

HAR EK KAAM DESH KE NAAM



**GAIL INDIA LIMITED**

**CONSTRUCTION OF STEEL PIPELINE AND ASSOCIATED FACILITIES  
FOR CGD CONNECTIVITIES**

**VOLUME II OF II (TECHNICAL)**



**E-TENDER REF : 8000017018**

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**LIMITED DOMESTIC COMPETITIVE BIDDING**







**Lyons Engineering Pvt. Ltd.**



Sr. No.	Description	Doc No.		Rev. No.
		GAIL-ENG-GN-DOC-DL-001		
 <b>DCI - MASTER DELIVERABLE CONTROL INDEX FOR CGD TO M/s TGPL MORADABAD &amp; CGD TO M/s TGPL GORAKHPUR</b>				<b>Doc No.</b> GAIL-ENG-GN-DOC-DL-001 Rev. 0
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54	Guide Support for Bare Pipe Size 1/ 2" to 24" Type G2	GAIL-STD-PI-DWG-TP-016	0	
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HAR EK KAAM DESH KE NAAM



**GAIL INDIA LIMITED**

**CONSTRUCTION OF STEEL PIPELINE AND ASSOCIATED FACILITIES  
FOR CGD CONNECTIVITIES**

**VOLUME II OF II (TECHNICAL) – A**

**SCOPE OF WORK**

**E-TENDER REF :**



**(BID DOCUMENT NO - 034/LEPL/GAIL/22-R0)**

**LIMITED DOMESTIC COMPETITIVE BIDDING**



**Lyons Engineering Pvt. Ltd.**



<b>PMC:</b> 	<b>DCI - MASTER DELIVERABLE CONTROL INDEX FOR  CGD TO M/s TGPL MORADABAD &amp; CGD TO M/s  TGPL GORAKHPUR</b>	<b>Doc No.</b> GAIL-ENG-GN-DOC-DL-001 Rev. 0	<b>CLIENT:</b> 
<b>Sr. No.</b>	<b>Description</b>	<b>Document / Drawing No.</b>	<b>Rev. No.</b>
<b>TECHNICAL VOLUME - II OF II</b>			
<b>A SCOPE OF WORK</b>			
i)	Scope of Work	GAIL-RFP-GN-DOC-SW-001	0




**GAIL INDIA LIMITED**

**CONSTRUCTION OF STEEL PIPELINE AND ASSOCIATED FACILITIES  
FOR CGD TO M/S TGPL MORADABAD & CGD TO M/s TGPL  
GORAKHPUR**

**SCOPE OF WORK**

**GAIL-RFP-GN-DOC-SW-001**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
0	08.07.2020	Issued For Bid	SR	TR	SB



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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.

- a) In order to supply gas to TGPL Moradabad, GAIL is laying 4" NB Pipeline to connect TGPL Moradabad Receiving Terminal (as per indicative plot plan / P&ID and Schematic attached elsewhere). Work shall include all the interconnecting piping, civil, electrical, Civil, instrumentation works at Customer End and Hook-up.
- b) In order to supply gas to TGPL Gorakhpur, GAIL is laying 4" NB Pipeline to connect TGPL Moradabad Receiving Terminal (as per indicative plot plan / P&ID and Schematic attached elsewhere). Work shall include all the interconnecting piping, civil, electrical, Civil, 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 CGD to M/s TGPL Moradabad & CGD to M/s TGPL Gorakhpur.
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, Dispatch, Receipt Station /Customer End.

### 1.2 PROPOSED FACILITIES:

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### CGD to M/s TGPL Moradabad

Laying of Piping API 5L grade X42 from proposed tap-off point to Proposed Metering skid upto 0.100 km (approx).


- Dispatch Station:
  - Existing 6" tap off is available on executed KMKRPL Pipeline.
    - Provision of Future Tap-off
- Customer End TGPL Moradabad:
  - Installation of metering skid  
Station Piping
  - Civil / Structural work, Fencing, Boundary wall (is to be done by Customer) with gate, Paving etc.
  - Adequate fire extinguishers etc.
  - Earthing, Outdoor Lighting, Outdoor Lighting DB etc.
  - Telecom System: HDPE Duct & OFC Cable with accessories

### CGD to M/s TGPL Gorakhpur

Laying of Piping API 5L grade X42 from proposed tap-off point to Proposed Metering skid upto 0.300 km (approx).

- Dispatch Station:
  - Existing 8" tap off is available on executed Pipeline.
    - Provision of Future Tap-off
- Customer End TGPL Gorakhpur:
  - Installation of metering skid  
Station Piping
  - Civil / Structural work, Fencing, Boundary wall (is to be done by Customer) with gate, Paving etc.
  - Adequate fire extinguishers etc.
  - Earthing, Outdoor Lighting, Outdoor Lighting DB etc.
  - Telecom System: HDPE Duct & OFC Cable with accessories
- The following indicative drawings for above CGD 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

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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 be applicable 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 CGD Connectivity.

The work involves in connectivity as follows:

- Laying of 4” pipeline between Dispatch terminal to Receipt Station/ Metering Station terminal.
- All Piping works at SV-6/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

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- 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 (consumer end) and SV/Tap-off is provided for reference purpose. Contractor shall carry out topographic surveys required for terminal

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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 (consumer end) and SV/tap-off is provided for reference purpose. Contractor shall carry out soil investigation surveys required for well 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.

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- 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 extra cost to 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 Überwachungs 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

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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 required quantities to be used for permanent installation into the system for all sizes and ratings of flanges 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.

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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 conduit for 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-Chargeas 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/

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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 to start 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.

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- v. On completion of the works Contractor shall submit a “Material Appropriation Statement” for all 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 arranged on 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.

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- 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

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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.

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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 hydrotest 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. Hydrotest shall be for 24 hours duration.

Hydrotest 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.

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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 of pre-commissioning activities. Dewatering of pipeline after hydrostatic testing shall be taken up 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. Such method of detection shall consume minimum possible time to complete the hydrotest activity 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.

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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 (above 2” size) 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.

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- Pre-Commissioning of complete system including Filtration and Pressure Reducing skid (If applicable)
- Commissioning with Natural Gas. This also includes commissioning of complete 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

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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

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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, rebeveling 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.

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- 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.

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- 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.
- 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.
- Pipe off cut

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 type and 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 groundpiping and all related miscellaneous items as per company specification enclosed with the bid document. Application thickness shall be as per painting Specification.

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- 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. as per specifications including supply of all materials.
- Hydro testing, dewatering, flushing & pre-commissioning activities of piping system of all sizes 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 the commissioning operations are complete.
- Any other works not specifically listed herein but required for completion of the works in all respects.

#### 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

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- 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 & other related 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 the satisfactory and successful completion of the project shall be included in the lump sum cost 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.

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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, consumables and 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.


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- 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/PPSM 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.


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- 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.

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- 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 made due 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 collect 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.

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Contractor shall prepare general arrangement drawing, isometric drawing & bill of materials, HDD design & drawing, Crossing drawings, Pipeline Alignment sheet including detour portion(whenever 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.

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• **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 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.

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HAR EK KAAM DESH KE NAAM



**GAIL INDIA LIMITED**

**CONSTRUCTION OF STEEL PIPELINE AND ASSOCIATED FACILITIES  
FOR CGD CONNECTIVITIES**

**VOLUME II OF II (TECHNICAL) – B**

**PROCESS**



**E-TENDER REF :**

**(BID DOCUMENT NO - 034/LEPL/GAIL/22-R0)**

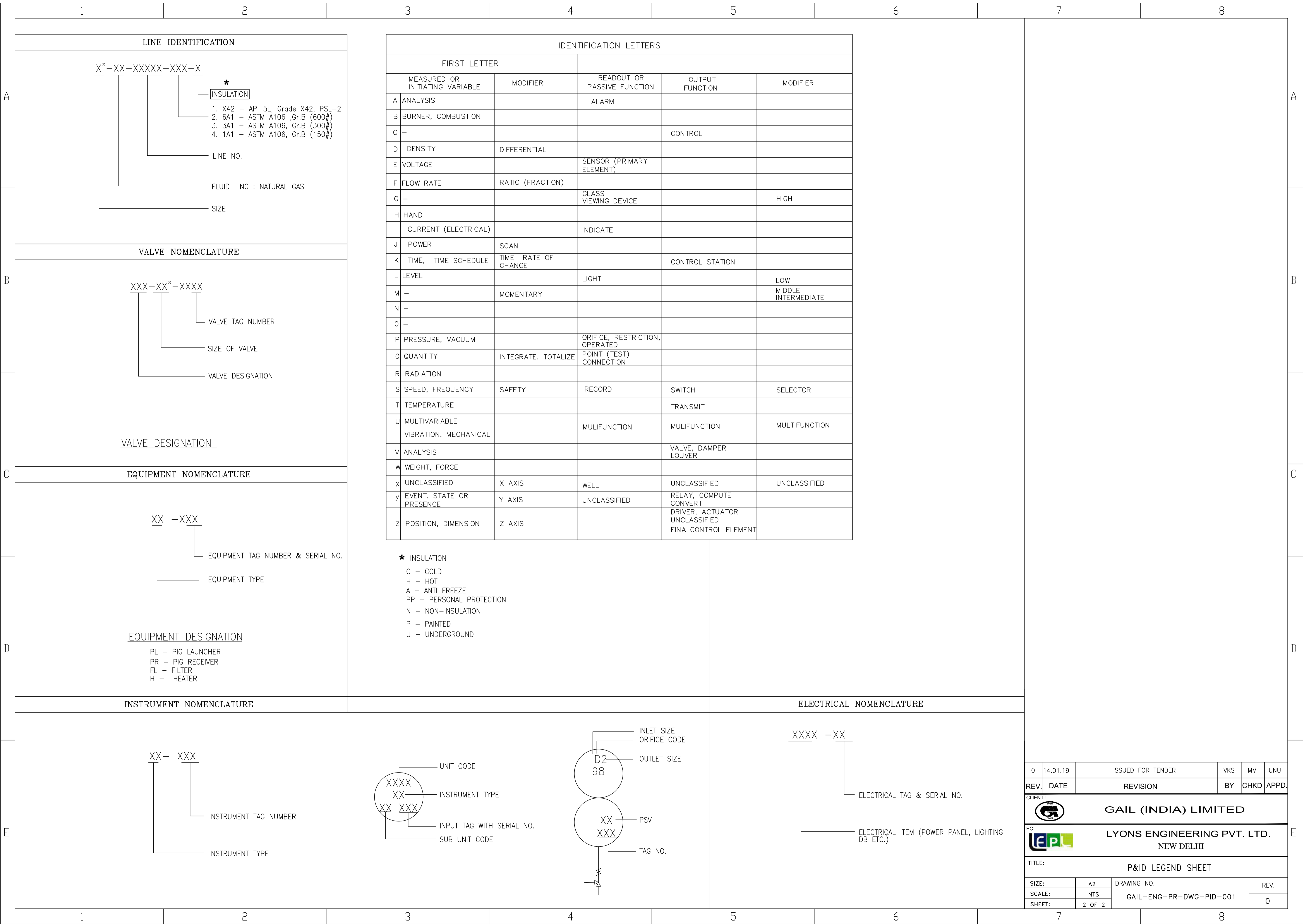
**LIMITED DOMESTIC COMPETITIVE BIDDING**



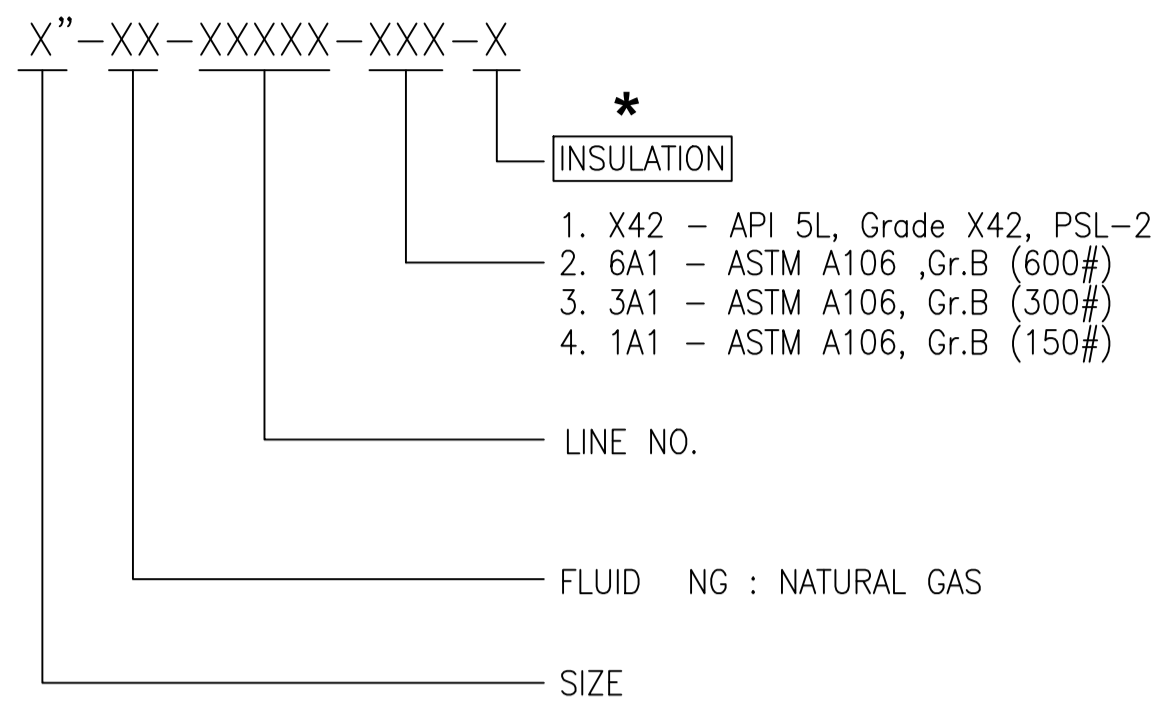
**Lyons Engineering Pvt. Ltd.**

<b>PMC:</b> 	<b>DCI - MASTER DELIVERABLE CONTROL INDEX FOR CGD TO M/s TGPL MORADABAD &amp; CGD TO M/s TGPL GORAKHPUR</b>	<b>Doc No.</b> GAIL-ENG-GN-DOC-DL-001 Rev. 0		<b>CLIENT:</b> 
<b>Sr. No.</b>	<b>Description</b>	<b>Document / Drawing No.</b>		<b>Rev. No.</b>
<b>TECHNICAL VOLUME - II OF II</b>				
<b>B PROCESS</b>				
<b>P&amp;ID</b>				
i)	P&ID Legend Sheet	GAIL-ENG-PR-DWG-PID-001		0
ii)	P&ID for CGD to M/S TGPL Moradabad	GAIL-034052-PR-DWG-003		0
iii)	P&ID for CGD to M/S TGPL Gorakhpur	GAIL-034030-PR-DWG-003		0
<b>SCHEMATIC DIAGRAM</b>				
iv)	Schematic Layout for CGD to M/s TGPL Moradabad	GAIL-034052-PL-DWG-002		0
v)	Schematic Layout for CGD to M/s TGPL Gorakhpur	GAIL-034030-PL-DWG-002		0

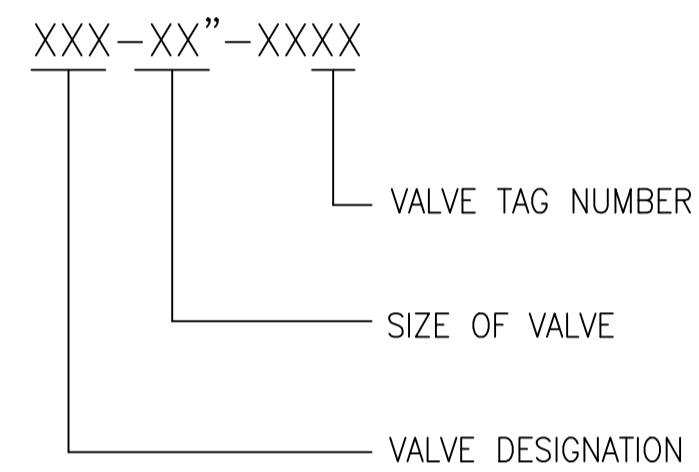
1	2	3	4	5	6	7	8																																																
<b>SYMBOLS</b>																																																							
<b>PIPING VALVES</b>	<b>PIPE COMPONENTS</b>	<b>INSTRUMENT SYMBOL</b>	<b>GENERAL ABBREVIATION</b>	<b>PRESSURE INSTRUMENTS</b>	<b>TEMPERATURE INSTRUMENTS</b>																																																		
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) NORMALLY CLOSED BALL VALVE CHECK VALVE AUTOMATIC RECIRCULATION VALVE GATE VALVE GLOBE VALVE PLUG VALVE NEEDLE VALVE BUTTERFLY VALVE MANUAL THREE WAY VALVE	FLAME ARRESTOR RESTRICTION ORRIFICE VENT FLAPPER EXPANSION JOINT FLEXIBLE HOSE SPOOL PIECE INSULATING JOINT FLOW TEE	LOGIC IN SCADA CONTROLLER EMERGENCY SHUTDOWN LOGIC SPECIALITY ITEM RUPTURE DISC FOR PRESSURE RELIEF RUPTURE DISC FOR VACUUM RELIEF TURBINE METER HAND SWITCH LOCAL RESET INTERLOCK ESD INTERLOCK AVAILABLE IN CONTROL ROOM TURBINE METER ORIFICE METER PD METER VORTEX METER ANNUBAR OR PITOT TUBE ULTRASONIC FLOW METER AVERAGING PITOT CORIOLIS METER CALIBRATED METER RUN WITH QUICK CHANGE FITTING PRESSURE INSTRUMENT WITH INTEGRAL DOUBLE BLOCK & BLEED INSTRUMENT CONNECTION WITH DIAPHRAGM SEAL INSTRUMENT CONNECTION WITH DIAPHRAGM SEAL AND BLEED CONNECTION	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 CONNECTION 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 GDOE - POINT TYPE GAS DETECTOR ELEMENT GDOE - OPEN PATH TYPE GAS DETECTOR ELEMENT	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 PCV - SELF ACTUATED PRESSURE REGULATOR DG - DRAFT GAUGE PSV - PRESSURE SAFETY VALVE CRV - CREEP RELIEF/SAFETY VALVE DPSH - DIFFERENTIAL PRESSURE SWITCH HIGH	TG - TEMPERATURE GAUGE TI - TEMPERATURE INDICATOR TR - TEMPERATURE 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 TRANSMITTER FCV - FLOW CONTROL VALVE																																																		
<b>ACTUATED VALVES</b>	<b>MISCELLANEOUS</b>			<b>FUNCTIONAL SYMBOLS</b>	<b>LINE SERVICE IDENTIFICATION</b>																																																		
GAS OVER OIL ACTUATED VALVE 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.	SLOPE TIE-IN POINT SPEC. BREAK CONTINUATION SYMBOL XXX = DRAWING NUMBER			FIELD MOUNTED INSTRUMENT LOCAL PANEL INSTRUMENT REAR LOCAL PANEL INSTRUMENT CENTRAL PANEL MOUNTED INSTRUMENT REAR CENTRAL PANEL MOUNTED INSTRUMENT INTERLOCK FUNCTION RUNNING LIGHT (LOCAL) RUNNING LIGHT (CENTRAL PANEL) INDICATING LIGHT MOUNTED ON LOCAL PANEL (LOCAL CONTROL PANEL) RUNNING LIGHT (SCADA) REMOTE TELEMETRY UNIT DIAPHRAGM PROCESS CONTROL SHARED DISPLAY INSTRUMENTATION (SCADA) SHARED DISPLAY DEVICES WITH LIMITED ACCESS TO ADJUSTMENTS LOCATED IN FEILD. AUXILIARY OPERATORS INTERFACE DEVICE FOR EXAMPLE, BACK UP CONTROLLER OR MANUAL STATION. 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" AUXILIARY COMPUTER COMPONENT NORMALLY ACCESSIBLE TO OPERATOR SEQUENTIAL LOGIC CONTROL LIMITED ACCESS TO OPERATOR. SEQUENTIAL LOGIC CONTROL ACCESSIBLE TO OPERATOR.	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																																																		
<b>PIPE FITTINGS</b>	<b>LINE SYMBOLS</b>		<b>EQUIPMENT SYMBOL</b>																																																				
'T' TYPE STRAINER 'Y' TYPE STRAINER TEMPORARY 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	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 CAPILLARY TUBING BURIED PIPELINE ELECTRIC HEAT TRACED LINE VENDOR LIMIT	PIG LAUNCHER/RECEIVER																																																					
						<table border="1"> <tr> <td>0</td> <td>14.01.19</td> <td>ISSUED FOR TENDER</td> <td>VKS</td> <td>MM</td> <td>UNU</td> </tr> <tr> <td>REV.</td> <td>DATE</td> <td>REVISION</td> <td>BY</td> <td>CHKD</td> <td>APPD.</td> </tr> <tr> <td colspan="6">CLIENT:  <b>GAIL (INDIA) LIMITED</b></td> </tr> <tr> <td colspan="6">PMC:  <b>LYONS ENGINEERING PVT. LTD.</b> NEW DELHI</td> </tr> <tr> <td colspan="2">TITLE:</td> <td colspan="4"><b>P&amp;ID LEGEND SHEET</b></td> </tr> <tr> <td>SIZE:</td> <td>A2</td> <td colspan="2">DRAWING NO.</td> <td colspan="2">REV.</td> </tr> <tr> <td>SCALE:</td> <td>NTS</td> <td colspan="2">GAIL-ENG-PR-DWG-PID-001</td> <td colspan="2">0</td> </tr> <tr> <td>SHEET:</td> <td>1 OF 2</td> <td colspan="4"></td> </tr> </table>	0	14.01.19	ISSUED FOR TENDER	VKS	MM	UNU	REV.	DATE	REVISION	BY	CHKD	APPD.	CLIENT: <b>GAIL (INDIA) LIMITED</b>						PMC: <b>LYONS ENGINEERING PVT. LTD.</b> NEW DELHI						TITLE:		<b>P&amp;ID LEGEND SHEET</b>				SIZE:	A2	DRAWING NO.		REV.		SCALE:	NTS	GAIL-ENG-PR-DWG-PID-001		0		SHEET:	1 OF 2					
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SCALE:	NTS	GAIL-ENG-PR-DWG-PID-001		0																																																			
SHEET:	1 OF 2																																																						



**LINE IDENTIFICATION**

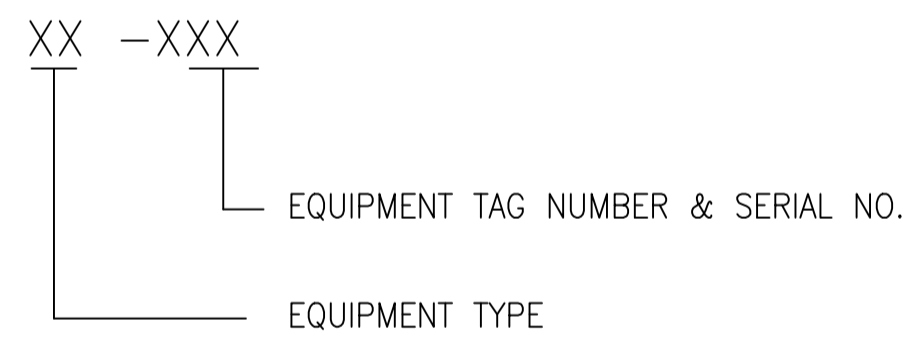


**VALVE NOMENCLATURE**



VALVE DESIGNATION

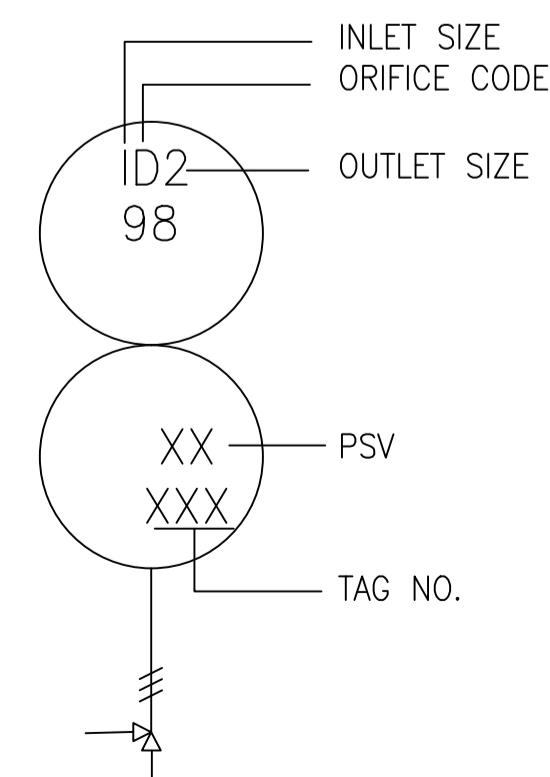
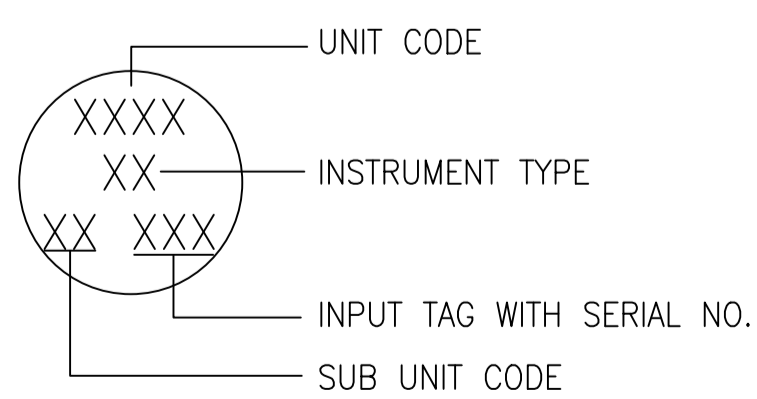
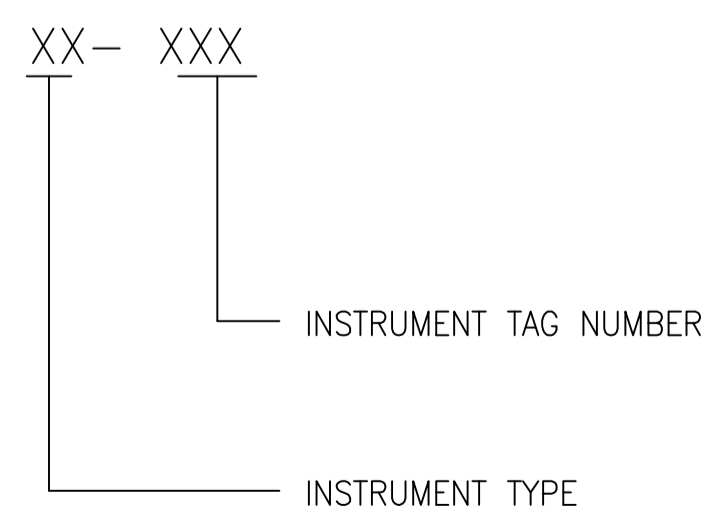
**EQUIPMENT NOMENCLATURE**



EQUIPMENT DESIGNATION

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

**INSTRUMENT NOMENCLATURE**

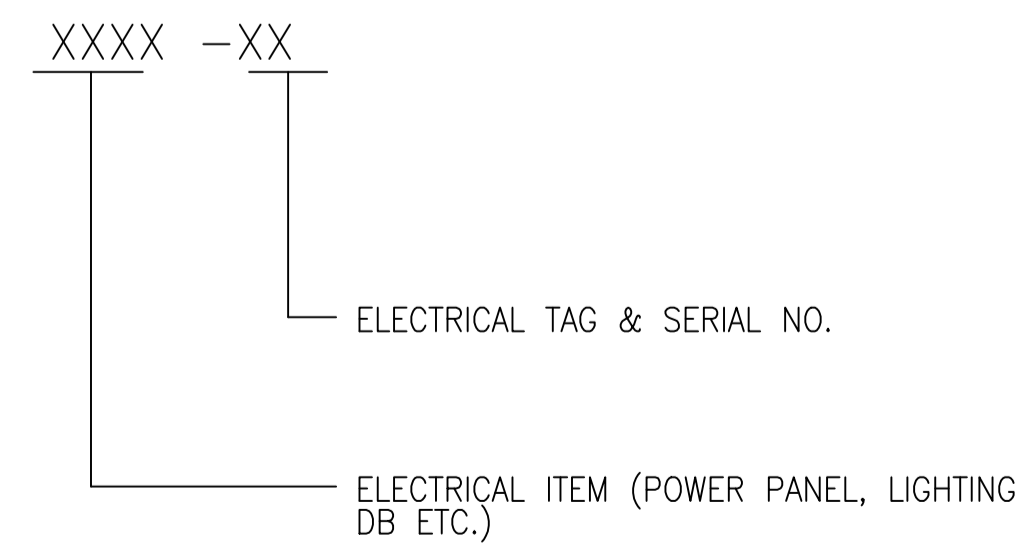


**IDENTIFICATION LETTERS**

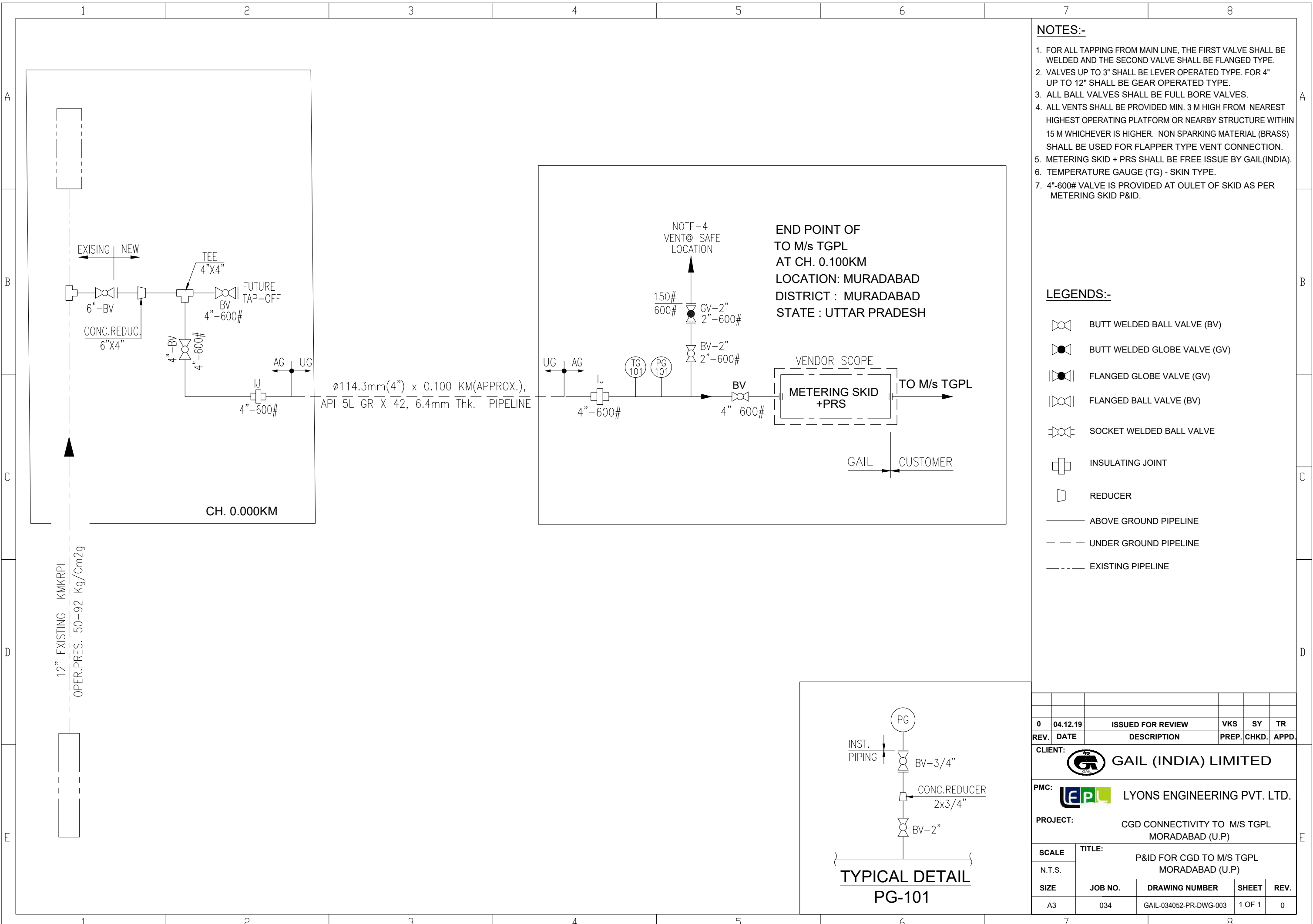
FIRST LETTER				
MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A ANALYSIS		ALARM		
B BURNER, COMBUSTION				
C -			CONTROL	
D DENSITY	DIFFERENTIAL			
E VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F FLOW RATE	RATIO (FRACTION)			
G -		GLASS VIEWING DEVICE		HIGH
H HAND				
I CURRENT (ELECTRICAL)		INDICATE		
J POWER	SCAN			
K TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L LEVEL		LIGHT		LOW MIDDLE INTERMEDIATE
M -	MOMENTARY			
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	MULIFUNCTION
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

**ELECTRICAL NOMENCLATURE**



0	14.01.19	ISSUED FOR TENDER	VKS	MM	UNU
REV.	DATE	REVISION	BY	CHKD	APPD.
CLIENT: <b>GAIL (INDIA) LIMITED</b>					
EC: <b>LYONS ENGINEERING PVT. LTD.</b> NEW DELHI					
TITLE: <b>P&amp;ID LEGEND SHEET</b>					
SIZE:	A2	DRAWING NO.	REV.		
SCALE:	NTS	GAIL-ENG-PR-DWG-PID-001	0		
SHEET:	2 OF 2				



- NOTES:-**
- FOR ALL TAPPING FROM MAIN LINE, THE FIRST VALVE SHALL BE WELDED AND THE SECOND VALVE SHALL BE FLANGED TYPE.
  - VALVES UP TO 3" SHALL BE LEVER OPERATED TYPE. FOR 4" UP TO 12" SHALL BE GEAR OPERATED TYPE.
  - ALL BALL VALVES SHALL BE FULL BORE VALVES.
  - ALL VENTS SHALL BE PROVIDED MIN. 3 M HIGH FROM NEAREST HIGHEST OPERATING PLATFORM OR NEARBY STRUCTURE WITHIN 15 M WHICHEVER IS HIGHER. NON SPARKING MATERIAL (BRASS) SHALL BE USED FOR FLAPPER TYPE VENT CONNECTION.
  - METERING SKID + PRS SHALL BE FREE ISSUE BY GAIL(INDIA).
  - TEMPERATURE GAUGE (TG) - SKIN TYPE.
  - 4"-600# VALVE IS PROVIDED AT OULET OF SKID AS PER METERING SKID P&ID.

