS WITH RESPECT TO SURVEY DETAILS FOR EACH ROAD/HIGHWAY CROSSING AND PREPARE DETAILED DRAWING FOR INDIVIDUAL CROSSING FOR OWNER'S APPROVAL BEFORE COMMENCEMENT OF CONSTRUCTION.
7. FOR DETAIL OF CONCRETE SLAB REFER DWG NO. **GAIL–STD–PL–DWG–TP–032**

LYONS ENGINEERING PVT. LTD. NEW DELHI									TYPICAL ROAD CROSSING (OPEN CUT)	DRAWING NO. / REV.
	DWG. NO.	REF. DRAWING	0	18.01.19	ISSUED FOR TENDER	SS	VKS	JR		GAIL–STD–PL–DWG–TP–032 / 0
			NO.	DATE	REVISION	DRN	CHKD	APPD		



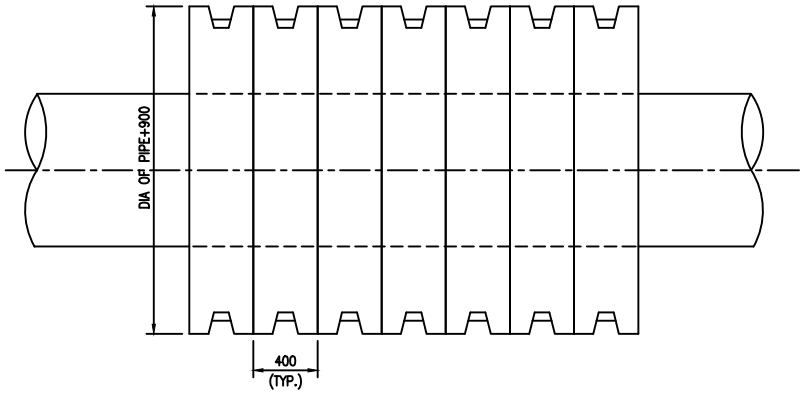




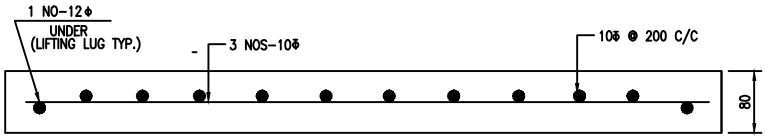
GABIONS ONLY FOR ROCKY RIVER

LYONS ENGINEERING PVT. LTD. NEW DELHI								TYPICAL DETAIL OF RIVER CROSSING (OPEN CUT)	DRAWING NO.	REV.
	DWG. NO.	REF. DRAWING	0	18.01.19	ISSUED FOR TENDER	SS	VKS	AP		
			NO.	DATE	REVISION	DRN	CHKD	APPD	GIGL-STD-PL-DWG-TP-033	0

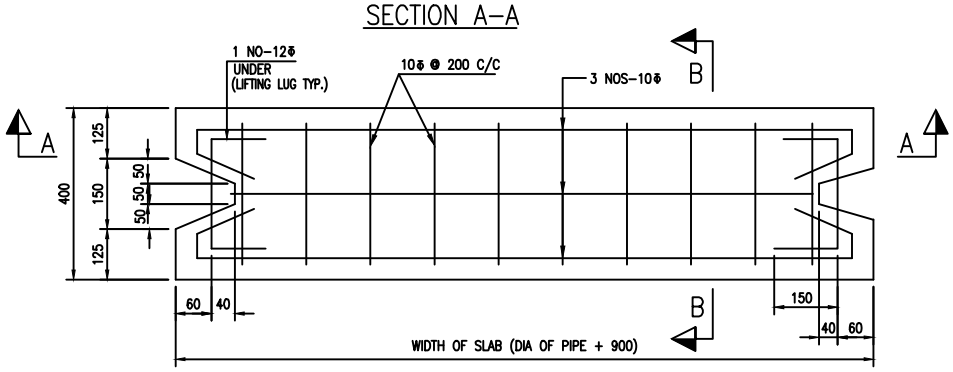
LYONS ENGINEERING PVT. LTD. NEW DELHI	TYPICAL CONCRETE SLAB DETAILS FOR MECHANICAL PROTECTION	DRAWING NO.
		GAIL–STD–PL–DWG–TP–034
		SHEET NO. 1 OF 1



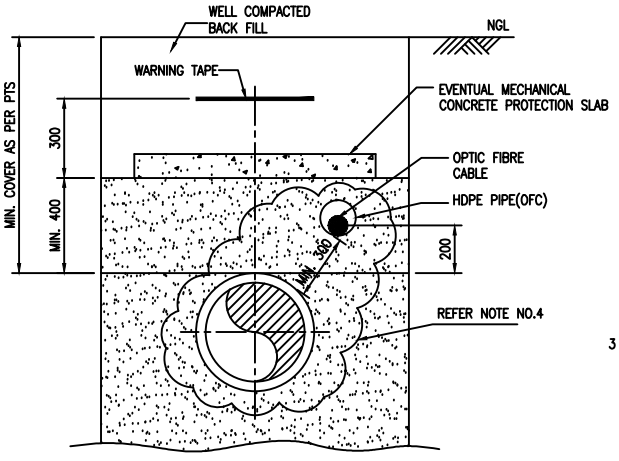
PROTECTIVE CONCRETE SLAB PLAN

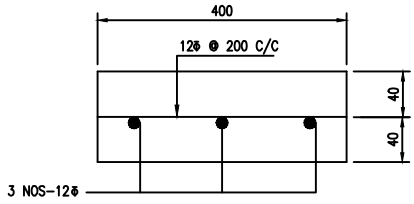


SECTION A–A



REINF. DETAIL PROTECTIVE CONCRETE SLAB





SECTION B–B

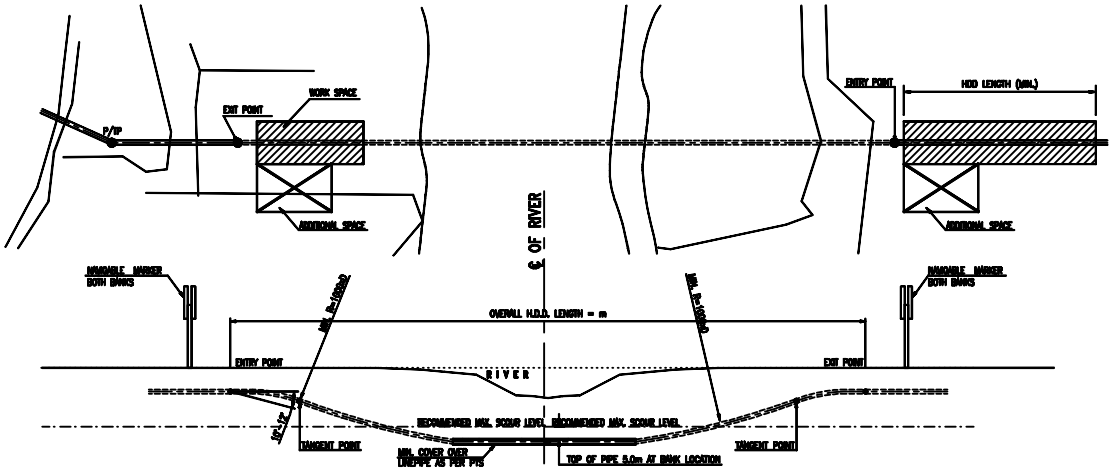
NOTES:-

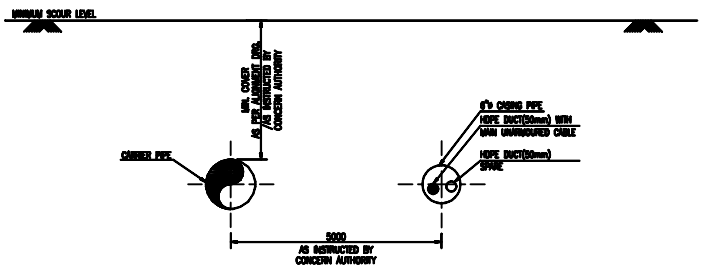
1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. MINIMUM COVER OVER LINE PIPE SHALL BE AS PER SPECIFICATION AND REQUIREMENT OF CONCERNED AUTHORIES.
3. THIS SKETCH IS INDICATIVE ONLY.
4. TYPE OF TRENCHING SHALL BE AS PER PTS AND APPROVED PROCEDURE.
5. CONCRETE MIX M20 SHALL BE USED.
6. LENGHT OF MECHANICAL PROTECTION SLAB SHALL BE CONSIDERED ALONG THE AXIS OF THE PIPE.

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	18.01.2019	ISSUED FOR TENDER	SS	VKS	AP

NOTES

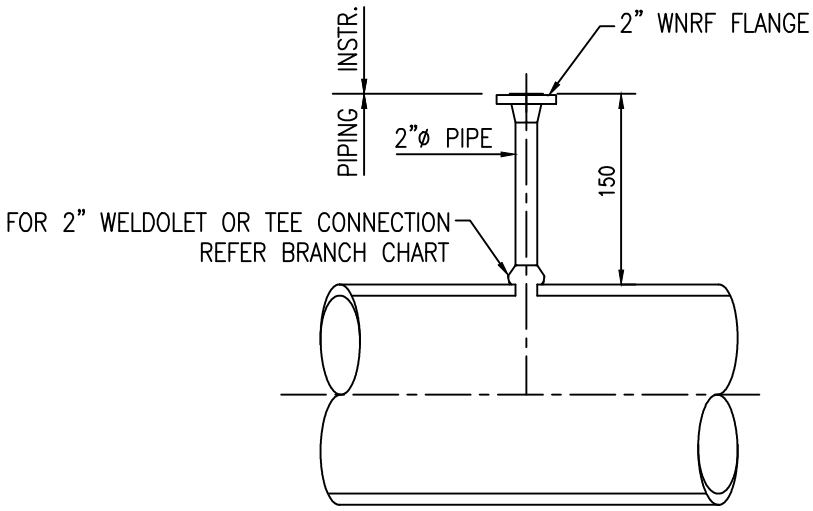
1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. THE MINIMUM TEMPORARY WORKING SPACE ALLOCATED TO CONTRACTOR AS PER SITE CONDITION. OWNER SHALL PROVIDE ONLY ROU TO THE CONTRACTOR, ANY OTHER TEMPORARY WORKING SPACE OR TEMPORARY ACEESS IF REQUIRED AT ALL HDD CROSSING SHALL BE ARRANGED BY THE CONTRACTOR AT HIS RISK & COST.
3. IF THE DRILLING POINTS (ENTRY/EXIT) ARE LOCATED BELOW THE HIGHEST WATER LEVEL THE CONTRACTOR SHALL PROTECT THE DRILLING POINTS BY CREATING A DYKE 50M MINIMUM ABOVE THE HIGHEST RECORDED WATER LEVEL. FOR PIPE LINE WITH NB >500mm THE CONTRACTOR SHALL SPECIFY THE BALLASTING METHOD HE INTENDS TO USE TO LIMIT THE FRICTION DRILLING PULL BACK.
4. PRIOR TO HDD THE PROFILE/DESIGN SHALL BE SENT TO OWNER /OWNER'S REPRESENTATIVE FOR THEIR APPROVAL.
5. ADDITIONAL ROU, IF REQUIRED, FOR WORKING AND EXCAVATION OF CROSSING TO AVOID CAVING OF SOIL SHALL BE PROCURED BY CONTRACTOR WITHOUT ANY COST IMPLICATION.





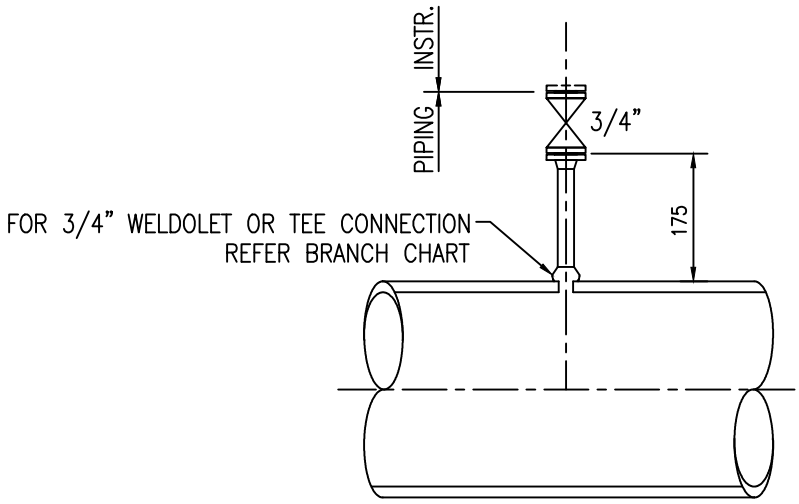
CROSS-SECTION

LYONS ENGINEERING PVT. LTD. NEW DELHI									TYPICAL HDD RIVER CROSSING MAX. SCOUR LEVEL & MIN. COVER FOR PIPE	DRAWING NO. / REV.
	DWG. NO.	REF. DRAWING	0	18.01.19	ISSUED FOR TENDER	SS	VKS	AP		GAIL-STD-PL-DWG-TP-035 / 0
			NO.	DATE	REVISION	DRN	CHKD	APPD		



REV.	DATE	SUBJECT OF REVISION	PREPD.		CHKD.		APPD.	
0	31.05.2018	ISSUED FOR TENDER	SS		VKS		JR	

LYONS ENGINEERING PVT. LTD. NEW DELHI	TYPICAL TEMPERATURE CONNECTIONS DETAILS	DRAWING NO. GAIL-STD-PL-DWG-TP-036 SHEET NO. 1 OF 1



0	10.01.2019	ISSUED FOR TENDER	SS		VKS		JR	
REV.	DATE	SUBJECT OF REVISION	PREPD.		CHKD.		APPD.	

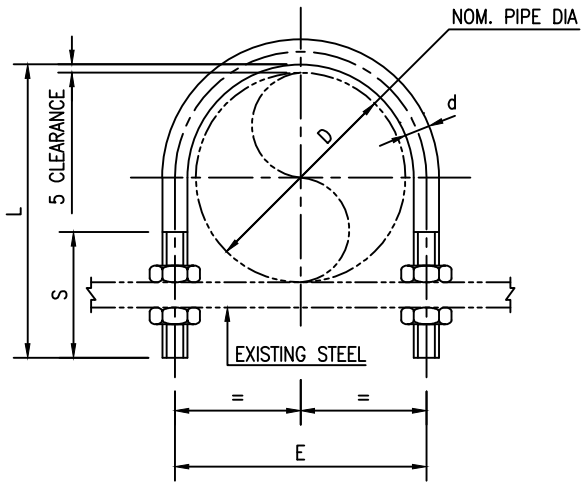
LYONS ENGINEERING PVT. LTD.
NEW DELHI

TYPICAL PRESSURE CONNECTIONS DETAILS

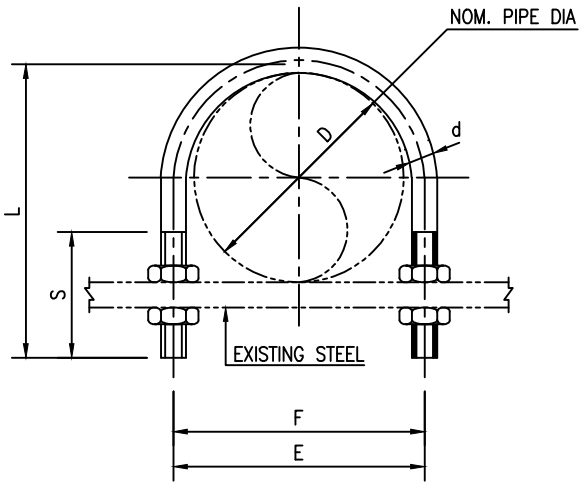
DRAWING NO.

GAIL-STD-PL-DWG-TP-037

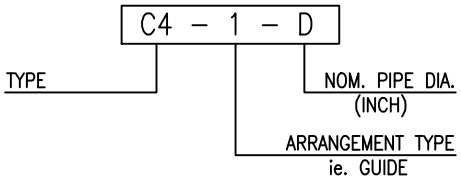
SHEET NO. 1 OF 1



GUIDE
ARRANGEMENT TYPE–1
(1/2" TO 24")



FIXED
ARRANGEMENT TYPE–2
(1/2" TO 1 1/2")



SYMBOL

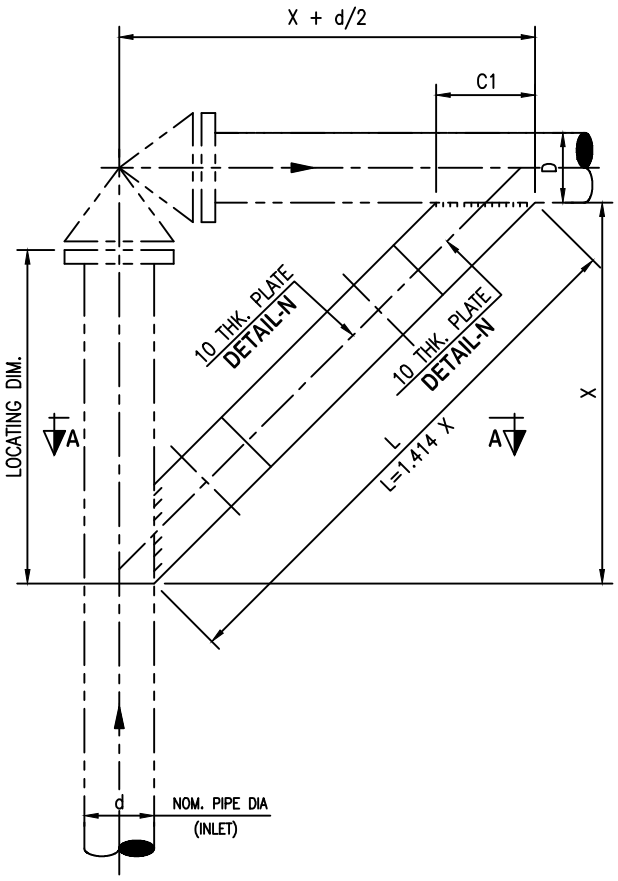
D	O.D. (mm)	'U' CLAMP				
		L	E	S	d	F
1/2"	21	65	30	50	6	24
3/4"	27	70	36	50	6	30
1"	33	75	45	55	8	37
1 1/2"	48	90	60	55	8	52
2"	60	105	72	60	8	64
3"	89	145	106	80	12	94
4"	114	170	130	80	12	119
6"	168	240	190	100	16	173
8"	219	290	242	100	16	226
10"	273	345	296	100	16	280
12"	324	420	351	130	20	331
14"	356	450	382	130	20	362
16"	408	500	435	130	20	414
18"	457	565	490	140	24	465
20"	508	620	540	140	24	515
24"	610	720	645	140	24	620

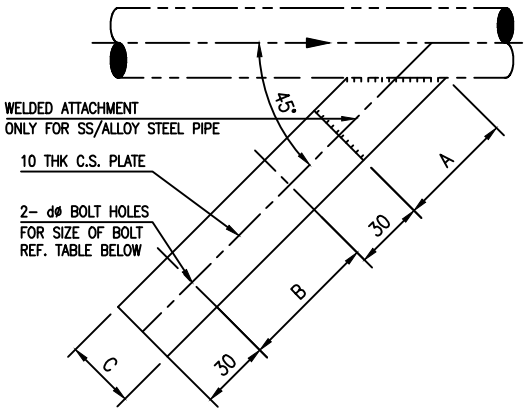
REV.	DATE	SUBJECT OF REVISION	PREPD.	CHKD.	APPD.
0	10.01.2019	ISSUED FOR TENDER	SS	VKS	JR

LYONS ENGINEERING PVT. LTD.
NEW DELHI

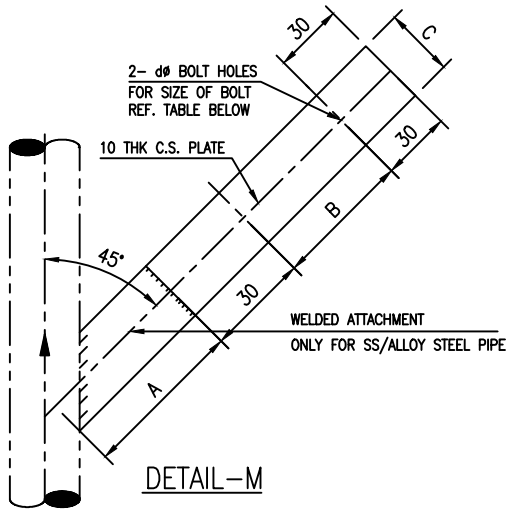
TYPICAL DRAWING FOR
U–CLAMP SUPPORT

DRAWING NO.
GAIL-STD-PL-DWG-TP-038
SHEET NO. 1 OF 1

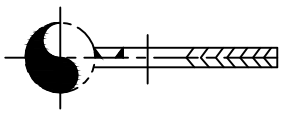




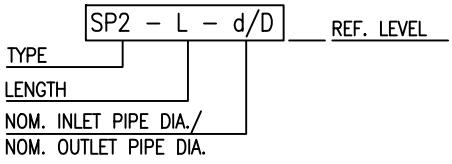
DETAIL–N



DETAIL–M



SECTION A–A



SYMBOL

NOTES:–

1. MATERIAL FOR WELDED ATTACHMENT SHALL BE EQUIVALENT TO PIPE MATERIAL.

D	BOLT SIZE dø	A	C	B MIN.	C1	D1
1" TO 4"	M12 X 50	75	50	150	71	14
6" TO 12"	M16 X 50	100	75	200	106	18

FOR TEMP. UP TO 400 °C ONLY

REV.	DATE	SUBJECT OF REVISION	PREPD.	CHKD.	APPD.
0	10.01.19	ISSUED FOR TENDER	SS	VKS	JR

LYONS ENGINEERING PVT. LTD.
NEW DELHI

TYPICAL DRAWING FOR SUPPORTING ARRANGEMENT FOR ANGLE &RELIFE VALVS.

DRAWING NO.
GAIL-STD-PL-DWG-TP-039
SHEET NO. 1 OF 1

GAIL INDIA LIMITED

CONSTRUCTION OF STEEL PIPELINE AND ASSOCIATED FACILITIES ON LMC TO M/S CARBORUNDUM UNIVERSAL LTD., HOSUR

VOLUME II OF II (TECHNICAL) – D

MECHANICAL / PIPING

E-TENDER REF :

(BID DOCUMENT NO - 034/LEPL/GAIL/15-R0)

Lyons Engineering Pvt. Ltd.

PMC:	DCI For LMC to M/s Carborundum Universal Ltd.		CLIENT:
D	**MECHANICAL / PIPING**		
Sr. No.	**Description**	**Document / Drawing No.**	**Rev. No.**
	TECHNICAL SPECIFICATION - MECHANICAL / PIPING		
1	Piping Material Specification	GAIL-STD-PI-DOC-TS-001	0
2	Technical Specification for Bolts and Nuts	GAIL-STD-PI-DOC-TS-002	0
3	Technical Specification for Seamless Fittings & Flange	GAIL-STD-PI-DOC-TS-003	0
4	Technical Specification for Painting	GAIL-STD-PI-DOC-TS-004	0
5	Technical Specification for Welding of Station Piping	GAIL-STD-PI-DOC-TS-005	0
6	Technical Specification for Fabrication and Installation	GAIL-STD-PI-DOC-TS-006	0
7	Technical Specification for NDT requirement of testing	GAIL-STD-PI-DOC-TS-007	0
8	Technical Specification for Inspection, Flusing and Testing	GAIL-STD-PI-DOC-TS-008	0
9	Technical Specification for Quick Opening & Closure	GAIL-STD-PI-DOC-TS-010	0
10	Technical Specification for Monolithic Isolation Joint	GAIL-STD-PI-DOC-TS-011	0
11	Technical Specification for Flow Tee	GAIL-STD-PI-DOC-TS-012	0
12	Technical Specification for Split Tee	GAIL-STD-PI-DOC-TS-013	0
13	Technical Specification for Clean Agent System	GAIL-STD-PI-DOC-TS-014	0
14	Technical Specification for CO2 type fire extinguisher system.	GAIL-STD-PI-DOC-TS-015	0
15	Technical Specification for fixed CO2 fire extinguisher system.	GAIL-STD-PI-DOC-TS-016	0
16	Technical Specification for Insulating Gasket.	GAIL-STD-PI-DOC-TS-017	0
17	Technical Specification for portable dry powder type fire extinguisher system	GAIL-STD-PI-DOC-TS-018	0
18	Technical Specification for hydrostatic testing of piping system	GAIL-STD-PI-DOC-TS-019	0
19	Technical specfication for erection of equipment and machinery	GAIL-STD-PI-DOC-TS-020	0
20	Technical specfication for Ball Valves	GAIL-STD-PI-DOC-TS-021	0
	DATA SHEET- MECHANICAL / PIPING		
21	Data Sheet of Monolithic Isolation Joint	GAIL-STD-PI-DOC-DS-002	0
22	Data Sheet of Flow Tee	GAIL-STD-PI-DOC-DS-003	0
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ENGINEERING STANDARD

PIPING MATERIAL SPECIFICATION

GAIL-STD-PI-DOC-TS-001

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1.0 GENERAL NOTES

This specification describes the minimum requirements for the design, furnishing of materials, fabrication, and inspection and testing of pipes, fittings and valves.
All material shall confirm to ASTM, API or BS standards. Design and fabrication shall confirm to ANSI / ASME for pressure piping, ANSI B 31.3 – Chemical Plant and petroleum Refinery Piping, and ANSI B 31.8 – Gas transmission and Distribution piping system.

2.0 CODES AND STANDARDS

The latest revision of the following shall be considered as part of this specification.

ASME B 16.5	Steel Pipe Flanges and Flanged Fittings
ASME B 16.9	Factory made Wrought Steel Buttwelding Fittings
ASME B 16.11	Forged Steel Fittings, Socket Welding and Threaded
ASME B 16.20	Metallic Gaskets for Pipe Flanges.
ASME B 16.21	Non-Metallic Flat Gasket for Pipe Flanges
ASME B 16.47	Large Diameter Steel Flanges (26” throu 60”)
ASME B 31.3	Process Piping
ASME B 31.4	Pipeline Transportation system for Liquid hydrocarbons & other Liquids
ASME B 31.8	Gas Transmissions and Distribution Piping System
ASME B 36.10	Welded and Seamless Wrought Steel Pipe
ASME B 46.1	Surface Texture
API 5L	Line Pipe
API 6D	Pipeline Valves
API 590	Steel Line Blank
API 600	Steel Gate Valves Flanges and Buttwelding Ends
API 602	Compact Steel Gate Valves
MSS SP 44	Steel Pipe line Flanges
MSS SP 75	Specification for High Test Wrought Butt Welding Fittings
MSS SP 97	Integrally Reinforced Forged Branch Outlet Fitting – Socket Welding, Threaded and Buttwelding Ends
ASTM A 105	Forging, Carbon Steel for Piping Components
ASTM A 193	Alloy Steel and Stainless Steel bolting Materials for High temp Service.

ASTM A 194	Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service
ASTM A 320	Standard Specification for Alloy Steel and Stainless Steel Bolting Materials
ASTM A 216	Steel Casting, Carbon, Suitable for Fusion Welding, for High Temperature Service.
ASTM A 234	Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperature
ASTM A 285	Pressure Vessel Plates, Carbon Steel, Low and Intermediate Tensile Strength.
ASTM A 694	Forging, Carbon and Alloy Steel, for Pipe Flanges, Fitting, Valves and Parts for High Pressure Transmission Service.
ASTM A 333	Low temperature service seamless pipe.
ASTM A 350	Forged Carbon and Low Alloy Steel requiring Notch Toughness Testing for Piping Components
ASTM A 420	Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low Temperature Service.
ASTM A 860	Standard Specification for Wrought High Strength Low Alloy Steel Butt Welding Fittings

3.0 ABBREVIATIONS

3.1 Flange Facing

RTJ	-	Ring Type Joint
FF	-	Flat Face
RF	-	Raised Face

3.2 Fittings

PE	-	Plain End
BE	-	Bevel End
BW	-	Butt Weld
PBE	-	Plain Both End
POE	-	Plain One End
TBE	-	Threaded Both End
TOE	-	Threaded One End
LR	-	Long Radius
SR	-	Short Radius

3.3 Connections

BW	-	Butt-Weld
FLGD	-	Flanged
SCRD	-	Screwed
SO	-	Slip-On

SW	-	Socket Weld
THRD	-	Threaded
WN	-	Weld Neck

3.4 Wall Thickness

SCH	-	Schedule in accordance with ANSI B 36.10 or B 36.19
STD	-	Standard Weight Wall Thickness
XS	-	Extra Strong Wall Thickness
XXS	-	Double Extra Strong Wall Thickness

3.5 Valve Description

BC	-	Bolted Cap
BB	-	Bolted Bonnet
ES	-	Extension Stem
FB	-	Full Bore
MO	-	Motor Operated
GO	-	Gear Operated
NRS	-	Non-Rising Stem (with inside screw)
OS&Y	-	Outside Screw and Yoke
RB	-	Reducer Bore
RS	-	Rising Stem
SC	-	Screwed Cap
UB	-	Union Bonnet
UC	-	Union Cap
WB	-	Welded Bonnet

3.6 Pipes Description

BE	-	Beveled End
CS	-	Carbon Steel
ERW	-	Electric Resistance Welded
EFW	-	Electric Fusion Welded
FS	-	Forged Steel
HFI	-	High Frequency Induction
KCS	-	Killed Carbon Steel
KFS	-	Killed Forged Steel
OH	-	Open Hearth
SAW	-	Submerged Arc Welded
SMLS	-	Seamless

4.0 PIPING CLASSES DESCRIPTION

Piping Classes assigned for the project are based on the following 2-digit system.

First Digit

Numerical, denoting the basic system rating or flange class

i.e.	1	= ASME Class 150
	3	= ASME Class 300
	6	= ASME Class 600
	9	= ASME Class 900

Second Digit

Letter, denoting the material

A	-	Carbon Steel
C	-	Stainless Steel

F	-	Fiberglass Reinforced plastic/epoxy (FRP)
G	-	Galvanized
P	-	Plastic (PEHD)
S	-	Stainless Steel
V	-	PVC

Third Digit

Sequential number to differentiate two or more piping classes of the same rating and same material but presenting some difference related to the handled fluid.

5.0 PIPES

5.1 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.

5.2 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.

5.3 All pipe threads shall conform to American Standard taper as per ASME B 1.20.1 NPT, unless otherwise specified.

5.4 For butt weld end, bevel shall be in accordance with API specification 5L or ASME B16.25 as applicable.

6.0 FITTINGS

6.1 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.

6.2 Threaded joints, if used, shall conform to American Standard taper as per ASME B1.20.1 NPT.

6.3 Dimensions of socket welded/screwed fittings shall conform to ASME B 16.11. Swage shall be as per BS 3799.

6.4 Dimensions of steel butt welded fittings shall be as per ASME B 16.9.

6.5 Bore of socket welded fittings shall suit outside diameter (OD) of pipe and its thickness.

6.6 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 31.8 shall apply.

6.7 Integrally reinforced forged branch fittings such as 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.

6.8 Fittings thickness tolerances shall match pipe thickness tolerance.

7.0 BENDS

7.1 Unless otherwise specified for process piping, elbow of radius R = 1.5 D shall only be used.

7.2 In order to accommodate changes in vertical and horizontal alignment in piggable section of pipeline, Elastic bends/ Cold field bends/ Hot formed long radius bends shall be used.

D = Specified Outside Diameter

Long Radius Bend shall be used only when indicated in AFC drawing.

7.3 Miters shall not be used.

8.0 FLANGES

8.1 Pressure Temperature rating of flanges shall conform to B16.5/ MSS-SP44/ B16.47 Series A, as applicable.

8.2 Dimensions of flanges shall be in accordance with B16.5/ MSS-SP44/ B16.47 Series A, as applicable.

8.3 Neck of weld neck (WN) flanges shall suit pipe bore and thickness.

8.4 Bore of socket welded (SW) flanges shall suit pipe O.D. and its thickness.

8.5 Threads for screwed flanges, if used, shall conform to American Standard taper as per ASME B 1.20.1 NPT.

8.6 Sizes for blind flanges shall be indicated by nominal pipe size.

8.7 Unless specified otherwise in Piping Material Specification the flange face finish shall be as per ASME B16.5.

8.8 Butt welding ends of WN flanges shall conform to ASME B 16.25.

8.9 Spectacle blind/spacer & blinds shall be in accordance with ASME B 16.48/ manufacturer's Standard.

9.0 GASKETS

9.1 Spiral wound metallic gasket with Graphite filled winding with SS304 inner ring and CS outer ring and shall conform to ASME B 16.20/ API 601.

9.2 Spiral wound gasket shall be self-aligning type.

10.0 BOLTING & THREADS

10.1 Nuts for stud bolts shall be American Standard Hexagon Heavy Series and double chamfered.

10.2 Dimension and tolerances for stud bolts and nuts shall be as per ASME B 18.2.1 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.

10.3 Threads for nuts shall be as per ASME B 1.1 as follows :

Nuts for stud bolts dia ¼" to 1" : UNC-2B

Nuts for stud bolts dia 1⅛" to 3¼" : 8UN-2B

10.4 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

10.5 Threads for threaded pipe, fitting, flanges and valve shall be in accordance with B 1.20.1 taper threads, unless specified otherwise.

10.6 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.

11.0 THREAD SEALANT

Threaded joints shall be made with 1" wide PTFE jointing tape.

12.0 VALVES

12.1 Valve ends shall be as per valve data sheets for various piping class.

12.2 Sectionalizing valves, Block valves and other isolation valves installed on the main pipeline shall be ball valves with butt welding ends. All inline isolation valves on the mainline (pipeline) shall be full bore valves to allow smooth passage of cleaning as well as intelligent pigs.

12.3 All buried valves shall be provided with stem extension, sealant, vent/drain and shall have butt welded ends as per relevant specification/ data sheet.

12.4 Flange dimensions and face finish of flanged end valves shall conform to clause 9.0 of this specification.

12.5 Butt welding ends of Butt Welded valves shall conform to ASME B 16.25.

12.6 Face to face and end to end dimensions shall conform to applicable standards.

12.7 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 EN ISO 15761
Check Valves	:	BS EN ISO 15761
Ball Valves	:	BS EN ISO 17292
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

12.8 All manual operated valves shall be provided with wrench / hand wheel or gear operator as specified here in below.

12.8.1 **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.

12.8.2 **Globe Valves**

For ANSI class 150, 300, 600 and 900 - Hand Wheel operated for all size

12.8.3 **Ball valves & Plug Valves**

For all ANSI class	-	Wrench operated for size ≤ 4" NB. Gear operated for size ≥ 6" NB.

12.8.4 **Actuated Valves**

Actuated valves shall be as per P & IDs. The actuator shall have provision for remote operation as per P & IDs. All Actuated valves shall have additional provision of hand wheel operation .

13.0 **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.

14.0 **PIPELINE SPECIATLITY ITEMS**

Pipeline specialty items viz. scraper traps, flow tees, insulating joints, LR bends etc. shall be as per data sheets and specification.

For Mainline Items, corrosion allowance shall be 1.0 mm except for scraper traps where 3 mm corrosion allowance shall be taken.

15.0 **INSULATING GASKET, SLEEVE AND WASHER**

The insulating gasket shall consist of a PTFE (Teflon) spring-energized face seal, or an elastomeric O-ring, seated in an isolating laminate, which shall be permanently bonded to a high strength metal gasket core. Due to this unique pressure activated sealing mechanism, the gasket requires far less bolt stress to seal than any other gasket. The gasket inner diameter shall be exactly matched to the flange bore to eliminate turbulent flow and flange face erosion/ corrosion. The seal elements shall be replaceable in the reusable gasket

retainer. The core of gasket shall be made of annealed 316 stainless steel or other metals including duplex and Inconel etc.

Insulating gasket shall include the following applications,

- Flange isolation in conjunction with cathodic protection.
- Isolation between dissimilar metals to prevent galvanic corrosion.
- Mating mismatched ring-joint to raised –face flanges.
- Eliminate fluid trap corrosion between ring-joint (RTJ) flanges where high concentrations of Co2, H2S and other aggressive hydrocarbon media are present.
- Eliminate turbulence and flow induced erosion between ring-joint (RTJ) flanges.
- Protect against coating impingement on coated flange faces.
- To seal between flanges subjected to vibration/ cavitation.

15.1 **Insulating Gasket, sleeves and washers material properties :**

Compressive strength	:	65000 PSI
Average Dielectric strength	:	15 KV
Electrical resistance	:	> 1 Mega Ohm (When tested with 500-1000 V DC megger)
Max. Operating temp.	:	302°F (150°C)
Min. Operating temp.	:	(minus) -200°F
Water absorption	:	5%
Flexural strength	:	70000 PSI
Tensile strength	:	50000 PSI
Bond strength	:	2600 lb
Shear strength	:	22000 lb.

15.2 **Seal Material**

The sealing elements shall intended to provide an impervious barrier through which no contained media or other substance can penetrate. The composite retainer backing material behind the seal remains uncontaminated and thus permanently holds the seal in place in a static, fully encapsulated manner.

Viton as a seal material shall consist following properties,

- General purpose oilfield elastomer.
- Excellent resistance to aliphatic hydrocarbons, glycols and H2S.
- Good resistance to aromatic hydrocarbons.

Isolation Sleeve

Mylar as a seal material shall consist following properties,

- Spiral wound Mylar is a general purpose material recommended for bolting application with flange temperatures below 250°F.
- Material shall be fair resistance to crushing, cracking, breaking and thread pinch.

Isolating washer: 1/8” (0.125) Thick washer.

Steel Washer: ZPS standard – Zinc plated steel washers.

Butt weld (BW) ends of the insulating assembly shall be protected by metallic or high impact plastic bevel protectors.

The dimensions of insulating components (gaskets, sleeves and washers) shall be as indicated in Data Sheet. The insulating gasket and washers shall have adequate compressive strength to permit proper tightening of flange bolts for leak proof joint.

The insulating material shall be suitable for pressure and temperature indicated in Data Sheet under connecting pipeline details and shall be resistant to the fluid to be handled through the pipeline.

I.D. and O.D. of insulating washers shall be designed to fit over insulating sleeves and within spot faces on flanges.

After the hydrostatic test, insulating flange assembly shall be tested with air at 5 kg/cm2 for 10 minutes. The tightness shall be checked by immersion or with a frothing agent. No leakage shall be accepted.

Insulating gasket, sleeve and washer after the field hydrostatic test shall be tested for dielectric integrity at 5000 V A.C., 50 Hz for one minute and the leakage current before and after shall be equal. Testing time, voltage and leakage shall be recorded and certified. The test shall be carried out in dry conditions.

16.0 CHARPY V-NOTCH TEST

All piping material like valves, fittings, flanges bolting etc. shall be Charpy impact tested. Charpy V-notch impact tests are required for the base metal, weld metal and heat-affected Zone (HAZ)

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL NOTES FOR BOLTS & NUTS

GAIL-STD-PI-DOC-TS-002

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TECHNICAL NOTES FOR BOLTS AND NUTS

1.0 GENERAL

1.1 The process of manufacture, heat treatment, chemical & mechanical requirements and marking for all stud bolts, bolts, jack screws & nuts shall be in accordance with the codes/standards and specifications given in the requisition. The applicable identification symbol in accordance with the material specification shall be stamped on each bolt and nut. Vendor shall strictly comply with MR/PR stipulations and no deviations shall be permitted.

1.2 **Testing**

1.2.1 Test reports shall be supplied for all mandatory tests as per the relevant material specifications.

1.2.2 Material test certificate shall also be furnished. (Heat Analysis, Product Analysis and Mechanical Requirement)

1.2.3 PMI shall be performed as per the scope and procedures defined in the Specification for PMI at Vendor's Works.

1.2.4 Stress Rupture Test as detailed in ASTM *A453* shall be carried out for all ASTM A453 bolting material irrespective of the temperature.

1.3 All bolting shall be as per ANSI B 18.2.1 for studs, M/c bolts and jackscrews and ANSI B18.2.2 for nuts.

1.4 Threads shall be unified (UNC for 1" dia and 8UN for > 1" dia) as per ANSI B.1.1 with class 2A fit for studs, M/c bolts and jackscrews and class 2B fit for nuts.

1.5 Stud bolts shall be threaded full length with two heavy hexagonal nuts. Length tolerance shall be in accordance with the requirement of ANSI B 16.5.

1.6 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.

1.7 Heads of jackscrews and m/c bolts shall be heavy hexagonal type. Jackscrew end shall be rounded.

1.8 Each size of studs & rn/c bolts with nuts and jackscrews 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.

1.9 All items shall be inspected and approved (stage wise) by LEPL.

1.10 The heat treatment for stud bolts & nuts shall be as per code unless mentioned otherwise.

1.11 All austenitic stainless steel bolts, nuts, screws shall be supplied in solution annealed condition unless specified otherwise in the material specification.

1.12 Stud bolts, nuts & jackscrews 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°C unless mentioned otherwise. For other materials impact energy and test shall be as per respective code.

1.13 Bolts/nuts of material of construction B7M/ 2HM shall be 100% Hardness tested as per supplementary requirement S3 of ASTM A 193.

1.14 When specified as galvanized, the studs, M/C bolts and nuts shall be 'hot dip zinc coated' in accordance with requirements of 'class C' of 'ASTM A *153'.* As an alternative, electro galvanizing as per IS 1573, 'Service Grade Number 2' is also acceptable.

1.15 All Stud Bolts of Bolt diameter size 1" and above shall be provided with three nuts irrespective of whatever has been specified elsewhere in the MR.

2.0 ACCEPTABLE DEVIATIONS

2.1 'Nuts' to ASTM A194Gr.7 are acceptable in place of ASTM A194Gr.4.

ENGINEERING STANDARD

GAIL INDIA LIMITED

SPECIFICATION FOR SEAMLESS FITTING AND FLANGE

GAIL-STD-PI-DOC-TS-003

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1. SCOPE

This specification covers the minimum requirements for the design, manufacture and supply of following items to be installed in pipeline system handling hydrocarbons in liquid or gaseous phase:

- Seamless fittings 450 mm (18") NB and smaller, such as tees, elbows, reducers and caps.

- Flanges 450 mm (18") NB and smaller, such as welding neck flanges and blind flanges

The specification does not cover the above mentioned items which are to be installed in pipeline system handling sour hydrocarbons (liquid / gas) service as defined in NACE standard MR-01-75-98.

2. REFERENCE DOCUMENTS

Reference has been made in this specification to the latest edition of the following codes, standards and specifications:

ASME B 16.5	-	Steel Pipe Flanges and flanged Fittings
ASME B 16.9	-	Factory-Made Wrought Steel Butt Welding Fittings
ASME B 16.11	-	Forged Steel Fittings, Socket Welding and Threaded
ASME B 31.3	-	Process Piping
ASME B 31.4	-	Liquid Transportation Systems for Hydrocarbons, Liquid Petroleum Gas, Anhydrous Ammonia and Alcohols
ASME B 31.8	-	Gas Transmission and Distribution Piping Systems
ASTM A 370	-	Mechanical Testing of Steel Products
API 590	-	Steel Line Blanks
MSS-SP-25	-	Standard Marking System for Valves, Fittings, Flanges and Union
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

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/ MSS-SP- 75, as applicable. These records shall be submitted at the time of bidding.

4.0 MATERIALS

4.1 The basic material for fittings and flanges shall be as indicated in the Material Requisition. Additionally; the material shall also meet the requirements specified hereinafter.

4.2 Each heat of steel used for the manufacture of fittings and flanges shall have carbon equivalent (CE) not greater than 0.45 % calculated from check analysis in accordance with following formula:

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

Carbon contents on check analysis shall not exceed 0.22%.

4.3 Unless specified otherwise, Charpy V-notch test shall be conduced for each heat of steel, in accordance with the impact test provision of ASTM A370 at 0°C temperature. 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 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 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 welding neck flanges and blind flanges shall conform to the requirement of ASMEB16.5.

5.2 Fittings such as tees, elbows and reducers shall be seamless type and shall conform to ASME B 16.9 for sizes 50 mm (2") NB and above and ASME B16.11 for sizes below 50mm (2") NB.

5.3 Fittings such as weldolets, sockolets, nippolets, etc., shall be manufactured in accordance with MSS-SP-97

5.4 Type, face and face finish of flanges shall be as specified in Material Requisition / Purchase Requisition.

5.5 Flanges and fittings manufactured from bar stock are not acceptable.

5.6 All butt weld ends shall be bevelled as per ASME B 16.5/ASME B 16.9/MSS-SP-97 as applicable.

5.7 Repair by welding on flanges and fittings are not permitted.

6.0 INSPECTION AND TESTS

6.1 and to, The Manufacturer shall perform all inspection and tests as per the requirement of this specification the relevant codes, prior to shipment at his works. Such inspection and tests shall be, but not limited the following:

6.1.1 Visual inspection.

6.1.2 Dimensional checks.

6.1.3 Chemical composition, mechanical properties and hardness examination.

6.1.4 All finished wrought weld ends shall be 100% ultrasonically tested for lamination type defects. Any lamination larger than 6.35 mm shall not be acceptable.

6.1.5 All other tests not specially listed but are required as per applicable standard / specification.

6.2 Purchaser's Inspector may also perform stage-wise inspection and witness tests as indicated in Clause 6.1 at Manufacture'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 the 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 submit following certificates to Purchaser's Inspector:

a) Test certificates relevant to the chemical analysis and mechanical properties of the materials used for construction as per this specification and relevant standards

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

TECHNICAL SPECIFICATION FOR PAINTING

GAIL-STD-PI-DOC-TS-004

0	30.01.2019	Issued for Bid	AP	JR	SB	
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1.0 GENERAL

1.1 These technical specifications shall be applicable for the work covered by the contract, and without prejudice to the provisions of various codes of practice, standard specifications etc. It is understood that contractor shall carry out 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.

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.

1.2 SCOPE

1.2.1 Scope of work covered in the specification shall include, without being limited to the following.

1.2.2 This specification defines the requirements for surface preparation, selection and application of primers and paints on external surfaces of equipment, vessels, machinery, piping, ducts, steel structures, external & internal protection of storage tanks for all services, MS Chimney without Refractory lining and Flare lines etc. The items listed in the heading of tables of paint systems is indicative only, however, the contractor is fully responsible for carrying out all the necessary painting, coating and lining on external and internal surfaces as per the tender requirement.

1.2.3 Extent of Work

1.2.3.1 The following surfaces and materials shall require shop, pre-erection and field painting:

a. All uninsulated C.S. & A.S. equipment like columns, vessels, drums, storage tanks(both external & internal surfaces), heat exchangers, pumps, compressors, electrical panels and motors etc.

b. All uninsulated 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, handrails, ladders, platforms etc.

e. Flare lines, external surfaces of MS chimney with or without refractory lining and internal surfaces of MS chimney without refractory lining.

f. Identification colour bands on all piping as required including insulated aluminium clad, galvanised, SS and nonferrous piping.

g. Identification lettering/numbering on all painted surfaces of equipment/piping insulated aluminium clad, galvanized, SS and non-ferrous piping.

h. Marking / identification signs on painted surfaces of equipment/piping including hazardous service.

i. Supply of all primers, paints and all other materials required for painting (other than Owner supplied materials)

j. Over insulation surface of equipments and pipes wherever required.

k. Painting under insulation for carbon steel, alloy steel and stainless steel as specified.

l. Painting of pre-erection/fabrication and Shop primer.

m. Repair work of damaged pre-erection/fabrication and shop primer and weld joints in the field/site before and after erection as required.

n. All CS Piping, equipments, storage tanks and internal surfaces of RCC tanks in ETP plant.

1.2.3.2 The following surfaces and materials shall not require painting in general. However, if there is any specific requirement by the owner, the same shall be painted as per the relevant specifications:

a. Uninsulated austenitic stainless steel.
b. Plastic and/or plastic coated materials
c. Non-ferrous materials like aluminum.

1.2.4 Documents

1.2.4.1 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.
e. Painting specifications including special civil defence requirements.

1.2.5 Unless otherwise instructed, final painting on pre-erection/ shop primed pipes and equipments shall be painted in the field, only after the mechanical completion, testing on systems are completed as well as after completion of steam purging wherever required.

1.2.6 Changes and deviations required for any specific job due to clients requirement or otherwise shall be referred to J P Kenny for deviation permit.

2.0 CODES & STANDARDS

Without prejudice to the specifications of the contract, the following codes and standards shall be followed for the work covered by this contract.

IS: 5	Colors for ready mixed paints and enamels.
IS: 101	Methods of test for ready mixed paints and enamels,
IS: 161	Heat resistant paints.
IS: 2074	Specifications for ready mixed paint, red oxide zinc chrome priming.
IS: 2339	Aluminum paint for general purposes in dual container.
IS: 2379	Color code for identification of pipelines.
IS: 2932	Specification for enamel, synthetic, exterior (a) undercoating. (b) Finishing.

3.0 CONDITIONS OF DELIVERY

Packaging

Every recipient will be fitted with a hermetically-sealed lid with an opening that is sufficiently large to allow the contents to be stirred: the outside and inside are protected against oxidation, and, the lid, are marked with a strip of color identical to the contents.

4.0 COMPOSITION OF THE PAINT PRODUCTS USED

a) Quality

The composition and quality of the products may not differ from batch to batch. A batch is all of the products of a specified manufacture. If the analyses of products bring to light that the composition does not conform to the specifications of the paint manufacturer, the

OWNER may refuse to use this batch of products. The paint products must comply with the following conditions

- They must have the viscosity necessary for the described use and the established condition: use of the brush - paint roller (spray gun only for special cases and in the workshop)

b) Quality control - Sampling

While the works are in progress on the construction site, the OWNER may carry out sampling on the paint being used for the purpose of checking conformity. The paint products must be made available free of charge to the laboratory or the approved supervisory body in sufficient quantities so that all the tests can be carried out on the same batch.

If analyses reveal a non-conformity in the composition of the products used (tolerance of $\pm$ 3 % of the dosage of every component), the OWNER may refuse application of the product under consideration, halt the work and have the nonconforming product already applied removed.

Before proceeding the work, a product that does conform will be required. The only Purpose of the analysis is to reveal any nonconformity of the composition of the products. Their purpose is therefore not to assess the quality of the different components. The analyses concerned are not acceptance tests of the products supplied and in no way affect the obligations of the contractor specified in the contract towards the OWNER.

5.0 IDENTIFICATION

Every recipient will bear the following information:

- Name of the manufacturer
- Date and number of manufacture
- Name of the product type
- Batch no
- Net weight of the produced or the contents of the recipient
- Date of the expiry.

At the time of delivery, this packaging must bear labels in conformity with the legal stipulations in force.

Leaving the site after work

After completion of a job a general clean-up shall be carried out by the Contractor to remove all debris, materials or irregularities that his work has brought to the site so that it is left tidy:

The restoration work includes among other things:

- the removal of abrasives.
- the removal of the different protective coverings.
- the Contractor will make the required repairs to any damage after refitting the supports.
- the removal of paint and cleaning of the stains on the floor.

6.0 SURFACE PREPARATION STANDARDS

Following standards shall be followed for surface preparations:

1 Swedish Standard Institution- SIS-05 5900-1967

2 Steel Structures Painting Council, U.S.A. (Surface Preparation Specifications (SSPC-SP)

3 British Standards Institution (Surface Finish of Blast-cleaned for Painting) BS-4232.

4 National Association of Corrosion Engineers. U.S.A. (NACE).

5. IS-1477-1971 (Part-1) - Code of Practice for Painting of Ferrous metals in Buildings. (Part 1, Pre-treatment)

a) The contractor shall arrange, at his own cost to keep a set of latest edition of above standards and codes at site.

b). The paint manufacturer's instruction shall be followed as far as practicable at all times. Particular attention shall be paid to the following:

- Proper storage to avoid exposure as well as extremes of temperature.
- Surface preparation prior to painting.
- Mixing and thinning.
- Application of paints and the recommended limit on time intervals between coats.

c) Any painting work (including surface preparation) on piping or equipment shall be commenced only after the system tests have been completed and clearance for taking up painting work is given by the OWNER, who may, however, at his discretion authorize in writing, the taking up of surface preparation or painting work in any specific location, even prior to completion of system test.

7.0 PREPARATION OF THE SURFACES

7.1 General Specifications

The cases that occur in practice on building sites, with regard to painted surfaces, can be broken down as follows:

- Material of which the oxide content disappears by natural oxidation.
- Material that has already been covered with a layer of paint in the workshop.
- Material that is covered with old paint layers that show different degrees of weathering.

Good preparation oldie surface is the best guarantee for good anti-corrosion protection.

Paintwork may never begin until the surface to be treated is dry and is independent of the base coat and cleared of dirt, dust, rust, scale, grease, salt attack, cement powder, cement mud-scale, sand, oil, etc.

Based on the environmental conditions of coastal and saline nature, the Painting specification for station pipes defines the complete requirements like:

- Surface preparation standards like NACE etc.
- Sand blasting process
- Color Codes for piping

- Paint materials types and their DFT measurement.
- Selection and application of paints on external surfaces.

The pipeline passes through the coastal and marine environment, the **Table-4** of this specification to be followed for the painting works.

The method of preparation of the surface will be implemented in accordance with the preparation methods described below:

- Cleaning (bright blast-cleaning);
- Mechanical cleaning;
- Manual derusting.

The Contractor should have the required material at his disposal to clean the surfaces to be coated thoroughly in accordance with the preparation methods regardless of the form or the condition of such surfaces. The cleaning devices that might be damaged during the surface preparation shall be screened off by the Contractor.

7.2 Sandblasting

Before beginning cleaning by blasting, the person carrying out the work will take the following measures:

- Clear the steel surface of oil and/or grease;
- Ensure that each flange collar (section where the sealing is applied) is properly screened off against the blasting and the subsequent works;
- Check that no blasting grains can act into the pipes during this process. Any openings not sealed off must be screened off;
- Where there are valves, regulators and other devices, the manufacturer's identification plate will be dismantled so that all surfaces can be treated. The plate will then be put back again.
- Screen off all non-metal structures such as rubber where there is a filter;
- With valves, operators and other devices, care should be taken to ensure that no metal filings or paint get into the apparatus:
- The OWNER reserves the right to carry out part or all of these works himself.

To prevent rust forming quickly as the result of humidity on the blasted surface, cleaning by blasting may only be carried out when the temperature of the steel surface is at least 3°C higher than the dew-point of the ambient air.

Blasting may not be carried out if the relative degree of humidity exceeds 80%. The choice of the type of blasting medium used depends on local circumstances such as the possible presence of gas and the material to be blasted.

The abrasive to be used must conform to the local low i.e. it may contain no carbon and less than 1% free silicon dioxide. The Sa 3 will always be requested and must at least reach Sa 2½ during the initial stage of the paintwork. For blasting followed by metallisation, the surface preparation degree to be achieved is always Sa 3. The degree of cleanliness to be obtained will be inspected in accordance with the Swedish standard SVENSK STANDARD ISO 8501-1-1988 SS 05.5900.

- Sa 3: surface blasted down to the bare metal; when the surface is inspected with a magnifying glass, scale, rust and foreign bodies must be completely removed and it should be possible to raise a metallic -shine on the treated surface.

- Sa 2 1/2: blasted very carefully. Scale, rust and foreign bodies must be removed in such a way that anything left behind will only be visible as nuances (shading) or strips.

The blast-cleaning will be carried out by means of compressed air free of water and oil.

After the blasting and before painting, the surface should be completely cleaned of blasting material and so forth with a soft brush, a dry cloth or dry compressed air.

7.3 Mechanical cleaning

If sandblasting is not permitted or if the metal structures are not easily accessible for blasting or blasting for one reason or another is technically unfeasible, mechanical derusting can be used instead. With mechanical cleaning by means of chipping, rotating steel brushes and sanding discs, a degree of cleanliness St. 3 should be reached.

St 3 : removal of the old paint layers of which the adhesion leaves something to be desired and/or of which the paint layer no longer fulfils the requirements.

If parts are present that are so corroded that St 3 is difficult to achieve, this should be notified to the OWNER representative prior to the start of the works.

N.B:

St. 3 : means removal of every old paint layer. Retouching means local polishing with St. 3 or Sa 3 followed by application of the desired painting system.

After mechanical cleaning, the surface should be made dust-flee with a cloth or a so brush, washed with an organic solvent and thoroughly dried off with a dry cloth (e.g. with 1.1.1. Trichoroethane such as Solvethane, Chloroethene).

7.4 Manual Derusting

Manual derusting with the aid of scrapers. steel brushes, sandpaper etc. shall only be permitted in exceptional cases for local repairs. Any deviation there from must be requested from the OWNER/ OWNER 's Representative.

With manual derusting, a surface preparation degree St 3 must be obtained. The length of the handles of the equipment used may not exceed 50 cm.

7.5 Preparation of a surface covered with a layer of paint in the workshop.

This layer is in general applied by the manufacturer, for example, on valves, regulators etc. Layers of this kind will be checked for their proper adhesion in accordance with ASTM D 3359, method A (Standard Test Method for measuring adhesion by tape test). The adhesion should be at least .

If the paint layer shows less adhesion or is incompatible with the rest of the system it should be completely removed. If the paint layer is not removed, the Contractor accepts it in the state in which the coating is found and the guarantee remains in force. The adhesion does not have to be examined if system 63 has already been applied in the workshop on behalf of the OWNER.

The Contractor, who must provide for the protection on the construction site, must therefore obtain the information regarding the treatment of the surface and the quality of the paint that was used and must, moreover, examine the adhesion of the layer on the construction site, the percentage of damage and weathering as well as the value of the preparation of the surface in the workshop together with the thickness thereof that must be supplemented if necessary.

a) Galvanized surface

Galvanized surfaces, both old and new will be carefully roughened up. Every foreign body (concrete splatters, chalk marks, grease and oil stains, etc.) will be removed. Thereafter, rub the surfaces with abundant water and, if necessary, with cleaning products.

To this end, nylon brushes will be used for every kind of dirt as well as for removing zinc salt residue. Thereafter, the surfaces will be treated in accordance with system 21. Where the zinc layer is lacking, it will be derusted manually to a degree of cleanliness St 3, after which a primer coat will be applied in accordance with system 22.

b) Metallised surfaces treated with an impregnation layer

- degrease with the desired degreasing product:
- clean under high pressure or with a product prescribed by the paint supplier.

If the paint layer adheres well and is applied on a clean base, the painting system described may be continued. If the percentage of damage and weathering does not exceed 5 % m. retouching may be considered. These partial repairs will be carried out.

If on the other hand, the percentage of damage does exceed 5 %/m or if the layer applied in the workshop comes loose the Contractor must draw the attention of the OWNER to this and carry out the complete application system.

7.6 Preparation of surfaces covered with earlier paint layers that show different degrees of weathering.

If the surfaces do not show deep weathering limited to the spread of rust by small pitted areas or non-penetrative rust in spots, it will very often be sufficient to clean the surfaces with abrasives or with an abrasive disc, then to rub them down with steel wool, remove the dust and wash off. If thick rust appears, in spots, scale rust and active rust canker, this should be removed with needle hammers or stripped away directly by blasting, removing the dust and washing oft.

7.7 Preparation of concrete or cement plaster surfaces

Remove unsound paint layers and loose components with scrapers, blades or rotating steel brushes. Thoroughly clean the entire surface with water containing ammonia. Thoroughly remove moss, algae and fungal growths. Where these growths have been removed, treat the area with a fungicide in accordance with the instructions for use.

Once the entire area is completely dry, brush off the dead residue of moss, algae and fungus with a hard brush. In the case of reinforcement steel that has been laid bare, remove as rust, dust and grease as possible and treat with a printer coat. When painting concrete surfaces, they must first be checked for cracks. Cracks larger than 0.3 mm must be repaired with an appropriate system in accordance with the type and extent of the repairs (e.g. injection with epoxy mortar). Repair damage such as cracks and bursts to concrete parts with a two-component mortar or preferably with micro-mortars. Finally check the alkalinity of the surface with the aid of litmus paper and neutralize it if necessary.

7.8 Use of solvents

It is sometimes necessary to use solvents when the surfaces to be painted are streaked with grease or oil. In this case a suitable organic solvent should be applied. The operation should be carried out with the aid of clean brushes or rags and clean solvent.

All the legal specifications in connection with solvents etc. must be adhered to. The OWNER/OWNER's Representative will be informed in advance of any toxicity or flammability. All measures must be taken to prevent any risk of fire and to nick out any possibility of poisoning (ventilation). The Contractor will provide drip collectors to keep the environment free of pollution.

7.9 Condition of the metal after stripping

The Contractor must call in a representative of the OWNER/OWNER's representative or of the Approved supervisory Body responsible for checking the condition of the metal during stripping and informing the OWNER/OWNER's representative immediately of any damage that he might have noticed.

- Deep corrosion of the plates - rivets - bolts
- Faulty welding

- Fittings that appear to be dangerous because of their age.

7.10 Removing coating from surface pipelines

The Contractor must have the equipment necessary for the removal of asphalt from the pipe without damaging the latter (scratching, impact, etc,). The Contractor undertakes to carry out the work in accordance with an approved procedure.

8.0 METALLISATION

8.1 Applying the metallisation

Metallisation must be carried out in accordance with ISO 2063,

Metallisation is carried out as rapidly as possible after blasting in order to limit corrosion of the pipes (max. 3 hours later). With metallisation, a surface preparation degree Sa 3 is compulsory. The roughness of the blasted surfaces should be from 25 to 50µ R_{Max}.

- The metallising is always carried out on dry parts in good weather conditions (maximum relative humidity 80 %);
- For metallisation, a wire composed of 85 % zinc and 15 % aluminum with a minimum guaranteed degree of purity of 99.5 % is used (subject to other specifications). The application thereof is always carried out in accordance with the conditions of the manufacturer and may at all times be submitted to the OWNER's representative.
- The sealant should be applied maximum 3 hours alter metallisation.
- The sealant must be thinned and applied as per the present specifications. A visual inspection whereby the sealant completely covers the metallisation will suffice here.
- When evaluating the metallisation, a negative deviation from the minimum coating thickness, to 80 µ for 20% of the measurements will be permitted.

9.0 CARRYING OUT THE PAINTWORK

9.1 Conditions for carrying out paintwork

Painting may not be carried out in unsuitable conditions.

All preparatory work and painting may only he carried out in dry weather and at a minimum temperature of 10°C, except for special eases requested by the OWNER's Representative.

Unless otherwise stipulated in the specifications of the paint supplier, application of the paint is forbidden if it is forecast that the temperature will fall to below 0°C before the paint is dry. The temperature of-the surface to be painted must be at least 3°C higher than the dew point of the ambient air. Application of the paint is also not permitted if there is a danger that the coat of paint will not be dry before dew or condensation sets in.

The work must be stopped:

- If the temperature of the surface to be painted is higher than that described by the supplier.
- In rain, snow, mist or fog or when the relative humidity is higher than 80 %.

Coats that have not yet dried and have been exposed to frost, mist, snow or rain and might thereby be damaged must be removed after drying and the surfaces must be repainted at the expense of the Contractor.

Working in direct sunlight or in hot weather must be avoided,

The first coat of paint must be applied maximum 3 hours after the preparation of the surface of the relative humidity of the air is between 50% and 80%. This time span may be increased to 6 hours if the relative humidity is less than 50%. In all cases, the preparation of the surface must exhibit degree Sa 3 and at the very least the appearance of degree Sa 2 ½ at the time of painting.

The coats of paint may only be applied on carefully cleaned surfaces that must be dry and free of grease and dust.

9.2 Special conditions

Painting may be carried out when the Contractor can be sure that the instructions of the paint supplier have been scrupulously followed with regard to the parameters in the following (non-exhaustive) list:

- Ambient temperature.
- Surface temperature.
- Relative humidity.
- Dew point.
- Drying times.

The Contractor must in this respect be able to produce the instructions for the paint on the site. The OWNER/CONSULTANT will guarantee 100% supervision in this regard during the execution of the work.

In addition, the paintwork may only be carried out to a minimum ambient temperature of 5°C and/or to a maximum relative degree of humidity of 85 %. Application of the paint is also not permitted if there is a danger that the coat of paint will not be dry before dew or condensation sets in.

9.3 Paint Materials

Manufacturers shall furnish the characteristics of all paints indicating the suitability for the required service conditions. Primer and finish coats shall be of class-I quality and shall conform to the following:

Primer (P-1)

Red oxide Zinc Chromate Primer

Type and Composition	Single pack, Modified phenolic alkyd medium pigmented with red oxide and zinc chromate.
Volume solids	30 - 35%
DFT	25 microns/coat (min)
Covering capacity	12-13 M²/Lit/coat

Primer (P-2)

High build chlorinated rubber zinc phosphate primer

Type and Composition	Single pack, Chlorinated rubber medium Plasticised with unsaponifiableplasticiser pigmented with zinc phosphate
Volume solids	35- 40%
DFT	50 MICRONS/COAT (MIT)
Covering capacity	7-8 M²/Lit/Coat

Primer (P-3)

High build zinc phosphate primer

Type and Composition	Single Pack, Synthetic medium, pigmented with zinc phosphate.
Volume solids	40-45%
DFT	35-50 microns/coat
Covering capacity	10-12 M²/Lit/coat
Heat resistance	Upto 100º C (dry)

Primer (P-4)

Etch Primer / Wash Primer

Type and Composition	Two pack Poly vinyl butyral resin medium cured with phosphoric acid solution pigmented with zinc tetroxy chromate.
Volume solids	7-8%
DFT	8-10 microns/coat
Covering capacity	7-8 M²/lit/coat

Primer (P-5)

Epoxy Zinc Chromate Primer

Type and Composition	Two pack, Polyamide cured epoxy resin medium pigmented with zinc chromate.
Volume solids	40%(min)
DFT	35 microns/coat (min)
Covering capacity	11-12 M2/lit/Coat

f) Primer (P-6)

Epoxy Zinc Phosphate Primer

Type and Composition	Two pack, Polyamide cured Epoxy resin medium pigmented with zinc phosphate.
Volume solids	40% 35 microns / coat (min)
Covering capacity	11-12 M²/lit/coat

g) Primer (P-7)

Epoxy high build M10 Paint (Intermediate Coat)

Type and composition	Two pack Poly Polyamide cured epoxy resin medium pigmented with micaceous iron oxide. Volume solids 7-8%

Volume Solids	50%
DFT	100 microns/coat (min)
Covering capacity	5.0 M²/lit/coat

h) Primer (P-8)

Epoxy Red Oxide zinc phosphate primer

Type and Composition	Two pack. Polyamine cured epoxy resin pigmented with Red oxide and Zinc phosphate.
Volume solids	42%
DFT	30 microns/coat (min)
Covering capacity	13-14 M/lit/coat

i) Primer (P-9)

Epoxy based tie coat (suitable for conventional alkyd based coating prior to application of acrylic polyurethane epoxy finishing coat)

Type and Composition	Two pack, Polyamide cured epoxy resin medium suitably pigmented.
Volume solids	50-60%
DFT	50 microns/coat (min)
Covering capacity	10-12 M²/Lit/Coat

j) Finish Coats (F-1)

Synthetic Enamel

Type and Composition	Single pack, Alkyd medium pigmented with superior quality water and weather resistant pigments
Volume solids	30-40%
DFT	20-25 microns/coat
Covering capacity	16-18 M/²lit/Coat

k) Finish coat (F-2)

Acrylic Polyurethane paint

Type and Composition	Two pack, Acrylic resin and iso-cyanate hardener suitably pigmented.
Volume Solids	40% (min)
DFT	30-40 microns / coat
Covering Capacity	10-12 M²/lit/ coat

l) Finish Coat (F-3)

Chlorinated Rubber Paint

Type and Composition	Single pack, Plasticised chlorinated rubber medium with chemical & weather resistant pigments.
Volume solids	30%
DFT	30 microns/coat (min)
Covering capacity	1 0.0 M^2 / lit /coat

m) Finish Coat (F-4)

High build chlorinated rubber M10 paint.