- LEGENDS:-**
- BUTT WELDED BALL VALVE (BV)
  - BUTT WELDED GLOBE VALVE (GV)
  - FLANGED GLOBE VALVE (GV)
  - FLANGED BALL VALVE (BV)
  - SOCKET WELDED BALL VALVE
  - INSULATING JOINT
  - REDUCER
  - ABOVE GROUND PIPELINE
  - UNDER GROUND PIPELINE
  - EXISTING PIPELINE

END POINT OF  
TO M/s TGPL  
AT CH. 0.100KM  
LOCATION: MURADABAD  
DISTRICT : MURADABAD  
STATE : UTTAR PRADESH

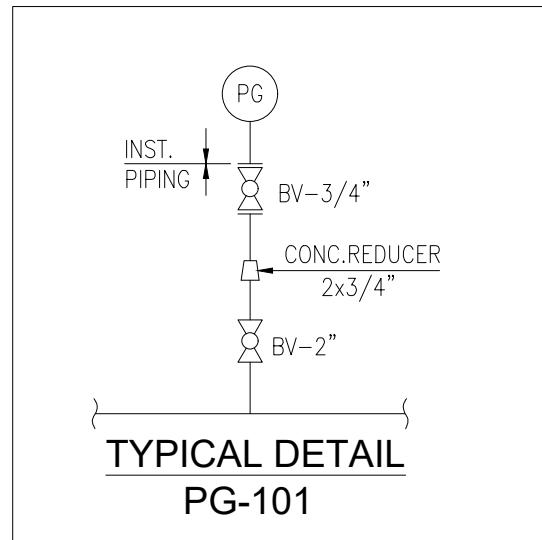
NOTE-4  
VENT@ SAFE  
LOCATION

VENDOR SCOPE

METERING SKID  
+PRS

TO M/s TGPL

GAIL ← CUSTOMER



REV.	DATE	DESCRIPTION	PREP.	CHKD.	APPD.
0	04.12.19	ISSUED FOR REVIEW	VKS	SY	TR

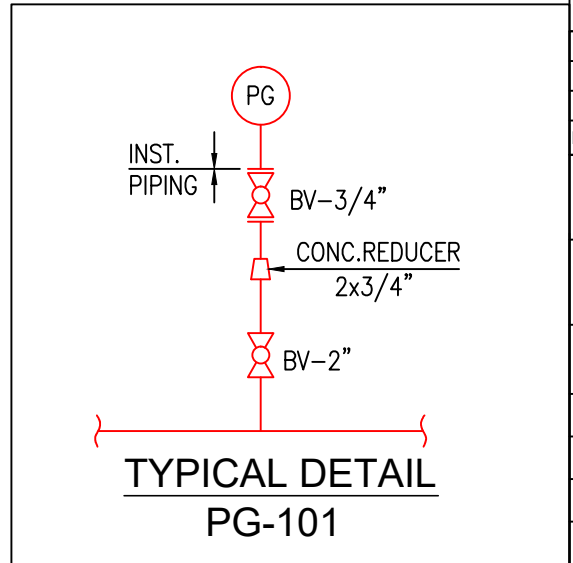
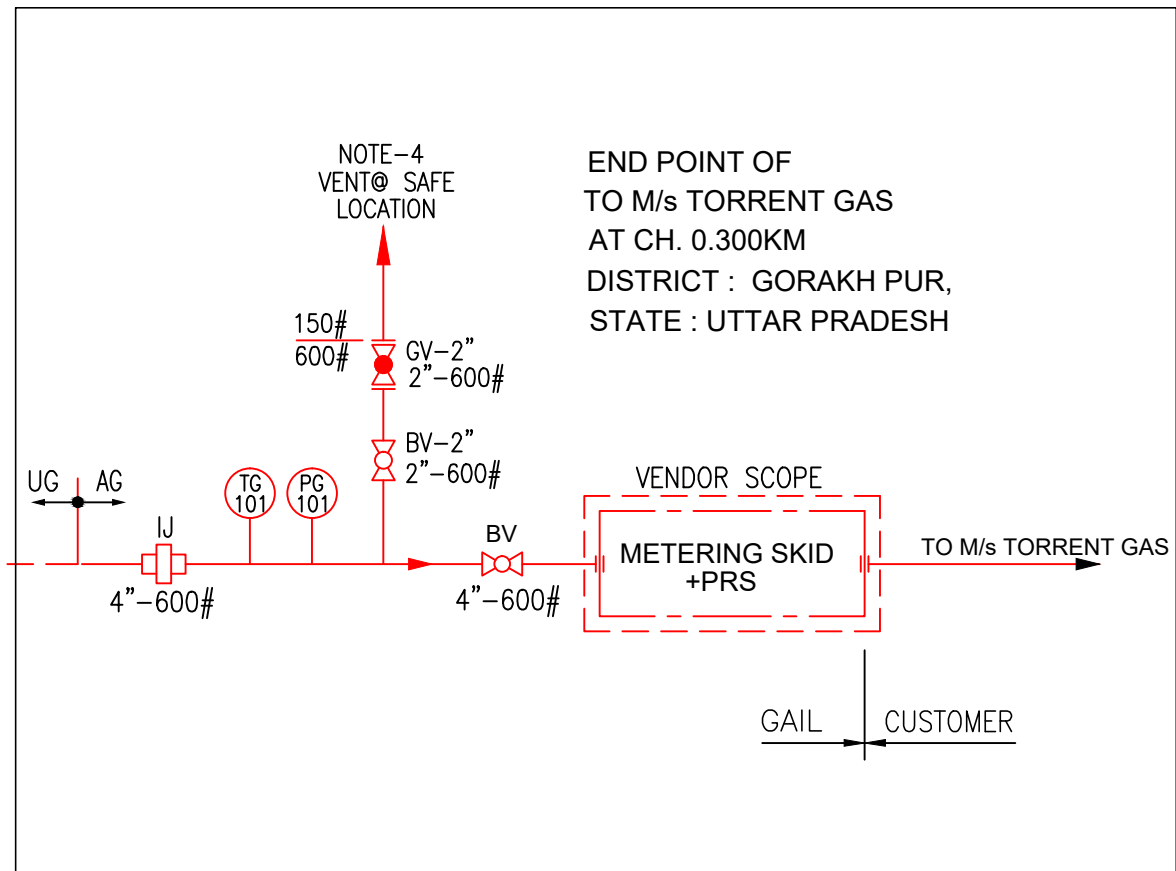
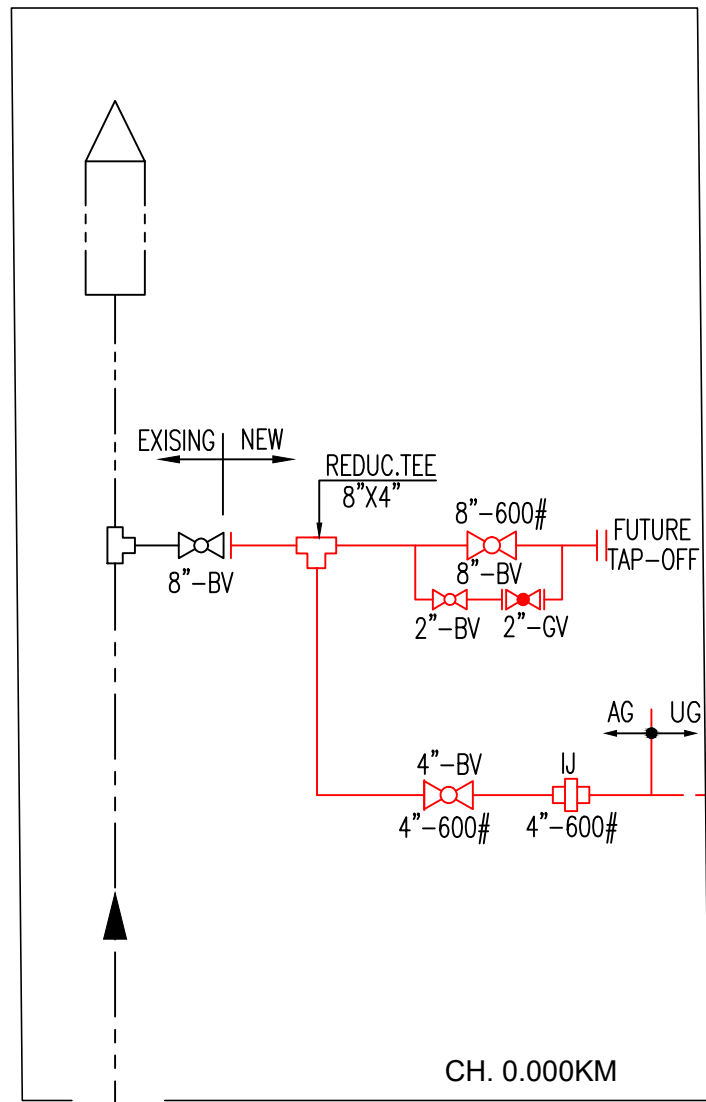
CLIENT: **GAIL (INDIA) LIMITED**

PMC: **LYONS ENGINEERING PVT. LTD.**

PROJECT: CGD CONNECTIVITY TO M/S TGPL MORADABAD (U.P)

SCALE: N.T.S. TITLE: P&ID FOR CGD TO M/S TGPL MORADABAD (U.P)

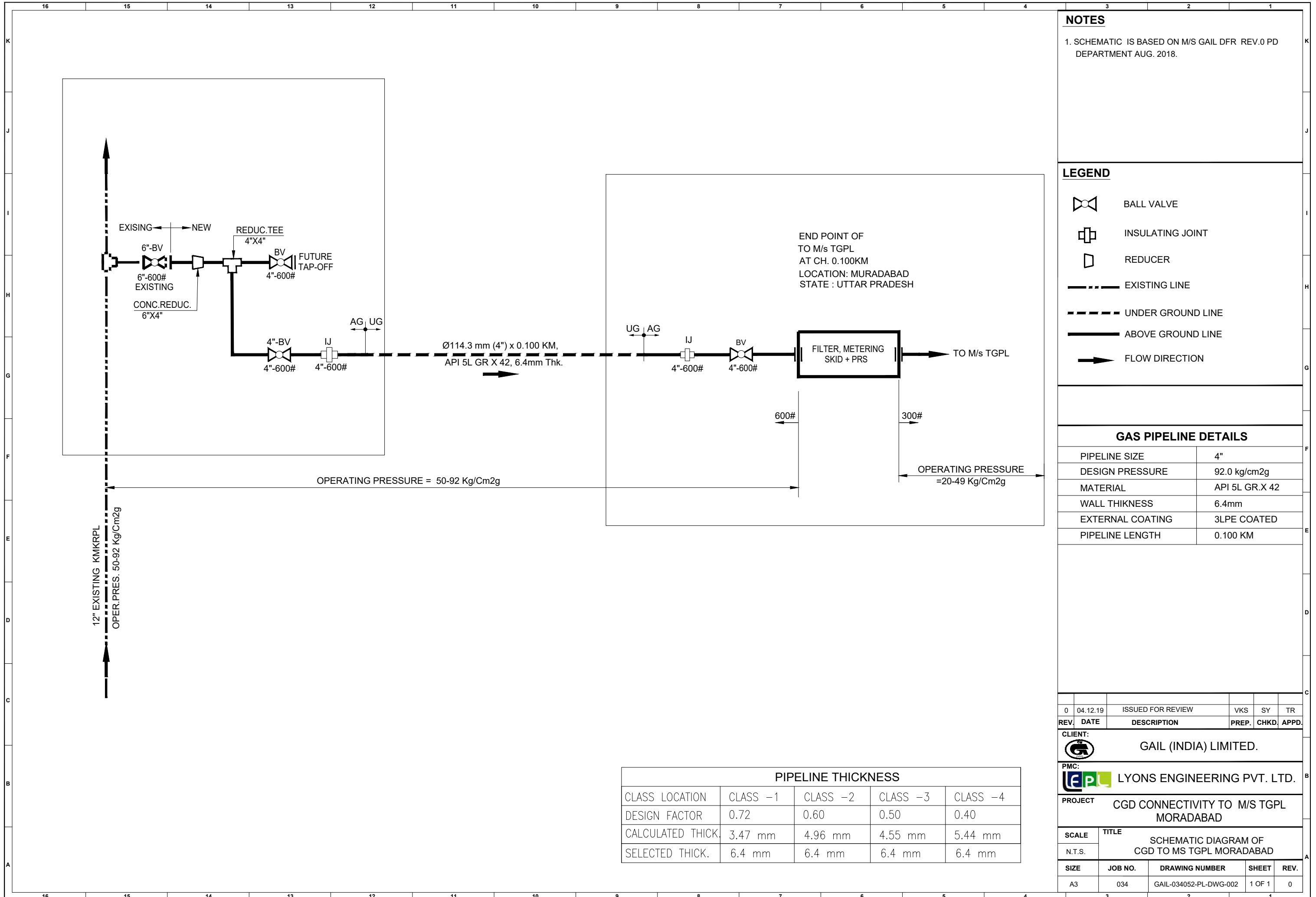
SIZE	JOB NO.	DRAWING NUMBER	SHEET	REV.
A3	034	GAIL-034052-PR-DWG-003	1 OF 1	0



- NOTES:-**
- FOR ALL TAPPING FROM MAIN LINE, THE FIRST VALVE SHALL BE WELDED AND THE SECOND VALVE SHALL BE FLANGED TYPE.
  - VALVES UP TO 3" SHALL BE LEVER OPERATED TYPE. FOR 4" UP TO 12" SHALL BE GEAR OPERATED TYPE.
  - ALL BALL VALVES SHALL BE FULL BORE VALVES.
  - ALL VENTS SHALL BE PROVIDED MIN. 3 M HIGH FROM NEAREST HIGHEST OPERATING PLATFORM OR NEARBY STRUCTURE WITHIN 15 M WHICHEVER IS HIGHER. NON SPARKING MATERIAL (BRASS) SHALL BE USED FOR FLAPPER TYPE VENT CONNECTION.
  - METERING SKID + PRS SHALL BE FREE ISSUE BY GAIL(INDIA).
  - TEMPERATURE GAUGE (TG) - SKIN TYPE.
  - GAS OVER OIL ACTAATED VALVE (GOOV) SHALL BE PROVIDED AT INLET OF MEETERING SKID.
- 4"-600# VALVE IS PROVIDED AT OULET OF SKID AS PER METERING SKID P&ID.

- LEGENDS:-**
- BUTT WELDED BALL VALVE (BV)
  - BUTT WELDED GLOBE VALVE (GV)
  - FLANGED GLOBE VALVE (GV)
  - FLANGED BALL VALVE (BV)
  - SOCKET WELDED BALL VALVE
  - INSULATING JOINT
  - ABOVE GROUND PIPELINE
  - UNDER GROUND PIPELINE
  - EXISTING PIPELINE

0	09.07.20	ISSUED FOR REVIEW	SK	SY	TR
REV.	DATE	DESCRIPTION	PREP.	CHKD.	APPD.
CLIENT:  GAIL (INDIA) LIMITED					
PMC:  LYONS ENGINEERING PVT. LTD.					
PROJECT: CGD CONNECTIVITY TO TORRENT GAS PRIVATE LIMITED AT GORAKHPUR					
SCALE	TITLE: P&ID FOR CGD TO M/S TORRENT GAS PRIVATE LIMITED AT GORAKHPUR				
N.T.S.					
SIZE	JOB NO.	DRAWING NUMBER	SHEET	REV.	
A3	034	GAIL-034030-PR-DWG-003	1 OF 1	0	



**NOTES**  
 1. SCHEMATIC IS BASED ON M/S GAIL DFR REV.0 PD DEPARTMENT AUG. 2018.

- LEGEND**
- BALL VALVE
  - INSULATING JOINT
  - REDUCER
  - EXISTING LINE
  - UNDER GROUND LINE
  - ABOVE GROUND LINE
  - FLOW DIRECTION

**GAS PIPELINE DETAILS**

PIPELINE SIZE	4"
DESIGN PRESSURE	92.0 kg/cm2g
MATERIAL	API 5L GR.X 42
WALL THICKNESS	6.4mm
EXTERNAL COATING	3LPE COATED
PIPELINE LENGTH	0.100 KM

0	04.12.19	ISSUED FOR REVIEW	VKS	SY	TR
REV.	DATE	DESCRIPTION	PREP.	CHKD.	APPD.

CLIENT: GAIL (INDIA) LIMITED.

PMC: LYONS ENGINEERING PVT. LTD.

PROJECT: CGD CONNECTIVITY TO M/S TGPL MORADABAD

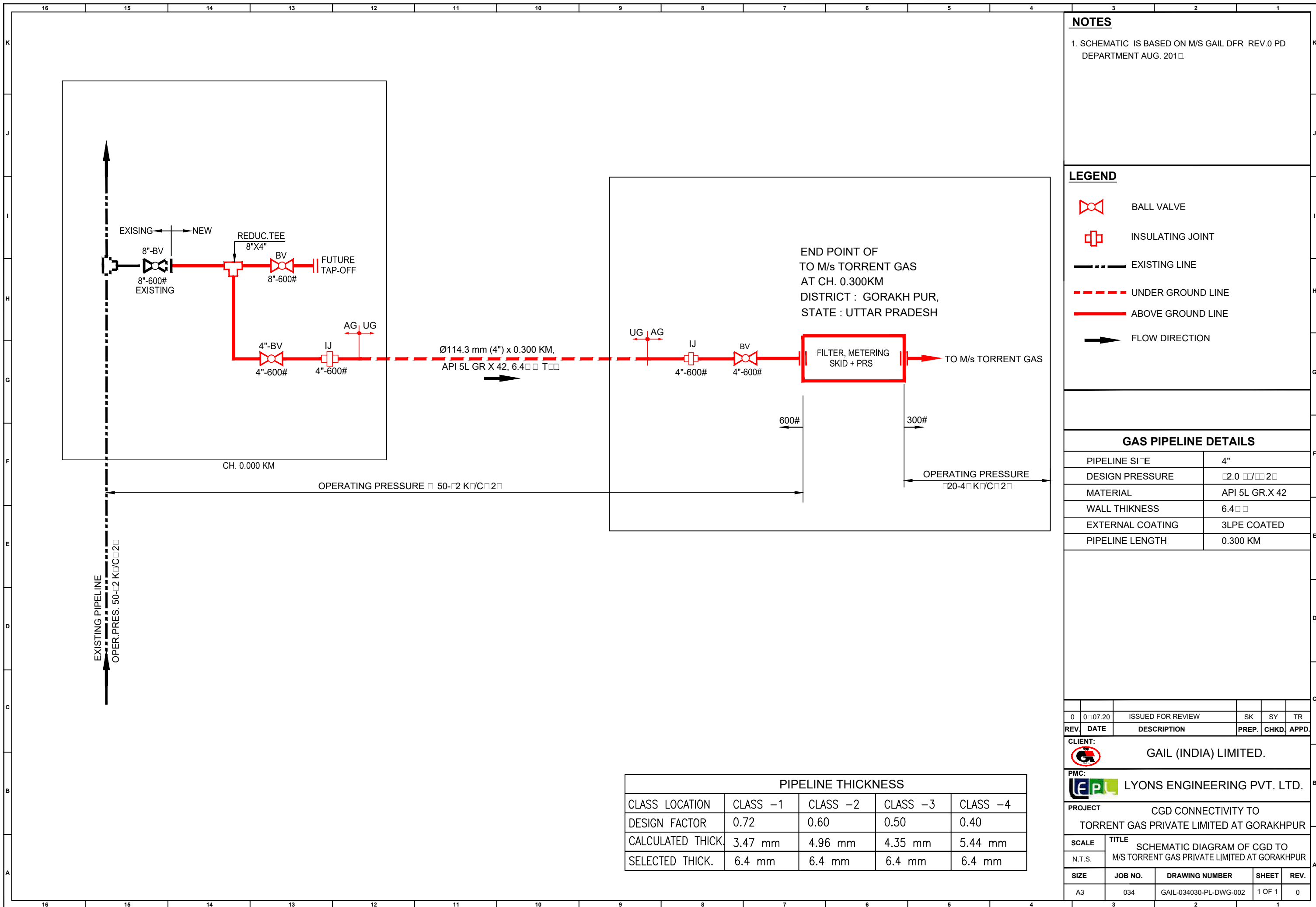
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SIZE	JOB NO.	DRAWING NUMBER	SHEET	REV.
A3	034	GAIL-034052-PL-DWG-002	1 OF 1	0

**PIPELINE THICKNESS**

CLASS LOCATION	CLASS -1	CLASS -2	CLASS -3	CLASS -4
DESIGN FACTOR	0.72	0.60	0.50	0.40
CALCULATED THICK.	3.47 mm	4.96 mm	4.55 mm	5.44 mm
SELECTED THICK.	6.4 mm	6.4 mm	6.4 mm	6.4 mm





**NOTES**  
 1. SCHEMATIC IS BASED ON M/S GAIL DFR REV.0 PD DEPARTMENT AUG. 2011

**LEGEND**

- BALL VALVE
- INSULATING JOINT
- EXISTING LINE
- UNDER GROUND LINE
- ABOVE GROUND LINE
- FLOW DIRECTION

**GAS PIPELINE DETAILS**

PIPELINE SIZE	4"
DESIGN PRESSURE	2.0 MPa
MATERIAL	API 5L GR.X 42
WALL THICKNESS	6.4 mm
EXTERNAL COATING	3LPE COATED
PIPELINE LENGTH	0.300 KM

REV	DATE	DESCRIPTION	PREP.	CHKD	APPD.
0	07.20	ISSUED FOR REVIEW	SK	SY	TR

CLIENT: GAIL (INDIA) LIMITED.

PMC: LYONS ENGINEERING PVT. LTD.

PROJECT: CGD CONNECTIVITY TO TORRENT GAS PRIVATE LIMITED AT GORAKHPUR

SCALE: N.T.S. TITLE: SCHEMATIC DIAGRAM OF CGD TO M/S TORRENT GAS PRIVATE LIMITED AT GORAKHPUR

SIZE	JOB NO.	DRAWING NUMBER	SHEET	REV.
A3	034	GAIL-034030-PL-DWG-002	1 OF 1	0

**PIPELINE THICKNESS**

CLASS LOCATION	CLASS -1	CLASS -2	CLASS -3	CLASS -4
DESIGN FACTOR	0.72	0.60	0.50	0.40
CALCULATED THICK.	3.47 mm	4.96 mm	4.35 mm	5.44 mm
SELECTED THICK.	6.4 mm	6.4 mm	6.4 mm	6.4 mm

HAR EK KAAM DESH KE NAAM



**GAIL INDIA LIMITED**

**CONSTRUCTION OF STEEL PIPELINE AND ASSOCIATED FACILITIES  
FOR CGD CONNECTIVITIES**

**VOLUME II OF II (TECHNICAL) – C**

**PIPELINE**



**E-TENDER REF :**



**(BID DOCUMENT NO - 034/LEPL/GAIL/22-R0)**

**LIMITED DOMESTIC COMPETITIVE BIDDING**



**Lyons Engineering Pvt. Ltd.**

	<b>DCI - MASTER DELIVERABLE CONTROL INDEX FOR CGD TO M/s TGPL MORADABAD &amp; CGD TO M/s TGPL GORAKHPUR</b>	<b>Doc No.</b>		
		GAIL-ENG-GN-DOC-DL-001		
		Rev. 0		
<b>Sr. No.</b>	<b>Description</b>	<b>Document / Drawing No.</b>		<b>Rev. No.</b>
<b>TECHNICAL VOLUME - II OF II</b>				
<b>C PIPELINE</b>				
1	Pipeline Design Basis	GAIL-STD-PL-DOC-DB-001		0
<b>TECHNICAL SPECIFICATION - PIPELINE</b>				
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-017		0
22	Technical Specification for Pipeline Drying and Commissioning	GAIL-STD-PL-DOC-TS-020		0
<b>STANDARD DRAWING - PIPELINE</b>				
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

PMC:		Doc No.		CLIENT:	
 <b>DCI - MASTER DELIVERABLE CONTROL INDEX FOR CGD TO M/s TGPL MORADABAD &amp; CGD TO M/s TGPL GORAKHPUR</b>		GAIL-ENG-GN-DOC-DL-001			
		Rev. 0			
		Sr. No.	Description		
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		
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	08.07.2020	Issued for Bid	SR	TR	SB	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

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<b>2.0</b>	<b>SCOPE</b>
<b>3.0</b>	<b>DESIGN CODES AND STANDARDS</b>
<b>4.0</b>	<b>DESCRIPTION OF FACILITIES</b>
<b>5.0</b>	<b>PIPELINE ROUTE</b>
<b>6.0</b>	<b>DESIGN DATA</b>
<b>7.0</b>	<b>PIPELINE AND ASSOCIATED FACILITIES DESIGN</b>
<b>8.0</b>	<b>OTHER TECHNICAL REQUIREMENTS</b>
<b>ANNEXURE-A</b>	<b>LIST OF CODES AND STANDARDS</b>

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## 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 the CGD to M/s TGPL Moradabad & CGD to M/s TGPL Gorakhpur.

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.

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#### 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, Blow down 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	-29 to 65.0
i. Above ground section	
ii. Underground section	-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

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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 environmental 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

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Class2	•Others	0.6
	•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 intended service, 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 coating conforming 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

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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.

SI. 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

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**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. In case, any private welling, 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 least 1.2.

**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 its end closure shall be designed and fabricated according to ASME Section VIII, Div.1. Adequate arrangements for launching, retraction, handling and lifting

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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 65°C or design temperature of pipeline whichever is higher.

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- 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 be 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 90° as possible. It should be noted that the extent of casing pipe generally specified by Railways is 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

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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 90° 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.

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## 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.

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**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

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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

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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.

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# ENGINEERING STANDARD



**GAIL INDIA LIMITED**

## **TECHNICAL SPECIFICATION FOR ONSHORE PIPELINE CONSTRUCTION**


**GAIL-STD-PL-DOC-TS-001**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
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)

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**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 ,<br>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. |   |   |

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- 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.

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#### 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.

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#### 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.

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### 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.

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## 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:

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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)	1.5 m
	2. When Scour depth is not known (below lowest bed level)	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.

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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.

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**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.

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### 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.

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- 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.

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- 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

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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.

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**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 shrink 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:

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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.

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# 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                   |

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### 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.

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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, pyrometers, 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

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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 90° 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.

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- 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.


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**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,

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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

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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 Brinell 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.

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- 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

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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.

## 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 100°C 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

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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 5°C 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.

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**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
<b>Wall thickness- under ½ inch</b>			
Under 2.375	0	0	0
2.375 to 4½	0	0	0
Over 4½ less than 12¾	2	2	12
12 ¾ and over	2	2	24
<b>Wall thickness-over ½ inch</b>			
4-½ and smaller	0	0	0
Over 4½ 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.

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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 0° 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.



**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

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- 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 defect 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

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- 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 90° 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 penetrometer 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

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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 DIN54109 or ISO1027. 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 IQI 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.

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## 2.18 Re-Radiography

The weld joints shall be re-radiographs in case of unsatisfactory quality of the radiographs, at the expense of the Contractor.

All the repaired weld joints shall be re-radiographed 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 with 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 and 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.


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### 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.

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# 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; Reaffirmed 1999) |
| 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                     |

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### 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.

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### 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 <sup>3</sup>
Compressive Strength (After 7 Days)	170 Kg/cm <sup>2</sup>
Compressive Strength (After 28 Days)	250 Kg/cm <sup>2</sup>

## 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**

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- 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 <sup>3</sup> )	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 <sup>3</sup> 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.

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**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<sup>2</sup>.

**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.

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## 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  $\pm 6$ mm 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

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**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 contact 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.

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**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<sup>2</sup> (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<sup>2</sup> and less than 0.3 m<sup>2</sup> 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<sup>2</sup>, 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.

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- 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.

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# ENGINEERING STANDARD



**GAIL INDIA LIMITED**

## **TECHNICAL SPECIFICATION FOR PIPELINE CROSSING RAIL, ROAD AND MINOR WATER WAYS**

**GAIL-STD-PL-DOC-TS-004**

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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


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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 th e 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 a pproved 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 piling, 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

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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 its 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

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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.

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- 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 crossings 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.

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- 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

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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.

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- 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<sup>2</sup> 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.

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## 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.

<b>TABLE – 1: MATERIAL PROPERTIES FOR CASING INSULATORS</b>		
<b>PROPERTY</b>	<b>VALUE</b>	<b>ASTM TEST METHOD</b>
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.