Type and Composition	Single pack Chlorinated rubber based high build pigmented with micaceous iron oxide.
Volume solids	40-50%
DFT	65-75 microns/coat
Covering capacity	6.0-7.0 M^2 / lit / coat

n) Finish coat (F-5)

Chemical Resistant Phenolic based Enamel

Type and Composition	Single pack phenolic medium suitably pigmented.
Volume solids	35-40%
DFT	25 microns/ coat
Covering capacity	15.0 M^2 /lit/ coat

o) Finish Coat (F-6)

Epoxy High Building Coating

Type and Composition	Two pack. Polyamide cured epoxy resin medium suitably pigmented.
Volume solids	60-65%
DFT	100 microns/coat (min)
Covering capacity	6.0-6.5 M^2 / lit / coat

p) Finish Coat (F-7)

High build Coal Tar Epoxy

Type and Composition	Two pack, Polyamine cured epoxy resin blended with Coal Tar.
Volume solids	65% (min)
DFT	100-125 microns/coat

Covering capacity	6.0-6.5 M² / lit / coat

q) Finish Coat (F-8)

Self-priming epoxy high build coating (complete rust control coating)

Type and Composition	Two packs. Polyamide-amine cured epoxy resin suitably pigmented. Capable of adhering to manually prepared surface and old coatings.
Volume solids	65-80%
DFT	125-150 microns/coat
Covering capacity	4-5 M² / lit / coat

r) Finish Coat (F-9)

Inorganic Zinc Silicate coating

Type and Composition	Two pack , Self cured Ethyl silicate solvent based Inorganic Zinc coating.
Volume solids	60% (min)
DFT	65-75 microns/coat
Covering capacity	8-9 M² / lit / coat

h) Finish coat (F-10)

High build Black

Type and Composition	Single pack. Reinforced bituminous composition phenol based resin.
Volume solids	55-60%
DFT	100 microns/coat (min)
Covering capacity	5.50-6.0 M ²/ lit / coat

t) Finish Coat (F-11)

Heat Resistant Aluminium Paint Suitable up to 250°C.

Type and Composition	Duel container (paste & medium). Heat resistant spec varnish medium combined with aluminium flakes.
Volume solids	20-25%
DFT	20 microns/coat (min)
Covering capacity	10-12 M² / lit/ coat

u) Finish Coat (F-12)

Heat Resistant Silicon Paint suitable up to 400º C.

Type and Composition	Single pack Silicone resin based with aluminium flakes.

Volume solids	20-25%
DFT	20 microns/coat (min)
Covering capacity	10-12 M²/lit/coat

v) Finish Coat (F-13)

Synthetic Rubber Based Aluminium Paint Suitable up to 150°C.

Type and Composition	Single Pack, Synthetic medium rubber medium combined with leafing Aluminium,
DFT	25 microns/coat
Covering capacity	9.5 M² /lit/ coat

Notes

1 Covering capacity and DFT depends on method of application Covering capacity specified above is theoretical. Allowing the losses during application, min specified DFT should be maintained.

2. 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.

3. Selected chlorinated rubber paint should have resistance to corrosive atmosphere and suitable for marine environment,

4 All primers and finish coats should be cold cured and air-drying unless otherwise specified.

5. Technical data sheets for all paints shall be supplied at the time of submission of quotations.

6. In case of use of epoxy tie coat, manufacturer should demonstrate satisfactory test for inter coat adhesion. In case of limited availability of epoxy tie coat (P-9) alternate system may be used taking into the service requirement of the system.

7. In case of F-6, F-9, F-1 1 & F-1 2 Finish Coats, No Primer are required.

MANUFACTURERS

The paints shall conform to the specifications given above and Class-I quality in their products range of any of the-following manufacturers:

i) Asian Paints (India) Ltd,
ii) Bombay Paints
iii) Berger Paints India ltd.
iv) Gaodlass Nerolac Paints Ltd.
v) Jenson & Nicholson
vi) Shalimar Paints

STORAGE

All paints and painting material shall be stored only in rooms to be provided by contractor and approved by OWNER/ OWNER 's Representative 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 given below shall be clearly displayed outside:
PAINT STORAGE No NAKED LIGHT highly -inflammable

COLOR CODE FOR PIPING:

i) For identification of pipelines, the color code as per Table -1 shall be used.

ii) The color code scheme is intended for identification of the individual group of the pipeline. The system of color coding consists of a ground color and color bands superimposed on it.

iii) Colors (Ground) as given in Table-2 shall be applied throughout the entire length of uninsulated pipes, on the metal cladding & on surfaces. Ground color coating of minimum 2m length or of adequate length not to he mistaken as color band shall be applied at places requiring color bands. Color bands shall be applied as per approved procedure.

V) Line coating shall meet DIN 30670 standard for external coating and API 5L RP – 2 for internal coating.

VI) The thickness for the epoxy should be 180 microns, adhesive 200 microns and balance should be PE

VII) The minimum coating thickness on weld seam shall be 3.2 mm and minimum coating thickness on body should be 3.2.

VIII) Minimum thickness for liquid epoxy for internal coating should be 100 ± 20 microns. Max design temperature for coating should be considered +80 ºC

COLOR CODE:

A) Ball Valve (Above Ground) : Off White
B) Globe Valve (Above Ground) : Oxford Blue-RAL 5005, IS-519941005
C) Check Valve(Above Ground) : Oxford Blue-RAL 5005, IS-519941005
D) Launcher / Receiver : Yellow Golden
E) Jib Crane / Trolley : Yellow Golden
F) All underground valves shall have epoxy base coating after surface finish of SA 2:5
G) Valves and above ground pipes need to be properly blasted to achieve surface finish of Sa 2:5 before the application of paints.

IDENTIFICATION SIGN

i) Colors of arrows shall be black or white and in contrast to the color on which they are superimposed

i) Product names shall be marked at pump inlet, outlet and battery limit in a suitable size as approved by OWNER.

ii) Size of arrow shall be either of the following:

a) Color Bands

Minimum width of color band shall be as per approved procedure.

b) Whenever it is required by the OWNER to indicate that a pipeline carries a hazardous material, a hazard marking of diagonal stripes of black and golden, yellow as per IS:2379 shall be painted on the ground color.

IDENTIFICATION OF EQUIPMENT

All equipment shall be stenciled in black or white on each vessels, column, equipment, painting as per approved procedure.

INSPECTION AND TESTING

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.

2. The painting work shall be subject to inspection by OWNER/ OWNER's Representative at all times. In particular, following stage wise inspection will be performed and contractor shall offer the work for inspection and approval at every stage before proceeding with the next stage.

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 OWNER/ OWNER's Representative 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.

PRIMER APPLICATION

i. The contractor shall provide standard thickness measurement instrument with appropriate range(s) for measuring.

   Dry film thickness of each coat, surface profile gauge for checking of surface profile in case of sand blasting. Holiday detectors and pinhole detector and protector whenever required for checking in case of immerse conditions.

ii. At the discretion of OWNER/ OWNER's Representative, contractor has to provide the paint manufacturers expert technical service at site as and when required. For this service, there should not be any extra cost to the OWNER.

iii. Final Inspection shall include measurement of paint dry film thickness, check of finish and workmanship. The thickness should be measured at as many points/ locations as decided by OWNER/ OWNER's Representative and shall be within +10% of the dry film thickness.

iv. The contractor shall produce test reports from manufacturer regarding the quality of the particular batch of paint supplied. The OWNER shall have the right to test wet samples of paint at random for quality of same. Batch test reports of the manufacturer's for each batch of paints supplied shall be made available by the contractor.

PAINT SYSTEMS

The paint system should vary, with type of environment envisaged in and around the plants. The types of environment as given below are considered for selection of paint system. The paint system is also given for specific requirements.

a) Normal Industrial Environment, Table 2.
b) Corrosive industrial Environment, Table3
c) Coastal & Marine Environment, Table 4

Notes 1. Primers and finish coats for any particular paint systems shall be from same manufacturer in order to ensure compatibility.

Table – 1

Colour Coding Scheme for Pipes and Equipment

Sl. No.	Content	Ground Color	First Color Band	Second Color Band
1	**COMPRESSED AIR**			
a)	Plant Air	Sky Blue	Silver Grey	-
b)	Instrument Air	Sky Blue	French Blue	-
2	*GASES*			
a)	Charge Gas	Canary Yellow	Signal Red	Smoke Grey
b)	Regeneration Gas	Canary Yellow	White	Dark Violet
c)	Residue Gas	Canary Yellow	White	French Blue
d)	LPG	Canary Yellow	Brilliant Green	White
e)	Acetylene	Canary Yellow	Dark violet	-
3	*ALL EQUIPMENT*			
a)	Such as vessels. columns, exchangers, etc. containing non-hazardous fluids.	Light Grey		
b)	All equipment containing hazardous fluids	Canary Yellow		
c)	Pipe carrying hazardous fluids	Bar is to be replaced by Hazardous Marking as per IS: 2379 Clause 7.1C		

Table 2

Normal Industrial Environment (Above Ground)

Sl. No.	Description	Temp. Range	Surface Preparation	Primer	Finish Coat	Total DFT	Remarks
1.0	**External surface of equipment's and piping.**						
1.1	-Do-	-10 to 20	SSPC-SP-3	One coat P-2 50 microns / coat (min)	One coat F-4 65 microns/ coat (min) Two coats F-3, 30 Microns/coat (min)	175	Primer and Finish coat can be applied at ambient temp.
1.2	-Do-	21 to 60	SSPC-SP-6	Two coats P-1, 25 microns/ coat (min.)	Two coats of F-1, 20 microns/coat (min)	90	-
1.3	-Do-	61 to 80	SSPC-SP-6	Two coats P-3, 50 microns/ coat (min)	Two coats of F-13, 25 microns/coat (min)	150	-
1.4	-Do-	81 to 250	SSPC-SP-6	Covered in Finish coat	Three coats of F-11, 20 microns/ coat (min)	60	Paint application at ambient temp. curing at elevated temp. during start-up.
1.5	-Do-	251 to 400	SSPC-SP-10	Covered in Finish coat.	Three coats of F-12, 20 microns/ coat (min)	60	-do-

Table- 3

Corrosive Industrial Environment (Above Ground)

Sl. No.	Description	Temp. Range	Surface preparation	Primer	Finish Coat	Total DFT	Remarks
1.0	**External surface of un-insulated and other equipment**						
I.1	- do -	-10 to 20	SSPC-SP-3	Two coat P-2, 50 microns) coat (min.)	Two coat F-3, 30 microns / coat (min.)	160	Primer and paint application at ambient temp.
1.2	- do -	21 to 80	SSPC-SP-10	Two coats P-5, 35 microns / coat (min.)	Two coats F- 6, 100 microns coat (min.)	270	Paint application at ambient temp.
I.3	- do -	81 to 400	SSPC-SP-3	Covered in finish coat	Three coats F- 12, 20 Microns / coat (min.)	60	Paint application. at ambient temp, and curing at 250'C for 4 hours,

Table – 4

Coastal and Marine Environment (Above Ground)

Sl. No.	Description	Temp. Range	Surface Preparation	Primer	Finish Coat	Total DFT	Remarks
1.0	**External surface of equipment's and piping.**						
1.1	-do-	-10 to 60	SSPC-SP-3	Two coats P-2, 50 micron/ coat (min)	Two coats F-3, 30 Microns/coat (min.)	160	Primer and Finish coat application at Ambient temp.
1.2	do -	61 to 80	SSPC-SP-10	Two coats P-5. 35 Microns. coat (Min.)	Two coats of F-6, 100 Microns/Coat (min.)	270	-do-
1.3	- do -	81 to 400	SSPC-SP-I0	One coat F-9, 83 Microns/ Coat(Min.)	-	85	Paint application at Ambient temp. Primer is acting as primer cum finish coat.
1.4	- do -	i) Upto 80	SSPC-SP-10	One coat F-9, 6.5 microns / coat (Min)	One coat of F-2. 30 Microns/coat (min.)	95	Paint application at ambient temp.
		ii) 8l to 400	SSPC-SP-10	-do-	-do-	85	Paint application at ambient temp. Primer is acting as primer cum finish coat.

1.9.4 Precautions to be taken

Neither the environment of the site nor the marking labels of devices may be covered with paint and they must be kept free of paint splashes. To this end, it is advisable to use removable masking tape.

Paint splashes, leaks, etc. on any adjacent installations such as measuring apparatus, valves, pipes. sources of light, insulation, heat insulators, walls, concrete, etc, must immediately be wiped up and the damage repaired before the paint is dry.

Otherwise, the OWNER will be obliged to have the cleaning carried out at the expense of the Contractor. The paint recipient will only be opened at the time of use (unless otherwise specified by the manufacturer).

The product will be mixed in the recipient with the aid of suitable tools and thus homogenized.

1.9.5 Method of application

Normally, three methods of application will be used on the construction site for the paint products. i.e. with a brush, with a roller or with a spray gun.

- The brush method makes it possible to obtain good penetration of the paint over irregularities in the metal.
- Only this method will be used for application of the base coats, for retouching and for protrusions, welded areas, riveted joints or bolted joints:
- The roller method may be used on large flat surfaces for the intermediate and topcoats.
- The spray gun method must be used in accordance with the instructions of the manufacturer and carried out by qualified personnel.

The Contractor must guarantee that all safety measures have been taken for such work. The spray gun method may only he used on site for places that arc difficult to reach with the brush. In this case, a request must be made to the OWNER/ OWNER's Representative for a deviation.

All paintwork will be carried out with good brushes or rollers that are suitable for the type of paint being used and for the form of the material to be painted and fitted with short handles. The maximum length of the brush and roller handles will be 50 cm; longer handles may only be used for places that are absolutely inaccessible. The maximum width of a brush will be 13 cm.

1.9.6 Application of the coating

Application of the paint will be carried out in accordance with best practice in order to obtain a homogeneous and continuous layer. The OWNER or the Approved Supervisory body demands that painting of a layer will only be started after acceptance by them of the surface preparation or of the previous layer of paint.

The layers of paint must have a uniform thickness. They must he spread in such a way that all concave parts are dried out and that the surface is completely covered and has a glossy appearance without leaving brush marks and without exhibiting bubbles, foam, wrinkles, drips, craters, skins or gums that arise from weathered paint,

Each layer must have the color stipulated in the tables of the present specifications, which clearly differs from the previous layer, taking account of the Color of the top layer, all of which for the purpose of being able to identify the number of coats and their order of sequence. If the color of the coats is not mentioned in the tables the color difference in consecutive coats must, if possible, he at least 100 RAL. The color of the top layer is given in the table.

The coating power should be such that the underlying layer is not visible. Only 1 layer per day may be applied, unless otherwise specified by the OWNER or the Approved Supervisory Body.

The drying times prescribed by the paint manufacturer must be strictly observed in relation to the environmental conditions before proceeding with the application of the next layer.

The dry coating thickness indicated in the description of the paint systems are minimum thickness. In this connection, the Contractor is obliged to contact the paint manufacturer and conform to his guidelines. The Contractor must respect the thickness specified by the supplier.

1.9.7 Transporting treated items

In the case of works being carried out in a workshop, the metal structures will be surrounded by ventilated contraction film that prevents damage during transportation. This film may only be applied after complete polymerization of the paint.

1.10 GROUND-LEVEL TRANSITION POINT

1.11 Polyester protection system

The Contractor will provide system 02 over the entire length of the pipes above ground and below ground and up to a height of 20 cm and a depth of 40 cm. perpendicular to the ground level mark. In each case, he must ensure that the jointing below the asphalt is in good condition and assures' faultless adhesion. He will apply the following products over the entire surface area, prepared in accordance with is Sa 3:

1) The primer of system 01.

2) Reinforced polyester ± 20 cm above the ground level marker and ± 5 cm on the asphalt cleaned beforehand (application of reinforced polyester is carried out in accordance with the work method prescribed by the manufacturer). Moreover, in the case of PE, in contrast to asphalt, he will apply a polygon primer to PE immediately before applying the reinforced polyester.

3) He will then apply the other coats of system 01a to the surface section and thus cover the reinforced polyester with about 5 cm.

4) For new constructions, the polygon primer will be applied to PE and then subsequently processed as described under point 2.

1.11.1 USE OF SCAFFOLDING

Mounting, maintenance and dismantling of scaffolding for carrying out adaptation and/or paintwork to surface gas pipes or gas transport installations in use;

- The Contractor will specify the cost of scaffolding in the price list.
- The supplementary rental price for delays attributable to the Contractor will be charged to him:
- In his price quotation the Contractor should present the OWNER with diagrams of the scaffolding that he intends to install for carrying out the works of the OWNER.

1.12 QUALITY CONTROLS AND GUARANTEE

1.12.1 The Contractor is responsible for checking the weather conditions to ascertain whether the paintwork can be carried out within the technical specifications.

The Contractor should have the required calibrated monitoring apparatus for this purpose on site (with calibration certificates). The personnel who will have to use this apparatus should have the training for this purpose.

The OWNER or his representative and possibly the approved supervisory body indicated by the OWNER will maintain supervision during the works and inspect the works with random checks. A daily report will be drawn up in relation to the department that maintains supervision of these works.

The supplementary inspection and the supervision by the OWNER or the approved supervisory body do not diminish in any way the liability of the Contractor. The proper execution of the work and the materials used may be checked at any time.

1.12.2 Reference Surfaces

At the start of the works. the OWNER or the approved supervisory body will indicate a few surfaces that the Contractor will prepare and cover in accordance with the recognized method of operation under the inspection and to the satisfaction of all parties ; the OWNER or his representative, the approved supervisory body. the contractor and possibly the paint manufacturer. These reference surfaces will serve as a point of comparison for the good adhesion of the paint on the installations as a whole. The parties will together work out a system for the identification of these surfaces in order to be able to monitor the conditions of the coatings over time. If the paintwork on a section of the installations is in a worse condition than the reference surfaces, the Contractor may be obliged to treat these parts again.

1.12.3 Measures to be taken in the event of a dispute

If on delivery of the works no agreement can be reached between the Contractor and the OWNER regarding the conformity of the works to the requirements of these specifications, an Approved Supervisory Body will he Called in. The Approved Supervisory Body will then carry out inspections' on site whereby the following assessment criteria wilt be used:

- The Swedish standards ISO 8501-1 1988 SS 05.5900 concerning the degree of cleanliness of the areas derusted by blasting, by machine or by hand.
- The wet film thickness of the paint will be measured in accordance with ISO 2808 or ASTM DI 212;
- The dry layer thickness of the film will be measured electronically, will complete statistical information. in accordance will, ISO 2808 or ASTM D 1186.
- The thickness of each layer will he measured in accordance with ISO 2808. ASTM 4138 or DIN 50986.
- Adhesion tests will be carried out in accordance with ISO 2409. ASTM 3359 or DIN 53151.
- Traction tests will he carried out in conformity with ISO 4624 or ASTM D 4541.
- The rugosity will be measured electronically in accordance with DIN 4768;
- The non-porosity will be measured with a test tension depending on the type of coating, the layer thickness and after consultation with the Paint manufacturer.
- Any defects in the paint film may be inspected visually by means of a magnifying glass or microscope. If necessary a photographic report may be drawn up in accordance with ASTM Standard D 4121-82,

The final judgement of the Approved Supervisory Body is irrevocable and binding for the Contractor and the OWNER. In the event of non-conformity of the works with the criteria of these specifications, all costs arising from the inspection by the Approved Supervisory Body shall be borne by the Contractor.

1.12.4 Guarantee

a) General Principles

The Contractor declares that he is aware of:

- The maximum operating temperature of the surfaces to be covered.
- The maximum permitted degree of humidity of the bearing surface.
- The properties of the environment to which the surfaces to be covered are: subject.

b) Summary of the Guarantee.

The contractor fully guarantees the following without reservation:

- The observance of all stipulations of the specifications for paintwork regarding, among other things:
  - The preparation of the surfaces.
  - The thickness of each layer.

- The total thickness of the covering.

- The uniformity of the materials used.
- The repair of all defects before delivery of the works.

The Contractor will carry out the requested repair work as promptly as possible.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR WELDING OF STATION PIPING

GAIL-STD-PI-DOC-TS-005

0	31.01.2019	Issued for Bid	AP	JR	SB	
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1.0 SCOPE

This specification covers general requirements for welding of all types of station piping works. The specification covers the scope of work, basis of work, standards, specifications and normal practice to be followed by the contractor during execution of station piping works.

No supplier, vendor, manufacturer or fabricator shall subcontract the welding fabrication of any item without written approval from the OWNER.

The CONTRACTOR shall be fully responsible for works completed by him.

2.0 CODES AND STANDARDS

The related standards referred to herein and mentioned below shall be of the latest editions prior to the date of the purchaser's enquiry:

a) Indian codes and standards (OISD & PNGRB) augmented with the following:

1. AWS (American Welding Society).
   a. A2.4 (Symbols for Welding and Non destructive Testing).
   b. A3.0 (Standard Welding Terms and their Definitions).
   c. A5.1 (Specification for Mild Steel Covered Arc Welding Electrodes).
   d. A 5.17(Specification for Bare Carbon Steel Covered Electrodes).
   e. A 5.18 (Specification for Carbon Steel Filler Metals for Gas Shielded Arc Welding).
   f. A 5.20 (Specification for Mild Steel Electrodes for Flux Cored Arc Welding Electrodes).
2. Boilers and Pressure Vessels Act and Regulations.
3. ASME B 31.3 Chemical Plant and Petroleum Refinery and Process Piping.
4. ASME Sec. VIII Div. 1 - Pressure Vessels.
5. ASME Sec. IX – Welding and Brazing Specifications.
6. ASME B31.8 - Gas Transmission and Distribution Systems.
7. ASME Sec V - Non-destructive examination.
8. API Std 1104 – Standard for Welding Pipelines and Related Facilities.

In case of conflict in the requirements of this specification and / or any of the above codes or standards, the requirement that is more stringent shall apply.

All welding procedures used by fabricators and CONTRACTORS shall have been established and qualified in accordance with the appropriate sections of one or more of the codes and standards listed above, and approved by the OWNER.

3.0 WELDING PROCEDURES

3.1 General

The CONTRACTOR shall submit welding procedures for review to the OWNER/ Consultant.

The CONTRACTOR shall have a separate welding procedure for each method of welding he intends to employ during construction. A Procedure Qualification Record (PQR) shall be conducted and recorded for each WPS. The PQR shall be witnessed by the OWNER/ Consultant, and shall be supported with destructive testing lab report from the testing laboratory.

All testing shall be performed and certified by OWNER approved testing laboratory, agency or equivalent. The written procedure must include the following details:

a. The scope of work performed under the procedures.

b. The base metals and applicable specifications.

c. The welding process.

d. Type, size, classification and composition of filler metals. (The specific brand name(s) of the flux-wire shall become an essential variable of the procedure qualification)

e. Type of current and voltage range Amperage

f. Width of electrode weave or oscillation

g. Joint preparation and cleaning procedures.

h. Tack welding procedures. Method of marking the location of tack welds to facilitate post weld inspection shall also be included

i. Electrode polarity.

j. Applicable welding positions.

k. Preheat and inter pass temperatures. (Control method)

l. Welding travel speed.

m. Root preparation prior to welding from second side, (where applicable).

n. Removal methods for weld defects and stray arc strikes.

o. Inter pass-cleaning method.

p. Repair welding.

q. Post welding heat treatments (if required).

r. Shielding gas, and flow rates

s. Type of (GTAW) electrode, size and tip angle.

t. Welders qualified and deployed in production welds shall always bear an identity card in the manner so approved by OWNER/OWNER's representative.

3.2 Consumables

The CONTRACTOR shall supply all the Owner/ Consultant approved welding consumables necessary for the execution of the job such as electrodes, filler wires, argon etc. The cost of all such consumables shall be deemed to be inclusive in the rates of welding.

The welding electrodes and filler wires supplied by the contractor shall confirm to this specification and standard codes and shall be of the make approved by the OWNER/ Consultant. The contractor shall submit all test certificates to the Engineer in Charge for review and approval.

The contractor shall submit batch test certificates from the electrodes manufacturers, giving details of physical and chemical tests carried out by them, for each batch of the electrodes to be used.

The contractor shall conduct Electrode Qualification Tests (EQT) and record the parameters for each batch. The EQT shall be witnessed and the test reports shall be reviewed by the Owner/ Consultant. No electrode shall be used without successful EQT of it's batch.

The electrodes, filler wires and flux used shall be free from rust, oil, grease, earth and other foreign matter, which affect the quality of the welding.

All coated metal arc-welding electrodes shall comply with the latest edition of AWS specification A 5.5 and A5.1 type unless approved otherwise by the OWNER.

All welding consumables, including fluxes shall be supplied in sealed containers and stored in a dry location at a minimum temperature of 68°F/ 20˚C and a maximum relative humidity of 60%. Low-hydrogen electrodes, after removal from factory sealed containers, shall be stored at a minimum temperature of 150°F/66˚C or as per manufacturer recommendations and suitably dried using a portable oven prior to every use.

The welding filler metals shall have a chemical composition as near as possible to the parent metals to be welded. The finished weld as deposited, or after post weld heat treatment (PWHT) when required, shall be at least equal to or greater than the parent metal in terms of unit strength, ductility, and other physical properties and in resistance to corrosion, hydrogen attack, or other operating environment factors as required. Permission to change filler metals to those other than the ones qualified in accordance with this specification must be obtained in writing, from the OWNER/ Consultant.

Electrode and rod diameters shall conform to the parameters of the weld procedure specification.

The CONTRACTOR shall provide adequate drying ovens and take proper precautions in the storage and handling of low-hydrogen electrodes.

Electrodes and filler rods shall be protected from mechanical damage or deterioration. All unidentified damaged or deteriorated electrodes or filler wires shall be removed from the working area and rejected. Any low hydrogen type SMAW electrodes not contained in heated quivers shall be removed from the site. Electrodes shall not be exposed to wet or high humid conditions.

Care of welding consumables is the responsibility of the CONTRACTOR however, the following are minimum requirements:

Low-hydrogen SMAW electrodes shall be kept in commercial electrode ovens after the factory container has been opened. The electrode holding oven temperature shall be maintained between 175°F (79°C) and 250°F (121°C). Any low-hydrogen SMAW electrodes that have been exposed for more than 4 hours prior to restocking into the holding oven or any SMAW low-hydrogen electrodes that have become wet or have damaged coatings shall not be used and shall be immediately removed from site.

Other (non-low-hydrogen) SMAW electrodes shall be kept in a dry and dust-free enclosure after opening of the factory container. These non-low-hydrogen electrodes shall be held at a temperature below 150°F (66°C).

Bare wire and bare filler rod (GTAW) shall be stored in a dry and free from dust, grease etc.

3.3 Welding Process

Welding of various materials under this specification shall be carried out using one or more welding process as given below with the approval of the ENGINEER IN CHARGE.

- Shielded Metal Arc Welding Process (SMAW)
- Gas Tungsten Arc welding process (GTAW)

The CONTRACTOR shall have a separate welding procedure for each method of welding he intends to employ.

Automatic and semiautomatic welding processes shall be employed only with the express approval of the ENGINEER IN CHARGE. The welding procedure shall be adopted and consumables used shall be specifically approved.

A procedure qualification record (PQR) shall be included for each WPS. The PQT shall be witnessed by the OWNER/ OWNER's Representative or shall be supported with the lab report from the testing laboratory, if so previously agreed to by the OWNER.

A combination of different welding process 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.

The CONTRACTOR shall only employ welders who have a valid welding certificate for the procedures being used.

The CONTRACTOR shall have all welders tested in accordance with the applicable code or standard. Testing shall be at the Contractor's expense including test pieces. Irrespective of pre qualification all welders proposed to be deployed in the work shall be tested and qualified afresh.

No welder shall be allowed to make any weld for which he is not qualified.

Welding with larger-size electrodes for specific applications may be allowed only if each welder qualifies with the largest-size electrode to be used in production. This option is strictly at the OWNER discretion. OWNER shall specify the details of the welder qualification tests.

For carbon steel, filler wire combinations shall be chosen such that the deposited hardness of the cap pass shall not exceed 240 BHN. For low-temperature materials and other materials heat input shall be minimized and comply with the WIPS parameters.

The CONTRACTOR may propose alternate process in addition to those listed. Any

proposed process shall require written OWNER approval and qualification prior to implement CONTRACTOR and OWNER shall agree on tests, results, and other criteria before OWNER approval is granted.

All butt welds in pipe smaller than 60.3 mm O/D ("NPS 2" inch) Schedule 40 shall be made by GTAW, Root pass by gas metal arc is acceptable for pipe larger than 60.3 mm O/D (NP (2") inch).

Permanently installed backing rings shall not be used,

All butt welds in pressure equipment shall have the same chemical and mechanical properties as the parent metal.

All welding procedures must be qualified for Charpy V impact testing when the Code requirements indicate that the parent material requires impact testing. When impact tests are required, tests shall be taken from the weld metal, fusion line, 2mm from fusion line, and 5mm from fusion line.

The electrodes shall be purchased from the list of approved manufacturer's and the same shall be supplied with proper certificates and batch certificates.

Extreme care shall be taken to ensure that electrode separation by classification is maintained in the CONTRACTOR's inventory. All storage bins and ovens for welding consumables shall be clearly labeled. In addition, all GTAW bare rod filler metals shall be tagged with the AWS designation of the filler metal. Any welding consumable that cannot be readily identified shall not be used for welding.

All pressure containing welds shall be of a minimum of two passes with overlap of starts and stops. This shall include socket welds and seal welds of threaded connections.

Weld stops and starts shall be staggered so that adjacent weld passes do not contain stops/ starts within 25mm (1 inch) of each other.

The width of weave during production welding shall be within the acceptable limit of the OWNER approved and qualified welding procedure, qualification certificates, and production welding operating sheets. As a norm this will be limited to a maximum of 3 times the core diameter of SMAW electrodes, whichever is less.

Each weld pass layer shall be completed in one full cycle/ circumference before proceeding with the next. Blocking out or segmental welding is not permitted.

All tools and equipment used in the welding operations shall be in first class operating condition and shall be of sufficient capacity to ensure welds of the specified quality are achieved throughout the work. It shall be the right of the OWNER to request at any times the re-calibration of gauges and meters. etc. to ensure compliance with welding procedure-operating sheets/ WPS.

3.4 Joint Preparation

The surface of the pipe at the weld area shall be free from dust, grease, scale, paint, grit or any other foreign material, which may adversely affect the final weld quality.

Bevels shall be 37½° and all field cuts shall be normal to the axis of the pipe, Miter welds are prohibited.

All pipes shall be beveled for welding with an approved mechanical beveling machine.

Damage to bevels, which could possibly affect the quality of the weld, shall be repaired prior to welding. If repair cannot be done, the pipe shall be cut and the pipe end re-beveled. Lamination check by UT method shall be done prior to welding of gas cutting end pipe.

Where welding pipe both to a flange or another pipe or component, there must be a band of at least 25 mm (1 inch) wide around the internal / external joint weld preparation that is ground to bright metal, and is free of all foreign matter,

To assure proper spacing and alignment in accordance with the applicable Code, an approved lineup clamp shall be used.

All welds shall conform to the straightness and alignment specified herein. Correction of improperly fitted parts shall be accomplished by disassembly and refitting. Reworking by hammering or flame straightening shall not be permitted.

The ends of piping components to be joined shall be aligned as accurately as is practicable within existing commercial tolerance on diameters, wall thickness, and out of roundness. Maximum bore mismatch shall not exceed 1/16” inch (1.6 mm), Alignment shall be preserved during welding.

When joints of unequal thickness are joined, the joint preparation shall be as per ASME B 31.8.

Maximum bore mismatch shall not exceed 0.8mm (1/32 inch), Where ends are to be Joined and the internal misalignment due to difference in wall thickness, etc. exceeds 1.6 min (1/16 inch), the wall extending internally shall be internally trimmed. Internal machining shall be performed so that the inside diameters of the components coincide.

When cutting pipe to length, it should be cut by mechanical means. if practical. Ends that are to be connected to flanges, either in the shop or in the field, must be cut true and square.

3.5 Preheating

Preheat for pressure piping and furnace tubs shall be in accordance with ASME B31.3 and B31.8.

All pipe joints having a wall thickness greater than 9.5 mm (0.375") shall he preheated to 100°C prior to welding when the ambient temperature is less than 10°C (50 °F).

Preheating shall he carried out with an approved torch system or with electrical induction coils which will provide uniform heating.

The preheating area shall be at least 200 mm (8") wide centered about the weld and shall extend around the entire circumference of the pipe.

Preheat temperatures shall be checked with temperature sensitive crayons or by other approved methods.

If a joint requires preheating, the same temperature requirements shall be maintained for each succeeding pass,

3.6.┐ Welding Details

3.6.1 All pressure welding shall be performed in accordance with approved and qualified welding procedures as required per code.

3.6.2 Each weld shall be uniform in width and size throughout its full length.

3.6.3 Each layer or welding shall be smooth and free of slag cracks, pinholes, undercuts (Internal and external), porosity and excessive bead shall be completely fused to the adjacent weld beads and base metal.

3.6.4 The cover pass shall be free of coarse ripples, irregular surface, non-uniform pattern, high crown, deep ridges or valleys undercut, arc strikes, porosity, undercut, slag, or shatter.

3.6.5 Butt welds shall be slightly convex, of uniform height, and have full penetration, unless otherwise approved.

3.6.6 For piping, limitations on weld reinforcement shall apply to the internal surfaces as well as to the external.

3.6.7 Fillet welds shall be of a specified size with full throat and the legs of uniform length.

3.6.8 Arcs shall only be struck in the weld groove. A controlled arc must be maintained while welding. Should an arc strike occur, it shall be removed by grinding and the area shall be etched (10% Nital) to confirm heat affected area removal, and MT examined to ensure absence of any surface cracking.

3.6.9 After each pass the layer of weld metal must be cleaned to remove all slag, scale dirt etc. wire brushes, grinder, or chipping hammer shall be used as needed to prepare proper surface for each succeeding weld pass.

3.6.10 Repair, chipping or grinding of welds shall be done in such a manner as not to gouge, groove or reduce the base metal thickness.

3.6.11 No welding shall be done if the temperature of the base metal is below 50°F. Nor shall there be any welding done if there is moisture, grease, or any foreign material on the joint to be welded.

3.6.12 A qualified welder shall make tack welds. Cracked lack welds shall be completely ground out and NDE by MT/PT prior to re-weld.

3.6.13 The CONTRACTORS shall make no substitution of materials or modifications to details without the prior written approval of the OWNER.

3.6.14 Welders and welding operators shall not be qualified on production welds.

3.6.15 The CONTRACTOR shall ensure that welders and welding operators are only employed on those parts of the work for which they are qualified.

3.6.16 Each welder and welding operator shall possess an appropriate temperature-measuring device. All supervisors shall possess a copy of the approved welding procedures.

3.6.17 Alternatively, welding procedures may he clearly display at each welding location. Welders shall be familiar with the requirements of the appropriate approved welding procedures. Any welder found not complying with the approved welding procedures during production welding shall be removed from the work and the non-conforming weld(s) may be completely rejected, at the discretion of the OWNER.

3.6.18 No welding should be undertaken without approved WPS.

3.6.19 The OWNER will not provide any WPS for the CONTRACTOR.

3.7 Welding Techniques

3.7.1 General

a) All welding shall be performed in accordance with an approved and qualified welding procedure.

3.7.2 Cleaning

a) All weld impurities shall be removed between passes. Cleaning may be done with either hand or power tools.

b) All rough irregularities in the cover pass and weld spatter shall be removed.

3.8 Weld Identification

Each finished weld shall be clearly marked to identify the portion made by each welder.

3.9 Defects and Repairs

Welds containing defects not exceeding an aggregate of five (5) percent of the length of the root bead may be removed by grinding, chipping or arc gouging and re-welded in accordance with an approved procedure. Welds containing defects exceeding that amount shall be cut out and replaced.

When defects are ground out the entire weld shall be preheated to a temperature of 150 °C (300 °F) prior to welding.

All repaired welds shall be radio graphed or by the same method of original defect detention. Repairing of Diameter Less than 2 inch is not allowed and the joint shall be cut and reweld.

3.10 WELDING PROCEDURE QUALIFICATION

Welding procedure qualification shall be in accordance with the relevant requirement of ASME Sec. IX latest edition or other applicable codes and the job requirements. The Contractor shall submit the welding procedure specification immediately after receiving the order. Owner's representative will review, check and approve the welding procedure submitted and shall release the procedure for qualification test. The complete set of test result as per ASME sec. IX shall be submitted to the OWNER/ OWNER's representative for approval immediately after completing the procedure qualification test and at least 2 weeks before the commencement of actual work. Standard test specified in the code shall be carried out in all cases. In addition to these test the following test shall be carried out.

a) Macro/ Micro Examination.

b) Hardness test.

c) Dye Penetrate examination.

d) Charpy V-notch Impact test at Weld and HAZ at (-) 20 °C

These tests shall be carried out on specimens depending upon the type of base material, operating conditions and requirements laid down in the detailed drawing and specification. It shall be the responsibility of the Contractor to carry out all the tests required to the satisfaction of the OWNER/ OWNER's representative.

3.11 Welder's Qualification

Welders shall be qualified in accordance with the ASME sec. IX or other applicable codes. It shall be the responsibility of the Contractor to carry out qualification tests of welders.

No welder shall be permitted to work without the possession of identity card.

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 expenses of the contractor.

3.12 Destructive Testing

OWNER has the authority to order the cutting of up to 0.1% of the total numbers of welds completed for subjecting to destructive test at no extra cost to OWNER. The destructive testing of joints shall be as per ASME- Sec IX welding procedure qualification.

In addition, welds already cut out for defects for any reason may also be subjected to destructive testing. The sampling and the re-execution of welds shall be carried out by the contractor at his own expenses. If the results are unsatisfactory, welding operations shall be suspended and may not be restarted until the causes have been identified and the contractors have adopted measures which guarantee acceptable results.

If it is necessary in OWNER opinion the procedure shall be re-qualified. The weld joint represented by unsatisfactory welds shall stand rejected unless investigation proves otherwise.

4.0 NON DESTRUCTIVE EXAMINATION

4.1 General

a) This specification shall govern the basic requirements for Non Destructive Examination (NDE) as it applies to the fabrication, testing and inspection of all Pressure Piping, and Transmission Piping.

b) No supplier, vendor, manufacturer or fabricator shall subcontract the non destructive examination of any such equipment without written approval from the OWNER, and the OWNER will not issue such an approval unless the proposed NDE SUB-CONTRACTOR has received prior OWNER approval for the type of NDE work proposed.

4.2 NDE Company Certification

All Non Destructive Examination (NDE) CONTRACTORs contracted by the OWNER or working for fabricators or CONTRACTORs 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 for which the CONTRACTOR'S SUB-CONTRACTOR 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.

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.

All the government and regulatory HSE requirements shall be fully complied.

4.3 Visual Inspection

a) Visual examination shall be carried out before, during and after fabrication in accordance with ASME Sec. V article 9 and ASME B31.3.

b) 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.

c) 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	None permitted.
3.	Incomplete penetration (for other than 100% Radiography butt-weld)	None permitted.
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 12.5% of pipe wall thickness, whichever is smaller and there shall not be more than 2 in. (50 mm) of undercutting in any continuous 12 in. (300 mm) length of weld

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 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.	

However repair of welds shall be allowed only once.

4.4 Radiographic Examination

4.4.1 General

a) The quality of radiographs shall meet or exceed all requirements of the appropriate International standards and applicable general specifications.

b) X - Ray is the preferred radiographic method. Use of Gamma ray for examination is not permitted.

c) 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).

d) ASTM wire type IQI's are preferred. The OWNER may permit the use of ASTM whole type IQI's on a pre-approved basis, provided the NDT CONTRACTOR can demonstrate satisfactory results.

e) Radiographic technique shall produce maximum contrast and good definition of IQI wires and shall obtain minimum radiographic density of 2.0 in the weld image. Fluorescent intensifying screens shall not be used.

f) Max radiographic density shall be 4.0 in all areas of the weld and parent metal.

g) 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 the OWNER.

4.4.2 Operator Certification

a) 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).

b) 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.

c) 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.

d) The OWNER shall review and approve all QA/QC personnel prior to deployment on the project.

4.5 Magnetic Particle Testing (MPT)

a) MPT shall be carried out in accordance with the requirements of ASME Section V Article 7 & Section VIII DIV 1, Appendix 6 and as modified by this specification.

b) AC electromagnetic yokes shall be used. A background of white contrast paint shall be used in conjunction with a black magnetic ink (wet particle). The technique shall be carried out in the continuous mode and two examinations shall be carried out at right angles to cover for both transverse and longitudinal defects. There shall be sufficient overlap to allow 100% coverage.

c) All unacceptable or spurious indications found by this method shall be investigated and removed by grinding followed by thickness check.

4.6 Dye Penetrate Test (DPT)

a) DPT shall be carried out accordance with the requirements of ASME BPV, Section V, Article 6, & ASME Section VIII DIV 1, Appendix 8, and as modified by this specification.

b) Unless requested otherwise, DPT shall be carried out using the solvent removable method.

c) If necessary welds may be lightly dressed to facilitate DPT testing or to assist in the interpretation of any indications.

d) All unacceptable or spurious indications found by this method shall be investigated and removed by grinding followed by thickness check.

4.7 ULTRASONIC WELD EXAMINATION (UT)

4.7.1 Ultrasonic Operators

a) Ultrasonic operators supplied by the NDE CONTRACTOR shall be certified to a General Standards Board (ASNT/PCN) approved by the OWNER.
b) Ultrasonic testing shall be carried out by minimum ANST Level-II qualified personnel.

4.8 Extent of Inspection And Testing

4.8.1

a) Piping systems which are designed and constructed in accordance with ASME Standard B31.3, Chemical Plant and Petroleum Refinery Piping shall be radiographed as per Table II.

b) Piping systems which are designed and constructed in accordance with ASME B31.8 standard for gas pipeline systems shall have all welds Ultrasonic and Radiographically inspected for 100%,

4.8.2 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.

4.8.3 Ultrasonic Testing

a) UT testing shall be carried out as per ASME B31.3 and ASME Sec. V article 5.

b) 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.

c) All tie-in welds where pressure testing are not possible shall be radiographically as well as ultrasonically tested in addition to MPT/ DPT.

TABLE-I

EXAMINATION CATEGORIES

CATEGORY I	HIGHER DUTY PIPING
	• Severe cyclic conditions as indicated in the respective isometric drawings, all service. • Carbon Steel material, ASME rating 600# all services • All ASME classes for lethal substances.(Category `M' fluid service)
CATEGORY II	NORMAL FLUID SERVICE ASME rating 150 & 300# not covered by Categories I & III
CATEGORY III	CATEGORY 1) FLUID SERVICE
	ASME rating 150 for all systems in Category `1' Fluid services such as: • Service air • Instrument air • Open Drains

Notes:

(1) Irrespective of category, all process piping connection shall be hydrostatically as well as pneumatically tested with 6 hours of holding period.
(2) Golden Tie-in joints root & hot pass shall be examined by DPI. Final weld shall be examined by MPI, RT & UT.

TABLE – II

EXTENT OF TESTING AND INSPECTION

METHOD	EXAMINATION CATEGORY I	EXAMINATION CATEGORY II	EXAMINATION CATEGORY III
Visual	100%	100%	100%
MPI (or DPI for non-ferromagnetic materials) (Note 2)	100% examination of all branch and attachment welds	100% examination of 1 in 10 branch and attachment welds	100% examination of 1 in 10 branch and attachment welds
RT (butt weld) (Note 1)	100% examination of all welds	100% examination of 1 in 10 welds (Nose 5)	100% examination of I in 10 welds
UT (Branch weld) (Note 5)	100% examination of all welds	0	0
Hydro test and Pneumatic test	Yes	Yes (Note 3)	Service Test
Minimum Duration	6 hour	6 hour	6 hour
Records	Yes	Yes	Yes

Notes:

1) Ultrasonic testing, in lieu of radiography, is acceptable only where radiography is not practicable e.g. branch connections.
2) UPI or DPI test of branch welds to be performed prior to and lifter attachment of compensating plate if applicable.
3) Open drains vents or other open ended line shall be leak tested only.
4) For piping within skid packages, the CONTRACTOR shall use this table as a guide only and prepared NDE plan for review and approval by OWNER as required in the respective package specification.
5) VAT required where wall thickness of scanning surfaces are less than 10mm and where branch size is less than NPS 4". Non-ferrite materials shall not be examined with UT methods.
6) RT shall be 20% of welds for all class 300# series.

5.0 REPAIRS OF WELDS

5.1 With the prior permission of ENGINEER IN CHARGE welds that do not comply with the standards of acceptability shall be repaired or the joint cut out and re-welded.

A separate welding procedure specification sheet shall be formulated and qualified by CONTRACTOR for repair welds simulating the proposed repair to be carried out. Separate procedures are required to be qualified for (a) through thickness repair (b) external repair and (c) internal repair. Welders shall be qualified in advance for repairs. The root pass, for repairs opening the root, shall be replaced by the vertical uphill technique. The procedure shall be proven by satisfactory procedure tests to API 1104 including the special requirements of the specification, and shall also be subjected to metallographic examination, hardness surveys and Charpy test to determine the effects of repair welding on the associated structure.

Root sealing or single pass repair deposit shall not be allowed. Internal root defects shall be ground thoroughly and welded with a minimum of two passes. However, while grinding for repairs, care shall be taken to ensure that no grinding marks are made on the pipe surface anywhere.

The repair shall be subjected, as a minimum requirement, to the same testing and inspection requirements as the original weld. Re-radiography of the repaired area shall be carried out. In addition, a minimum of 6" weld length on the either side of the repaired area, shall be re-radiographed. A 100% ultrasonic test shall be done at the repaired area externally. Any repaired area that is wide, irregular or rough shall be rejected and a full cut out shall be done.

Repairs are limited to a maximum of 30% of the weld length. Welds containing cracks shall be cut out and rebeveled to make a joint. COMPANY shall authorize all repairs.

5.2 Weld Rejected by Accumulation of Defects

Where a weld is rejected by accumulation of defect clause, as defined by API 1104 and this specification, repairs within these limitations are permitted. Defects in the filling and capping passes shall be repaired preferentially.

6.0 INSPECTION

6.1 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.

6.2 Although is the Contractor's primary responsibility to perform weld examination, OWNER shall have the right to observe the examination of all welds by nondestructive means. The inspection may be at any time before, during and after fabrication. The CONTRACTOR shall conduct daily NDE percentage of welds to assess weld quality. Up-to-date examinations are required to identify and prevent the reoccurrence of weld defects on subsequent welds. Records and evidence of all weld examinations shall be available at all times for OWNER to review and approve.

6.3 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.

6.4 OWNER reserves the right to perform inspection at shop / field where fabrication and erection of piping is in progress for (but not limited) for the following objective:

a) To check conformance to relevant stands and suitability of various welding equipments and welding performance.
b) To witness the welding procedure qualification.
c) To witness the welder performance qualification.
d) To witness the Electrode qualification Test.

6.5 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.

6.6 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.

7.0 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 and the NDT procedure.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR FABRICATION AND INSTALLATION

GAIL-STD-PI-DOC-TS-006

0	31.01.2019	Issued for Bid	AP	JR	SB	
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I GENERAL

1.0 SCOPE

This specification covers general requirements of fabrication and installation of aboveground and underground 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. Its scope is essentially the same as that of ASME Code B31.3. This specification shall apply to all piping installed by or pre-fabricated for installation by CONTRACTOR

2.0 CODES AND STANDARDS

Unless otherwise stated the design of piping systems shall confirm to the requirement of latest edition of following Codes and Standards.

i)	ASME B31.8	-	Gas Transmission and Distribution piping systems
ii)	ASME B31.3	-	Process piping for refineries and chemical plant and terminals.
iii)	API 1104	-	Standard for Welding Pipelines and related facilities.
iv)	API 1105	-	Bulletin on construction practices for oil and products pipelines.
v)	OISD 118	-	Layout of Oil & Gas Installations
vi)	API 598	-	Valve Inspection and Test

Dimensional Standards

Flanges	- ASME B16.5, B 16.47
Welding Fitting	- ANSI B16.9, B16.11
Pipe	- ANSI B36.10
Gaskets	- ANSI B16.20, B16.21
Butt Weld Ends	- ANSI B 16.25
Spec. for line pipe	- API 5L
Valves – Flanged, Threaded end Welding end	- ASME B 16.34

In the event of any conflict between the requirements of this specification and any code/ standard, the most stringent requirement shall be followed.

II PIPING FABRICATION

1.0 GENERAL

Fabrication and erection of all piping systems by CONTRACTOR shall be in accordance with this specification and applicable drawings and standards.

a) Fabrication and erection of supporting elements i.e. shoes, guides, stop anchors, clips, cradles etc, shall include applying one coat of epoxy red oxide zinc phosphate primer

(Minimum DFT 100µ) and two coat of final painting of high build epoxy paint 125µ for each coat.

b) Fabrication and erection of supporting fixtures i.e. brackets, cantilever struts etc. shall include application of one coat of epoxy red oxide zinc phosphate primer (Minimum DFT 100µ) and two coat of final painting of high build epoxy paint (Min. 125µ per coat)

c) Fabrication and erection of drain assemblies

The contractor shall fabricate all pipe work in conformity with the requirements of pertinent general arrangement drawings and specifications where specific details of fabrication are not indicated on the drawings or not specified, herein, fabrication and erection shall be done in accordance with ASME B 31.3/ ASME B 31.8 latest edition.

2.0 CUTTING

Following shall be applied for all cutting works:

2.1 For laying out headers, tees, laterals and other irregular details, cutting templates shall be used to ensure accurate cutting and proper fit-up.

2.2 Machine cut bevels to form the welding groove are preferred in carbon steel pipe. However, smooth, clean, slag free false cut bevels are acceptable.

2.3 Cutting of pipes may be done either by mechanical means or by thermal cutting. Whenever cutting is employed all oxides and traces of previously melted metal and occasional notches shall be removed from edges by grinding or machining.

2.4 Pipe cutting is to be performed using sawing only for galvanized, stainless steel and copper nickel materials.

2.5 Cutting shall be made with suitable allowance taken in to account for shape of connections and shrinkage due to cutting and welding.

2.6 All cutting shall follow the outline of the templates.

2.7 Special care shall be taken to remove internal burrs resulting from cutting especially on pipes equal to or less than 2” NPS in diameter.

3.0 WELDING

3.1 Welders shall be qualified in accordance with the Welding Specification ENG-STD-PI-DOC-TS-009 and other applicable standards i.e. ASME SEC. IX.

3.2 The joints to be field welded shall be beveled as per ASME B 16.25.

3.3 Adjacent sections of longitudinally welded pipe that are joined by butt-welding shall have the longitudinal weld seams positioned so that they are at least 30 degrees apart from the horizontal centerline.

3.4 Wherever possible, longitudinal weld seam should not be located on the top or bottom of the line so that branch connections are not positioned on the seam.

3.5 No backings strips/ rings shall be used.

3.6 Welding shall be is per approved as per Welding Procedure Specification (WPS) and

Procedure Qualification Record (PQR).

3.7 Non-Destructive Testing (NDT) such as Radiography Testing (RT), Ultrasonic Testing (UT), etc. should be carried out, after Post Weld Heat Treatment (PWHT).

3.8 Tack welds with full penetration shall be used and shall become the part of the finished weld, defection welds or tack welds with lack of penetration are not acceptable and shall be chipped/ ground out.

4.0 INTERNAL MISALIGNMENT

The pipes to be joined by welding shall be aligned correctly with existing tolerances on diameters, wall thickness and out of roundness. The same alignment shall be preserved during welding for the internal misalignment due to difference in wall thickness of the mating components exceeding 1/16"; the component with higher wall thickness shall be internally machined/ grounded so that the adjoining surfaces are approximately flushed.

4.1 Internal misalignment shall be as per the criteria set out in ASME B 31.3 and as per the following guidelines:

a) 24" NPS and smaller pipe-to-pipe fitting: 1.5mm maximum deviation.

b) Greater than 24" pipe-to-pipe or pipe-to-fitting: 3.2mm maximum Deviation when permitted by the relevant WPS.

c) Dimensional tolerances for the fabrication and installation of piping systems shall be ± 1/8 inch and ± 2 degrees. Misalignment of flange faces and welding ends shall be limited to 3/64 inch per foot measured across any diameter.

4.2 If the deviation factors are exceeded, one of the following procedures shall be used:

a) Rotate the pipe or fittings to reduce misalignment to the acceptable tolerances (before attempting any of the following methods) allowing for seam alignment.

b) Use spreaders or internal or external line-up clamps to correct moderate out-of- round Condition.

c) Taper the wall of the component internally after obtaining approval from OWNER for the proposed method and ensure wall thickness is not reduced below the minimum required by the ASME B 31.8 code.

d) If allowable deviations are exceeded beyond repair methods, the fabrication shall be redone.

4.3 All flange facing shall be true and perpendicular to the axis of the pipe to which they are attached. Flange bolt holes shall span the normal center lines unless different orientation is shown in drawings to match the equipment connections etc.

5.0 FLANGES

Flange bolt holes are to be oriented as follows, unless otherwise indicated in the fabrication drawings:

5.1 Flange faces vertical - bolt holes to straddle vertical centerline.

5.2 Flange faces horizontal - bolt holes to straddle the horizontal plane centerline.

5.3 Where line taps are called for, the hole shall be drilled square to the axial centerline clean, sharp, free from burrs, wire edges, or other irregularities. The hole shall be drilled after first attaching the connection fitting.

5.4 Where slip-on flanges are called for, they shall be welded inside and outside (See Figure 328.5.2B of ASME B 31.3). The weld shall be applied so that the flange face shall be free of weld spatter and does not require facing.

5.5 Orifice flanges shall be installed with the taps in the exact orientation shown in the isometric. The sections of pipe to which the orifice flanges are attached may be standard mill run pipe, but shall be choice selected pieces and shall be round, smooth and free from blisters and scale. The interior of the pipe, at welds, shall he ground smooth, Welds to be performed on site shall be kept at a maximum distance hack from the face of the orifice flange.

6.0 REINFORCING PADS & NON PRESSURE ATTACHMENTS

6.1 The CONTRACTOR shall be responsible for working to the exact dimensions as shown on the drawings irrespective of individual tolerances permissible. Where errors and/ or omissions occur on the drawings, it shall the Contractor's responsibility to notify the Engineer-in-charge prior to fabrication or erection.

6.2 Reinforcing pads shall be installed only where called for in the isometric. Basic material shall be the same as the pipe material unless otherwise authorised by the OWNER. The isometric will specify size and pad thickness. It is preferable to have pad shapes circular, but the pad site may be altered, provided an equivalent cross-sectional area is maintained and ASME requirements are met. Each pad or each piece, if the pad is made from more than one piece, shall have 1/8" NPS vent hole, drilled and tapped NPT (American National Taper Pipe Thread) prior to installation (at the side and not at the crotch) of the pad. Branch connection weld shall be 100% complete and subjected to the required examination (including visual) prior to installation of reinforcing pads. Reinforcing pad to be air tested at 1 kg/cm^2. After test, the vent shall be seal welded.

6.3 Non-pressure attachments shall he installed in accordance with the isometric and any supplemental data provided by the detailed engineering CONTRACTOR.

6.4 Piping requiring post weld heat treatment shall have all welded-on non-pressure attachments installed by the shop fabricator. Piping not requiring post-weld heat treatment may have the welded-on non-pressure attachments installed by the installation CONTRACTOR. If field welding is required on post weld heat-treated piping, then localized field post weld heat treatment shall be done after welding as approved by the OWNER.

7.0 FABRICATION TOLERANCES

7.1 The CONTRACTOR shall be responsible for working the exact dimensions as shown on the drawings irrespective of individual tolerances permissible. Where errors and/ or omissions occur on the drawing it shall be the contractor’s responsibility to notify the OWNER prior to fabrication or erection.

7.2 Thinning of Wall Thickness and Quality in Bends.

The maximum decrease of wall thickness shall not exceed 10% of the nominal wall thickness as specified in the line classes and in any case shall not be less than that required

by the design.

The tolerances for the maximum flattering of a bend shall be per ASME B 31.3 section 332.2.

7.3 Flange Face Alignment

The maximum deviation measured in any direction shall not exceed 2.5mm. When branches are in the same plane and their flanges are also positioned in one plane, the flange facings shall not deviate more than 1 mm from the latter plane in the same direction.

7.4 Position of Bolt Holes for Flanged Piping

The maximum deviation allowed from the required position as measured along the bolt circle is 1.5mm.

7.5 Field-Fit Weld

Where the requirement is called for in the isometric, a field-fit weld is used when the exact piping dimension cannot be predetermined, to allow the installation CONTRACTOR adjustability of two spool pieces. 150mm to be added the calculated length of one of the spools. The installation CONTRACTOR is to verity the dimension before trimming and beveling. The isometric will indicate only the calculated length.

7.6 Pup-pieces installed to make-up a spool length shall be a minimum of (2) pipe diameters long or 150mm which ever is higher unless stated otherwise by the OWNER.

8.0 EXAMINATION AND INSPECTION

8.1 Examination and Inspection shall be as per NDT Specification of document No. ENG-STD-PI-DOC-TS-011

8.2 In case of fillet welds where carrying out radiography is not possible, magnetic particle test or dye penetrant test shall be carried out. The extent of inspection shall be same as for radiography. Finished weld shall also he visually inspected for parallel and axial misalignment of the work, cracks, inadequate penetration and shall present neat workman like appearance.

8.3 All the lines, which are stress relieved or have design pressure more than 50 kg/cm^2 shall be fully radiographed (100%)

9.0 SURFACE PREPARATION AND PAINTING

Applicable surface preparation and painting shall be in accordance with painting Specification document No. ENG-STD-PI-DOC-TS-008 attached elsewhere in the bid document.

10.0 PROTECTION, PRESERVATION AND STORAGE

Piping shall be protected as follows:

10.1 After fabrication, flange faces shall be cleaned, coated with rust preventative, & protected

with non-metallic flange covers, secured to the flange prior to erections/ installation/ shipment. Other methods and products for flange protection may be acceptable, subject to OWNER approval.

10.2 Socket-weld connections shall be cleaned and plugged, or capped with metal or plastic protectors.

10.3 The open ends of pipe shall be protected with metal or plastic caps.

10.4 A metal cap secured by a steel strap around the pipe shall be used to protect open end "O-lets".

10.5 Fabricated spool pieces shall be carefully loaded with the proper amount of tonnage and ample tie-downs to protect each piece during shipping. Tie-downs shall be nylon straps; chains or cable are prohibited.

10.6 Adequate protection shall be provided to prevent mechanical damage and atmospheric corrosion in transit and at the job site.

10.7 Fabricated spool pieces and materials shall be protected to withstand ocean transit and extended period of storage at the job site for a minimum period of 18 months. Fabricated spool pieces and piping components shall be protected to safeguard against all adverse environments, such as humidity, moisture, rain, dust, dirt, sand, mud, salt air, salt spray, and seawater.

10.8 Field weld joints shall be coated and wrapped as per specification.

III PIPING INSTALLATION

1.0 GENERAL

Unless specified otherwise, the piping in general shall:

1.1 Be run level and plumb.

1.2 All piping shall be fabricated and installed to the configurations as shown in the Isometric.

1.3 Be run on the North-South and East-West axis

2.0 ERECTION

The intent of pre-fabrication at the shop is to accelerate progress of pipe work and to minimize work in the field. Such prefabrication should be based on approved isometric and piping layouts furnished to the CONTRACTOR. Field weld is indicated by "FW" on isometrics. Field weld means position weld of prefabricated piece at site or near the plant.

However the contractor shall bear in mind that there can be variations in dimensions between those appearing at the site due to minor variations in the location of equipment, inserts etc. The CONTRACTOR shall, therefore, provide adequate field joints, if required, other than shown in isometrics and fit-in sections permitting the pre-assembly to be installed without any modification.

All piping shall be routed and located as shown in piping drawings keeping in view the piping specifications.

While fitting up mating flanges, care shall be exercised to properly align the pipes and to

check the flanges for trueness, so that faces or the flanges can be pulled up together without inducing any stresses on the pipes. The bolt holes of flanges in the vertical plane shall straddle the vertical center line of the pipe in the erected position and for flanges in the horizontal plane, the bolt holes shall straddle horizontal plane unless otherwise indicated on the drawings.

The CONTRACTOR shall maintain slopes specified for various lines in the drawings. In case the CONTRACTOR is unable to maintain the indicated slope he shall check the sagging of the pipe with a precision spirit level. Vents and drains are shown in the isometric of each line and these are intended, during hydrostatic test for releasing the trapped air and draining out the test fluid after testing. Valves vents and drains are also shown wherever required.

Where practicable and except when otherwise shown on the drawings, valve stems shall be installed in a vertical direction and shall not be installed with stems below the horizontal axis.

3.0 UNDERGROUND PIPING

3.1 Underground piping shall be laid according to piping general arrangement drawing Issued during the course of construction

3.2 Pipeline trenches shall be dug wherever necessary according to drawing, true to line and gradient as per specification

3.3 No excavation material shall be deposited within 1.5m from excavated trench.

3.4 Coated pipes shall not be placed in trenches until sharp, hard stones, skids, welding rods etc. have been removed.

3.5 Coated pipe shall not be handled or moved by means of cables or chains or by prying

3.6 With skids or bars, it shall be tied and lowered by using lowering-in belts of a Standard Width for the size of pipe being used.

3.7 Coated pipe shall not be dragged along the ground or otherwise handled in a manner that will be detrimental to its coating.

3.8 Backfilling with the excavated material shall be done in layers of 200 mm. well watered and rammed to avoid settling afterwards.

4.0 FLANGE BOLTING

4.1 Use a logical sequence of bolt tightening to ensure even gasket compression, as indicated in ANSI B16.5.

4.2 Prior to bolt up, inspect flange faces. Flange faces shall be in “as-new" condition and shall be wiped clean of any debris excess oil or grease and dirt. Do not perform weld repairs on flange faces or flanges.

4.3 Do not use washers or spacers to make-up bolt length. Bolt lengths are specified prevent over sizing.

4.4 While fitting up mating flanges, care shall be exercised to properly align the pipes and check the flanges for trueness, so flanges can be pulled together without inducing stresses at pipes.

5.0 JOINTS

The relevant piping class will be assigned to each line identified on the isometric. In general, joining for lines 2" and above in utility piping system shall be accomplished by butt-welding connections. Pipe lines of size 1½" and below shall have socket welded/butt welded/screwed joints as specified in the piping materials specifications.

5.1 Do not apply insulation over any joints until testing has been completed.

5.2 Gaskets on flanged joints shall be used only once.

5.3 Gaskets shall be selected in accordance with Piping Materials.

6.0 SUPPORTS

6.1 Installation of supports shall be as indicated in the isometric / support piping layouts.

6.2 Supports, guides and anchors for piping shall be fabricated and provided as shown in the drawings. No anchors on piping shall be used except at locations shown in the drawings. The pipe shall be secured firmly at anchor supports.

6.3 Fabrication and erection of supporting elements and structural fixtures wherever required whether indicated in drawings or not, to prevent vibration, excess sag etc. shall be carried out by the CONTRACTOR.

6.4 Erection of these additional supports will be deemed as part of piping erection work scope.

7.0 CLEANLINESS OF PIPING

7.1 On completion of fabrication, all pipes and fittings shall be cleaned inside and outside by suitable means (mechanical cleaning tool, Wire brush, etc.) before erection to ensure that assembly is free from all loose foreign materiel such as scale, sand, weld spatter particles, cutting chips etc.

7.2 All field fabricated piping shall also be cleaned at the completion of the fabrication. All burrs, welding circles and weld spatter shall be removed by any suitable means (mechanical tools, wire brush etc.).

7.3 Both shop and field fabricated piping shall be blown out with compressed air at the termination of cleaning and capped.

7.4 Open end and flanges protection shall be used throughout installation. Protect open pipes at all times when work on them is not actually taking place.

7.5 Inspect individual pipe section, prefabricated spools and pipeline items internally during installation and remove any foreign matter before final welding or bolting.

7.6 Adjoining Piping with special equipment or piping within a packaged, vendor provided "skid", which requires cleaning in accordance with the equipment's Manufacturer's procedures, shall be inspected by, and have cleaning supervised by, the Manufacturer's representative.

8.0 INSTALLATION PROCEDURE FOR SOCKET WELDED SMALL BORE VALVES

As well as complying with all applicable code requirements for quality and strength of the

weld, it is necessary to avoid damage to soft seats and distortion of "small bore" valve bodies by excessive heat input.

a) Process

The process to be used shall be manual metal arc, metal inert gas or CO_2 with preference for the lower heat input high deposition (dip transfer) processes. Gas welding shall not be used because of its excessive heat input.

b) Preparation

Ensure that valve is in open position. Correctly locate and align the pipe in the valve socket with a clearance of approximately 1.6 mm (1/16 inch) between the end of the pipe and the bottom of the socket.

c) Procedure

Deposit the first run of weld metal around the pipe.Deposit metal for making additional runs as required, ensuring that each run of weld metal is cleaned and any visible defects such as cracks, cavities or other faults are removed before deposition of further weld metal.

9.0 DRAIN AND VENT CONNECTION

High point vents and low point drains required for the purpose of hydro testing shall be of size 1" and consist of sockolet, Plug & Ball valve for vent, Globe & Ball Valve for drain, flange & blind flange.

All low points in a line shall be provided with drain connections of nominal size as given in table below. All drains shall be with valve and blind except for water lines where valves are not required.

10.0 LINE MARKING / IDENTIFICATION

Process and utility type shall be identified stenciled lettering used to identify service and flow direction. Lettering shall be identified every 10 meters in pipe rack and should be visible from ground level.

IV TESTING

1.0 PIPING

R2

Pressure tests shall be performed as per ANSI B 31.8 latest edition or as per design basis and appropriate piping material specification class chart per Piping Material Specification document No. ENG-STD-PI-DOC-TS-001.

The field test pressure shall not be less than the highest of the following:

a) 1.5 times the design line class pressure.
b) 1.5 times the maximum operated pressure
c) 1.5 times the maximum pipeline static pressure
d) Sum of the maximum sustained operating pressure or maximum operating or maximum pipe line static pressure and the maximum calculated surge pressure.

The hold period shall be minimum 6 hours.

The testing shall be carried out in convenient section as approved by site engineer. The joints of pipe connecting the testing section shall be 100% radiographed and UT tested and shall be tested with other applicable NDT method as specified in specification.

If some defects are noticed during the hydrostatic testing, the same shall be brought to the notice of the OWNER. Joints, if leaking, shall be rectified as per welding specification and instructions and tested to the complete satisfaction of the OWNER.

The following items shall not be subjected to field pressure testing

a) Pressure relieving devices such as rupture discs and pressure relief valves.

b) Locally mounted pressure gauges.

c) Control valves, shutdown/ isolation valves etc.

d) Any other equipment designated by the OWNER.

All the elements, which are not to be tested along with the piping, shall either be blanked off during testing or spool pieces inserted during testing.

Any temporary corrosion protection coating given on piping at manufacturer's shop/ fabrication yard is to be removed at all inspection points, before final testing.

Prior to Hydro testing, vessels and piping are to be flushed by high pressure, high volume fresh water or inhibited water.

Following are the general requirements for testing of piping:

a) Test pressures shall be maintained for a sufficient length of time to permit through inspection of all the joints for a leakage or sign of failure. The duration shall in no case be less than six (6) hours.

b) Instrument take-off piping up to the first block valve shall be tested with the connected piping.

c) Lines open directly to atmosphere such as vents, drains, safety valve discharge etc. shall be leak tested and all the joints shall be visually inspected.

2.0 MAXIMUM ALLOWABLE VALVE TEST PRESSURE

Test pressure applied to valves under closed position shall not be greater than the manufacturer's recommendations nor less than required API 6D latest edition where the required test pressure is greater than the allowable seat pressure, test shall be made through the 50% open valve.

3.0 HYDROSTATIC TEST FLUID

3.1 Fresh potable water shall be used as the testing medium for hydrostatic testing of piping in fabrication yard and at site.

3.2 The lines shall be completely drained and dried by air immediately after the successful

completion of testing.

3.3 Salt water shall not be used for testing.

3.4 A strainer shall be installed in the line to minimize the possibility of foreign matter being introduced into the system during the pressure test and flushing operations.

4.0 PNEUMATIC TESTING

4.1 Pneumatic testing of instrument air, utility air, starting air and instrument gas piping shall be performed with compressed air. The test pressure shall be 110 percent of design pressure or 98 bar (g) whichever is higher in case of 600# and 110% of design pressure or 49 bar (g) whichever is higher in case of 300# rating piping.

4.2 In addition to hydro test, all the station piping shall be pneumatic tested. The test pressure shall be per clause 4.1 above.

4.3 When pneumatic testing at over 25 psi, a preliminary test at 25 psi shall be made to locate major leaks. Then the pressure shall be increased gradually to test pressure.

5.0 TEST PROCEDURE

5.1 All events and other connections, which serve as vents, shall be open during filling so that all air is vented prior to applying test pressure to the system.

5.2 Gauges used for testing shall be installed as close as possible to the highest point of the piping system.

5.3 Care shall be exercised to avoid increase in pressure due to temperature variation during the test.

5.4 After completion of the recorded test pressure recorder, the pressure shall be reduced to the design pressure and all valves, including check valves, in the section of the line shall be tested by being closed for a ten (10) minutes period with pressure contained by specific valve at one end and by positive closure at the other to determine whether each valve is in turn positively shutting off and holding pressure.

5.5 After completion of hydrostatic test, the pressure shall be released gradually in steps. All the vents and drains shall be kept open till the lines are fully drained. The CONTRACTOR shall then dry the system by blowing compressed dry air and reinstall items removed during Hydrotesting.

5.6 Record shall be made of each piping system during the testing. These records shall be prepared in tabulated foams and shall include.

a) Date of Test

b) Identification of piping and equipment tested with medium

c) Test medium

d) Test Pressure

e) Test Duration

f) Acceptance of Test Results by OWNER

g) Calibration certificates of test gauges, recorders and PSV's.

5.7 Testing shall be deemed as complete only after defects noticed during testing have been rectified and testing of the system / line has been done to the satisfaction of the OWNER's representative.

5.8 The CONTRACTOR shall supply all plain test blanks required for the pressure testing.

5.9 Gauges and pressure recorders used for testing shall be calibrated at a reputed laboratory at least every 6 months.

5.10 Temporary supports shall be provided wherever required during testing to the satisfaction of OWNER.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR NDT

GAIL-STD-PI-DOC-TS-007

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1.0 SCOPE

This specification covers the general requirements for non destructive examination of shop & field fabricated Pressure and Transmission piping.

2.0 CODES AND STANDARDS

Referred codes/ standards are as follows. Latest editions of the Codes/ Standards referred to shall be followed.

a) ASME Boiler & Pressure Vessel Codes, Section V & VIII (Div. 1) including addenda.

b) ASME B31.3

c) ASME 31.8

d) ASME B16.5

e) ASME B16.34

f) Standard Specification for Fabrication & Installation of Piping

3.0 NDE COMPANY CERTIFICATION

All Non Destructive Examination (NDE) CONTRACTORs contracted by the OWNER, or working for fabricators or CONTRACTORs carrying out work on the OWNER's 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-CONTRACTOR 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 reviewed by the OWNER.

4.0 VISUAL EXAMINATION

4.1 Visual examination shall be carried out before, during and after fabrication in accordance with ASME Sec. V article 9 and ASME B31.3.

4.2 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.

4.3 Weld shall be visually inspected wherever accessible in accordance with the following requirements:

a)	Internal misalignment	1.5 mm or less
b)	Cracks or lack of fusion	not permitted

c)	Incomplete penetration (For other than 100% radiography butt-weld)	not permitted
d)	Surface porosity and exposed slag inclusions (For nom. wall thickness 4.7 mm and less)	not permitted
e)	Concave root surface (Suck 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.
f)	Weld ripples irregularities	2.5 mm or less.
g)	Lack of uniformity in bead width	2.5 mm or less.
h)	Lack of uniformity of leg length	2.5 mm or less.
i)	Unevenness of bead	2.0 mm or less.
j)	Weld undercutting	0.8 mm or 12.5% of pipe wall thickness, whichever is smaller and there shall not be more than 2 in. (50 mm) of undercutting in any continuous 12-in. (300 mm) length of weld
k)	Overlap	1.5 mm or less
l)	Bead deflection	2.5 mm or less

m) 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

n) Throat thickness of fillet welds: Nominal thickness of the thinner component x 0.7 or more.

p) 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.

q) 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.

4.4 Welds having any of imperfections which exceed the limitations specified in various clauses of 4.3 shall be repaired by welding, grinding or overlaying etc. However a weld shall be allowed to be repaired only once.

5.0 NON DESTRUCTIVE TESTING

5.1 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 B31.8 & the requirements of this standard specification.

5.2 Welds between dissimilar materials shall be examined by method & to the extent required for the material having the more stringent examination.

6.0 TABLE-I (with applicable notes)

TABLE 1: CLASS, TYPE & EXTENT OF WELD EXAMINATION

INSPN. CLASS	SERVICE	MATERIAL	TEMP (DEG. C)	PRESS. CLASS	TYPE OF EXAMINATION	TYPE OF WELD EXAMINED		
						GIRTH BUTT WELD	SOCKET WELD	ATTACH-MENT/ BRANCH WELD
I	RLNG/ NG	CARBON STEEL	-45 TO 150	300#	a) VISUAL	100%	100%	100%
					b) RADIOGRAPHY	100%	10% for gap check	100%
					c) LP, MP & UT	-	100%	-
					d) HARDNESS	NOTE a	NOTE a	NOTE a
2	RLNG/	CARBON	-45 TO		a) VISUAL	100%	100%	100%

	NG	STEEL	200	600#	b) RADIOGRAPHY	100%	10% for gap check	100%
					c) LP, MP & UT	-	100%	100%
					d) HARDNESS	Note a	Note a	Note a

Notes:

a. Hardness Test:

i. 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.

ii. Hardness test where specifically called out in QAP (attached elsewhere in the bid document) or in Piping Material Specification (PMS), shall be carried out irrespective of thickness and to the extent (% age) as mentioned therein.

iii. All welds which are given heat treatment shall be hardness tested. Hardness test shall be performed after final heat treatment.

iv. 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.

v. For C-0.5 Mo steels, a minimum of 10% of welds shall be hardness tested.

vi. Hardness test requirement not covered in ii) & v) above shall be as per ASME B31 .3.

vii. The hardness limit applies to the weld and heat affected zone. Following hardness values shall be maintained:

Base Metal Group	**Maximum Hardness (BHN)**
CS	238 BHN

b. For branch connections, LP/ MP test shall be done on root pass and final pass.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR INSPECTION, FLUSHING AND TESTING

GAIL-STD-PI-DOC-TS-008

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1.0 SCOPE

This specification covers the general requirements for inspection, flushing and testing of piping systems.

Flushing and testing of all piping systems shall be witnessed by the owner/ consultant.

2.0 CODES AND STANDARDS

ASME B31.8 : Gas Transmission and Distribution piping systems

3.0 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.

- 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.

4.0 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 pressurized 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/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 of 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 Performa provided/approved by the Engineer-in-Charge.

5.0 TESTING

Pressure testing, in general shall be as per requirements of ASME B31.8, unless otherwise specified.

5.1 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 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.

5.2 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 program, to enable him to be present for witnessing the test.

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 1/2" 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/cm^2 (g) 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.

5.3 Testing Media, Test Pressure and Test Pressure Gauges

5.3.1 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.

5.3.2 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:

a. Test pressure required as per line list.

b. 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.

5.3.3 Test Pressure Gauge

All gauge used for field testing shall have suitable range so that the test pressure of the various system falls in 35% to 65% of gauge scale range. Pressure gage shall be minimum of 150 mm. Size of Bourdon shall not be less than 75% of nominal diameter of dial 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 programmes, all test gauges shall be calibrated using a standard dead weight gauge tester or other suitable approved testing apparatus. Any gauge having 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.

5.4 Testing Procedure

5.4.1 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 pressurizing and depressurizing the system, temporary isolating valves shall be provided if valves 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 stabilized 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.

5.4.2 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)

5.5 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.

5.6 Test Records

Records in triplicate shall be prepared and submitted by the contractor for each piping system, for the pressure test done in the Performa provided/approved by the Engineer-in-Charge.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR QUICK OPENING END CLOSURE

GAIL -STD-PI-DOC-TS-010

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1.0 SCOPE

This specification covers the minimum requirements for design, manufacture and supply of quick opening end closures to be installed at blow-down points handling hydrocarbons in gaseous phase. This specification does not cover quick opening end closures for sour hydrocarbons service as defined in NACE Standard MR0175-98.

1.1 Abbreviations

The following definitions shall apply:

- ASME : American Society of Mechanical Engineers.
- ASNT : American Society for Non-destructive Testing.
- ASTM : American Society for Testing and Materials.
- ISO : International Standards Organization.
- NDE : Non-destructive Examination.
- MSS : Manufacturers Standardization Society.
- NPS : Nominal Pipe Size.
- UNS : Unified Numbering System.

1.2 Definitions

Purchaser	:	The Company which makes purchase order.
Manufacturer	:	Manufacturer who receives the purchase order.
Shall	:	This verbal form indicates requirements strictly to be followed in order to confirm to the standards and form in which no deviation is permitted.
Should	:	This verbal form indicates that among several possibilities one is particularly suitable without mentioning or excluding others or that a certain course of action is preferred but not necessarily required.
May	:	This verbal form indicates a course of action permissible within the limits of this standard.
Can	:	This verbal form used for statements of possibility & capability, whether material, physical or casual.
Owner	:	GAIL INDIA LIMITED

1.3 Compliance

Compliance by the manufacturer with this specification shall not relieve him of his responsibilities to supply Quick opening end closure suited to meet the specified requirements and/or local codes governing health and safety.

The MANUFACTURER shall notify the purchaser / PMC / Owner in writing, of any proposed deviation from this Specification. The purchaser / PMC / Owner decision in respect of concession requests will be final.
The MANUFACTURER shall continually verify the quality and fitness for purpose of the launchers/receivers, and shall propose appropriate actions/measures if any aspects of manufacture are found to be unsatisfactory.

1.4 Quality Conformance

The MANUFACTURER shall demonstrate to the satisfaction of the purchaser / PMC / Owner that his activities within the scope of this document are in accordance with the relevant section of BS EN ISO 9001. The MANUFACTURER shall submit to the purchaser / PMC / Owner for review and approval, a Quality Plan and procedural specifications prior to commencement of work. The Quality Plan shall define all sub Manufacturer's involvement in the work. The review in this Specification shall only indicate a general requirement and shall not relieve the MANUFACTURER of his obligations to comply with the requirements

1.5 Safety

Safety is paramount. All work shall be performed in accordance with the safety requirements listed in the contract documentation.

2 CODES, STANDARDS AND DOCUMENTS

2.1 Codes and standards

Scraper launchers, receivers or combined traps specified herein shall be designed, manufactured and tested in accordance with the latest edition of the following codes and standards and/or others as applicable. These Codes and Standards are the minimum requirements, and manufactured design shall meet or exceed them.

API Spec 5L	:	Specification for Line pipe.
API 1104	:	Welding of Pipelines and Related Facilities.
ASME V	:	Boiler and Pressure Vessel Code - Non Destructive Testing.
ASME VIII	:	Boiler and Pressure Vessel Code - Div 1- Pressure Vessels.
ASME IX	:	Boiler and Pressure Vessel Code - Welding & Brazing qualification
ASME B 31.3	:	Process Piping.
ASME B 31.8	:	Gas Transmission and Distribution Pipeline System.
ASME B 16.5	:	Steel Pipe Flanges and Flanged Fittings.
ASME B 16.9	:	Factory-made Wrought Steel Butt Welding Fittings.
ASME B 16.11	:	Forges Steel Fittings, Socket Welding and Threaded.

ASME B 16.25	:	Butt Welded Ends.
ASME B 16.47	:	Large Diameter Steel Flanges: NPS 26 Through NPS 60.
ASTM A 350 LF2	:	Standard Specification forCarbon and Low-Alloy Steel Forgings
ASTM A 105	:	Forging, Carbon Steel for Piping Components.
ASTM A 181	:	Forging, Carbon Steel for General-Purpose Piping.
ASTM A 234	:	Piping Fitting of Wrought Carbon Steel and Alloy Steel for moderated and Elevated Temperatures.
ASTM A 370	:	Mechanical Testing of Steel products.
ASTM A 216	:	Carbon Steel Castings suitable for Fusion Welding for High temperature Service.
ASTM A 20	:	General requirements for steel plate for pressure vessels.
ASTM A 516	:	Carbon steel pressure vessel plates for moderate and low temperature service.
ASTM A 106	:	Carbon steel seamless pipe for high temperature service.
ASTM A 193	:	Alloy steel and stainless steel bolting materials for high temperature.
ASTM A 194	:	Carbon and alloy steel nuts for bolts for high pressure or temperature.
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.
MSS-SP-75	:	High test wrought butt-welded fittings.
ISO 9712	:	Non-destructive testing qualification and certification of personnel.
ISO 10474	:	Steel and Steel Structures Inspection documents.
ISO 9000	:	Quality Management and Quality Assurance Standards.
ISO 9001	:	Quality Systems – Model for quality assurance in design, development, production, installation and servicing.
ISO 9002	:	Quality Systems – Model for quality assurance in production, installation and servicing.

3.0 MATERIALS

3.1 Carbon steel material used in the manufacture of pressure containing parts of quick opening end closure shall be fully killed. In addition, the material shall also meet the requirements specified herein. 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 *0.43* based on Check analysis for each heat of steel used, calculated as per the following formula:

$$CE = C + Mn/6 + (Cr+Mo+V)/5 + (Ni+Cu)/15$$

3.3 Charpy V-notch test shall be conducted on each heat of base material, weld metal and heat affected zone of all pressure containing parts, welding ends in accordance with the impact test provisions of ASTM A 370 at a temperature of -20 °C. The charpy impact test specimens shall be taken in the direction of principal grain flow and notched perpendicular to the original surface of the plate of forging. Average impact energy value of three full sized specimens shall be 35 joules. Minimum impact energy value of individual specimen shall be 28 joules. No specimen shall exhibit less than 80% shear area.

In addition to above when Low Temperature carbon steel (LTCS) materials are specified in data sheet, the charpy V-notch test shall be carried at temperature of -46 deg. C or shall be complied with specified material specification in addition to the above mentioned test at -20°C.

3.4 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 HAZ of all the pressure containing parts shall not exceed 248 HV10.

4.0 DESIGN AND CONSTRUCTION

4.1 End closures shall be designed in accordance with the provisions of ASME Sec. VIII Division 1. Design factor and corrosion allowance shall be as indicated in the Data Sheet.Quick Opening End closure shall be ASME U stamp certified.

4.2 The quick opening end closure shall be of band lock or equivalent type and operable by a single lever operation. The closure shall also consist of a safety system allowing the opening only when there is no pressure in the line.

4.3 Threaded / screwed / Plug- In type end closures are not acceptable.

4.4 End closure shall be suitable for installation in horizontal position at an elevation of 1.2 meters from above ground level.

4.5 The handling device shall be attached to the welding end hub, which shall be suitable for such attachment.

4.6 All welds shall be made by qualified 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 when required as per Clause 3.4 and 3.5 of this specification and shall meet the requirements as specified therein. WPS & PQR shall be reviewed by TPIA for each size and class prior to commencement of work.

4.7 Completed assembly shall be stress relieved as per the provisions of the design codes.

5.0 INESPECTION AND TESTING

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 shall be, but not limited to, the following:

5.1.1 Chemical composition and mechanical properties shall be checked.

5.1.2 All closures shall be visually inspected.

5.1.3 Dimensional check shall be carried out as per the approved drawings.

5.1.4 All butt welds shall be 100% radiographic inspected. Procedure and acceptance criteria shall be as per API 1104.

5.1.5 Hydrostatic test shall be conducted for all end closures complete in all respects, at a pressure equal to *1.5* times the design pressure. Test duration shall be minimum 4 hours.

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 butt 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 10 closing and opening cycles shall be performed and correct operation of both quick opening and safety system shall be established. QOC include safety device to prevent opening before de-pressurizing in compliance with ASME Sec VIII DIV 1 UG 35 (b).

5.2 Purchaser's Inspector / TPIA 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 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.

6.0 TEST CERTIFICATES

Manufacturer shall furnish the following certificates:

a) Test Certificates relevant to chemical and mechanical properties (YS, UTS, YS / UTS Ratio, Micro, Hardness, Impact (-20 & 46 deg. C) of the material used as per the relevant standards.

b) Report on Non-Destructive examination.

c) Hydrostatic test certificates

d) Certificate of satisfactory performance of end closure as per Clause 5.1.8.

7.0 PAINTING, MARKING AND SHIPMENT

7.1 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.

7.2 Marking shall be done on a stainless steel plate and affixed to the body permanently. Marking shall include the following:

- Order number

- Manufacturer's Name
- Year of Manufacture
- Tag number
- Serial number
- size and rating
- Design Pressure
- Design Temperature

7.3 Before shipment, closures shall be properly packed against damage during transportation. Suitable protection shall be provided for the weld ends.

7.4 Only those closures, which have been inspected and certified by Purchaser's Inspector, shall be shipped.

8.0 SPARES

8.1 Manufacturer shall furnish list of recommended spares and accessories for Quick Opening End Closures required during start up and commissioning. Cost of such spares shall be included by the Manufacturer in the item rates indicated in purchase Requisition.

8.2 Manufacturer shall furnish separately a list of recommended spares and accessories required for two years of normal operation and maintenance of Quick Opening End Closures.

9.0 DOCUMENTATION

9.1 All documents shall be in English Language only.

9.2 Within three weeks of placement of order, the Manufacturer shall submit two copies of, but not limited to, the following drawings, documents and specifications for approval:

a) Design calculations according to relevant codes for the end closure.
b) Welding procedure and method of manufacture.
c) Closure assembly and sectional drawings showing all parts with materials and dimensions.
d) General arrangement drawing of end closure with overall dimensions.
e) Clause wise list of deviations from this specification, if any.
f) Quality Assurance Plan.

9.3 Within four weeks from the approval date, Manufacturer shall submit one reproducible and six copies of the approved drawings, documents and specifications listed in Clause 9.3 of above.

9.4 Prior to shipment, the Manufacturer shall submit one reproducible and two copies of the Test certificates as listed in clause 6.0 of this specification and manual for installation, erection, instructions, maintenance and operation instruction.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR MONOLITHIC ISOLATION JOINT

GAIL-STD-PI-DOC-TS-011

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1.0 SCOPE

This specification defines the minimum technical requirements for the design, manufacture, testing and supply of carbon steel Insulating joints to be installed in onshore pipelines of Natural Gas services.

1.1 Abbreviations

The following definitions shall apply:

- ASME : American Society of Mechanical Engineers.
- ASNT : American Society for Non-destructive Testing.
- ASTM : American Society for Testing and Materials.
- ISO : International Standards Organization.
- NDE : Non-destructive Examination.
- MSS : Manufacturers Standardization Society.
- NPS : Nominal Pipe Size.
- UNS : Unified Numbering System.

1.2 Compliance

Compliance by the manufacturer with this specification shall not relieve him of his responsibilities to supply to meet the specified requirements and/or local codes governing health and safety.

The MANUFACTURER shall notify the purchaser / PMC / Owner in writing, of any proposed deviation from this Specification. The purchaser / PMC / Owner decision in respect of concession requests will be final.
The MANUFACTURER shall continually verify the quality and fitness for purpose of the Monolithic Isolation Joint, and shall propose appropriate actions/measures if any aspects of manufacture are found to be unsatisfactory.

1.3 Quality Conformance

The MANUFACTURER shall demonstrate to the satisfaction of the purchaser / PMC / Owner that his activities within the scope of this document are in accordance with the relevant section of BS EN ISO 9001. The MANUFACTURER shall submit to the purchaser / PMC / Owner for review and approval, a Quality Plan and procedural specifications prior to commencement of work. The Quality Plan shall define all sub Manufacturer's involvement in the work. The review in this Specification shall only indicate a general requirement and shall not relieve the MANUFACTURER of his obligations to comply with the requirements

1.4 Safety

Safety is paramount. All work shall be performed in accordance with the safety requirements listed in the contract documentation.

2.0 REFERENCE DOCUMENTS

2.1 Reference has been made in this specification to the latest edition of, the following Codes, Standards and Specifications.

API 1104	: Specification for welding pipelines and related facilities.
ASME B 31.3	: Process piping.
API 5L	: Specification for Line Pipe
ASME B 31.8	: Gas Transmission and Distribution piping systems.
ASME Section VIII	: Boiler & pressure Vessel Code.
BPVC Section V	: Non-Destructive Examination.
BPVC Section IX	: Welding and Brazing qualifications
ASME B16.9	: Factory made Wrought Butt Weld Fittings.
ASTM A 370	: Standard Test Methods and Definitions for Mechanical Testing of steel Products.
ASTM B 733	: Auto catalytic Nickel Phosphorous coating on metals.
ASME B16.34	: Valves – Flanged, Threaded and welding end
ANSI B 16.25	: Butt Welding Ends
ASTM A694	: Standard Specification for Carbon and Alloy Steel Forgings for Pipe Flanges, Fittings, Valves, and Parts for High-Pressure Transmission Service
ASTM D2000	: Classification system for Rubber Products in Automotive.
ASTM D709	: Specification for Laminated Thermosetting Materials
MSS-SP-75	: Specification for High Test Wrought Welding Fittings
BS-EN-I0204	: Metallic Products - Types of Inspection Documents
ISO 2808	: Paints and Varnishes Determination of Film thickness
ISO 8501-1	: Preparation of Steel Substrates before Application of Paints and Related Products - Visual Assessment of Surface Cleanliness.
PNGRB	: Petroleum & Natural Gas Regulatory Board
EN 1024	: Metallic Materials-Types of inspection documents.
NACE RP 286	: The electrical isolation of catholically protected pipelines.
ISO 13623	: Petroleum & Natural Gas industry –Pipeline transportation system.
ISO 14313	: Petroleum & Natural Gas Industry, Pipeline transportation system –pipeline valves.
SSPC-VIS-I	: Steel structures painting council-Visual standard

SP-10	: Surface Preparation.
MSS-SP-25	: Standard marking systems for valves, Fittings, Flanges and union.
MSS-SP-75	: Specification for High Test Wrought welding fittings.
MSS-SP-53	:Quality standard for steel casting and forging for valves, flanges, fittings and other piping components –Magnetic particle Examination method.

OIL INDUSTRY SAFETY DIRECTORATE (OISD STANDARDS)

OISD 106	: Process design and operating philosophies on pressure relief and disposal system
OISD 113	: Classification of Area for electrical installation at Hydrocarbon and handling facilities
OISD 115	: Guidelines on Fire Fighting, Equipment and Appliance in Petroleum Industry
OISD 163	: Process control room safety
OISD 226	: Natural Gas Transmission pipelines and city gas distribution networks.
OISD 118	: Layouts for Oil & Gas Installation
OISD 141	: Design and Construction Requirements for Cross Country Hydrocarbon Pipelines.

MISCELLANEOUS

NEC	: National Electric Code.
ISO 2409	: Paints and Varnishes - Cross-Cut test.

In case of conflict between various requirements of this specification and reference standardsmentioned above, more stringent requirement shall apply unless otherwise agreed by Purchaser.

3.0 MATERIALS

3.1 Material for the pressure containing parts of the isolation joints shall be as indicated in the monolithic isolation joint data sheets. Material for pups shall be equivalent or superior to the material of connecting pipeline, which is indicated in the data sheets. Pup piece material shall be such as to limit the thickness of pup piece to be welded with pipeline. Other part shall be as per Manufacturer's standard suitable for the service condition indicated in Isolation Joint Data Sheets and shall be subject to approval by purchaser / Purchaser's representative.

All process wetted parts, metallic and non-metallic shall be suitable for the commissioning fluids and service specified by the company. Manufacturer shall confirm that all wetted parts are suitable for treated water/sea water environment, which may be used during field testing.

3.2 Isolation joints which are subjected to field welding by purchaser shall have carbon equivalent (CE) not exceeding 0.43 based on check analysis for each heat of steel calculated according to the following formula:

$$CE = C + Mn/6 + (Cr+Mo+V)/5 + (Ni +Cu)/15$$

3.3 Charpy V-notch test shall be conducted on each heat of base material, weld metal and heat affected zone of all pressure containing parts such as body, welding ends in accordance with the impact test provisions of ASTM A 370 at a temperature of -20 °C. The charpy impact test specimens shall be taken in the direction of principal grain flow and notched perpendicular to the original surface of the plate of forging. Average impact energy value of three full sized specimens shall be 35 joules. Minimum impact energy value of individual specimen shall be 28 joules. No specimen shall exhibit less than 80% shear area.

3.4 Carbon steel used for the manufacture shall be fully killed.

3.5 Hardness test shall be carried out as per ASTM A370 for each heat of steel used. The maximum hardness of base metal, weld metal and heat affected zone of all pressure parts shall be 248 HV_{10}, unless specified otherwise.

4.0 DESIGN & CONSTRUCTION REQUIREMENTS

4.1 Mechanical

4.1.1 Isolation joints shall be of integral type fabricated by welding and with suitable pups on either side. A corrosion allowance as indicated in data sheet shall be considered in design. Bolted and threaded joints are not acceptable.

4.1.2 All materials used for the manufacture of the Isolation joint shall be in accordance with clause 4.0 of this Specification.

41.3 Isolation joints shall be designed using the design principles of ASME Section-VIII Div. 1.

4.1.4 Isolation joint design and materials shall be capable of being vacuum tested to 5 millibar.

4.1.5 The reinforcement of inside weld seam, in case pups fabricated from LSAW pipes, shall be removed for a distance of at least 50mm from each end to facilitate welding.

4.1.8 Isolation joints shall allow free passage of scraper/ instrumented pigs. The internal bore shall be same as that of connecting pipe including its tolerances.

4.1.9 The Isolation joint shall be formed by sandwiching and locking in positions the Isolation material in a bell and spigot type of joint. The joint shall be assembled in such a way that its various components are firmly locked in position and the completed joint is capable of withstanding stresses due to designed operating conditions and field hydrostatic testing.

4.1.10 Isolation joints shall be suitable for aboveground installations as indicated in the data sheets.

4.1.11 All welds shall be made by welders and welding procedures qualified in accordance with the provisions ASME section IX. The procedure qualification shall include impact test and hardness test and shall meet the requirements of clause 3.3 & 3.5 of this specification.

4.1.12 Repair welding on parent metal is not allowed. Purchaser's representative for each repair shall carry out repair of welds only after specific approval. Welders shall carry out the repair welding and welding procedures duly qualified as per ASME section IX and records for each repair shall be maintained.

4.1.13 Calculations shall be provided to show that the designed joint can withstand torsional stress up to 10% of the SMYS of the pup piece material.

4.1.14. The Manufacturer shall submit the detailed sectional drawing of the longitudinal face of the joint. The cross sectional drawing shall show all parts, materials, dimensions surface finishes and tolerances.

4.1.15. The insulating joint material shall be resistant to creep.

4.1.16. The external fasteners shall be hot dip galvanized as per ASTM A 153.

4.1.17. The selected seal material shall be resistant to the chemicals and the operating temperature and pressure of the pipe system. At least 90% of the gasket shall be in contact with bare metal surface. The sealing gasket shall be of sufficient thickness and shall be made out of one piece of material, no joints are permitted.

4.1.18. No stress inducing recess, protrusions or notches, are permitted in the internal surface of the supplied joint. Additional fillers are not permitted to fill these flaws.

4.1.19. The cavities inside the joint shall be filled with low viscosity dielectric material that solidifies on curing. Air pockets and impurities in the dielectric material shall not be accepted.

4.1.20.. The Manufacturer shall submit the detailed sectional drawing of the longitudinal face of the joint. The cross sectional drawing shall show all parts, materials, dimensions surface finishes and tolerances.

4.2 Electrical

4.2.1 The average dielectric strength of the Isolation joint shall be minimum 15 kilo Volts or more.

4.2.2 Two cleats shall be provided on the pups on either side of the Isolation joint for connecting 10 mm^2 and 50 mm^2 cables for measurement/ shorting purposes. Cleats shall be attached to the Isolation joint by welding.

4.3 NON METALLIC COMPONENTS

Minimum thickness requirement of insulating material shall comply with NACE RP 0286.

Epoxy resin filler material used shall be CIBA Araldite CY-220 & Araldite HT-951 hardener or an approved equivalent.

Insulating rings and joint filler material shall be flame resistant and capable of safely withstanding the maximum operating temperature without distortion or loss of insulating properties. Non-metallic seal materials, if provided, shall be resistant to amine based corrosion inhibitors and explosive decompression.
The spacing ring shall be of epoxy glass fiber reinforced laminate. It shall possess high insulating properties that would comply with ASTM D 709 Type TV, Group G.1.1 properties. The materials compressive properties shall be equal to or greater than 450 MPa. The epoxy glass fiber laminates material shall possess anti-aging properties. The spacing ring, sealing gasket and filling material shall be resistant to flames and diffusion of gases, absorption of moisture and shall be capable of maintaining their required compressive strength and insulating properties over the design life of the pipeline.

Adhesive sealant or a low viscosity, cold curing thermosetting resin shall be used as filling material. Its compressive strength shall be equal to or greater than 150 MPa. Plastic material shall be compatible to the materials they are in contact with. The Manufacturer shall give the details of the plastic used and its mechanical, chemical and temperature resistance properties.

4.4 WELDING

a. All welds except closing weld shall be butt welds. The closing weld shall be full penetration girth weld in accordance with ASME BPVC Section VIII, Division I. The weld design shall conform to the ASME acceptable standards. Fillet welds if required, shall have minimum two passes.

b. Welding end of the pipe pups to be welded to the insulating joint shall be prepared in accordance with ASME B31.4/ B31.8, as applicable. All butt weld ends shall be checked for surface defectsusing dye penetrate prior to welding.

c. All welding shall be carried out by welders and welding procedure qualified in accordance with ASME Section IX. The procedure quantification to include hardness and impact test shall meet therequirement of clause 3.3& 3.5.

d. No repairs by welding shall be carried out on base metal of any component of insulating joint. Manufacturer shall obtain Purchaser approval prior to carrying out any repair of welds. The repair welding shall be carried out by welders and welding procedures duly qualified per ASME Section IX and records for each repair shall be maintained. Welding procedure and repair welding procedure qualification shall include requirements for impact testing.

e. Cold die stamping on insulating joints or pups is not permitted on the body. Cold die stamping can be done on the pipe bevel.

f. The repair of the forging by welding is not permitted. All production welding, including tacking shall be done as per the qualified procedure by the qualified welder/ operators. The acceptable weld processes are:

- Shielded Metal Arc Welding (SMAW)
- Submerged Arc Welding (SAW)
- Gas Metal Arc Welding (GMAW)

g. The Manufacturer shall ensure that all the mechanical works are completed prior to the post weld heat treatment and hydrostatic test. Any re-work (welding, cutting and grinding) on the surface of the material after the PWHT or hydrostatic testing is not permitted.

h. The need for Post Weld Heat Treatment (PWHT) shall be assessed by the Manufacturer in accordance with the relevant weld procedure.

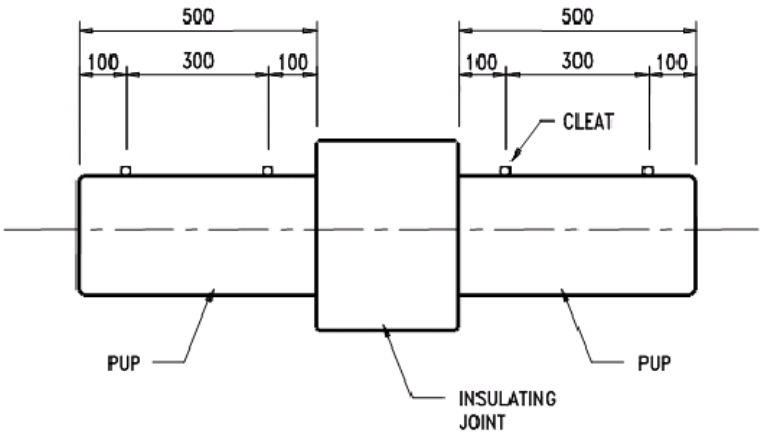

FIG. 4.1

5.0 INSPECTION & TESTING

5.1 The manufacture shall perform all inspection and tests as per the requirements of this specification and the relevant codes, prior to shipment at his works. Inspection & tests shall be performed to ascertain the requirements of this specification & not limited to the following:

5.1.1 All Isolation joints shall be visually inspected.

5.1.2 Dimensional checks shall be carried out as per the purchaser approved drawings.

5.1.3 Chemical composition and mechanical properties including hardness shall be checked as per relevant material standards and this specification, for each heat of steel used.

5.1.4 Non-destructive inspection of Isolation joints shall be carried out as given below:

a) 100% radiography shall be carried out on all butt & repair welds of pressure containing parts. Acceptance limits shall be as per API 1104.

Welds, which in purchaser's representative opinion 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.

b) All finished weld ends shall be 100% ultrasonically tested for lamination type defects for a distance of 50mm from the ends. Any lamination is not acceptable.

c) All forgings shall be wet magnetic particle inspected on 100% of forged surfaces. Method and acceptance shall comply with MSS-SP-53 and ASME Sec VIII DIV 2.

d) All fillet weld of thickness < 6mm shall be examined 100% by magnetic particle inspection and ≥ 6mm shall be examined 100% by UT. Acceptance criteria for MPI & UT shall be as per ASME Sec.VIII Appendix-6 & Appendix-12 respectively.

5.1.5 Isolation joint shall be hydrostatically tested to a pressure as indicated in data sheet. The test duration shall be of 60 minutes.

5.1.6 Upon successful completion of hydrostatic testing, the joint shall be subjected to a minimum of 40 Pressure cycles from 10 bars to 85% of the hydrostatic test pressure. After cycling, the pressure shallbe raised to the hydrostatic test pressure and maintained for at least 30 minutes.

5.1.6 After the hydrostatic test Isolation joints shall be tested with air at 7 bar (g) for 10 minutes.The tightness shall be checked by immersion or with a frothing agent. No leakage shall be acceptable.

5.1.7 Dielectric Test

a) Insulation resistance of each Isolation joint shall be at least 50 mega-ohms when checked with1000 V DC.

b) Isolation joint before and after the hydrostatic test, shall be tested for dielectric integrity for one minute at 5000 V A.C., 50 cycles and the leakage current before and after hydrostatic test shall be equal. Testing time voltage and leakage shall be recorded and certified. No repair shall be permitted to the Isolation joints failed in the above mentioned tests.

5.2 Purchaser reserves the right to perform stage wise inspection and witness test as indicated in Para 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 purchaser's Representative.

Inspection and tests performed/witnessed by the Purchaser's Representative shall in no way relieve the Manufacturer's obligation to perform the required inspection and test.

6.0 TEST CERTIFICATES

6.1 Manufacturer shall submit following certificates to Purchaser's Representative.

a) Test certificates relevant to the chemical analysis and mechanical properties including hardness of the materials used for construction of Isolation joint as per this specification and relevant standards.

b) Test reports on non-destructive testing.

c) Test certificates for hydrostatic and air tests.

d) Test certificate for electrical resistance test.

e) Test report for dielectric strength test.

7.0 PAINTING, MARKING AND SHIPMENT

7.1 Isolation joint 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-10 in accordance with "steel structures painting council - Visual standard SSPC-VIS-I." External surfaces of Isolation joints shall be painted with three coats of suitable epoxy resin with a minimum dry film thickness of 320 microns and it shall be suitable for corrosive industrial environment.

Manufacturer shall indicate the type of corrosion resistant paint used, in the drawings submitted for approval.

7.2 Isolation joints shall be marked with indelible paint with the following data:-

a. Manufacturer's name

b. Suitable for- inch nominal diameter pipeline

c. End thickness in mm

d. Material

e. Design Pressure/ Hydrostatic Test Pressure

f. ANSI Class Rating

g. Tag No.

h. Year of Manufacture

i. PO No.

7.3 Isolation joints shall be suitably protected to avoid any damage during transit. Metallic bevel protectors shall be provided to weld ends.

7.4 Only those Isolation joints, which have been inspected and certified by Purchaser, shall be shipped.

8.0 SPARES AND ACCESSORIES

Not Applicable

9.0 DOCUMENTATION

9.1 All documents shall be in English Language.

9.2 At the time of bidding, Bidder shall submit the following documents:-

a) General arrangement drawing along with cross sectional view, overall dimensions and details of Isolation materials recommended.

b) Reference lists of previous supplies of Isolation joint of similar specification.

c) Clause wise list of deviation from this specification, if any.

9.3 Within two weeks of placement of order, the Manufacturer shall submit 2 copies of but not limited to the following drawings, documents and specifications for approval.

a) Fabrication drawings and relevant calculations for pressure containing parts.
b) Welding procedure and method of manufacture for all phases of manufacture.
c) Quality Assurance Plan (QAP)

Once the approval has been given by purchaser any changes in design, material and method of manufacture shall be notified to the Purchaser whose approval in writing of all changes shall be obtained before the isolation joint are manufactured.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR FLOW TEE

GAIL-STD-PI-DOC-TS-012

0	12.01.18	Issued for Bid	AP	JR	SB	
Rev	**Date**	**Purpose**	**Prepared By**	**Checked By**	**Approved By**	

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1.0 SCOPE

This specification covers the basic requirements for design, manufacture, testing and supply of carbon steel Flow Tees to be installed in onshore Pipeline of Natural Gas Services.

1.1 Abbreviations

The following definitions shall apply:

- ASME : American Society of Mechanical Engineers.
- ASNT : American Society for Non-destructive Testing.
- ASTM : American Society for Testing and Materials.
- ISO : International Standards Organization.
- NDE : Non-destructive Examination.
- MSS : Manufacturers Standardization Society.
- NPS : Nominal Pipe Size.
- UNS : Unified Numbering System.

1.2 Compliance

Compliance by the contractor with this specification shall not relieve him of his responsibilities to supply Flow tee suited to meet the specified requirements and/or local codes governing health and safety.

The CONTRACTOR shall notify the CONSULTANT & OWNER in writing, of any proposed deviation from this Specification. The Owner/Consultant's decision in respect of concession requests will be final.

The CONTRATOR shall continually verify the quality and fitness for purpose of the Flow tee, and shall propose appropriate actions/measures if any aspects of manufacture are found to be unsatisfactory.

1.3 Quality Conformance

The CONTRACTOR shall demonstrate to the satisfaction of the OWNER / CONSULTANT that his activities within the scope of this document are in accordance with the relevant section of BS EN ISO 9001. The CONTRACTOR shall submit to the CONSULTANT for review and approval, a Quality Plan and procedural specifications prior to commencement of work. The Quality Plan shall define all sub Contractor's involvement in the work. The review in this Specification shall only indicate a general requirement and shall not relieve the CONTRACTOR of his obligations to comply with the requirements of the Contract.

1.4 Safety

Safety is paramount. All work shall be performed in accordance with the safety requirements listed in the contract documentation.

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 Section VIII	Boiler & pressure Vessel Code
ASME B 16.25	Butt Welding Ends
ASME B 16.9	Factory made wrought steel butt welding fittings
ASME B 31.8	Gas Transmission & Distribution piping System
ASTM A 370	Mechanical testing of Steel Product
API 1104	Standard for welding pipelines and related facilities
SSPC-VIS-1	Steel Structures painting Council Visual Standard
MSS-SP-53	Quality standard for steel castings and forgings for valves flanges and fittings and other piping components - magnetic particle examination method
MSS-SP-75	Specification for High Test Wrought welding fittings
ASME Section IX	Qualification standard for Welding and Brazing Procedures
PNGRB	Petroleum & Natural Gas Regulatory Board

2.2 In case of conflict between the requirements of this specification and any code, Standard or Specification referred to in this Specification, the requirements of this specification shall govern.

3.0 MANUFACTURER'S QUALIFICATION

Manufacturers who intend bidding for flow tees must posses the records of a successful proof test for tees used in the fabrication of flow tees, in accordance with the provisions of ASME B 16.9/MSS-SP-75. These records shall be submitted at the time of bidding

4.0 MATERIALS

4.1 Material for the pressure containing parts of the flow tees shall be as indicated in the data sheets. Other part shall be as per Manufacturer's standard suitable for the service condition and shall be subject to approval by purchaser.

4.2 Flow Tees which are subject to field welding by purchaser, shall have carbon equivalent (CE) not exceeding 0.43 based on check analysis for each heat of steel calculated according to the following formula:

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

4.3 When specified in the Data Sheet, charpy V-notch test shall be conducted on each heat of base material, weld metal and heat affected zone of all pressure containing parts such as body, welding ends in accordance with the impact test provisions of ASTM A 370 at a temperature of -20 °C. The charpy impact test specimens shall be taken in the direction of principal grain flow and notched perpendicular to the original surface of the plate of forging. Average impact energy value of three full sized specimens shall be 35 joules. Minimum impact energy value of individual specimen shall be 28 joules. No specimen shall exhibit less than 85% shear area.

When Low Temperature carbon steel (LTCS) materials are specified in data sheet, the charpy V-notch test shall be carried at temperature of -46 deg. C or shall be complied with specified material specification in addition to the above mentioned test at -20°C. For flow tees used for the transportation of other hydrocarbons, the charpy V-notch test requirements as stated above shall not be applicable unless required by specified material standard or mandatory requirement.

4.4 Carbon steel used for the manufacture shall be fully killed.

4.5 When specified in data sheet, hardness test shall be carried out as per ASTM A370 for each heat of steel used. The maximum hardness of base metal, weld metal and heat affected zone of all pressure parts shall be 248 HV_{10}, unless otherwise specified.

5.0 DESIGN & CONSTRUCTION REQUIREMENTS

5.1 Flow tees shall be designed and manufactured in accordance with the provisions of Codes and Standards referred in Section 2.0 of this specification. In addition, design factor and corrosion allowance, as indicated in the Data Sheet, shall also be taken into account for design of Flow tees.

5.2 Flow tees shall generally conform to the figure shown in the Data Sheet and shall meet the following requirements:

a) An internal pipe having the same internal diameter as the connecting pipeline allowing the passage of scrapper/instrumented pigs, provided with holes/slots located in the centre line of the branch. The slots shall be designed to prevent the pig getting stuck or damaged without affecting the flow through the branch line. The area of the holes/slots shall be 1.5 times internal area of branch size.

b) A forged/submerged arc welded “tee” as per ASME B 16.9/MSS-SP-75, enclosing internal pipe and fixed to it by suitably shaped forged steel rings. Machined steel rings shall not be used. Circumferential welding on the branch outlet is not acceptable. Pups shall not be provided either at the run or at the branch.

5.3 Butt weld ends shall be beveled as per MSS-SP-75 and ASME B 16.25.

5.4 All flow tees shall be completely stress relieved as per MSS-SP-75 and other relevant code / standard.

5.5 Stub-in or pipe-to-pipe connection shall not be used in the manufacture of flow tees. Tees used for manufacturing of flow tees shall be manufactured by forging or extrusion methods. In case flow tees are manufactured using welded tees, the longitudinal weld seam shall be at least 90 deg to the branch connection

5.6 All welds shall be made by welders and welding procedures qualified in accordance with ASME Section IX. The procedure qualification shall include impact test and hardness test and shall meet the requirements of clause 4.3 and 4.5of this specification respectively.

5.7 Repair by welding on parent metal is not permitted. Repair of welds shall be carried out only after specific approval by Purchaser's Inspector for each repair. The repair welding shall be carried out by the welders and welding procedures duly qualified as per ASME Section IX and include all tests, which are applicable for regular production welding procedure qualification. Records for all repairs shall be maintained.

5.8 The tolerance on internal diameter and out of roundness at the ends for welded flow tees shall be as per applicable connected pipe specification as indicated in the Data Sheet.

6.0 INSPECTION & TESTS

6.1 The Manufacturer shall perform all inspections and tests as per the requirements of this specification and the relevant codes, prior to shipment at his works. Such inspections and tests shall be, but not limited to, the following.

6.1.1 All flow tees shall be visually inspected. The internal and external surfaces of the flow tees shall be free from any strikes, gauges and other detrimental defects.

6.1.2 Hydrotest shall be carried out at 1.5 times of design pressure for minimum 15 minuntes. Dimensional checks shall be carried out as per the purchaser approved drawings.

6.1.3 Chemical composition and mechanical properties including hardness shall be checked as per relevant material standards and this specification, for each heat of steel used.

6.1.4 Non-destructive inspection of flow tees shall be carried out as given below:

a) 100% radiography shall be carried out on all butt & repair welds of pressure containing parts. Acceptance limits shall be as per API 1104 & ASME SEC VIII DIV 1.
Welds, which in purchaser's Representative opinion cannot be inspected by radiographic methods, shall be checked by ultrasonic or magnetic particle methods. Acceptance criteria shall be as per ASME SEC VIII DIV 1.

b) All finished weld ends shall be 100% ultrasonically tested for lamination type defects for a distance of 50mm from the ends. Lamination is not acceptable.

c) All forgings shall be wet magnetic particle inspected on 100% of forged surfaces. Method and acceptance shall comply ASME Sec VIII Div 2.

d) MPI/D.P inspection for cold formed butt welding with extruded outlet that are subjected to extreme fiber elongation of 5% or more as per MSS-SP-53 and ASME Sec VIII Div 2.

6.2 Purchaser's Inspector shall also perform stage wise inspection and witness tests as indicated in clause 6.1 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 Purchaser's Inspector.
Inspection and tests performed/witnessed by Purchaser's Representative shall in no way relieve the Manufacturer's obligation to perform the required inspection and tests.

7.0 TEST CERTIFICATES

7.1 Manufacturer shall submit following certificates to Purchaser's Representative.

a) Test certificates relevant to the chemical analysis and mechanical properties including hardness of the materials used for construction of Flow Tee as per this specification and relevant standards.

b) Test reports on non-destructive testing (Radiography, Ultrasonic inspection, wet MPI and etc).

c) Test certificates for each flow tee stating that it is capable of withstanding test pressure without leakage. This results in a hoop stress equivalent to 95% of the specified minimum yield strength for the pipe with which the flow tee is to be attached without impairing its serviceability.

d) Test reports on heat treatment carried out.

8.0 PAINTING, MARKING AND SHIPMENT.

8.1 Flow Tee surface shall be thoroughly cleaned, freed from rust and grease and applied with sufficient coats of corrosion resistant paint, after all the required tests have been performed and accepted by purchaser's representative. Surface preparation shall be carried out by shot blasting to SP-6 in accordance with "steel structures painting council - Visual standard SSPC-VIS-l."
Manufacturer shall indicate the type of corrosion resistant paint used, in the drawings submitted for approval.

8.2 Flow Tee shall be marked with indelible paint with the following data:-

a. Manufacturer's name
b. Suitable for- inch nominal diameter pipeline
c. End thickness in mm T1 X T2.
d. Material
e. Design Pressure
f. ANSI Class Rating
g. Tag No.
h. PO No.
i. Project Name

8.3 Flow Tee shall be suitably protected to avoid any damage during transit. Metallic bevel protectors shall be provided to weld ends.

8.4 Only those flow tee, which have been inspected and certified by Purchaser, shall be shipped.

9.0 DOCUMENTATION

9.1 All documents shall be in English Language.

9.2 At the time of bidding, Bidder shall submit the following documents:-

a) General arrangements drawing of flow tee along with cross sectional view, overall dimensions and details of insulating materials recommended.

b) Reference lists of previous supplies of flow tee of similar specification.

c) Clause wise list of deviation from this specification, if any.

d) Records of successful proof test for tees used for fabrication of flow tees, qualifying the range of sizes quoted.

e) Brief description of the manufacturing, heat treatment and quality control facilities of the Manufacturer's Works.

9.3 Within two weeks of placement of order, the Manufacturer shall submit four copies of but not limited to the following drawings, documents and specifications for approval.

a) Fabrication drawings and relevant calculations for pressure containing parts.

b) Calculations for the number of holes/slots size/flow area.

c) Method of manufacture, welding procedure and heat treatment details.

d) Quality Assurance Plan (QAP)

Once the approval has been given by purchaser any changes in design, material and method of manufacture shall be notified to the Purchaser whose approval in writing of all changes shall be obtained before the flow tee are manufactured.

9.4 Within four weeks from the approval date Manufacturer shall submit one reproducible and six copies of the approved drawings, documents and specifications as listed in 9.3 of this specification.

9.5 Prior to shipment, the manufacturer shall submit one reproducible and three copies of the test certificates as listed in Clause 7.0 of this specification.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR SPLIT TEE

GAIL-STD-PI-DOC-TS-013

0	12.01.19	Issue for Bid	AP	JR	SB	
Rev	**Date**	**Purpose**	**Prepared By**	**Checked By**	**Approved By**	

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1.0 SCOPE

This specification covers the basic requirements for the design, manufacture and supply of carbon steel split tees as hot tap material to be installed in pipeline system for handling hydrocarbons in liquid or gaseous phase.

2.0 REFERENCE DOCUMENTS

2.1 Reference has also been made in this specification to the latest edition of the following codes, standards and specifications:

a) ASME B 31.4: Liquid Transportation Systems for Hydrocarbons, Liquid Petroleum Gas, Anhydrous Ammonia and Alcohols.

b) ASME B 31.8: Gas Transmission and Distribution Piping System

c) ASME B 16.9: Factory made wrought steel butt-welding fittings.

d) ASME B 16.25: But Welding Ends

e) ASME Sec. VIII: Boiler & Pressure Vessels Code-Rules for the construction of Pressure vessels.

f) ASME Sec. IX : Boiler & Pressure Vessel Code-Welding & Brazing Qualifications.

g) ASTM A 370: Mechanical Testing of Steel Products

h) MSS-SP-53 : Quality Standard for Steel Castings and Forgings for Valves, Flanges and fittings and other Piping components and - Magnetic Particle Examination Method.

i) MSS-SP-75: Specification for High Test Wrought Butt Welding Fittings

j) API 1104: Specification for Welding Pipeline and Related Facilities

k) SSPC-VIS-1: Steel Structures Painting Council

2.2 In case of conflict between the requirements of this specification and any code, Standard and Specification referred in Clause 2.1 above. Order of precedence shall be as follows:
- Data Sheets
- This Specification
- Other Referred Codes & Standards
- Manufacturer's Standard.

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. These records shall be submitted at the time of bidding when specified in data sheet.

4.0 MATERIALS

4.1 The basic materials required for manufacturing of split tees have been indicated in the data sheet. Other additional materials required for manufacturing split tees shall be as per manufacturer's standard suitable for the service conditions indicated in data sheet and shall be subjected to approval by Purchaser.

4.2 Fully killed Carbon steel shall be used in the manufacture of split tees.

4.3 Each heat of steel used for the manufacture of pressure containing parts of the flow tees shall have carbon equivalent (CE) not greater than 0.45 calculated from the check analysis in accordance with the following formula.

$$CE = C + Mn/6 + (Cr+Mo+V)/5 + (Ni +Cu)/15$$

Carbon content on check analysis shall not exceed 0.22%.

4.4 When specified in Data sheet, Charpy V-notch test shall be conducted for each heat of steel used in manufacture of split tee. Test shall conform to the provisions of ASTM A-370 and at a temperature of 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 the plate or forging. The average impact energy values of three full sized specimens shall be 27 joules, unless indicated otherwise in the data sheets:

Minimum impact energy value of any one specimen of the three specimens analysed shall not be less than 80% of the average impact energy specified. No specimen shall exhibit less than 80% shear.

When Low Temperature Carbon Steel (LCTS) materials are specified in Datasheet or offered by Manufacturer, the Charpy V-notch test requirements of applicable material standard shall be complied with.

4.5 When specified in the data sheet, 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 HAZ of all pressure containing parts shall not exceed 248 HV10, unless otherwise specified.

5.0 DESIGN AND CONSTRUCTION REQUIREMENTS

5.1 Split tees shall be designed and manufactured in accordance with the provisions of codes and standards referred in Section 2.0 of this specification. Design factor and corrosion allowance indicated in data sheet shall be taken into account for design of split-tees.

5.2 Split tees shall meet following requirements as minimum:

a) Sleeves shall be designed to meet pressure & reinforce requirements of ASME Codes.
b) Fittings shall be manufactured with controlled carbon equivalent for its welding in harsh out side environments.

c) Split tee shall be of full branch or reducing branch & meet the requirement for fittings with hot tap machine.

5.3 Butt weld ends shall be beveled as per MSS-SP-75/ B16.25.

5.4 Split tees shall be manufactured by hot drawn, full branch/ reduced branch opening, snug-fitting sleeve or fabricated full size nipple, branch outlet welded to snug-fittings sleeve.

5.5 All welds shall be made by welders and welding procedures qualified in accordance with ASME Section-IX. The welding procedure qualification test shall include charpy impact test and hardness test and shall meet the requirements of clause 4.4 and 4.5 of this specification respectively.

5.6 Repair by welding on parent metal is not allowed. Repair of welds shall be carried out only after specific approval by Purchaser's Representative for each repair. The repair welding shall be carried out by the welders and welding procedures duly qualified as per ASME Section-IX and records for each repair shall be maintained.

6.0 INSPECTION AND TESTS

6.1 The manufacturer shall perform all inspections 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:

6.1.1 All split tees shall be visually inspected.

6.1.2 Dimensional checks shall be carried out as per the approved drawing.

6.1.3 Chemical composition and Mechanical properties shall be checked as per MSSSP-75 and this specification for each heat of steel used.

6.1.4 Non destructive examination of individual split tees shall be performed as given below:

a) 100% inspection by radiography shall be carried out on all pressure containing welds on fittings. Acceptance limits shall be as per API 1104.

b) Welds which in Purchaser's Representative's opinion 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.

c) All finished weld ends shall be 100% ultrasonically tested for lamination type defects for a distance of 50mm from the end. Any lamination larger than 6.35mm shall not be acceptable.

d) All forgings shall be wet magnetic particle examined on 100% of the forged surfaces. Method and acceptance shall comply with MSS-SP-53.

6.2 Purchaser's Representative shall also perform stage wise inspection and witness tests as indicated in clause 6.1 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 Purchaser's Representative.

Inspection and tests performed/ witnessed by Purchaser's Representative shall in no way relieve the Manufacturer's obligation to perform the required inspection and tests.

7.0 TEST CERTIFICATES

7.1 Manufacturer shall submit following certificates to Purchaser's Representative:

a) Test certificates relevant to the chemical analysis and mechanical properties of the materials used for construction as per this specification and relevant standards.

b) Test reports on radiographic and ultrasonic inspection and wet magnetic particle examination.

c) Certificates for each split tee stating that it is capable of withstanding without leakage for a test duration of 15 minutes and test pressure which results in a hoop stress equivalent to 95% of the specified minimum yield strength.

d) Test reports on heat treatment carried out.

8.0 PAINTING, MARKING AND SHIPMENT

8.1 Split tees entire surface shall be thoroughly cleaned, freed from rust and greaseand applied with sufficient coats of corrosion resistant paint, after all the required tests have been performed and accepted by Purchaser's Representative. The surface preparation shall be carried out by shot blasting to SP 6 in accordance with "Steel Structures Painting Council - Visual Standard -SSPC-VIS-1"

.

8.2 Manufacturer shall indicate the type & recommended coats of corrosion resistant paint used, in the drawing submitted for approval.

8.3 Split tees shall be marked with indelible paint with the following data:

a) Manufacturer's Name
b) Nominal diameter in mm D1 x D2
c) End thickness in mm T1 x T2
e) Material

8.4 Split tees shall be suitably protected to avoid any damage during transit. Metallic or high impact plastic bevel protectors shall be provided for weld ends.

9.0 WARRANTY

Purchaser will be reimbursed by Manufacturer for any Split tee furnished to this specification which fails under field hydrostatic testing and if such failure or non-performance is caused by a defect in the Split tees which is outside the acceptance limits of this specification. The reimbursement cost shall include cost of Split tee, labour and equipment rental for finding, excavating, cutting, and installation of replaced Split tee in position.

10.0 DOCUMENTATION

10.1 At the time of bidding, bidder shall submit the following documents: -

a) General arrangement drawing of split tees with overall dimensions and cross sectional drawings.

b) Reference list of previous supplies of split tees of similar specification

With relevant details viz Project, Year of supply, Client, size, Rating and service for the last five years.

c) Clause wise list of deviation from this specification, if any.

d) Records of successful proof test for tees qualifying the range of sizes quoted.

e) Brief description of the manufacturing, heat treatment and quality control facilities of the manufacturer's work.

f) Quality Assurance Plan (QAP) enclosed with this tender duly signed, stamped and accepted.

10.2 Within two weeks of placement of order, the manufacturer shall submit four copies, of but not limited to, the following drawings, documents and specifications for approval.

a) Fabrication drawings and relevant calculations for pressure containing parts.
b) Calculation for fittings thickness.
c) Method of manufacture, welding procedure and heat treatment details.
d) Quality control Manual.

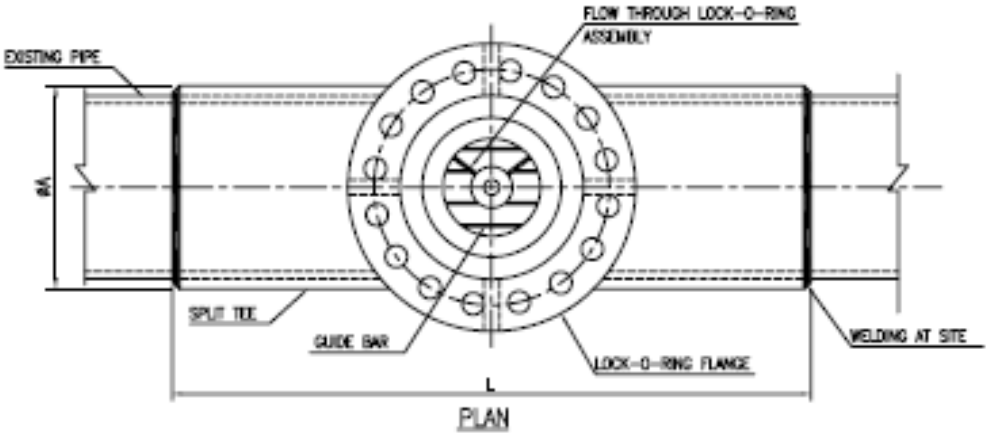
Once the approval has been given by Purchaser, any change in design, material method of manufacture shall be notified to Purchaser whose approval in writing of all changes shall be obtained before the Split tees are manufactured.

10.3 Within four weeks from the approval date Manufacturer shall submit one reproducible and six copies of the approved drawings, documents and specification as stated in clause 10.3 of this specification.

10.4 Prior to shipment, Manufacturer shall submit one reproducible and six copies of test certificates as listed in clause 7.0 of this specification.

10.5 All documents shall be in English Language.

ATTACHMENT



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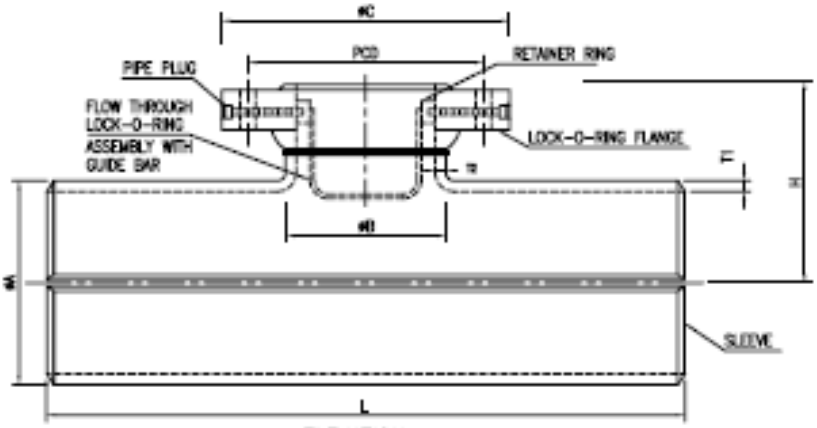

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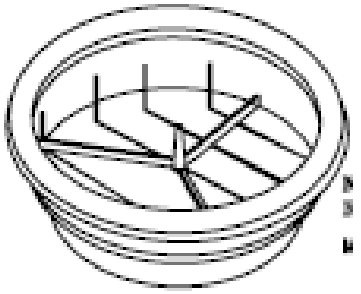

FLOW THROUGH LOCK-O-RING
ASSEMBLY WITH GUIDE BAR

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECNICAL SPECIFICATION FOR
CLEAN AGENT SYSTEM IC-SPE-101

GAIL-STD-PI-DOC-TS-014

0	16.01.19	Issued For Bid	AP	JR	SB	
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1.0 SCOPE OF WORK

This specification covers the requirements of design, supply of materials, installation, testing and commissioning of total flooding centralised Clean Agent System (clean agents to be considered are : IG-541, IG-55, IG-01 and IG-100 as per NFPA-2001) for fire protection of Control Room building mentioned in this specification.

The work shall include electrically actuated automatic Clean Agent Fire Extinguishing System complete with clean agent cylinders, manifolds, pressure reducing devices, cylinder valves, directional valves, pipes, discharge nozzles, brackets supports, hangers and such other fittings as necessary for complete installation of the system including chipping of existing RCC/brick walls of control room buildings, fixing fasteners, etc. The system shall also comprise of both Automatic and Manual actuation, cancellation facility etc. with necessary control panel. Complete Fire Detection and alarm system is in the scope of this requisition. The clean agent shall be discharged/actuated automatically after a adjustable time delay based on the detection signal received. The delay shall be maximum 180 seconds, however it shall be adjustable from 0 to 180 seconds.

It may be noted that clean agent system to be provided shall meet the requirements of NFPA-2001 (Latest). Hence any thing specified as "mandatory" in NFPA-2001, although not specifically mentioned in this specification, shall form part of this specification and scope of work for the job to be executed

2.0 CODES AND STANDARDS

NFPA 2001	:	Standard on Clean agent Fire Extinguishing System, 2004 Edition
BS-5445,5446,5839	:	For Detectors
SMPV Rules,1981,CCE Nagpur	:	For Storage Containers

Clean Agent Manufacturer's Recommendations.

Tariff advisory Committee (TAC) Rules

3.0 DESIGN REQUIREMENTS

Vendor shall design the system to meet the minimum requirements of total flooding fire extinguishing clean agent system as per NFPA-2001 and having design concentration as specified at 70_F(21 _C).

The system design shall be centralized and shall protect other risk as defined in the requirements and scope of work of the project.

3.1 SYSTEM DESIGN

The centralised system of a station shall be designed to protect any of the risk(volume wise) in a particular room of a building as defined in Annexure-I to this specification.

The quantity of Clean Agent gas provided shall be sufficient to protect the single largest risk in each building with 100% standby filled up cylinders. The system shall have its own storage, distribution piping, nozzles, alarm, and actuation system, etc.

Both primary and standby supply shall be permanently connected to the distribution piping through manifold and arranged for easy and auto changeover.

As the system is designed for the largest risk and there are several risks varying in size in particular building, the system shall permit use of required no. of cylinders for any individual risk involved so that the concentration of gas in that risk does not exceed the design concentration specified in the table below.