<b>TABLE – 2: MATERIAL PROPERTIES FOR CASING END SEALS</b>		
<b>PROPERTY</b>	<b>VALUE</b>	<b>ASTM TEST METHOD</b>
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:

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- 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

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# ENGINEERING STANDARD



**GAIL INDIA LIMITED**

## **TECHNICAL SPECIFICATION FOR FIELD JOINT COATING**


**GAIL-STD-PL-DOC-TS-005**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
0	17.01.19	Issued For Tender	AP	JR	SB



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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<br>Regulation<br>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/ copolymer 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 @+25°C	N/mm <sup>2</sup>	> 12	DIN EN 12068
b.	Ultimate Elongation @+25°C	%	> 250	DIN EN 12068
c.	Dielectric withstand with 1000 Volts/ sec	KV	> 30	ASTM D 149
d.	Water absorption, @+25°C for 24 hours	%	<0.05	ASTM D 570
e.	Volume Resistivity @+25°C	Ohm-cm	> 10 <sup>15</sup>	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	@ 23°C	N/mm	1.5	Annexure B
	@T max	N/mm	0.3	
Outer to Outer	@ 23°C	N/mm	1.5	
	@T max	N/mm	0.3	
To Pipe Surface	@23°C	N/mm	3.5	Annexure C
	@T max	N/mm	0.5	
To Factory Coating	@23°C	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.

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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.

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## 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.

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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

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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.

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- 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.

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- 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.

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# ENGINEERING STANDARD



**GAIL INDIA LIMITED**

## **TECHNICAL SPECIFICATION FOR CASING INSULATORS AND CASING END SEALS**

**GAIL -STD-PL-DOC-TS-006**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
0	18.01.19	Issued For Tender	AP	JR	SB



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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 ,<br>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.

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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  $\geq 2$  inch (min):-

$$\frac{\text{Casing Internal Dia} - \text{Carrier Outer Dia}}{2}$$

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.

Property	Value	Test Method
Backing (Sleeve and closure patch)		
Tensile Strength	2200 psi	ASTM D-638
Ultimate Elongation	400%	ASTM D-638
Heat Shock	No visual cracks, flow or drips (at 250 °C, 4 hours)	ASTM D-2671
Adhesive		
Ring and Ball softening point	90 °C	ASTM E-28
Lap Shear	60 °C - 25 psi 23 °C - 250 psi (2 inch/min.)	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.

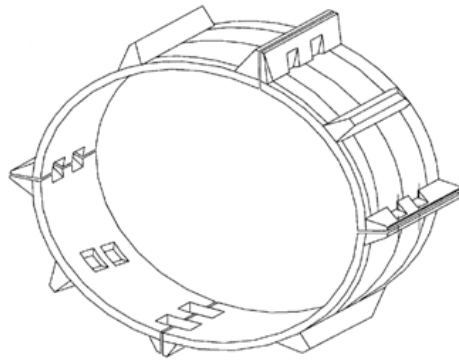
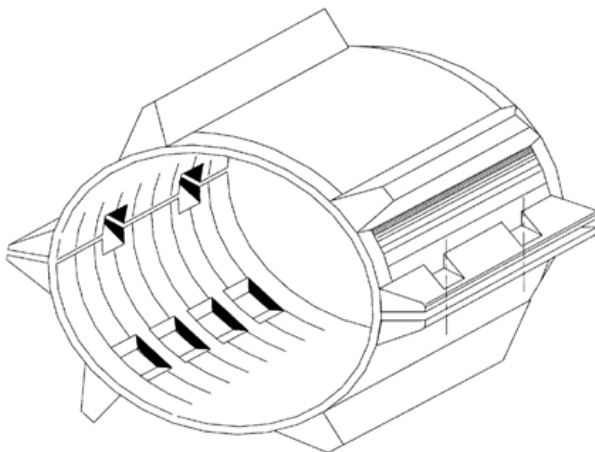
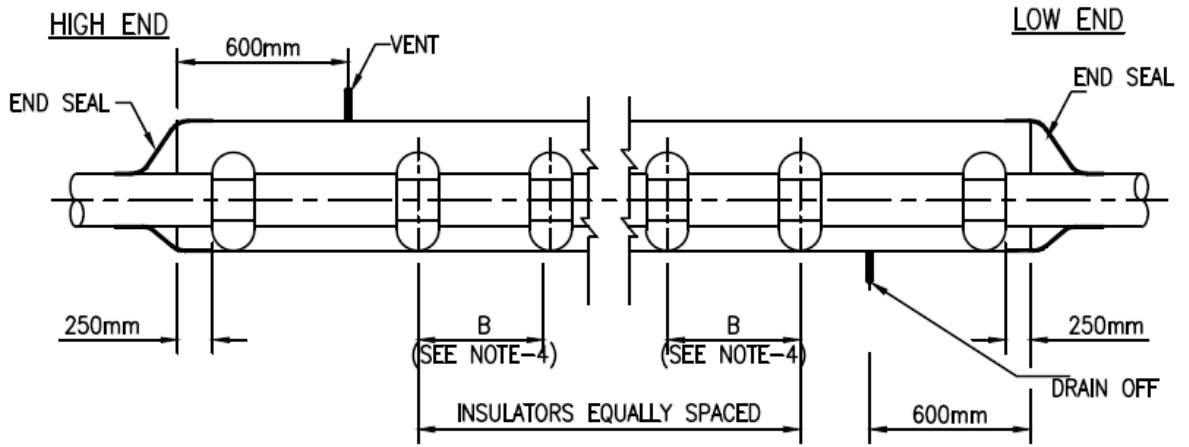



Fig 1: Casing Insulators





Refer standard drawing for casing pipe details.

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# 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.

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### 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 90°. 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 .

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- j) The fracture toughness test shall be determined by manufacturer at 0° C & -20 °C.
- 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.

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## 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 10° 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.

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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.

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- 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.

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## 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 :  $(\pm) 0.5^\circ$   
 Bend Radius :  $(\pm) 0.5\%$  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:

$$\text{Ovality} = \frac{2(\text{OD max} - \text{OD min})}{\text{OD nom}}$$

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  $(\theta/90) \times 10\text{mm}$ , where  $\theta$  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 .

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- 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
- Purchase order/Item number
  - Bend angle
  - Heat number
  - Owner/Consultant name
  - API-5L material grade
  - Specified wall thickness, outside diameter, bend angle, bend radius
  - Heat treatment
  - Measured weight
  - 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:
- Order Number
  - Tag Number
  - Manufacturer's Name
  - Size (Inches) and wall thickness (mm)
  - 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.

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**ENGINEERING STANDARD**



**GAIL INDIA LIMITED**

**TECHNICAL SPECIFICATION FOR  
INSPECTION & TESTING OF  
PRODUCTION WELD**


**GAIL-STD-PL-DOC-TS-008**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
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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,

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dimensions of the weld, surface porosity and other surface defects. Undercutting adjacent to the 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
  - $\leq 0.5$  mm: acceptable if ground out
  - $> 0.5$  mm: unacceptable and cut out
- Clamp Crates
  - $\leq 0.5$  mm: acceptable if ground out
  - 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:

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- 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 Penetrant 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 penetrant 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.

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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 film 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.

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## 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.

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# 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.

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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.

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## 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 be 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.

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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 °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.

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- 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.

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**ENGINEERING STANDARD**



**GAIL INDIA LIMITED**

**TECHNICAL SPECIFICATION FOR  
MAJOR CROSSING BY HDD**

**GAIL -STD-PL-DOC-TS-010**

						
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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.

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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.

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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.

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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 GAIL 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.

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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 any 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.

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## 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

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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 GAIL-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.

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**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;

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- 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.

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**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

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- 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.

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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.

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# ENGINEERING STANDARD

## TECHNICAL SPECIFICATION FOR HYDRO TESTING OF PIPELINES

**GAIL-STD-PL-DOC-TS-012**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
0	12.01.19	Issued For Tender	AP	JR	SB



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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.

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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

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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<sup>3</sup>/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<sup>3</sup>/h  
 Maximum 1000 m<sup>3</sup>/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 straighteners 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  $\pm 0.2^\circ\text{C}$ .
- 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  $\pm 0.1^\circ\text{C}$  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.

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- 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<sup>3</sup>. Contractor shall submit laboratory test reports of water used for testing.

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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

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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 1°C 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 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.

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#### 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.

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- 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.

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## 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:


$$V_p = (0.884 r_1/t+A) \times 10^{-6} \times V_t \times \Delta P \times K$$

Where:

$V_p$  = Computed water amount required to raise the pressure by 'ΔP' in the section to be tested (m<sup>3</sup>)

$V_t$  = Geometrical volume of the section (m<sup>3</sup>)

$\Delta P$  = Pressure rise (bar)

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$r_1$  = 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 ( $\text{bar}^{-1}$ ).

$K$  = 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:

$$\Delta P = B * \Delta T / \{ ( 0.884 r_1 / t ) + A \}$$

Where;

$\Delta P$  = Pressure change resulting from a temperature change (bar).

$\Delta T$  = Algebraic difference between water temperature at the beginning of the test and water temperature as measured at the end of the test ( $^{\circ}\text{C}$ ).

$B$  = 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 ( $^{\circ}\text{C}$ ). Refer Table-1.

$A$  = Isothermal compressibility value of water as estimated at the pressure and temperature values obtained at the end of test ( $\text{bar}^{-1}$ ). 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.


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- 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.

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- 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.

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**Table 1**

Difference between the water thermal expansion factor and the steel thermal expansion factor ( $^{\circ}\text{C}^{-1}$ ) ( $10^{-6}$ )

$^{\circ}\text{C}$ Bar	1	2	3	4	5	6	7	8
0.98	-98.62	-79.89	-61.8	-44.34	-27.47	1.14	4.66	19.98
10	-95.55	-76.94	-58.9	-41.65	-24.89	-8.67	7.02	22.23
20	-92.15	-73.68	-55.8	-38.64	-22.01	-5.92	9.65	24.74
30	-88.74	-70.4	-52.7	-35.63	-19.14	-3.16	12.29	27.26
40	-85.32	-67.12	-49.5	-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	-43.2	-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	-33.7	-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	-27.4	-11.38	4.1	19.08	33.58	47.61
120	-57.84	-40.74	-24.2	-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	-14.7	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 ( $^{\circ}\text{C}^{-1}$ ) ( $10^{-6}$ ).

$^{\circ}\text{C}$ Bar	9	10	11	12	13	14	15
0.981	34.82	49.22	63.276.78		89.99	102.83	115.34
10	36.97	51.26	65.1578	64.91.75		104.51	116.93
20	39.36	53.55	67.3380	71.93.72		106.39	118.71
30	41.76	55.84	69.5182	79	95.7	108.26	120.49
40	44.18	58.14	71.784.37		97.68	110.14	122.28
50	46.6	60.45	73.986.96		99.68	112.04	124.07
60	49.02	62.76	76.189.07		102.67	113.93	125.88
70	51.44	65.08	78.3291	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	82.7595	41.107.7		119.67	131.32
100	58.77	72.07	84.9897	53	109.73	121.59	133.15
110	61.21	74.41	87.2299	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
150	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 ( $^{\circ}\text{C}^{-1}$ ) ( $10^{-6}$ ).

$^{\circ}\text{C}$	16	17	18	19	20	21	22	23
<b>Bar</b>								
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 ( $^{\circ}\text{C}^{-1}$ ) ( $10^{-6}$ )

$^{\circ}\text{C}$ 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

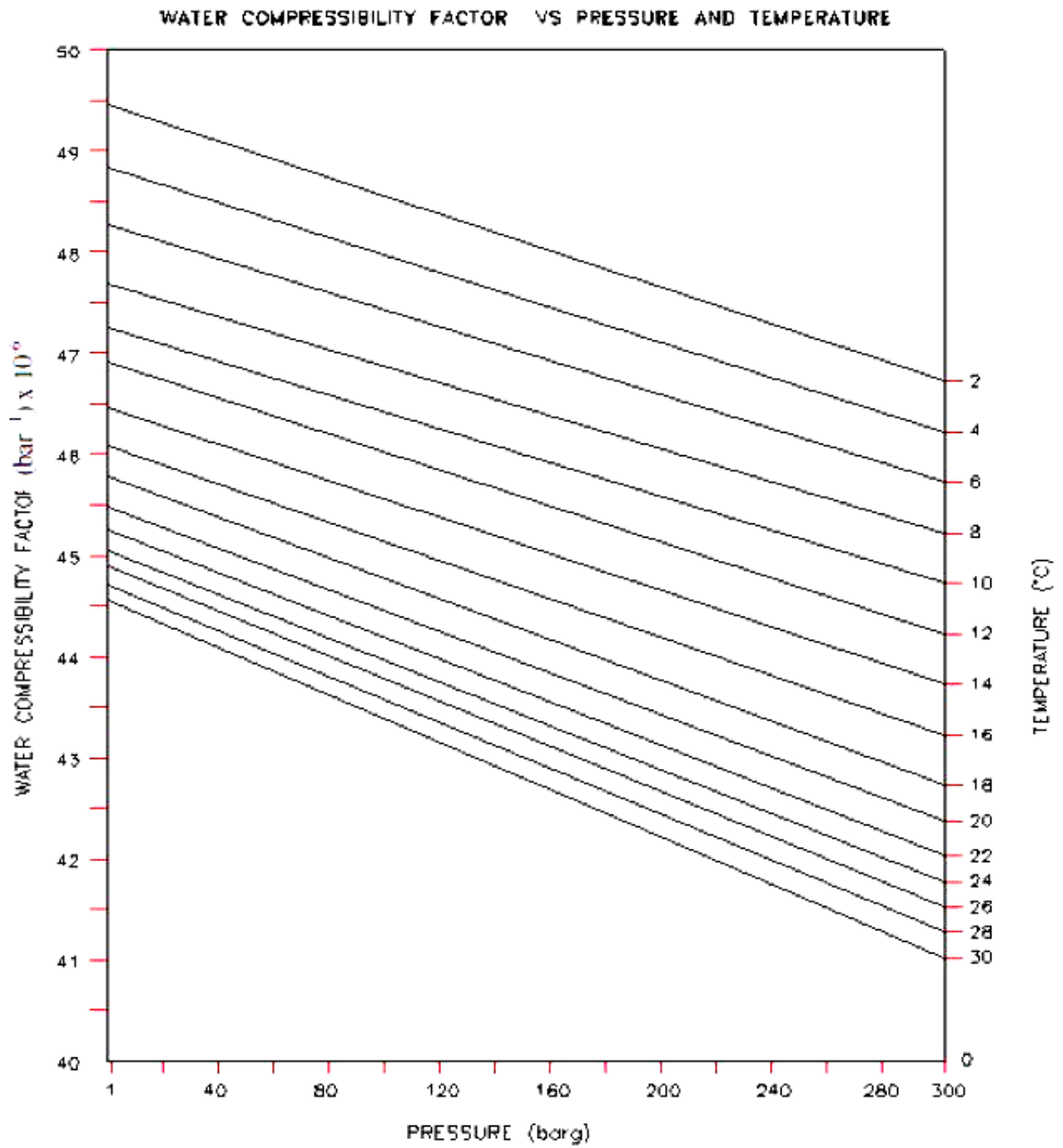


Fig.1 Water Compressibility Factor



# ENGINEERING STANDARD

## TECHNICAL SPECIFICATION FOR CALIPER PIGGING

GAIL-STD-PL-DOC-TS-013

Rev	Date	Purpose	Prepared By	Checked By	Approved By
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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.

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#### 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.

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## 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

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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

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- 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 with 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.

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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

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# ENGINEERING STANDARD



**GAIL INDIA LIMITED**

## TECNICAL SPECIFICATION FOR INTELLIGENT PIGGING

**GAIL-STD-PL-DOC-TS-014**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
0	13.01.19	Issued For Tender	AP	JR	SB



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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

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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 /

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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° 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


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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.

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- 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  $\pm 0.2m$  (Within pipe)  
Axial  $\pm 1.0m$  (from marker)
- Circumferential :  $\pm 5^\circ$

(For dents, ovalities and pipeline feature as detailed above).

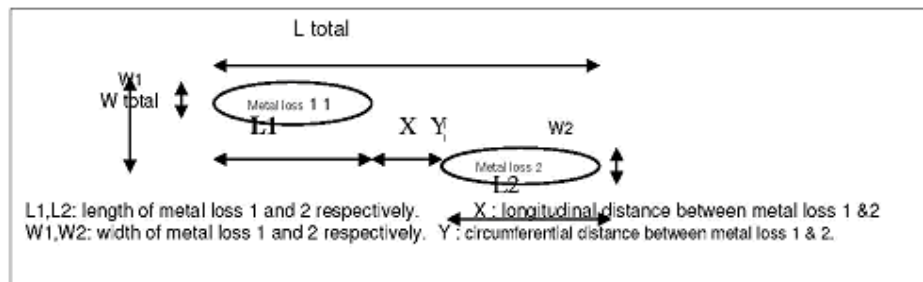
6.2 The following information/performance is expected out of the intelligent pig inspection:

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
GENERAL 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.

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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

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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:

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- 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.

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- 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.

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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

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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.

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**ANNEXURES  
FOR  
INTELLIGENT PIGGING**

<b>TECHNICAL SPECIFICATION FOR INTELLIGENT PIGGING</b>	<b>Doc No.</b>	<b>Rev</b>	
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**PROFORMA FOR GUAGING PIG, BRUSH CLEANING PIG, MAGNET CLEANING  
PIG DETAILS**

Sr. No.	Description	Bidders Details
<b>1.0</b>	<b>GAUGE PIG</b>	
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.	
<b>2.0</b>	<b>BRUSH CLEANING PIG</b>	
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.	
<b>3.0</b>	<b>MAGNET CLEANING PIG</b>	
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.	

## PROFORMA FOR ELECTRONIC GEOMETRY PIG DETAILS

Sr. No.	Description	Bidder Details or (Yes / No.)
<b>ELECTRONIC GEOMETRY PIG</b>		
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	

**PROFORMA FOR HIGH RESOLUTION MFL INSPECTION PIG DETAILS**

<b>Sr. No.</b>	<b>Description</b>	<b>Bidders Details or (Yes / No.)</b>
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 $\pm 0.1t$ 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**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
0	12.01.19	Issued For Tender	AP	JR	SB



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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

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- 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

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- 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.

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**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

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- 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

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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
- Date 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.

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**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:

<u>Type document</u>	<u>Software</u>
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**

0	12.01.19	Issued For Tender	AP	JR	SB	
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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 activities 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.


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- 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.

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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.

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- 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**

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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.

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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.

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#### 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.

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**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.

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Extent of inspection shall be minimum as per QAP enclosed; however the manufacturer shall ensure that pipes are in 100% conformance 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.

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#### 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	-	A non-mandatory requirement, advisory or recently Amended

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, 45<sup>th</sup> 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, 45<sup>th</sup> 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.

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**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:

- Quantity (e.g. total mass or total length of pipe);
- PSL -2
- Type of pipe (Refer table 2 or 3 of API 5L, 45<sup>th</sup> edition)
- Steel grade
- 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, 45<sup>th</sup> 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

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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  $-20^{\circ}\text{C}$  &  $0^{\circ}\text{C}$  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

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**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

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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:

$$\text{CEPCM} \leq 0.20 \%$$

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:

$$\text{CE IIW} \leq 0.40 \%$$

The CE IIW limit shall not apply if  $C \leq 0.12\%$


- **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.

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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**

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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 0° & 90°. 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.

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- **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:

$$A = 2 R = \frac{1.4 (D - t) t}{e (D - 2 t) - 1.4 t} - t$$

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:

<u>Grade of Steel</u>	<u>Min 'e' value</u>
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<sup>0</sup> (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<sup>0</sup> 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.

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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  $\geq 85\%$  and individual area shall be  $\geq 80\%$  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  $\geq 85\%$  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

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- **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 defined place. 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:

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- 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  $\leq 5\% t$  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

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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  
 $\geq 4 \frac{1}{2}$  and  $\leq 12$                        $\pm 2$  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  $\leq 12$ ".

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.

<u>Pipe Size</u>	<u>Tolerance</u>
$\geq 4 \frac{1}{2}$ and $< 12$	$\pm 2$ 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  $\leq 12''$ ) at pipe ends, shall not exceed the following:

Size Tolerance

$\leq 10 \frac{3}{4}$ : 2 mm

$\geq 12 \frac{3}{4}$ : 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**

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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:

- The outside flash shall be trimmed to an essentially flush condition.
- 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:**

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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 45<sup>th</sup> 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**

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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  $\frac{1}{3}$  Size or  $\frac{1}{4}$  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

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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 HV<sub>10</sub>. 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<sub>10</sub>.

#### 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

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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

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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.

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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

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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

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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.


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**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.

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## 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.

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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:

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- 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  $\geq 85\%$  and individual area shall be  $\geq 80\%$  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

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temperature is only to establish transition curve) however Average shear fracture area shall be  $\geq 85\%$  at  $-20^{\circ}\text{C}$  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  $-20^{\circ}\text{C}$  &  $0^{\circ}\text{C}$  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.

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**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.

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## 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.

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## 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 length 200 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.

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## 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.

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**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.

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## 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 10° and not more than 45°. Alternatively, webbing slings of adequately capacity may be used.

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**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 form 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:

$$\sigma_s = 0.2 \sqrt{D} \frac{(nL)}{B} \frac{D}{t} \ln \left( \frac{D}{2t} \right) \text{ for USC units}$$

$$\sigma_s = 9.05 \times 10^{-4} \sqrt{D} \frac{(nL)}{B} \frac{D}{t} \ln \left( \frac{D}{2t} \right) \text{ for SI Units}$$

n = Stacking load factor which is the number of rows in the pipe load, whether provided with separator strips or nested,

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- 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 row - 1.0 M Min.

**3.0 TRANSPORTATION**

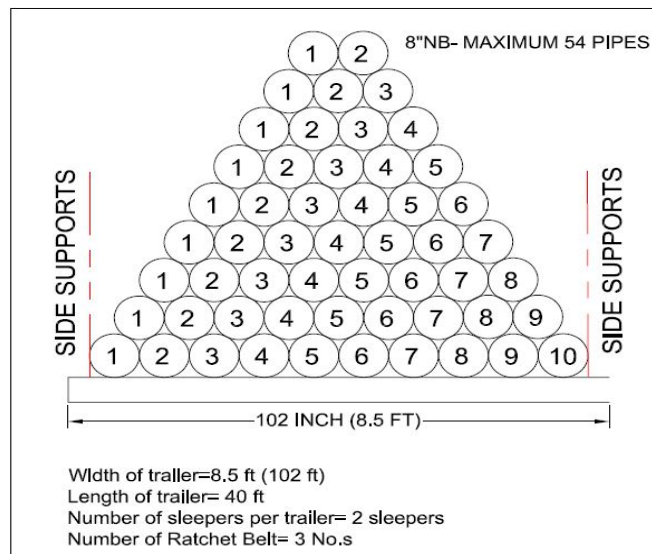
**3.1 Trailers**

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 radiused 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.

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## ANNEXURE - R: REQUIREMENTS 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 : XXXXXXXX

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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).

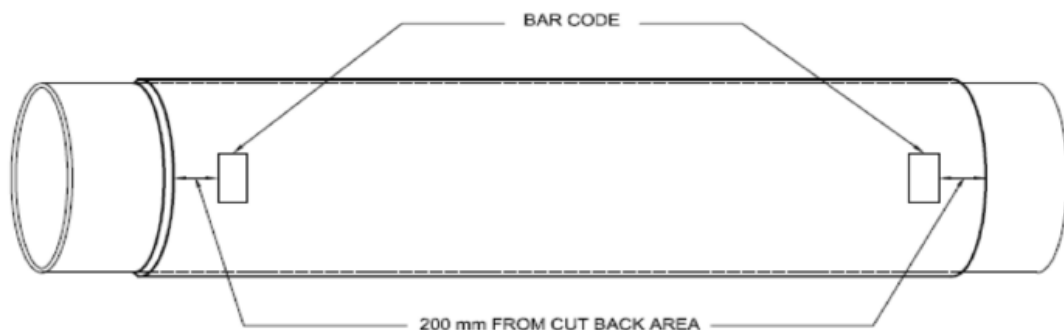
### 3.1.4 Verification of Barcode Labels


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)**



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FIGURES

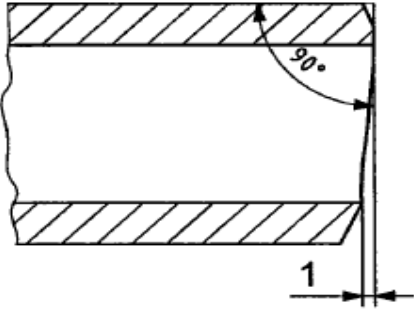


FIG 1: OUT OF SQUARENESS

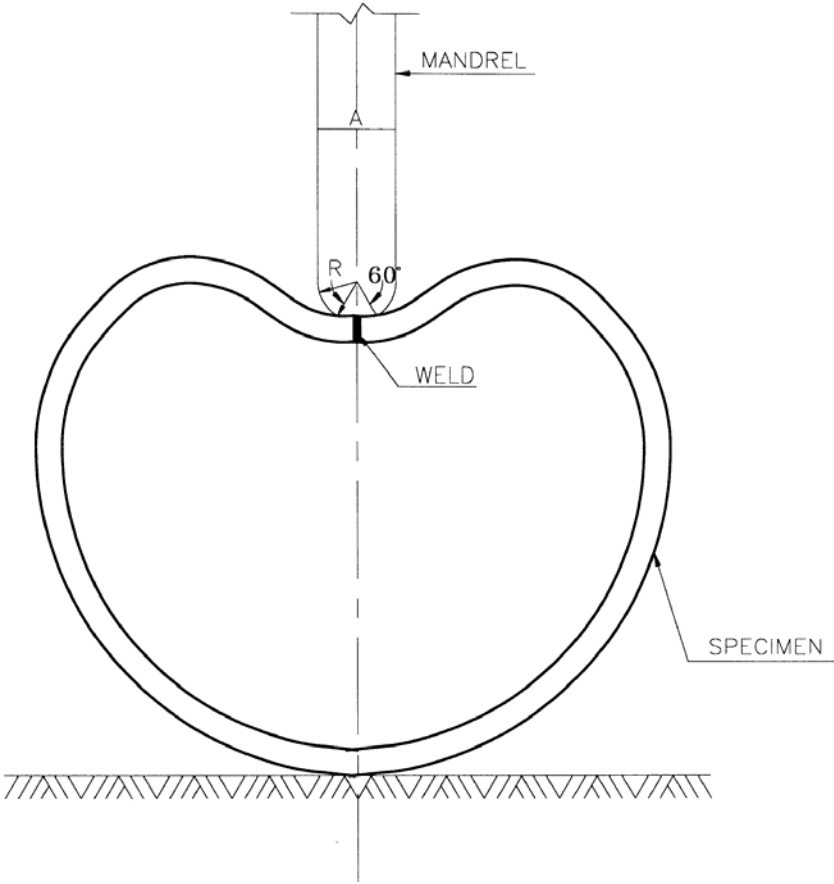
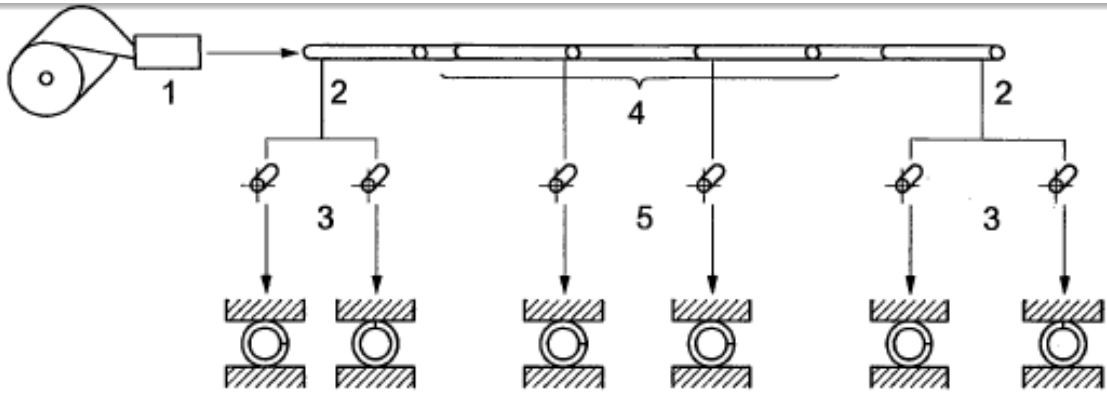


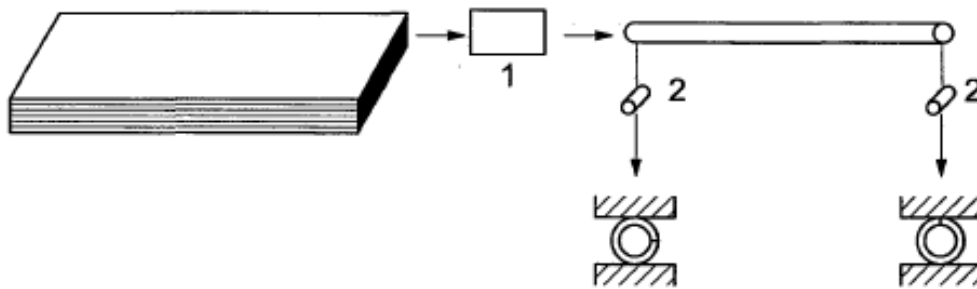
FIG 2 : REVERSE BEND TEST



**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

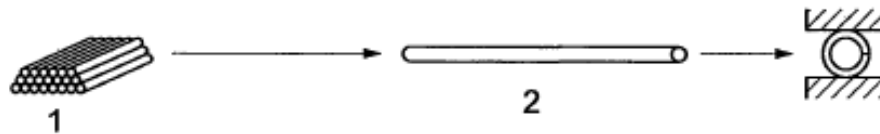
**a) EW pipe in grades  $\geq$  L245 or B and LW with  $D < 323,9$  mm (12.750 in) — Non-expanded, produced in multiple lengths**



**Key**

- 1 welding
- 2 two test pieces, one from each pipe end

**b) EW pipe in grades  $\geq$  L245 or B — Non-expanded, produced in single lengths**



**Key**

- 1 test unit of  $\leq$  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  $D \geq 73,0$  mm (2.875 in)**

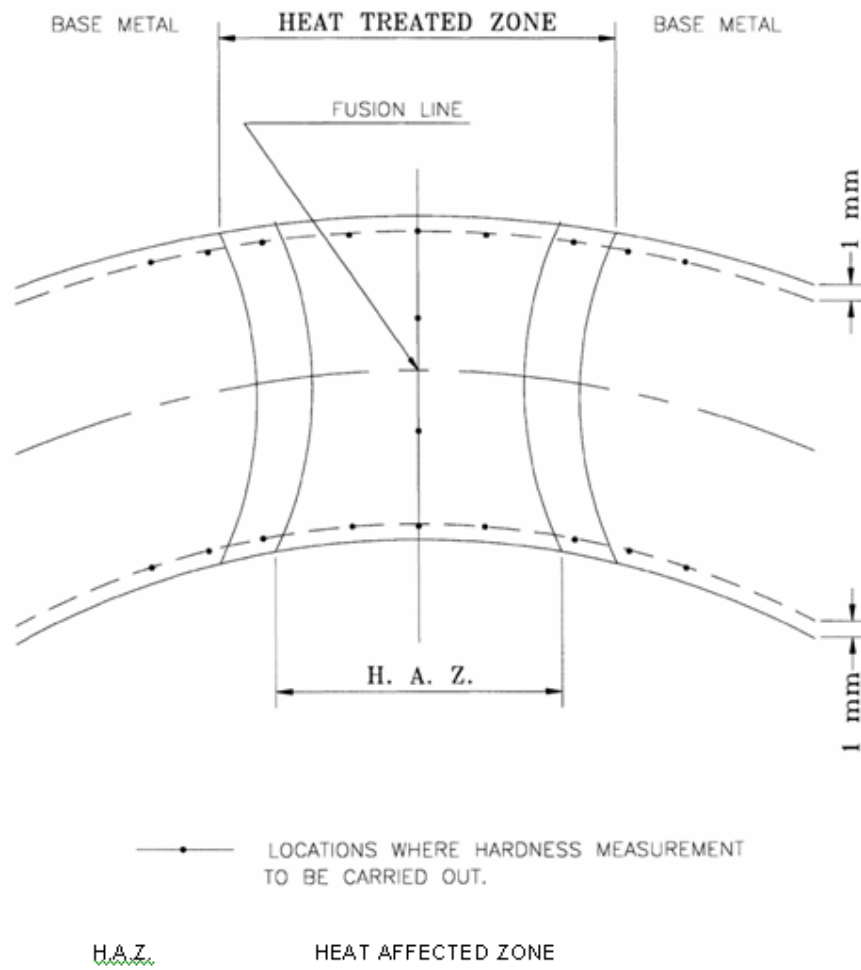


**Key**

- 1 test unit of  $\leq$  100 lengths of pipe
- 2 one test piece, from one pipe end

**d) EW pipe in grades  $\geq$  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 layer polyethylene 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 polyethylene coatings shall 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 minimum standards for the work.