Properties Of Inert Gas Agents Used As Fire Extinguishing Agent

Name	Formula	Noael (%)	Loael (%)	Normal charging pressure	Min. Design pressure at 130°f	Extinguishing concentration	
						%age	M^3/m^3 of vol.
IG-541	N_2 -52% Ar -40% CO_2 -8%	43	52	2175 psi	2575 psi	37.5	0.470
IG-55	N_2 -50% Ar -50%	43	52	2222 psi	2475 psi	37.5 (*)	0.470 (*)
IG-01	Ar -99.9%	43	52	2371 psi	2650 psi	37.5 (*)	0.470 (*)
IG-100	N_2 -99.9%	43	52	2404 psi	2404 psi	37.5 (*)	0.470 (*)

Note:- Any other agent complying with provisions of NFPA-2001 Latest Editions, may be added to list

NOAEL: No Observable Adverse Effect Level, the highest concentration at which no adverse physiological or toxicological effect has been observed.

LOAEL: Lowest Observable Adverse Effect Level, the lowest concentration at which an adverse physiological or toxicological effect has been observed.

(*) Or higher %/quantity of volume as specified by clean agent manufacturer for clean agent system.

IG-541, 55, 01 and 100 are called as inert gas as per NFPA-2001.

The agent discharge shall be substantially completed in a nominal 60 seconds for IG-541, 55, 01 and 100, or a shorter time .The measured discharge time is considered to be the time when the measuring device starts to record reduction of oxygen untill the design oxygen reduction level is achieved.

The min. Oxygen concentration shall be maintained after release of clean agent (IG) as 16%.

3.2 SYSTEM FLOW CALCULATIONS

System flow calculations shall be performed using A CALCULATION METHOD LISTED OR APPROVED BY THE AUTHORITY HAVING JURISDICTION (e.g. FM/UL/LPC/VDS) and TAC. The system design shall be within the manufacturers listed limitations. System design including computerized flow calculations, piping & storage layout of Clean Agent System shall be submitted along with the technical bids.

3.3 CLEAN AGENT QUANTITY

Minimum design concentration of Clean Agent gas shall be 37.5%(min) for IG-541,55, 01 and 100 at $70^{O}F$ by volume unless otherwise specified by the agent manufacturer for clean agent fire extinguishing system.

Clean Agent concentration requirement shall be computed considering the volume of the hazard as specified.

The quantity of Clean Agent shall be worked out by the bidder, as per NFPA-2001 and in the Performa given in Annexure-I, however vendor shall quote minimum quantity of agent as given in the Annexure-I.

3.4 CLEAN AGENT STORAGE CYLINDERS

The Clean Agent storage cylinders shall be designed to hold clean agent at ambient temperatures. Container shall be of approved type and freshly imported. Minimum container design level working pressure of storage container shall be as per clause 2.1.4 and table A-2-1.4.1 of Appendix-A to NFPA-2001. The containers shall not be charged to a fill density or superpressurisation (superpressurisation means the addition of a gas to fire suppression agent container necessary to achieve the pressure required for proper system operation) level different from manufacturer's listing.

The vendor shall select the capacity of cylinder as follows:

IG-01, 55, 541and 100 435 cu.ft

The vendor shall standardized the capacity of cylinder for better replacement & inter changeability.

The design pressure for cylinders shall be suitable for the maximum pressure developed at 130_ F (55_C) at the max. controlled temperature limit.

Each container shall have a permanent name plate specifying the agent, tare and gross weight in addition to the pressurization level, and nominal agent volume.

All clean agent cylinders shall be seamless and bear the mark of manufacturer, serial number and shall be duly listed by a competent approval authority of country of origin (FM/UL/VDS/LPC) in addition to approval by CCE Nagpur (India). Cylinders without the approval will not be accepted. A reliable means of indication, other than weighing shall be provided to determine the pressure in refillable containers.

Each container shall have pressure relief valve to protect the cylinders against excess pressure conditions.

Clean Agent containers shall be arranged in the following manner:

i) In a battery of cylinders manifolded together and leading to common distribution pipe and discharge nozzles for the risk to be protected including below floor board and above false ceiling spaces.

ii) A reserve battery of cylinders with manifold, directional valve and automatic change over to any of the two banks after actuation shall be provided. The reserve of standby Clean Agent battery shall be 100% of the quantity required for the single largest risk as per scope of work.

Automatic means such as check valve shall be provided to prevent agent loss if the system is operated when any containers are removed for maintenance.

The manifolded containers referred to above shall be securely mounted on the floor and suitably supported in a rack with provision for convenient individual servicing and content weighing according to the manufacturers installation manual. Such servicing or weighing shall be possible without shutting down the system.

A space marked as cylinder shed on the drawing be made available to the contractor for placing Clean Agent cylinders. Vendors shall confirm the adequacy of space provided for storage of Gas cylinders.

3.5 PIPING, FITTINGS AND DISCHARGE NOZZLES

CLEAN AGENT NAME	PRESSURE U/S OF PR/PIPE CLASS	PRESSURE D/S OF PR/PIPE CLASS	FITTINGS U/S OF PR	FITTINGS D/S OF PR
IG-541,55,01 & 100	2650 PSIG/ASTM A-106,GR C SEAMLESS,WLD	1000 PSIG/ASTM A-106,GR C SEAMLESS,WLD	AS PER TABLE A-2.2.3.1 OF NFPA	AS PER TABLE A-2.2.3.1 OF NFPA

The pressure reduction device shall be easily identifiable.

Discharge nozzles shall conform to cl.2.2.5 of NFPA. Discharge nozzles used in this system shall be listed for the use intended for discharge characteristics. The selection of nozzle orifice shall be such that the 95% of IGs is discharged within 60 seconds through the number of nozzles of the system. Each nozzle shall be permanently marked to identify by the part number, orifice code, or other suitable marking as specified by the authority having jurisdiction.

The vender to note that the clean agent piping to be laid in existing building, hence the clean agent piping and nozzles etc. shall have to be planned clearing other facilities coming in the areas where clean agent protection is being envisaged. The different items that are to be provided for efficient functioning of the automatic clean agent system have been indicated but not the quantity of any of them, which has to be worked out by the contractor.

The clean agent piping shall have to clear:

i) The beams and ribs which criss cross the ceiling.

ii) Path of AC ducts.

iii) Cabling in false flooring.

The vendor shall have to lay the clean agent piping in existing building. All necessary civil works including breaking the brick walls and making them good shall be in the scope of work.

3.6 DETECTION, ACTUATION AND ALARM SYSTEM

Fire detection, actuation and alarm system for the system shall be as per NFPA-2001 latest revision.

There shall alarm in clean agent local control panel at the time of gas release.

3.7 PAINTING

Painting and colouring of pipelines, nozzles, clean agent storage containers, supports, etc. shall be done as per Specification O-611.

3.8 OPERATING DEVICES

a) Operating devices shall include clean agent releasing devices or valves, discharge controls, and shut down equipment necessary for successful performance of the system.

b) Electric Supply: The vendor shall provide 100 V $\pm$ 6% @ 50 Hz $\pm$ 3%, 3 phase power supply at a convenient point. Convertor required to convert 24V shall be in vendor's scope.

c) Electric Supply: The vendor shall provide 100 V $\pm$ 6% @ 50 Hz $\pm$ 3%, 3 phase power supply at a convenient point. Convertor required to convert 24V shall be in vendor's scope.

d) The clean agent cylinders shall be mounted on front and firmly supported in brackets in a manner that they will not be easily subjected to mechanical chemical or other damage, which would render the system in-operative.

e) In addition to Automatic actuation, there shall be a normal manual control for actuation, which shall be located so as to be conveniently and easily accessible at all times including the time of fire. This control shall cause the complete system to operate in its normal fashion.

f) Manual controls shall not require a pull of more than 40 lb nor a movement of more than 14 inches to secure operation. At least one manual control for activation shall be located not more than 4 feet above the floor.

g) i) A signal shall be provided from the clean agent control panel to shut off the air handling unit and air conditioning dampers/louvers.

ii) Supervision of automatic systems shall be provided and shall include electrical supervisions of the actuating device and the wiring connecting the actuation device and the detection system.

h) Operating instructions shall be displayed on a name plate fitted permanently on the clean agent skid.

i) Clean agent extinguishing system shall incorporate a pre-discharge alarm with a time delay sufficient to allow personnel evacuation prior to discharge.

3.9 LOCAL CONTROL PANEL FOR CLEAN AGENT SYSTEM

The system shall have a main control console and shall consist of:

I) Two alarms and one fault indicator lamp for each zone to be protected.

II) Combination of alarm silence and alarm off switch.

III) Combination of fault silence and trouble lamp switches.

IV) Alarm test switch

V) Alarm re-set switch

a. The installation shall have arrangement to indicate by alarm as well as indication about actuation of the system, hazard to personnel of failure of any supervised system. The extent and type of alarms or indicators equipment shall be to the satisfaction of the Engineer-in-Charge.

b. The system shall have a positive warning device by sounding alarm to alert personnel of the impending discharging and also a positive indication to show that the system has actuated.

c. Alarm indicating failure of supervised devices of equipment shall give prompt and positive indication of any failure and shall be distinctive from alarm indicating operation of hazardous conditions.

d. Warning and instruction signs at entrance to and inside protection areas shall be provided.

The following additional provisions shall be made in the main control panel:

a. Automatic shut off of the Air conditioning dampers/louvers by solenoid damper closing unit or electrically operated damper motor. Only signal to be provided from clean agent system control panel. Rest of the job shall be done by others.

b. Automatic shut off of the air-handling units.

4.0 MATERIALS OF CONSTRUCTION

The materials of construction used in the system shall be in accordance with NFPA-2001 or as specified by the equipment manufacturer for the intended use. (if the same is not specified in NFPA-2001).

5.0 INSPECTION AND TESTING

Approval Of Installation

The completed system shall be tested to meet the approval of Owner. The entire clean agent system shall be TAC (Tariff Advisory Committee, India) approved & vendor to obtain the same. Only listed or approved equipment and devices shall be used in the systems. All critical equipments such as cylinders, cylinder valves, directional valves, pressure reducers, nozzles, actuatation controls, pressure gauges etc. shall have listings (FM/UL/Vds/LPC) To determine that the system has been properly installed and will function as specified, the following tests shall be performed:

a. A thorough visual inspection of the installed system and hazard area. The piping, operational equipment and discharge nozzles shall be inspected for proper size and location. The locations of alarms and manual emergency releases shall be confirmed. The configurations of the hazard shall be compared, to the original hazard specification. The hazard shall be inspected closely for un-closable openings and sources of agent loss, which may have been overlooked in the original specifications.

b. A check of labeling of devices for proper designations and instructions. Nameplate data on the storage containers shall be compared to specifications.

c. A test for mechanical tightness of the piping and associated equipment to assure that leakage will not occur and that there will be no hazardous pipe movements during discharge.

d. Non-destructive operational tests on all devices necessary for proper functioning of the system.

Vendor shall provide suitable safety measures against increase in pressure inside the protected area due to release of clean agent.

6.0 VENDOR DATA REQUIREMENTS

6.1 ALONG WITH THE TECHNICAL BIDS

- List of clause wise deviations, if any, to the specifications. It will be vendor's responsibility to furnish the deviations. If the same are not furnished it will be assumed that the offered equipments meet the specifications of the enquiry document in toto.
- System design including computerised system flow calculations, piping & storage layout.
- Indian/International standards to which the offered equipments conform.
- Catalogues/Brochures giving technical particulars and details of operation/maintenance of the offered elements/system.
- Certificates of agencies who have accorded approval for the elements offered.
- Numbers & placement / Area coverage for type of nozzles used.
- Quantity of each type of equipment offered along with the calculations.
- Protected room/area layouts.
- Quantity of clean agent offered for various areas as per specifications.

- PFD, P&ID and GA drawing.

6.2 AFTER AWARD OF THE CONTRACT

- Calculations for pipe sizes, time of discharge, flow, nozzle rate of discharge etc.
- GA and dimensional drawings of the areas showing storage, piping and nozzles for various areas.
- Mounting/fixing details of all the elements
- Testing and inspection schedule and procedure.
- Cylinders data sheets.
- Other data sheets as per the list attached.
- If the vendor is collaborating with any foreign party for basic engineering, design etc., he should provide certificate of collaboration and first submission of design and detailed drawing shall be approved by the collaborator.
- List of drawings.

7.0 MANDATORY SPARES

The bid must include in the quoted price the following mandatory spares to be supplied with the clean agent system:

1. Clean Agent Cylinders for Centralised System	:	5% of the total cylinder (filled).
2. Automatic and Manual release system	:	One of each type/size used in the system supplied
3. Cylinder Valve with safety pressure relief device	:	One of each type/size used in the systems supplied.
4. Clean Agent Nozzles	:	10% of total nozzles used in each size/type.
5. Clean Agent Release Push Buttons	:	10% of total used of each type etc.

Recommended Spares:

In addition to above mandatory spares, vendor must recommend list of spares required for 2 years trouble free operation with unit rates and quantity along with the offer.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECNICAL SPECIFICATION FOR CO_2 TYPE EXTINGUISHER

GAIL-STD-PI-DOC-TS-015

0	20.01.19	Issued For Bid	AP	JR	SB	
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ABBREVIATIONS:

kg	:	Kilogram
IS	:	Indian Standard
M.S.	:	Mild Steel

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1. SCOPE

This standard lays down requirements regarding material, shape, construction, method of operation performance and tests of portable fire extinguisher of carbon dioxide type. The extinguisher shall be supplied along with CO_2 gas duly charged.

2. REFERENCES

IS: 2878
& IS:
307

3. MATERIAL, SHAPE, CONSTRUCTION, METHOD OF OPERATION, PERFORMANCE, CONTENTS AND TESTS

3.1 The material, shape, construction, method of operation, performance and test shall comply with IS: 2878.

3.2 Nominal size.

3.2.1 The extinguisher shall be of following nominal sizes in kg: 2, 3 and 5.0 for portable type and 7, 9 and 22.5 for trolley mounted.

3.3 Contents

3.3.1 Carbon dioxide gas used shall conform to IS: 307 and extinguisher shall be filled as per Clause no.4.0 of IS: 2878.

4. APPROVALS

A clearance/ approval certificate for filling the extinguisher from "Chief Controller Explosive" Govt. of India, Nagpur shall be submitted for each cylinder.

5. MARKING

Each extinguisher shall be clearly and permanently marked as per IS: 2878 along with IS: certification mark and purchaser's name

6. ACCESSORIES

Each extinguisher shall be supplied with M.S. bracket, wood screws and spanner as may be necessary. The details of the bracket shall be submitted with the offer.

7. INSPECTION

Authorized representative shall have access at all reasonable time to the manufacturer's works where extinguishers ordered are being manufactured and or tested.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECNICAL SPECIFICATION FOR FIXED CO_2 FIRE EXTINGUISHER SYSTEM

GAIL-STD-PI-DOC-TS-016

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Abbreviations:

AC	Alternating Current
Ah	Ampere Hour
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials Carbon Dioxide
CCOE	Chief Controller of Explosives
DC	Direct Current
F&G	Fire And Gas
PM	Factory Mutual
IS	Indian Standard
LPC	Loss Prevention Council
NFPA	National Fire Protection Association
PESO	Petroleum Explosive Safety Organisation (Formerly known as CCOE)
Psi	Pounds per Square Inch
RCC	Reinforced Cement Concrete
SMPV	Static and Mobile Pressure Vessels
TAC	Tariff Advisory Committee
UL	Underwriters Laboratory
VdS	Verband der Sachversicherer

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1.0 SCOPE

This specification covers the general description, material of construction and test for the fixed type auto actuated carbon dioxide fire extinguishing system.

2.0 REFERENCE CODE

NFPA 12	Carbon Dioxide Extinguishing System
SMPV (Unfired)	Rules by PESO (Formerly known as CCOE)

3.0 GENERAL DESCRIPTION OF SYSTEM

3.1 The CO_2 system shall be designed and supplied strictly as per the requirements of NFPA-12 and having design concentration as per NFPA-12 for the single largest risk area to be protected and the criteria given herein below:

3.2 The system shall be a high pressure (850psi) and shall be such that it is a. Extremely quick in action
b. Non-poisonous
c. Non-corrosive, non-damaging and non-deteriorating d. Safe and Clean

3.3 Fire shall be extinguished by the total flooding of the space with CO_2 gas to render. the atmosphere inert and non-supporting to combustion.

3.4 CO_2 gas cylinder's capacity provided shall be sufficient to discharge CO_2 gas, equivalent to 50 per cent of the cubical content of the space involved, depending on the floor area of the enclosure. Consideration of extra requirement due to opening in the enclosure shall also be given.

3.5 System operation shall be by listed or approved mechanical, electrical or pneumatic means as per NFPA-12. Where multiple cylinders are required for one hazard area. a common manifold shall be used. Each cylinder shall discharge through the manifold through common piping and discharge nozzles. All cylinders supplying a common manifold shall be interchangeable and of one standard size. Two (2) cylinders in each bank shall be provided with control heads if a total of 3 or more cylinders are required. Where pilot cylinder is used, actuation of the control heads on the "pilot" cylinders shall pneumatically actuate the remaining cylinders.

3.6 A 100% reserve supply equal to primary supply shall be provided. It shall provide protection during the period the main supply is out of service for re-charge.

3.7 Hydraulic calculations for each system shall be based upon two-phase flow equations for unbalanced piping systems with regardless if a single nozzle or balanced piping network is used. A complete set of hydraulic calculations shall be submitted for each carbon dioxide system:

3.8 The Manual Release Station (MRS) and Manual Release Inhibit station (MRD shall be located at major points of egress. In addition auto/manual selector switch shall also be provided. The MRS shall provide a means of manually discharging the automatic fire extinguishing system when used in conjunction with the control panel. The MRS switch shall be of the "dual-action" type, to prevent accidental operation. The switch shall remain in the operated position until reset by means of a key. Supervision of automatic systems and Lock- out valves shall be provided as per NFPA requirements.

3.9 The 'system shall be auto actuated through fire detection system. As a safety measure a time delay relay unit shall be provided. On detection of fire an audible alarm shall sound & CO_2 discharge shall take' place after some time to' allow' for any' personnel in the building to evacuate. A manual change over switch shall be provided at entry point of building allowing the system to be put in manual mode at any point of time for prolonged human entry.

3.10 Pre-discharge alarms and electrical/mechanical discharge delays shall be provided, These shall *be* of sufficient duration to warn personnel of an impending discharge of carbon dioxide and allow for hazard area evacuation and preparation, Warning signs shall be provided at each entrance to the hazard area.

3.11 The design shall be in accordance with, the requirements of NFPA-12. The duration of discharge and minimum liquid discharge time shall be as per NFPA-12. The discharge period shall be lengthened as appropriate by considerations such as deep-seated type fires.

3.12 Upon entering the alarm mode, audible indication shall be supplied by the steady sounding of an alarm electronic sounder. This unit shall be polarized for full supervision and shall be UL listed, It shall have an output of 86-90 DBA at 24V DC. The sounder shall be provided with a red finish. All field wiring connections shall be made to terminal strips or wire leads on the device.

3.13 All the mandatory requirements of NFFA-12 shall be fully complied.

3.14 The vendor shall fill the required data in the Technical data sheet (Annexure- 1)

4.0 SYSTEM COMPONENTS AND HARDWARES

4.1 All the system components used in the system shall be in accordance with NFPA-12. Only listed new materials and devices shall be installed. All components shall be UL Listed and/or PM Approved as compatible components of a carbon dioxide system. The system components are cylinder and its assembly with automatic weighing system, valves, nozzles, pipes and fittings, guards, etc.

i) Cylinder

- Cylinder shall be fabricated, tested, and marked in accordance with applicable Department of Transportation (DOT) and U.S. Bureau of Explosives specifications. The cylinders shall be equipped with differential pressure valves. No replacement parts shall be necessary to recharge the Carbon Dioxide containers
- Cylinder filling density for high pressure system shall be as per NFP A:12.
- Cylinder shall be shipped with maintenance record card and shipping cap attached.
- Cylinder shall have serial number, along, with the full and empty, weight capacities, stamped near neck of cylinder.

ii) Cylinder Assembly

- Carbon Dioxide storage cylinders shall be provided with a safety rupture disc. An increase in internal pressure due to high temperature shall rupture the safety disc and allow the contents to vent before the rupture pressure of the container is reached. The contents shall not be vented through 'the discharge piping and nozzles. .

- Cylinder valve shall contain safety pressure relief device shall be provided as per NFPA-12.

- For system installations consisting of 3 or more cylinders, a framing arrangement for supporting the cylinders and manifold shall be provided.

- Automatic weighing system to indicate weight loss in each cylinder bank shall be provided. The system shall be UL listed IFM approved.

- Operation devices shall be listed or approved electrical or pneumatic means as per NFPA-12. Each Carbon Dioxide system shall utilize a solenoid operated releasing device (control head) which causes discharge of all storage containers in the system. Each releasing device shall be separately series supervised and operated directly from the control panel.

- The releasing device (control head) shall be easily removable from the cylinder without' emptying the cylinder. While removed from cylinder, the releasing device shall be capable of being operated, with no replacement of parts required after operation.

- The releasing device shall also be capable of direct mechanical actuation, providing a means of discharge in the event of total electrical malfunction. The device shall be provided with a manual lever and a faceplate with clear instructions on how to mechanically activate the system.

- The storage cylinders shall be located in the building. iii) Distribution piping for high pressure system

- All Pipe fittings and valve shall be provided and installed per NFPA-12 requirements.

iv) Discharge Nozzles

- Nozzles shall be listed and approved type design as required by the type of hazard being protected and shall provide flow rates in accordance with system design hydraulics. Nozzle spacing shall be in accordance with the listed or approved coverage for each nozzle type.

v) Electric Actuator

- Electrical actuation of agent cylinder to be accomplished by an electric actuator/solenoid valve interfaced through F&G panel.

vi) Manual /Pneumatic Actuator

- Manual Pneumatic Actuator shall be provided for manual/pneumatic on the actuator.
  Pneumatic actuation shall be accomplished by a remote pressure device UL listed IFM approved. It shall consist of a nitrogen cylinder mounted at the entrance of each protected area. Pneumatic tubing shall be connected up to the cylinder actuator valve.

vii) Supports and Hangers

- The supports and hangers shall be of a reputed make and subject to Company approval. However listed supports and hangers are acceptable.

4.2 All pipe work shall be identified / banded at a minimum of 3 m and where it passes through the wall.

4.3 The laying of fittings at branch connection or other fixed point of the system shall be such, as to allow provision of movement without causing undue stress on the pipe work. Pipe work shall, be arranged to reduce the strain due to expansion on all equipment.

4.4 All sleeves shall be built into the structure by the contractor in such a manner as to maintain the integrity of the structure and the fire barriers. Non-combustible matter shall be used for sealing the opening.

5.0 CHARACTERISTICS OFFIXED INSTALLATION

5.1 The time to reach the specific concentration of CO_2 shall be dearly mentioned. The system shall be interlocked with the air conditioning / ventilation system wherever applicable. In case of CO_2 injection into the rooms, the relevant air-handling units shall be automatically shut off.

5.2 The distribution piping shall have to clear the RCC beams and ribs which criss-cross the ceiling, path of air ducts and electrical conduits. All supports, hangers and clips etc. required for supporting the distribution piping cylinders, manifolds etc. shall also be supplied with the system.

6.0 CHARGING

Each CO~ cylinder shall be equipped with a valve permitting refilling of cylinder. The cylinder shall be sealed with a puncturable diaphragm and shall be provided with a safety pressure relief for abnormal pressure formation. .

7.0 DISCHARGE HEADS

Each cylinder of CO2 battery shall be equipped with a discharge head for automatic piercing of the sealing diaphragm. One or two cylinders in the multiple cylinder discharge group shall have discharge heads operated directly from the control panel and the others shall be operable by the-gas-pressure discharged from the first one or two.

8.0 MANIFOLDS WITH CONNECTIONS TO DISCHARGE HEADS

The pressure manifold shall be designed in such a way that it shall collect the gas from all the cylinders and discharge collected quantities of the gas in the main manifold which shall be connected with the discharge of outlets in the rooms.

9.0 CO_2 SYSTEM CONTROL PANEL

9.1 The control panels shall be located in building/shed and shall be wall mounted type. The control panels shall be provided for .manual actuation and shall be designed to accommodate relays, auxiliary switches, pilot and signal lamps. The control panels shall be also be provided with the facility of audio alarm and on receipt of fire alarm signal from fire alarm panel, audio· alarm shall be initiated' from CO2 control panel with necessary signal' to
.shut off air conditioning / ventilations system, if any. Manual push button for discharge of
CO2, in each protected area (after audit alarm and 30 seconds time delay) shall be provided near exit of the room.

9.2 Sign boards, caution boards, illumination board, alarm, given as per requirements of NFPA-
12 shall be provided in and around building protected with CO_2 system.

10.0 MATERIAL SPECIFICATIONS

Material for cylinder body, valve, cylinder body nozzles, spray nozzles, piping and CO_2 gas quality shall conform to NFPA-12.

11.0 STATUTORY APPROVAL

Approval from PESO (formerly known as CCOE) for cylinders along with cylinder valve assemblies & for handling, storage, disposal of CO_2 shall be taken by contractor.

12.0 INSPECTION TESTING AND APPROVAL OF INSTALLATION

12.1 The completed system shall be inspected arid tested to meet the approval of Owner. Only listed or approved equipment and devices shall be used in the systems. All critical equipment's such as cylinder, cylinder assembly, valves, nozzles, etc. shall have FM/UL marking and listings and shall be from one source. To determine that the system has been properly installed and will function as specified, all the requirements of NFP A-12 shall be complied with.

12.2 Tests shall demonstrate that the entire system functions as intended. All circuits shall be tested: Automatic discharge, manual discharge and equipment shutdown and alarm devices. In addition to that supervision of each circuit shall be tested.

12.3 All test procedures and discharge tests shall be performed in accordance to NFPA-12. Tests shall be conducted by the contractor, equipment manufacturer, or equipment manufacturer's representative in the presence of the Owner's representative. .Such tests shall be made only after the control system has tested satisfactorily. Carbon Dioxide shall be used as the test agent. Contractor shall include the price of full discharge test for each location in his quoted price.

12.4 Test containers shall be filled to the designed weight. The amount of gas shall be certified by the contractor.

12.5 The contractor shall provide all necessary test apparatus and instrumentation including gas to be expended.

12.6 Gas analysers capable of automatically monitoring three (3) sampling points simultaneously shall be provided. Concentration measurements shall be recorded

every 5 seconds on separate strip charts. Sampling probes shall be placed at 3 different heights in different sections of the protected area. In no case will a probe be placed higher than the highest anticipated combustible hazard.

12.7 The contractor shall correct all defects and make additional tests, at no cost to owner, until the system complies with all contract requirements.

12.8 Upon acceptance by the Owner, the complete system shall be reconditioned containers refilled and/or replaced, and the system placed in operation.

12.9 As a condition of final acceptance, the contractor shall provide operational training to the Owner's personnel. The training sessions shall include emergency procedures, system control panel operation, trouble procedures, and safety requirements.

12.10 System shall be warranted for parts and labor for not less than a period of one (1) year from date of installation. Contractor shall specify the maintenance to be performed during the warranty period to maintain warranty conditions.

12.11 All material test certificates and inspection release notes shall be submitted before dispatch of the system. ·

12.12 Contractor to note that acceptance of any equipment or system during factory acceptance test shall in no way absolve the vendor of their responsibility for the performance of the system.

12.13 It shall be Contractor's responsibility to modify and/or replace the hardware if the specified functions are not achieved during testing and factory acceptance.

13.0 PAINTING AND MARKING

Painting of piping, nozzles, C02 cylinders·, supports, etc. shall be done as per standard practice including supply of all paints and consumables and other. items required for carrying out painting.
Each cylinder shall be clearly and permanently marked with the following information:

a. Manufacturer's name and trade mark.
b. Year of manufacture.
c. Marking as
per code

14.0 SPARES

14.1 The bid must include in the quoted price, the mandatory spares to be supplied with the CO_2 system.

14.2 In addition to the above spares, vendor shall also furnish the list of spares required for two years trouble free operation with unit rates and quantity along with the offer.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR INSULATING GASKET

GAIL-STD-PI-DOC-TS-017

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1. INTRODUCTION

This present document covers the technical specification for the procurement of Insulating Gaskets used inhigh pressure natural gas transmission systems. It describes the general requirements, controls, tests,QA/QC examination and final acceptance criteria which need to be fulfilled.

2. DEFINITIONS

Client / Owner	Shall mean GAIL India Limited
Manufacturer	Means the Manufacturer of the Insulating Joint.
EPC Contractor / Contractor	The party which carries out all or part of Engineering, Procurement, Construction, Pre-commissioning & Commissioningof the project. It shall mean EPC Contractor in the present context.
Third Party Inspection Agency(TPIA)	Means the Inspection Agency to be appointed by the EPC contractor
Consultant / OwnerRepresentative	Lyons Engineering Pvt. Ltd. (LEPL)

3. TECHNICAL SPECIFICATION

3.1 The material of insulating gasket kit shall be as follows:

I. Insulating Gaskets: It shall be machined glass reinforced epoxy (GRE) resin (G 10 or G11) with O-ringor spring energised seal made from rubber/PTFE.
II. Insulating Washer: - Material shall be GRE.
III. Insulating sleeve: - Material shall be GRE. Insulating length shall be two flange thicknessincluding raised face, plus gasket, plus two insulating washers, plus one steel washer.
IV. Steel machine cut washer: - It shall be zinc plated steel.

3.2 One Insulating Gasket kit shall consist of one no. central insulating gasket, one no. insulating sleeve per bolt, two nos. insulating washer per bolt and two nos. metallic washer per bolt.

3.3 Manufacturer shall guarantee that Insulating Gasket shall with stand test pressure equal to 1.5 times designpressure of Pipeline.

3.4 The dimensions of the gaskets shall be suitable for WNRF flange as per ASME B 16.5

3.5 The Insulating gaskets is required for 600# ratings.

3.6 The minimum thickness of insulating gasket shall be 3 mm.

3.7 Insulating gaskets shall have bolt holes punched out.

3.8 Asbestos shall not be used.

3.9 The insulating gaskets shall match flanges (Weld neck raised face & Blind face) to ASME 16.5

3.10 Packing size of Insulating Gaskets Kit to be mentioned to ensure uniformity in delivery conditions of the material being procured. Bidder shall submit the packaging details during offer and also complied with atthe time of delivery.

3.11 Following electrical properties:

- Dielectric Strength (min.) = 550 VPM
- Electrical Resistance = 25 Mega Ohm

(When tested with 500-1000V DC megger).

3.12 Each kit shall be clearly marked with the size, rating, material specification etc.

3.13 Inspection shall be carried out as per Technical Specification.

Owner Representative or Third Party Inspection Agency appointed by Supplier shall carry out stage wise inspection during manufacturing / final inspection.

Vendor shall furnish all the material test certificates, proof of approval / licence from specified authority asper specified standard, if relevant, internal test / inspection reports as per Owner Tech. Spec. & specifiedcode for 100% material, at the time of final inspection of each supply lot of material.

4. INSPECTION AND TESTING

The manufacturer shall perform all inspections and tests as per the requirements of this specification and theapplicable codes at his works prior to shipment. Such inspections and tests shall be, but not be limited to thefollowing:

4.1 All the insulating gasket assemblies shall be visually inspected.

4.2 Insulating flange assembly shall be hydrostatically tested to a pressure equal to 1.5 times design Pressure infollowing manner;

- 5 minutes at a hydrotest pressure.
- Reduce to Zero.
- Repeat the above procedure twice

4.3 Insulating flange assembly shall be tested with air at 5 kg/cm2 for 10 minutes. The tightness shall be checked by immersion or with a frothing agent. No leakage shallbe accepted.

4.4 Dimensional checks shall be carried out as per Approved Drawings.

4.5 Chemical composition and mechanical properties shall be checked as per relevant material standards andthis specification, for each heat of material used.

4.6 Each insulating gasket shall be tested for dielectric integrity at 5000 V A.C., 50 Hz for one minute and theleakage current before and after shall be equal. Testing time, voltage and leakage shall be recorded andcertified. The test shall be carried out in dry conditions.

4.7 The insulation resistance of each insulating gasket assembly shall be at least 25 mega ohms when checkedwith 500V - 1000V D.C. This test shall be carried out in dry conditions.

4.8 Each Insulating Gasket Assembly shall be Dielectric Tested before and after hydrostatic Test.

4.9 Purchaser reserves the right to perform stage wise inspection and witness tests as indicated above 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 by the Inspector. Inspections and tests performed/witnessed by the Inspector shall in no way relieve the Manufacturer of hisobligation to perform the required inspection and tests.

For any control, test or examination required under the supervision of TPIA/Owner/Owner's representative,latter shall be informed in writing one (1) week in advance by vendor about inspection date and place alongwith production schedule.

Even after third party inspection, Owner reserves the right to select a sample of pipes randomly from eachmanufacturing batch & have these independently tested. Should the results of these tests fall outside thelimits specified in Owner technical specification, then Owner reserves the right to reject all productionsupplied from the batch.

5. TEST CERTIFICATES

Manufacturer shall submit following certificates to EPC contractor/owner/Owner's representative:

a) Test certificates relevant to the chemical analysis and mechanical properties of the materials used forconstruction as per this specification and relevant standards.
b) Test reports as per QAP
c) Recorded and Certified Voltage and leakage

6. MARKING AND SHIPMENT

6.1 Marking

In addition to the marking required by the applicable standard, the following information shall be markedby cold stamping on the centering ring of each insulating gasket:

a) The MANUFACTURER's name and trademark
b) The diameter
c) The rating

6.2 Packing

The gaskets must be packed in sea-packing, which must be tight and meet the requirements of all stages oftransport (rail, road, air, etc.).

7. DOCUMENTATION

Within two weeks of placement of order, the manufacturer shall submit two copies of the drawings, documents and specifications for approval.

Once the approval has been given by Owner/Owner's Representative. Any change in design, material method of manufacture shall be notified to Owner/Owner's Representative whose approval in writing of all changesshall be obtained before the manufacturing.

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECNICAL SPECIFICATION FOR
PORTABLE DRY POWDER TYPE EXTINGUISHER

GAIL-STD-PI-DOC-TS-018

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ABBREVIATIONS:

KG : Kilogram

IS : Indian Standard

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1.0 SCOPE

This specification lays down the requirements regarding material, shape, type, construction, anticorrosive treatment and test for ordinary dry powder type fire extinguisher. The extinguisher shall be supplied along with the dry powder duly charged.

2.0 REFERENCES

IS: 2171 & IS: 4308

3.0 MATERIAL, SHAPE, TYPES, CONSTRUCTION, ANTICORROSIVE TREATMENT, PAINTING AND TEST.

3.1 The material, shape, construction, anticorrosive treatment, painting and test shall be as per IS: 2171.

3.2 The extinguisher shall be gas cartridge or pressure type.

4.0 PRINCIPLE

The method of expulsion of dry powder shall be as per IS: 2171 with either of the method of operation specified therein. The vendor shall indicate clearly the method adopted for operation.

5.0 CAPACITY

5.1 Nominal capacity of the extinguisher and the dry powder contents of the assembled body or dry powder container shall be as follows when charged with dry powder conforming to IS: 4308.

Nom. capacity of Extinguisher (kg)	Dry powder contents when charged Min. (kg)
1	1
2	2
5	5
10	10

5.2 Only dry powder conforming to IS: 4308 shall be used for charging the extinguisher.

6.0 ACCESSORIES

Each extinguisher shall be supplied with a suitable wall bracket or holder onto which it may be mounted and from which it may be removed for use in an emergency and screws and spanner as may be necessary.

7.0 MARKING

Each extinguisher shall be clearly and permanently marked with the information specified in IS: 2171 along with IS: certification mark and purchaser's name.

8.0 INSPECTION

Authorized representative shall have access at all reasonable times to the manufacturer's works where the extinguishers are being manufactured and or being tested. Samples from lots under a quality control system shall be done as per Appendix B of IS: 2171

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR HYDROSTATIC TESTING OF PIPING SYSTEM

GAIL-STD-PI-DOC-TS-019

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ABBREVIATIONS

ASME	American Society of Mechanical Engineers
API	American Petroleum Institute
OISD	Oil Industry Safety Directorate (of India)
SMYS	Specified Minimum Yield Strength

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1. SCOPE

1.1 This specification covers the minimum requirements of supply and various activities to be performed by Contractor for hydrostatic testing of cross-country pipelines transporting hydrocarbons in liquid or gaseous phase under high pressure.

1.2 This specification shall be read in conjunction with scope of work, specifications, documents, drawings and other requirements indicated in and included in the Contract between the Company and the Contractor. Unless specified otherwise, all sections of this specification shall apply to all specifications referred in this specification.

1.3 This specification does not cover the requirements of caliper pigging, swabbing/ drying/ pre-commissioning of the tested pipelines.

2. REFERENCE DOCUMENTS

2.1 The latest edition of following Codes and Standards are referenced in this specification and all provisions of these reference codes and standards shall be applicable.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B31.4 : Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids.

ASME B 31.8 : Gas Transmission and Distribution Piping Systems.

ASME Sec. VIII Div. 1 : Boiler and Pressure Vessels Code.

AMERICAN PETROLEUM INSTITUTE (API)

API RP 1110 : Pressure Testing of Liquid Petroleum Pipelines.

OIL INDUSTRY SAFETY DIRECTORATE (OISD)

OISD-STD-141 : Design and Construction Requirements for Cross Country Hydrocarbon Pipelines

OISD-STD-226 : Natural gas transmission pipelines and city gas distribution networks

COMPANY STANDARD SPECIFICATION

SS-PL-015 : Standard Specification for Pipeline Construction (Onshore)

2.2 In case of conflict between various requirements of this specification and reference codes, standards and specifications mentioned above, more stringent requirement shall apply

3. GENERAL REQUIREMENT

3.1 The Contractor shall ensure that the complete pipeline section undergoing hydrostatic test is mechanically complete in all respects, welds have been accepted and the pipeline has been laid and backfilled, all mechanical and civil works completed. Hydrostatic test shall

include those sections which have been previously tested viz. Rail/ road crossings, major water crossings including test on banks and in place after installation.

3.2 Hydrostatic test shall be performed on the entire length of the pipeline in accordance with approved Hydrostatic Test procedure and Diagrams clearly indicating the number of test sections and minimum and maximum test pressures in each test sections.

3.3 The maximum length of each test section shall not exceed 50 Kms.

3.4 For pipeline sections (i.e. River Crossing, Railway Crossing, HDD Crossing, National Highway Crossing, etc.) which in Company's opinion, once installed would require an inordinate amount of effort for repair in case of a leak, a provisional pre-test shall be conducted. However, after installation, such pre-tested sections shall be tested again along with the entire pipeline.

3.5 All works required for hydrostatic testing shall start only after obtaining prior approval from the Company.

4. TEST PROCEDURE

4.1 The Contractor shall submit a comprehensive hydrostatic test procedure to the Company for approval. The procedure shall also include all temporary materials and equipment to successfully complete hydro testing, but not be limited to the followings:

a. A diagram for the system to be tested, indicating all fittings, vents, valves, temporary connection and ratings. The diagram shall also indicate injection locations and intake and discharge lines.
b. A diagram indicating the lengths, elevations, and locations of the test sections.
c. Pipeline details of the test section pipe diameter, wall thickness and material
d. Source of water for testing and test water discharge location for each test section
e. Estimated quantity of water for filling and pressurizing
f. Details of chemicals/ inhibitors and the dosage
g. Cleaning, gauging flushing, and filling procedures including type and number of pigs, details of gauging pig.
h. Procedures for Pig Tracking System (which shall be used in case of pig getting stuck inside pipeline).
i. Procedures for location and rectification of dents/ buckles/ other deformation, etc.
j. Temperature stabilization procedure.
k. Pressure testing procedure including all calculations and test section isolation details.
l. Procedure for detection, location and rectification of leaks.
m. Safety precautions and procedures.
n. Repair procedures for coating damage at thermocouple locations.
o. Formats to be used for recording the test data.
p. Procedure for dewatering and neutralization of corrosion inhibitor of the pipeline sections(s) after testing.

The Contractor shall not commence hydrostatic testing activities until the testing procedure is approved.

5. SAFETY PRECAUTIONS DURING THE HYDROTEST

5.1 The Contractor shall take all necessary safety precautions during the hydrotest. As a minimum, the following shall be taken during the hydrostatic test:
a. Provision shall be made for the installation of no-admittance signs to unauthorised personnel from the roads to the R.O.U.
b. Warning signs stating ‘PIPELINE UNDER TEST-KEEP OFF” with local language translation shall be placed where the pipeline is uncovered, and particularly where the provisional traps/

test headers and stations are located. Such areas shall be suitably fenced in such a way as to prevent access of unauthorised personnel and no unauthorised personnel shall be closer than 40 m to the testing equipment or pipeline under test. Warning tapes and signboards shall also be placed near the crossings and regular intervals along the route to warn the public around those areas.

c. The test station shall be placed in such a location as to prevent it from being affected by a catastrophic failure in the test head.
d. Once dewatering is over the sectionalizing valves and other valve assemblies tested previously, shall be installed at locations shown in the drawings and in accordance with the procedures contained in the relevant specifications.
e. All thermocouples installed in the pipeline shall be removed and damage corrosion coating shall be repaired using Company approved materials and procedure.

6. TEST PRESSURE AND DURATION

6.1 TEST PRESSURE

Unless otherwise specified in the Contract, the minimum hydrostatic test pressure for different classes shall be as follows:

For pipeline handling hydrocarbon in gaseous phase:

Class 1	: 1.25 times the design pressure.
Class 2	: 1.25 times the design pressure
Class 3 and Class 4	: 1.4 times the design pressure

For pipeline handling hydrocarbon in liquid phase:

All Location	: 1.25 times the design pressure for pipeline Handling liquids including Liquefied Petroleum Gas (LPG).

The test pressure shall be generated at the highest point in the section under test. At any point in the test section, hoop-stress due to test pressure and static head shall not exceed 95% of the Specified Minimum Yield Strength (SMYS) of pipe material.

6.2 TEST DURATION

The duration of the hydrostatic test shall be 24 hours after thermal stabilization.

7. EQUIIPMENT AND INSTRUMENTATION

The Contractor shall provide all necessary equipment and instrumentation for performing the work as stated in cleaning, flushing, filling, stabilizing, testing and dewatering procedures.

7.1 EQUIPMENT

The equipment to be provided shall include, but not be limited to, the following in sufficient numbers along with spares:

a. Pigs for cleaning, gauging, flushing and filling.

- Cleaning pigs with spring loaded steel wire brushes
- Four cup batching pigs
- Two cups/ Four cups pigs fitted with gauge plate

b. Fill pumps:

The Contractor shall determine the type and number of fill pumps in order to guarantee the following:

- Differential head : 20% greater than the maximum required
- Flow rate : Minimum 400 m^3/ hr; Maximum 1000 m^3/ hr for 24" and above pipeline
  Minimum 200 m^3/ hr; Maximum 400 m^3/ hr up to 18" Pipeline

c. Pressurizing pump:

Variable speed positive displacement pumps equipped with a stroke counter, capable of generating pressure of 20 bar (g) over and above the required test pressure of the section.

d. Positive displacement meters/ Turbine meters to measure the volume of water used for filling the line.
e. Portable tanks/ Break tanks of sufficient size to provide a continuous supply of water to the pump during filling and pressurizing.
f. Injection facilities to inject chemicals/ inhibitors into the test medium in the required proportions.
g. The temporary test header shall be installed at both ends of section. Proper piping and valving arrangements shall be available to allow launching and receiving of each pig independently

The test heads shall be sized in conformity with ASME specification Section VIII, Division 2 with particular reference to Appendices 4 and 5.

7.2 INSTRUMENTATION

The instrumentation to be provided shall include, but not be limited to, the following in sufficient numbers along with spares:

a. Bourdon pressure gauges of suitable pressure range and accuracy.
b. Dead weight testers with an accuracy of 0.02 bar, measuring in increment of 0.05 bar and provided with a calibration certificate not older than one month.
c. 48 hours recording pressure gauges complete with pressure recording charts duly tested with dead weight tester prior to use. These shall be installed at the test head. The gauge shall having following specification :

Accuracy	:	± 0.1% of the full-scale value
Recording	:	continuous on tape or disk, graph width 100 mm
Feed	:	7.5 °/ hr for disk diagrams, 20 mm/ hr for tape diagrams
Recording	:	Range to be such as to record pressure between 50% and 90% of the diagram width

d. Temperature recorders for fill water.

Accuracy	:	± 1% of the scale range
Scale		-10 °C to +40 °C
Recording	:	continuous on tape or disk, graph width 100 mm
Feed	:	7.5 °/ hr for disk diagrams, 20 mm/ hr for tape diagrams

e. Environmental temperature shall be recorded from the beginning of pressurization to the end of the test by means of a recording thermometer featuring the following characteristics:

Accuracy	:	± 1% of the scale range
Scale		- 0 °C to + 60 °C
Recording	:	continuous on tape or disk, graph width 100 mm

Feed : 7.5 °/ hr for disk diagrams, 20 mm/ hr for tape diagrams

f. Thermocouples for measuring the pipe wall temperatures, with an accuracy of ±0.2 ^{0}C
g. Two laboratory thermometers of range 0 °C to 60 °C and with accuracy of ±0.01 °C to be used in thermowells.
h. Means to measure the volume of water necessary to drop the line pressure by 0.5 bar (container with scales or graduated cylinder)
i. Thermocouples for measuring the temperature of the pipe wall shall be installed on the pipeline to be tested at the following locations:

- One (1) thermocouple at about 500 m distance from the pumping head.
- One (1) thermocouple every 2500 m of the pipe. The spacing may be increased to maximum 5000 m depending on the terrain and nature of sub soil along the alignment of test section.
- One (1) thermocouple at about 500 m distance from the terminal head

8. HYDROSTATIC TESTING

8.1 Equipment and/ or parts which need not or must not be subjected to the test pressures or which must not be tested with water, must be disconnected or separated from the pipeline to be tested.

8.2 If the difference of minimum and maximum atmospheric temperature should cause thermal instability on the pipe section directly exposed to atmospheric condition, the test header and above ground pipeline shall be properly protected.

The pipeline test shall exclude long segments of line exposed to atmospheric conditions, viz. aerial lengths on piers, suspension bridges, etc. Such sections shall be tested separately.

8.3 TEST MEDIUM

The test medium shall be soft non-aggressive water supplied by the Contractor. The water to be used shall be filtered, shall not be contaminated and free from sand of silt. Contractor shall submit laboratory test reports of water used for testing. The possible use of sea water shall be subjected to its degree of cleanness, the possibility of obtaining a pre-determined salinity neutralization. The Contractor shall furnish and install all temporary piping, which may be necessary to connect from source of water to its pump and manifolds/ tankages.

8.4 INHIBITORS

Contractor shall provide Company approved corrosion inhibitors, oxygen scavengers and bactericides to be added to the test water.

Contractor shall note the following:

- All chemicals for hydro testing shall be procured from approved vendors.
- Contractor shall get the samples tested, testing shall be carried out for accelerated % corrosion inhibition efficiency, % SRB and TBC killing efficiency test. Company reserves the right to witness the testing. The test report shall be submitted to company for approval prior to undertaking hydro testing works.
- Only those chemicals which have passed the above tests shall be used for hydro-testing.

Inhibitors shall be uniformly mixed with the test water in the dosage recommended by the Manufacturer depending upon the water used and in sufficient concentration to ensure the inhibitor remains active for the duration of the test, and any possible delays to testing.

8.5 CLEANING

The pipeline shall initially be cleaned by running a series of wire brush cleaning pigs propelled by compressed air, to remove all mill scale, rust, sand, etc. from the internal of the pipe section. For these purpose temporary headers for air cleaning shall be attached to the pipeline. The

number of pig runs is depending upon the cleaning results and shall be determined by company at site.

8.6 GAUGING

After cleaning the pipeline by using air and acceptance by Company, gauging shall be carried out by using gauging pig. The gauge plate diameter shall be equal to 95% of inside diameter of the heaviest wall pipe in the test section. While computing the Inside Diameter (ID) of heaviest wall pipe, pipe manufacturing tolerances shall not be considered. A 10 mm thick aluminium plate shall be used for making gauge plate. Compressed air shall be used to run gauging pig.

After receipt of gauging pig at the other end, the gauge plate shall be inspected in the presence of Company representative. A deformed, bent or severally nicked plate or damaged pig shall be evidence of gauging pig run failure and the same shall not be acceptable to COMPANY. In such cases, the Contractor shall locate any obstruction and/ or faults such as dents, buckles, flat spots, etc. and rectify the same to the satisfaction of the Company. A written approval shall be obtained from Company regarding successful completion of gauging pig run. After acceptance of gauging operation, air header shall be cut and removed.

8.7 FILLING

After acceptance of gauging run, water filling of the testing shall commence. For this purpose, pretested test headers loaded with three numbers of batching pig shall be welded to the test section. Un-inhibited water equal to 10% of the volume of test section shall be filled ahead of the first pig. The first batching pig shall be launched using minimum un-inhibited water equivalent to 1.5 Km of test section. Then the second pig shall be launched using inhibited water till the second pig is received at the other end. The Contractor shall continuously monitor the volume and pressure, the temperature of the fill water during the filling operation.
When it has been confirmed that the filling pigs have arrived in the receiving test header, the thermal stabilization and pressurization operations can commence subsequently.

8.8 THERMAL STABILIZATION

After a check has been made to confirm if the pressure has attained minimum 1 bar (g) on the highest section, the thermal stabilization can be started.
Thermal equilibrium between the pipeline and environment shall be checked through the thermocouples installed on the pipeline.

Temperature readings shall be made at 2 hours-intervals. Thermal stabilization shall be considered to have been achieved when a difference not higher than 1 °C is attained between the average values of the last two readings.
Thermal stabilization completion shall be approved by Company.

8.9 PRESSURIZATION

8.12.1 The pressurization shall be performed in the presence of Company at a moderate and constant rate not exceeding 2 bars/ min. One pressure recording gauge shall be installed in parallel with the dead weight tester. Volume required to reach the test pressure shall be recorded periodically throughout the pressurization as follows:

- Each 5 bar increments up to 80% of test pressure as recorded by the dead weight tester
- Each 2 bar increments between 80% to 90% of test pressure as recorded by the dead weight tester
- Each 0.5 bar increments between 90% of the test pressure to full test pressure as recorded by the dead weight tester.

8.12.2 The pressurization shall be cycled according to the following sequence:

- Pressurize to 50% of test pressure, hold pressure for 1 hour,

- Drop pressure to 10% of test pressure of test section at test head,
- Pressurize to 75% of test pressure, hold pressure for 1 hour
- Drop pressure to 10% of test pressure of test section at the test head
- Pressurize to test pressure.

During the pressurization to each test pressure, two tests shall be carried out for the calculation of air volume in the pipeline under test.

In case, during the hold pressure periods indicated above, a decrease in pressure is observed, the above operations shall not be repeated more than twice, after which the line shall not be considered capable of test, until the Contractor has isolated and eliminated the cause for the lack of water tightness.

8.10 AIR VOLUME CALCULATION

Two separate consecutive pressures lowering of 0.5 bar shall be carried out after pressurizing to test pressure in order to check the presence of air in the pipeline.

For calculation of air in the pipeline the second pressure lowering shall be used, and the relevant drained water shall be accurately measured (V1). This amount measured shall be compared to the theoretical amount (Vp) corresponding to the pressure lowering that has been carried out, by using the procedure outlined in clause 9.1 of this specification.

If no air is present in the length under test, then $V_1/V_0 = 1$

In order that the above ratio is acceptable, it shall not differ by more than 6% (i.e. 1.06). If the air found in the pipeline is within the above established tolerance, then the pressurizing can continue. If the ratio V1 / V0 exceeds 1.06, the hydrostatic testing cannot go on and additional pig passages shall be performed to remove the air pockets.

The test shall be repeated as per the above procedure until above estimated tolerances are satisfied. The pressurizing can then continue, to reach the value of the test pressure.

8.11 TESTING

The section to be pressurized to the test pressure and after the air volume test has given acceptable results. When temperature and pressure has stabilized, the injection pump, pressuring pump shall be disconnected and all connections at the test heads shall be checked for leakage. The test pressure shall be held for a minimum of 24 hours after stabilization. The pressure recorders shall then be started with the charts in a real time orientation for continuous recording throughout the test.

During the testing period the following measurements shall be recorded:

- Pressure measurements from dead weight tester: Every hour
- Ambient temperature and the pipe temperature at the thermocouples: Every two hours

All data shall be recorded on appropriate forms attached to the hydrostatic test procedure manual. Care shall be taken that the maximum test pressures are not exceeded. Bleed-off water shall be accurately measured and recorded.

8.12 MEASUREMENTS

8.12.1 WATER QUANTITY

The quantity of water added to the test section shall be measured during the filling stage through a positive displacement meter (a turbine meter may also be used).

The quantity of water added during pressurization shall be measured during the pressurization stages.

8.12.2 PRESSURE MEASUREMENT

Pressure shall be measured with a dead weight tester. The pressure shall also be recorded by means of a recording pressure gauge. The recording pressure gauge shall be checked by means of a dead weight tester at the beginning, during and at the end of the hydrostatic test.

8.12.3 TEMPERATURE MEASUREMENT

- Water temperature shall be taken at every 2 hours through the thermocouples that have been installed on the pipe wall along the section.

In addition, the temperature measurement shall be taken during filling operation, thermal stabilization stage and during the pressure hold period.

- Water temperature shall also be measured at the pump delivery through a recording thermometer throughout the filling stage.

- Ground temperature shall be taken by measuring pipe temperature at the thermocouples prior to starting the filling operation.

- Ambient temperatures shall be recorded from the beginning of pressurization to the end of the test by means of a recording thermometer.

9. CALCULATIONS

The theoretical water amount that is necessary for filling the section to be tested shall be obtained from the geometrical volume of the section considering the pipe tolerances.

The theoretical water amount that is necessary for pressurizing the section shall be calculated by means of the following formula:

$$Vp = (0.884\ r_1/t+A) \times 10^{-6} \times V_t \times \Delta P \times K$$

Where:

Vp = Computed water amount required to raise the pressure by 'ΔP' in the section to be tested (m^3)

Vt = Geometrical volume of the section (m^3)

ΔP = Pressure rise (bar)

r_1 = Nominal inner radius of the pipe (mm)

t = nominal pipe thickness (mm)

A = isothermal compressibility value for water at the pressurization temperature in the P range (bar^{-1}).

K = a dimensionless coefficient that is equal to a value of 1.02 for Longitudinally welded pipe, and 1.0 for seamless pipe.

The pressure change due to a water temperature change shall be calculated through the following formula:

$$\Delta P = B * \Delta T / \{ (0.884\ r1 / t) + A \}$$

Where;

ΔP = Pressure change resulting from a temperature change (bar).

ΔT = Algebraic difference between water temperature at the beginning of the test and water temperature as measured at the end of the test (ºC).

B = Value of the difference between the thermal expansion of water at the pressure and temperature as measured at the end of the test and that of Steel (ºC). Refer Table-1.

A = Isothermal compressibility value of water as estimated at the pressure and temperature values obtained at the end of test (bar^{-1}). Refer Fig-1.

r_1 = Nominal inner radius of the pipe (mm).

t = Nominal pipe thickness (mm).

10. ACCEPTANCE

10.1 The hydrostatic test shall be considered as positive if pressure has kept a constant value throughout the test duration, except for change due to temperature effects. Such changes shall be evaluated as described under clause 9.2 of this specification.

10.2 The pressure change value as a function of temperature change shall be algebraically added to the pressure value as read on the meters. The pressure value thus adjusted shall be compared with the initial value and the test shall be considered as acceptable if the difference is less than or equal to 0.3 bar. In case of doubt the testing period shall be extended by 24 hours.

10.3 If test section fails to maintain the specified test pressure after isolation, Contractor shall determine the location of leakage or failure by suitable means. All leaks and failures within the pipe wall or weld seams shall be repaired by replacement of entire joint or joints in which leakage or failure occurs. In those cases where leaks occur in circumferential welds the method of repair shall be determined by the Company. Contractor shall comply with instructions of the Company whether to replace a section of the line pipe that includes the line leak or whether to repair the circumferential weld. This repair should, however, meet the requirements of applicable welding specification enclosed with the Contract. Where failures occur in pipeline field bends, bends shall be replaced with same degree of bends. After completion of repairs, the hydrostatic test shall be repeated in full, as per this specification.

10.4 The cost of repairs or replacements, followed by refilling and depressurizing the line, due to poor workmanship, shall be borne by the Contractor. In the event of leaks or failures resulting from faulty Company furnished materials, Contractor shall be reimbursed as per the provisions of Contract. All work of reinstalling line pipe, to replace failures, shall be done in accordance with the relevant specifications included in the CONTRACT.

10.5 Contractor shall haul and stockpile all damaged and defective pipes to storage location designated by the Company. All cracks and splits resulting from failure shall be coated with an application of grease to preserve the characteristics of failures from corrosion. Joint of failed pipes shall be marked with paint, with a tag indicating failure details, date and location of failure and pressure at which failure occurred.

11. TERMINATION

11.1 After the positive result of testing and all the data have been gathered, the test shall be terminated upon written approval given by the Company. The pipeline shall be slowly depressurized at a moderate and constant rate as instructed by Company. Subsequent operations such as installation of sectionalizing valves, caliper pigging, swabbing, precommissioning checks, purging/ inertising and commissioning shall be carried out as per the relevant specifications.

11.2 All thermocouples installed in the pipeline shall be removed and damaged coating shall be repaired using Company approved materials and procedure.

11.3 Contractor shall dewater the tested line as per the following requirement after test acceptance. The dewatering shall be carried out by using four cup pigs and foam pigs driven by compressed air. The detailed dewatering procedure shall be deployed by the Contractor in such a way as to provide adequate control of pigs during dewatering. Pigs and equipment required for dewatering the line shall be furnished by Contractor and shall be approved in advance by the Company. Four cup pigs run shall be made through the line to displace the water. Foam pigs shall then be passed in order to complete the line dewatering. Contractor shall use a number of foam pigs each in different colours/ numbered for this purpose. The line shall be considered dewatered when a negligible amount of water is flushed out by the last foam pig and approval is given by the Company.

11.4 During dewatering, care shall be taken to properly dispose the discharging water in order to avoid pollution, damages to fields under cultivation and/ or existing structures and interference with the traffic. Before the start of dewatering and disposal of hydro test water, a procedure for treatment of inhibited water to prevent pollution shall be submitted by Contractor to Company for review and approval.

11.5 Upon completion of the testing and dewatering operation, any provisional traps/ headers for pigs and all other temporary installation relating to the test shall be removed. Subsequently, the individual sections of the line already tested shall be joined in accordance with the requirements of relevant specifications issued for the purpose.

12. TEST REPORT

A complete report signed by Contractor and the Company shall be submitted upon completion of the hydrostatic test for each test section.

This report shall contain as a minimum:

- Water test certificate;
- Inhibitor test certificate;
- The cleaning, gauging, flushing, filling and testing procedures used;
- Schematic layout of cleaning, filling and testing facilities;
- Equipments and Instruments calibration certificate;
- A profile of the pipeline that shows the test sites, all instrument and injection connections;
- Pipe filling logs and records;
- Additive specification, required concentration and additive injection records;

- Pig specifications;
- Pig inspection records including photographs of the damages; records of gauging pig survey and photographs;
- Pressurization and stabilization records;
- Pressure and temperature recording charts with appropriate information inscribed thereon;
- Temperature data along the pipeline;
- Dead weight tester logs and recordings;
- Air volume calculations;
- Pressure change due to temperature change calculations;
- Environmental data;
- Depressurization logs and records;
- Dewatering procedure and schematic layout of relevant facilities; dewatering logs and records;
- Records and photographs of all leaks, if applicable.

13. PRESERVATION OF PIPELINE

When so stated in the CONTRACT, to preserve/ conserve the pipeline for a specified duration, Contractor shall completely fill the pipeline with water, with sufficient quantity of corrosion inhibitors depending upon quality of water and the period of conservation, at a pressure as per relevant specification/ Contract. Contractor shall obtain necessary approval from the Company of the procedure, type and quality and quantity of inhibitors used before commencement of the works.

14. DOCUMENTATION

PRIOR TO COMMENCEMENT OF HYDROSTATIC TEST

The Contractor shall furnish the Hydrostatic Test Procedure at least six weeks prior to commencement of hydrostatic test operations for the approval of the Company Representative. Hydrostatic test operations shall commence only after obtaining written approval from Company.

Prior to commencement of the testing, copies of certifications, calibrations, etc of any equipment/ instrumentation to be incorporated in the test set-up shall be submitted to the Company Representative.

ON COMPLETION OF HYDROSTATIC TEST

The Contractor shall furnish the Test Report duly signed by both the Contractor and the Company Representative, immediately upon completion of successful hydrostatic test.

All documents shall be in English language only.

Table 1

Difference between the water thermal expansion factor and the steel thermal expansion factor ($^oC^{-1}$) (10^{-6})

^oC Bar	1	2	3	4	5	6	7	8
0.98	-98.62	-79.89	-61.81	-44.34	-27.47	-11.14	4.66	19.98
10	-95.55	-76.94	-58.99	-41.65	-24.89	-8.67	7.02	22.23
20	-92.15	-73.68	-55.86	-38.64	-22.01	-5.92	9.65	24.74
30	-88.74	-70.4	-52.72	-35.63	-19.14	-3.16	12.29	27.26
40	-85.32	-67.12	-49.58	-32.62	-16.24	-0.41	14.93	29.78
50	-81.9	-63.84	-46.43	-29.6	-13.36	2.36	17.57	32.31
60	-78.47	-60.55	-43.27	-26.58	-10.46	5.15	20.23	34.85
70	-75.03	-57.25	-40.1	-23.54	-7.56	7.92	22.89	37.39
80	-71.6	-53.96	-36.94	-20.51	-4.65	10.7	25.55	39.94
90	-68.16	-50.66	-33.77	-17.47	-1.73	13.5	28.23	42.5
100	-64.72	-47.35	-30.6	-14.43	1.18	16.29	30.9	45.05
110	-61.28	-44.05	-27.43	-11.38	4.1	19.08	33.58	47.61
120	-57.84	-40.74	-24.26	-8.34	7.02	21.88	36.26	50.18
130	-54.4	-37.44	-21.08	-5.29	9.95	24.68	38.94	52.75
140	-50.96	-34.13	-17.9	-2.25	12.87	27.49	41.63	55.32
150	-47.53	-30.83	-14.73	0.8	15.79	30.29	44.31	57.89
160	-44.1	-27.53	-11.56	3.85	18.72	33.1	47	60.46
170	-40.67	-24.23	-8.4	6.89	21.64	35.9	49.69	63.04
180	-37.24	-20.94	-5.23	9.94	24.56	38.7	52.37	65.62
190	-33.83	-17.65	-2.06	12.98	27.48	41.51	55.06	68.19
200	-30.42	-14.37	1.09	16.01	30.4	44.3	57.75	70.77
210	-27.02	-11.09	4.25	19.04	33.31	47.1	60.43	73.34
220	-23.63	-7.82	7.4	22.06	36.22	49.9	63.12	75.9
230	-20.24	-4.56	10.54	25.08	39.13	52.69	65.8	78.48
240	-16.87	-1.3	13.67	28.1	42.03	55.48	68.48	81.05
250	-13.58	1.94	16.79	31.11	44.92	58.26	71.15	83.61
260	-10.14	5.17	19.9	34.12	47.81	61.04	73.81	86.81
270	-6.8	8.39	23	37.11	50.69	63.8	76.48	88.73
280	-3.48	11.6	26.11	40.09	53.56	66.57	79.14	91.29
290	-0.17	14.8	29.19	43.07	56.43	69.33	81.78	93.83
300	3.13	17.98	32.27	46.03	59.29	72.06	84.83	96.38

Table 2

Difference between the water thermal expansion factor and the steel thermal expansion factor ($ºC^{-1}$) (10^{-6}).

°C Bar	9	10	11	12	13	14	15
0.981	34.82	49.22	63.2	76.78	89.99	102.83	115.34
10	36.97	51.26	65.15	78.64	91.75	104.51	116.93
20	39.36	53.55	67.33	80.71	93.72	106.39	118.71
30	41.76	55.84	69.51	82.79	95.7	108.26	120.49
40	44.18	58.14	71.7	84.87	97.68	110.14	122.28
50	46.6	60.45	73.9	86.96	99.68	112.04	124.07
60	49.02	62.76	76.1	89.07	102.67	113.93	125.88
70	51.44	65.08	78.32	91.17	103.68	115.84	127.69
80	53.88	67.4	80.53	93.29	105.69	117.76	129.5
90	56.32	69.73	82.75	95.41	107.7	119.67	131.32
100	58.77	72.07	84.98	97.53	109.73	121.59	133.15
110	61.21	74.41	87.22	99.66	111.75	123.52	134.98
120	63.67	76.74	89.45	101.79	113.79	125.46	136.82
130	66.12	79.09	91.69	103.93	115.83	127.39	138.67
140	68.58	81.45	93.93	106.07	117.67	129.34	140.51
70	71.05	83.8	96.18	108.21	119.9	131.2	142.37
160	73.51	86.15	98.43	110.36	121.96	133.74	144.22
170	75.97	88.51	100.68	112.51	124.01	135.19	146.08
180	78.44	90.87	102.94	114.66	126.06	137.15	147.94
190	80.91	93.23	105.19	116.82	128.12	139.11	149.81
200	83.37	95.59	107.45	118.97	130.17	141.07	151.68
210	85.84	97.95	109.71	121.13	132.24	143.03	153.55
220	88.3	100.31	111.97	123.29	134.29	144.99	155.42
230	90.67	102.67	114.23	125.45	136.36	146.96	157.3
240	93.22	105.03	116.48	127.6	138.42	148.93	159.18
250	95.69	107.39	118.74	129.76	140.48	150.9	161.05
260	98.14	109.74	121	131.92	142.54	152.87	162.93
270	100.6	112.1	123.25	134.08	144.61	154.84	164.81
280	103.05	114.44	125.5	136.24	146.67	156.84	166.69
290	105.5	116.79	127.75	138.39	148.73	158.78	168.57
300	107.94	119.13	130	140.54	150.79	160.75	170.45

Table 3

Difference between the water thermal expansion factor and the steel thermal expansion factor ($^oC^{-1}$) (10^{-6}).

°C Bar	16	17	18	19	20	21	22	23
0.981	127.52	139.41	151	162.31	173.37	184.18	194.75	205.08
10	129.02	140.83	152.36	163.58	174.56	185.3	195.79	206.07
20	130.71	142.42	153.85	165	175.9	186.55	196.96	207.16
30	132.4	144.02	155.35	166.42	177.23	187.8	198.14	208.26
40	134.1	145.62	156.87	167.85	178.58	189.07	199.33	209.37
50	135.8	147.24	158.39	169.85	179.93	190.34	200.52	210.49
60	137.51	148.86	159.92	170.73	181.29	191.62	201.72	211.61
70	139.22	150.49	161.46	172.18	182.66	192.91	202.93	212.74
80	140.95	152.11	163	173.64	184.03	194.2	204.14	213.88
90	142.67	153.75	164.56	175.1	185.41	195.5	205.36	215.03
100	144.42	155.4	166.11	176.58	186.8	196.8	206.59	216.17
110	146.15	157.04	167.66	178.05	188.2	198.12	207.82	217.33
120	147.9	158.7	169.24	179.54	189.59	199.44	209.06	218.49
130	149.65	160.36	170.81	181.02	191	200.75	210.31	219.66
140	151.4	162.03	172.39	182.51	192.41	202.09	211.56	220.84
70	153.16	163.7	173.98	184	193.82	203.42	212.81	222.02
160	154.93	165.37	175.56	185.51	195.24	204.76	214.08	223.2
170	156.69	167.05	177.15	187.02	196.66	206.1	215.34	224.39
180	158.47	168.73	178.75	188.53	198.09	207.45	216.61	225.55
190	160.24	170.42	180.35	190.05	199.52	208.8	217.89	226.79
200	162.01	172.1	181.95	191.57	200.97	210.16	219.17	227.99
210	163.8	173.8	183.55	193.09	202.4	211.53	220.46	229.2
220	165.58	175.43	185.16	194.62	203.85	212.89	221.74	230.41
230	167.36	177.19	186.78	196.14	205.3	214.26	223.04	231.63
240	169.16	178.89	188.39	197.68	206.75	215.63	224.33	232.85
250	170.94	180.59	190.01	199.21	208.2	217	225.63	234.08
260	172.73	182.3	191.63	200.75	209.66	218.4	226.93	235.31
270	174.53	184	193.25	202.29	211.12	219.77	228.24	236.54
280	176.32	185.7	194.88	203.83	212.59	221.16	229.55	237.77
290	178.11	187.42	196.5	205.37	214.05	222.54	230.86	239.01
300	179.9	189.13	198.13	206.92	215.51	223.93	232.18	240.26

Table 4

Difference between the water thermal expansion factor and the steel thermal expansion factor ($^oC^{-1}$) (10^{-6})

°C Bar	24	25	26	27	28	29	30
0.981	215.22	215.14	234.88	244.41	253.79	263	272.03
10	216.13	225.99	235.66	245.13	254.44	264.27	272.57
20	217.15	226.94	236.53	245.94	255.18	264.59	273.18
30	218.18	227.88	237.41	246.75	255.93	264.95	273.8
40	219.21	228.85	238.3	247.58	256.69	265.64	274.42
50	220.25	229.82	239.2	248.4	257.45	266.33	275.07
60	221.3	230.79	240.11	249.24	258.22	267.04	275.7
70	222.35	231.78	241.02	250.08	258.99	267.75	276.35
80	223.42	232.77	241.94	250.93	259.78	268.47	277.01
90	224.48	233.76	242.87	251.79	260.57	269.19	277.66
100	225.56	234.76	243.79	252.66	261.36	269.92	278.33
110	226.64	235.78	244.73	253.53	262.17	270.77	279.01
120	227.73	236.79	245.68	254.4	262.98	271.41	279.69
130	228.82	237.81	246.63	255.28	263.69	272.16	280.38
140	229.92	238.84	247.59	256.18	264.62	272.92	281.08
150	231.03	239.87	248.55	257.07	265.44	273.69	281.78
160	232.14	240.91	249.52	257.97	266.28	274.46	282.49
170	233.26	241.96	250.49	258.88	267.12	275.23	283.2
180	234.38	243.01	251.47	259.79	267.97	276.01	283.92
190	235.51	244.06	252.46	260.71	268.82	276.8	284.64
200	236.64	245.12	253.45	261.63	269.67	277.59	285.37
210	237.77	246.18	254.45	262.5	270.54	278.39	286.11
220	238.91	247.26	255.45	263.49	271.4	279.19	286.85
230	240.06	248.33	256.46	264.43	272.28	280	287.59
240	241.21	249.41	257.46	265.37	273.16	280.82	288.35
250	242.36	250.49	258.48	266.31	274.04	281.63	289.11
260	243.52	251.58	259.49	267.27	274.92	282.46	289.86
270	244.68	252.66	260.52	268.23	275.82	283.29	290.64
280	245.84	253.76	261.54	269.18	276.71	284.12	291.4
290	247.01	254.86	262.57	270.15	277.61	284.95	292.18
300	248.18	255.96	263.6	271.11	278.51	285.79	292.95

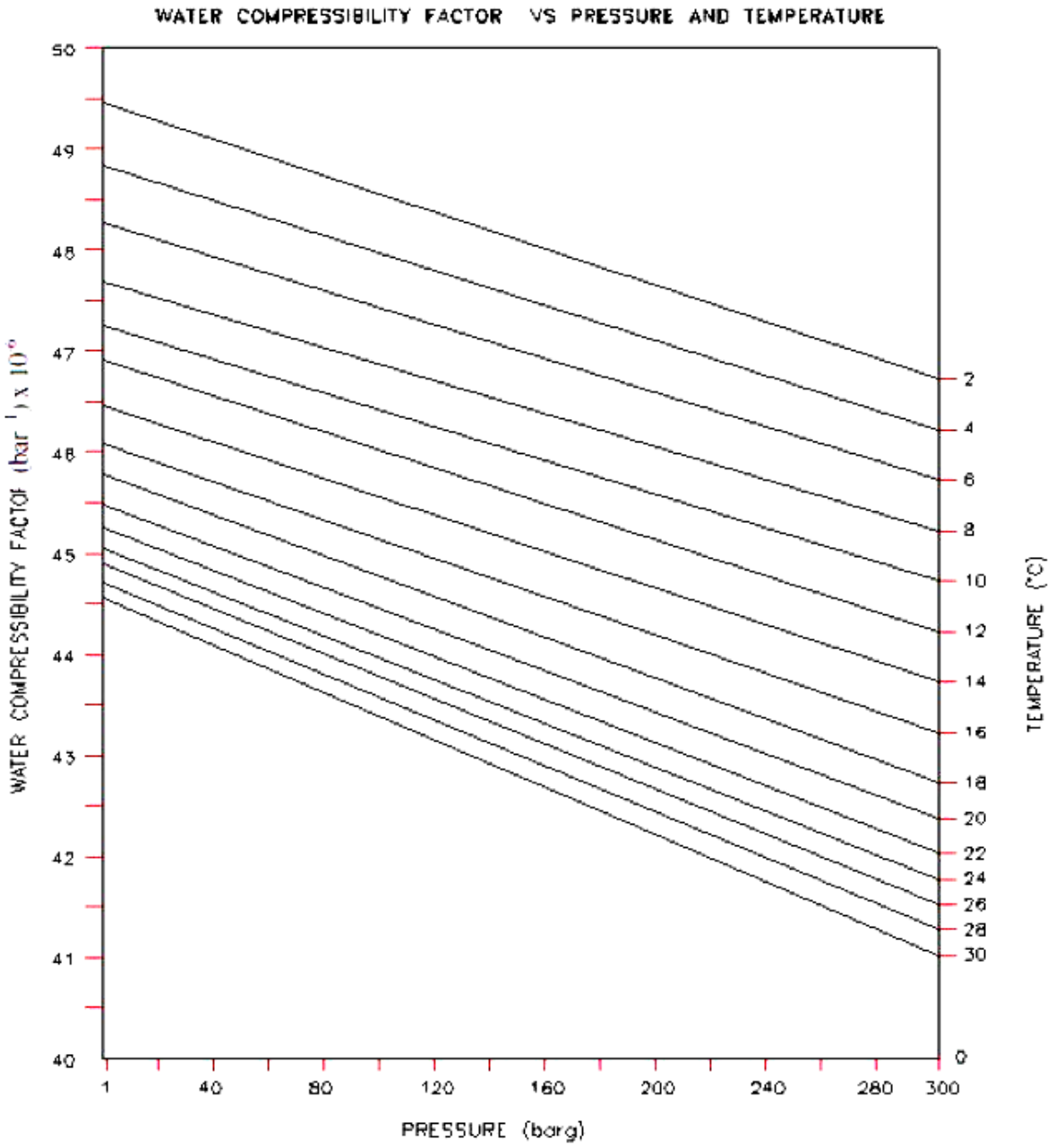

Fig.1 Water Compressibility Factor

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR ERECTION OF EQUIPMENT AND MACHINERY

GAIL-STD-PI-DOC-TS-020

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1. SPECIFICATION FOR ERECTION OF EQUIPMENT AND MACHINERY

1.1 Scope:

This specification covers technical requirements for erection of all static and rotating equipment by erection contractor at site.

1.2 General

1.2.1 All necessary handling equipment's, tools, tackles and precision instruments for carrying out the works as specified shall be provided by the Erection

Contractor (EC) at his cost. EC must provide all tools and gauges for erection and alignment. Special tools, if any, received as part of machinery, will be given to EC for erection purposes, which shall be returned in good condition after use. Suitable deductions will be made by the Engineer-in-Charge (EIC) in case of loss or damage of the special tools. The value of such loss or damage wi l l be decided by the EIC and EC shall be bound by such a decision.

1.2.2 Equipment Manufacturer's recommendations regarding preservation during storage at site and detailed specifications for the installation along with layout drawings, general arrangement/equipment outline drawings and sub-assembly drawings of the various equipment and machinery will be provided to EC during the performance of work. The requirements stipulated in these shall be fulfilled by EC in addition to what is stated in this specification. Erection shall be carried out as per the instructions and supervision of Machine manufacturer's representative, wherever such supervisory services are applicable.

1.2.3 All the items of work covered in the tender shall be carried out as per this Specification and other details to be furnished to EC. However, EIC reserves the right to give additional/alternative specifications and instructions, at any time, for execution of any particular work and EC shall execute such works in accordance with such additional/alternative specifications and instructions of the EIC.

Such a step taken by the EIC shall not constitute a breach of the contract.

1.3 Preparation for Erection:

1. 3.1 EC shall be responsible for organizing the lifting of the equipment in the proper sequence, so that orderly progress of the work is ensured and access routes for erecting the other equipment are kept open.

Rigging procedure for all the major lifts (above 10 MT) and at maximum crane capacity shall be submitted by EC for the approval of EIC. However, approval to rigging procedure proposed by EC shall not relieve EC from his responsibility in following the proper lifting/erection methods on ensuring orderly.

1.3.2 Orientation of all foundations, elevations, length and disposition of anchor bolts and diameter of holes in the supports saddles shall be checked by EC, well in advance. Minor rectifications including chipping of foundations as the case may be, shall be carried out by EC after obtaining prior approval of EIC -. EC shall also be provided with the necessary structural drawings and piping layouts etc. wherever required for reference. EC shall crosscheck such piping and structural drawings with actual construction at site and in case of any mismatch inform the EIC before taking up the erection.

1.3.3 During the performance of the work, EC shall keep structures, materials or equipments adequately braced by guys, struts or otherwise approved means which shall be supplied and installed by EC as required till the installation work is satisfactorily completed. Such guys, shoring, bracing, strutting, planking supports etc.shall not interfere with the work of other agencies and shall not damage or cause distortion to other works executed by him or other agencies.

1.4 Abbreviations used:

EC - Erection Contractor
EIC - Engineer-in-Charge

2. ERECTION OF COLUMNS, TANKS, VESSELS AND DRUMS ETC.

2.1 Scope of work of Erection Contractor

a. Preparation of erection scheme and rigging procedure and obtaining its approval from EIC wherever necessary.
b. Withdrawal of equipments from Owner's storage point, checking and reporting its conditions, transporting the same to EC's stores of work site including unloading etc.
c. Erection on foundations furnished by Owner including aligning, leveling and grouting including grouting wherever necessary.
d. Assembly and fixing of demisters, grids, internal distributors and other internal fittings in Columns, Vessels etc.
e. Filling of Columns, Reactors, and Vessels/Drums etc. with Raschig rings, supporting elements, sand, concrete etc. as required.
f. Welding of washers for equipment's, erection of pipe davit & minor welding of their parts as per specifications and instruction of EIC.
g. Assembly & erection of Agitator (Mixer) along with drive unit (Motor) including all accessories for vessels/drums/reactors (wherever indicated) as per specification drawings & instructions of EIC.
h. Flushing, cleaning and drying of Columns, Vessels/Drums etc.
i. Completing the equipments in all respects for commissioning the plant as per drawings, specifications & instructions of EIC.
j. Any modification in the erected Columns, Reactors, Vessels/Drums to the complete satisfaction of EIC.

2.2 General Conditions of Erection

2.2.1 Unless otherwise specified Columns, Vessels, Drums etc. will be generally supplied to the Erection Contractor in single piece and EC will not be required to carry out any assembly or welding. In case column is supplied in multiple pieces and erection of the equipment is not possible in single piece, EC shall be responsible for lifting the pieces, for aligning, welding and hydro test etc. in vertical position under the supervision of column Supplier (Fabricator). However, EIC shall be responsible for coordination between Erection Contractor & Fabricator. The schedule of quantities (SOQ) for equipment erection enclosed with the tender document outlines details of each equipment such as diameter, overall height, type of support (saddle/skirt/leg/bracket), position (horizontal or vertical) and approximate erection weight, etc. However the erection elevation and location of equipment shall be as per the piping layout drawing enclosed with the tender.

2.2.2 Rigging procedures and erection schemes for all the heavy lifts weighing 10 MT & above shall be prepared by EC and got approved by EIC. Approval by EIC shall not relieve EC of his responsibilities. The details to be submitted will include the location of equipment from where it will be lifted, location of crane(s), details of crane(s) (like

configuration, boom length, operating radius, boom point elevation, clearance underside the boom and the equipment, lifting capacity, counter weights to be deployed, holds on any neighbouring foundations, structures, equipment's etc.), the load chart of the crane(s), design of the lifting tackles like spreader beam, D-shackles, wire rope slings, etc. Unless the erection scheme and rigging procedures are approved by EIC, erection of such equipment's shall not be undertaken in any case by EC.

2.2.3 Before starting the erection of Columns, Vessels etc., top surface of the foundations is to be cleared/chipped, roughened to obtain proper bond, while grouting. Also the sleeves are to be cleaned before erecting the equipment's. Line (orientation) and levels are to be marked on all the foundations to facilitate checking of alignment.

EC shall also check the correct elevation and orientation of civil, structural foundations, before proceeding with the erection work. Discrepancy, if any, shall be brought to the notice of EIC. However, minor rectifications and chipping of foundations up to a thickness of 15 mm in foundation height shall be carried out at no extra cost, by the EC. EC shall be responsible for supply of levelling plates, (if required) and shall carry out levelling of equipment under the directions of EIC.

2.2.4 While handling, transporting or erecting the equipment's, care shall be taken not to damage the nozzles, instrument connections, structural clips etc. EC shall also take care of the orientation of the nozzles and other connections of the equipment's while erecting the same and ensure compliance with the drawings and specifications supplied. Discrepancy, if any, in the number/orientation of the nozzles, cleats etc. should be brought to the notice of the EIC before actual erection is started.

2.2.5 Verticality of the Columns, Reactors/Vessels shall be checked with theodolites. After erection the equipment shall be levelled and properly aligned with necessary shims and wedges supplied by EC, at his cost. After the level, alignment and verticality etc. are checked and approved by EIC, EC shall carry out grouting and finishing Cement for grouting shall be supplied by Owner at issue rates.

2.2.6 EC shall produce recent test certificates of the slings which they will be using for erection work. However, retesting of the slings shall be done at site by EC at his cost, as and when required by EIC. The weights of test loads shall be as per IS-807. The test loads shall be supplied by EC at his cost. Tested slings will be punched for test loads and date of testing as directed by EIC.

2.2.7 EC shall also carry out the assembly, erection, levelling and alignment of all types of weir plates, baffles, distributors, collectors, spray nozzles, demisters, grids and other internal fittings etc. Work shall be carried out as per manufacturer's standards/specifications which shall be made available to EC at the time of erection. Raschig rings, molecular sieves, intalax saddles packing and other types of tower packings such as sand, catalyst etc. and S.S. wire mesh shall be loaded into sections of Vessels, Columns as per specifications and drawings. Details for internals to be installed by EC shall be as per separate schedule of quantities enclosed with the tender document. All packing's except clay and lime stone shall be washed with water before filling. Bottom layers, if required, shall be arranged as directed and random filling shall be done afterwards with equipment filled with water. Installation of packing's, shall be done only after flushing and cleaning of Columns/Vessels and completed to the satisfaction of EIC

2.2.8 EC shall carry out minor welding for attachment of prefabricated pipe davit parts

such as rain covers, handles etc. with pipe davit, during or after erection of the same as per the manufacturer's specifications, at no extra cost to the Owner.

2.2.9 EC shall execute erection of wooden pillow for saddle support for cold horizontal vessels wherever necessary as indicated on the drawings/Ell, STD 7-12-0003 and as per the instructions of EIC.

2.2.10 EIC shall execute assembly & erection of agitator/mixer along with drive unit including all accessories as per supplier's instructions, specification drawings & instructions of EIC.

2.3 Flushing & Cleaning of Columns, Vessels, Drums etc.

2.3.1 After the erection, alignment and grouting of these equipments are complete, flushing and cleaning shall be carried out by EC as per specifications and instructions of EIC.

2.3.2 After flushing, cleaning and draining, equipment's shall be dried by compressed air at the pressure and for duration decided by the EIC. The Vessel interior shall be thoroughly inspected to the complete satisfaction of EIC before it is finally boxed up. Boxing up of manholes and hand holes shall be leak proof. All joints which need remaking shall be remade. Compressed air for drying shall be arranged by EC.

2.4 Inspection and Acceptance Limits for Level and Alignment.

2.4.1 Co-ordinates of foundations/supporting structures/mounting holes etc. shall be checked with respect to the plot plans by EC.

2.4.2 Before equipment's are placed on foundations, orientations shall be checked with respect to piping drawings.

2.4.3 When equipment's are firmly bolted down but prior to grouting, verticality of all the Columns, vertical vessels etc. shall be checked by using theodolite. Tolerances for equipment after erection shall be as per Standard. The allowable deviation from plumb line shall be 1 mm per meter height, subject to maximum of 15 mm unless otherwise stated on the drawings.

2.4.4 Horizontal Vessels shall be checked for level across machined face of nozzle flanges with precision level.

2.5 Additional requirements for Underground buried vessels

2.5.1 Underground vessels for operating temp up to 60°C:
The vessels shall be supplied at site with one coat of inorganic zinc silicate primer duly applied on its external surfaces as per painting spec. All other works such as application of coal tar enamel, as per painting Spec. & wrapping and coating as per painting spec. shall be carried out by EC. This shall include necessary materials, tools and tackles to complete the job in all respect as per the instructions of EIC.

2.5.2 Underground Vessels for operating temp. Above 60°C and up to 300°C:
The vessels shall be supplied at site with one coat of inorganic zinc silicate primer as per painting Spec. GAIL-STD-PI-DOC-TS-004 duly applied on its external surfaces. EC shall be required to carry out touch-up and repair of outside primer before erection of equipment.

2.5.3 EC shall do the necessary excavation, backfilling and removal of surplus earth at the site as per the directions of the EIC. EC's rate shall include the excavation, blast cleaning, painting, wrapping by craft paper, placing and fixing of Vessels, backfilling and removal of excess earth.

3. ERECTION OF MECHANICAL EQUIPMENT

3.1 Scope of Work of Erection Contractor

The scope of EC shall consist of withdrawal and transportation of equipments and accessories from Owner's stores to site, assembly of loose supplied components/parts erection of equipment on foundations, levelling, aligning and grouting, preparation of equipments for trial runs and hand over in fit condition for the start-up of the plant as per instructions of EIC.

3.2 Details of Owner Supplied Equipment's

Equipment's to be erected shall be supplied by the owner. Equipment's may be supplied in any of the following conditions.

-Single equipment such as filter, static mixer, silencer etc.
-Skid mounted equipment, fully assembled.
-Skid mounted equipment with some items supplied loose or as subassemblies involving interconnections also.
-System comprising of many equipment's, skids with interconnected piping & hook up.

3.3 Technical Requirements

3.3.1 All equipment/machinery erection shall be done by experienced fitters. For this purpose EC shall employ an experienced erection supervisor and crew who have done similar jobs.

3.3.2 EC shall study the layout drawings, for the machineries and equipment's with their auxiliaries, controls defining scope of supply.

3.3.3 Equipment's shall be checked for any damages as a result of transport, handling and defects, if any, shall be reported to the EIC. Rectification of defects shall be carried out in accordance with approved procedure.

3.3.4 Correct procedures for handling of equipment & installation on the foundation shall be followed as given in the manufacturer's manual. In case of non-availability of such procedures, EC shall develop & submit handling procedures for all equipment weighing more than 10 metric tonnes. The handling procedure shall be approved by the EIC.

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3.3.5 EC shall check the correctness of equipment foundations or supporting structures as per the drawings. Equipment/Skid foot print dimensions shall be verified to match with the foundation. Minor chipping of foundation, pockets if required shall be carried out by EC.

3.3.6 All accessories like pressure gauges, seal oil, cooling water &Lube oil headers etc., shall be tagged and separately kept in Contractor's stores till erection. All flanged

connections and openings shall be kept blanked with dummies, plugs to prevent entry of foreign particles.

3.3.7 Equipments shall be installed on the foundations in proper sequence. In case the equipments are delivered in subassemblies, EC shall do the assembly work as per manufacturer's instructions.

3.3.8 Equipments shall be installed in the correct orientation and alignment.

3.3.9 After installation and leveling the equipment shall be grouted with the specified grouting applied to the base plate and support.

3.3.10 EC shall remove all the packing and protective devices used during transport and handling from the equipment such as shock absorbent materials from machined faces, blocking of shafts or rolling bearings & restraining devices from instruments, safety devices and protective equipments.

3.3.11 after the grouting is set & cured, the foundation bolts shall be checked to make sure that they are in straight and vertical position and properly tightened. Shims, if used, shall be on either side of the foundation bolts.

3.3.12 Desiccant, catalyst where supplied loose shall be loaded on to the respective vessels in specified quantities as per the suppliers instructions.

3.3.13 Internals, where supplied loose shall be assembled as per the drawings and manufacturer's instructions.

3.3.14 Unless otherwise specified, all the instruments such as pressure gauges, sight glasses temperature recorders etc. including instrument panels, if any, supplied along with the equipment with necessary connections, shall be installed by EC as part of Equipment erection.

3.3.15 Equipments shall be checked for final cleanliness before boxing up.

3.3.16 any interconnected piping & ducting shall be properly installed and supported. EC shall connect the gas, steam, air, utility piping, instruments, oil piping etc. as per manufacturer's drawings, specifications and instructions of the EIC.

3.3.17 Safety devices shall be correctly installed.

3.3.18Ladders, platforms, walkways shall be correctly installed with handrails, and flooring shall be properly secured.

3.3.19Field welding, where specified shall be in accordance with the specified procedures and NDT tests where specified shall be carried out. Results of NDT tests shall be recorded.

3.3.20 Equipment alignment & couplings shall comply with tolerances specified in manufacturer's drawings and manuals. Provisions of dowel pins or similar arrangements for retaining the alignment shall be carried out.

3.3.21 After the piping has been connected, the alignment shall be checked by EC again, to ensure that piping connections do not induce any undue stresses on the Equipment's. After making necessary corrections on the piping, if any, realignment shall be done by EC to ensure that no undue stresses are induced on the equipment.

3.3.22 Painting, insulation & fireproofing where specified shall be carried out in accordance with the applicable specifications attached in the tender document.

3.3.23 Any alterations, deviations made during equipment erection with respect to manufacturer's drawings or instructions shall be duly recorded and approval shall be taken from the EIC.

3.3.24 Any special tools, tackles supplied along with the equipment and used during installation shall be returned to the stores through the EIC.

3.3.25 Any protection of the equipment after installation, if required shall be carried out in accordance of the instructions of the EIC.

3.4 Trial Runs

3.4.1 Wherever specified, Machinery & Equipment erected & installed by EC under the supervision of Machinery/Equipment supplier shall be subjected to trial runs in accordance with clause 5.4 of this specification. Job specific trial run procedure, if specified, supersedes the trial run procedure as described in clause 5.4.

3.5 System Start-up

During this phase of work, EC shall provide as part of his work necessary skilled personnel as per requirement of EIC. Any defects noticed in the Equipment shall be made good by EC at his cost if such defects are attributable to him.

4. ERECTION OF ROTATING EQUIPMENT

4.1 Scope of Work of Erection Contractor

The scope of work shall consist of transportation of Rotating Equipment's and accessories from Owner's stores to site, assembly of sub-assemblies/parts, erection of Rotating Equipment's on foundations, leveling, aligning and grouting, preparation of Rotating Equipment's for trial runs, carrying out no load/trial runs, return of any unused material to the owners stores and hand over in fit condition for the start- up of the Plant, as per instructions of EIC.

Defects due to EC's fault noticed during trial runs shall be rectified by him. Schedule of Quantities, indicate estimated numbers, dimensions and weights of the Rotating Equipment's. The actual data on dimensions and weights will be in the vendor data manuals.

The term 'Rotating Equipment' includes all pumps, compressors, steam & gas turbines, fans and blowers, diesel engine/steam turbine/gas turbine generator sets along with drivers accessories & auxiliary systems.

4.2 General Conditions of Erection

4.2.1 All Rotating Equipment erection shall be done by experienced fitters. For this purpose EC shall employ experienced and suitably qualified erection supervisor and crew who have done similar jobs.

4.2.2 The Rotating Equipment manufacturer's instructions as available regarding installation and trial runs will be passed on to EC during the course of work. The requirements prescribed. Therein shall be met in addition to what is stated in this specification. Erection shall be carried out as per instructions of the Rotating Equipment manufacturer's representative and under their supervision whenever the manufacturer is present at site. In all other cases instructions of the EIC, regarding procedure/sequence of erection shall be binding on EC.

4.2.3 For all Rotating Equipment, EC shall follow the proper sequence for assembly and erection. For Rotating Equipment received along with driver in coupled condition, the coupling bolts shall be dismantled by EC, and alignment shall be rechecked. Realignment, if required, shall be done before re-coupling.

Where drivers and couplings are provided separately, drilling and tapping of holes in the base plates for fixing drivers, fixing of couplings on shafts, after enlarging the pilot bores to the correct size with key way etc. and dowelling including provision of dowel pins, alignment screws, jack-up screws or similar arrangements for retaining the alignment shall be carried out by EC as part of erection work. Shims & wedges as required for alignment shall be supplied by EC.

4.2.4 Process and utility (such as cooling water, steam flushing, quenching, lubricating oil, sealing etc.) Connections connected with rotating equipment and its auxiliaries shall be fabricated and/or installed by EC from materials supplied by the Owner as per drawings, specifications and instructions of the EIC.

4.2.5 Piping and accessories supplied with the rotating equipment such as seal oil/Gas system, cooling water system & Lube oil system etc. shall be tagged separately and kept in EC's stores till erection. All flanged connections and openings shall be kept blanked with dummies/plugs to prevent entry of foreign matter.

4.2.6 The local mounted instruments such as pressure gauges, sight glasses, temperature gauges etc. and Local instrument panels, if any, with necessary connections, shall be installed by EC as part of rotating equipment erection.

4.2.7 After initial alignment, the Rotating Equipment's shall be properly grouted. Grouting shall be carried out as per this specification. Wherever grout holes are provides in the base plates, grout shall be filled through the also.

Epoxy grout where recommended by the rotating equipment manufacturer, shall be provided by EC and shall be as specified in this standard.

4.2.8 Alignment between the Driver and driven equipment shall be done without connecting the equipment nozzles to respective piping. After completion of alignment, the equipment shall be connected to Piping. After the piping has been connected, the alignment shall be re-checked by EC, to ensure that piping connections do not induce any undue stresses on the Rotating Equipment's. After making necessary corrections on the piping, if any, re-alignment shall be done by EC and he will ensure that no undue stresses are induced on the Rotating Equipment.

4.3 Special Instructions

EC in addition to general instructions for erection as out lined in Para 4.2 above, shall also follow the following special instructions

4.3.1 Depending upon the size of equipment, Pump train will be supplied for erection in any of the following modes:

(a) Pumps with drivers and accessories fully assembled on a common skid (Base plate).
(b) Pumps mounted on base plate and couplings and driver supplied loose in separate packs.

(c) Various major components such as pump, drivers, couplings, gear boxes & base plates auxiliary systems like lube, seal flush equipment in separate packs.

4.3.2 Reciprocating type Compressors

4.3.2.1 Reciprocating compressors may be supplied for erection in knocked down condition in multiple packaged subassemblies such as frame assembly, distance pieces, fly wheels, cylinder block assemblies, valve assemblies etc. and other accessories such as, drivers, couplings, gear boxes (if any), control panels, gauge boards, coolers, lube oil systems, cooling water systems, etc. would be in separate packages.

Besides the above there would be other packages for loose supplied items such as instruments, pre-fabricated piping, and piping/tubing in commercial lengths.

Lifting devices for erection shall be arranged by EC depending on the weight of packages and elevation of installation.

4.3.2.2 In case of Rotating equipment's received in knocked down condition, the various parts shall be assembled as per instructions of the EIC and as per manufacturer's instructions. All parts of the Compressor shall be thoroughly cleaned with solvents to remove protective compounds if any, before assembly.

4.3.2.3 The compressor, driver and other accessories shall be erected on their respective foundations and the compressor, couplings, gear box and driver shall be aligned and grouted as per the manufacturer's instructions and instructions of EIC and the manufacturers supervisor (when present).There-after all process and utility, drain & vent connections shall be completed as per the relevant drawings/instructions of EIC.

4.3.2.4 Final alignment shall be done after all the piping connections such as water, steam, drains and connection to coolers etc. are made. Tolerances for alignment shall b e maintained as specified in the Manufacturer's Instruction Manual. To ensure that piping connections do not induce a n y undue s t r e s s e s on the Rotating E q u i p m e n t , the alignment shall be checked once again by EC after the piping has been connected. Any correction necessary f o r proper a l i g n m e n t shall be done by EC.

4.3.2.5 EC shall carefully study the vendor drawings, m a n u a l s and other data before start o f the job to ensure correct erection, alignment and commissioning.

4.3.3 Centrifugal Compressors & Expanders

4.3.3.1 Centrifugal Compressors are supplied for erection in multiple packages such as,

- Compressor casings
- Drivers (Electrical m o t o r s , Steam/Gas t u r b i n e s -.)
- {.: Steam/Gas turbines would be further supplied in multiple packages}
- Base plates (or skids)
- Lube oil/control oil systems
- Sealing systems
- Air filters (for gas turbines & compressors for air service)
- Temporary strainers
- Couplings
- Gear boxes
- Coolers
- Gauge boards
- Control panels
- Lube & Seal Oil tanks
- Fire systems (for gas turbines)
- Condenser (for steam turbines)
- Condensate systems (for steam turbines)
- Loose supply items
- Pre-fabricated & Commercial lengths piping, tubing .
- Other miscellaneous packages

4.3.3.2 Other requirements shall be same as defined in para's 4.3.2.2 t o 4.3.2.5 above.

4.4 Trial Runs of Machinery

4.4.1 Any construction defects shall be intimated to EIC before start-up. All protective and safety guards shall be installed and rotating equipment shall be checked for free movement by manual barring over. All foundation bolts and alignment shall be checked before starting the trial runs, if damaged, rotating equipment may have to be opened and repaired as directed by EIC. Prior to carrying out the trial runs, the rotating equipment will be subjected to necessary checks by the EIC and the trial runs shall be commenced only after the approval of the EIC.

4.4.2 Unless otherwise specified, all the rotating equipment will be subjected to trial runs for a continuous operation of 72 hours. In case of motor driven rotating equipment's, motors shall be decoupled and turned over to other agencies doing electrical work for testing and no load running of motors. After the no load runs of motors are satisfactorily completed, EC shall re-couple the motors to the rotating equipment and recheck the alignment. The trial run of the rotating equipment shall be started only after the above is completed. EC shall provide, as part of his work, necessary skilled personnel (excluding the operating personnel) for conducting the trial runs round the clock during the trial runs period. The duration of trial run may be extended if it is considered necessary in the opinion of EIC and EC shall provide personnel for such extended period also. Final inspection of bearing etc. shall be carried out by EC after the Machinery had gone through the trial run and defects, if any, shall be made good for rendering the rotating equipment ready for start-up.

4.4.3 During the trial runs, readings of bearing temperature, cooling water inlet and outlet temperatures, lube oil inlet/outlet temperature and pressure, rotating equipment discharge pressure a n d temperature, starting in current, no load/full load current etc.

shall be recorded, wherever necessary, by EC. Trial reports shall be prepared in the approved proforma by EC containing all the above details and submitted to the EIC as part of completion documents.

4.4.4 EC shall also provide necessary improvised fencing and watch & ward personnel as safety measures during trial runs.

4.5 System Start up

During start-up, EC shall provide necessary skilled personnel as per requirement of EIC, to rectify defects noticed in the rotating equipment, if such defects are attributed to him

5. **EQUIPMENT GROUTING**

All anchor bolt sleeves/pockets and space under Base plates/machine base frames/shoe plates, etc. Shall be grouted with either free flow non shrink cementations or epoxy grout as per the following categorisation:

Sr. No.	Type of Grout	Application
1	Non shrink cementations grout	All static and rotating equipment's, Unless covered in 2) below, viz Static equipment's like tall columns, vertical silo, blender etc. and horizontal vessel, drum, sphere, bullets, filter, heat exchangers, coolers etc. and other Similar equipment's, steel stack/chimney, furnace etc. Low frequency, medium frequency, high frequency rotating machines like compressors (centrifugal, reciprocating, diaphram, screw, gear type etc.). Induced draft fan, forced draft fan, air blowers, pumps (centrifugal, reciprocating, diaphram, gear type etc.), expanders, turbine, generator, diesel generator, air coolers (fin fan cooler) and other Machine like screen vibrator, extractor, centrifuge pulverizer, dryer, drop hammer, ball mill, crushers, bagging machine and general
2	Epoxy grout	Specifically if requested by the Machine vendor

5.1 Grout (Material)

All material used for grout shall be approved by EIC. EC shall submit details for prior approval of EIC. Only approved grout material shall be used.

5.1.1 Non-Shrink Grout

Non-shrink grout shall be premix type of cementitious (cement pregraded fibre and additive) non-shrink, ready to use grout in dry powder form. It shall have free flow property when mixed with required quantity of water. It shall have initial setting time of 30 minutes.

It shall have the following features:

- Non corrosive to anchor bolts, base plate/saddle/frame, sliding plate.
- Not harmful to concrete and reinforcing steel.
- Non toxic
- Frost, oil and fire resistant
- Require normal curing
- Suitable to use under restraints and grout thickness required
- Expansive to counteract initial shrinkage
- Ensure high early strength without surface crack.
- Suitable for temperature of above 0 deg. C to 200 deg. C.
- Maximum flow distance is compatible to the dimensions of base plate/ saddle/frame.
- It should be resisted to the chemicals, gases etc. being handled in equipment/machinery.

It should have the following physical properties:

Minimum Compressive Strength	at 3 Days :	25 kN/mm2
		30 kN/mm2
	at 7 Days :	40 kN/mm2
	at 28 Days	
Minimum Tensile Strength	at 28 Days	20 kN/mm2
Minimum Bond Strength	at 7 Days :	12 kN/mm2
Maximum on strained expan in	2 Hours :	4%
	.	2000 kg/m

5.1.2 Epoxy Grout

Epoxy grout shall consist of epoxy resin base, hardener and filler component like graded and blended aggregate. Components of epoxy grout shall be of desired grade and mixed in proportion recommended by manufacturer such that it is injectable under base plate/frame/saddle, etc., has low viscosity to meet the flow distances according to dimensions of base plate saddle/frame, it is suitable for the desired thickness, it is homogenous, free from segregation, attains high early and high fmal strength. It shall have minimum Pot life of 30 minutes. It shall have all the features as specified in clause 6.1.1 except for expansive properties.

It should have the following physical properties :

Minimum Compressive Strength	at 1 Day	:	75 kN/mm²
	at 7 Days	:	85 kN/mm²
Minimum Flexural Strength	at 7 Days	:	25 kN/mm²

5.2 Grouting (Placement)

5.2.1 Surface Preparation

Prior to positioning of equipment/machine etc. Over concrete pedestal, foundation, slab, beam, etc. All laitance & loose material shall be removed by wire brushing & chipping. The bearing concrete surface shall be sufficiently leveled, hacked with flat chisels to make it rough, clean (using compressed air). Additional chipping, if required, to suit level of base plate and/or minimum thickness of grout shall also be done. In case of use of cementations grout surface shall be thoroughly wet. All pockets for anchor bolts shall also be similarly cleaned. Any excess water shall be removed. In case of use of epoxy grout, it shall be ensured that surface/pocket to receive grout is totally dry. After erection, alignment/plumbing of equipment/machine in required level, orientation and plumb and installation of sliding plate. Forms shall be constructed around and joints made tight to prevent leakage of the grout.

5.2.2 Preparation of Grout

5.2.2.1 In case of premix type of grout water shall be added in required quantity as specified by supplier and/or EIC. Any specific instruction of manufacturer will be strictly followed.

5.2.2.2 In case of epoxy grout required quantity of all constituents shall be mixed in proportion recommended by manufacturer/supplier and/or EIC. All specific requirements of manufacturer supplier shall be strictly followed.

5.2.2.3 Required quantity of grout shall be made considering initial setting/pot life of grout. Any grout not used within initial setting time/pot life shall be rejected and in no case used for grouting.

5.2.3 Placement of Grout

5.2.3.1 Placing of grout shall be taken up only after level, orientation, alignment of equipment/machine has been approved by EIC and anchor bolts are placed in pocket.

5.2.3.2 In case of epoxy grout EC shall give details of grouting scheme and get approval of EIC.

5.2.3.3 The grout mixture shall be poured/injected continuously (without interruption till completion) by grouting pump/injecting gun from one side of base plat and spread uniformly with flexible steel strip and rammed with rods till the space is filled solidly and grout mixture carried to the other side of base plate and fill all pockets. Any specific requirement of manufacturer supplier shall be strictly followed. Epoxy grout shall be done by or under supervision of manufacturer/supplier and/or agency having adequate experience in this field as

per direction of EIC.

Total work shall be done under supervision and direction of EIC and care shall be taken that alignment of equipment/machine is not disturbed

5.2.3.4 Grout mixture shall be allowed to harden for a period of minimum 7 days or as required by manufacturer/supplier of grout and/or as decided by EIC. At the end of this period, the shims/edges/pack plate may be removed and anchor bolts tightened uniformly. Alignment of equipment/machine shall be rechecked and if found correct, the voids left by the removal of shims/wedges/pack plate (if removed) must be filled up with a similar mixture of grout. In case after checking, serious misalignment is indicated, the grout shall be removed completely and fresh grouting is done after making appropriate correction of alignment.

5.2.3.5 Minimum thickness of grout shall be 25mm for all types of grout and maximum thickness shall be 40mm for non-shrink grout. For epoxy grout the maximum thickness shall be as per manufacturer's recommendation and/or as specified in drawing

ENGINEERING STANDARD

GAIL INDIA LIMITED

TECHNICAL SPECIFICATION FOR BALL VALVES

GAIL-STD-PI-DOC-TS-021

0	31.01.19	Issued For Bid	AP	JR	SB	
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1.0 SCOPE

This specification covers the minimum requirements for design, manufacture, testing and supply of carbon steel ball valves of size DN 50 mm (2") and above and ANSI pressure rating 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 provides minimum requirement for design, manufacturing, inspection, testing and supply of Carbon steel Ball Valves of ANSI class 150# to 300# and sizes ½" NB to 24"NB for service in non-sour gas pipelines.

Supply of Ball Valve is in scope of owner / client. This specification is for contractor's reference only.

2.0 REFERENCE DOCUMENTS

Reference has been made in this specification to the latest codes, standards and specifications:

API 6D	:	Specification for Pipeline Valves
API 6FA	:	Specification for Fire Test for Valves
ASME B 16.5	:	Steel Pipe Flanges and Flanged Fittings.
ASME B 16.34	:	Valves - Flanged, Threaded and Welding Ends.
ISO 17292: 2015	:	Metal ball valves for petroleum, petrochemical and allied industries
ASME B 31.8	:	Gas Transmission and Distribution Piping Systems
ASME B 16.5	:	Pipe flanges and flanged fittings
ASMEB 16.10	:	Face-to-face and end-to-end dimensions of valves
ASME B 16.25	:	Butt welding ends
ASME B 16.34	:	Valves – flanged, threaded and welding ends
EN 10204	:	Metallic products: Types of inspection documents
-	:	Data sheet for ball valves
API 598	:	Valve Inspection and Testing
ASME 16.20	:	Metallic gasket for pipe flanges – Ring joint or spiral wounds and jacketed.
ASME 16.21	:	Non Metallic Gaskets for Pipe Flanges.
ASTM A370	:	Standard Test Methods and Definitions for Mechanical Testing of Steel Products.
EN 10204	:	Metallic Materials – Types of Inspection Documents

MSS-SP-6	:	Standard Finishes for Contact Faces of Pipe Flanges and Connecting -end Flanges of Valves and Fittings.
MSS-SP-25	:	Standard marking system for Valves, Fittings, Flanges and Union.
MSS-SP-44	:	Steel Pipeline Flanges.
MSS-SP-53	:	Quality Std for Steel Casting & Forgings for Valves, Flanges & Fittings &Other Piping Components – Magnetic Particle Examination Method.
MSS-SP-55	:	Quality Standard for Steel casting of valves, Flanges, Fittings & other Piping components (Visual Method)
MSS-SP-72	:	Ball Valves with Flanged or Butt welding ends for General Service.
ISO 5208	:	Industrial Valves – Pressure Testing of Valves
ISO 10497	:	Testing of Valves – fire type testing requirements.
ISO 13623	:	Petroleum & Natural Gas Industry – Pipeline Transportation System. Petroleum & Natural Gas Industry. Pipeline Transportation System – Pipeline Valves
ISO 14313	:	NACE TM0177-2005,
SSPC-VIS-1	:	Steel Structures Painting Council Visual Standard. In case of contradiction the most stringent shall apply.
NACE TM0177-2005	:	Standard test method. Laboratory testing of metals for resistance to specific forms of environmental cracking in H2S environments
BS 5351	:	Steel Ball Valves for Petroleum, petrochemical and allied industries
BS EN 331	:	Manually Operated Ball Valves and Closed Taper Plug Valves for Gas Installations
BS 6755-2	:	Testing of Valves. Specification for fire type-testing requirement.

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 service conditions as indicated in valve data sheet), which shall be subjected 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 0.43% (as calculated by the following formula) on check analysis for each heat of steel used:

$$CE = \%C + \frac{\%Mn}{6} + \frac{\%Cr + \%Mo + \%V}{5} + \frac{\%Ni + \%Cu}{15}$$

3.4 The steel used shall be suitable for field welding to pipes, flanges or fittings manufactured under ASTM A -234,A – 694, A – 420, A – 333, and API – 5L etc.

3.5 For all such valves where carbon steel is used as ball material, the ball shall have 75 micrometer (0.003 inch) 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 For valves specified to be used for Gas service or LPG service, Charpy V-notch test, on each heat of base material shall be conducted as per API 6D-Clause 8.5, 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 0°C. Test procedure shall conform to ASTM A 370. The average absorbed energy value of three full sized specimens shall be 27 J. The minimum impact energy value of any one specimen of the three specimens analyzed as above shall not be less than 22 J.

When Low Temperature Carbon Steel (LTCS) materials are specified in Valve Data Sheet oroffered by Manufacturer, the Charpy V-notch test requirements of applicable material standardshall be complied with.

3.7 Valves shall be subjected to hardness test on base material for each heat for pressure containing parts. A full thickness cross section shall be taken for this purpose and the maximum hardness of the material of the valve components shall not exceed 248 HV_{10} based on minimum four (4) measurements.

3.8 The ratio of effective YS/UTS of the steel shall not exceed 0.85.

4.0 DESIGN AND CONSTRUCTION

4.1 Valve design shall be as per API 6D and other referred codes and shall be suitable for the process conditions indicated in the valve Data Sheet. The ASME Boiler & Pressure Vessel Code, Section VIII, Division 1 may be used to design the valve body. Allowable stress requirements shall comply with the provisions of 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 B16.34. The manufacturer shall have valid license to use API monogram on valves manufactured as per API 6D.

4.2 Corrosion Allowance for all valves to be used in sweet gas services shall be considered nil.

4.3 The manufacturer shall have valid license to use API monogram on valves manufactured as per API 6D.

4.4 Valve body design shall be fully welded for underground buried application. For above ground services body design can be either welded or bolted. Threaded body joints shall not be accepted.

4.5 Ball shall be of single piece, solid type construction.

4.6 All valves 4”NB and above shall be trunnion mounting type or as mentioned in the data sheet. Valves below 4” shall be floating/ TMBV type unless specifically mentioned in data sheet otherwise.

4.7 Valve seats shall have metal to metal contact. O - Rings or other seals if used for drip tight sealing shall be encased in a suitable groove in such a manner that it cannot be removed from seat ring and there is no extrusion during opening or closing operation at maximum differential pressure. The seat rings shall

be designed so as to ensure sealing at low as well as high differential pressures. Seat design shall be as per valve data sheet.

4.8 All valves shall have two seating surfaces which in close position blocks the flow from both ends. The cavity between the seating surfaces is vented through a bleed connection provided on the body cavity, i.e., the valves shall be Double Block & Bleed (DBB).

4.9 Valves shall be designed to withstand a sustained internal vacuum of at least 1 (one) milli-bar in both open and closed positions.

4.10 Full bore valves of nominal valve size DN 200 mm (8") & above and Reduced Bore valves ofnominal valve size DN 250 mm (10") & above, shall have provision for secondary sealantinjection under full line pressure for seat and stem seals. All sealant injection connectionsshall be provided with an internal non-return valve. Valve design shall have a provision toreplace the sealant injection fitting under full line pressure. Valves shall be provided with ventand drain connections. Drain sizes shall be in accordance with API 6D or MSS-SP-45. Drainsizes shall be as specified in MSS-SP-45 for valve size NPS 2 to NPS 24. For sizes larger than NPS 24, manufacturer shall specify suitable drain size for purchaser approval.

4.11 All valves shall be provided with a vent and drain connection. Location and arrangementof vents and drains shall be as per Figure-1. Body vent and drain shall be provided with ball valve. Number and size shall be as per Figure-1.

4.12 Valve design shall ensure repair of stem seals/ packing under full line pressure.

4.14 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/ 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 API 6D shall be in accordance with ASME B 16.10. Face-to-face and end-to-end dimensions not shown in API 6D or in ASME B 16.10 shall be as per Manufacturer Standard and shall be subject to approval by Purchaser.

b) The length of butt welding ends shall be sufficient to allow welding and heat treatment without damage of the internal parts of the valves. Pup-Piece length shall be as per valve data sheet.Pipe for pup piece shall be seamless type only.

c) Flanged end shall have dimensions as per ASME B 16.5, for valve sizes up to DN 600 mm (24”) excluding DN 550 mm (22”) MSS-SP-44 shall be referred. Flange face shall be either raised face or ring joint type as indicated in Valve Data Sheet. In case of RTJ flanges, the groove hardness shall be minimum 140 BHN. All flanged face shall have concentric serration with 125- 250 AARH finish.

d) Butt welding end preparation shall confirm to ASME B 16.25. In case of difference in thickness of valve body & mating pipelines, the bevel end of valve shall be as per ASME B 31.8. The end preparation shall take care of outside diameter of connecting pipe, wall thickness, material grade, SMYS & Special chemistry of welded material as indicated in the data sheet.

4.13 The temperature and pressure range of the valves shall be in accordance with the indicated values on the relevant piping specification and valve data sheet.

4.14 Wall thickness of parts used for the welding connection with the line pipe shall meet the following requirements:

a) The maximum allowable stress in the material of butt-welds connection for butt welding shall be equal to 50% of the minimum yield strength guaranteed by the specification of steel used.

b) The minimum wall thickness for butt welding connection must be greater than or equal to the largest valve of either the calculated minimum thickness of butt welding connections or the nominal thickness of pipe as indicated on data sheet.

c) If the butt welding connections has a yield strength lower than the yield strength of the pipe to which it is intended to be welded, the wall thickness in each zone of the butt welding connection is at least equal to the specified pipe wall thickness time the ratio of minimum yield strength guaranteed by the specification of the steel of the pipe & minimum yield strength guaranteed by the specification of the steel of the butt welding connection.

d) The specified pipe wall thickness and grade with which the valve is intended to be used is specified in the data sheet.

e) All valves under this specification shall be designed to withstand a field hydrostatic test pressure with non corrosive water. After installation during 24 hours when the ball is partially or fully open at a pressure level.
P = 1.5 X D.P
P = hydrostatic test pressure (bar)
D.P =Design Pressure.

4.15 Valve shall be provided with ball position indicator and stops of rugged construction at the fully open and fully closed positions.

4.16 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 unless specified otherwise. Tapped holes and eyebolts 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. The lifting lugs shall be stamped with safe working load.

4.17 In order to avoid stress induced crack and soft seat damage during direct field welding operation to valve body, all valves shall be supplied with welded pups at both ends which shall be considered as an integral part of the valves and also the ID of the pup shall match with pipe ID. The pup piece welding shall be carried out in controlled condition of temperature at manufacturer's workshop. Field welding of pup piece shall not be allowed. Material & length of pup piece shall be as per Data sheet.

4.18 When indicated in Material Requisition, valves shall have locking devices to lock the valve either in full open (LO) or full close (LC) positions. Locking devices shall be permanently attached to the valve operator and shall not interfere with operation of the valve. Locking device shall be such that the valve shall operate when the differential pressure across the valve is ≤ 3bar.

4.19 Valve design shall be such as to avoid bimetallic corrosion between carbon steel and high alloy steel components in the assembly. Accordingly, Suitable insulation shall be provided as required.

4.20 The valve stem shall be capable of withstanding the maximum operating torque required to operate the valve against the maximum differential pressure as per the appropriate class.

4.21 The combined stress shall not exceed the maximum allowable stresses specified in ASME Section VIII, Division 1. The design shall take into account a safety factor of 1.5 based on the maximum output torque of the operating mechanism. The valve Manufacturer shall guarantee that the breakaway

torque after long periods of non- movement cannot exceed the normal short term breakaway torque by a factor more than 1.25, and that the safety factor specified above is not compromised.

4.22 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. The Length of stem extension shall be as indicated on the Valve Data Sheet. The length indicated corresponds to the distance between centerline of the valve opening and the centerline of the rim of the hand wheel on vertical shaft or centerline of the hand wheel on a horizontal shaft. In conformity with ISO 17292, 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.

b) Manual override devices shall be provided on all valves

c) Vent, drain and sealant connections shall be terminated adjacent to the valve operator by means of suitable piping anchored to the valve body. The pipe usedshall be API 5L Gr. B/ ASTM A 106 Gr. B, with Sch 160. Fittings shall be ASTM A105/ASTM A234 Gr. WPB, Socket welded ANSI class 600.

d) The stem extension shall be self relieving.

e) 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.

f) Outer casing of stem extension shall have 3/8” or 1/2" NPT plugs at the top and bottom, for draining and filling with oil to prevent internal corrosion.

4.24 Operating Devices

a) In case of manual operation, valve sizes, 100 mm (NPS 4”) and below shall be wrench/ hand wheel/ lever operated for Valves from 6”-10” shall be gear operated.

Valve design shall be such that damage due to malfunctioning of the operator or its control gear train or power cylinder and other damaged parts can be replaced without the valve cover being removed.

b) Thepoweractuatorshallbeinaccordancewiththe PurchaserSpecificationissuedforthe purposeandasindicatedintheValveandActuatorDataSheet.Operatingtimeshallbeas indicatedinValveDataSheet.Valveoperatingtimeshallcorrespondtofullclosetofullopen/ fullopentofullcloseundermaximumdifferentialpressurecorrespondingtothevalverating. Foractuatedvalves,theactuator’sratedtorqueoutputshallbe1.25timesthebreaktorque requiredto operatetheballvalveunderthemaximumdifferentialpressurecorrespondingto theValveClassRating.

c) For the manual operation 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 350N. 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. The wrench length or hand wheel diameter shall be in accordance with API 6D requirements.

The manufacturer shall indicate the number of turns of the hand wheel (for gear operators), required for operating the valve from fully open to the fully closed 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.

f) The direction of closing to be marked on hand wheel.

4.25 Welding including repair welding of pressure controlling parts shall be as per welding procedure qualification specified in ASME Section IX.

4.26 The welders involved in welding shall be qualified in accordance with ASME Section IX.

4.27 Repair by welding is not permitted for 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.

4.28 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.

4.29 When specified on the Valve Datasheet, ball valves shall be “fire safe” in accordance with API 6FA, for which qualifying certificates, covering the range of items offered, shall be supplied by theManufacturer.

4.30 VALVE CONFIGURATION

Valves shall be Full bore (FB) or Reduced bore (RB) as indicated in the Valve Data Sheet.

FULL OPENING VAVE

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 basiswithout causing damage to either the valve component or the pig. The full bore, valve shallprovide an unobstructed profile for pigging operations in either direction. Full bore valves shallbe designed to minimize accumulation of debris in the seat ring region to ensure that valvemovement is not impeded. The bore size of a full bore-valve shall be as per API 6D.

REDUCED OPENING VAVE

The bore size of reduced bore valve shall be as indicated in Table- A below:

TABLE–A

NominalValveSize	**ReducedBoreSizes**	**NominalValveSize**	**ReducedBoreSizes**
DNmm(NPS**inches**)	DNmm(NPS**inches**)	DNmm(NPS**inches**)	DNmm(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)
550(22)	450(18)		

4.31 SEAT DESIGN

Valve seat shall comprise of a hard metallic seat ring energized with bellville or helical spring and shall provide bubble tight shutoff at high pressure. 'O' ring or other seals if used for drip tight sealing shall be encased in a suitable groove in such a manner that it cannot be removed from seat ring and there is no extrusion during opening or closing operation of valve, at maximum differential pressure corresponding to valve class rating.

4.31 Valves shall be designed to withstand a sustained internal vacuum of at least 1 (one) mille-barin both open and closed positions.

4.32 For valves to be used in liquid service, the body cavity over-pressure shall be prevented byself-relieving seat rings/ assemblies. Self-relieving seat rings shall relieve at a body cavitydifferential pressure not exceeding 50% of the valve class rating pressure.

5.0 INSPECTION AND TESTS

5.1 All inspection & testing shall be carried out as per QSL3 of API 6D as minimum and QAP provided elsewhere in the Bid.

The valve manufacturer must deliver a Certificate EN 10204 3.2 stating the quality, the mechanical properties (yield strength, tensile strength, and impact test at - 29 º C), the chemical analysis of the process of manufacture and the marking (for ex: - heat number of material)

A new chemical analysis (up gradation) shall be done on specimen of valve in presence of TPIA.

5.2 All valves shall be visually inspected. The external and internal surfaces of the valves shall be free from any arc strikes, gouges and other detrimental defects.

5.3 Dimensional check on all valves shall be carried out as per the Purchaser approved drawings.

5.4 Chemical composition and mechanical properties shall be checked as per relevant material standards and this specification, for each heat of steel used.

5.5 Pressure containing parts of all valves such as body, bonnet, flange, welding ends and balls etc shall be subjected to impact test on each heat of base material as per API 6D.

5.6 Notch toughness properties Charpy V: The standard impact test temperature is - 29º C. The average value per series of 3 test specimen shall be equal to 35 J/cm². The minimum value per test specimen

shall be equal to 35 J/cm²; this value may drop to 28 J/cm² per only test specimen per series. Number of Tests: 2 test sets (3 test specimens constitute one test set). For casting only 1 test set.

5.7 Non Destructive Examination

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. All castings shall be wet magnetic particle inspected 100% of the internal surfaces. Method and acceptance shall comply with MSS-SP-53.

a) Body castings of all valves shall be 100% radio graphically examined as per ASME B16.34. Procedure and acceptance criteria shall be as per ASME B 16.34. For all sizes body casting shall be subjected to 100% radiography.

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 forgings shall be 100% ultrasonically examined in accordance with the procedure and acceptance standard of Annexure E of ASME B 16.34. All forgings shall be subject to wet magnetic particle inspection on 100% of the internal surfaces. Method and acceptance shall comply with MSS-SP-53.

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 5.7 (a) for cast components or 5.7 (b) for forged components and plates.

5.8 Full inspection by radiography shall be carried out on all welds of pressure containing parts. Acceptance criteria shall be as per ASME Sec-VIII Div.1, ASME B 31.3 or ASME B31.8 as applicable and API 1104.

5.9 a) All finished 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 dyepenetrateorwet - magnetic particle method. Lamination defects in the bevel are not acceptable irrespective of the length. Rejectable defects must be removed. Weld repair of bevel surface is not permitted.

5.10 All valves shall be tested in compliance with the requirements of API 6D. During pressuretesting, 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 included in the hydrostatic shell test. No leakage is permissible during hydrostatic testing.

Following tests shall be performed as per Quality Assurance Plan:-

- High pressure pneumatic (N2), shell and seat testing including extended stem at 1.1 x Design Pressure(300#)
- Air seat test at 7 kg/cm2
- Hyd. Shell Test at 1.5 times of rated design pressure

- High pressure closure test
- Double Block and Bleed Test
- Testing shall be 100% checked and guide line shall be as per API 6D/ ASME B 16.34.
- Antistatic Test shall be with 100% checking and guide line shall be BS EN 17292/ API6D.
- Certificate / records of Fire safe Test shall be as per API 607/ API 6FA.
- Visual inspection shall be 100% as per API 1104 / MSS-SP-55 and Dimension Inspection shall be 100% as per APPR.DRG./ B16.5/ B16.10/ B6.25/ API 6D.

5.11 A supplementary air seat test as per API 6D, Appendix C, Para C3.3 Type II 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.

5.12 Valves shall be subjected to Operational Torque Test as per Appendix C, Para C.6, 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 this specification.

5.13 Subsequent to successful testing as specified 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 min 100 Nos. 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.

Previously carried out prototype test of similar nature shall not be considered acceptable in place of this test.

5.15 Purchaser reserves the right to perform stage wise inspection and witness tests as indicated above at Manufacturer's works prior to shipment. Manufacturer shall give reasonable access and facilities required for inspection to the Purchaser/Company's Inspector. Purchaser or Purchaser representative reserves the right to require additional testing at any time to confirm or further investigate a suspected fault. The cost incurred shall be borne to Manufacturer.

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.

5.16 Checks shall be carried out to demonstrate that the dissimilar metals used in the valves are successfully insulated as per the requirement of clause 4.19 of this specification.

5.17 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 above 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 Company's Inspector.

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 / QAP.

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, Visual, Dimensional.

d) All other test reports and certificates as required by API 6D, this specification and data sheets.

e) Fire safe test certificates as per API 6FA.

f) Test report on operation of valves conforming to clause 5.12, 5.17 and 5.13 of thisspecification.

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 Polyurethane (PU) epoxy resin with a minimum dry film thickness of 1000 microns for UG Valve,300 microns (epoxy point) for AG Valve.

7.2 All valves shall be marked as per API 6D. The units of marking shall be metric except nominal 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.

Design of weld end valves shall be such that during field welding operations, the soft seals or plastic components of the valve (where ever used) is not liable to be damaged. The manufacturer shall

furnish necessary field welding instructions and post-weld test procedureto demonstrate integrity and leak-tightness of valves after field welding operations.

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 and procurement documentation. All valves shall be transported with ball in the fully open condition.

7.6 On packages, following shall be marked legibly with suitable marking ink:

a) Order Number
b) Manufacturer's Name and/or make
c) Valve size and rating
d) Tag Number
e) Serial Number

F) API monogram;

G) API class designation;

H) Maximum Operating Pressure;

I) Part number, year of manufacture and/or order 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) Filled in Data Sheet

b) 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.

c) Sectional drawing showing major parts with reference numbers and material specification. In particular a blow up drawing of ball-seat assembly shall be furnished complying with the requirements of this specification.

d) 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.

e) 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.

f) Clause wise list of deviations from this specification, if any.

g) Descriptive technical catalogues of the manufacturer.

h) Installation, Operational and Maintenance Manual.

i) Copy of valid API 6D Certificate.

j) Details of support foot including dimensions and distance from valve centerline to bottom of support foot.

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 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.

Manufacturer 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 anufacture shall be notified to Purchaser whose approval in writing of all changes shall be obtained before the valve is manufactured.

9.3 CD containing all docs shall be submitted within 30 days from the approval date, Manufacturer shall submit to Purchaser one reproducible and six copies of the approved drawings, documents and specifications.

9.4 Prior to shipment, Manufacturer shall submit to Purchaser one reproducible and six copies of the following:

a) Test certificates

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 only.

10.0 GUARANTEE

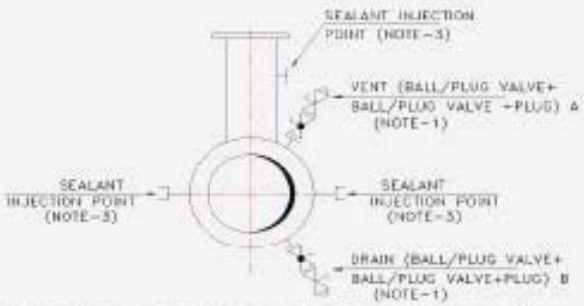
10.1 Manufacturer shall guarantee that the material and machining of valves and fittings comply with the requirements in this specification and in the purchase order.

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.

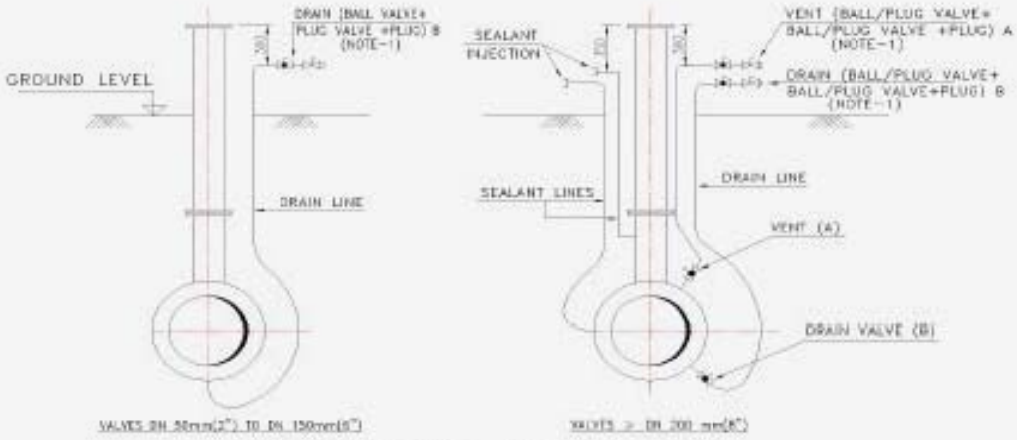
10.3 If valve defect or malfunctioning cannot be eliminated, Manufacturer shall replace the valve without delay.

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.



ABOVE GROUND INSTALLATION



UNDERGROUND INSTALLATION

SIZES OF VENT & DRAIN CONNECTIONS		
NOM. VALVE SIZE	A, DN(mm)	B, DN(mm)
50 TO 150	-	15
200 TO 600	15	25
750 & ABOVE	15	50 [SEE NOTE-2]

LEGEND:
- BALL VALVE
- PLUG VALVE
- PLUG

NOTES:
1. ALL VALVES (BALL OR PLUG) AND PLUGS FOR A AND B SHALL BE APPROVED BY THE PURCHASER.
2. VALVES OF SIZE 50mm SHALL BE MANUFACTURED AS PER API-60.
3. SEALANT INJECTION POINTS SHALL BE PROVIDED FOR FULL OPENING VALVES OF NOMINAL VALVE SIZE 200mm (8") & ABOVE AND REDUCED OPENING VALVES OF NOMINAL VALVE SIZE, DN 250mm (10") AND ABOVE ONLY.
3. IN BURIED SECTION, ALL VENT & DRAIN CONNECTION SHALL BE OF WELDED CONSTRUCTION.

FIGURE-1

VENT, DRAIN & SEALANT INJECTION DETAILS

Tag No.	:	As per PO
Owner Specification No.	:	GAIL-STD-PI-DOC-TS-011
Design Std	:	ASME BPVC SEC VIII DIV 1, ASME B31.8
Size	:	4”
ANSI Rating	:	600#
End Connection	:	Butt Weld Ends ASME B16.25/ ASME B 31.8

VALVE DESIGN CONDITION

Corrosion Allowance	:	0.5 mm	Temperature in °C	:	(-)20 to (+)65
Service	:	Natural Gas (Non-sour)	Installation	:	A/G
Design Factor	:	0.5	Connecting Pipe	:	4 Inch (API 5L X42), 6.4 mm WT

VALVE MATERIAL SPECIFICATION (Equivalent or superior)

Description	**Material Specified**	**Material Offered****
Body	MSS SP-75, WPHY Gr.42/ ASTM A 694 Gr. F 42.	
Pup Piece	Seamless API 5L X-42 6.4 mm	
Insulation	As per specification	

**- To be filled by vendor

TESTING REQUIREMENTS

Charpy Impact	:	(-)20 °C
Hydrostatic Test	:	1.5 x Design Pressure (Duration 1 hour)
Pneumatic test	:	7 Bar, duration 10 mins
Di-electric Strength Test	:	5 KV 50 Hz AC for 1 min (Before & after hydro-test)
Insulation Resistance Check	:	>50 M-Ω (1000 V DC) (After Hydro-test)
Vacuum Test	:	5 millibar, duration 5 min
Adhesion Test	:	Min 5 Mpa
Holiday Test	:	2.5 kV AC 50 Hz
Cyclic Test	:	40 cycles from 10 Bar (g) to 85% hydro-test pressure

NOTES:

1. This data sheet shall be read in conjunction with Standard Specification, and PMS (if any).
2. The pup piece shall be conformed to connecting Line Pipe and comply all chemical and mechanical testing requirements as per Owner requirement.
3. For the welding end, the out of roundness (i.e. difference between maximum and minimum ID at pipe end) tolerance shall be as per API 5L.
4. Manufacture shall ensure that the wall thickness of all parts of Insulating joint is adequate to sustain design pressure and temperature. Also selected wall thickness shall be suitable for welding with wall thickness of connected pipeline.
5. The Charpy V-notch test shall be conducted at -20°C. Test procedure shall conform to ASTM A 370. The average absorbed energy value of three full sized specimens shall be 35J. The minimum impact energy value of any of the specimen analyzed as above shall not be less than 28 J.
6. All Inspection and tests shall be carried out. Unless otherwise specified, all tests shall be witnessed by the purchase / control authority.
7. Insulating material shall meet requirement specified in Standard Specification/ Data Sheet for Insulating Joints.