- DIN 30670 Polyethylene Coatings for Steel Pipes and Fittings

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- 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 related products 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

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abrasive blast-cleaned surfaces EN 10204 Test Certificates for Stainless Steel Products SIS 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 by owner 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 continuous work 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

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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 trials 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 and one 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 to owner / 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.

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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 of 40 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 the contractor 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 be rejected by Owner. Such materials shall not be used for coating and shall be removed from site and replaced by manufacturer at his expense.

## 8.0 PROPERTIES

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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 the following 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 23deg.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/cm <sup>3</sup>	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 <sup>2</sup>	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 <sup>15</sup> min.	ASTM D 257
g.	Dielectric withstand, 1000 Volt/second @ + 25 °C	Volts/mm	30,000 min.	ASTM D 149
h.	Vicat Softening Point	°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 <sub>50</sub> ) 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 along the 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 <sup>2</sup>	10 <sup>8</sup> 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 per diameter 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 ASTM G42.


**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 each shift.

**10.0 PIPE 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.

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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  $\mu\text{mho/cm}$  5 max.
- c. Hardness - Nil
- d. Total Alkalinity as  $\text{CaCO}_3$  mg/l 2 to 3
- e. Chloride as  $\text{Cl}^-$  mg/l 1 max.
- f. Sulphate as  $\text{SO}_4$  = 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.

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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  $2\mu\text{g}/\text{cm}^2$ . 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  $2\mu\text{g}/\text{cm}^2$ . 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  $2\mu\text{g}/\text{cm}^2$  shall be either reblasted or deionised water washed and then rechecked for salt contamination. In case salt level less than  $2\mu\text{g}/\text{cm}^2$  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 Owner Representative 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.

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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 %	Maximum elapsed 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 200mm<sup>2</sup> in area and/or having contamination of steel surface shall be rejected and sent for re- blasting.

## 11.0 COATING APPLICATION

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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 Owner Representative'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.

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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 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

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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, disbanded 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<sup>2</sup> 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.

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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 12.5 above.


### 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

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(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 ( $\Delta T_g$ ) and % cure ( $\Delta H$ ) 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.

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### 12.12 Hot water immersion

Hot water immersion shall be carried out as per requirement of clause no. 8.4 of 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).

### 13.0 HANDLING, 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.

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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/calculation generally 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 Owners shall 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.

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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:

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- Pipes showing porosities or very small damage not picked up during holiday test and having a surface less than  $0.5 \text{ cm}^2$  or linear damage (cut) of less than 3 cm shall be repaired by stick using material of same quality.
- 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  $20 \text{ cm}^2$  shall be rebuild by heat shrink patch only and without exposing to bare metal.
- 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  $100 \text{ cm}^2$  attributable to process of coating application shall be maximum one number per pipe.
- In addition to the above, defects to be repaired by heat shrink patch/sleeve shall be maximum 1 (one) per pipe.

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.

**15.0 MARKING**

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.

**16.0 QUALITY 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.


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**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, the following:

- 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.

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- 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 and proposals:

- a. Pipe inspection at the time of bare pipe receipt.
- 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 and consumables.
- c. Pipe heating, temperatures and control prior to epoxy application.
- 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 from manufacturer(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 and temperature.
- 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 stripping technique
- i. Details of instrument and equipment calibration methods including relevant standards and examples of calibration certificates.
- 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

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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.

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## 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 ( $\Delta T_g$ ) and % cure ( $\Delta H$ ) 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

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**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 bonded epoxy 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 of ISO 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 each temperature from all pipes (8 pipes) shall be taken. If any one of these samples 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.

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**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) for 28 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 shall be 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**

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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 ( $\Delta T_g$ ) and % cure ( $\Delta H$ ) 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- Polyolefin Coatings.

#### 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 acceptance criteria 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.

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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.

<b>Epoxy Powder (Manufacturer)</b>	<b>Adhesive (Manufacturer)</b>	<b>PE Compound (Manufacturer)</b>
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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 the Contractor.

# ENGINEERING STANDARD



**GAIL INDIA LIMITED**

## **TECNICAL SPECIFICATION FOR MAJOR WATER CROSSINGS (CONVENTIONAL TRENCHING) GAIL-STD-PL-DOC-TS-019**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
0	25.01.19	Issued For Tender	AP	JR	SB



**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**

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- 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.
- 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.

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**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 each 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

Rev	Date	Purpose	Prepared By	Checked By	Approved By
0	12.01.19	Issued For Tender	AP	JR	SB



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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-01-75.

## 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.

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- 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 conform 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:

$$CE = C + \frac{Mn}{6} + \frac{Cr}{5} + \frac{Mo}{5} + \frac{V}{5} + \frac{Ni}{15} + \frac{Cu}{15}$$

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 Valve 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.

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- 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 conform 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.
- 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

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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.

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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:

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- 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.

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- 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.

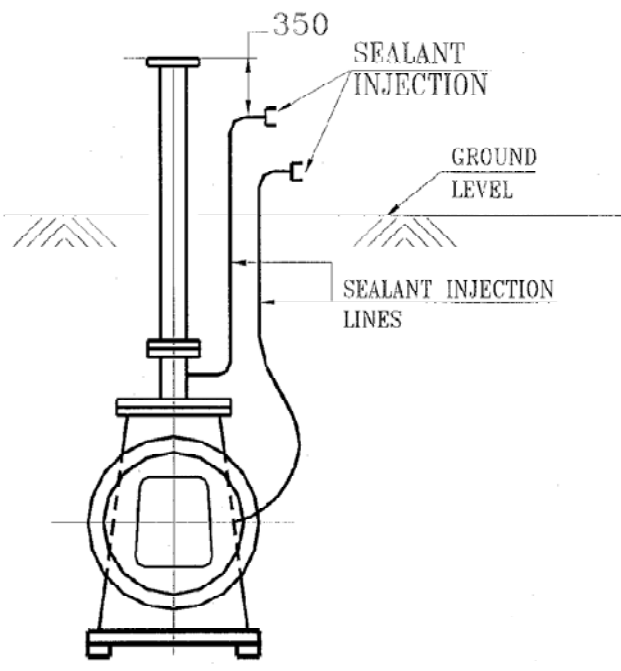
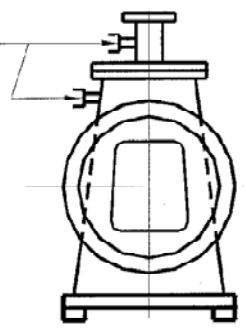
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- h) Copy of valid API 6D Certificate.
  - i) Details of support foot including dimensions and distance from valve centerline to bottom of support foot.
- 10.2 Within three weeks of placement of order, the Manufacturer shall submit four copies of, 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

ABOVE GROUND  
INSTALLATION

SEALANT  
INJECTION



## CHECK VALVE

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## 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

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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	-	≤ DN 400mm (16")	-	100%
		≥ 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).

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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**

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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 charge to the Purchaser as per the relevant clause of the bid document.

10.5 All expenses shall be to Manufacturer's account.

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# ENGINEERING STANDARD

GAIL INDIA LIMITED

## TECHNICAL SPECIFICATION FOR PIPELINE


### DRYING & COMMISSIONING

GAIL-STD-PL-DOC-TS-020

						
0	10.06.2020	Issued for Bid	SR	TR	SB	
<b>Rev</b>	<b>Date</b>	<b>Purpose</b>	<b>Prepared By</b>	<b>Checked By</b>	<b>Approved By</b>	

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## 1.0 Preamble

Drying the pipeline immediately after pressure test or any cleaning operation using water and preserving the dry condition before a dry & inert gas is introduced into it, is the most critical operation that will determine the health of pipeline and extent of service life.

Drying in natural gas pipelines assumes greater significance as poor or deficient drying will lead to internal corrosion of carbon steel pipelines in addition to causing formation of hydrate that will have further adverse impact on operations including that of downstream equipment.

## 2.0 Objectives

The objective of this document is to outline the methods and essential processes of pipeline drying operation, to define acceptance criteria and to specify immediate mandatory post drying steps such that the drying operation is effective meeting the requirement and is preserved until transition to operation.

It is also the objective of this document to spell out the processes of verifying and recording the readiness of a pipeline system to enter operational phase and to receive actual introduction of pipeline fluid.

## 3.0 Scope

This document shall mainly focus on the drying and commissioning of carbon steel pipeline systems that may include piping & equipment in dispatch / receiving terminals and intermediate SV/IP/TOP stations.

## 4.0 Approach

All pipelines, piping, vessels and equipment which have been subjected to pressure test or any cleaning operation using water, shall be subjected to 'drying operation' before introduction of process fluid viz., natural gas or LPG. Such a drying operation shall be conducted in accordance with acceptable methods and procedures meeting the acceptance criteria set out in this document.


Hydro-testing should preferably start only when all the segments of a pipeline section (pig launcher to pig receiver or between first and last valve) are mechanically ready (welding completed & accepted). This will ensure that all sections are sequentially tested and dried and situations where one segment is tested but could not be taken up for drying / commissioning for want of completion of balance segments of the section is avoided. Storage of hydro-test water for extended periods should not be permitted unless appropriate measures in treating the water with corrosion inhibitors, oxygen scavengers and biocides based on quality of water are taken.

Drying operation should commence immediately after de-watering and in no case the commencement of drying operation should be delayed beyond six months from the date of dewatering. Thorough dewatering will help in an efficient and fastest drying.

Once the drying operation is completed, the systems shall be immediately filled with Nitrogen and thereafter with process fluid as per commissioning sequence.

Drying operation should be performed on the complete system i.e., pig launcher to pig receiver or between first and last valve including connected piping. In case, short sections are dried after hydro-testing, the drying operation shall be once again conducted after tying-in all segments to form the complete section.

It shall be recognized that each pipeline section is unique in terms of route alignment, physical characteristics, environment, materials used, construction quality and nature of fluid to be handled. Accordingly, a written drying plan shall be prepared for the specific section.

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Natural gas and LPG are hazardous, highly flammable & can easily form explosive mixtures, can cause asphyxiation, cold burns etc. Safety must therefore be of foremost concern and each action at every step shall be taken with utmost attention to safety.

## 5.0 Methodology

Subsequent to pressure testing of pipelines, piping, vessels and equipment or after cleaning/ flushing using water, the system shall be thoroughly drained of the water, in the following manner:

(1) In case of piping, vessels and equipment, all the vents, drains and flanged connections shall be opened to drain out the entire water in the system, followed by blowing with nitrogen until it can be reasonably considered that all liquid water inside the system is removed.

(2) In case of pipeline segments / sections, dewatering shall be carried out by running cup or bi-di pigs driven by nitrogen / air pressure. The water being removed from one section may be used for filling subsequent section(s) with due consideration to quality of water and addition of corrosion inhibitors, oxygen scavengers and biocides.

(3) After dewatering, swabbing shall be done by running several foam pigs with air / nitrogen pressure, progressively from low density to high density foam pigs to absorb and remove water entrapped at low points. Swabbing operation shall be considered to be complete when there is no free water left in the pipeline as indicated by increase in weight of less than 10% of the original weight (prior to launching) of the last retrieved pig or when pigs are received in touch-dry condition.

(4) During dewatering foam pigging runs, a constant velocity of 0.5 to 1.0 m/s shall be maintained and maximum velocity should be restricted to 1.5 m/s.

Once dewatering and swabbing are completed, pretested (and dewatered) sectionalizing valve assemblies shall be installed and tie-ins shall be carried out with other hydro-tested sections and hydro-tested terminal piping.

A pipeline section mechanically completed in all respects, tested, dewatered and swabbed as described above, shall then be taken up for drying as per a written plan in conformity with the provisions given hereunder.

In order to confirm readiness of pipeline system or section for Drying and Commissioning, a checklist for each specific section including terminals / intermediate installations forming part of the section, shall be prepared comprising of the following minimum and essential points:


(1) Conformity of constructed pipeline and installations with the issued for Construction Drawings (P&I D and PGA for each station and alignment sheets for pipeline section(s) – duly certified by Engineer-in-Charge and GAIL Site-in-Charge (if not Engineer-in-Charge).

(2) Hydrotest Acceptance Report of pipeline section and associated stations (piping and equipment)

(3) Confirmation that piping and equipment of the originating station (from where Drying and Commissioning will proceed) has been dewatered and dried to acceptance criteria.

(4) Confirmation on pipeline dewatering including draining of remaining free water from valve body cavities and dead ends of piping (preferably confirmed by blowing compressed air). With regard to pipelines, swabbing activity has been completed and the last foam pig weight within acceptance criteria.

(5) Confirmation that station piping & equipment including valve body cavities and dead ends (of originating station from where drying & commissioning will proceed) have been dewatered and dried to within acceptance criteria.

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(6) Confirmation that all associated station piping and equipment is tested for leak tightness by pressurizing the same to minimum 6 kg/cm<sup>2</sup> and leak check carried out on all flanged, threaded and tubing connections.

(7) Inspection of pipeline route to confirm that there are no exposed pipeline section.

(8) Barricading of all facilities to be taken up for Drying and Commissioning, Access control and round- the- clock security, Warning Signage.

(9) All instruments control and safety valves are calibrated and installed as per P& I D.

(10) Draft ERDMP should be prepared and endorsed by accredited agency of PNGRB prior to this stage and all concerned involved in the commissioning operation should be sensitized of their roles and responsibilities in this regard.

(11) Identification of Commissioning Team from Contractor, Vendors, Consultant and GAIL with the approval of GAIL Head / CGM of Operation

(12) Preparation of Commissioning Plan for each section (along with associated stations) and approval by GAIL Head / CGM of Operation of Concerned Network

(13) Inspection of pipeline section and clearance by GAIL's designated F&S personnel.

(14) Communication facilities (including wireless handsets)

(15) Personal Protective Equipment for all members of team

Prior to commencement of Drying and Commissioning, the leader of the Commissioning team shall ensure that the checklist as above is verified and Drying & Commissioning activity can start.

Drying using deeply pre-dried air (super dry air) or nitrogen and Vacuum Drying are two acceptable methods of drying of pipelines and facilities. Drying and Commissioning Operations involve three phases:

- (1) Drying Phase where the moisture inside the piping / pipeline system is removed.
- (2) Soak test to confirm that there is no significant residual moisture in the pipeline.
- (3) Final Purging to replace the full pipeline volume with inert gas and process gas.


## 5.1 Drying

Before commencement of drying, valves at the battery limit of the section under drying shall be closed. As a precaution against moisture or moist air ingress through the battery limit valves, all valves immediately adjacent to the battery limit valves shall also be closed and the pressure in the piping between adjacent valves shall be reduced to atmospheric pressure.

The pressure measuring instruments, pressure safety valves, actuator taps etc. shall be isolated by closing the isolation valves. All vents, drains, utility connections, tapping valves shall be closed and the ends shall be blind flanged. The blow-down piping at the terminals and SV stations shall also be isolated by closing respective valves. The by-pass piping across the mainline valves at SV stations shall be isolated by closing all the by-pass valves. All other valves shall be kept open.

### 5.1.1 Drying by deeply pre-dried air / nitrogen

The super drying operation shall follow within 48 hours of swabbing. In case drying is delayed beyond this time duration, then the swabbing shall be repeated again.

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Drying is achieved in this method by flowing dry air over wet surface to remove the water. In case of pipelines, the efficiency of drying is enhanced by running a series of foam pigs initially of low density and later by higher density.

The pressure of air, in particular the outlet back pressure, is kept as low as possible to maximize drying efficiency.

The pipeline geometrical effects should be considered including how the liquid film is distributed on the wall, the adhesion and absorption of the liquid film on the pipe wall and the actual pressure profile considering the air gravitational head.

A water dew point of the inlet air of at least (-) 40o C at atmospheric pressure (0.1 MPa) should be required. Lower air dew point may be required at cold climates.

Nitrogen if used for drying shall have a minimum dew point of -50o C at atmospheric pressure.

Compressors shall provide oil-free air to prevent fouling / degradation of the downstream drying columns / sieves and to avoid oil deposits forming in the pipeline which can shield water from the dry air or depress its actual vapour pressure due to the oil-water interfacial tension force.

The optimum rate of dry air flow shall be established. For an efficient operation, the dry air flow rate shall be sufficiently high to maintain turbulent flow throughout the pipeline length.

The pipeline shall be pigged with high sealing disc pigs driven by dry air or nitrogen in combination with water absorbing foam pigs having large water absorption capacity (approximately 80% of their body mass), high abrasion resistance and a density between 30 to 50 kg/m<sup>3</sup> as follows:

- (1) The travelling speed of the foam pigs should not exceed 1.2 m/s.
- (2) a back-pressure of 0.5 bar (g) shall be maintained at the receiving end and
- (3) pigs in a pig train should be separated by at least 300 meters.

Pigging shall continue until the dew point of the drying medium at the receiving end remains below the dew point specified in the acceptance criteria and does not fluctuate by more than 3o C while replacement of the content of the line by a pig.

#### 5.1.1.1 Purging for Drying:


After pigging as above, the pipeline should be purged with the drying medium with a minimum velocity of 3 m/s in the pipeline at the discharge end.

Purging shall continue until the dew point at the discharge end remains below the dew point specified in the acceptance criteria while replacing twice the content of the pipeline at purging pressure.

#### 5.1.1.2 Acceptance Purging:

Upon completion of purging, the pipeline shall be blocked in for a period of at least 12 hours and at a pressure of 0.5 bar (g) above the ambient pressure at all points along the pipeline. After this period the pipeline content shall be replaced at the lowest possible pressure and the dew point continuously measured at the discharge end.

Drying is complete when the dew point during acceptance purging remains below the final dew point specified in the acceptance criteria for the pipeline while replacing line content. Purging for drying shall be repeated until this requirement is met.

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### 5.1.1.3 Acceptance Criteria:

In drying by super dry or deep dried air, the following criteria shall be acceptable.

Drying until all the following conditions are achieved and verified:

- (1) achievement of outlet dew point of (-) 20o C at atmospheric pressure.
- (2) performance for soak test for a minimum of 24 hours
- (3) no significant increase of the outlet dew point (by more than 3o C) after one pipeline volume at pipeline drying pressure is replaced after soak by dry air or nitrogen test during final purging still reaching a dew point plateau below the minimum.

Upon completion of drying, the pipeline shall be blocked in at a pressure of 0.5 bar (g) above ambient pressure at any point along the pipeline.

### 5.1.2 Vacuum Drying

#### 5.1.2.1 General:

Water vapour shall be evacuated from the pipeline by vacuum units alone or in combination with dry air or dry nitrogen vacuum purging as specified in the scope of work. The final dew point temp. of the dry pipeline shall be -20 °C, which is equivalent to a pressure of 1 mbar (absolute), unless otherwise specified in the scope of work.

Vacuum drying should consist of the following stages:


- (1) pre-drying checks;
- (2) one or more leak tests;
- (3) pump-down;
- (4) evaporation/evacuation, including vacuum purging (if applicable);
- (5) soak test/acceptance test;

#### 5.1.2.2 Pre-drying Checks

The size of the vacuum units should be sufficient to reduce the pressure in the pipeline to the vaporization pressure during pump-down within typically 12 h to 36 h of commencement of the pump-down operation, depending on the length and diameter of the pipeline. Vacuum units having excessive capacity would draw down the pressure too rapidly, which could cause localized ice formation. The Contractor shall prepare a theoretical pressure/ time graph each of the drying phases and submit it along with detailed work procedure for approval of GAIL.

Before commencement of vacuum drying the Contractor shall verify that:

- (1) The pipeline has been isolated from other pipelines and piping by closing valves at the battery limit. As a precaution against possible “air-in” leaks through the battery limit valves, all valves immediately adjacent to the battery limit valves shall also be closed wherever possible;
- (2) All pressure safety valves, actuator tappings etc. shall be isolated by closing the respective valves;
- (3) All vent drain, utility connections, tapping valves shall be closed and ends shall be blind flanged;

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- (4) The blow down piping (if any) shall also be isolated by closing the respective valves;
- (5) The bypass piping across the mainline valves at SV stations shall be isolated by closing all the by-pass valves;
- (6) valves are designed for vacuum drying and have been placed in to the half open position;
- (7) valve body bleeder parts are vacuum tight;
- (8) Temporary connections, pig trap valves and pig trap end closure seals are able to withstand the prevailing vacuum pressure. If this is not the case, Contractor shall provide adequate seals for the vacuum drying operation and replace these seals by the permanent seals once the vacuum drying operation has been completed.

### 5.1.2.3 Leak Tests

The piping connecting the vacuum unit with the pipeline, including pig trap(s) and vacuum unit(s), shall be isolated from the pipeline and the pressure in the isolated piping lowered to slightly above the theoretical evaporation pressure.

The vacuum unit shall be switched off and the isolated piping checked for leaks by soap solution. Leaks shall be cured by flange tightening etc.

The pipeline shall then be opened to the vacuum unit(s) and the pressure in the entire system reduced to a pressure of 50 mbar (abs) to 100 mbar (abs) for the final leak test. The pressure shall be maintained at this level and all other piping, such as at the pig trap system at the other end of the pipeline if vacuum drying is carried out from one end only, shall be checked for leaks. Leaks shall be cured as stated above.

After all leaks have been cured, where possible, the vacuum unit shall be turned off and isolated from the pipeline and the pressure in the pipeline and the associated pipe work monitored for at least 1 hr. Pressure increases shall be recorded and plotted on a pressure/time chart. From the measured pressure increase, the total leak rate shall BE calculated. Curing of leaks shall be continued until the calculated total leak rate is less than 10 % of evacuation capacity of the vacuum units at the initial leak test pressure. The final in-leak rate shall be recorded for use when analyzing the final soak test results.


### 5.1.2.4 Pump-down:

The pressure in the pipeline shall then be reduced at a steady rate to a vacuum level of 40-50 torr (53- 67 mbar). Alternatively, the contractor may reduce the pressure in the pipeline further to a level where the ambient temperature of the pipeline will cause the free water to boil and then eventually to evaporate. The approximate pressure value is calculated in advance but it is easily recognized at site by a fall in the rate of pressure reduction, which is noted from the plot of pressure against time.

A significantly shorter pump down time than that theoretically predicted could indicate freezing and shall be evaluated immediately. The pressure shall be kept at this level, and pig traps and piping inspected for vacuum tightness and any leaks cured.

### 5.1.2.5 Evaporation / Evacuation

As the pressure in the pipeline approaches the saturated vapour pressure at the pipeline's ambient temperature, the rate of vapour evolution will increase, resulting in a reduction in the rate of pressure decrease. During this phase, the pressure will remain at more or less constant level until all the free water has been converted into water vapour. The vaporization pressure shall be maintained and water vapour evacuated by pumping until all residual water has evaporated. Once all the free water has evaporated from the pipeline, the rate of pressure decrease will increase.

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Ice formation in the pipeline and associated fittings shall be avoided by control of the evacuation rate through the vacuum units.

A vaporization pressure plateau at a level markedly lower than expected or erratic pressure fluctuations during plateau are indications of ice formation.

Vaporization and evacuation by pumping shall continue until the vapour pressure has reached the level that is equivalent to the dew point specified for the dry pipeline. This pressure shall be maintained for at least 3 hrs to confirm that a stable balanced vacuum pressure is established throughout the pipeline. Evacuation shall then be stopped and a soak test carried out.

Vacuum purging with dry air or nitrogen at pressures in the range of 3 mbar (abs) to 10 mbar (abs) may be applied in addition to evacuation by pumping to reduce the time needed for conventional evaporation and water vapour evacuation. The rates and pressures are dependent on the performance curves of the vacuum equipment, as the aim is to increase the pressure in the pipeline to an efficient volume transfer level. If applied, purging and evacuation shall continue until the dew point at the vacuum unit is constantly below the dew point for a dry pipeline as specified in the scope of work while replacing at least twice the contents of the pipeline. Purging shall then be stopped, and the pressure reduced to 3 mbar (abs) and maintained at this level for at least 3 hrs to achieve stable conditions in the pipeline. A soak test shall then be performed.

The draw-down pumping shall be maintained until a pressure lower than that required for the specified dew point is achieved i.e., for the target pressure of 0.1 kPa (1 mbara), the drawn down should be continued until 0.05 kPa (0.5 mbar). This is carried out to ensure that a stable balanced absolute pressure of 0.1 kPa (1 mbara) is obtained throughout the pipeline system.

#### 5.1.2.6 Soak Test / Acceptance Test

The pipeline shall be blocked in and isolated from all equipment other than that required for pressure monitoring for a period of at least 24 h, at a pressure of:

- (1) 1 mbar (abs) if vapour is being evacuated by pumping only;
- (2) 3 mbar (abs) if vapour is being evacuated by pumping and purging;
- (3) Pressure monitoring shall be carried out by means of pressure gauges and recorders with range 0 mbar to 10 mbar, a reading division of 0.1 mbar and an accuracy of  $\pm 1\%$  of the measured value.

#### 5.1.2.7 Acceptance Criteria


Acceptance Criteria for vacuum drying is achievement of the dew point of (-) 20o C at the outlet corresponding to a saturation absolute pressure of 0.103 kPa (1.03 mbara) and to residual water content in the pipeline of 0.9 g/m<sup>3</sup>.

## 5.2 Nitrogen Filling

Following the acceptance of dry condition of the pipeline, shall be immediately followed by introducing and filling the pipeline with Nitrogen of purity level 99.9% or above.

The entire section of pipeline including all above ground piping at dispatch and receipt stations, SV stations and hook-up / tap of points, the piping shall be purged with nitrogen till the residual oxygen content in the piping is below 1% (vol/vol).

Nitrogen required for Inertisation purpose of the pipeline and aboveground piping shall be preferably generated from Liquid Nitrogen through vaporizers. Care must be taken to check the purity of Nitrogen at each stage. Nitrogen gas at ambient temperatures (AND NOT LIQUID NITROGEN) and in completely vaporized and gaseous state shall be used.

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Nitrogen filling shall be done to the following minimum level:

- (1) 50 mbar (abs), for nitrogen when gas filling is to immediately follow drying.
- (2) 500 mbar (ga) above the ambient pressure at any point along the pipeline, for nitrogen (if there will be a delay between drying and gas filling) or for dry air.

Warning signs, in English and the local or working languages, such as "PIPELINE UNDER VACUUM" or "PIPELINE FILLED WITH DRY AIR" shall be placed at all affected pipe work, including block valve stations and pig trap systems.

### 5.3 Gas-in / Commissioning and Stabilization

After completion of drying activities and safety review prior to start-up, the systems associated with the pipeline system including the underground pipeline and the above ground piping at dispatch and receipt stations, SV stations and hook-up / tap-of points are reviewed for ready for gas-in/commissioning by Contractor, Consultant and GAIL.

'Ready for commissioning status' shall be jointly reviewed by GAIL and Contractor and final clearance for start-up shall be given by GAIL. 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'.


The introduction of natural gas from upstream system or supplier shall proceed sequentially from each sub system (dispatch terminal, pipeline section (if necessary from SV to SV), receiving terminal etc.) with careful displacement of air inside the system with gas to maximum acceptable level of oxygen and in stages of increasing pressure initially to 2-5 kg/cm<sup>2</sup>, then with intermediate hold points at 20%, 40%, 60%, 80% & 100% of maximum operating pressure and leak check and rectification at each stage.

Tightening of flanges at line pressure beyond 20% MOP shall be avoided and concerned section should be attended after reducing the pressure to minimum level.

During introduction of natural gas into the pipeline, natural gas shall be the motive fluid for driving the last pig of the nitrogen slug train. The pig train speed shall be maintained at 3 to 4 Km/hr. Maintenance of proper backpressure shall control pig train speed.

Venting shall be controlled at the pig-receiving end to achieve the desired dynamics. In this fashion, slowly the desired portion of the pipeline shall be commissioned.

On reaching MOP and ensuring leak tightness, the system may be declared for successful commissioning for commencement of operation.

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PIPELINE SYMBOLS

DRAWING NO.

GAIL-STD-PL-DWG-TP-001

SHEET NO.

1 OF 1

	PROPOSED PIPELINE		INSULATION JOINT
	EXISTING PIPELINE		K.M. POST
	TURNING POINT		
	UNCASED CROSSING		PIPELINE WARNING SIGN
	CASED CROSSING		
	CNNTINUOUS CONCRETE WEIGHT COATING		AERIAL MARKER
	GRAVEL FILLED GEO TEXTILE BAGS		NAVIGABLE WATERWAY PIPELINE WARNING SIGN
	OPTICAL FIBER CABLE INSIDE HDPE		
	OPTICAL FIBER CABLE INSIDE HDPE CONDUIT SUBDUCTED IN CS PIPE		DIRECTION MARKER
	INTERMEDIATE PIGGING STATION		
	SECTIONALISING VALVE (SV)/ BLOCK VALVE		TEST STATION CHAINAGE C.P. TYPE INSTALLATION
	EXISTING UNDERGROUND CABLE/PIPELINE/ STRUCTURE CROSSING		
	PUMP/ COMPRESSOR STATION		
	HOT INDUCTION BEND		

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TOPOGRAPHICAL SYMBOLS

DRAWING NO.

GAIL-STD-PL-DWG-TP-002

SHEET NO.

1 OF 1



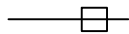
METALLED ROAD



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



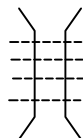
HUTS (TEMPORARY)



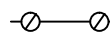
GRAVES



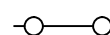
TREE



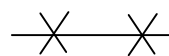
BRIDGE



POWER LINE



TELEPHONE LINE



FENCE



GROUND PROFILE



SWAMP OR MARSH/MUD



SAND DUNES

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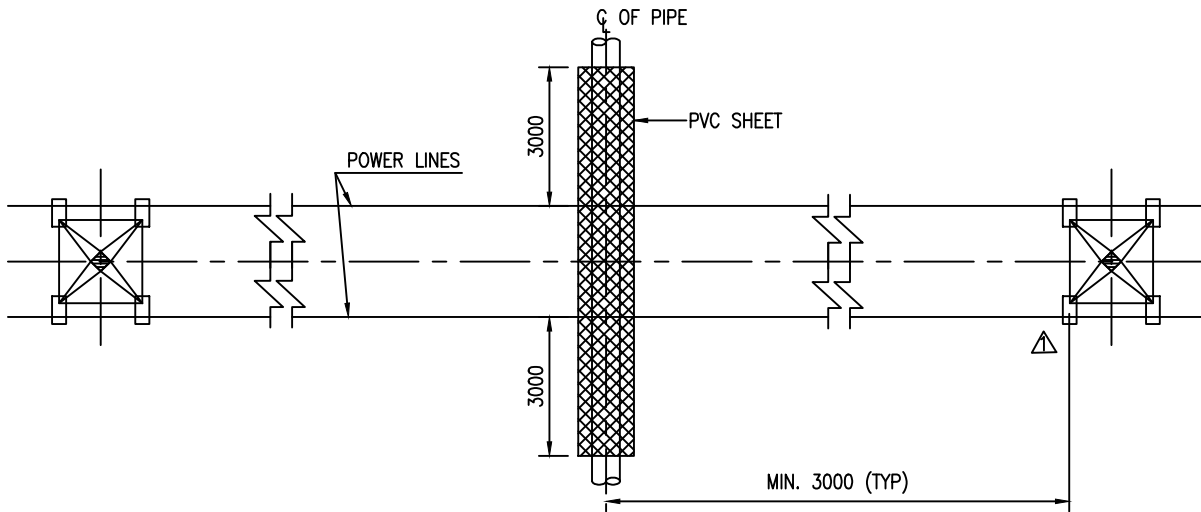
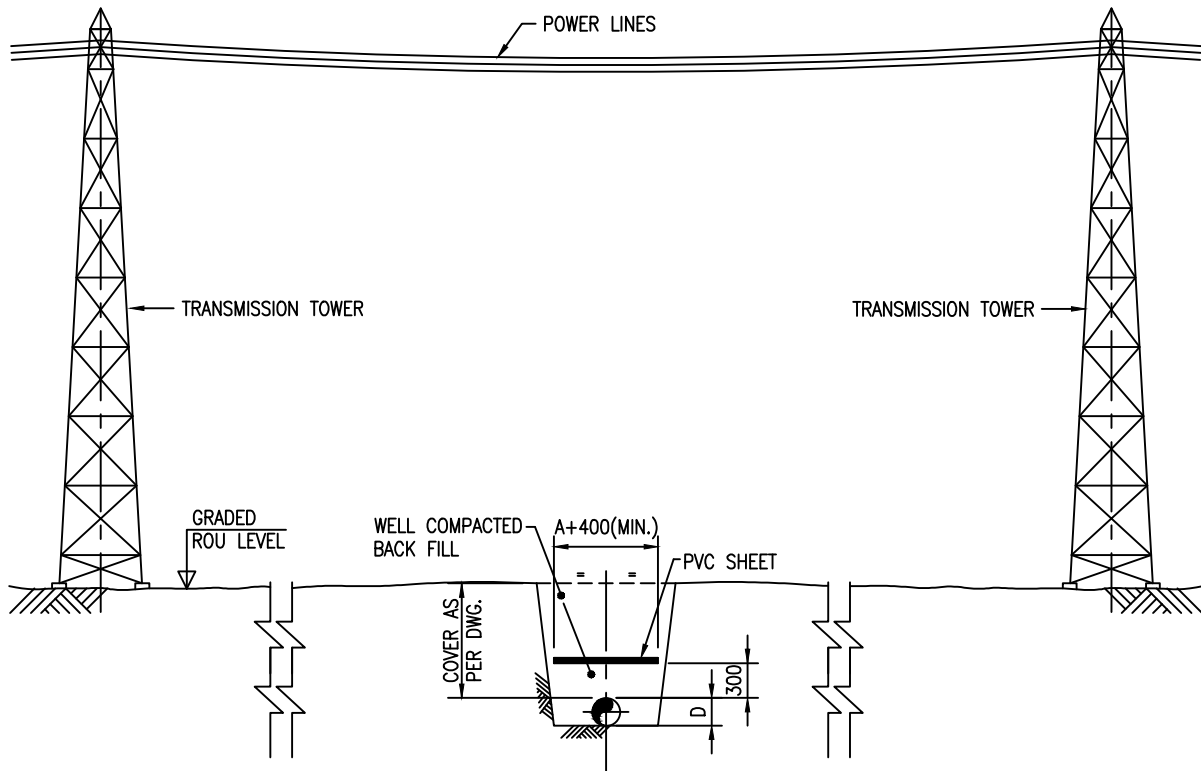
OVERHEAD POWER LINE  
CROSSING

DRAWING NO.

GAIL-STD-PL-DWG-TP-003

SHEET NO.

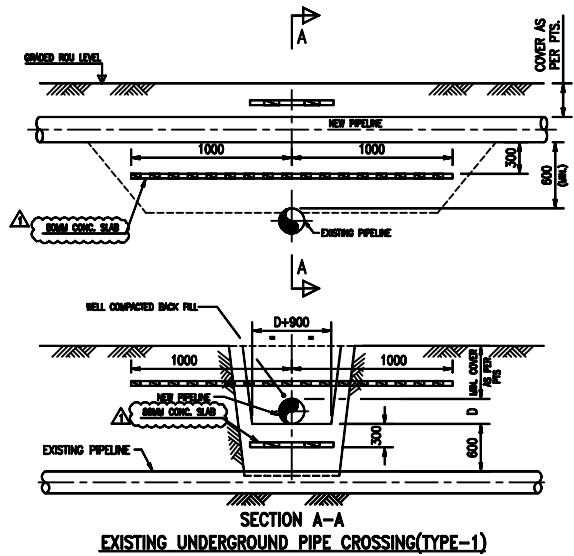
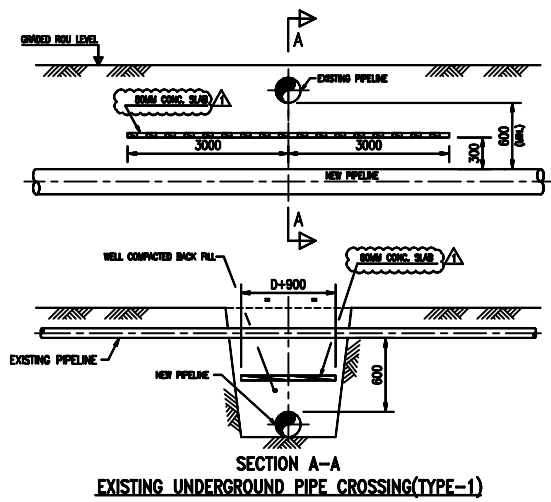
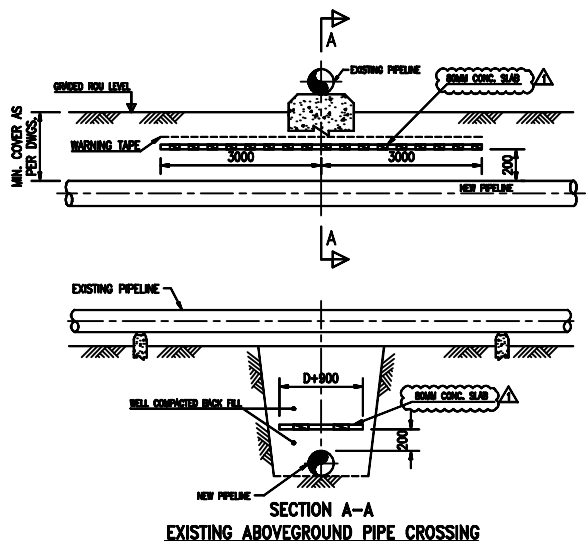
1 OF 1



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.

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**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.

DWG. NO.	REF. DRAWING	0	18.01.19	ISSUED FOR TENDER	SS	YS	JR
				REVISION	DRN	CHKD	APPD

TYPICAL EXISTING PIPELINE CROSSING	DRAWING NO.	REV.
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RAIN CAP

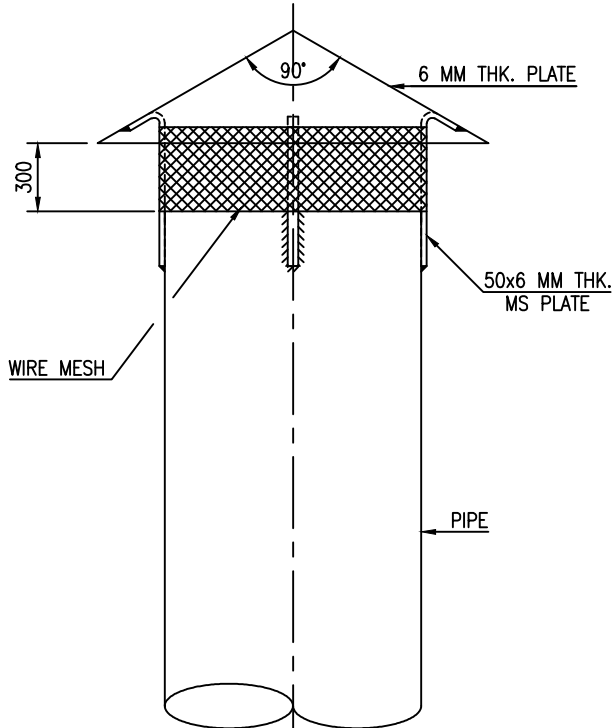
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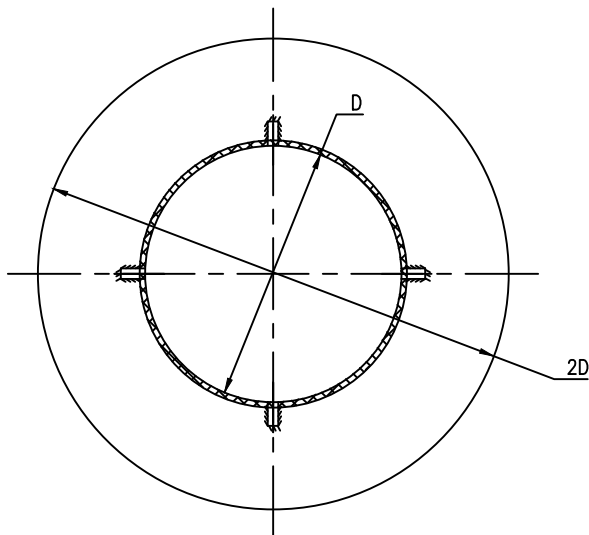
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1 OF 1

TYPE-I

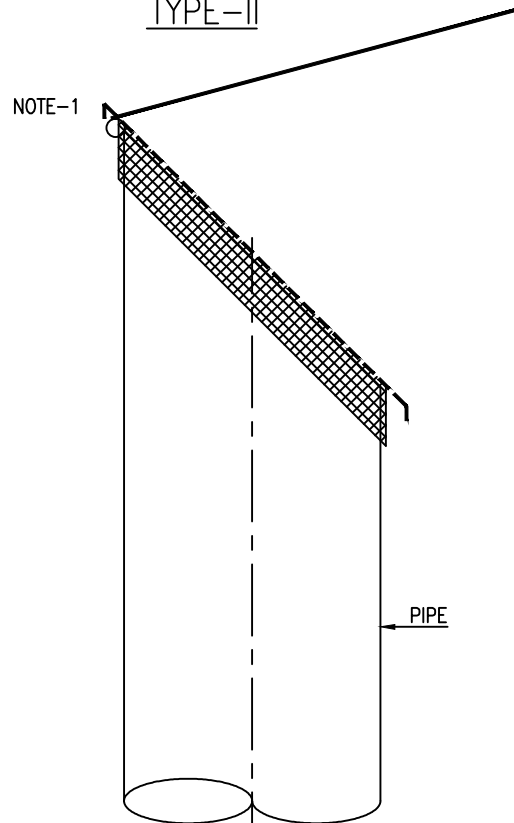


ELEVATION

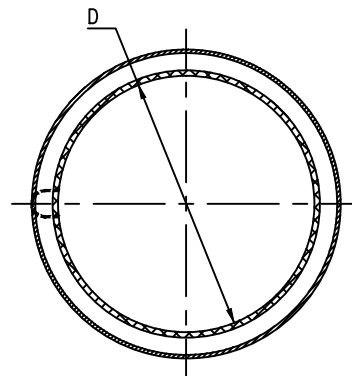


PLAN

TYPE-II



ELEVATION

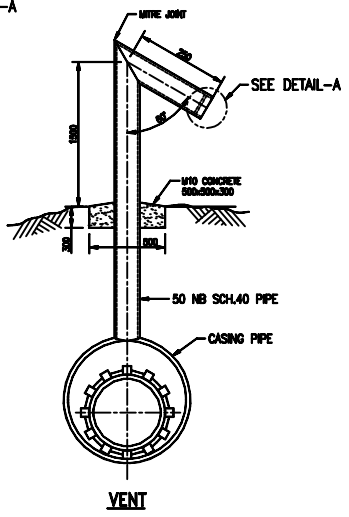
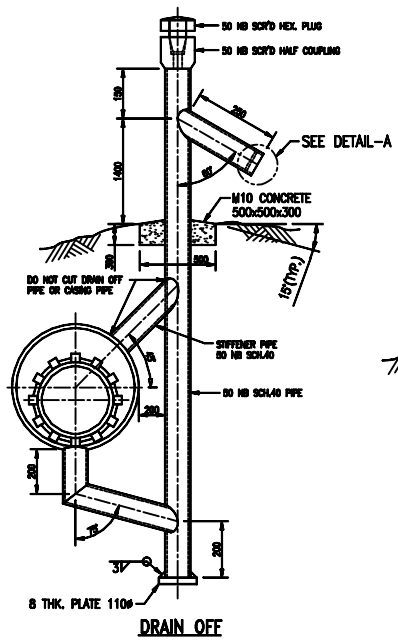
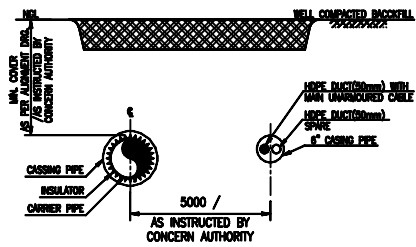
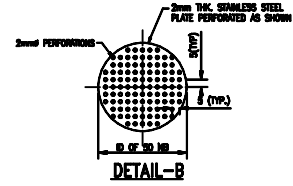
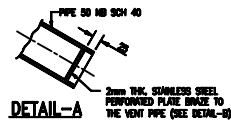
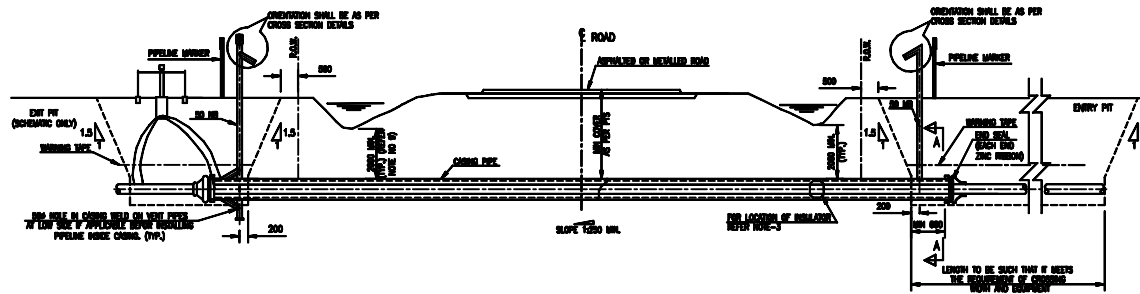


PLAN

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.

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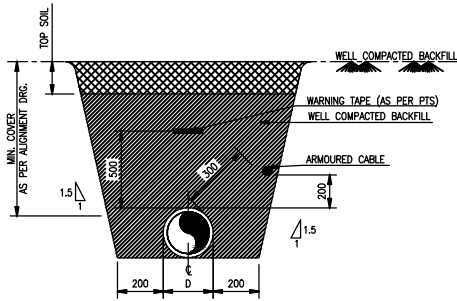


**NOTES**

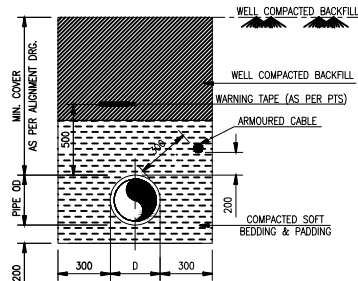
1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. THE CROSSING WORKS SHALL BE EXECUTED IN ACCORDANCE WITH API RECOMMENDED PRACTICE 1102 LATEST EDITION.
3. 500mm AWAY FROM BOTH ENDS, TWO NOS. INSULATORS SHALL BE PLACED. IN BALANCE LENGTH MAX. SPACING OF INSULATORS SHALL BE 2000 mm.
4. ELECTRICAL INSULATION BETWEEN THE CASING AND CARRIER PIPE SHALL BE CHECKED WITH A SUITABLE MEGGER.
5. MATERIAL OF THE CASING INSULATORS SHALL BE HOPE. 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 ROAD, IF REQUIRED, FOR APPROACH TO CROSSING, PIPELINE STRING, HYDROTESTING WORKING PIT FOR CROSSING TO AVOID CAVING OF SOIL SHALL BE PROVIDED 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 LENGTH OF CASING PIPE SHALL BE 72M FOR NATIONAL HIGHWAY CROSSING, AND 60M FOR ALL STATE HIGHWAY/MDR CROSSING.

DWG. NO.	REF. DRAWING						
0	18.01.19	ISSUED FOR TENDER	SS	YS	JR		
		REVISION	DRN	CHKD	APPD		

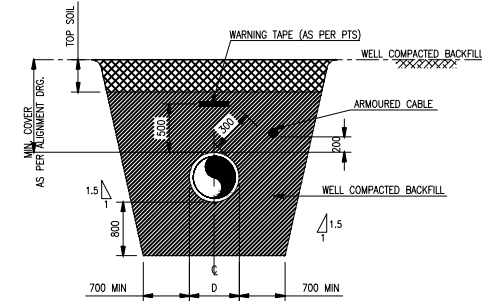
CASED CROSSING PIPELINE ROAD / HIGHWAY	DRAWING NO.	REV.
	GAIL-STD-PL-DWG-TP-007	0



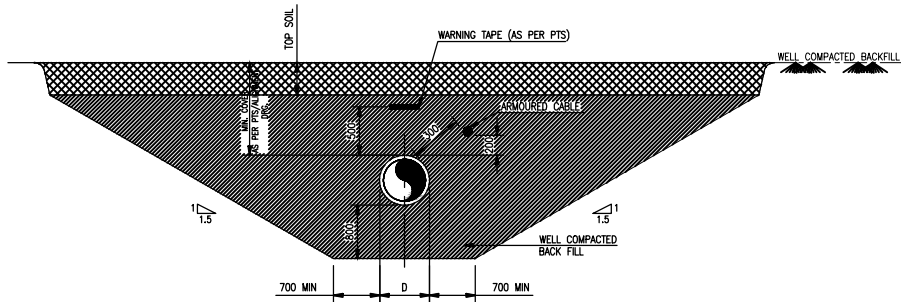
TYP. TRENCH DETAILS IN NORMAL SOIL  
TYPE-1



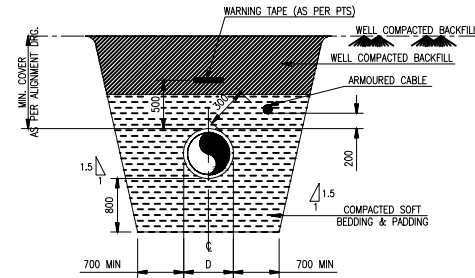
TYP. TRENCH DETAILS IN ROCK AREA  
TYPE-2



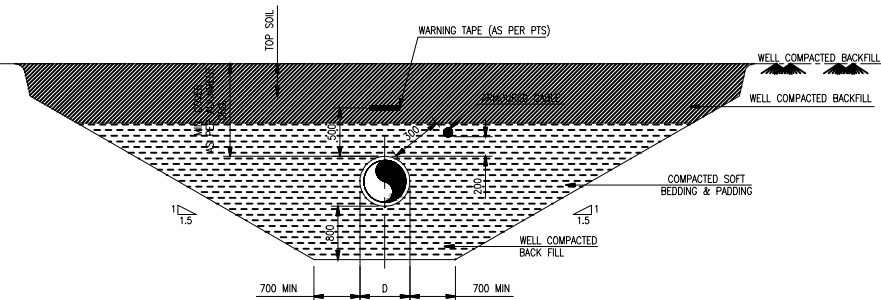
TYP. TRENCH DETAILS FOR REVERSE SLIP FAULT (IN NORMAL SOIL) AREAS  
TYPE-3



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.

DWG. NO.	REF. DRAWING	NO.	DATE	ISSUED FOR TENDER	SS	YS	JR
		0	18.01.19	REVISION	DRN	CHKD	APPD

DRAWING NO.	REV.
GAIL-STD-PL-DWG-TP-008	0



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NEW DELHI

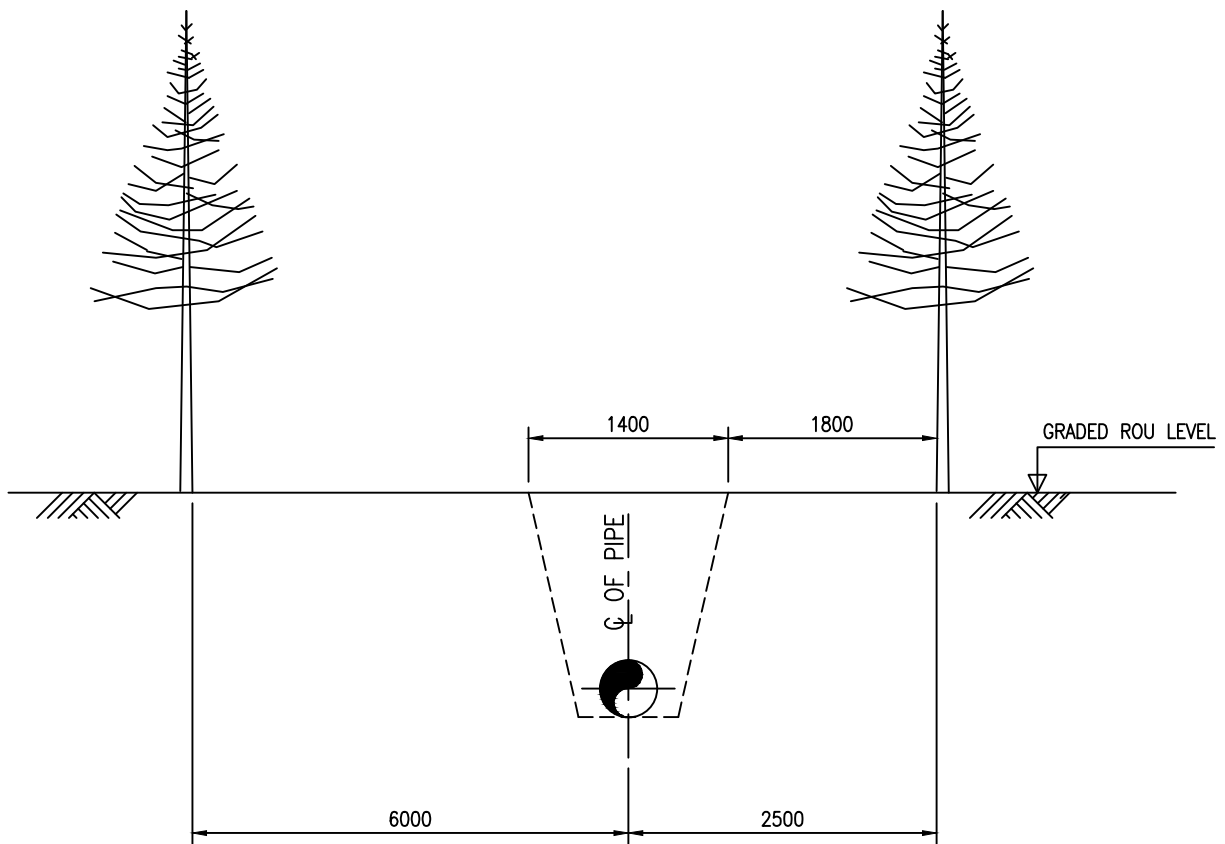
ROU FOR FOREST AREA

DRAWING NO.

GAIL-STD-PL-DWG-TP-009

PAGE NO.

Page 1 of 1



NOTES:-

ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE STATED.

0	10.01.2019	ISSUED FOR TENDER	SS	VKS	AP
REV. NO.	DATE	SUBJECT OF REVISION	PREP	CHKD	APPD



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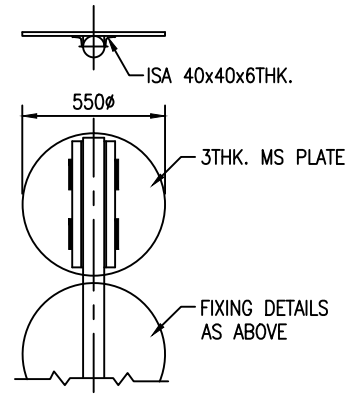
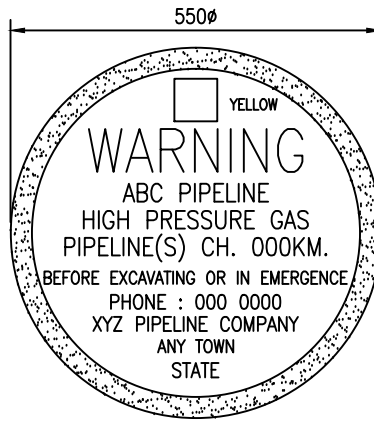
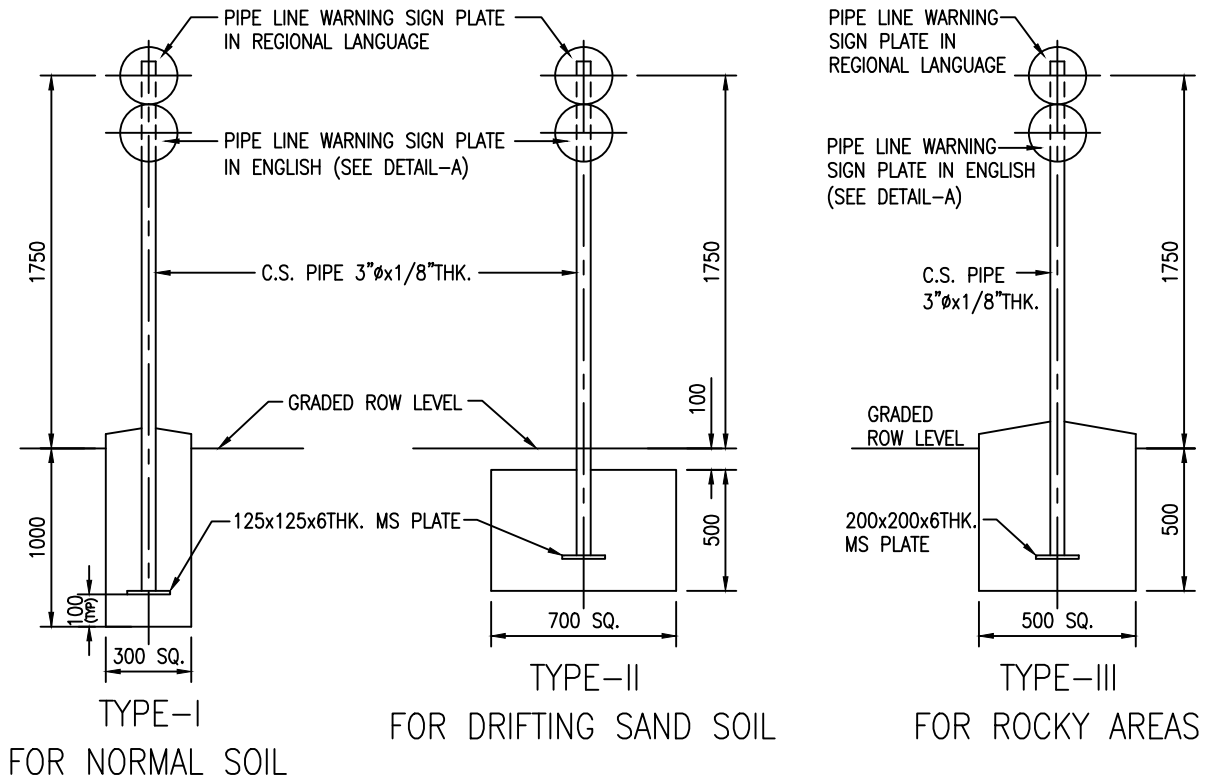
PIPE LINE WARNING SIGN

DRAWING NO.

GAIL-STD-PL-DWG-TP-010

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) 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 CONTRACTOR ON SIMILAR LINES AND APPROVED BY THE OWNER.

0	18.01.19	ISSUED FOR TENDER	SS	VKS	AP
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED



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NEW DELHI

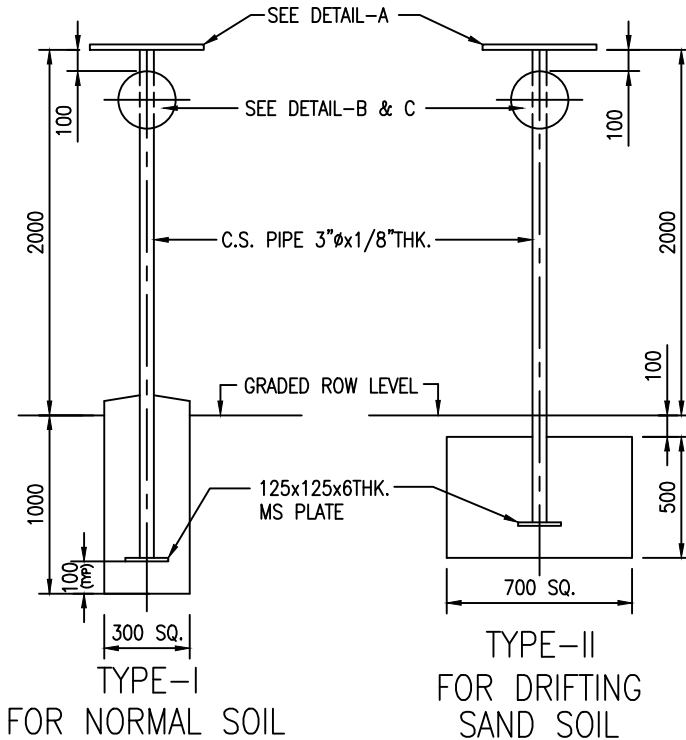
DIRECTION MARKER

DRAWING NO.