8. Minimum Dry film thickness of paint shall be 400 microns for both Inner & outer coating.
9. Pipe pup length shall be min 500 mm or 1 times outside diameter whichever is higher.
10. Material compliance as per EN 10204 3.2 certification.
11. The painting shall be carried out as per Vendor Specification / Data Sheet.
12. Minimum Marking: Manufacturer Name, Nominal Diameter, Heat number, Tag number, Material, Design Pressure, and Hydro test Pressure, Year of Manufacturing.

Tag No.	:	As per PO
Owner Specification No.	:	GAIL-STD-PI-DOC-TS-011
Design Std	:	ASME BPVC SEC VIII DIV 1, ASME B31.8
Size	:	12”
ANSI Rating	:	600#
End Connection	:	Butt Weld Ends ASME B16.25/ ASME B 31.8

VALVE DESIGN CONDITION

Corrosion Allowance	:	0.5 mm	Temperature in °C	:	(-)20 to (+)65
Service	:	Natural Gas (Non-sour)	Installation	:	A/G
Design Factor	:	0.5	Connecting Pipe	:	12 Inch (API 5L X60), 8. 7 mm WT

VALVE MATERIAL SPECIFICATION (Equivalent or superior)

Description	**Material Specified**	**Material Offered****
Body	MSS SP-75, WPHY Gr.60/ ASTM A 694 Gr. F 60.	
Pup Piece	Seamless API 5L X-60 8.7 mm	
Insulation	As per specification	

**- To be filled by vendor

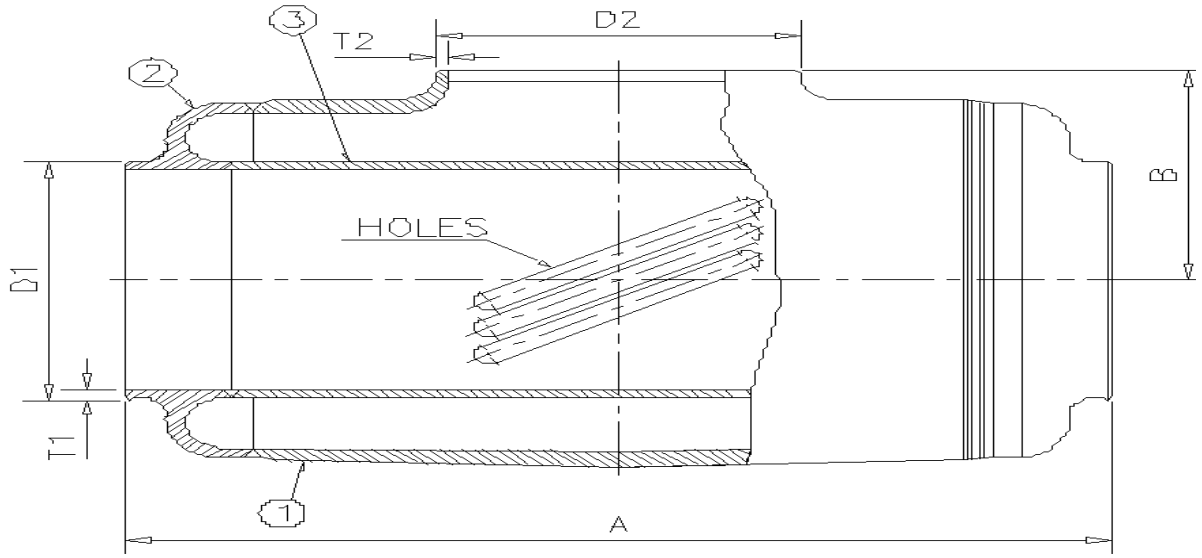
TESTING REQUIREMENTS

Charpy Impact	:	(-)20 °C
Hydrostatic Test	:	1.5 x Design Pressure (Duration 1 hour)
Pneumatic test	:	7 Bar, duration 10 mins
Di-electric Strength Test	:	5 KV 50 Hz AC for 1 min (Before & after hydro-test)
Insulation Resistance Check	:	>50 M-Ω (1000 V DC) (After Hydro-test)
Vacuum Test	:	5 millibar, duration 5 min
Adhesion Test	:	Min 5 Mpa
Holiday Test	:	2.5 kV AC 50 Hz
Cyclic Test	:	40 cycles from 10 Bar (g) to 85% hydro-test pressure

NOTES:

1. This data sheet shall be read in conjunction with Standard Specification and PMS (if any).
2. The pup piece shall be conformed to connecting Line Pipe and comply all chemical and mechanical testing requirements as per Owner requirement.
3. For the welding end, the out of roundness (i.e. difference between maximum and minimum ID at pipe end) tolerance shall be as per API 5L.
4. Manufacture shall ensure that the wall thickness of all parts of Insulating joint is adequate to sustain design pressure and temperature. Also selected wall thickness shall be suitable for welding with wall thickness of connected pipeline.
5. The Charpy V-notch test shall be conducted at -20°C. Test procedure shall conform to ASTM A 370. The average absorbed energy value of three full sized specimens shall be 35J. The minimum impact energy value of any of the specimen analyzed as above shall not be less than 28 J.
6. All Inspection and tests shall be carried out. Unless otherwise specified, all tests shall be witnessed by the purchase / control authority.
7. Insulating material shall meet requirement specified in Standard Specification/ Data Sheet for Insulating Joints.
8. Minimum Dry film thickness of paint shall be 400 microns for both Inner & outer coating.

9. Pipe pup length shall be min 500 mm or 1 times outside diameter whichever is higher.
10. Material compliance as per EN 10204 3.2 certification.
11. The painting shall be carried out as per Vendor Specification / Data Sheet.
12. Minimum Marking: Manufacturer Name, Nominal Diameter, Heat number, Tag number, Material, Design Pressure, and Hydro test Pressure, Year of Manufacturing.



DESIGN DATA			
Design Standard		ANSI B 31.8 for Tee and internal Sleeve ASME Sec VIII Div I for End Piece	
Dimension Standard		ANSI B 16.9& ASME B 16.25	
Service		Natural Gas(NG)	
Installation		Above Ground/ Under Ground	
ANSI Class		600#	
Design Pressure		98 barg	
Design Temperature (°C)		-29 to 65 (Above Ground) -29 to 60 (Under Ground)	
Corrosion Allowance(mm)		0.5 mm 3.0 mm for End Piece. 1.6 mm for Tee & Internal Sleeves	
Design Factor (F)		0.5	
Hydrostatic Test Pressure		1.5 x Design Pressure(For 15 Mins)	
Suitability of Flow Tee		FOR ALL TYPES OF PIGS	
Flow Direction		Bi-directional	
Hardness Test		As per specification	
Charpy Impact Test		At -29 deg C	
FLOW TEE MATERIAL (Equivalent or superior)			
Part No.	Description	Material of Construction	
		Specified	Offered
1	Tee	ASTM A 860 WPHY-52/MSS-SP-75, GR.WPHY-52	
2	End Pieces/Forged Rings	ASTM A 694 Gr.F52	

3	Internal sleeve	API 5L Gr B (SMLS) Or Equivalent	

S.NO	**CONNECTING PIPELINE DETAILS**					
	RUNNING PIPE DETAILS		**BRANCH PIPE DETAILS**			
	O.D.(inch)	MATERIAL	O.D.(inch)	MATERIAL	Loc.	Qty.
1	4”	API 5L Gr X 52 (PSL-2) 6.4 mm thk.	4”	WPHY-52	AG	
2	8”	WPHY-52	8”	WPHY-52	AG	

NOTES:

1. Manufacturer to indicate dimensions A, B, T1 and T2 marked in the sketch above.
2. Documents of successful Proof Test & Type Test shall be verified by TPIA.
3. All flow tees shall be completely stress relieved as per MSS SP-75 (After welding).
4. Vendor has to submit all required design & thickness calculations for client approval.
5. Holes/ Slots in the sleeve shall be arranged at 45 degto the center line of Flow Tee.
6. For the welding end, the maximum out of roundness (i.e. difference between maximum and minimum ID at pipe end) shall be less than 5.0 mm and tolerance on internal diameter at pipe ends shall be same as diameter tolerance for the pipe ends indicated in API 5L Table 8.
7. Bevel end preparation shall be as per ANSI B 16.25.
8. The wall thickness of ends of Flow Tee shall match with run pipe and branch pipe thickness.
9. Manufacturer shall ensure that the wall thickness (W.T.) of all parts of flow tee shall be adequate to sustain design pressure and selected wall thickness shall be suitable for welding with wall thickness of connecting Pipeline/Piping.
10. Manufacturer shall furnish details of slots in internal sleeve. The area of slot shall be 1.5 times the area of branch internal diameter and relevant calculations have to be furnished.
11. All testing shall be carried out as per approved QAP.
12. TPIA shall issue 3.2 certificates as per EN 10204.

QUANTITY	2	**SIZE**	VTC
SERVICE		NATURAL GAS	

DESIGN CONDITIONS	
Type	BAND LOCK WITH O RING
PRESSURE (BAR g)	98
TEMPERATURE (°C)	(-)29 to 65
CORROSION ALLOWANCE(mm)	3
DESIGN CODE (DOOR & HUB)	ASME SEC. VIII DIV. 1- LATEST VERSION
ANSI RATING	600#
HYDROSTATIC TEST PRESSURE(BAR g)	147 @ min. 4 hr. with barrel.
Hinge orientation	LEFT/RIGHT HAND
Closure Orientation	Horizontal
Equipment (for which QOEC required)	Scraper trap L/R
ASME U Stamp requirement	Yes

QOEC MATERIAL DETAIL

PART	**SPECIFIED MATERIAL**	**MATERIAL OFFERED**
PRESSURE CONTAINING PARTS	VTC	
INSERTS/Door Seal	Viton	

Connecting Major Barrel Material Detail

S.NO.	O.D.(inch)	MATERIAL
1	8”	API 5L Gr. X-42/ Equivalent material

Inspection Testing & Certification		
1	EN 10204 3.2 certification	DOOR & HUB
2	MPI ON WELD PREPARATION	YES
3	UST of HUB	YES
4	UST of DOOR	YES
5	IMPACT TESTING	At -29

Note: VTS: Vendor to confirm

1. Commissioning spares: 2 nos. seals provided for each tag no.
2. QOEC shall be designed for a vacuum of 1 mili bar (abs.)
3. All Testing & inspection shall be carried out as per approved QAP of QOEC.

1. PROCESS DATA :	
PIPE CLASS	6A1
PRESSURE RATING	600 #
FLUID	NATURAL GAS
Fluid Symbol	NG
OPERATING CONDITIONS	
Pressure (barg)	-
Temperature (°C)	-
DESIGN CONDITIONS	
Pressure (barg)	98
Temperature (°C)	-29 TO 65 for A/G
2. CONSTRUCTION DATA :	
DESIGN AND CONSTRUCTION CODE	To suit WNRF flange as per ASME B16.5
BORE	To suit WNRF flange as per ASME B16.5
MAKE / MODEL	(*)
INSULATING GASKET	GLASS REINFORCED EPOXY (GRE) resin (G10 orG11) with O ring or spring energized seal made from rubber/PTFE
INSULATING WASHER	GRE Washers
INSULATING SLEEVE MATERIAL	GRE Sleeve
METALLIC WASHER	Zn plated steel
INSULATING GASKET KIT	
INSULATING GASKET	One central gasket
INSULATING SLEEVE	One Nos. per bolt
INSULATING WASHER	Two Nos. per bolt
METALLIC WASHER	Two Nos. per bolt
INSPECTION AND TESTING	
HYDROSTATIC TEST	Tested at 1.5 times of Design Pressure in following manner • 5 minutes at hydrotest pressure (at 1.5 times the rated pressure at 100°F) • Reduce to Zero.
PNEUMATIC TEST	Insulating flange assembly shall be tested with air at 5 kg/cm² for 10 minutes. The tightness shall be checked by immersion or with a frothing agent. No leakage shall be accepted.
DIELECTRIC TEST	Each insulating gasket shall be tested for dielectric integrity at 5000 V A.C; 50 Hz for one minute and the leakage current before and after shall be equal. Testing time, Each Insulating Gasket Assembly shall be Dielectric Tested before and after hydrostatic Test.
INSULATION RESISTANCE	Each insulating gasket assembly shall be at least 25 mega ohms when checked with 500V – 1000V D.C. This test shall

	be carried out in dry conditions.
TESTING INSPECTION AND CERTIFICATES	Refer to Quality Assurance Plan
DIMENSIONAL STANDARD	Manufacturer's standard
MARKING	Manufacture name TAG Number
MATERIAL CERTIFICATES	EN 10204 Latest Edition

Notes:

1. Manufacture shall guarantee that proposed Insulating Gasket shall withstand test pressure equal to 1.5 times design pressure of Pipeline.
2. The Non Metallic Gasket as per ASME B 16.21 shall match flanges to ASME B 16.5 up to 24" (except size 22).
3. Voltage and leakage shall be recorded and certified. The test shall be carried out in dry conditions for insulations Resistance test.
4. Insulating Gasket shall be fitted in Flanges (Weld neck raised face & Blind).
5. Flanges Dimension standard shall be as per ASME B 16.5.
6. (*) To be indicated by vendor in his bid.

ENGINEERING STANDARD

GAIL INDIA LIMITED

DATA SHEET - CLEAN AGENT SYSTEM

GAIL-STD-PI-DOC-DS-006

0	25.01.2019	Issued for Bid	AP	JR	SB	
Rev	**Date**	**Purpose**	**Prepared By**	**Checked By**	**Approved By**	

ABBREVIATIONS:

kg/m^2 : Kilogram Per Square Meter

NFPA : National Fire Protection Association

CONTENTS

Sl.No.	Description	Page No.
Annexure – II	Data Sheet for clean agent system…….4	

ANNEXURE-II DATA SHEET

DETAILS TO BE FURNISHED BY THE BIDDER ALONG WITH THE OFFER

(Clean Agent Data sheet shall be filled in as per NFPA-2001separately for each station)

1.0	Type of system	:	Total flooding centralized system (Mention name of agent & manufacturer)
		:	Formula
	Normal Charging Pressure	:	____C____

2.0	Design code/standard to which design/ manufacture/testing conforms.	:	NFPA-2001-(Latest)
3.0	System designed to protect the largest or total risk in the building as specified.	:	Largest risk
3.1	Risk/volume	:	C
3.2	Design Concentration	:	C
3.2.1	Amount of gas required. (Attach separate sheet, if required). (List out gas supplied, number of cylinders etc. for working and. standby requirements, risk wise.)	:	C
3.3	Clean agent Cylinder Details (Seamless)		
	a) Manufacturer	:	C
	b) Design Code	:	
	NFPA-2001 c)		
	Capacity (Preferably: - IG-01, 55, 541 & 100	:	
	d) Gas Holding Capacity (kg)	:	C
	e) Total number supplied	:	C
	f) Approving Agency TAC FM/UL/LPC/ VDS & TAC (This must be acceptable to TAC).	:	FM/UL/LPC/VSD &
	g) Approved-by CCE	:	YES
	h) Working pressure (kg/cm^2)	:	C
	i) Design Pressure (kg/cm^2)	:	As per NFPA-2001
	j) Dimension of Cylinder Dia x length x thickness	:	C

3.4 Pipes, valves and fittings.
a) Manufacturers

i.	Pipes	:	Approved vendor
ii.	Fittings	:	Approved vendor
iii	Valves	.	C

b) Material for Construction

i.	Pipes	:	As per specification
ii.	Fittings	:	As per specification
iii.	Valves	:	As per specification

c) Design Code

i.	Pipes	:	As per NFPA
ii.	Fittings	:	As per NFPA
iii.	Valves	:	As per NFPA

d) Type of Joints : As per NFPA

e) Hydraulic test Pressure of Manifold/supply lines (kg/cm^2) : As per NFPA

f) Directional Valve

i.	Make and Type	:	C
ii.	Material of Construction	:	C
iii.	Test Pressure (kg/cm^2)	:	C
iv.	Approved by FM/ULNDS /LPC & TAC (Yes/No)	:	C

g) Discharge Nozzles

i. Manufacturer and Type C

h) Pressure Gauge

i.	Make	:	C
ii.	Pressure Range	:	C
iii.	Approved by FM/UL/VDS /LPC & TAC (Yes/No)	:	C

i) Pressure Reducer

i.	Make	:	C

ii.	Approved by FM/UL/VDS /LPC & TAC (Yes/No)	:	C
j)	Cylinder valve		
i.	Make	:	C
ii.	Approved by FM/UL/VDS /LPC & TAC (Yes/No)	:	C
k)	Cylinder valve actuator		
i.	Make	:	C
ii.	Approved by FM/UL/VDS /LPC & TAC (Yes/No)	:	C
3.5	Painting and coloring of pipeline	:	C (As per O-611)
4.0	Material of Construction selected in accordance with 'NFPA-2001' (Yes/No)	:	C
5.0	Inspection and Testing		
a)	Visual inspection of installed system & hazard area.	:	C
b)	Check of labeling of devices.	:	C
c)	Check for mechanical tightness of piping and associated equipments	:	C
d)	Non-destructive operational tests for all devices included.	:	C
e)	Test with clean agent gas (one no. Cylinder)	:	As per pump

Legend:-

C : Bidder to furnish data/details.

DATA SHEET FOR BALL VALVES (BELOW 2" 800#)			
Sr. No.	**Description**		**Specification**
GENERAL			
1	Valve Size		Below 2"
2	ANSI Rating		ANSI 800#
3	Design Standard		BS EN ISO 17292 / API 6D
4	Corrosion allowance		1.5MM
5	Design Factor		0.5
SERVICE CONDITIONS			
6	Service		Natural Gas
7	Design Pressure		98 Bar-g
8	Design Temperature		-29°C to 65°C
VALVE CONSTRUCTION DESIGN			
9	Location		Above Ground
10	Valve Type		Floating
11	Bore		Full Bore
12	End Connections		Socket welded (as per ASME B 16.11)
13	Locking arrangement		Locking facility with stops for both fully open position and fully closed position
14	Welded/ Bolted		Required
15	Bi- Directional		Required
16	Double Block and Bleed		Not Applicable
17	Blow out proof stem		Required
18	Anti-static device		Required
19	Lever operation		Required
20	Open and close Ball position indicator		Required
VALVE MATERIAL SPECIFICATION			
	Part		**Specified Material / Equivalent Material**
21	Body		ASTM A 105
22	Ball (SOLID)		13% Cr Steel / SS-316
23	Seat		RPTFE with secondary metal to metal
24	Stem (ANTI BLOW OUT)		13% Cr Steel / SS-316 (No Casting)
25	Stem seals		Grafoil / PTFE V-RING+Grafoil
26	Stud bolts / Nuts		ASTM A 193 Gr. B7/ASTM A 194 Gr. 2H
27	Anti-static device		SS302
28	Gland Packing		GRAFOIL
VALVE TESTING REQUIREMENT			
29	Fire Resistant Design Requirement		As per API 6FA/API 607
30	Hydrostatic Test	Body	147 barg& 30 Min

		Seat	107.8barg & 30 Min
31	Air Seat Test		7.0 barg& 15 Min
32	Anti Static Test		As per API 6D Latest Edition
33	Torque Test		As per relevant code

NOTES:

1. This Valve data sheet shall be read in conjunction with Technical specification of Ball valve/QAP.
2. Vendor to confirm the suitability of material for specified pressure-temperature rating.Valves shall be lever operated
3. All Valves Shall be Provided with antistatic feature and antistatic test as per ISO EN 17292 / API 6D shall be performed.
4. All valves shall be provided with anti blowout proof arrangement as per ISO EN 17292 / API 6D.
5. All Inspection and tests shall be carried out as per relevant approved QAP. Unless otherwise specified, all tests shall be witnessed by the approved third party inspection agency.
6. TPIA shall issue EN 10204 3.2 certification for valve.
7. Vendor shall submit cross sectional drawing, catalogues showing the material of construction for each component of the valve as a part of documents.
8. Valve shall have position indicator showing open and close positions.

DATA SHEET FOR BALL VALVES (BELOW 2” 800#)			
Sr. No.	**Description**		**Specification**
GENERAL			
1	Valve Size		Below 2"
2	ANSI Rating		ANSI 800#
3	Design Standard		BS5353
4	Corrosion allowance		1.5MM
5	Design Factor		0.5
SERVICE CONDITIONS			
6	Service		Natural Gas
7	Design Pressure		98 Bar-g
8	Design Temperature		-29°C to 65°C
VALVE CONSTRUCTION DESIGN			
9	Location		Above Ground
10	Valve Type		Quarter Turn, Socket Welded
11	Bore		NA
12	End Connections		Socket welded (as per ASME B 16.11)
13	Locking arrangement		NA
14	Anti-static device		Required
15	Lever operation		Required
VALVE MATERIAL SPECIFICATION			
	Part		**Specified Material / Equivalent Material**
16	Body		ASTM A 105
17	Plug (Lubricated)		ASTM A105 + 0.003” ENP
18	Cover		ASTM A105
19	Stem (ANTI BLOW OUT)		AISI 4140 + 0.003” ENP / AISI 410
20	Stem seals		PTFE / RPTFE
21	Stud bolts / Nuts		ASTM A 193 Gr. B7/ASTM A 194 Gr. 2H
22	Lubricant Screw		Manufacturer’s Standard
23	Handle/Lever/Hand Wheel		Carbon Steel
24	Gland		ASTM A105
VALVE TESTING REQUIREMENT			
25	Fire Resistant Design Requirement		As per API 6FA/API 607 Latest Edition
26	Hydrostatic Test	Body	147 barg & 30 Min
		Seat	107.8barg & 30 Min
27	Air Seat Test		7.0 barg & 15 Min
28	Anti Static Test		As per API 6D Latest Edition

29	Hardness Test	248 HV10
30	Valve Painting	As per Painting Specification (Suitable for corrosive Industrial Environment)

NOTES:

1. This Valve data sheet shall be read in conjunction with Technical specification of Plug valve/QAP.
2. All tests shall be as per BS 6755,Part-I / API 598 / API 6D
3. Gland packing assembly shall permit repair of gland packing under full line pressure
4. Minimum port area for regular pattern shall be 55%.
5. Valve shall have an inherent feature using the line pressure to ensure that the line pressure cannot cause taper locking of the plug/plugmovement into the taper i.e. valves shall be of “pressure balanced” design.
6. All valves shall be provided with valve position indicator.
7. Separate wrench shall be provided with each valve.
8. Plug valves in accordance with API-599 / API-6D are also acceptable.
9. Gland packing material shall be provided with corrosion inhibitor.

DATA SHEET FOR GLOBE VALVES		
Sr. No.	**Description**	**Specification**
GENERAL		
1	Valve Size	Below 2"
2	ANSI Rating	ANSI 800#
3	Design Standard	BS 1873
4	Corrosion allowance	1.5MM
5	Design Factor	0.5
SERVICE CONDITIONS		
6	Service	Natural Gas
7	Design Pressure	98 Barg
8	Design Temperature	-29°C to 65°C
VALVE CONSTRUCTION DESIGN		
9	Location	Above Ground
10	End Connections	Socket Welded (As per ASME B 16.11)
11	Body/ Bonnet connection	Bolted
VALVE MATERIAL SPECIFICATION		
	Part	**Specified Material or Equivalent Material**
12	Body	ASTM A 105
13	Bonnet& Yoke Material	ASTM A 105
14	Stem (NO CASTING)	13% Cr. Steel (No Casting)
15	Disc (Plug Type)	STELLITED
16	Body Seat Ring	STELLITED
17	Gland Packing	Graphited Asbestos with Sacrificial Corrosion Inhibitor & Inconel Wire Reinforcement.
18	Stem seals	As per Manufacturer's recommendation
19	Stud bolts / Nuts	ASTM A 193 Gr. B7 / ASTM A 194 Gr. 2H
20	Bonnet Gasket Type	Spiral Wound inner & outer SS316 ring
21	Seat and back seat arrangement	Renewable
24	Hand Wheel	Carbon steel
VALVE TESTING REQUIREMENT		
25	Hydrostatic Test	Body: 147 barg & 30 Min; Seat: 107.8 barg & 30 Min
26	Anti-Static Testing Requirement	As Per Code

27	Pneumatic Test Pressure & Time	7 Barg, duration shall be at least 15 minutes
28	NDE Test	Refer Note no -8
29	Hardness Test	248 HV10
30	Charpy Impact Test @ Temperature	Yes (at -29 deg. C)
31	Fire Safe Test Design	API 6FA / ISO10497
32	Valve Painting Specification	As per Painting Specification (Suitable for Corrosive Industrial Environment)

NOTES:

1. This Valve data sheet shall be read in conjunction with Job specification /QAP of Globe valve.
2. Vendor to confirm the suitability of material for specified pressure-temperature rating.
3. Vendor shall submit cross sectional drawing, catalogues showing the material of construction for each component of the valve as a part of documents.
4. All Inspection and tests shall be carried out as per relevant approved QAP. Unless otherwise specified, all tests shall be witnessed by the approved third party inspection agency.
5. Valve shall be OS & Y type. Flow direction shall be mark on body and Valves shall be suitable for Horizontal installation.
6. TPIA shall issue EN 10204 3.2 certification for valve.
7. Each valve shall be tested as per BS EN 12266 (Part-1 & 2) / API 598.
8. Non Destructive Examination

    - Body castings of all valves shall be 100% radio graphically examined as per ASME B16.34. Procedure and acceptance criteria shall be as per ASME B 16.34. For all sizes, body casting shall be subjected to 100% radiography.
    - All forgings shall be ultrasonically examined in accordance with the procedure and acceptance standard of Annexure E of ASME B 16.34.
    - Full inspection by radiography shall be carried out on all welds of pressure containing parts. Acceptance criteria shall be as per ASME B31.8 and API 1104 as applicable.
    - All finished 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.

- 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.
- After final machining, all bevel surfaces shall be inspected by dye penetrate or wet - magnetic particle methods. All defects longer than 6.35 mm shall be rejected. Reject able defects must be removed. Weld repair of bevel surface is not permitted.

		PROJECT: GAIL ARC - INVENTORY CREATION PROJECT FOR LAST MILE CONNECTIVITY **CLIENT: GAIL INDIA LTD.** **CONSULTANT: LEPL** **VENDOR:**					**QAP No.: GAIL--034-PL-QAP-003** **ITEM DESCRIPTION/QUANTITY: FLOW TEE** **Prepared:** AP **Checked:** JR **Approved:** SB		
Sr. No.	**Operation**	**Characterstics**	**Extent of Check**	**Reference Document**	**Acceptance Criteria**	**Format Of Records**	**Inspection By**		**Remarks**
							Supplier	**TPIA**	
1	**Procedure**								
1.1	Heat Treatment, NDTand Other Procedures	Documented Procedures	100%	Refer Note-6	Refer Note-5	Procedure Documents	H	R	
1.2	WPS,PQR & WPQ	Welding Parameters & Qualification Record	100%	Refer Note-6	Refer Note-5	WPS,PQR & WPQ	H	W- New R-Existing	
1.3	Design Proof Test*(To be conducted under TPI appointed by supplier)	Hydrostatic proof test	100%	Refer Note-6	Refer Note-5	Proof test record	H*-New R-Already qualified	R	
2	**Material Inspection**								
2.1	Pipes / Fittings / Forgings (Pressure containing parts)	Chemical, tensile, impact, hardness, NDT, Heat treatment and other applicable Properties	100%	Refer Note-6	Refer Note-5	Test Certificates	H	Chem & Mech testing of raw material - W	
3	**In Process Inspection**								
3.1	Raw material Identification of pressure containing parts	Verification of marking & correlation with MTC	100%	Refer Note-6	Refer Note-5	MTC, Inspection Report	H	W	
3.2	Raw Material Identification of non pressure parts	Chemical & mechanical properties	100%	Refer Note-6	Refer Note-5	MTC, Inspection Report	H	R	
3.3	Welding	Welding Parameters as per WPS / PQR	100%	Refer Note-6	Refer Note-5	Inspection Reports	H	R	

	PROJECT: GAIL ARC - INVENTORY CREATION PROJECT FOR LAST MILE CONNECTIVITY CLIENT: GAIL INDIA LTD. CONSULTANT: LEPL VENDOR:	QAP No.: GAIL--034-PL-QAP-003 ITEM DESCRIPTION/QUANTITY: FLOW TEE Prepared: AP Checked: JR Approved: SB

Sr. No.	Operation	Characterstics	Extent of Check	Reference Document	Acceptance Criteria	Format Of Records	Inspection By		Remarks
							Supplier	TPIA	
3.4	Heat Treatment as applicable	Heat treatment temperature and time	100%	Refer Note-6	Refer Note-5	HT chart / Record	H	START & STOP TEMP. CHART SHALL BE SIGNED BY TPIA, ALSO POWER FAILURE LOG SHALL BE MAINTAINED	
3.5	RT of pressure containing butt welds	Defects	100%	Refer Note-6	Refer Note-5	RT Film / Report	H	R	
3.6	UT/LPT/MPT as applicable	Lamination / Defects	100%	Refer Note-6	Refer Note-5	NDT Report	H	UT- W , rest – R.	
4	**Final Inspection**								
4.1	Visual and Dimensional Inspection (VDI)	Surface Condition / Dimensions, Marking, etc	100% By Supplier & At RandomBy TPIA	Refer Note-6	Refer Note-5	Inspection Report	H	H	
4.2	Final Stamping	Stamping of accepted flow tees	100%	Refer Note-6	Refer Note-5	Inspection Report	H	H	
5	**Painting**								
5.1	Corrosion protection painting & Color Coding as applicable	Visual Inspection & Color Coding	100%	Refer Note-6	Refer Note-5	Inspection Report	H	R	
6	**Documentation & IC**								
6.1	Documentation & Inspection Certificate(IC)	Review of Stage Inspection Reports / Test Reports & Issue of IC	100%	Refer Note-6	Refer Note-5	Manufacturer TC & IC	H	H	
6.2	Final Document submission	Compilation of Inspection reports, drawings, etc as per VDR / PR	100%	Refer Note-6	Refer Note-5	Final data folder/Completeness certificate	H	H	

LEGENDS:

H- Hold (Do not proceed without approval), Random -10%, **R**-Review, **RW**- Random Witness, **W**-Witness (Give due notice, work may proceed after scheduled date).

	PROJECT: GAIL ARC - INVENTORY CREATION PROJECT FOR LAST MILE CONNECTIVITY **CLIENT: GAIL INDIA LTD.** **CONSULTANT: LEPL** **VENDOR:**	**QAP No.: GAIL--034-PL-QAP-003** **ITEM DESCRIPTION/QUANTITY: FLOW TEE** **Prepared:** AP **Checked:** JR **Approved:** SB

Sr. No.	Operation	Characterstics	Extent of Check	Reference Document	Acceptance Criteria	Format Of Records	Inspection By		Remarks
							Supplier	TPIA	

NOTES:

1. Wherever W/R is indicated, Inspection Engineer shall decide the option to be exercised for the particular stage and supplier.
2. Supplier's in house procedures may be accepted in case TPI is satisfied with adequacy of procedures to comply with Purchase Order/Specifications Requirements. In case of non availability of suitable procedures, fresh procedures may be qualified under TPI witness.
3. In case of conflict between purchase specification, contract documents and QAP, more stringent conditions shall be applicable.
4. This document describes generally the requirements pertaining to all types of the item. Requirements specific to PO and the item are only applicable.
5. Acceptance Norms/ Acceptance Criteria for all the activities shall be as per relevant specification/ data sheets/applicable codes & standards etc. referred there in /Job Specification /Approved Documents.
6. Reference documents are relevant Specifications/ Data sheets/ Applicable Codes & Standards.
7. For all forging materials, The specimen shall br taken from the integral part of the forging.
8. TPIA shall issue 3.2 certificate as per BS EN 10204

Abbreviations:

CCE or CCOE	:	Chief Controller of Explosives	MPT/MT	:	Magnetic Particle Testing
CEIL	:	Certification Engineers International Limited	MRT	:	Mechanical Run Test
CIMFR	:	Central Institute of Mining & Fuel Research	MTC	:	Material Test Certificate
CE	:	Carbon Equivalent	NPSH	:	Net Positive Suction Head
DFT	:	Dry Film Thickness	NDT	:	Non Destructive Testing
DT	:	Destructive Testing	PO	:	Purchase Order
DPT	:	Dye Penetrate Testing	PESO	:	Petroleum Explosive Safety Organization
DHT	:	De-hydrogen Heat Treatment	PQR	:	Procedure Qualification Record
ERTL	:	Electronics Regional Test Laboratory	PR	:	Purchase Requisition
FCRI	:	Fluid Control Research Institute	PMI	:	Positive Material Identification
HT	:	Heat Treatment	RT	:	Radiography Testing
HIC	:	Hydrogen Induced Cracking	SSCC	:	Sulphide Stress Corrosion Cracking
ITP	:	Inspection and Test Plan	TC	:	Test Certificate
IP	:	Ingress Protection	TPI or TPIA	:	Third Party Inspection Agency
IHT	:	Intermediate Heat Treatment	UT	:	Ultrasonic Testing
ISR	:	Intermediate Stress Relieving	VDR	:	Vendor Data Requirement
IC	:	Inspection Certification	WPS	:	Welding Procedure Specification
IGC	:	Inter Granular Corrosion	WPQ	:	Welders Performance Qualification
LPT	:	Liquid Penetrate Testing			

	QUALITY ASSURANCE PLAN OF STATION PIPES	**DOCUMENT NO: GAIL-STD-PI-DOC-QAP-004 Rev :00**

SR. NO	COMPONENTS & OPERATIONS	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMET OF RECORD	INSPECTION	
							VENDOR	TPIA
1	RAW MATERIAL							
1.1	REVIEW OF PROCEDURES	REVIEW OF HYDROTEST,NDT PROCEDURES BY TPI	DOCUMENT REVIW	TENDER SPECIFICATION	TENDER SPECIFICATION	PROCEDURE	P	R
1.2	MANUFACTURE OF PIPES	REVIEW OF MANUFACTURER TEST CERTIFICATE	EACH HEAT	API 5L/TENDER DOC.	API 5L/TENDER DOC.	MILL TEST CERTIFICATE/LAB TEST REPORT 3.1	P	R
2	INPROCESS INSPECTION.							
	1. INPROCESS & INSPECTION.	VERIFICATION OF HEAT NO. ACCORDING TO RAW MATERIAL T.C.	EACH HEAT	API 5L/TENDER DOC.	API 5L/TENDER DOC	INSPECTION REPORT	P	R
	2.HYDRO TEST	HYDROSTSTIC TEST	EACH PIPE	API 5L/TENDER DOC.	API 5L/TENDER DOC.	INSPECTION REPORT	P	W
	3.CHEMICAL ANALYSIS	CHEMICAL COMPOSITION	EACH PIPE	API 5L/TENDER DOC.	API 5L/TENDER DOC.	INSPECTION REPORT	P	R
	4.MACHENICAL TESTING	TENSILE TESTING (TS YS,YS/UTS,%EL)	EACH PIPE	ASTM A 370/API 5L/TENDER DOC.	ASTM A 370/API 5L/TENDER DOC	INSPECTION REPORT	P	W
		FLATTEING	EACH PIPE	ASTM A 370/API 5L/TENDER DOC.	ASTM A 370/API 5L/TENDER DOC.	INSPECTION REPORT	P	W
		HARDNESS TESTING	EACH PIPE	ASTM A 370/API 5L/TENDER DOC.	MAX248 HV10/TENDER DOC.	INSPECTION REPORT	P	W
		MICRO TEST	EACH PIPE	ASTM A 370/ASTM E 112	GRAIN SIZE : RANGE 8 TO 12	INSPECTION REPORT	P	W
		IMPACT TEST AT - 20° C	EACH PIPE	ASTM A 370/API 5L/TENDER DOC	AVG 35J & IND 28J / Tender Spec.	INSPECTION REPORT	P	W
	5. NDT	1. MPT AT BEVEL END	EACH PIPE	ASME SEC V	SEC. VIII DIV. 2 ARTICEL 7.5 6.2	INSPECTION REPORT	P	W
		2. UT AT BOTH ENDS FOR 100MM LENGTH COVERING ENTIRE CICRUMFERENCE	EACH PIPE	ASME SEC V	ASME SEC VIII DIV. 1 UF-55	INSPECTION REPORT	P	W
	6. PMI	1. CHEMICAL CHCK	PIPE SIZE & THICKNESS AS PER PMS	API 5L/TENDER DOC.	API 5L/TENDER DOC.	INSPECTION REPORT	P	W
3	FINAL INSPECTION							
	1.FINAL INSPECTION	1. VISUAL & MARKING	EACH PIPE	API 5L/TENDER DOC	API 5L/TENDER DOC	INSPECTION REPORT	P	W
		2.DIMENTION (Straightness, End finish, Bevel angle, Root face, Diameter, Thickness, Length, Weight)	EACH PIPE	API 5L/TENDER DOC	API 5L/TENDER DOC	INSPECTION REPORT	P	W
		3.RUST PREVENTIVE COATING & COLOUR CODING	EACH PIPE	API 5L/TENDER DOC	API 5L/TENDER DOC	INSPECTION REPORT	P	R

SR. NO	COMPONENTS & OPERATIONS	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMET OF RECORD	INSPECTION	
							VENDOR	TPIA
4	FINAL DOCUMENT							
	1.FINAL DOCUMENT	1.QAP/PO/MTC/IR/COMPLIANCE CERTIFICATE	100%	API 5L/TENDER DOC	API 5L/TENDER DOC	COMPLIANCE CERTIFICATE	P	R
		2.INSPECTION RELEASE NOTE	100%	API 5L/TENDER DOC	API 5L/TENDER DOC	COMPLIANCE CERTIFICATE	-	P

Legend:	P-Perform, R-Review, W-Witness, H-Hold TPIA-Third Party Inspection Agency, RW: 10% Random witness

NOTE :	1. TPIA SHALL ISSUE 3.2 CERTIFICATE AS PER BS EN 10204 (applicable only for above refer test witness by TPIA)
	2. MATERIAL & TYPE SHALL BE AS PER PIPING MATERIAL SPECIFICATION (PMS).
	3. ALL MEASURING INSTRUMENTS CALIBRATION CERTIFICATE TO BE REVIEWED BY TPIA
	4. LOCATION OF THICKNESS CHECKED BY TPIA SHALL BE MARKED WITH PAINT
	5. RED OXIDE PAINT TO BE APPLIED WITH MIN. DFT 50 MICRON AFTER SURFACE PREPARATION.
	6. IN CASE OF CONFLICT BEEWTWEEN SPECIFICATION, QAP, DAATASHEET, MORE STRAIGENT CONDITION SHLL BE APPLICABLE.
	7.SAMPLE FROM ANY ONE LOT/HEAT SHALL BE TESTED BY CLIENT (GAIL) UNDER THEIR WITNESS THIRD PARTY LAB AT DISCRETION
	8. QUANTITY AS PER APPROVED P&ID

		REVIEWED & ACCEPTED BY	
PREPARED BY:	APPROVED BY:	CONSULTANT:	CLIENT: GAIL

	PROJECT: GAIL ARC- INVENTORY CREATION PROJECT FOR LAST MILE CONNECTIVITY CLIENT: GAIL INDIA LIMITED CONSULTANT: LEPL VENDOR	GAIL-STD-PI-DOC-QAP-005 ITEM DESCRIPTION/ QUANTITY: FITTINGS PAGE NO: 1 of 1

		OPERATION	CHARACTERISTICS	REF. DOC. & ACCEPTANCE NORMS	FORMAT OF RECORD	TYPE OF CHECK	INSPECTION	
							Vendor	TPI
RAW MATERIAL INSPECTION								
Pipes/ Plates		Chemical	Correlation with Mill Test Certificate & Check Test Cert. as per TS	Applicable Codes	Mill T.C. or Check T.C.	Verification of marking with MTC & Check test if any	P	R
Electrodes			Batch Test Certificate	ASME Sec II Part C	Test Cert.		P	R
IN PROCESS								
1	HEAT TREATMENT		Quenching, Normalising and Tempering	ASTM A 234 Gr.WPB	HT Records	Visual & Review of T.C.	P	R
DESTRUCTIVE TESTING - PRODUCT								
2	MECHANICAL TEST		Testing - per heat	ASTM A 234 Gr.WPB	LR	Witness/ Scrutiny of the Report	P	R
3	HARDNESS TEST		Testing - per heat	350 HV 10	LR	Witness/ Scrutiny of the Report	P	R
4	Impact Test at 0 deg C (Base Material, Weld, & Haz)		Testing - one set per heat	AVG - 27 J IND - 20J (for one specimen)	LR	Witness/ Scrutiny of the Report	P	R
5	NDT (Whichever applicable)		U.T.	ASME Sev V	LR	Witness/ Scrutiny of the Report	P	R
			M.P.I at Bevel Ends THK>= 6MM, D.P> at Bevel if t<= 6 MM, 100%	ASME Sec V	LR	Witness/ Scrutiny of the Report	P	R
FINAL								
6	Overall Dimension		100%	As per Code	IIR		P	R
7	Visual Check		FFD - 100%					
8	MARKING		Logo, Matl. Specn., Size, Sch/ Rating, Lot No.	P.O. Spec.	SPECIFIED IN T.C	Visual	P	R
9	Review of Manufacter's		Correlation of TC			LR	P	R
10	Preparation of documentation and issue of Release Note				Standard	LR	P	R

CTC/ MTC : CHECK/ MILL TEST CERT., P: PERFORM, IIR: INTERNAL INSPECTION REPORT, W: WITNESS, FFD: FREE FROM DEFECTS, TPI: THIRD PARTY INSPECTION AGENCY, H: HOLD, LR: LAB REPORTS

NOTE 1 : ALL FITTINGS 18" & ABOVE SHALL BE IN WELDED CONSTRUCTION - EXISTING WPS, PQR SHALL BE REVIEWED BY TPI

NOTE 2 : TPI TO ISSUE CERTIFICATE AS PER EN 10204 3.2 FORMAT

	PROJECT: GAIL ARC - INVENTORY CREATION PROJECT FOR LAST MILE CONNECTIVITY CLIENT: GAIL INDIA LIMITED CONSULTANT: LEPL VENDOR	GAIL-STD-PI-DOC-QAP-006 ITEM DESCRIPTION: FLANGES (WNRF & SPACER BLIND) PAGE NO: 1 of 1

OPERATION	CHARACTERISTIC	TYPE/ METHOD CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	INSPECTION	
							Vendor	TPI
Review of PO/ TDC/ DRG	Review of PO/ DOC./ DRG & TD	Scrutiny/ Varification	Each doc of	Appl. Spec./ Std			R	R
RAW MATERIAL	Manufacturing Process of Steel	Verification with M.T.C.	Each Heat	ASTM A 105	Material Spec/ Std/ Customer Spec	Material Test Cert. / RMI Register	R	R
	Chemical Composition	Spectro Analysis	Each Heat					
FORGINGS	Reductino Ratio	Measurements	Minimum 1 per size	CHW Standard Manufacturing Procedure FFD	Std. Procedure	Forging Process Record/ Internal Register	W	R
	Temperature during Forging	Optical Pyrometer						
	Forging Dimensions	Measurements	100%		Forging Drwg ANSI B16.5			
Heat Treatment (Quenching and Tempering)	Heat Treatment Cycle	Verification of Heat Treatment Cycle	HT one Lot	ASTM A 105	ASTM A 105	T.P.M Sheet, Heat Treatment Graph	R	R
MECHANICAL TESTING	Tensile Test (TS,YS,EL%)	Tensile Testing	One Lot	ASTM A 105 ASTM E-112	YS-485 MPA min TS-565 MPA min %EL - 18 Grain Size ASTM 5 to 8	Mechanical Test Report & T.C.	W	R
	Hardness *							
	Micro Test							

	Impact Test				20 J min (one specimen) 27 J avg			
FINAL								
	Overall Dimension		100%	As per Grade	IIR		W	R
	Visual Check		FFD - 100%				W	R
	Marking	Visual	Logo, Matl. Specn., Size, Sch/ Rating, Lot No.	P.O.	Specified in T.C.		R	R
	Review of Manufacturer's Documents	LR	Correlation of TC				R	R
	Preparation of Documentation and Isuue of Release Note	LR					R	R

CTC/MTC: Check /Mill Test Cert. P: Perform, IIR: Internal Report, W: Witness, R - Review, FFD: Free from defects, TPIA: Third party inspection agency.

H: Hold, LR: Lab Reports, RMI: Raw material indent

* Hardness - 248 HV10

RMI - Raw Material Indent NOTE:TPI TO ISSUE 3.2 CERTIFICATE AS PER EN10204.

GAIL INDIA LTD.	**QUALITY ASSURANCE PLAN** **FASTNERS**	**DOCUMENT NO:** GAIL-STD-PI-DOC-QAP-007 **Rev**:00	

SR. NO	COMPONENTS & OPERATIONS	TYPES OF CHECK	QUANTAM OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMET OF RECORD	INSPECTION	
							VENDOR	TPIA
1	RAW MATERIAL							
	1. RAW MATERIAL	1. MANUFACTURING PROCESS OF STEEL	PER HEAT	ASME B18.2.1&2.2 / ASTM A 320 L7 / A 194 GR4/GR7	ASME B18.2.1&2.2 / ASTM A 320 L7 / A 194 GR4/GR7	MTC / LAB TEST REPORT 3.1	R	R
		2. CHEMICAL COMPOSITION	PER HEAT	ASME B18.2.1&2.2 / ASTM A 320 L7 / A 194 GR4/GR7	ASME B18.2.1&2.2 / ASTM A 320 L7 / A 194 GR4/GR7	MTC / LAB TEST REPORT 3.1	P	R
		3. MECHANICAL PROPERTIES	PER HEAT	ASME B18.2.1&2.2 / ASTM A 320 L7 / A 194 GR4/GR7	ASME B18.2.1&2.2 / ASTM A 320 L7 / A 194 GR4/GR7	INSPECTION REPORT 3.2	R	R
		4. VISUAL	100%	ASME B18.2.1&2.2 / ASTM A 320 L7 / A 194 GR4/GR7	ASME B18.2.1&2.2 / ASTM A 320 L7 / A 194 GR4/GR7	INSPECTION REPORT 3.2	P	W
2	IN PROCESS INSPECTION.							
	1. MFG. OF BOLT & NUT	1.CUTTING , GRINDING, FORGING, THREADING ETC.	100%	VENDOR DRG./ ASTM A 320 L7 / A 194 GR4/GR7/ ASME B18.2.1&2.2	ASTM A 320 L7 / A 194 GR4/GR7/ ASME B18.2.1&2.2	DIMENSION REPORT 3.1	P	R
		2. PRODUCT DIMENSIONS	100%	VENDOR DRG./ ASTM A 320 L7 / A 194 GR4/GR7/ ASME B18.2.1&2.2	ASTM A 320 L7 / A 194 GR4/GR7/ ASME B18.2.1&2.2	DIMENSION REPORT 3.1	P	R
	2. HEAT TREATMENT	1. HEAT TREATMENT CYCLE	TEMP. / TIME	ASTM A 370 / A 320 L7 / A194 GR4/GR7/ TENDER SPEC.	ASTM A 370 / A 320 L7 / A194 GR4/GR7/ TENDER SPEC.	HT GRAPH / INSPECTION REPORT 3.1	P	R
	3. STAMPING OF SAMPLE FOR TESTING	1. STAMPING OF TEST SAMPLE	100%	ASTM A 370 / A 320 L7 / A194 GR4/GR7/ TENDER SPEC.	ASTM A 370 / A 320 L7 / A194 GR4/GR7/ TENDER SPEC.	INSPECTION REPORT 3.2	P	W
	4. MECHANICAL TESTING	1. TENSILE TESTING ((YS,UTS, YS/UTS, EL %)	ONE / HEAT/LOT	ASTM A 370 / A 320 L7 / A194 GR4/GR7/ TENDER SPEC.	ASTM A 370 / A 320 L7 / A194 GR4/GR7/ TENDER SPEC.	INSPECTION REPORT 3.2	P	W
		2. PROOF LOAD TEST	ONE / HEAT/LOT	ASTM A 370 / A 320 L7 / A194 GR4/GR7/ TENDER SPEC.	ASTM A 370 / A 320 L7 / A194 GR4/GR7/ TENDER SPEC.	INSPECTION REPORT 3.2	P	W
		3. HARDNESS TESTING	ONE / HEAT/LOT	ASTM A 370 / A 320 L7 / A194 GR4/GR7/ TENDER SPEC.	ASTM A 370 / A 320 L7 / A194 GR4/GR7/ TENDER SPEC.	INSPECTION REPORT 3.2	P	W
		4. IMPACT TEST AT - 101° C	ONE / HEAT/LOT	ASTM A 370 / A 320 L7 / A194 GR4/GR7/ TENDER SPEC.	AVG 27J & IND 20J / Tender Spec.	INSPECTION REPORT 3.2	P	W
	5. PRODUCT CHEMICAL CHECK ANALYSIS	1. CHEMICAL ANALYSIS	ONE / HEAT/LOT	ASTM A 370 / A 320 L7 / A194 GR4/GR7/ TENDER SPEC.	ASTM A 370 / A 320 L7 / A194 GR4/GR7/ TENDER SPEC.	INSPECTION REPORT 3.2	P	W
		2. PMI TEST	ONE / HEAT/LOT	ASTM A 370 / A 320 L7 / A194 GR4/GR7/ TENDER SPEC.	ASTM A 370 / A 320 L7 / A194 GR4/GR7/ TENDER SPEC.	INSPECTION REPORT 3.2	P	W

GAIL INDIA LTD.	**QUALITY ASSURANCE PLAN** **FASTNERS**	**DOCUMENT NO:** GAIL-STD-PI-DOC-QAP-007 **Rev**:00	

SR. NO	COMPONENTS & OPERATIONS	TYPES OF CHECK	QUANTAM OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMET OF RECORD	INSPECTION	
							VENDOR	TPIA
3	FINAL INSPECTION							
	1.FINAL INSPECTION	1. VISUAL\ STAMPING \ MARKING	100%	TENDER SPEC./ ASTM A 320 L7 / A194 GR4/GR7	TENDER SPEC./ ASTM A 320 L7 / A194 GR4/GR7	INSPECTION REPORT 3.2	P	100% W
		2. DIMENSIONS	100%	APPRD. DRG./ ASTM A 320 L7 / A194 GR4/GR7	APPRD. DRG./ ASTM A 320 L7 / A194 GR4/GR7	INSPECTION REPORT 3.2	P	100% W
		3. PACKING	100%	TENDER SPEC.	TENDER SPEC.	INSPECTION REPORT	P	R
4	FINAL DOCUMENTS							
	1.FINAL DOCUMENTS	1. QAP / PO / MTC / IR / COMPLIANCE CERTIFICATES	100%	AS PER TENDER SPEC / AS PER APPR. DRG. & QAP	AS PER TENDER SPEC / AS PER APPR. DRG. & QAP	COMPLIANCE CERTIFICATE	P	R
		2. INSPECTION RELEASE NOTE	100%	AS PER TENDER SPEC / AS PER APPR. DRG. & QAP	AS PER TENDER SPEC / AS PER APPR. DRG. & QAP	COMPLIANCE CERTIFICATE	H	P
5	PAINTING							
	1.RUST PREVENTIVE COATING & COLOUR CODING	VISUAL & COLOUR COADING AS APPLICABLE	100%	AS PER TENDER SPEC	AS PER TENDER SPEC	INSPECTION REPORT	P	R

Legend:	P-Perform, R-Review, W-Witness, H-Hold TPIA-Third Party Inspection Agency

NOTE :	1. TPIA SHALL ISSUE 3.2 CERTIFICATE AS PER BS EN 10204
	2. MATERIAL & TYPE SHALL BE AS PER TENDER SPECS/DATA SHEET
	3. SAMPLE FROM ANY ONE LOT/HEAT SHALL BE TESTED BY CLIENT (GAIL) UNDER THEIR WITNESS THIRD PARTY LAB AT DISCRETION
	4. EACH STUD BOLT SHALL BE SUPPLIED WITH MATCHING TWO NUTS & TWO WASHERS.
	5. AFTER TESTING & BEFORE SHIPMENT, ALL STUD BOLTS, NUTS AND WASHERS SHALL BE CLEANED OF DIRT, RUST, MILL SCALE ETC. AND THE THREADS SHALL BE PROPERLY GREASED BEFORE PACKING THEM IN WOOD CRATES FOR AVOIDING FORMATION OF RUST.
	6. QUANTITY AS PER APPROVED P&ID.

PREPARED BY:	APPROVED BY:	REVIEWED & ACCEPTED BY	
		CONSULTANT:	CLIENT: GAIL

GAIL INDIA LIMITED	**QUALITY ASSURANCE PLAN** **GASKET**	**DOCUMENT NO:** GAIL-STD-PI-DOC-QAP-008 **Rev**:00	

SR. NO	COMPONENTS & OPERATIONS	TYPES OF CHECK	QUANTAM OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMET OF RECORD	INSPECTION	
							VENDOR	TPIA
1	RAW MATERIAL							
	1. SPIRAL WOUND GASKET WINDING MATERIAL- SS316 / SS316L	1. CHEMICAL TESTING	PER HEAT	ASME B 16.20 / ASTM A 240 / Tender Doc.	ASME B 16.20 / ASTM A 240 / Tender Doc.	MTC / LAB TEST REPORT 3.1	P	R
		2. PHYSICAL TESTING	100%	ASME B 16.20 / ASTM A 240 / Tender Doc.	ASME B 16.20 / ASTM A 240 / Tender Doc.	MTC / LAB TEST REPORT 3.1	P	R
	2. FILLER MATERIAL-GRAPHITE	1. CHEMICAL TESTING	PER HEAT	AS PER APPLICABLE CODE OF MAT./ ASME B 16.20	AS PER APPLICABLE CODE OF MAT/ ASME B 16.20	MTC / LAB TEST REPORT 3.1	P	R
	3. OUTER RING-CARBON STEEL	1. CHEMICAL TESTING	PER HEAT	ASME B 16.20 / ASTM A 240 / Tender Doc.	ASME B 16.20 / ASTM A 240 / Tender Doc.	MTC / LAB TEST REPORT 3.1	P	R
		2. PHYSICAL TESTING	100%	ASME B 16.20 / ASTM A 240 / Tender Doc.	ASME B 16.20 / ASTM A 240 / Tender Doc.	INSPECTION REPORT 3.1	P	R
2	INPROCESS INSPECTION.							
	1. FINISH DIMENSION	1. FINISH DIMENSION MEASURMENT OF SPW	100%	APPR.VENDOR DRG./ ASTM A 240 / ASME B16.20	APPR.VENDOR DRG./ ASTM A 240 / ASME B16.20	DIMENSION REPORT 3.1	P	R
	2. COMPRESSION & RECOVERY	2. TESTING SPW	ONE / SIZE / LOT	ASTM A 370 / ASME B16.20	ASTM A 370 / ASME B16.20	INSPECTION REPORT 3.1	P	R
	3. MARKING	3. VISUAL	100%	APPR.VENDOR DRG./ ASTM A 240 / ASME B16.20	APPR.VENDOR DRG./ ASTM A 240 / ASME B16.20	INSPECTION REPORT 3.2	P	W
	4. PMI TEST	CHEMICAL CHECK	PMI MACHINE (ONE SAMPLE PER HEAT NO)	AS PER MATERIAL SPECIFICATION	AS PER MATERIAL SPECIFICATION	INSPECTION REPORT 3.2	P	W
3	FINAL INSPECTION							
	1.FINAL INSPECTION	1. VISUAL\ TAGGING \ MARKING	100%	TENDER SPEC./ ASME B16.20	TENDER SPEC./ ASME B16.20	INSPECTION REPORT 3.2	P	100% W
		2. DIMENSIONS	100%	APPRD. DRG./ ASTM A 240 / ASME B16.20	APPRD. DRG./ ASTM A 240 / ASME B16.20	INSPECTION REPORT 3.2	P	100% W
4	FINAL DOCUMENTS							
	1.FINAL DOCUMENTS	1. QAP / PO / MTC / IR / COMPLIANCE CERTIFICATES	100%	AS PER TENDER SPEC / AS PER APPR. DRG. & QAP	AS PER TENDER SPEC / AS PER APPR. DRG. & QAP	COMPLIANCE CERTIFICATE	P	R
		2. INSPECTION RELEASE NOTE	100%	AS PER TENDER SPEC / AS PER APPR. DRG. & QAP	AS PER TENDER SPEC / AS PER APPR. DRG. & QAP	COMPLIANCE CERTIFICATE	H	P

Legend:	P-Perform, R-Review, W-Witness, H-Hold TPIA-Third Party Inspection Agency

NOTE :	1. TPIA SHALL ISSUE 3.2 CERTIFICATION AS PER BS EN 10204.
	2. MATERIAL & TYPE SHALL BE AS PER TENDER SPECIFICATION / DATA SHEET.
	3. IN CASE OF CONFLICT BEEWTWEEN SPECIFICATION, QAP, DAATASHEET, MORE STRAIGENT CONDITION SHLL BE APPLICABLE.
	4. QUANTITY AS PER APPROVED P&ID.

PREPARED BY:	APPROVED BY:	REVIEWED & ACCEPTED BY	
		CONSULTANT:	CLIENT: GAIL

QUALITY ASSURANCE PLAN – BALLVALVE

REV	DATE	DESCRIPTION	PREP	CHK	APPR
0	16.01.2019	ISSUEDFORBID	AP	JR	SB

1.0 SCOPE:

ThisQuality Assurance Plan coverstheminimum testing requirementsofBall Valves.

2.0 REFERENCE DOCUMENTS:

PO /PR/Standardsreferredthere in /Job specifications/Approved documents.

3.0INSPECTIONANDTESTREQUIREMENTS:

SL. NO.	COMPONENT& OPERATION	CHARACTERISTICS/METHOD OFCHECK	QUANTUM OFCHECK	REFERENCE DOCUMENT&ACCEPTENCE CRITERIA	FORMATOF RECORD	SCOPEOFINSPECTION	
						SUPPLIER	TPIA
1.0	RAWMATERIAL						
1.1	Casting: Body&Bonnet/Connector	Chemical:ChemicalAnalysis	AllHeats	Material& Technical Specification	VendorTest Certificate	100% R	R
		Mechanical:MechanicalTest	AllHeats	Material& Technical Specification	VendorTest Certificate	100% R	R
		Impact (@ - 29°C) : Impact Test	AllHeats	ASMEB16.34	TestReport	100% R	R
		NonDestructiveExamination (NDT):Radiography(100% CriticalArea&BWEnds)	100%	ASMEB16.34	RT Report	100% R	R
		NonDestructiveExamination (NDT): MagneticParticle Examination(100%exterior&accessibleinterior)	100%	ASMEB16.34	MPIReport	100% R	R

SL. NO.	COMPONENT& OPERATION	CHARACTERISTICS/METHOD OFCHECK	QUANTUM OFCHECK	REFERENCE DOCUMENT&A CCEPTENCE CRITERIA	FORMATOF RECORD	SCOPEOFINSPECTION	
						SUPPLIER	TPIA
1.2	Forging: Ball,SeatRing&S pindle/Stem	Chemical:ChemicalAnalysis	AllHeats	Material&Tec hnical Specification	VendorTest Certificate	100% R	R
		Mechanical:MechanicalTest	AllHeats	Material&Tec hnical Specification	VendorTest Certificate	100% R	R
		Impact(@- 29^{0}C):ImpactTest	AllHeats	ASMEB16.34	TestReport	100% R	R
		NonDestructiveExamination (NDT):Radiography(100% CriticalArea&BWEnds)	100%	ASMEB16.34	RT Report	100% R	R
		NonDestructiveExamination (NDT):MagneticParticle Examination(100%exterior&ac cessibleinterior)	100%	ASMEB16.34	MPIReport	100% R	R
		ENP(ForBall): Visual, Thickness&Hardness	100%	25microns(min) &50HRC(min)	VendorTest Certificate	100% R	R
2.0	INCOMING/ BOFITEMS						
2.1	Stem	Chemical:ChemicalAnalysis	AllHeats	Material& Technical Specification	VendorTest Certificate	100% R	R
		Mechanical:MechanicalTest	AllHeats	Material& Technical Specification	VendorTest Certificate	100% R	R

SL. NO.	COMPONENT& OPERATION	CHARACTERISTICS/METHOD OFCHECK	QUANTUM OFCHECK	REFERENCE DOCUMENT&A CCEPTENCE CRITERIA	FORMATOF RECORD	SCOPEOFINSPECTION	
						SUPPLIER	TPIA
2.2	Fasteners	Chemical:ChemicalAnalysis	AllHeats	Material& Technical Specification	VendorTest Certificate	100% R	R
		Mechanical:MechanicalTest	AllHeats	Material& Technical Specification	VendorTest Certificate	100% R	R
		Impact(@- 29^{O}C):ImpactTest	AllHeats	ASMEB16.34	TestReport	100% R	R
3.0	MACHINEDCOMPONENTS						
3.1	Body,Connector, Ball&SeatRing	Surfaceexamination& DimensionInspection:Visual& Measurement	100%	Manufacturer's Drawing	GRN	100% R	R
4.0	IN-PROCESS						
4.1	Body&Connector jointwelding	NonDestructiveExamination (NDT):MagneticParticle Examination(MPI)	100%	ASMESec VIII-AppendixV &VI	MPIReport	100% R	R
4.2	Valve&PupPiece BevelEndsjoint welding	NonDestructiveExamination (NDT):Radiography(100% onweldjoint)	100%	ASMEB16.34	RT Report	100% R	R

SL. NO.	COMPONENT& OPERATION	CHARACTERISTICS/METHOD OFCHECK	QUANTUM OFCHECK	REFERENCE DOCUMENT&A CCEPTENCE CRITERIA	FORMATOF RECORD	SCOPEOFINSPECTION	
						SUPPLIER	TPIA
5.0	FINALINSPECTION						
5.1	FinishedValveAssembly: PressureTest&Final Inspection	ShellTest:Hydrostatic	100%	Testing Procedureasper Code	TestRecord	W	W
		SeatTest:Hydrostatic				W	W
		SeatTest:Pneumatic				W	W
		FunctionalTest- ActuatedValve @Atm.Pressure& Max.Diff. Pressure:Operation-Open/ Close				W	W
		DoubleBlock&Bleed: Hydrostatic				W	W
		FinalInspection: Visual, Dimension,TCVerification, SpecialRequirements&Marking aspersaleorder	100%	ApprovedGA Drawing(if applicable)	SCN	~	W
		Anti-StaticTest	100%	API6D& Technical Specification	TestRecord	W	W
		FireSafeTest	100%	API-6FA/ ISO-10497	Firesafetype testreport	~	R
5.2	Painting&Packing	Surfaceexamination&DFT Inspection: Visual& Measurement	100%	AsperTender Specification	Painting Record	100%	W

Legend:

H -Hold(Do notproceedwithoutapproval), P -

Perform,

RW- RandomWitness [Asspecified or10% (min.1 no.ofeachsize andtype ofBulkitems)], R -Review,

W-Witness(Give due notice,work mayproceedafterscheduleddate).

NOTES (As applicable):

1.Supplier TestCertificatesto bereviewed by CLIENT/TPIA.

2. Thisdocumentdescribes thegenerictest requirements. Anyadditional testorInspectionscope ifspecified/required in contractdocumentsshall also be applicable (unless otherwise agreed upon).

3.AcceptanceNormsforall the activities shall beas per PO/PR/STANDARDS referredthere in/Job Specification/Approved Documents.

4.Fororderspla ced onstockist,itemsshall be accepted based onmanufacturer'sTC with EN310204 type 3.2certificationfromapproved suppliers.

QUALITY ASSURANCEPLAN– GLOBEVALVE

REV	DATE	DESCRIPTION	PREP	CHK	APPR
0	16.01.2019	ISSUED FORBID	AP	JR	SB

1.0 SCOPE:

ThisQuality Assurance Plan coversthe minimum testing requirementsof GlobeValves.

2.0 REFERENCE DOCUMENTS:

PO /PR/Standardsreferredthere in /job specifications/approved documents.