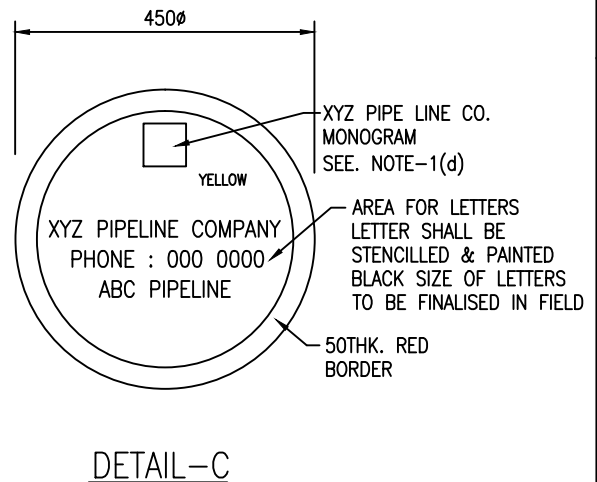
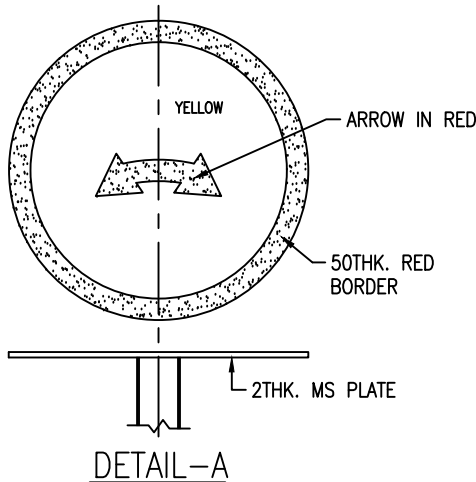
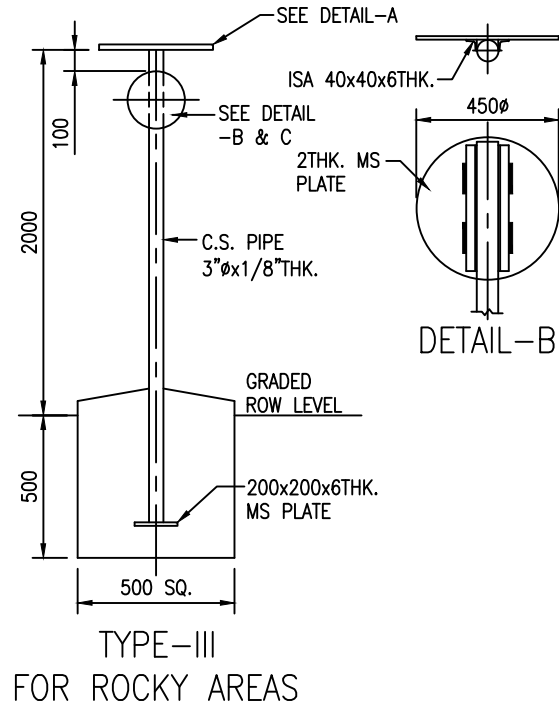
GAIL-STD-PL-DWG-TP-011

SHEET NO.

1 OF 1



TYPE-II  
FOR DRIFTING  
SAND SOIL



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 CONTRACTOR ON SIMILAR LINES AND APPROVED BY THE OWNER.

0	18.01.19	ISSUED FOR TENDER	SS	VKS	JR
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED





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NEW DELHI

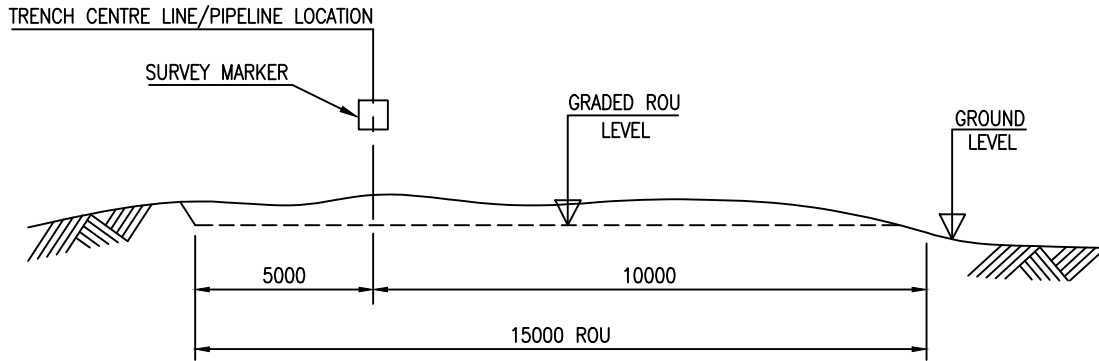
TYPICAL RIGHT OF USE FOR  
PIPELINES

DRAWING NO.

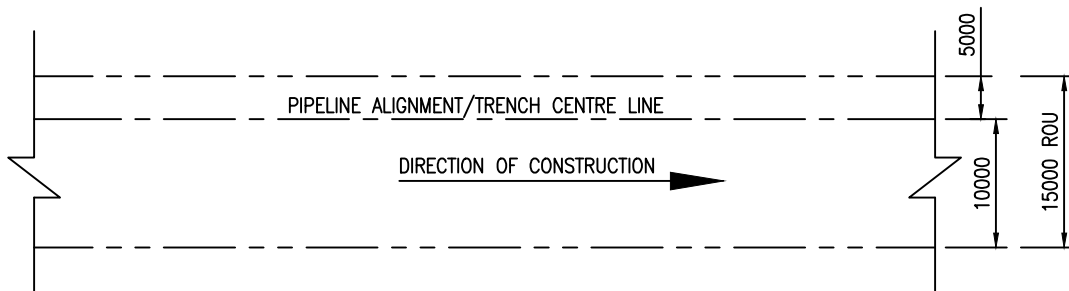
GAIL-STD-PL-DWG-TP-012

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.

0	18.01.19	ISSUED FOR TENDER	SS	VKS	AP
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED



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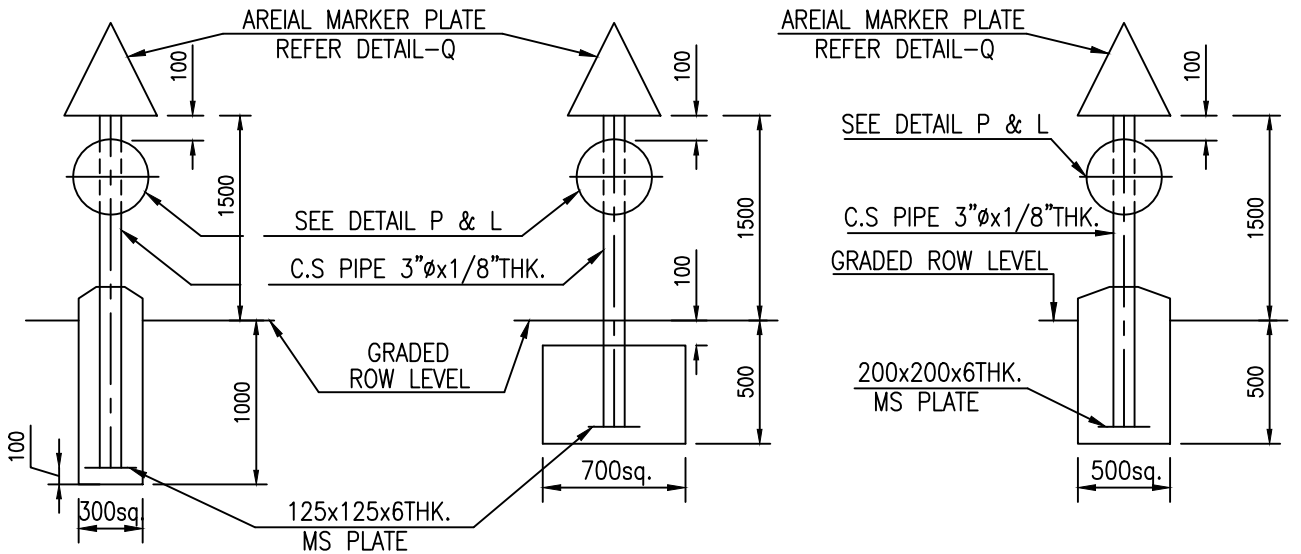
TYPICAL K.M. POST MARKERS

DRAWING NO.

GAIL-STD-PL-DWG-TP-013

SHEET NO.

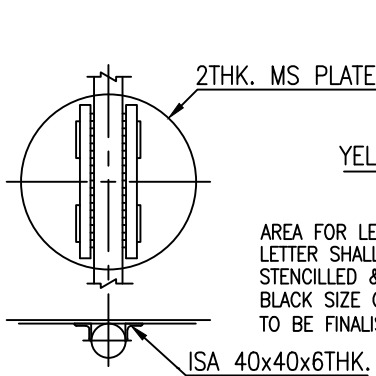
1 OF 1



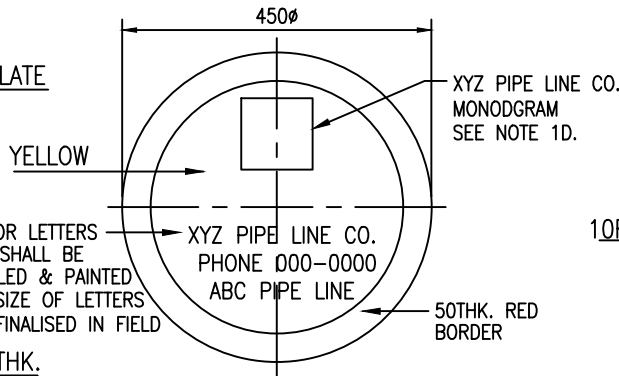
TYPE-I  
FOR NORMAL SOIL

TYPE-II  
FOR DRIFTING SAND SOIL

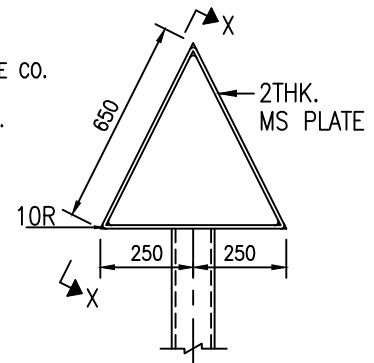
TYPE-III  
FOR ROCKY AREAS



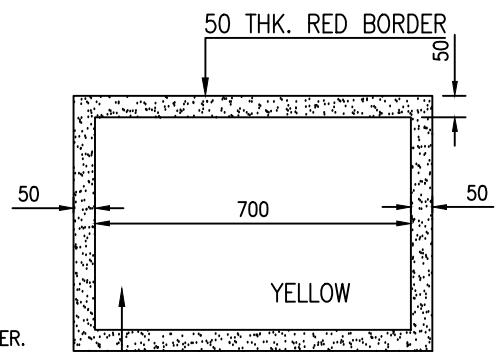
DETAIL-P



DETAIL-L



DETAIL-Q



AREA FOR FIGURES  
FIGERS : BLACK, 300 HIGH  
MIN. 80 THK. STROKE

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 CONCRETE M20.
5. THE HEIGHT OF THE K.M. POST MAY BE VARIED TO SUIT FIELD REQUIREMENTS.

0	18.01.19	ISSUED FOR TENDER	SS	VKS	AP
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED



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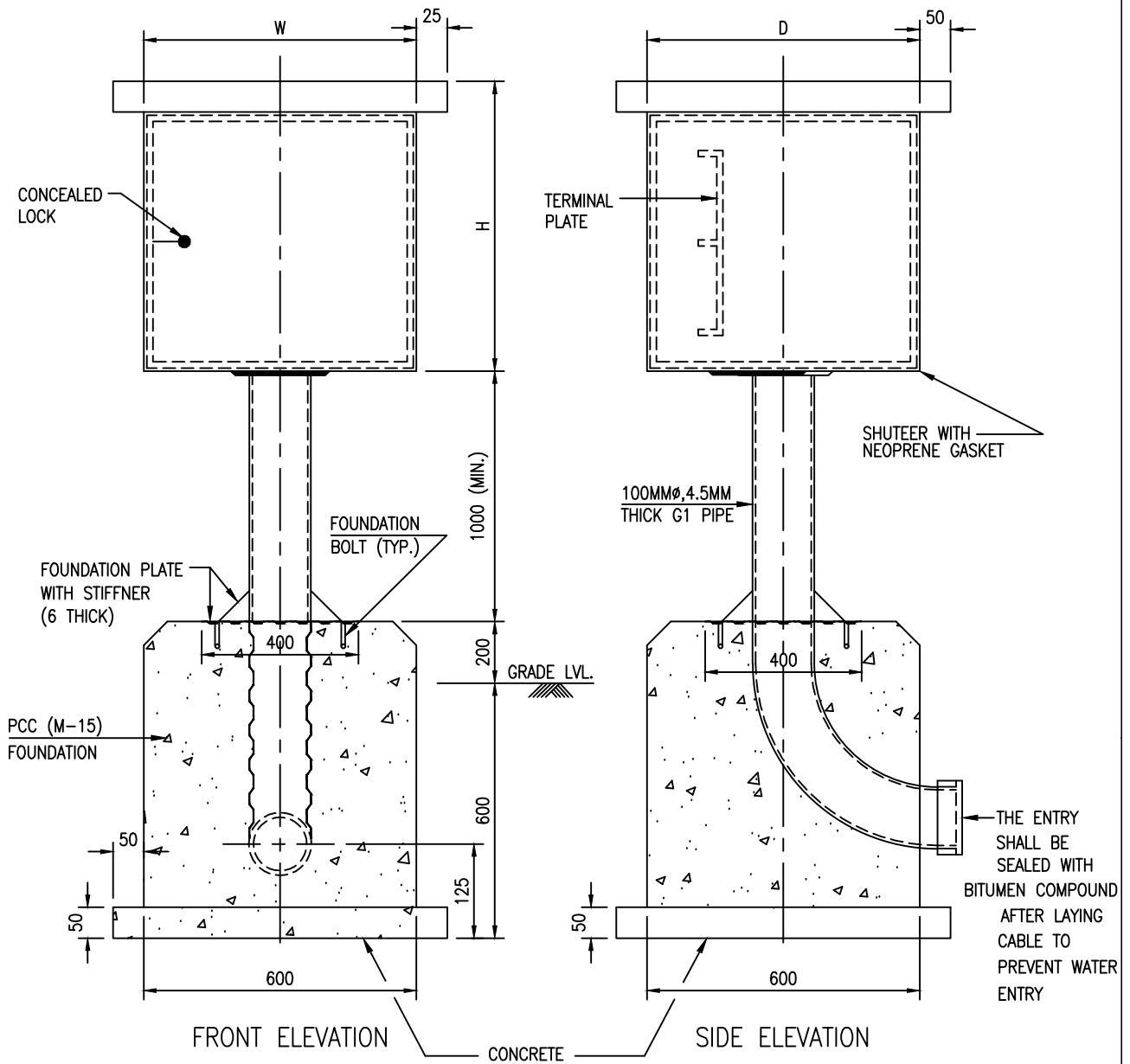
TEST STATION WITH FOUNDATION  
DETAILS

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.

0	10.01.2019	ISSUED FOR TENDER	SS	VKS	AP
REV. NO.	DATE	SUBJECT OF REVISION	PREP	CHKD	APPD



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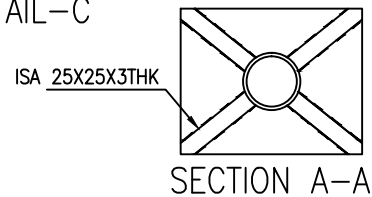
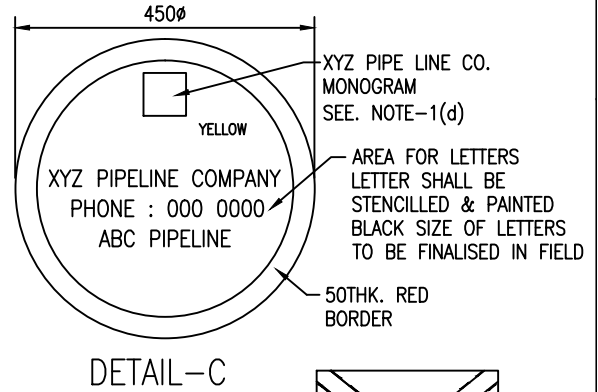
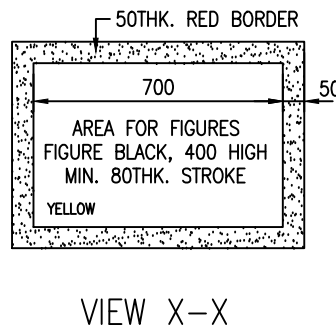
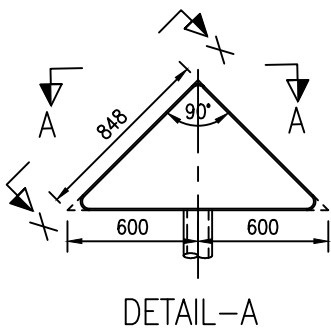
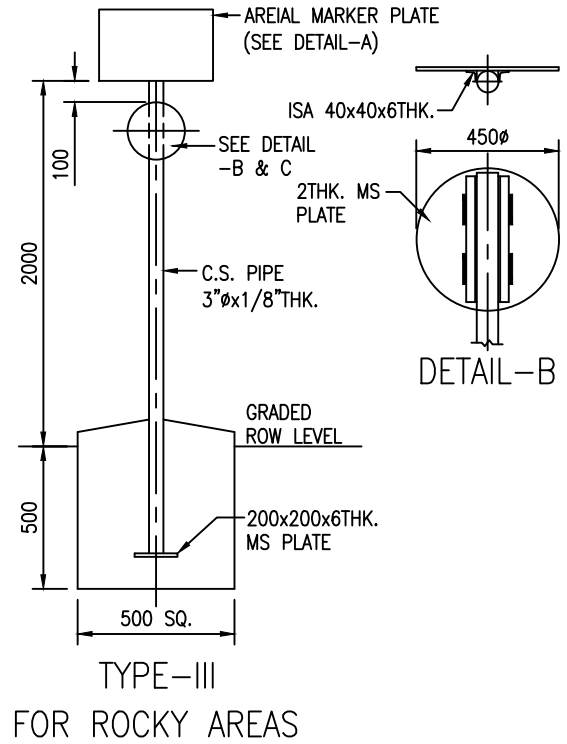
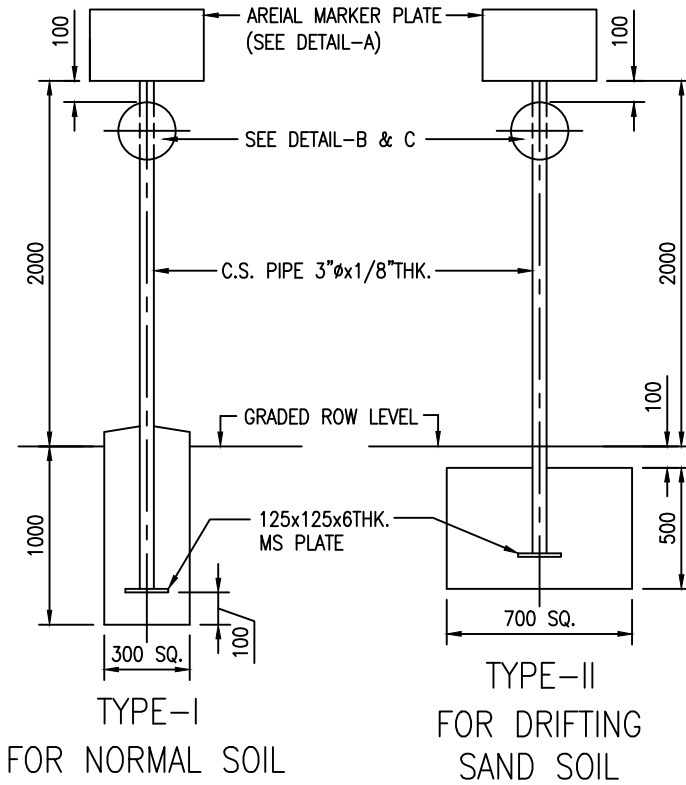
AERIAL MARKER

DRAWING NO.

GAIL-STD-PL-DWG-TP-015

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 STENCILLED 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 CONTRACTOR ON SIMILAR LINES AND APPROVED BY THE OWNER.
6. ALL WELD SHALL BE 4 MM.

0	10.01.2019	ISSUED FOR TENDER	SS	VKS	JR
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED



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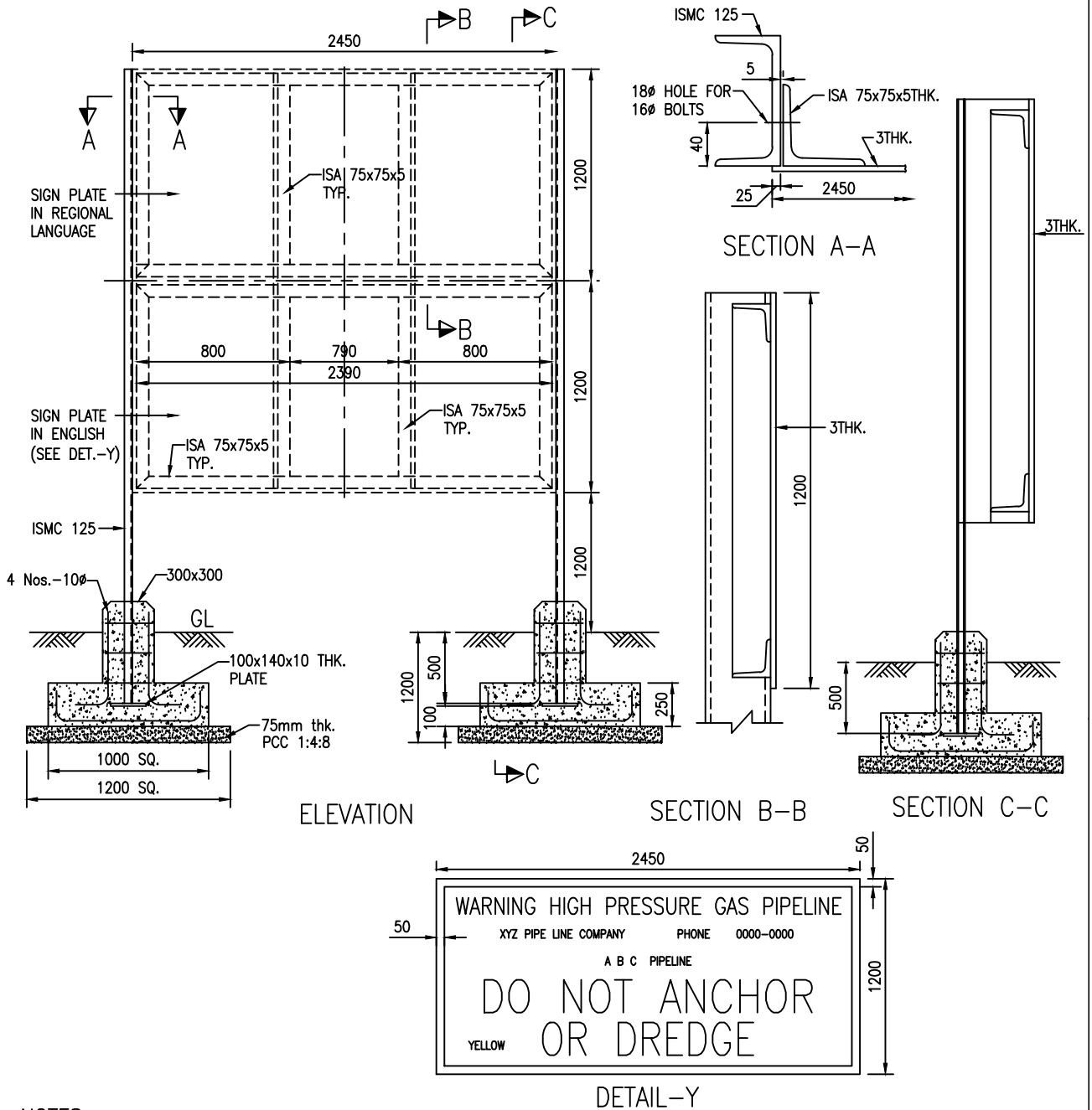
NAVIGABLE WATERWAY PIPELINE  
CROSSING WARNING SIGN

DRAWING NO.

GIGL-STD-PL-DWG-TP-016

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) 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 CONTRACTOR ON SIMILAR LINES AND APPROVED BY THE OWNER.
6. ALL WELDS SHALL BE 4 MM.

0	08.01.2019	ISSUED FOR TENDER	SS	VKS	JR
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED



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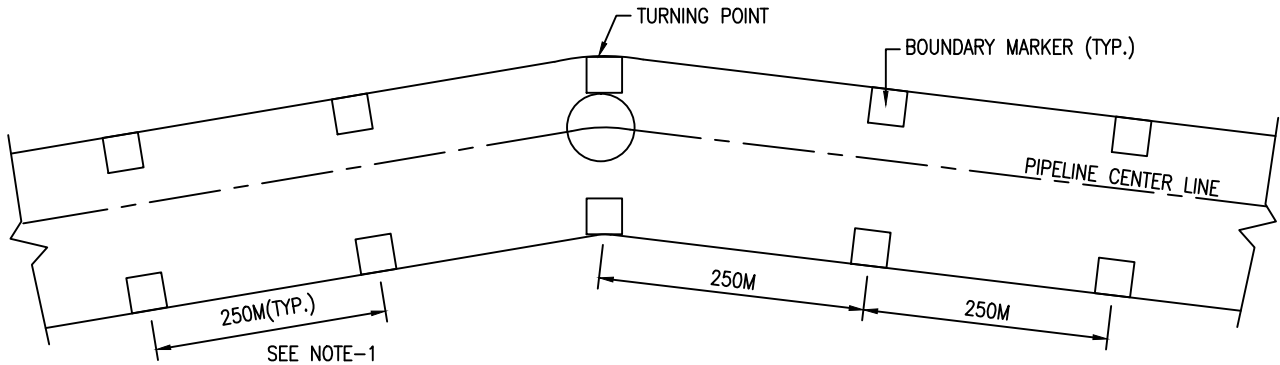
TYPICAL ROW BOUNDARY  
MARKER

DRAWING NO.

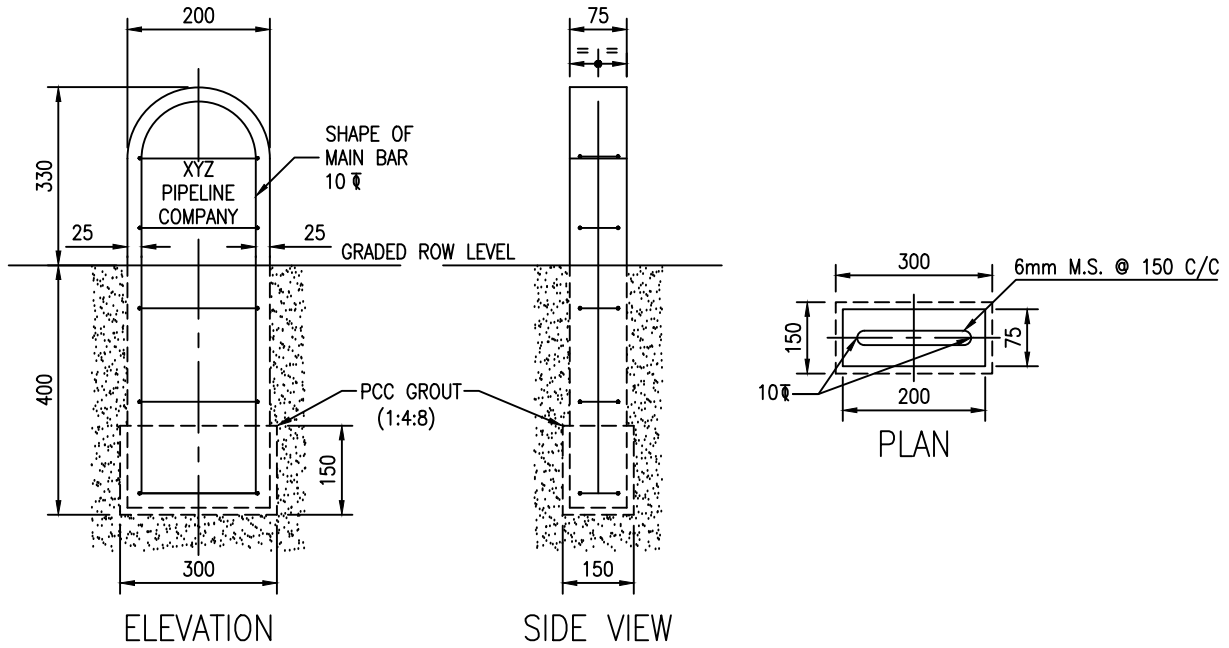
GAIL-STD-PL-DWG-TP-017

SHEET NO.

1 OF 1



LOCATION PLAN OF BOUNDARY MARKER



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.

0	18.01.2019	ISSUED FOR TENDER	SS	VKS	AP
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED



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NEW DELHI

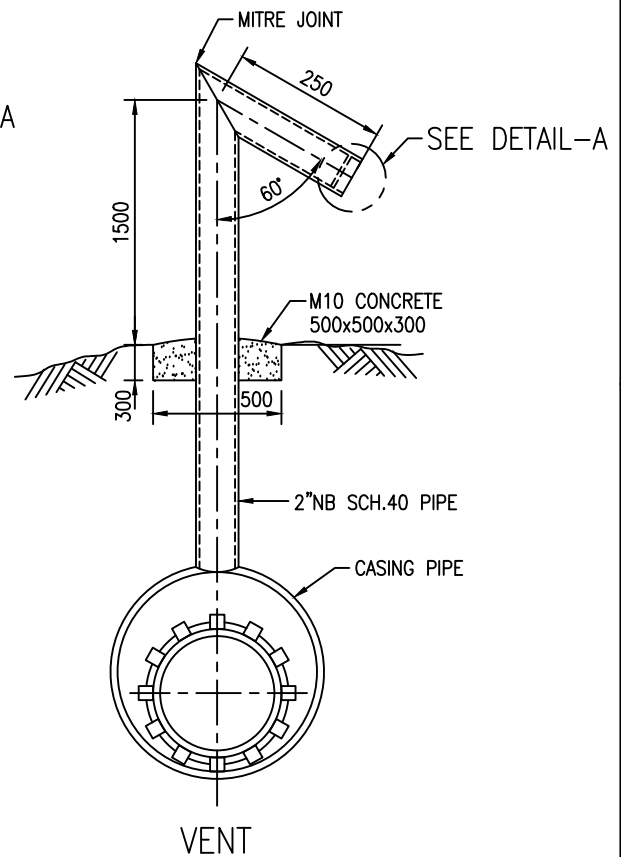
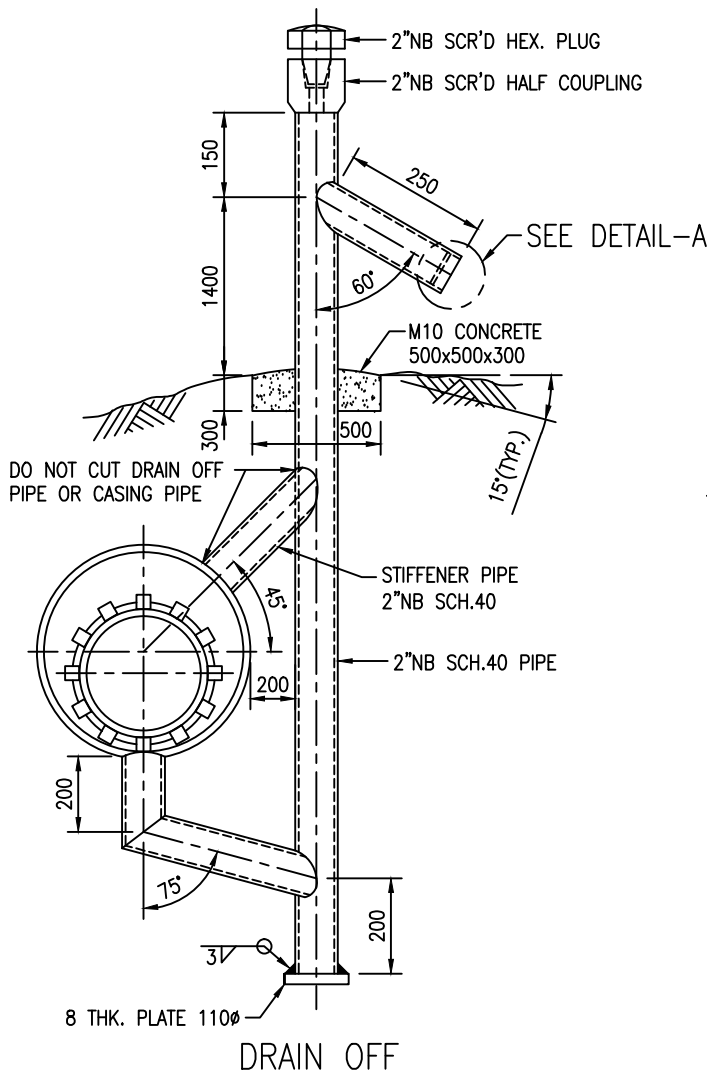
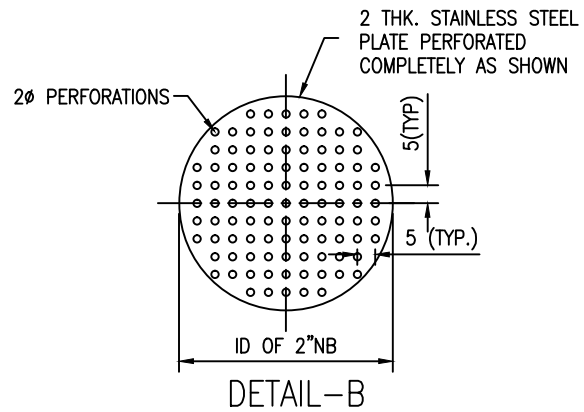
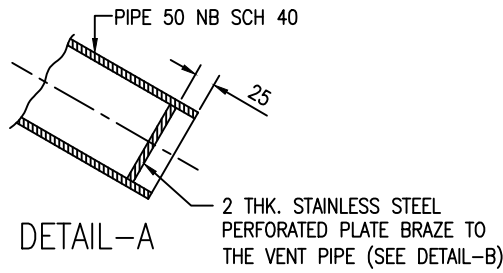
DETAILS OF CASING VENT  
AND DRAIN

DRAWING NO.