3.0 INSPECTIONANDTESTREQUIREMENTS:

APPLICABLE CODES AND SPECIFICATIONSWITH AMENDMENTS									SCOPE OFINSPECTION	
SL. NO.	STAGE	COMPONENT	CHARACTERI -STICS	METHOD OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECO RD	Vendor	TPI
1a	Incoming Material	Castings, Forgings&b/o Items	Surface Quality&Dim ensions	Visual	Each piece	Applicable PO and Specifications	Applicable PO and Specifications	Inspection Report /B/o Certifi cates	W	R
1b	Incoming Material	----Do----	Chemical, Mechanical Properties&H T requirements (Notespecial requirementof heat treatment hardness, impact, Bend,tensile etc.forH_2 Service& NACE)	Reviewof Documents	All Heats	Asper applicable PO and Specifications	Asper applicable PO and Specifications	Inspection Report / Vendor TC/ HT Records	R	R

APPLICABLE CODES AND SPECIFICATIONSWITH AMENDMENTS									SCOPE OFINSPECTION	
SL. NO	STAGE	COMPONENT	CHARACTERI -STICS	METHOD OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECO RD	Vendor	TPI
1c	Incoming Material	Castings/ Forgingsof Austenitic Stainless steel	Intergranular Corrosion (IGC) Test &Stabilisation heat treatment	Chartor TC Lab Check	Persolution Annealed lot	Asper applicable PO and Specifications	Asper applicable PO and Specifications	HT Chart orTC	R	R
1d	Incoming Material	RTCastings	Radiography Examination	Reviewof RTfilms	Applicable POand Specification s	Asper applicable PO and Specifications	Asper applicable PO and Specifications	Film and report	R	R
2	WPS, PQR, WPQ Previous Qualificationsf or Overlay/ Stelliting	Bodyseatring /Wedge	Thicknessof overlay/ stelliting, Hardness	Visual &Hardness	100%	Applicable PO and Specifications	Applicable PO and Specifications	WPS/ PQR/ WPQ	— W	H/ R[1]
3	HydrostaticTe st	Finished Valve	Pressure testing for bodyand seat	Hydrostatic Test	100%by manufacturer andat random by LEPL	Approved drawings, ApplicablePO and Specifications	Approved drawings, Applicable PO and Specifications	Test Report	W	H
4	PneumaticTe st	Finished Valve	Pressure Testingfor seat/ backseat	Approved drawings, Applicable POandSpecifi cations	100%by manufacturer andat random by LEPL	Approved drawings, Applicable PO and Specifications	Approved drawings, Applicable PO and Specifications	Test Report	—— W	H
5	Functional Test	Finished Valve	Functional / operationTest	Approved drawings, Applicable POand Specifications	100%by manufacturer andat random by LEPL	Approved drawings, Applicable PO and Specifications	Approved drawings, Applicable PO and Specifications	Test Report	W	H

APPLICABLE CODES AND SPECIFICATIONSWITH AMENDMENTS									SCOPE OFINSPECTION	
SL. NO.	STAGE	COMPONENT	CHARACTERI -STICS	METHOD OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD	Vendor	TPI
6	NDT Testing	Forgings&Pl ate components	UT/ MPT/DPT	UT/ MPT/ DPT	100%by manufacturer andat random by LEPL	Approved drawings, Applicable PO and Specifications	Approved drawings, Applicable PO and Specifications	Test Report	W	W
7	PMI Check for SS/AS Valves	Finished Valve	PMICheck	X-Ray Florescence/ Emission Spectrometer	Asper Company specification	Company specification	Asper applicable PO and Specifications		W	H
8	Final Inspection	Finished Valve	Visual, Dimensional	Visual &Std measuring instruments	100%by manufacturer andat random by LEPL	Approved drawings, Applicable PO and Specifications	Approved drawings, Applicable PO and Specifications	Inspection Report	W	W
9	Strip Check	Finished Valve	Verify Components	Visual	1 Valve per Type/Size &Order	Approved drawings, Applicable PO and Specifications	Approved drawings, Applicable PO and Specifications	Inspection Report	W	H
10	Packing	Finished Valve	-----	Packing Listasper applicable POand Specifications	---	Approved drawings, Applicable PO and Specifications	Approved drawings, Applicable PO and Specifications	---	W	R

Legend:

H -Hold(Do notproceedwithoutapproval),

P -Perform,

RW- RandomWitness [Asspecified or10%(min.1 no.ofeachsize andtype ofBulkitems)],

R -Review,

W-Witness(Give due notice,work mayproceedafterscheduleddate).

NOTES (As applicable):

1.SupplierTestCertificatesto bereviewed by CLIENT/TPIA.

2. Thisdocumentdescribes thegenerictest requirements. Anyadditional testorInspectionscope ifspecified/required in contractdocumentsshall also be applicable (unless otherwiseagreed upon).

3.AcceptanceNormsforall the activities shall beas per PO/PR/STANDARDS referredthere in/Job Specification/Approved Documents.

4.Forordersplaced onstockist,itemsshall be accepted based onmanufacturer'sTC with EN310204 type 3.2certificationfromapproved suppliers.

	QUALITY ASSURANCE PLAN –PLUGVALVE	GAIL-STD-PI-DOC-QAP-011

QUALITY ASSURANCEPLAN–PLUGVALVE

0	16.01.2019	ISSUEDFORBID	AP	JR	SB
REV	**DATE**	**DESCRIPTION**	**PREP**	**CHK**	**APPR**

1.0 SCOPE:

ThisQuality Assurance Plan coverstheminimum testing requirementsofPlugValves.

2.0 REFERENCE DOCUMENTS:

PO /PR/Standardsreferredthere in /Job specifications/Approved documents.

3.0 INSPECTIONANDTESTREQUIREMENTS:

SL. NO.	COMPONENT& OPERATION	CHARACTERISTICS/METHOD OFCHECK	QUANTUM OFCHECK	REFERENCE DOCUMENT&A CCEPTENCE CRITERIA	FORMATOF RECORD	SCOPEOFINSPECTION	
						SUPPLIER	TPIA
1.0	RAWMATERIAL						
1.1	Casting: Body&Bonnet/Connector	Chemical:ChemicalAnalysis	AllHeats	Material& Technical Specification	VendorTest Certificate	100% R	R
		Mechanical:MechanicalTest	AllHeats	Material& Technical Specification	VendorTest Certificate	100% R	R
		Impact(@-29°C):ImpactTest	AllHeats	ASMEB16.34	TestReport	100% R	R
		NonDestructiveExamination (NDT):Radiography(100% CriticalArea&BWEnds)	100%	ASMEB16.34	RT Report	100% R	R
		NonDestructiveExamination (NDT): MagneticParticle Examination(100%exterior&accessibleinterior)	100%	ASMEB16.34	MPIReport	100% R	R

SL. NO.	COMPONENT& OPERATION	CHARACTERISTICS/METHOD OFCHECK	QUANTUM OFCHECK	REFERENCE DOCUMENT&A CCEPTENCE CRITERIA	FORMATOF RECORD	SCOPEOFINSPECTION	
						SUPPLIER	TPIA
1.2	Forging: Ball,SeatRing&S pindle/Stem	Chemical:ChemicalAnalysis	AllHeats	Material&Tec hnical Specification	VendorTest Certificate	100% R	R
		Mechanical:MechanicalTest	AllHeats	Material&Tec hnical Specification	VendorTest Certificate	100% R	R
		Impact(@- 29°C):ImpactTest	AllHeats	ASMEB16.34	TestReport	100% R	R
		NonDestructiveExamination (NDT):Radiography(100% CriticalArea&BWEnds)	100%	ASMEB16.34	RT Report	100% R	R
		NonDestructiveExamination (NDT):MagneticParticle Examination(100%exterior&ac cessibleinterior)	100%	ASMEB16.34	MPIReport	100%R	R
		ENP(ForBall): Visual, Thickness&Hardness	100%	25microns(min) &50HRC(min)	VendorTest Certificate	100% R	R
2.0	INCOMING/ BOFITEMS						
2.1	Stem	Chemical:ChemicalAnalysis	AllHeats	Material& Technical Specification	VendorTest Certificate	100% R	R
		Mechanical:MechanicalTest	AllHeats	Material& Technical Specification	VendorTest Certificate	100% R	R

SL. NO.	COMPONENT& OPERATION	CHARACTERISTICS/METHOD OFCHECK	QUANTUM OFCHECK	REFERENCE DOCUMENT&A CCEPTENCE CRITERIA	FORMATOF RECORD	SCOPEOFINSPECTION	
						SUPPLIER	TPIA
2.2	Fasteners	Chemical:ChemicalAnalysis	AllHeats	Material& Technical Specification	VendorTest Certificate	100%R	R
		Mechanical:MechanicalTest	AllHeats	Material& Technical Specification	VendorTest Certificate	100%R	R
		Impact(@- 29^{o}C):ImpactTest	AllHeats	ASMEB16.34	TestReport	100%R	R
3.0	MACHINEDCOMPONENTS						
3.1	Body,Connector, Ball&SeatRing	Surfaceexamination& DimensionInspection:Visual& Measurement	100%	Manufacturer's Drawing	GRN	100%R	R
4.0	IN-PROCESS						
4.1	Body&Connector jointwelding	NonDestructiveExamination (NDT):MagneticParticle Examination(MPI)	100%	ASMESec VIII-AppendixV &VI	MPIReport	100%R	R
4.2	Valve&PupPiece BevelEndsjoint welding	NonDestructiveExamination (NDT):Radiography(100% onweldjoint)	100%	ASMEB16.34	RT Report	100%R	R

SL. NO.	COMPONENT& OPERATION	CHARACTERISTICS/METHOD OFCHECK	QUANTUM OFCHECK	REFERENCE DOCUMENT&A CCEPTENCE CRITERIA	FORMATOF RECORD	SCOPEOFINSPECTION	
						SUPPLIER	TPIA
5.0	FINALINSPECTION						
5.1	FinishedValveAssembly: PressureTest&Final Inspection	ShellTest:Hydrostatic	100%	Testing Procedureasper Code	TestRecord	W	W
		SeatTest:Hydrostatic				W	W
		SeatTest:Pneumatic				W	W
		FunctionalTest- ActuatedValve @atm.Pressure& Max.Diff. Pressure:Operation-Open/ Close				W	W
		DoubleBlock&Bleed: Hydrostatic				W	W
		FinalInspection: Visual, Dimension,TCVerification, SpecialRequirements&Marking aspersaleorder	100%	ApprovedGA Drawing(if applicable)	SCN	~	W
		Anti-StaticTest	100%	API6D& Technical Specification	TestRecord	W	W
		FireSafeTest	100%	API-6FA/ ISO-10497	Firesafetype testreport	~	R
5.2	Painting&Packing	Surfaceexamination&DFT Inspection: Visual& Measurement	100%	AsperTender Specification	Painting Record	100%	W

Legend:

H -Hold(Do notproceedwithoutapproval),

P -Perform,

RW- RandomWitness [Asspecified or10% (min.1 no.ofeachsize andtype ofBulkitems)],

R -Review,

W-Witness(Give due notice,work mayproceedafterscheduleddate).

NOTES (As applicable):

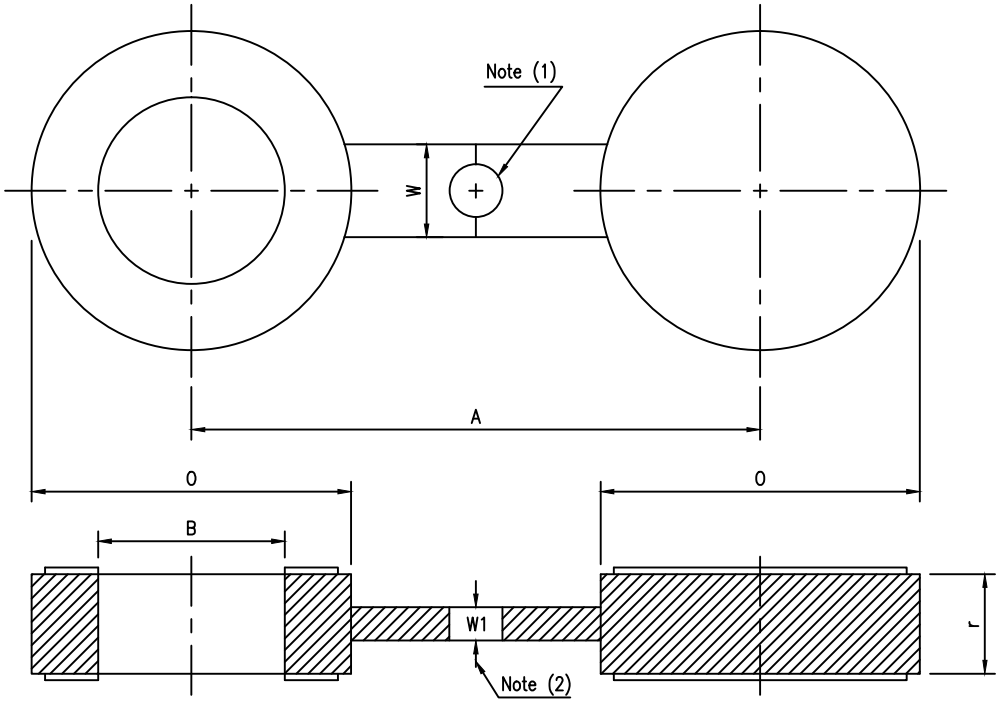
1.Supplier TestCertificatesto bereviewed by CLIENT/TPIA.

2. Thisdocumentdescribes thegenerictest requirements. Anyadditional testorInspectionscope ifspecified/required incontractdocumentsshall also be applicable (unless otherwise agreed upon).

3.AcceptanceNormsforall the activities shall beas per PO/PR/STANDARDS referedthere in/Job Specification/Approved Documents.

4.Forordersplaced onstockist,itemsshall be accepted based onmanufacturer'sTC with EN310204 type 3.2certificationfromapproved suppliers.

LYONS ENGINEERING PVT. LTD. NEW DELHI	SPECTACLE BLIND FLANGE	DRAWING NO.
		GAIL–STD–PI–DWG–TP–001
		SHEET NO. 1 OF 1



TABLE–4 DIMENSIONS OF CLASS 600 RAISED FACE FIGURE 8 BLANKS

NPS	INSIDE DIAMETER B, in.	OUTSIDE DIAMETER O, in.	CENTERLINE DIMENSION A, In.	THICKNESS r, in.	WEB WIDTH W, In.
1/2	0.62	2.00	2.62	0.25	1.50
3/4	0.82	2.50	3.25	0.25	1.50
1	1.05	2.75	3.50	0.25	2.25
1¼	1.44	3.12	3.98	0.38	2.25
1½	1.68	3.62	4.50	0.38	2.62
2	2.16	4.25	5.00	0.38	2.25
2½	2.64	5.00	5.88	0.50	2.62
3	3.26	5.75	6.62	0.50	2.62
3½	3.76	6.25	7.25	0.62	3.00
4	4.26	7.50	8.50	0.62	3.00
5	5.30	9.38	10.50	0.75	3.38
6	6.36	10.38	11.50	0.88	3.38
8	8.33	12.50	13.75	1.12	3.75
10	10.42	15.62	17.00	1.38	4.12
12	12.39	17.88	19.25	1.62	4.12
14	13.62	19.25	20.75	1.75	4.50
16	16.62	22.12	23.75	2.00	4.88
18	17.62	24.00	25.75	2.12	5.25
20	19.58	26.75	28.50	2.50	5.25
24	23.50	31.00	33.00	2.88	6.00

NOTES:

(1) HOLE SIZE (WHERE REQUIRED DUE TO BOLT SPACING) SHALL BE THE SAME AS THE FLANGE BOLT HOLE. AND LOCATED SUCH THAT IT WILL NOT INTERFERE WITH BOLTING BETWEEN TWO FLANGES.

(2) THE THICKNESS OF THE WEB (OR TIE BAR) DIMENSION W1 SHALL BE 0.25 IN. MINIMUM.

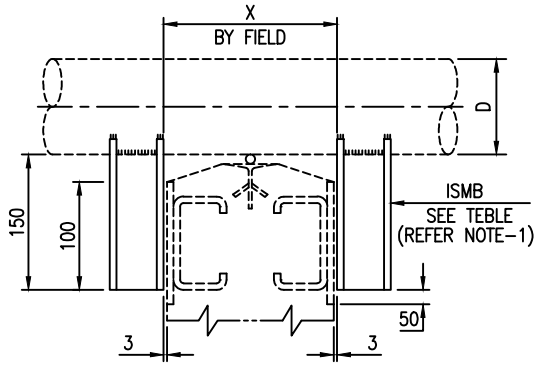
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	10–01–2019	ISSUED FOR TENDER	VKS	AP	JR

LYONS ENGINEERING PVT. LTD.
NEW DELHI

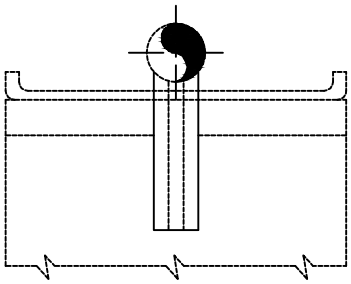
ANCHOR FOR BARE PIPE SIZE 2" THRU 24" TYPE–G5 (FOR OFFSITE)

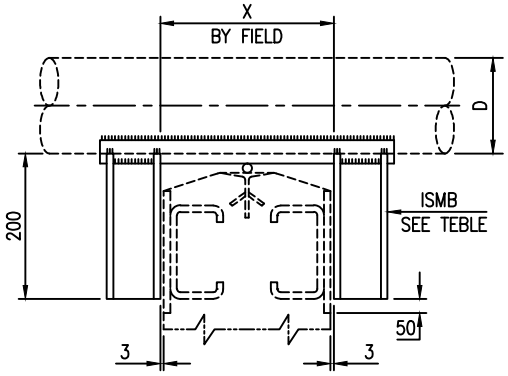
DRAWING NO.
GAIL–STD–PI–DWG–TP–002
SHEET NO. 1 OF 1

D	8	10	12	14	16	18	20	24
I BEAM	150				200		250	

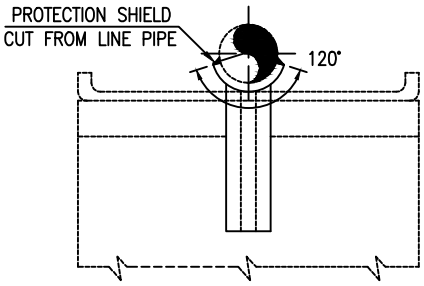


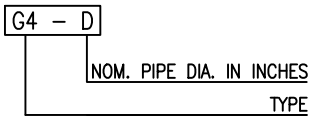
FOR PIPE 2" THRU 12"





FOR PIPE 14" THRU 24"





SYMBOL

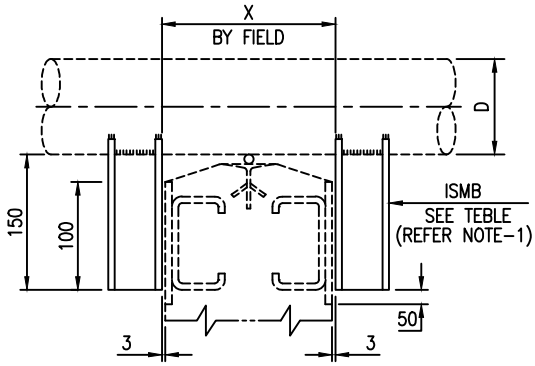
NOTE:–

1. FOR SUPPORTING DETAILS FOR PIPE SIZE 2" THRU 6", REFER STD. 7–44–0753.

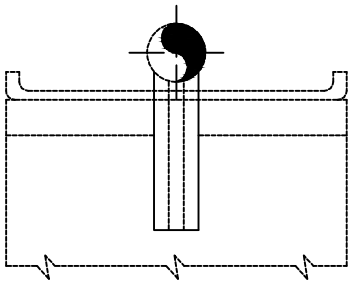
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	10–01–2019	ISSUED FOR TENDER	VKS	AP	JR

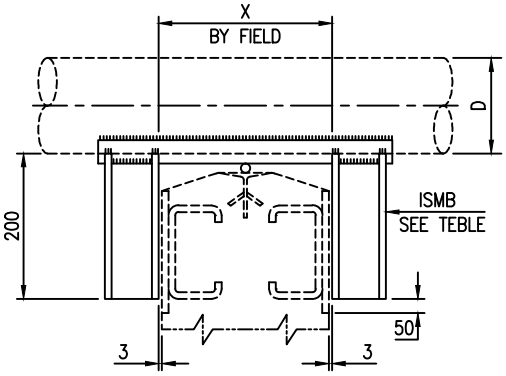
LYONS ENGINEERING PVT. LTD. NEW DELHI	CROSS GUIDE FOR BARE PIPE SIZE 2" THRU 24" TYPE–G4 (OFFSITE)	DRAWING NO. GAIL–STD–PI–DWG–TP–003
		SHEET NO. 1 OF 1

D	8	10	12	14	16	18	20	24
I BEAM	150				200		250	

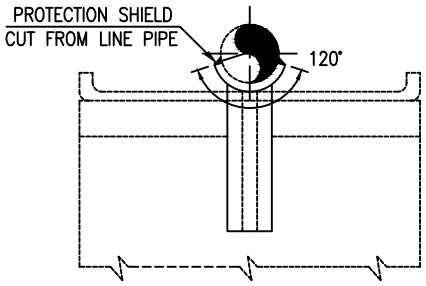


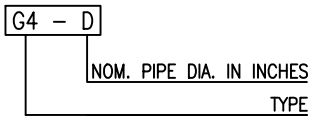
FOR PIPE 2" THRU 12"





FOR PIPE 14" THRU 24"





SYMBOL

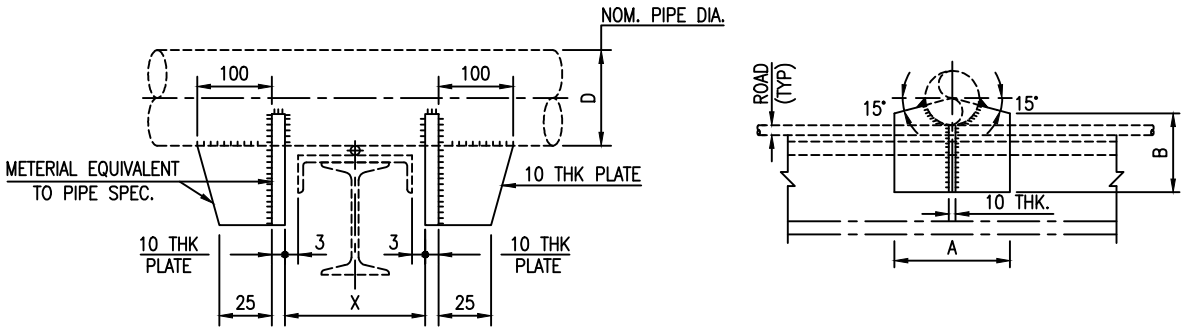
NOTE:–

1. FOR SUPPORTING DETAILS FOR PIPE SIZE 2" THRU 6", REFER STD. 7–44–0753.

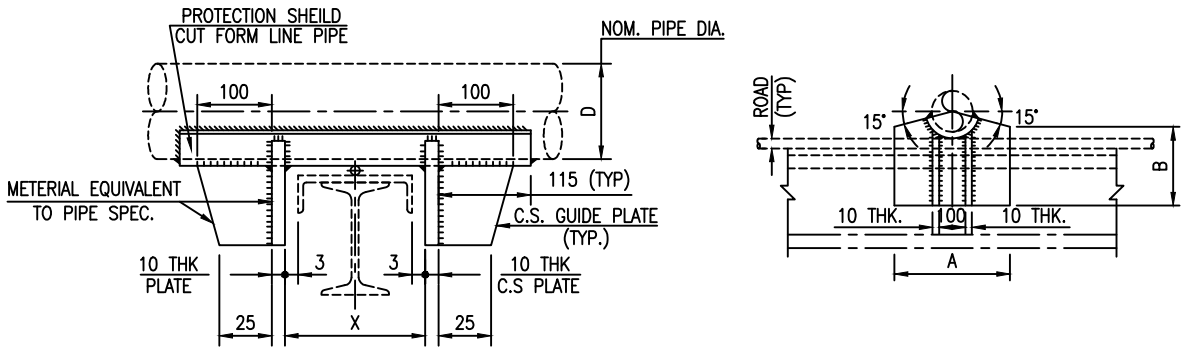
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	10–01–2019	ISSUED FOR TENDER	VKS	AP	JR

LYONS ENGINEERING PVT. LTD. NEW DELHI	CROSS GUIDE FOR BARE PIPE SIZE 2" THRU 24" TYPE–G3	DRAWING NO.
		GAIL–STD–PI–DWG–TP–004
		SHEET NO. 1 OF 1

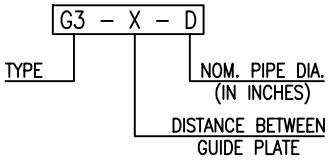
CROSS GUIDE													
D	2"	3"	4"	6"	8"	10"	12"	14"	16"	18"	20"	22"	24"
A	100	130	154	208	280	314	364	396	446	498	548	598	650
B	67	78	86	106	131	145	163	175	193	212	231	248	268



CROSS GUIDE 2" THRU 12"



CROSS GUIDE 14" THRU 24"



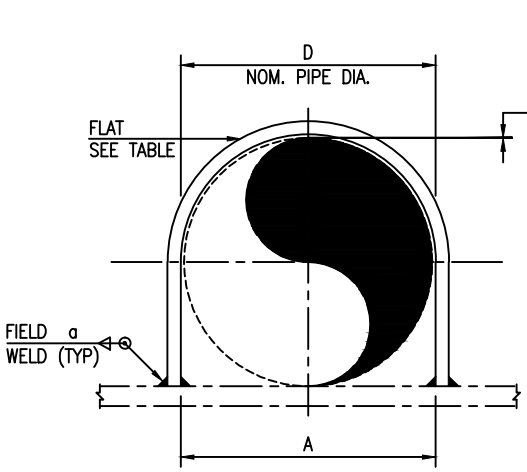
SYMBOL

NOTE:–

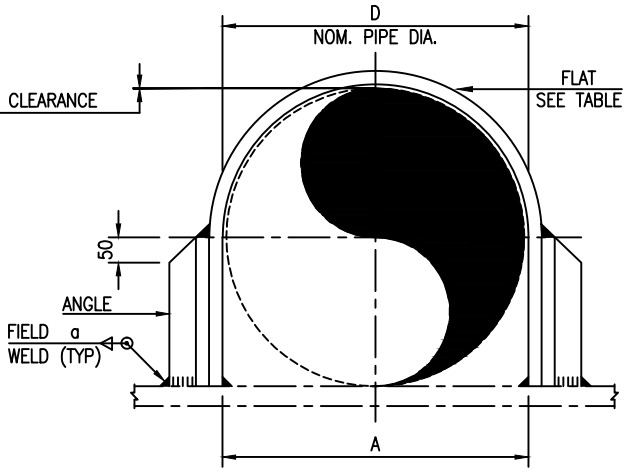
1. PROTECTION SHIELD SHALL BE CUT FROM LINE PIPE.

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	10–01–2019	ISSUED FOR TENDER	VKS	AP	JR

LYONS ENGINEERING PVT. LTD. NEW DELHI	GUIDE SUPPORT FOR BARE PIPE SIZE 1/2" THRU 24" TYPE-G1	DRAWING NO.
		GAIL-STD-PI-DWG-TP-005
		SHEET NO. 1 OF 1

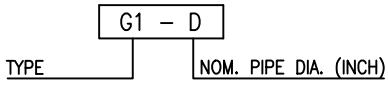


FOR SIZE UPTO 10"



FOR SIZE 12" THRU 24"

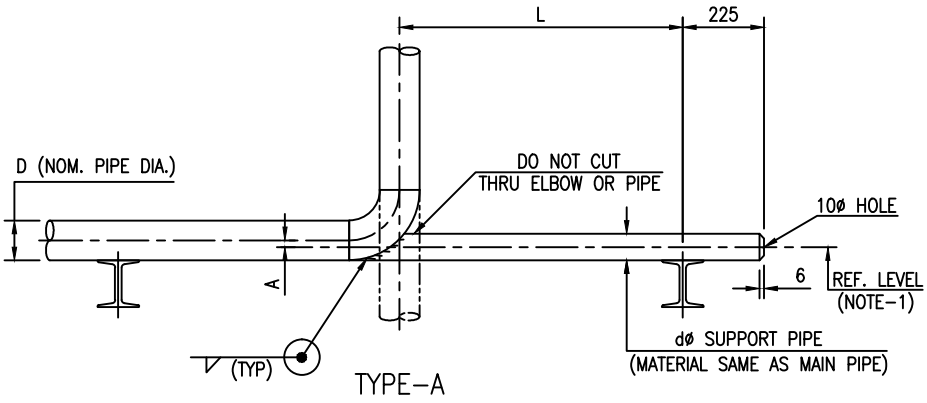
D	A	a	FLAT SIZE	ANGLE SIZE
1/2"	26	6	40 x 6	–
3/4"	33			
1"	40			
1 1/4"	48			
1 1/2"	55			
2"	65			
2 1/2"	80			
3"	95			
3 1/2"	107	10	50 x 10	–
4"	120			
5"	146			
6"	174			
8"	225			
10"	278			
12"	328	10	65 x 12	75x75x10
14"	362			
16"	412			
18"	463	10	75 x 12	90x90x10
20"	515			
24"	616			



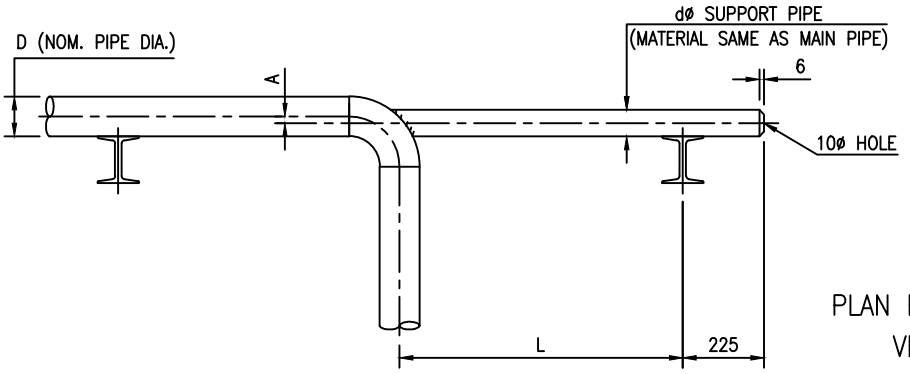
SYMBOL

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR

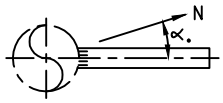
LYONS ENGINEERING PVT. LTD. NEW DELHI	DUMMY PIPE SUPPORT FOR BARE PIPE SIZE 2" THRU 24" TYPE-B-39	DRAWING NO. GAIL-STD-PI-DWG-TP-006
		SHEET NO. 1 OF 1



TYPE-A



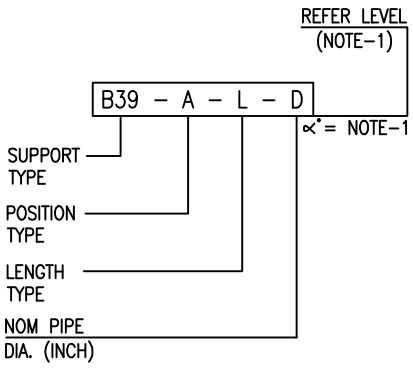
TYPE-B



PLAN FOR SUPPORT ON VERTICAL PIPE

FOR L, 1500 OR LESS		
D	d (NOTE 2)	A
2"	2"-SCH.40	-
3"	2"-SCH.40	15
4"	3"-SCH.40	13
6"	3"-SCH.40	40
8"	4"-SCH.40	52
10"	6"-SCH.40	52
12"	6"-SCH.40	78
14"	8"-SCH.40	68
16"	8"-SCH.40	94
18"	8"-SCH.40	119
20"	10"-SCH.40	118
24"	10"-SCH.40	168

FOR L, OVER 1500		
D	d (NOTE 2)	A
2"	2"-SCH.40	-
3"	2"-SCH.40	15
4"	3"-SCH.40	13
6"	4"-SCH.40	27
8"	6"-SCH.40	25
10"	8"-SCH.40	27
12"	8"-SCH.40	52
14"	10"-SCH.40	41
16"	10"-SCH.40	67
18"	10"-SCH.40	92
20"	12"-SCH.40	92
24"	12"-SCH.40	143



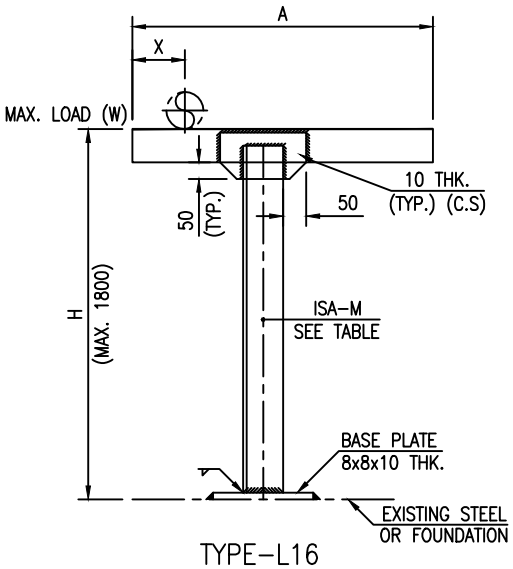
SYMBOL

NOTES:-

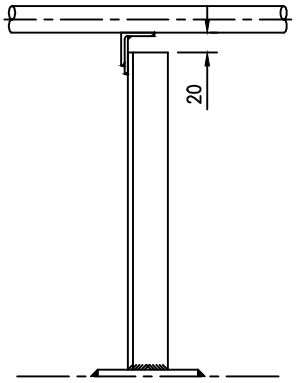
1. REF. LEVEL & ∝. TO BE GIVEN IN CASE SUPPORT IS WELDED TO VERTICAL PIPE.
2. IN CASE SIZE AND/OR SCH. OF SUPPORT PIPE (d) LISTED IN THE TABLE IS NOT AVAILABLE USE NEXT HIGHER SIZE AND/OR NEAREST EQUIVALENT THICKNESS AVAILABLE.

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR

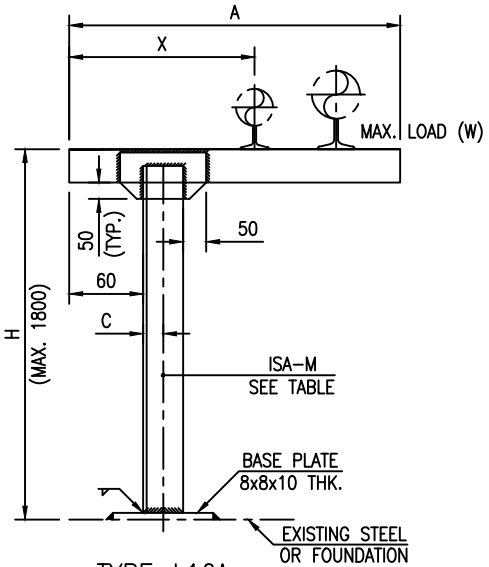
LYONS ENGINEERING PVT. LTD. NEW DELHI	LOW SUPPORT STANCHION TYPE–L16 AND L–16A	DRAWING NO. GAIL–STD–PI–DWG–TP–007
		SHEET NO. 1 OF 1



TYPE–L16



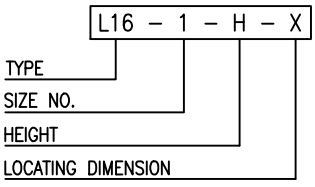
SIDE VIEW



TYPE–L16A

NOTE:–

1. DO NOT USE FOR ANCHORING THE PIPE.

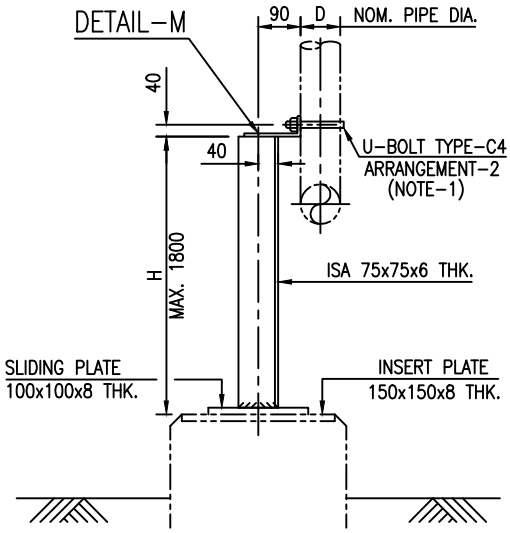


SYMBOL

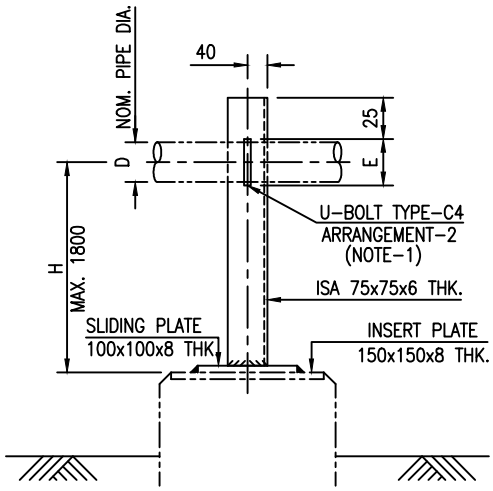
SIZE NO.	MAX. LOAD (W) Kg.	M	A	B	C
1	500	ISA 80x80x8	600	150	45
2	800	ISA 100x100x10	700	150	60
3	1500	ISA 130x130x12	800	150	80

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	10–01–2019	ISSUED FOR TENDER	VKS	AP	JR

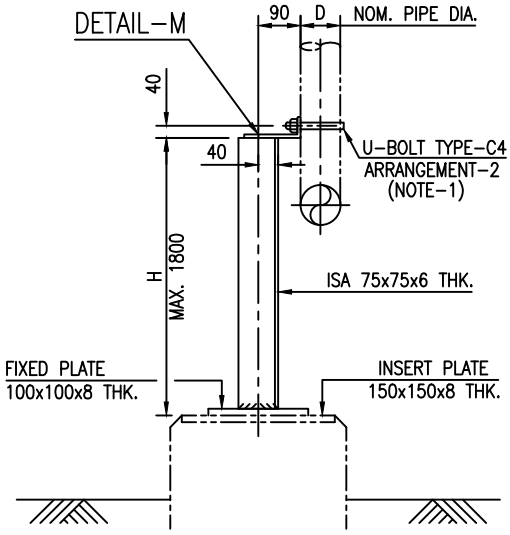
LYONS ENGINEERING PVT. LTD. NEW DELHI	LOW SUPPORT SLIDING AND FIXED FOR PIPE SIZE 3/4" THRU 1.1/2"TYPE L-15	DRAWING NO. GAIL-STD-PI-DWG-TP-008
		SHEET NO. 1 OF 1



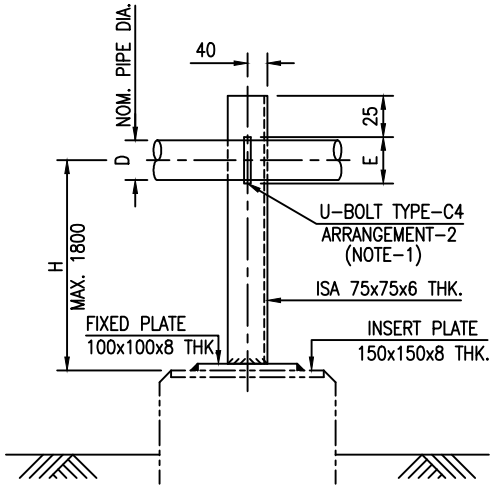
ARRANGEMENT TYPE-1
(SLIDING)



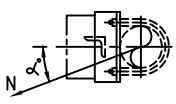
ARRANGEMENT TYPE-2
(SLIDING)



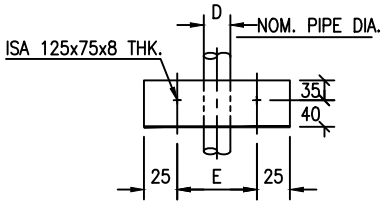
ARRANGEMENT TYPE-3
(FIXED)



ARRANGEMENT TYPE-4
(FIXED)



(FIXED)
(FOR TYPE-1 & 3)



DETAIL-M

D	E
3/4"	36
1"	45
1 1/2"	60

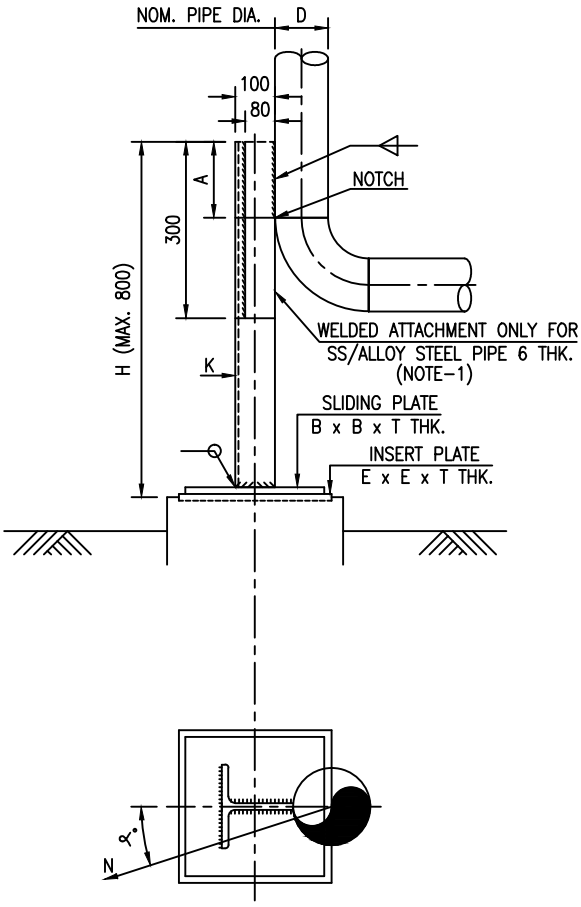
∝°= (FOR TYPE 1 & 3) L15 - 1 - H - D

TYPE
ARRANGEMENT TYPE
HEIGHT
NOM. PIPE DIA. (INCH)

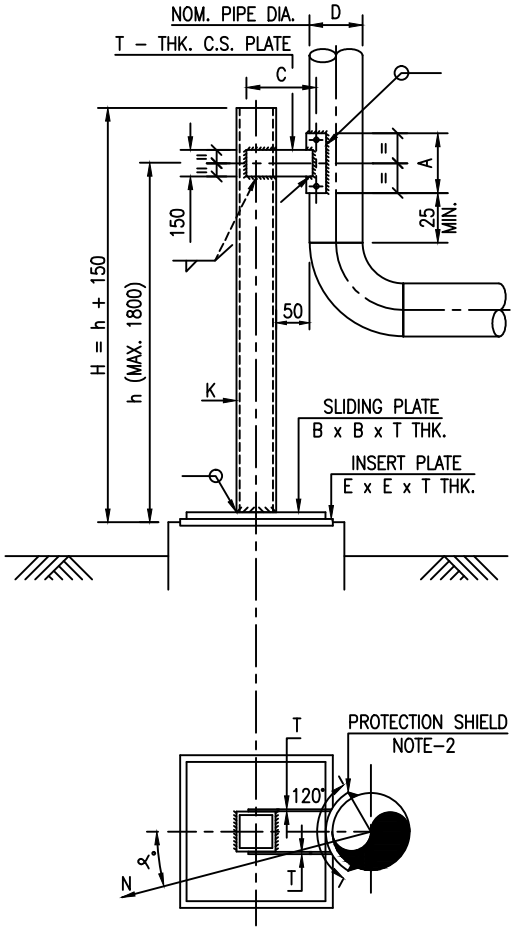
SYMBOL

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR

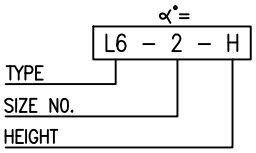
LYONS ENGINEERING PVT. LTD. NEW DELHI	LOW SUPPORT SLIDING FOR BARE & INSULATED PIPE SIZE 2" THRU 24"TYPE-L6	DRAWING NO. GAIL-STD-PI-DWG-TP-009
		SHEET NO. 1 OF 1



FOR PIPE SIZES 2" THRU 4"



FOR PIPE SIZES 6" THRU 24"



SYMBOL

NOTES:-

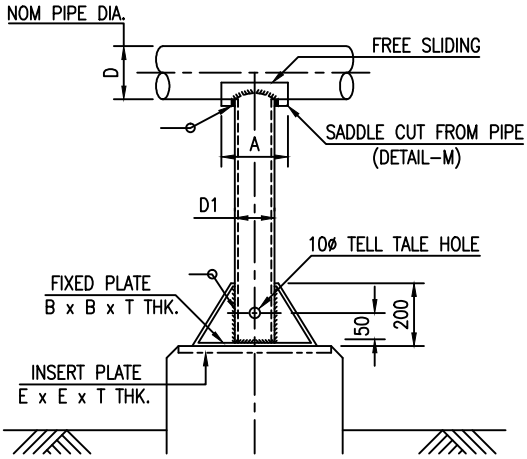
1. MATERIAL FOR WELDED ATTACHMENT SHALL BE EQUIVALENT TO PIPE MATERIAL.
2. PROTECTION SHIELD IS TO BE CUT FROM LINE PIPE.

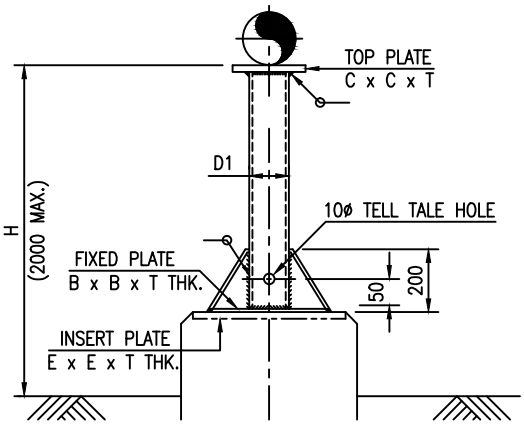
SIZE NO.	D	K	A	T	C	E	B
1	2" TO 4"	CUT FROM ISMB 200	200	10	–	250	150
2	6" TO 10"	ISMC-125 2 NOS.	200	12	150	300	200
3	12" TO 24"	ISMC-225 2 NOS.	300	12	230	400	300

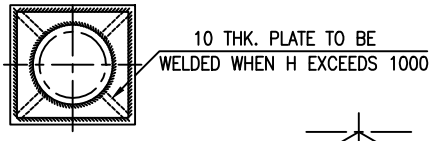
FOR TEMP. UP TO 400 °C ONLY

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR

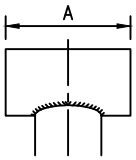
LYONS ENGINEERING PVT. LTD. NEW DELHI	LOW SUPPORT SLIDING FOR BARE PIPE SIZE 3/4" THRU 36" TYPE–L5 & L–5A	DRAWING NO. GAIL–STD–PI–DWG–TP–010
		SHEET NO. 1 OF 1

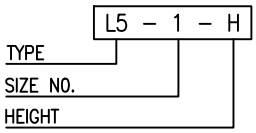




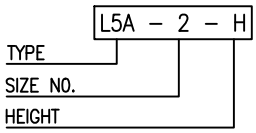


DETAIL–M





SYMBOL



SYMBOL

SIZE NO.	D	A	D1 (NOTE–1)	C	B	E	T
1	3/4"	2" NB x 100 Lg.	2" HEAVY IS :1239	150	150	200	12
	1"						
	1.1/2"	3" NB x 100 Lg.		200			
	2"						
2	3"	6" NB x 150 Lg.	2" HEAVY IS :1239	200	150	200	12
	4"						
3	6"	10" NB x 250 Lg.	3" HEAVY IS :1239	300	200	250	16
	8"						
4	10"	14" NB x 350 Lg.	4" HEAVY IS :1239	350	200	250	16
	12"						
5	14"	18" NB x 350 Lg.	6" HEAVY IS :1239	400	250	300	20
	16"						
6	18"	20" NB x 350 Lg.	8" SCH. 40	400	300	350	20
7	20"	24" NB x 350 Lg.	10" SCH. 40	450	350	400	20
	24"						
8	26"	30" NB x 350 Lg.	12" SCH. 40	550	400	500	20
	30"						
	36"	36" NB x 400 Lg.					

NOTES:–

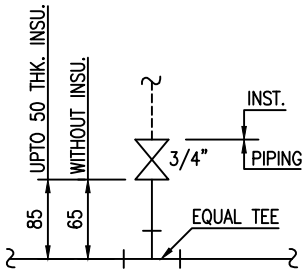
1. IN CASE SIZE AND/OR SCH. OF SUPPORT PIPE (D) LISTED IN THE TABLE IS NOT AVAILABLE, USE NEXT HIGHER SIZE AND/OR NEAREST EQUIVALENT THICKNESS AVAILABLE.
2. MATERIAL FOR SUPPORT PIPE & PLATE SHALL BE CARBON STEEL.

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	10–01–2019	ISSUED FOR TENDER	VKS	AP	JR

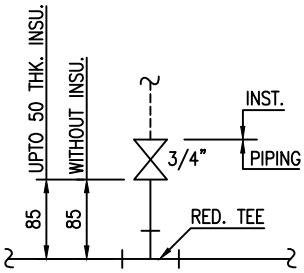
LYONS ENGINEERING PVT. LTD.
NEW DELHI

PRESSURE TAPPINGS (PA, PG, PC, PT, PIC ETC.)

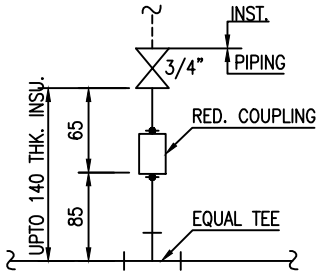
DRAWING NO.
GAIL-STD-PI-DWG-TP-011
SHEET NO. 1 OF 1



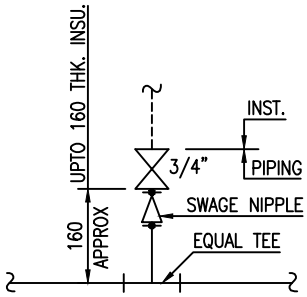
PC-1 ON LINE 3/4"



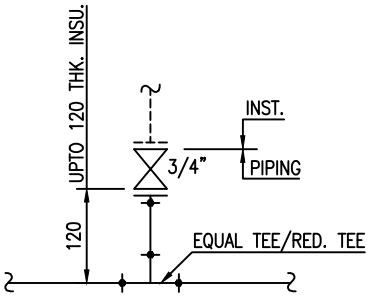
PC-2 ON LINE 1"-1 1/2"



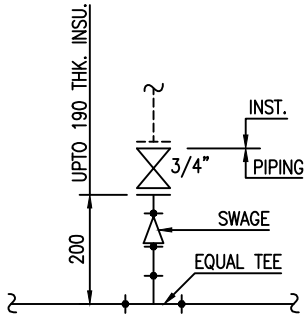
PC-3 ON LINE 1"-1 1/2"



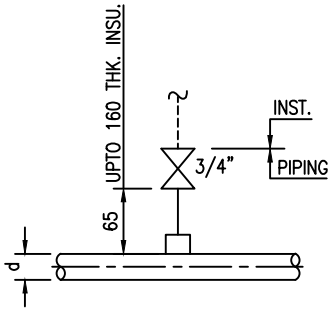
PC-4 ON LINE 1"-1 1/2"



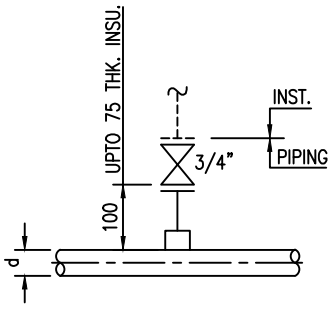
PC-5 ON LINE 3/4"-1 1/2"



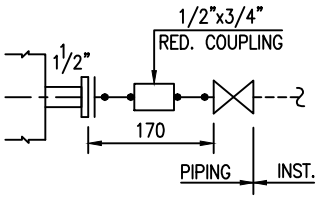
PC-6 ON LINE 1"-1 1/2"



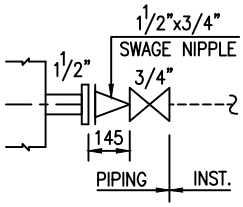
PC-10 ON LINE 2" & ABOVE



PC-11 ON LINE 2" & ABOVE

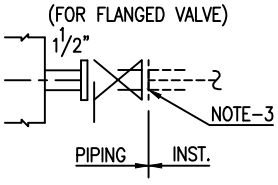


PC-12



PC-13

ON VESSELS / COLUMNS



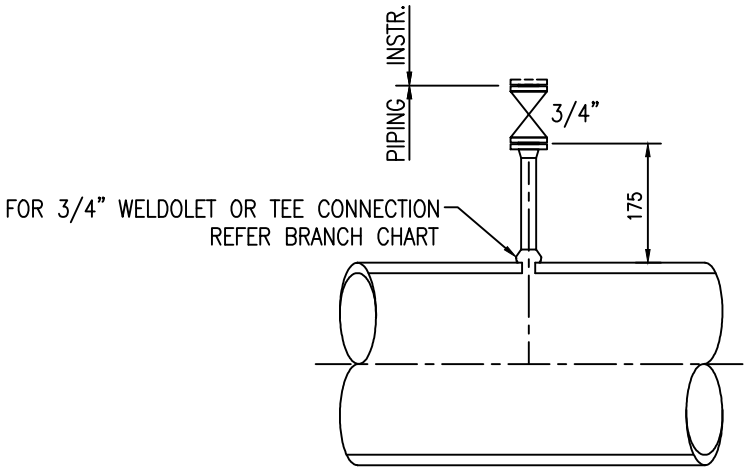
PC-14
PC-15
WITH 2" NO 220 E & 2" VALVE

NOTES:-

1. THE INDICATED DIMENSIONS ARE MINIMUM WHICH ALSO COVER INSULATION TO THE EXTENT SHOWN ABOVE IN HIGHER THICKNESS OF INSULATION THAN INDICATED, THE DIFFERENCE SHALL BE ADDED IN THE DIMENSIONS SHOWN ABOVE ACCORDINGLY.
2. PRESSURE TAPPING SHALL BE PROVIDED WITH GATE, GLOBE OR PLUG VALVE (FLGD. SW. OR SCR'D) WITH TEE (EQ. OR RED.) HALF COUPLING (.W. OR SCR'D) OR STUB-IN AS PER PIPING SPECIFICATION.
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 FOR OR CARRIED OUT.

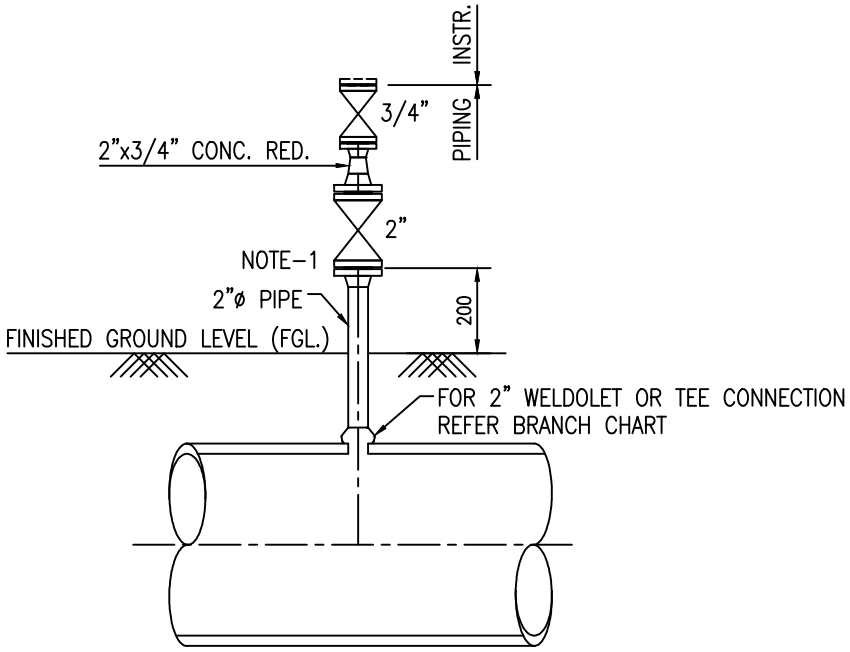
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR

LYONS ENGINEERING PVT. LTD. NEW DELHI	DETAIL OF PRESSURE CONNECTIONS ABOVE GROUND PIPE	DRAWING NO. GAIL-STD-PI-DWG-TP-012
		SHEET NO. 1 OF 1



REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR

LYONS ENGINEERING PVT. LTD. NEW DELHI	DETAIL OF PRESSURE CONNECTIONS UNDER GROUND PIPE	DRAWING NO. GAIL-STD-PI-DWG-TP-013
		SHEET NO. 1 OF 1

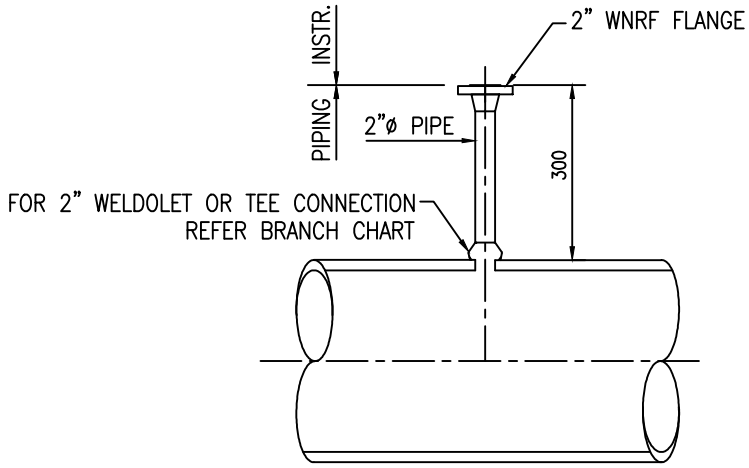


NOTE:

1 INSULATION GASKET SHALL BE INSTALLED.

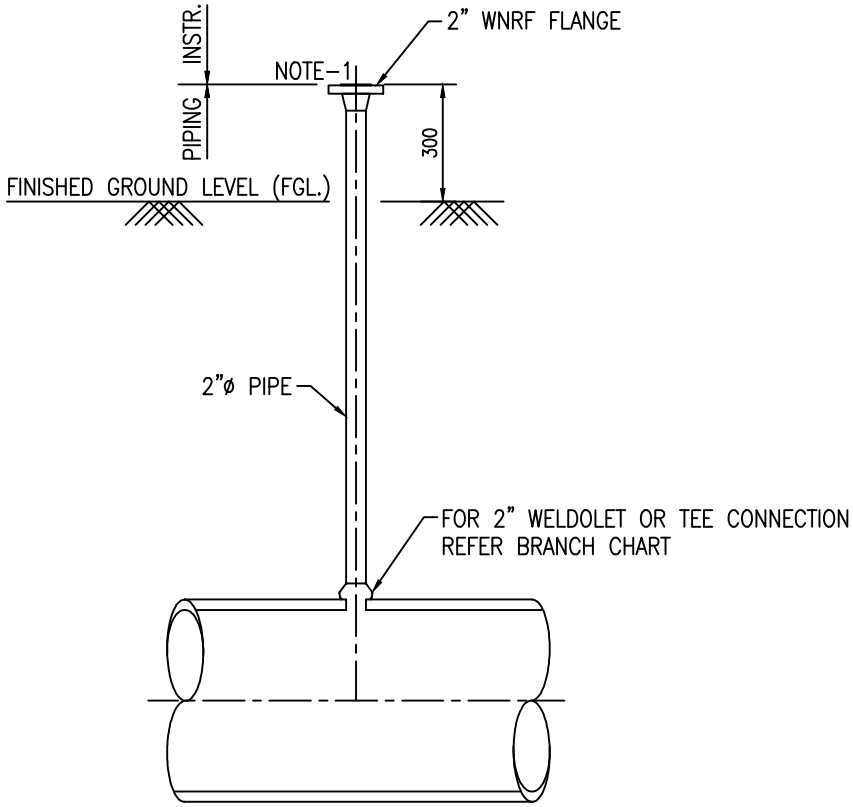
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR

LYONS ENGINEERING PVT. LTD. NEW DELHI	DETAIL OF TEMPERATURE CONNECTIONS ABOVE GROUND PIPE	DRAWING NO. GAIL-STD-PI-DWG-TP-014
		SHEET NO. 1 OF 1



REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR

LYONS ENGINEERING PVT. LTD. NEW DELHI	DETAIL OF TEMPERATURE CONNECTIONS UNDER GROUND PIPE	DRAWING NO. GAIL-STD-PI-DWG-TP-015
		SHEET NO. 1 OF 1

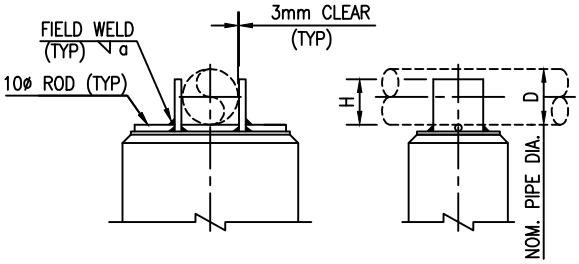


NOTE:

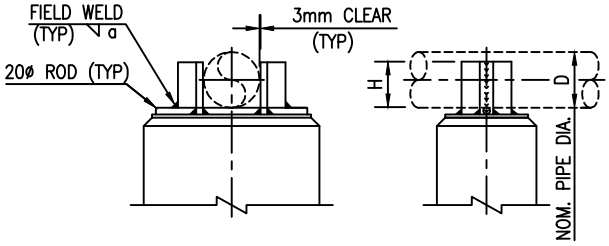
1 INSULATION GASKET SHALL BE INSTALLED.

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR

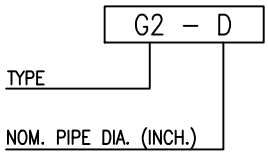
LYONS ENGINEERING PVT. LTD. NEW DELHI	GUIDE SUPPORT FOR BARE PIPE (SIZE 1/2" TO 24") TYPE G2	DRAWING NO. GAIL-STD-PI-DWG-TP-016
		SHEET NO. 1 OF 1



FOR SIZES UPTO 4"



FOR SIZES 6" THRU 24"



SYMBOL

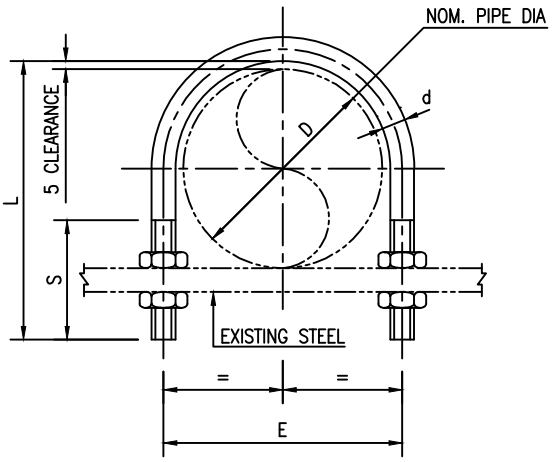
D	H	a	METERIAL
2" & SMALLER	40	6	FLAT 60 x 10
3" TO 4"	70	6	FLAT 75 x 10
6" TO 8"	130	6	2 NOS. ISA 50 x 50 x 6
10" TO 18"	230	10	2 NOS. ISA 75 x 75 x 10
20" TO 24"	350	10	2 NOS. ISA 90 x 90 x 10

NOTES:-

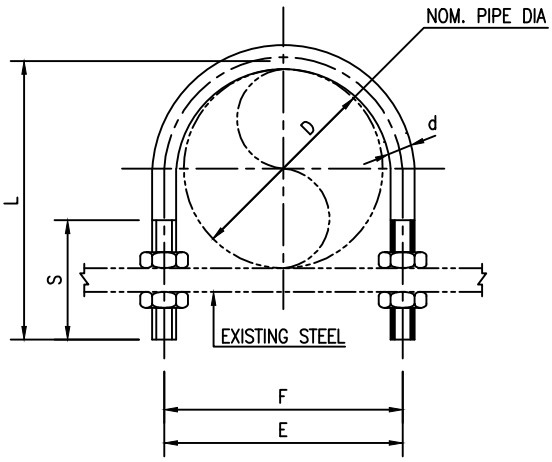
GUIDE ANGLES SHOULD BE SUITABLY TRIMMED WHEREVER THESE OBSTRUCT ADJOINING GUIDE ANGLES.

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR

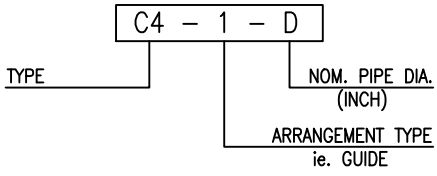
LYONS ENGINEERING PVT. LTD. NEW DELHI	U-BOLT FOR BARE PIPE (SIZE 1/2" TO 24")	DRAWING NO. GAIL-STD-PI-DWG-TP-017
		SHEET NO. 1 OF 1



GUIDE
ARRANGEMENT TYPE-1
(1/2" TO 24")



FIXED
ARRANGEMENT TYPE-2
(1/2" TO 1 1/2")



SYMBOL

D	O.D. (mm)	'U' CLAMP				
		L	E	S	d	F
1/2"	21	65	30	50	6	24
3/4"	27	70	36	50	6	30
1"	33	75	45	55	8	37
1 1/2"	48	90	60	55	8	52
2"	60	105	72	60	8	64
3"	89	145	106	80	12	94
4"	114	170	130	80	12	119
6"	168	240	190	100	16	173
8"	219	290	242	100	16	226
10"	273	345	296	100	16	280
12"	324	420	351	130	20	331
14"	356	450	382	130	20	362
16"	408	500	435	130	20	414
18"	457	565	490	140	24	465
20"	508	620	540	140	24	515
24"	610	720	645	140	24	620

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
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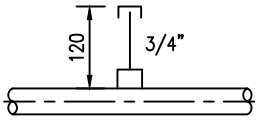
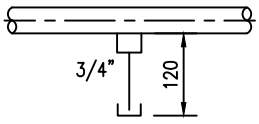
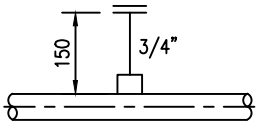
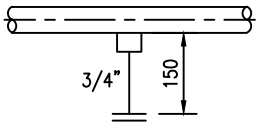
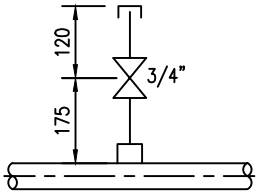
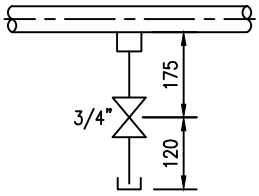
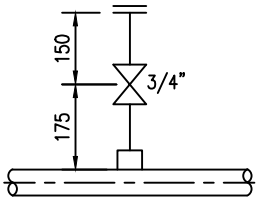
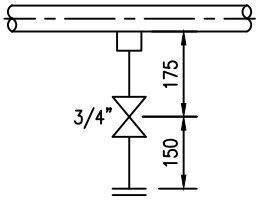
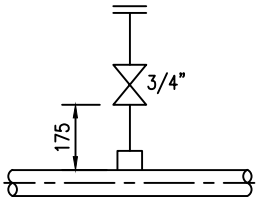
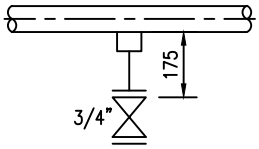
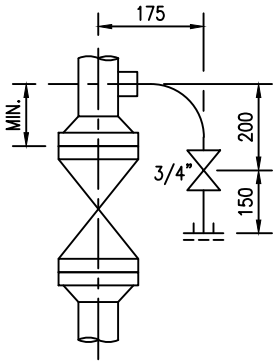
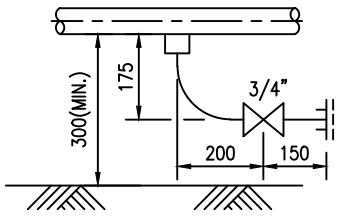
LYONS ENGINEERING PVT. LTD.
NEW DELHI

VENTS AND DRAINS (ON LINES 2" AND ABOVE)

DRAWING NO.
GAIL-STD-PI-DWG-TP-018
SHEET NO. 1 OF 1

TYPE	VENT	DRAIN	TYPE
VP1, V1C			D1, D1C
V2F			D2F
V3, V3C			D3, D3C
V4F			D4F
V5F			D5F
			DC9, DF9
			DC10, DF10

NOTES:-

1. VENTS & DRAINS SHALL BE PROVIDED WITH GATE, GLOBE OR PLUG VALVE (FLG'D.) WITH HALF COUPLING. OR STUB IN, WITH CAP OR FLANGE & BLIND FLANGE AS PER PIPING SPECIFICATIONS.
2. LEGEND : V = VENT; D = DRAIN; C = CAP; F = FLANGE; P = PLUG.