GAIL-STD-PL-DWG-TP-018

SHEET NO.

1 OF 1



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 QUALITY. 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.

0	18.01.2019	ISSUED FOR TENDER	SS	VKS	AP
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED



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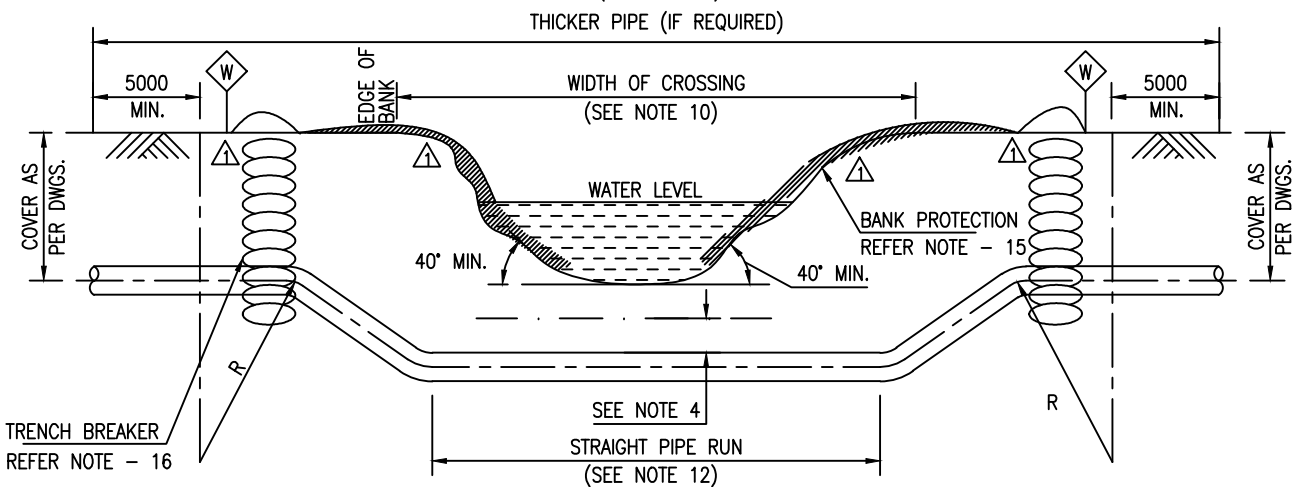
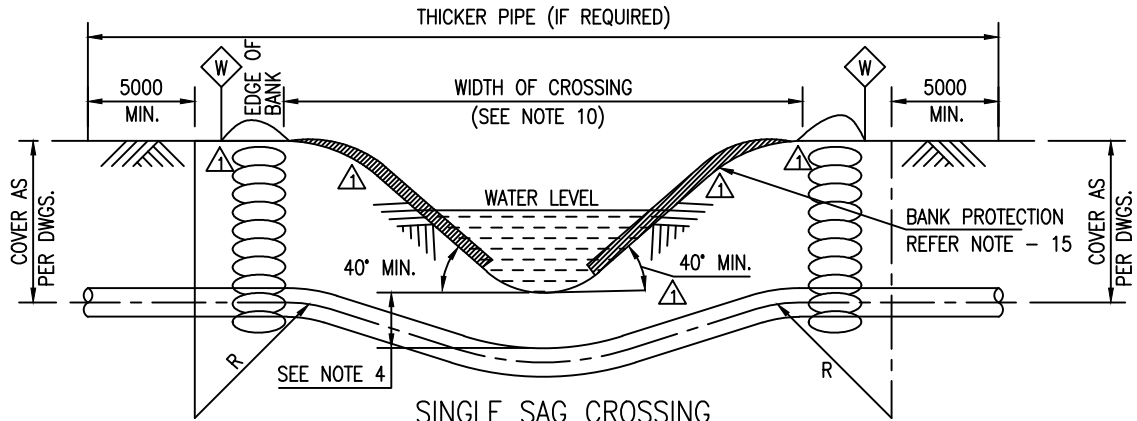
TYPICAL WATERWAY CROSSING  
(OPEN CUT)

DRAWING NO.

GIGL-STD-PL-DWG-TP-019

SHEET NO.

1 OF 1



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 NOT 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 LEVEL 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.

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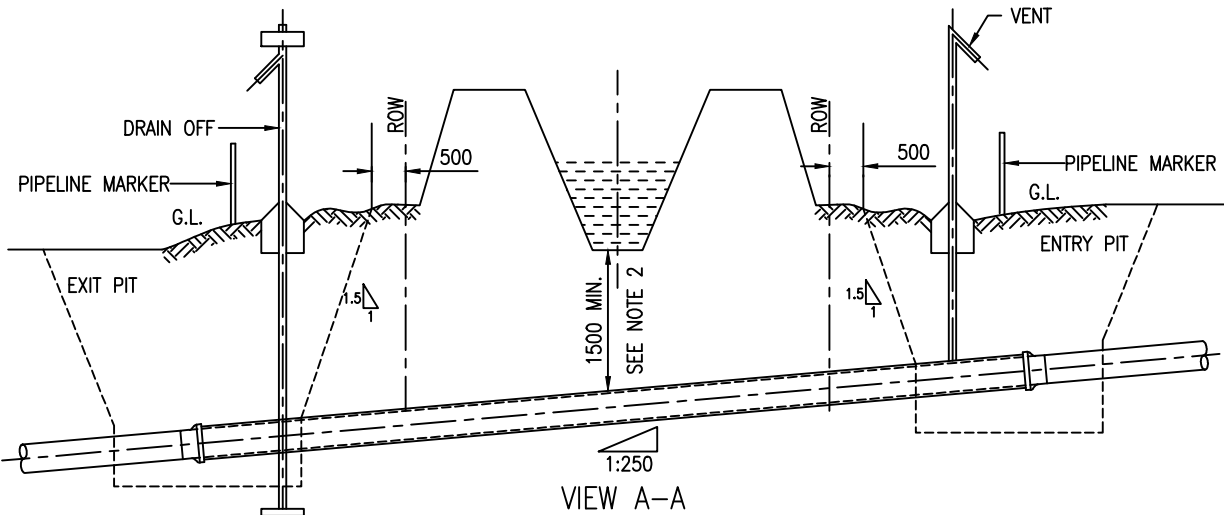
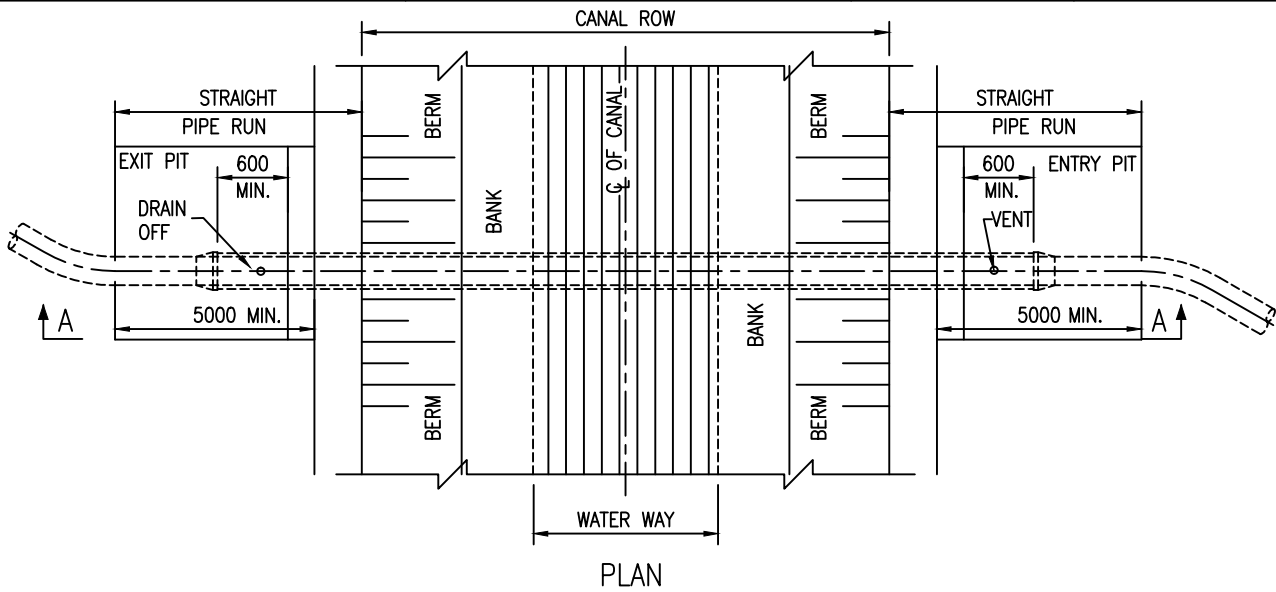
CASED CROSSING  
PIPELINE-CANAL

DRAWING NO.

GAIL-STD-PL-DWG-TP-020

SHEET NO.

1 OF 1



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 AUTHORITIES.
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 CATHODICALLY PROTECTED, HENCE CONTRACTOR SHALL AVAIL NECESSARY APPROVAL BEFORE EXECUTING THE WORK.

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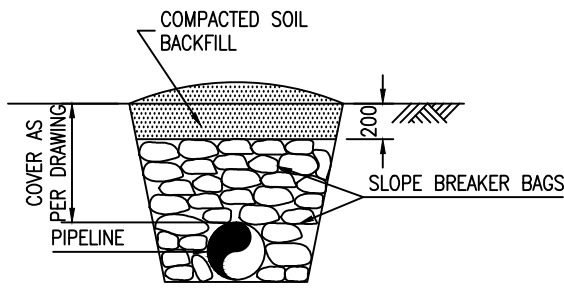
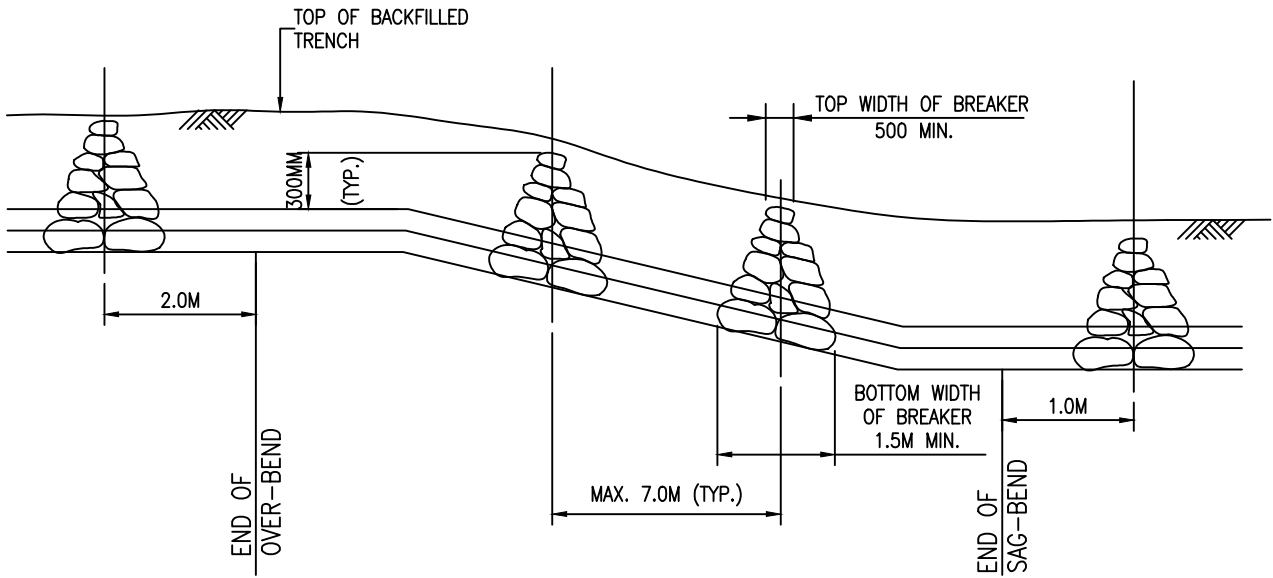
TYPICAL SLOPE BREAKERS  
DETAILS

DRAWING NO.

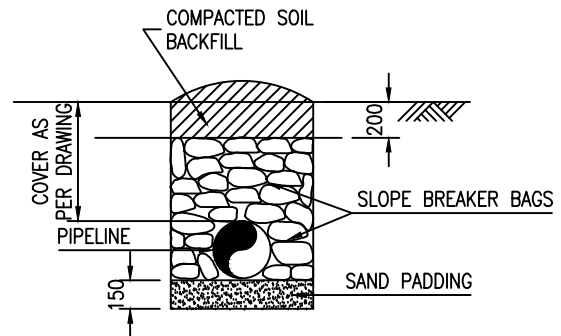
GAIL-STD-PL-DWG-TP-021

SHEET NO.

1 OF 1



SECTION  
(NORMAL SOIL AREA)

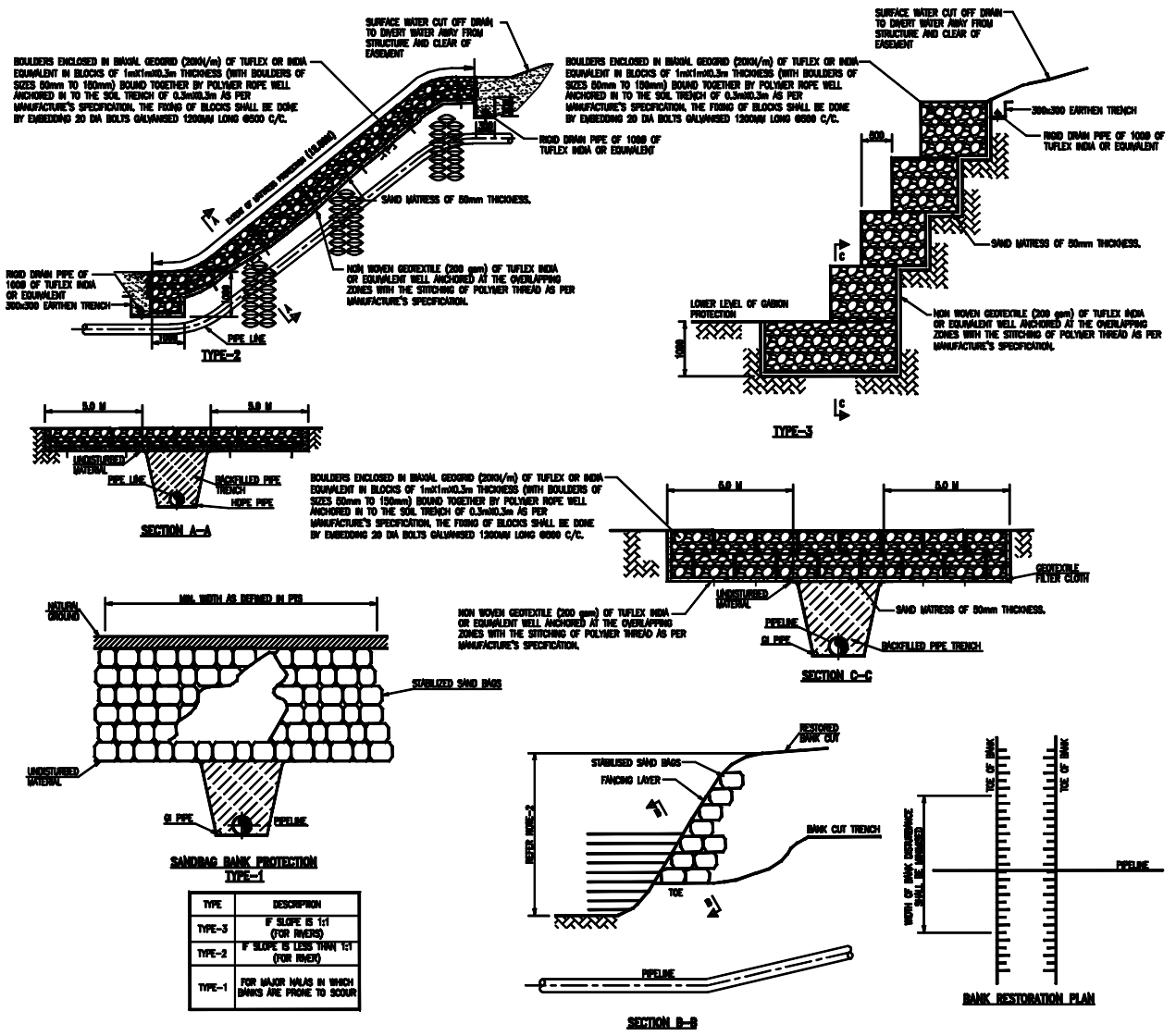


SECTION  
(ROCKY AREA)

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.

0	18.01.2019	ISSUED FOR TENDER	SS	VKS	AP
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED

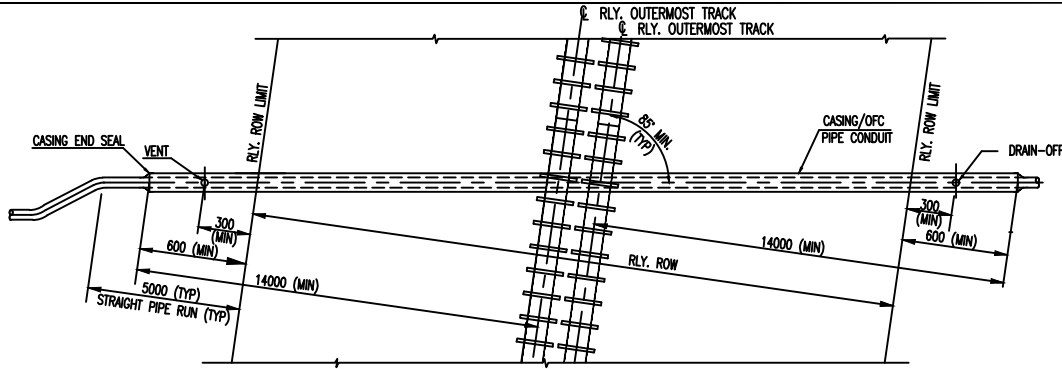


**NOTES**

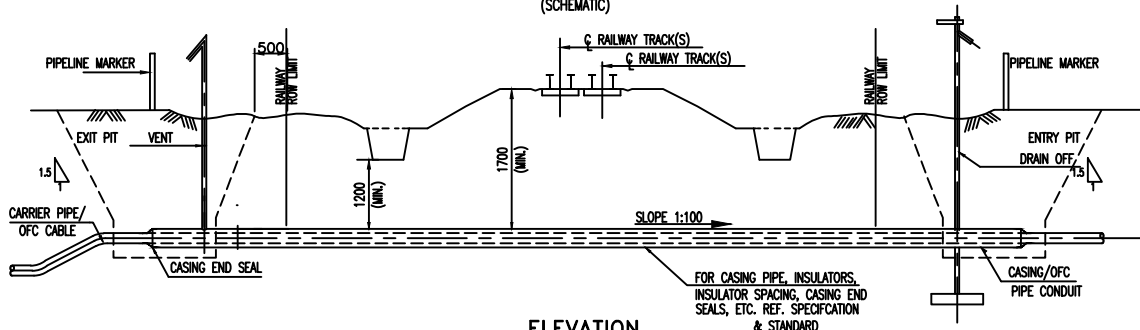
- 1 ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
- 2 THE HEIGHT OF BANK PROTECTION SHALL EXTEND TO 2METER ABOVE ABOVE HFL OR UPTO THE BANK TOP.
- 3 STABILISED SAND BAGS SHALL BE LAID IN AN INTERLOCKING PATTERN.
- 4 GABIONS (GALVANISED MESH) INSTALLED IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATION.

DWG. NO.	REF. DRAWING	NO.	DATE	ISSUED FOR TENDER	SS	YS	AP
		0	18.01.19	REVISION	DRN	CHKD	APPD

<b>BANK PROTECTION DETAIL FOR WATER BODY</b>	DRAWING NO.	REV.
	GAIL-STD-PL-DWG-TP-022	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 BENTONITE. 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.



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DWG. NO.	REF. DRAWING	0	18.01.19	ISSUED FOR TENDER	SS	YS	AP
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**TYPICAL DETAILS OF  
RAILWAY CROSSINGS**

DRAWING NO.	REV.
GIGL-STD-PL-DWG-TP-023	0



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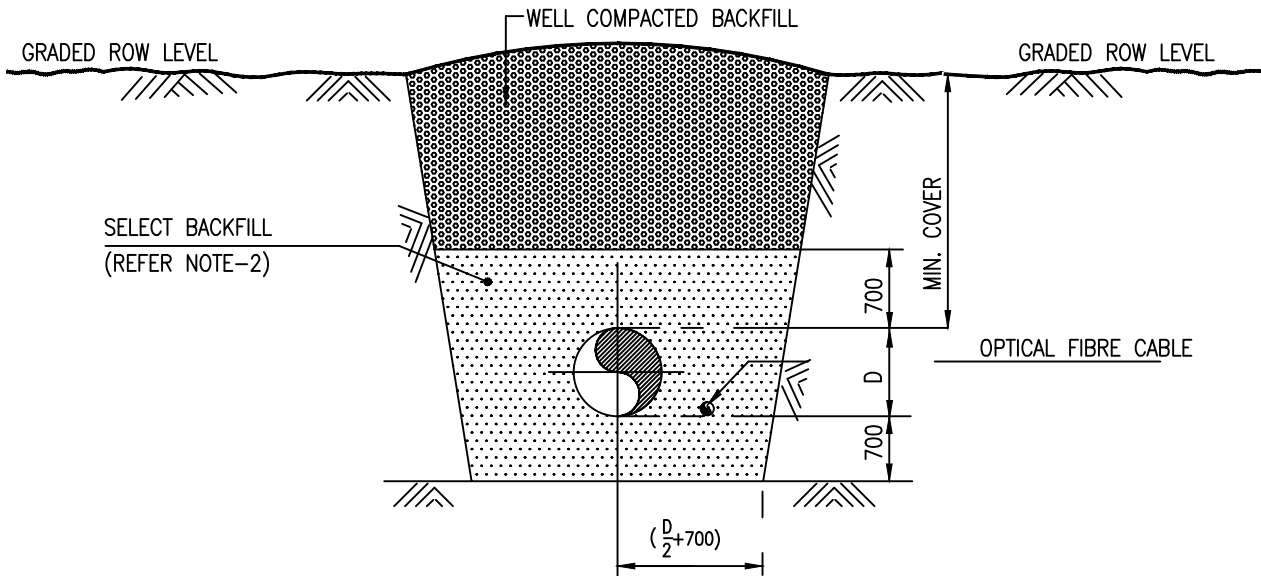
TRENCH DIMENSIONS AND  
COHESIONLESS SELECT BACKFILL  
FOR PIPELINE IN SEISMIC ZONE

DRAWING NO.

GAIL-STD-PL-DWG-TP-024

SHEET NO.

1 OF 1

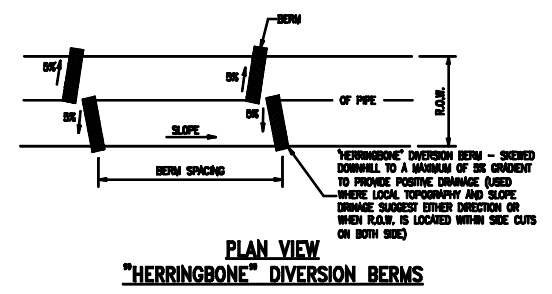
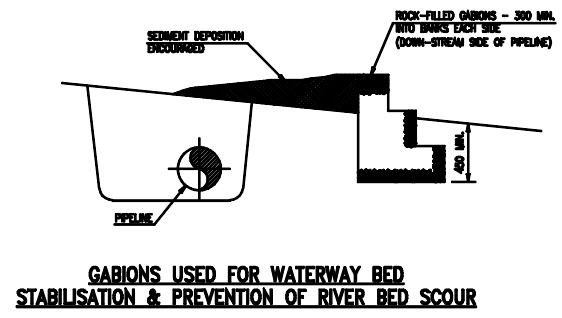
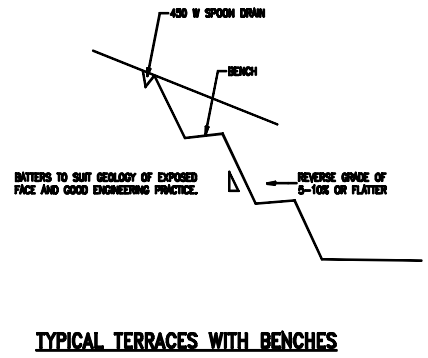
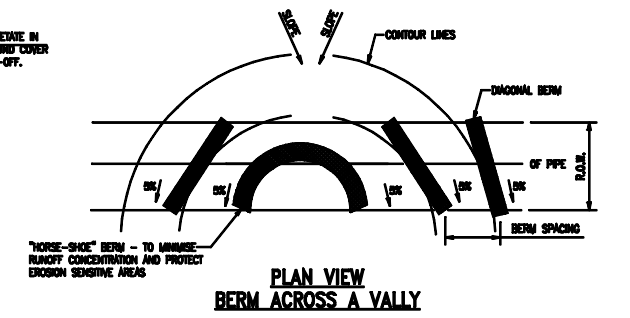
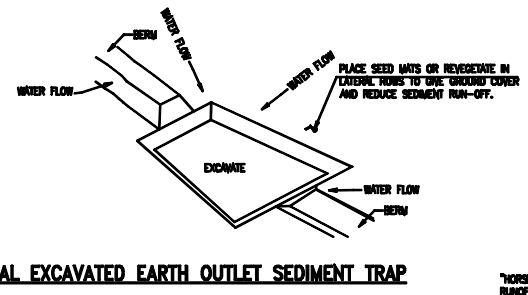
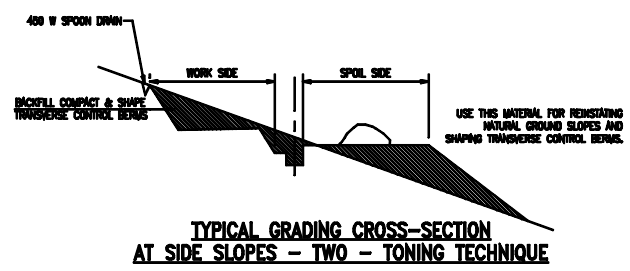
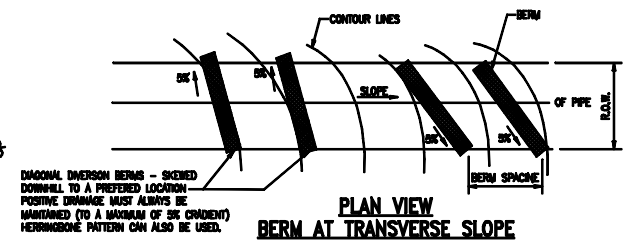
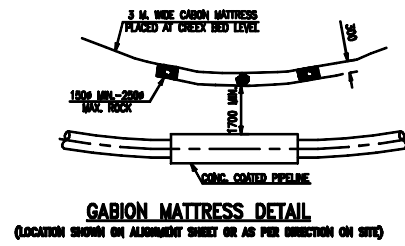
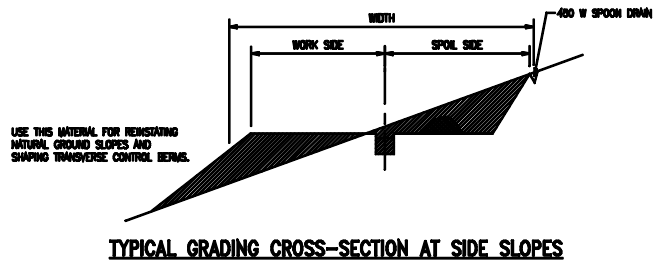


SELECT BACK FILL FOR SEISMIC ZONE

NOTES:

- 1 ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED.
- 2 SELECT BACKFILL SHALL BE COHESIONLESS 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<sup>3</sup> 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.

0	18.01.2019	ISSUED FOR TENDER	SS	VKS	JR
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED



DWG. NO.	REF. DRAWING							
0	10.01.19	ISSUED FOR TENDER	SS	YS	AP			
		REVISION	DRN	CHKD	APPD			

PROTECTION DETAIL AT HILLY TERRAIN	DRAWING NO.	REV.
	GAIL-STD-PL-DWG-TP-026	0



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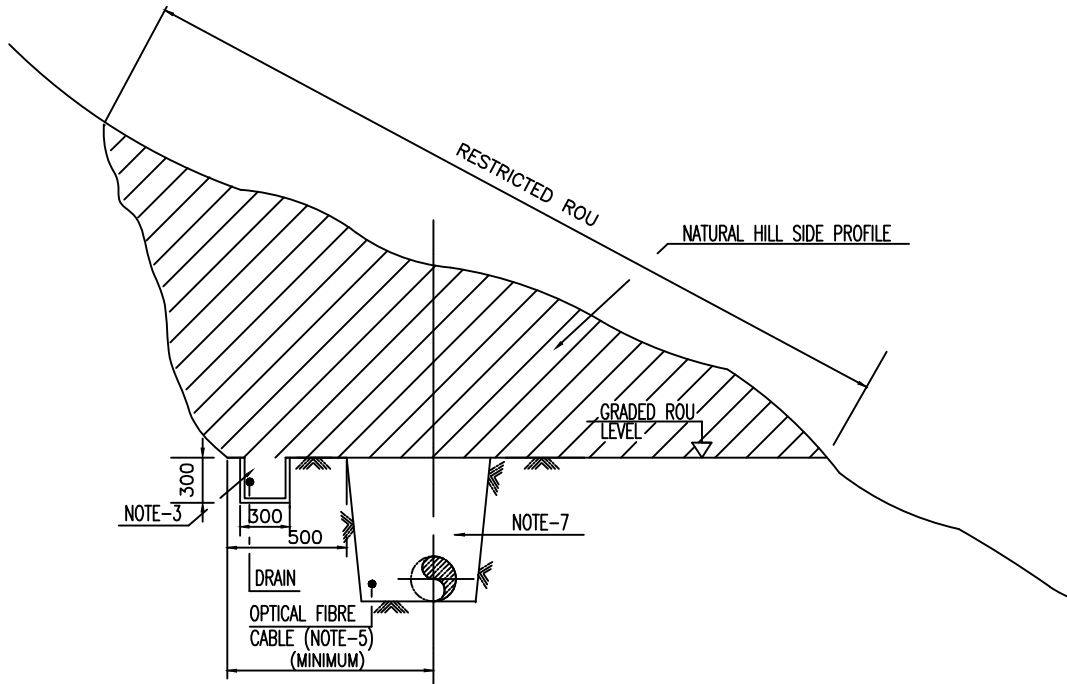
TYPICAL CROSS SECTION  
FOR ROU PREPARATION  
IN HILL AREAS

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 ALIGNMENT SHEETS OR AS DIRECTED BY ENGINEER-IN-CHARGE.
7. RESTORATION OF ROU SHALL BE CARRIED OUT AS PER THE INSTRUCTIONS OF ENGINEER-IN-CHARGE.