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR

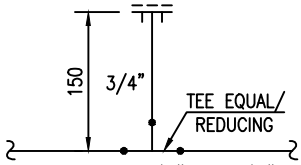
LYONS ENGINEERING PVT. LTD.
NEW DELHI

VENTS AND DRAINS (ON LINES 1 1/2" AND BELOW)

DRAWING NO.
GAIL-STD-PI-DWG-TP-019
SHEET NO. 1 OF 1

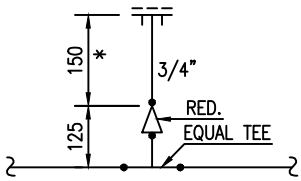
TYPE AS LINE SIZE

VC1, VF1, VP1

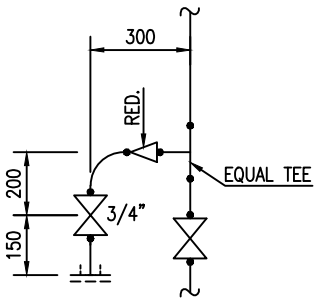


ON LINE 3/4"-1 1/2"

VC2, VF2, VP2



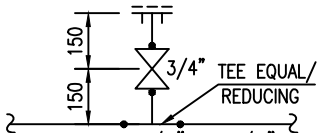
ON LINE 1"-1 1/2"



ON LINE 1"-1 1/2"

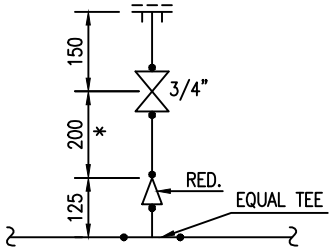
DC7, DF7, DP7

VC3, VF3, VP3

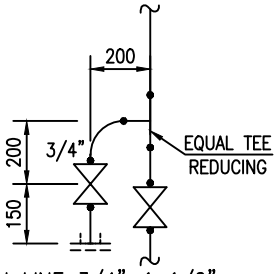


ON LINE 3/4"-1 1/2"

VC4, VF4, VP4



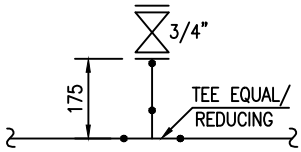
ON LINE 1"-1 1/2"



ON LINE 3/4"-1 1/2"

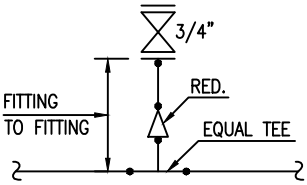
DC8, DF8, DP8

VF5, VP5



ON LINE 3/4"-1 1/2"

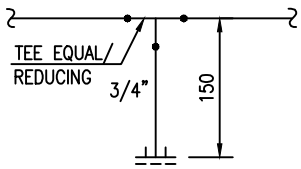
VF6, VP6



VENT ON LINE 1"-1 1/2"

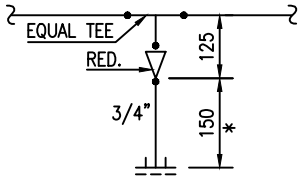
TYPE

DC1, DF1, DP1



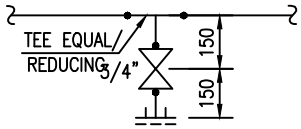
ON LINE 3/4"-1 1/2"

DC2, DF2, DP2



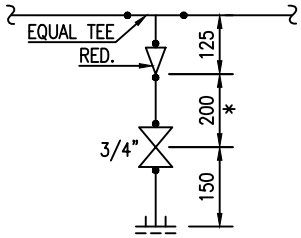
ON LINE 3/4"-1 1/2"

DC3, DF3, DP3



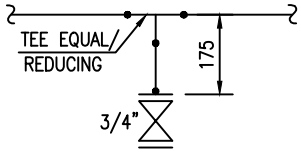
ON LINE 3/4"-1 1/2"

DC4, DF4, DP4



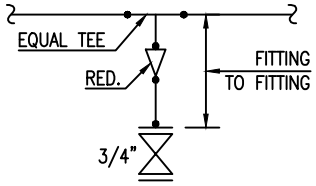
ON LINE 1"-1 1/2"

DC5, DF5



ON LINE 3/4"-1 1/2"

DC6, DF6

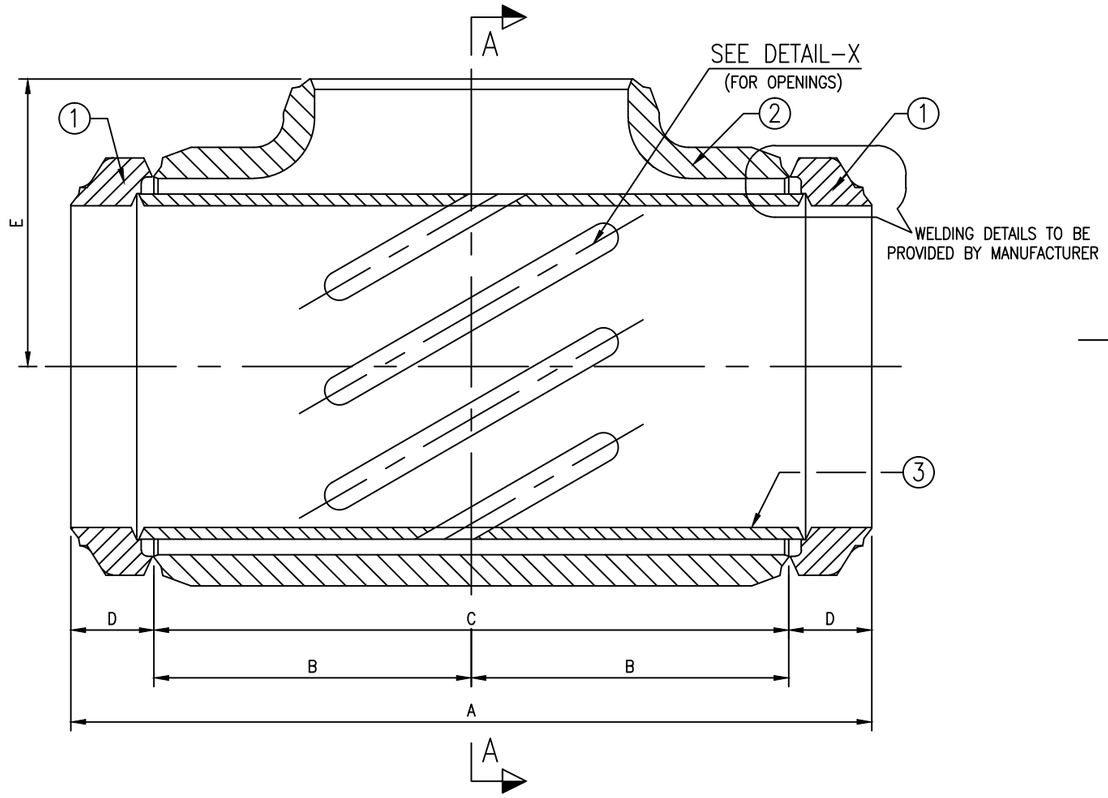


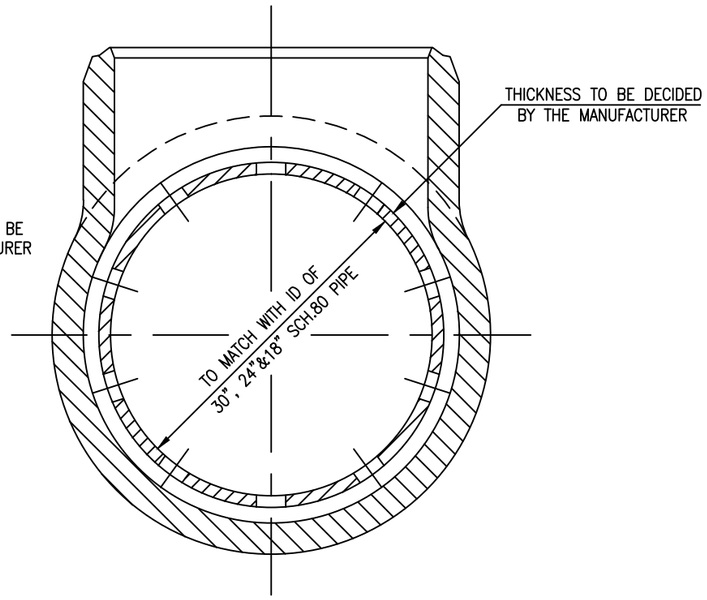
VENT ON LINE 1"-1 1/2"

NOTES:-

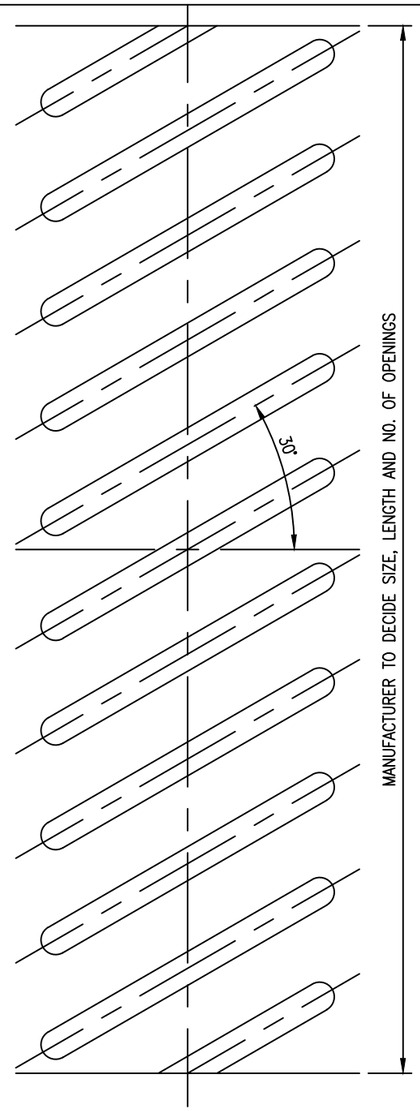
1. DIMENSIONS ARE VALID FOR 50mm(MAX) INSULATION THICKNESS, INCREASE DIMENSIONS AS REQUIRED, DIMENSIONS MARKED '*' ARE MAXIMUM AND MAY BE REDUCED TO SUIT.
2. VENTS & DRAINS SHALL BE PROVIDED WITH GATE, GLOBE OR PLUG VALVE (FLGD.) WITH TEE (EQUAL OR REDUCING), HALF COUPLING OR STUB IN, CAP OR PLUG FLANGE AND BLIND FLANGE AS PER PIPING SPECIFICATION.
   LEGEND : V = VENT; D = DRAIN; C = CAP; F = FLANGE; RED. = REDUCER, COUPLING OR SOCKET; P = PLUG.

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR





SECTION A–A



DETAIL–X

3.	INNER CASING	REFER TABLE–1	–	T ST E355 / EQUIVALENT
2.	WELDED RED. TEE	REFER TABLE–1	ASME B16.9/MSS SP 79	**
1.	END PLATE	REFER TABLE–1	–	ASTM A 350 LF 2
PART NO.	DESCRIPTION	SIZE	DIM. STD.	MATERIAL

** MATL. ASTM–A240 WPL6 UPTO 16" API5L Gr.X60 OR ASTM A694 F60 OR ASTM A860 WPHY6 ABOVE 16"

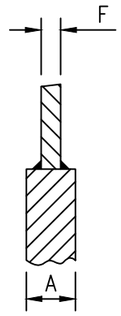
TABLE–1					
SIZE	A	B	C	D	E
30"x30"	1518	559	1118	200	559
30"x24""	1518	559	1118	200	533
30"x18"	1518	559	1118	200	495
24"x24"	1264	432	864	200	432
24"x18""	1264	432	864	200	419
18"x18"	1086	343	686	200	343

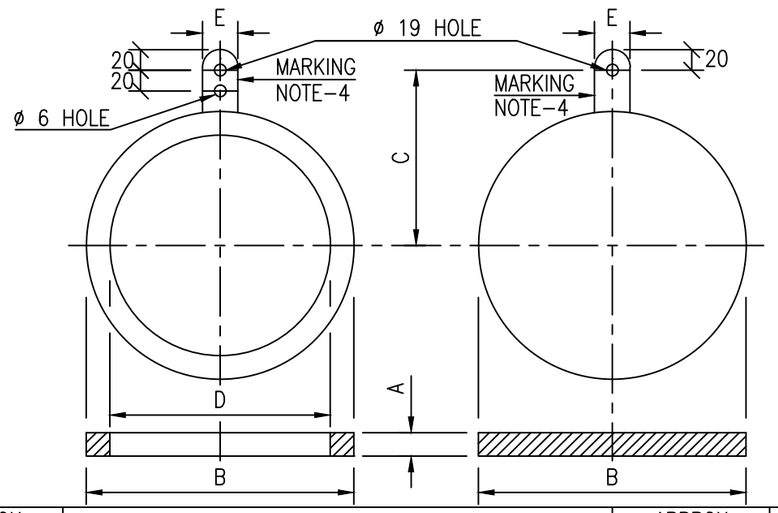
LYONS ENGINEERING PVT. LTD.
NEW DELHI

REV. NO.	DATE	SUBJECT OF REVISION	PREPD.		CHKD.		APPRD.	
0	10.01.2019	ISSUED FOR TENDER	VKS		TR		JR	

FLOW TEE

DRAWING NO.
GAIL-STD-PI-DWG-TP-020
SHEET NO. 1 OF 1





NOTES:–

1. PROVIDE CONCENTRIC SERRATED FINISH ON BOTH SIDES WITH GROOVES 0.8 mm APART AND DEPTH APPROX 0.4 mm.
2. DIMENSIONS ARE FOR FLANGES TO ANSI B16.5 FOR SIZE UP TO 24" & MSS–SP–44 FOR SIZE ABOVE 24" FOR FLANGES TO API 605 CALCULATE DIMN.
3. THE DIA METER RATING AND MATERIAL SPECIFICATION SHALL BE MARKED ON WELDED FIXED PLATE.
4. MATERIAL AS PER PIPE CLASS.

PIPE SIZE INCH	150# FF							APPROX WT KGS		300# FF							APPROX WT KGS		600# FF							APPROX WT KGS		PIPE SIZE INCH
	A	B	C	D	E	F		BLIND	SPECER	A	B	C	D	E	F		BLIND	SPECER	A	B	C	D	E	F		BLIND	SPECER	
1"	5	62	105	29	25	4		0.2	0.1	5	70	115	29	25	4		0.2	0.1	5	70	125	29	25	4		0.28	0.15	1"
1½"	5	82	115	43	25	4		0.3	0.2	5	92	125	43	25	4		0.4	0.3	7	92	125	43	25	4		0.5	0.35	1½"
2"	7	102	125	55	25	4		0.4	0.3	7	108	130	55	25	4		0.6	0.4	10	108	130	55	25	4		0.75	0.5	2"
2½"	7	121	140	65	25	4		0.8	0.6	10	127	150	65	25	6		1.1	0.7	15	127	150	65	25	6		1.2	0.9	2½"
3"	7	134	150	80	40	4		0.9	0.7	10	146	155	80	40	6		1.7	1.0	15	146	155	80	40	6		2.0	1.2	3"
4"	8	170	165	106	40	6		1.8	1.0	13	178	180	106	40	6		2.1	1.2	18	190	180	106	40	6		3.7	2.4	4"
6"	11	218	190	157	40	6		3.7	1.5	18	248	210	157	40	6		7.2	3.8	24	263	225	157	40	8		11.0	6.2	6"
8"	15	275	220	207	40	6		7.5	2.7	21	305	240	207	40	8		13.5	6.3	30	314	260	207	40	10		19.5	10.0	8"
10"	18	335	250	260	40	8		13.0	4.3	26	358	270	260	40	10		22.5	8.8	37	397	300	260	40	10		37.0	19.0	10"
12"	19	405	290	312	40	8		22.0	8.0	30	418	310	312	40	10		35.0	13.8	43	454	325	312	40	15		57.0	27.5	12"
14"	22	445	320	342	40	10		28.0	12.5	34	480	340	342	40	15		52.0	23.5	48	448	350	342	40	15		71.0	33.0	14"
16"	26	510	350	393	40	10		42.0	15.0	38	536	375	393	40	15		70.0	30.0	54	560	390	393	40	20		110	55	16"
18"	29	545	370	445	40	10		53.0	17.0	43	592	400	445	40	20		100	42.0	62	608	415	445	40	20		140	65	18"
20"	30	600	400	496	40	15		70.0	20.0	48	650	440	496	40	20		128	49.0	67	678	450	496	40	20		190	83	20"
24"	37	710	450	597	50	15		120	52.0	57	772	510	597	50	20		210	74.0	81	785	515	597	50	25		307	125	24"
TOLERANCE	± 0.3	± 0.5		± 0.5	± 1.0					± 0.3	± 0.5		± 0.5	± 1.0					± 0.3	± 0.5		± 0.5	± 1.0					TOLERANCE

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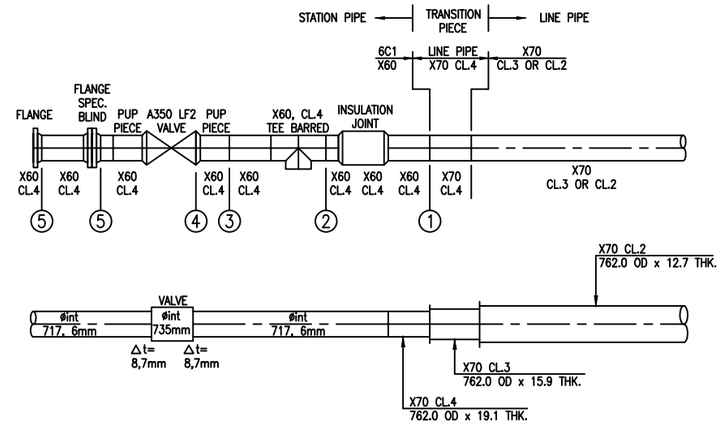
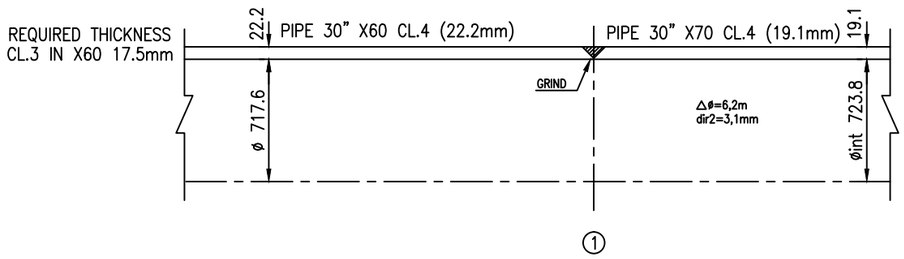
NEW DELHI

REV. NO.	DATE	SUBJECT OF REVISION	PREPD.	CHKD.	APPRD.
0	10.01.19	ISSUED FOR TENDER	VKS	TR	JR

SPACERS BLINDS
150#,300# & 600# FF

DRAWING NO.
GAIL-STD-PI-DWG-TP-021
SHEET NO. 1 OF 1





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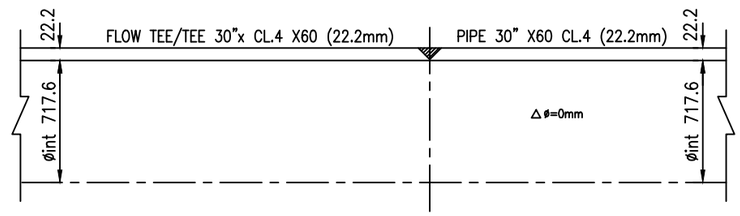

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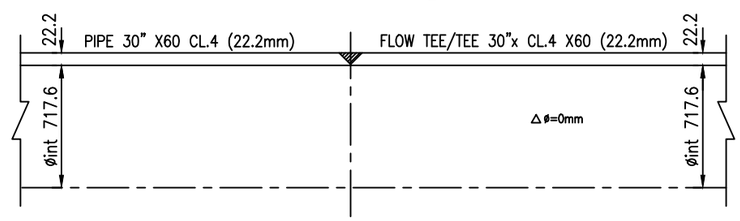

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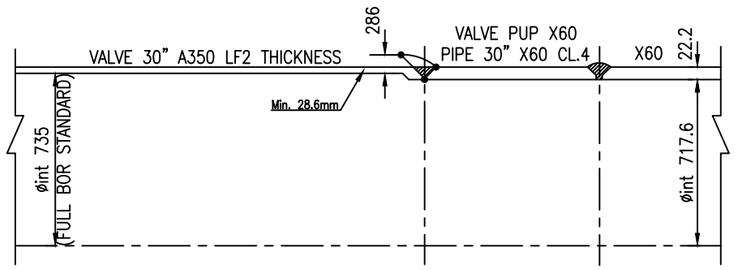

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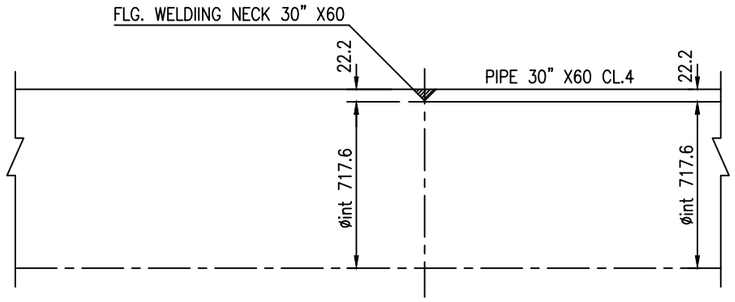
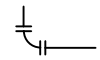
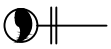
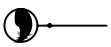
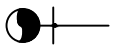
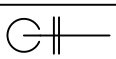
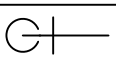
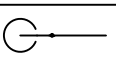
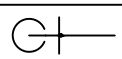
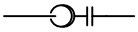
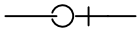
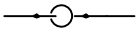
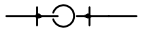
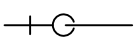
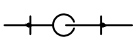
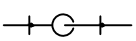
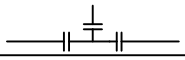
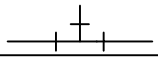
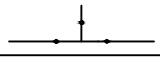
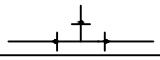


⑤

LYONS ENGINEERING PVT. LTD. NEW DELHI									TYP. PIPING ARRANGEMENT FOR 30" SECTION	DRAWING NO.	
										GAIL-STD-PI-DWG-TP-022	
	0	10.01.19	ISSUED FOR TENDER	VKS		TR		JR		SHEET NO.	1 OF 1
	REV. NO.	DATE	SUBJECT OF REVISION	PREPD.		CHKD.		APPRD.			

LYONS ENGINEERING PVT. LTD. NEW DELHI	SYMBOLS OF PIPING ELEMENTS ON DRAWINGS	DRAWING NO. GAIL-STD-PI-DWG-TP-023
		SHEET NO. 1 OF 4

DESCRIPTION	FLANGED	SCREWED	WELDED (NOTE-1)	SOCKET WELD
90° ELBOW				
ELBOW (TURNED UP)				
ELBOW (TURNED DOWN)				
MITERED BEND 90°				
MITERED BEND 45°				
45° ELBOW				
45° ELBOW (TURNED UP)				
45° ELBOW (TURNED DOWN)				
TEE EQUAL/UNEQUAL				
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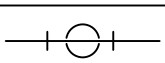
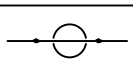
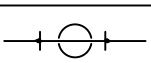
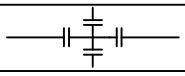
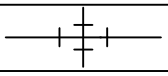
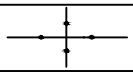
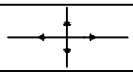
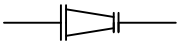
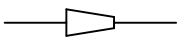
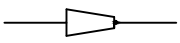
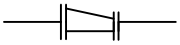
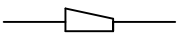
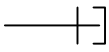
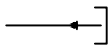
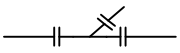
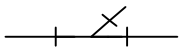
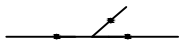
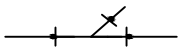
TEE (OUTLET DOWN)				
CROSS				
CONCENTRIC REDUCER				
ECCENTRIC REDUCER				
DEAD END				
LATERAL				
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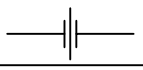
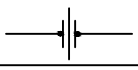
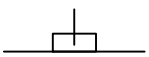
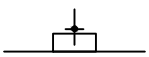
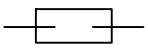
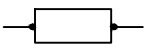
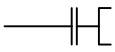
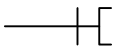
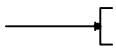
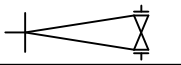
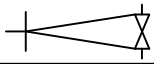
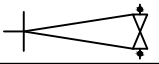
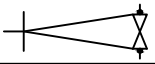
UNION				
HALF COUPLING				
FULL COUPLING				
HOSE COUPLING				

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR

LYONS ENGINEERING PVT. LTD. NEW DELHI	SYMBOLS OF PIPING ELEMENTS ON DRAWINGS	DRAWING NO. GAIL-STD-PI-DWG-TP-023
		SHEET NO. 2 OF 4

DESCRIPTION	FLANGED	SCREWED	WELDED (NOTE-1)	SOCKET WELD
GATE VALVE (PLAN)				
GATE VALVE (ELEVATION)				
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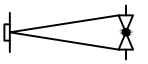
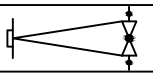
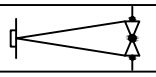
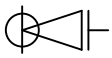
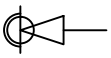
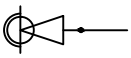
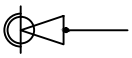
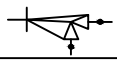
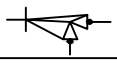
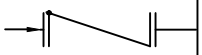
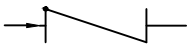
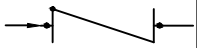
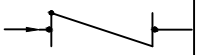
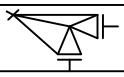
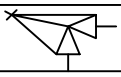
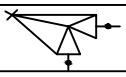
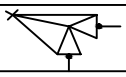
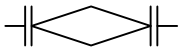
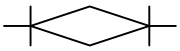
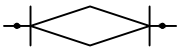
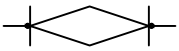
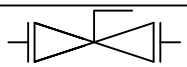
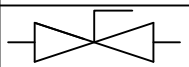
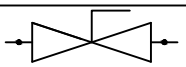
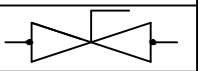
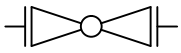
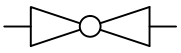
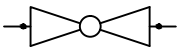
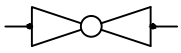
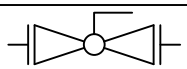
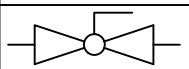
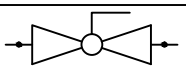
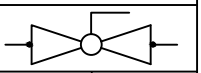
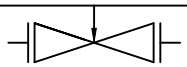
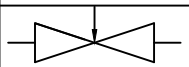
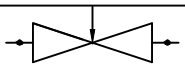
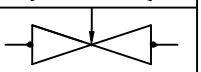
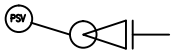
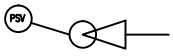
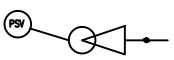
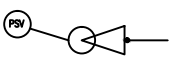
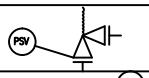
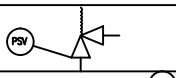
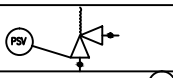
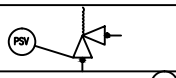
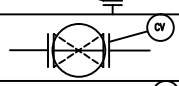
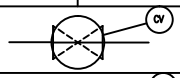
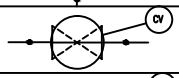
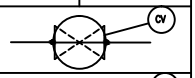
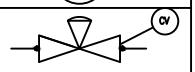
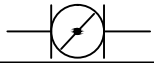
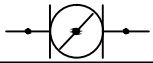
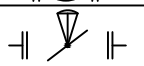
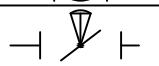
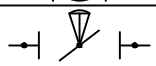
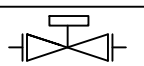
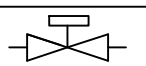
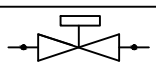
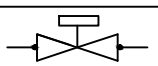
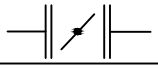
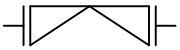
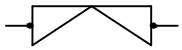
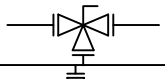
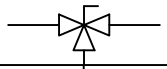
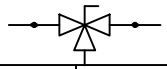
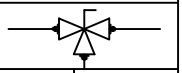
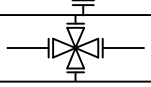
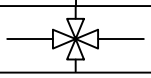
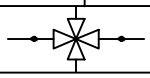
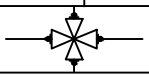
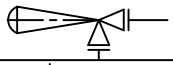
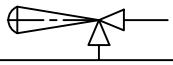
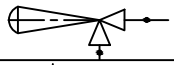
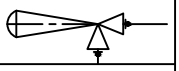
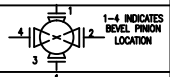
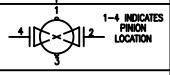
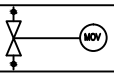
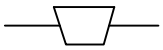
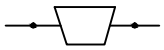
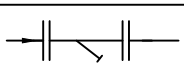
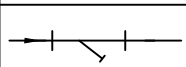
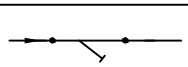
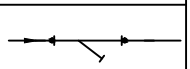
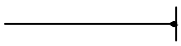
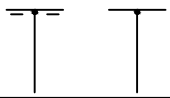
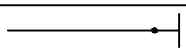
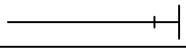
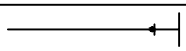
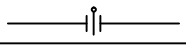
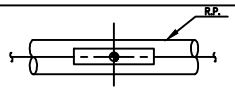
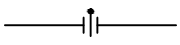
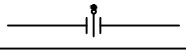
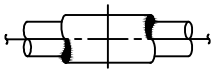
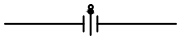
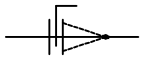
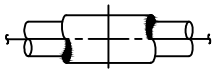
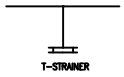
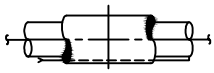
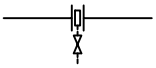
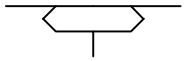
GLOBE VALVE (ELEVATION)				
ANGLE VALVE (PLAN)				
ANGLE VALVE (ELEVATION)				
CHECK VALVE (PLAN OR ELEVATION)				
ANGLE STOP CHECK VALVE (PLAN)				
ANGLE STOP CHECK VALVE (ELEVATION)				
PLUG VALVE (PLAN)				
PLUG VALVE (ELEVATION)				
BALL VALVE (PLAN)				
BALL VALVE (ELEVATION)				
NEEDLE VALVE (PLAN OR ELEVATION)				
RELIEF VALVE (PLAN)				
RELIEF VALVE (ELEVATION)				
CONTROL VALVE GLOBE TYPE(PLAN)				
CONTROL VALVE GLOBE TYPE(ELEVATION)				
CONTROL VALVE BUTTERFLY TYPE(PLAN)				
CONTROL VALVE BUTTERFLY TYPE(ELEV.)				
SOLENOID OPERATED VALVE(PLAN OR ELEV.)				

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR

DESCRIPTION	FLANGED	SCREWED	WELDED (NOTE-1)	SOCKET WELD
BUTTERFLY VALVE (PLAN OR ELEVATION)				
DIAPHRAGM VALVE (PLAN OR ELEVATION)				
3-WAY PLUG VALVE (PLAN OR ELEVATION)				
4-WAY PLUG VALVE (PLAN OR ELEVATION)				
EXPANSION JOINT				
ANGLE CONTROL VALVE				
CHAIN OPERATING VALVE				
GEAR OPERATED VALVE (BEVEL GEAR)PLAN				
GEAR OPERATED VALVE (SPUR GEAR)PLAN				
MOTOR OPERATING VALVE				
STEAM TRAP				
Y-STRAINER				

DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL
SLIP ON FLANGE		STUB – IN (WITH OR WITHOUT RENIF)	
WELDNECK FLANGE			
SCREWED FLANGE		STUB – IN (SADDLE RENIF)	
SOCKET WELD FLANGE			
SPACER		STUB – IN WITH RENIF (IN PLAN)	
SPACER BLIND			
SPECTALE FIG. 8 (BLIND)		INSULATED (LINES 12" AND BELOW)	
SPECTALE FIG. 8 (OPEN)			

LYONS ENGINEERING PVT. LTD. NEW DELHI	SYMBOLS OF PIPING ELEMENTS ON DRAWINGS	DRAWING NO. GAIL-STD-PI-DWG-TP-023
		SHEET NO. 4 OF 4

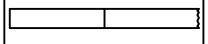
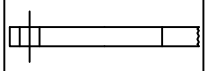
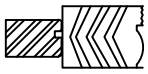
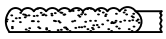
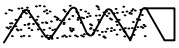
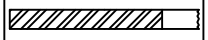
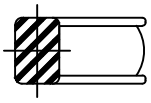
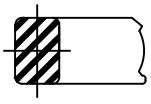
DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL
CONICAL STRAINER		INSULATED (LINES 14" & ABOVE)	
Y- TYPE STRAINER		STEAM TRACED	
DRIP RING		WELDOLET	

NOTES :

1. WELD DOTS NOT TO BE SHOWN ON PIPING G.A.Ds.
2. FOR SYMBOLS/LEGENDS RELATED TO CIVIL ENGINEERING/UNDERGROUND REFER CIVIL ENGINEERING STANDARD 7-65-0001

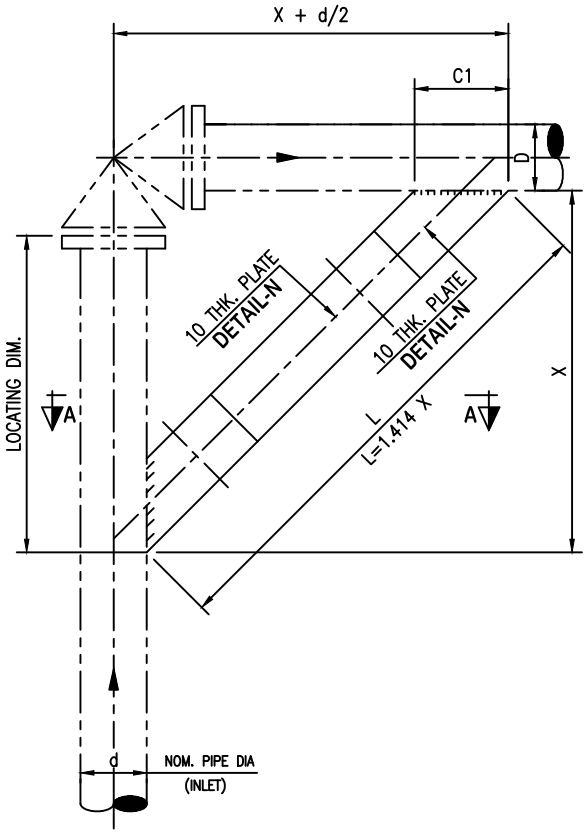
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR

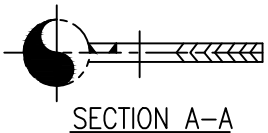
LYONS ENGINEERING PVT. LTD. NEW DELHI	GASKET THICKNESS	DRAWING NO.
		GAIL–STD–PI–DWG–TP–024
		SHEET NO. 1 OF 1

TYPICAL CROSS SECTION	DESCRIPTION		THICKNESS OF GASKET	COMPRESSED THICKNESS (NOTE –1)
	FLAT RING FOR RAISED FACE FLANGE	COMPRESSED ASBESTOS FOR SYNTHETIC RUBBER	2.0	2.0
	FULL FACE FOR FLAT FACE FLANGES			
	SPIRAL WOUND METAL FLAT RING GASKET, NON METALLIC FILTER, AND A STEEL SOLID RING TYPE CENTERING DEVICE– FOR RAISED FACE FLANGES.		4.4	3.0
	FLAT METAL JACKETED GASKET, NON METALLIC FILTER COMPLETELY ENCLOSED WITHIN A FULLY ANNEALED DOUBLE METAL JACKET–FORRAISED FACE FLANGES		3.0	2.0
	CORRUGATED METAL JACKETED GASKET, NON METALLIC FILTER, COMPLETELY ENCLOSED WITHIN A FULLY ANNEALED DOUBLE METAL CORRUGATED JACKET– FOR RAISED FACE FLANGES.		3.2	1.0
	CORRUGATED METAL GASKET–FULLY ANNEALED CORRUGATED METAL WITH FILTER MATERIAL CEMENTED TO THE CORRUGATIONS ON BOTH FACES –FOR RAISED FACE FLANGES		3.2	1.0
	SOLID METAL FLAT RING FOR SMALL TONGUE AND GROOVE FLANGES.		AS SPECIFIED	
	SOLID METAL FLAT RING FOR LARGE TONGUE AND GROOVE FLANGES.		AS SPECIFIED	
	SOLID METAL OCTAGONAL RING FOR R.T.J FLANGES		DIMENSIONS SHALL BE AS PER ASME B 16.20(NOTE–2)	
	SOLID METAL OVAL RING FOR R.T.J FLANGES		DIMENSIONS SHALL BE AS PER ASME B 16.20(NOTE–2)	
	FULLY ANEALED CORRUGATED METAL FOR RAISED FACE FLANGES.		3.2	1.0

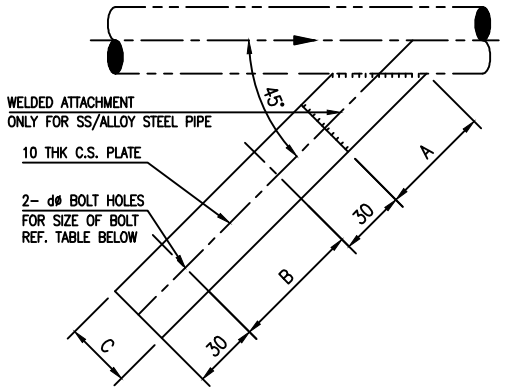
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	10–01–2019	ISSUED FOR TENDER	VKS	AP	JR

LYONS ENGINEERING PVT. LTD. NEW DELHI	SUPPORTING ARRANGEMENT FOR ANGLE AND RELIEF VALVES TYPE–SP2	DRAWING NO. GAIL–STD–PI–DWG–TP–025
		SHEET NO. 1 OF 1





SECTION A–A



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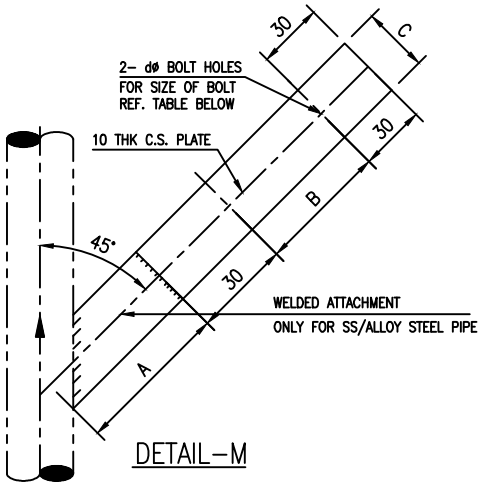

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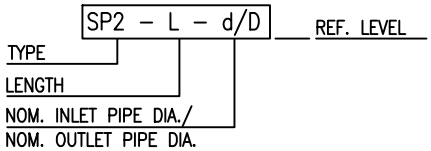


SYMBOL

NOTES:–

1. MATERIAL FOR WELDED ATTACHMENT SHALL BE EQUIVALENT TO PIPE MATERIAL.

D	BOLT SIZE dø	A	C	B MIN.	C1	D1
1" TO 4"	M12 X 50	75	50	150	71	14
6" TO 12"	M16 X 50	100	75	200	106	18

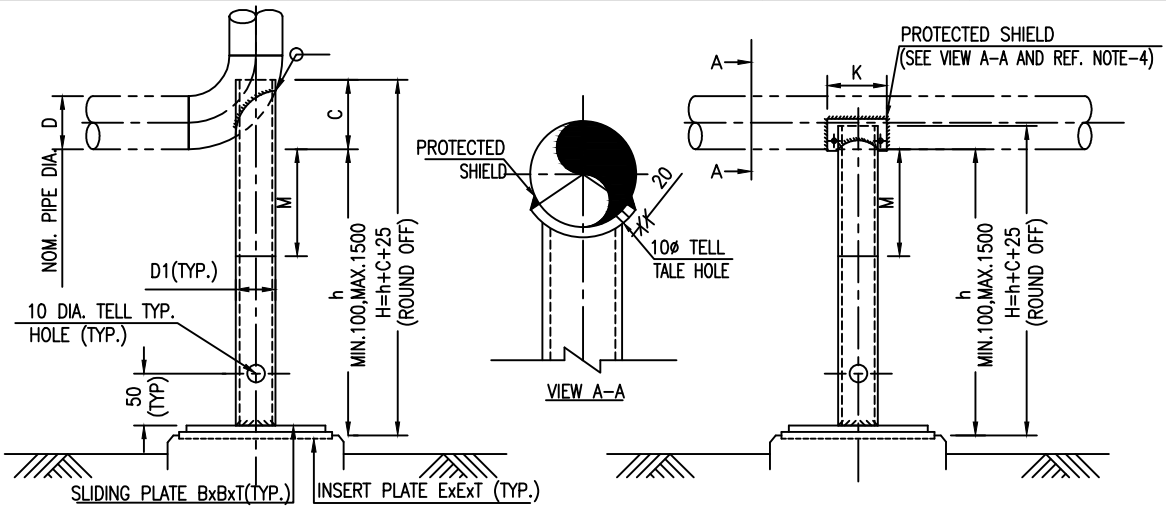
FOR TEMP. UP TO 400 °C ONLY

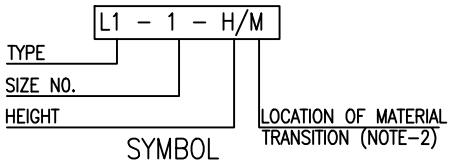
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	10–01–2019	ISSUED FOR TENDER	VKS	AP	JR

LYONS ENGINEERING PVT. LTD.
NEW DELHI

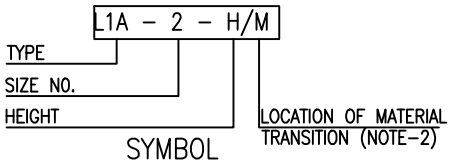
LOW SUPPORT SLIDING FOR BARE & INSULATED PIPE SIZE 2" THRU 36" TYPE-L1 AND L1A

DRAWING NO.
GAIL-STD-PI-DWG-TP-026
SHEET NO. 1 OF 1





SYMBOL



SYMBOL

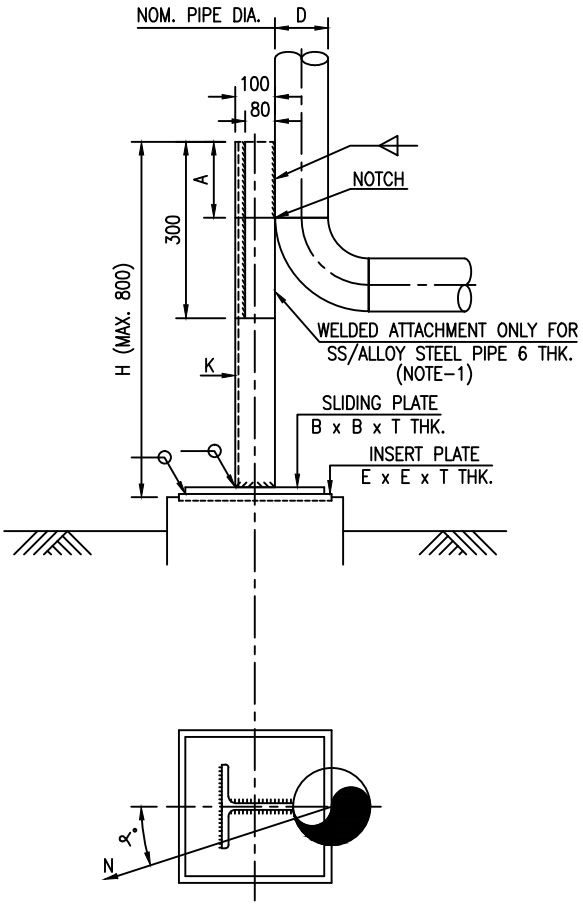
SIZE NO.	D	D1 (NOTE-3)	B	T	C (NOTE-5)	E	K (NOTE-4)
1	2"	2" S40/10S	150	10	70	250	160
	3"				115		
2	4"	3" S40/10S	200	10	137	300	190
	6"				174		
3	8"	4" S40/10S	200	12	205	300	215
	10"				262		
	12"				287		
4	14"	6" S40/10S	250	12	388	350	270
	16"				418		
5	18"	8" S40/10S	300	12	454	400	320
6	20"	10" S40/10S	350	12	554	450	375
	24"				615		
7	26"	12" S40/10S	400	16	675	500	425
	30"				800		
	36"				950		

NOTES:-

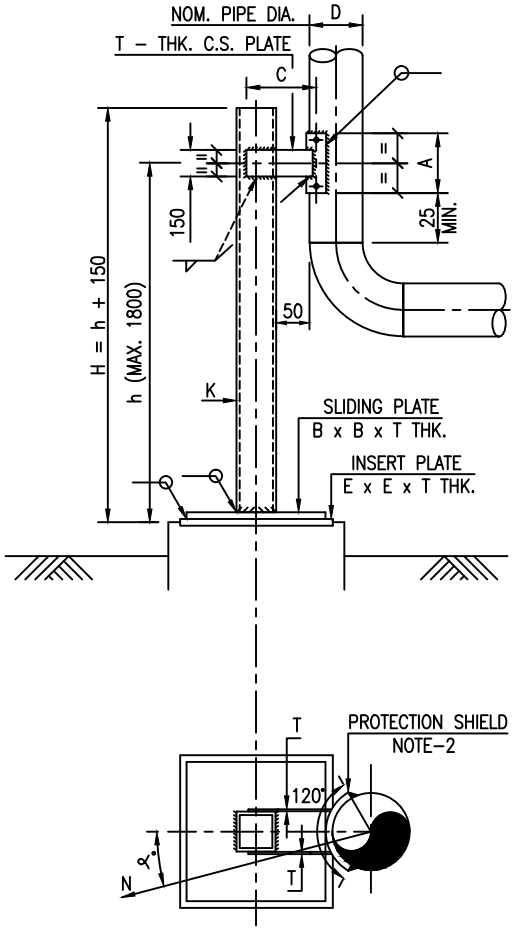
1. INSERT AND SLIDING PLATE MATERIAL SHALL BE CARBON STEEL WHERE DESIGN TEMP. IS >345°C WITH h < 200MM, SLIDING PLATE MATERIAL SHALL BE EUIVALENT TO PIPE MATERIAL.
2. DIMENSION "M" LOCATES THE POINT OF MATERIAL TRANSITION ON THE SUPPORT. THE STUB MATERIAL SHALL BE EQUIVALENT TO THAT OF LINE PIPE AND THE LOWER SUPPORT PIPE SHALL BE CARBON STEEL. MINIMUM VALUE OF M SHALL BE "INSULATION THICKNESS+25MM".
   A. FOR CARBON STEEL(CS) LINE PIPE, THE ENTIRE SUPPORT PIPE SHALL BE CS, THAT IS M=0.
   B. FOR ALLOY STEEL(AS) OR STAINLESS STEEL(SS) LINE -PIPE, SUPPORT PIPE SHALL CONSIST OF THE FOLLOWING-
   -FOR h LESS THAN OR EQUAL TO 500MM, ENTIRE SUPPORT PIPE MATERIAL SHALL BE EQUIVALENT TIO THAT OF LINE PIPE, THAT IS M=h.
   -FOR h GREATER THAN 500MM,SUPPORT PIPE SHALL BE COMPOSITE WITH M=INSULATION-THK.+25MM OR 100MM, WHICHEVER IS GREATER.
3. IN CASE SIZE AND/OR SCH. OF SUPPORT PIPE (D1) LISTED IN THE TABLE IS NOT AVAILABE USE NEXT HIGHER SIZE AND/OR NEAREST HIGHER THICKNESS AVAILABLE.
4. PROTECTION SHIELD (LENGTH=KMM) CUT FROM LINE-PIPE OR EQUIVALANT PLATE SHALL BE PROVIDED ON HORIZONTAL LINE AS FOLLOWS-
   A. FOR 150# AND 300# CLASS PIPEING
      CS AND AS LINES - 10" AND ABOVE
      SS LINES - 2" AND ABOVE
   B. FOR 600# AND HIGHER CLASS PIPING
      CS, AS AND SS LINES - 10" AND ABOVE
5. DIMENSION "C" IS TO BE MODIFIED IF OTHER THAN 1.5 D RADIUS ELBOWS ARE USED.
6. IN CASE CALCULATED h EXCEEDS THE MAX. VALUE, PEDESTAL SHALL BE RAISED ACCORDINGLY.

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR

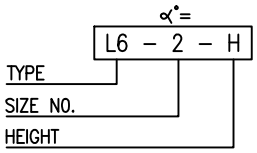
LYONS ENGINEERING PVT. LTD. NEW DELHI	LOW SUPPORT FIXED FOR BARE & INSULATED PIPE SIZE 2" THRU 24"TYPE–L6	DRAWING NO. GAIL–STD–PI–DWG–TP–027
		SHEET NO. 1 OF 1



FOR PIPE SIZES 2" THRU 4"



FOR PIPE SIZES 6" THRU 24"



SYMBOL

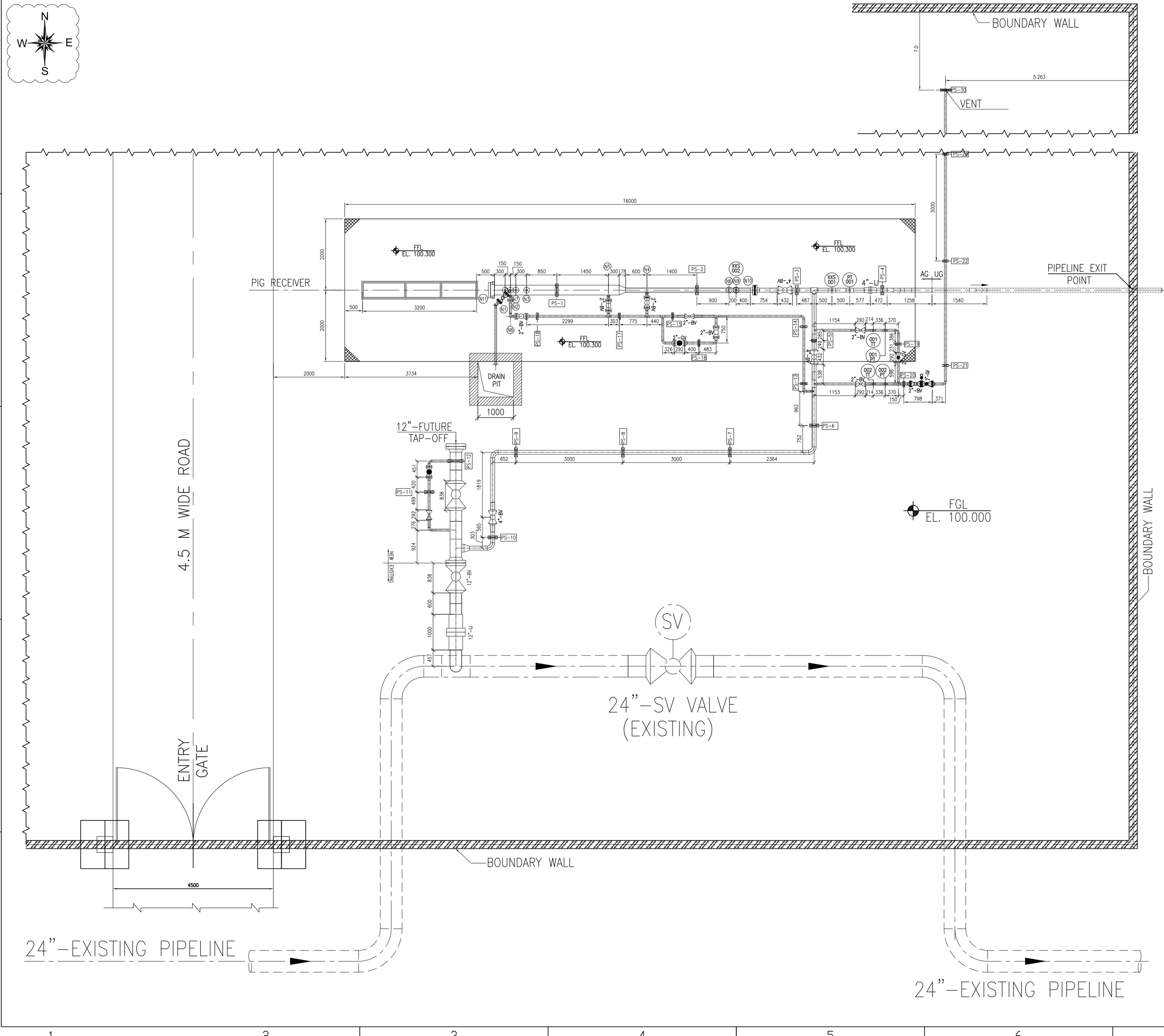
NOTES:–

1. MATERIAL FOR WELDED ATTACHMENT SHALL BE EQUIVALENT TO PIPE MATERIAL.
2. PROTECTION SHIELD IS TO BE CUT FROM LINE PIPE.

SIZE NO.	D	K	A	T	C	E	B
1	2" TO 4"	CUT FROM ISMB 200	200	10	–	250	150
2	6" TO 10"	ISMC–125 2 NOS.	200	12	150	300	200
3	12" TO 24"	ISMC–225 2 NOS.	300	12	230	400	300

FOR TEMP. UP TO 400 °C ONLY

REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED
0	10–01–2019	ISSUED FOR TENDER	VKS	AP	JR



CONNECTING DRAWING/DOCUMENTS:-

S.NO.	DOCUMENTS/DRAWING NAME	DRAWING NO.
1	P& ID FOR DISPATCH TERMINAL	GAIL-034054-PR-DWG-003
2	PLOT PLAN FOR DISPATCH TERMINAL	GAIL-034054-CV-DWG-005
3	GAD FOR BI-DIRECTIONAK LAUNCHER/RECEIVER	CP/GAIL/10X4/L&R/18/002-3

NOTES:-

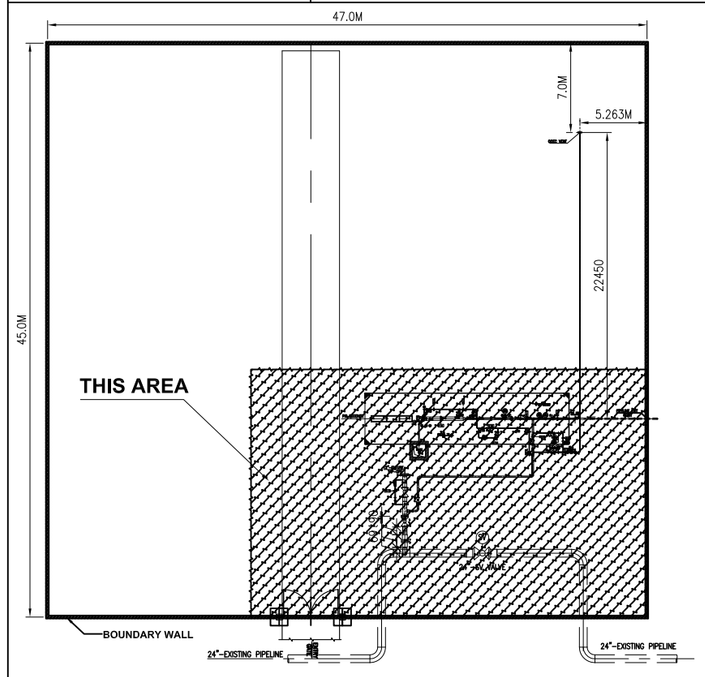
1. ALL DIMENSIONS ARE IN mm. & LEVELS ARE I METERS UNLESS OTHERWISE SPECIFIED.
2. ALL STATION PIPING AS PER TECHNICAL SPECIFICATION.
3. ALL 2" AND BELOW PIPES & FITTINGS AS PER TECHNICAL SPECIFICATION.
4. ALL VENTS SHALL BE PROVIDED MIN. 3 M HIGH FROM NEAREST HIGHEST OPERATING PLATFORM OR NEARBY STRUCTURE WITHIN A RADIUS OF 15 M WHICHEVER IS HIGHER.
5. PAINTING OF ALL ABOVE GROUND PIPING SHALL BE DONE AS PER RELEVENT SPECIFICATION.
6. COROSSION RESISTANT COATING OF PIPE SHALL BE CONTINUED TO ATLEAST 500mm. ABOVE GROUND WHEREVER THE PIPE TRANSITS FROM UNDERGROUND TO ABOVE GROUND.
7. BENDS SHALL BE SUITABLE PROVIDED AS PER SITE CONDITIONS TO ENSURE THE PIPELINE COVER IS 1.5 METER OUTSIDE AS WELL AS INSIDE
8. CONTRACTOR TO ENSURE THE AVAILABILITY OF BENDS TO COMPLETE THE WORK ON TIME AS PER SITE REQUIREMENT.
9. DRAIN PITS OF SIZE 1.0M X 1.0M X 1.0M SHALL BE PROVIDED WITH STEEL CHEQUERED PLATE.

ABBREVIATIONS

FFL	FINISHED FLOOR LEVEL
TOP	TOP OF PLATFORM
EL	ELEVATION
PS	PIPE SUPPORT
AG	ABOVE GROUND
UG	UNDER GROUND
BOP	BOTTOM OF PIPE
TOC	TOP OF CONCTETE
IJ	INSULATION JOINT
GV	GLOVE VALVE
BV	BALL VALVE

LEGEND:-

- BUTTWELDED BALL VALVE
- FLANGED BALL VALVE
- FLANGED GLOVE VALVE
- LEVEL IN PLAN.
- SPECTACLE BLIND
- CENTER LINE
- EXISTING LINE (UG)
- PROPOSED LINE (AG)
- PIPE SUPPORT



KEY PLAN

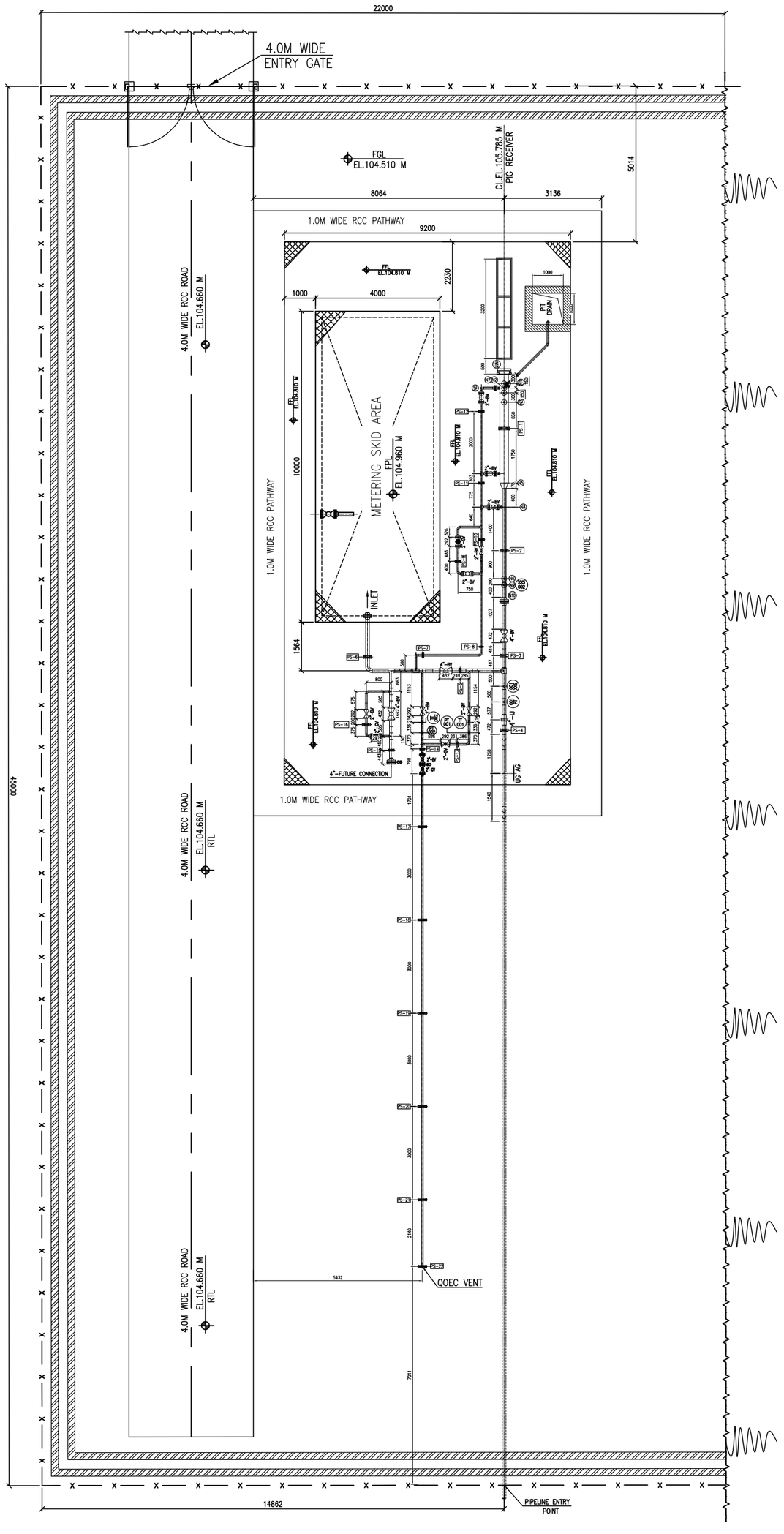
REV.	DATE	DESCRIPTION	PREP.	CHKD.	APPD.
0	03.12.19	ISSUED FOR BID	VKS	SY	TR

CLIENT: GAIL (INDIA) LIMITED

PMC: LYONS ENGINEERING PVT. LTD.

PROJECT: LMC TO MS MS CARBORUNDUM UNIVERSAL LTD AT KRISHNAGIRI, TAMILNADU

SCALE	TITLE: GA DRAWING FOR DESPATCH TERMINAL (LMC TO MS MS CARBORUNDUM UNIVERSAL LIMITED)			
1:50				
SIZE	JOB NO.	DRAWING NUMBER	SHEET	REV.
A1	034	GAIL-034054-PI-DWG-011	1 OF 1	0



CONNECTING DRAWING/DOCUMENTS:-

S.NO.	DOCUMENTS/DRAWING NAME	DRAWING NO.
1	P& ID FOR RECEIVING TERMINAL	GAIL-034054-PR-DWG-004
2	PLOT PLAN FOR RECEIVING TERMINAL	GAIL-034054-CV-DWG-006
3	GAD FOR BI-DIRECTIONAK LAUNCHER/RECEIVER	CP/GAIL/10X4/L&R/18/002-3

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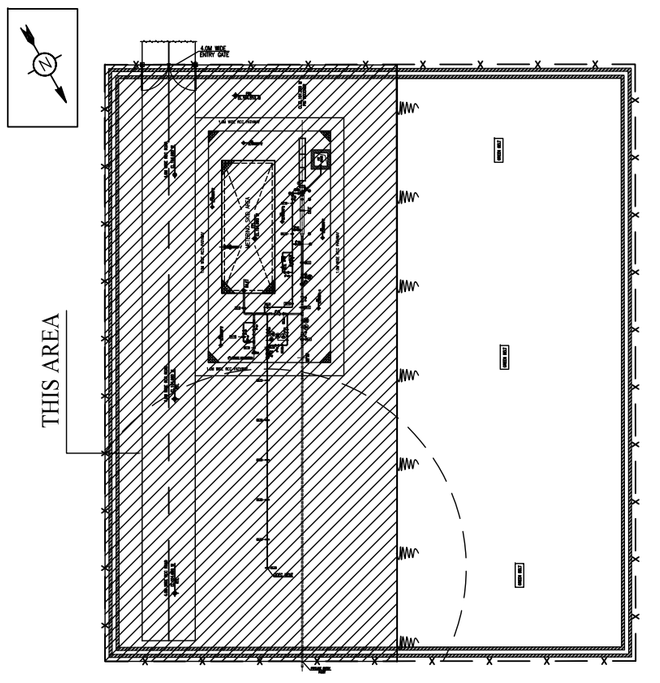
ABBREVIATIONS

FFL	FINISHED FLOOR LEVEL
TOP	TOP OF PLATFORM
EL	ELEVATION
PS	PIPE SUPPORT
AG	ABOVE GROUND
UG	UNDER GROUND
BOP	BOTTOM OF PIPE
TOC	TOP OF CONCTETE
IJ	INSULATION JOINT
GV	GLOVE VALVE
BV	BALL VALVE

LEGEND:-

	BUTTWELDED BALL VALVE
	FLANGED BALL VALVE
	FLANGED GLOVE VALVE
	LEVEL IN PLAN.
	SPECTACLE BLIND
	CENTER LINE
	EXISTING LINE (UG)
	PROPOSED LINE (AG)
	PIPE SUPPORT



KEY PLAN

REV.	DATE	DESCRIPTION	PREP.	CHKD.	APPD.
0	04.12.19	ISSUED FOR REVIEW	VKS	SY	TR

CLIENT: GAIL (INDIA) LIMITED

PMC: LYONS ENGINEERING PVT. LTD.

PROJECT: LMC TO MS MS CARBORUNDUM UNIVERSAL LTD AT KRISHNAGIRI, TAMILNADU

SCALE	TITLE:
1:100	GA DRAWING FOR RECEIVING TERMINAL (LMC TO MS MS CARBORUNDUM UNIVERSAL LIMITED)

SIZE	JOB NO.	DRAWING NUMBER	SHEET	REV.
A1	034	GAIL-034054-PI-DWG-012	1 OF 1	0