0	12.01.2019	ISSUED FOR TENDER	SS	VKS	JR
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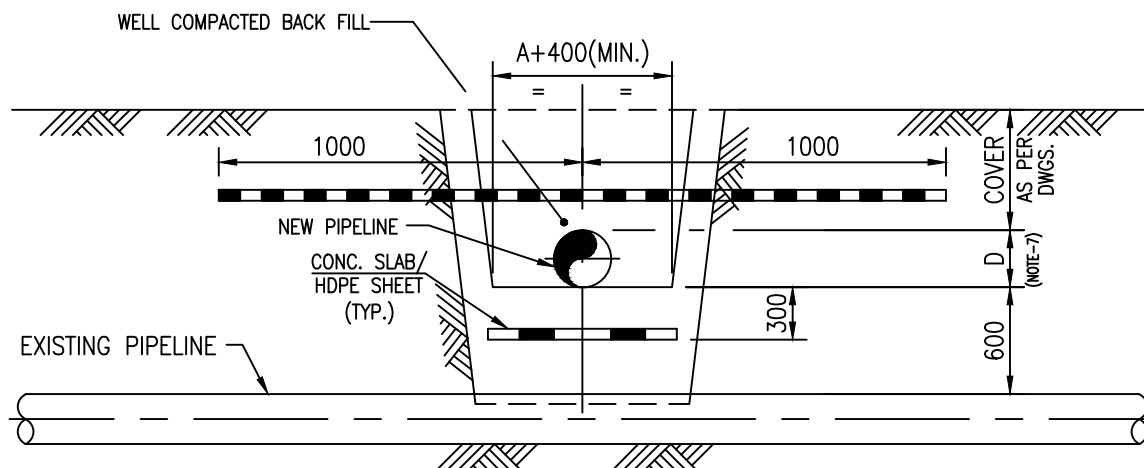
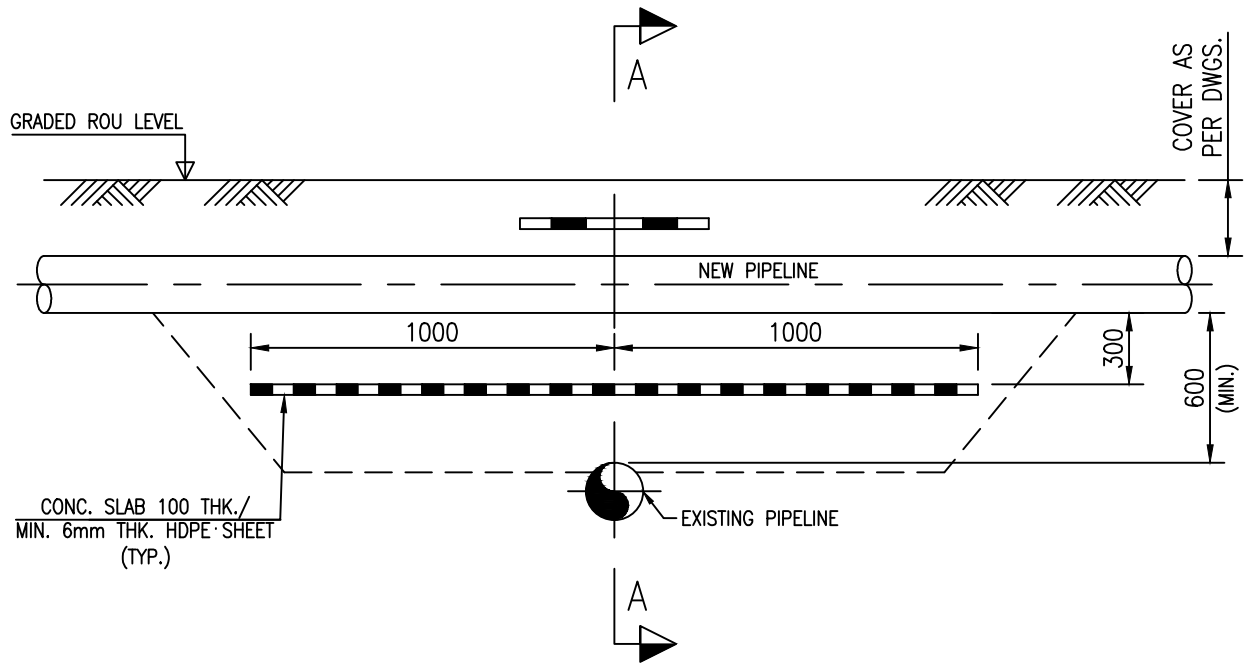
EXISTING UNDERGROUND PIPE  
CROSSING

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  $A=(D1+D2+....Dn) + (n-1) \times 500$  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 RELEVANT STANDARDS/SPECIFICATIONS.
9. APPROVAL OF THE CROSSING SHALL BE OBTAINED FROM CONCERNED AUTHORITIES.

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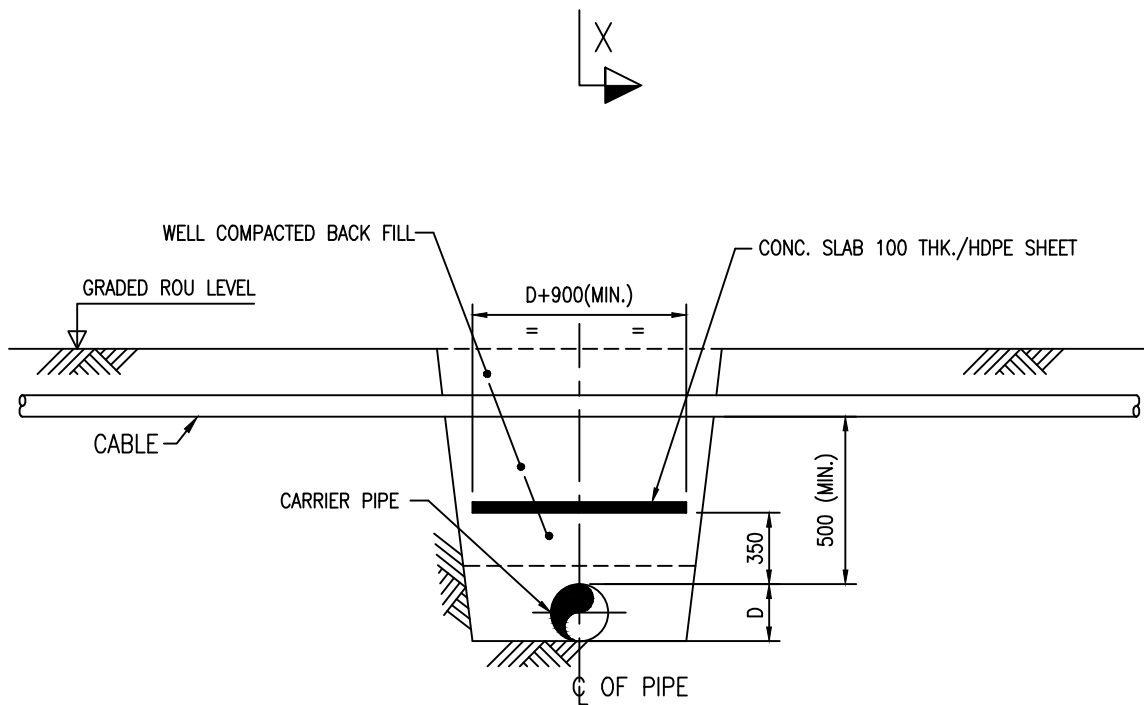
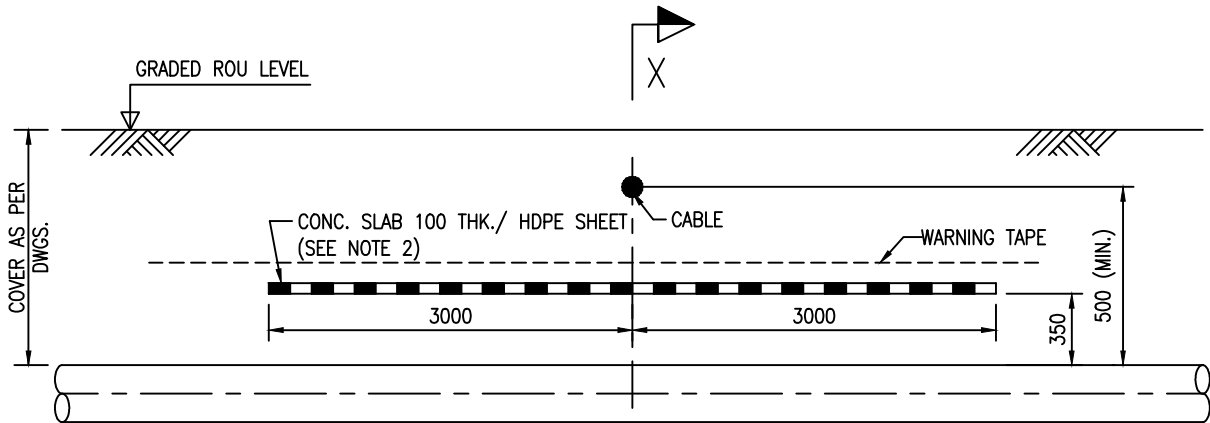
UNDERGROUND CABLE CROSSING

DRAWING NO.

GAIL-STD-PL-DWG-TP-029

SHEET NO.

1 OF 1

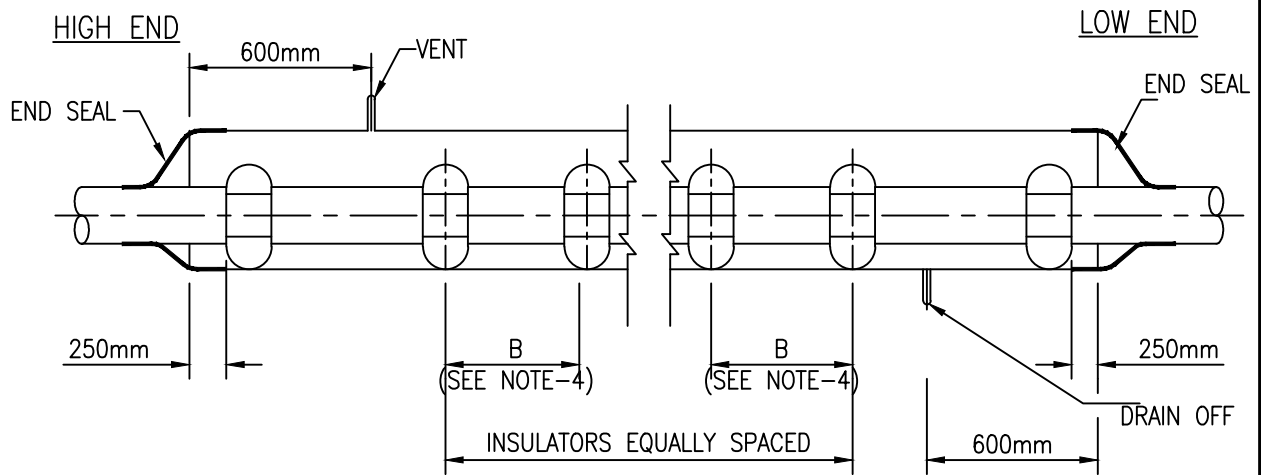


SECTION X-X

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  $A=D+500$ MM.
6. TRENCH DIMENSIONS SHALL BE IN ACCORDANCE WITH RELEVANT STANDARDS/SPECIFICATIONS.
7. APPROVAL OF THE CROSSING SHALL BE OBTAINED FROM CONCERNED AUTHORITIES.

0	18.01.2019	ISSUED FOR TENDER	SS	VKS	AP
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED

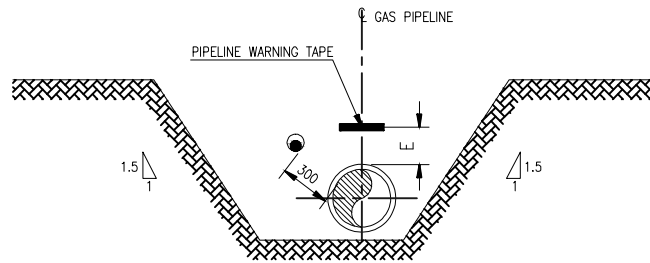
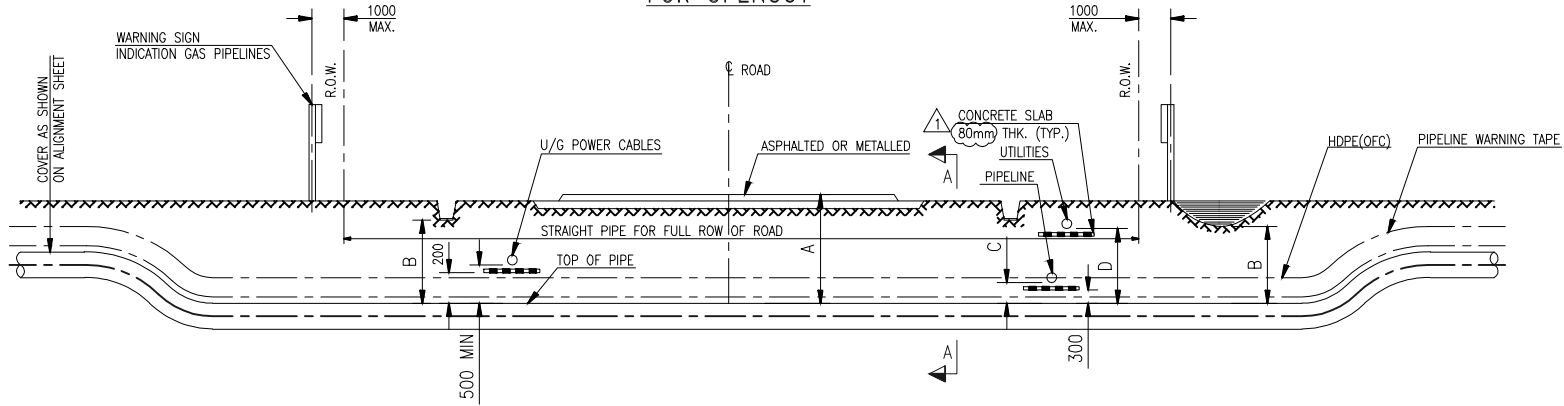


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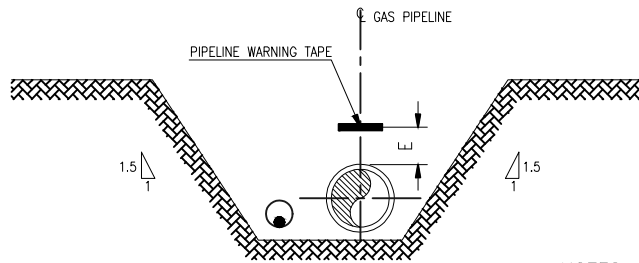
1. THE CASING PIPE SHALL BE DESIGNED IN ACCORDANCE WITH API RP 1102.
2. CASING PIPE IS NOT NORMALLY TO BE COATED BUT IN HIGHLY CORROSIVE AREAS THE CASING SHALL BE COATED, WRAPPED AND CATHODIC PROTECTION PROVIDED WITH SACRIFICIAL ANODES.
3. AT BOTH ENDS OF CASING PIPE A DOUBLE SET OF INSULATORS SHALL 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.

0	18.01.2019	ISSUED FOR TENDER				SS	VKS	AP	
REV.	DATE	SUBJECT OF REVISION				PREPD.	CHKD.	APPD.	
 <b>LYONS ENGINEERING PVT. LTD.</b> NEW DELHI		<b>CASING PIPE DETAILS</b>			DRAWING NO. GAIL-STD-PL-DWG-TP-031				
					SHEET NO.		1 OF 1		

FOR OPENCUT



SECTION A-A TYPE-1



SECTION A-A TYPE-2

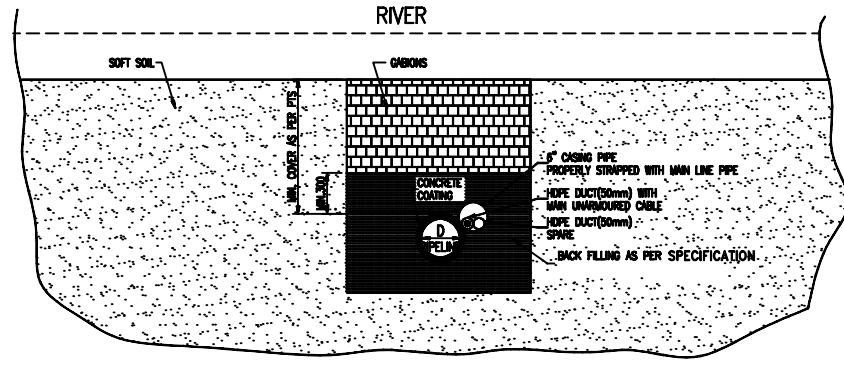
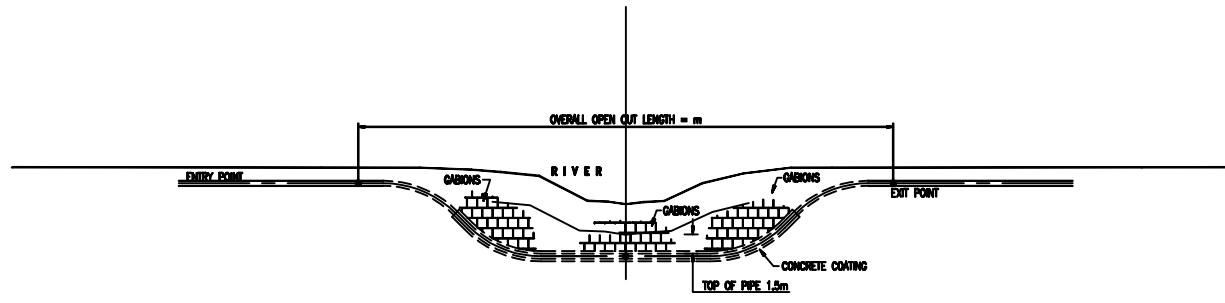
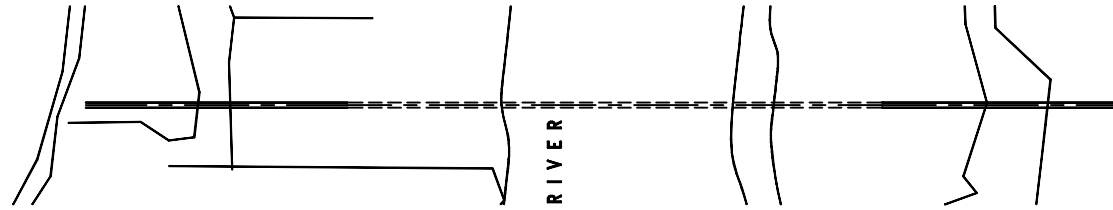
	A	B	C	D	E
ASPHALTED OR METALLED ROAD	1500 (MIN.)	2000 (MIN.)	600 (MIN.)	650 (MIN.)	500 (MIN.)

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 POSSIBLE 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

DWG. NO.	REF. DRAWING	NO.	DATE	REVISION	DRN	CHKD	APPD
		0	18.01.19	ISSUED FOR TENDER	SS	VKS	JR

DRAWING NO.	REV.
GAIL-STD-PL-DWG-TP-032	0



GABIONS ONLY FOR ROCKY RIVER

 LYONS ENGINEERING PVT. LTD. NEW DELHI									<b>TYPICAL DETAIL OF RIVER CROSSING (OPEN CUT)</b>	DRAWING NO.	REV.
	DWG. NO.	REF. DRAWING	0	18.01.19	ISSUED FOR TENDER	SS	YS	AP		GIGL-STD-PL-DWG-TP-033	0
			NO.	DATE	REVISION	DRN	CHKD	APPD			



LYONS ENGINEERING PVT. LTD.  
NEW DELHI

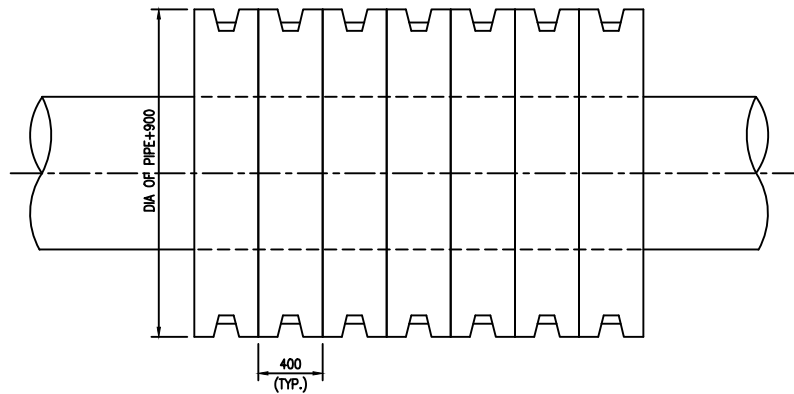
TYPICAL CONCRETE SLAB DETAILS  
FOR MECHANICAL PROTECTION

DRAWING NO.

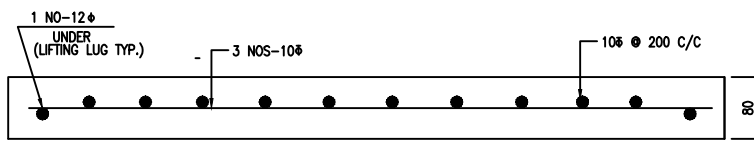
GAIL-STD-PL-DWG-TP-034

SHEET NO.

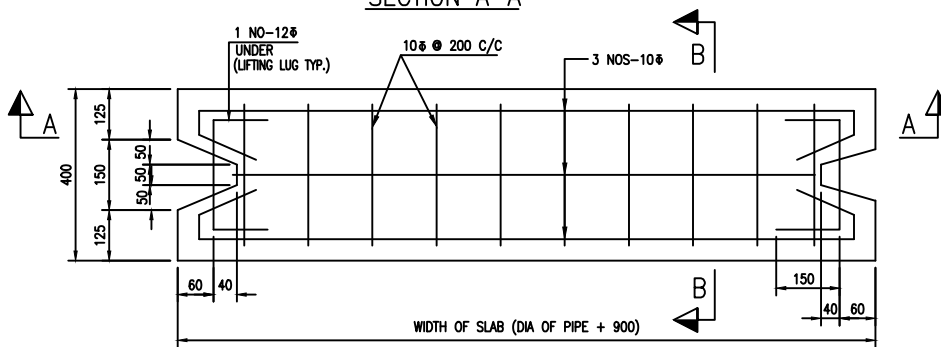
1 OF 1



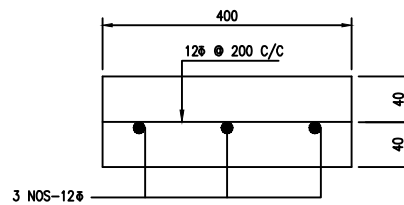
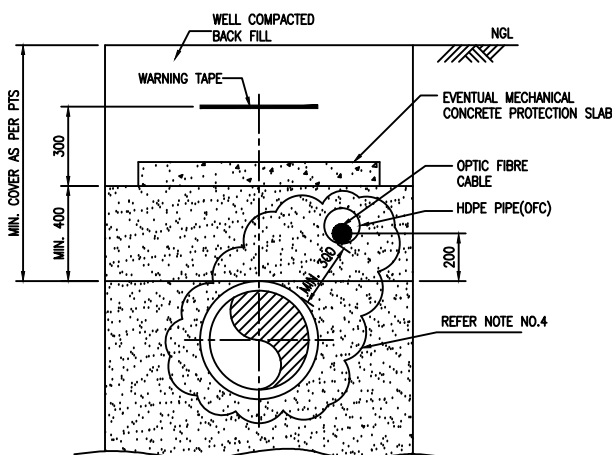
PROTECTIVE CONCRETE SLAB PLAN



SECTION A-A



REINF. DETAIL PROTECTIVE CONCRETE SLAB



SECTION B-B

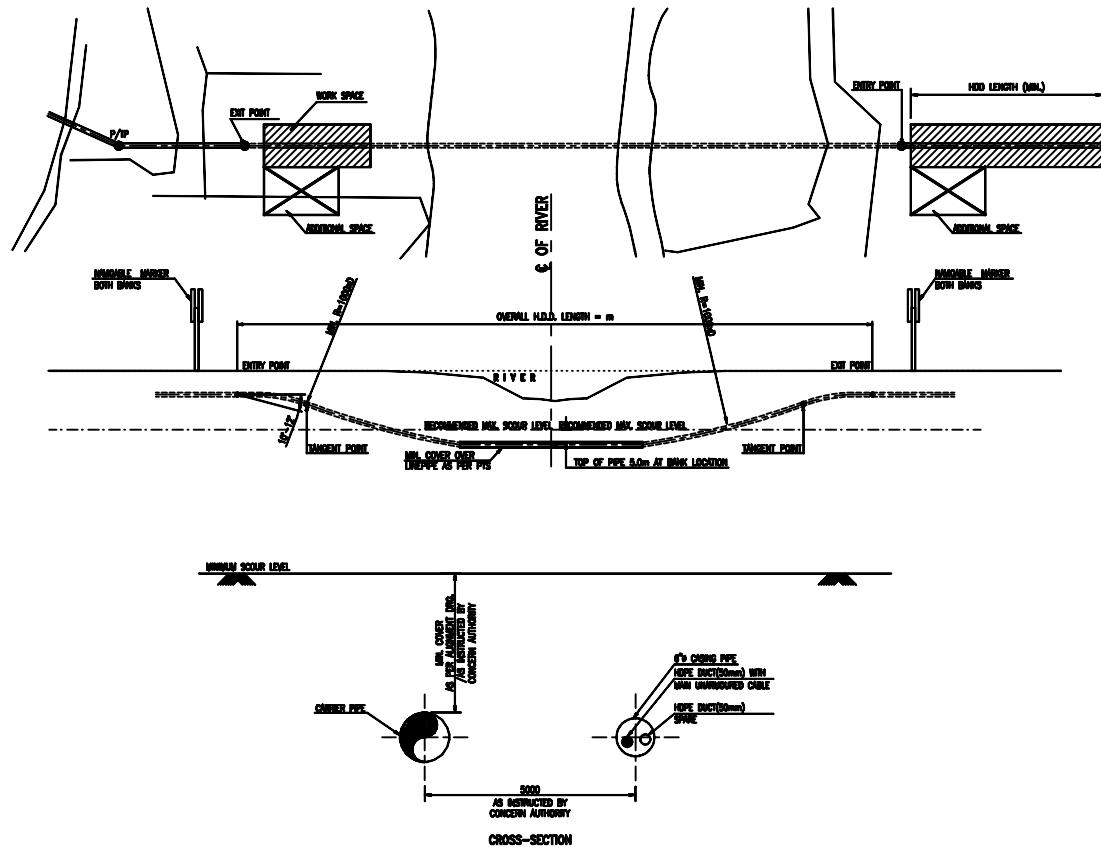
NOTES:-

1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. MINIMUM COVER OVER LINE PIPE SHALL BE AS PER SPECIFICATION AND REQUIREMENT OF CONCERNED AUTHORITIES.
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. LENGTH OF MECHANICAL PROTECTION SLAB SHALL BE CONSIDERED ALONG THE AXIS OF THE PIPE.

0	18.01.2019	ISSUED FOR TENDER	SS	VKS	AP
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED

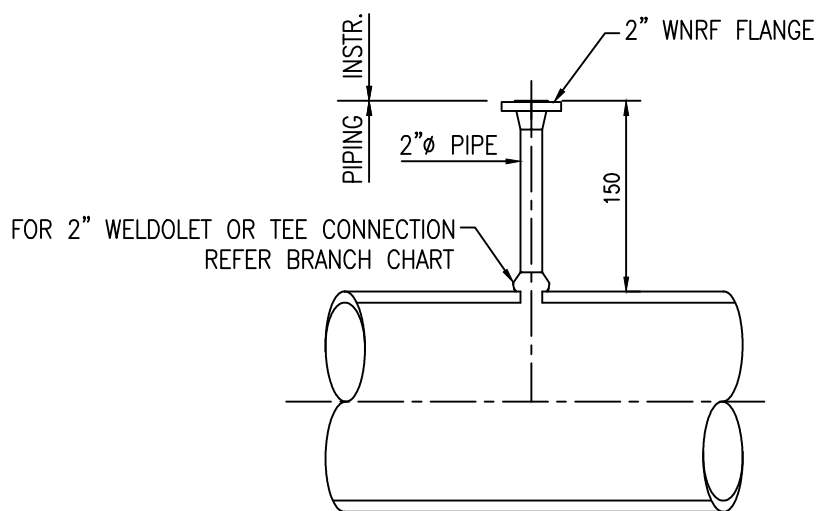
**NOTES**

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 ROW TO THE CONTRACTOR, ANY OTHER TEMPORARY WORKING SPACE OR TEMPORARY ACCESS 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 >300mm 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 ROW, IF REQUIRED, FOR WORKING AND EXCAVATION OF CROSSING TO AVOID CAVING OF SOIL SHALL BE PROCURED BY CONTRACTOR WITHOUT ANY COST IMPLICATION.



DWG. NO.	REF. DRAWING						
			0	18.01.19	ISSUED FOR TENDER	SS	YS
					REVISION	DRN	CHKD
							APPD

DRAWING NO.	REV.
GAIL-STD-PL-DWG-TP-035	0



0	31.05.2018	ISSUED FOR TENDER				SS	VKS	JR	
REV.	DATE	SUBJECT OF REVISION				PREPD.	CHKD.	APPD.	



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 NEW DELHI

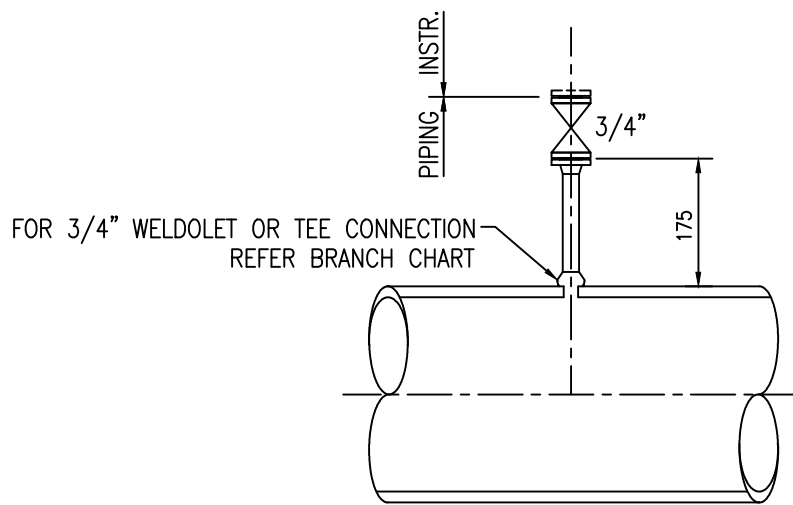
TYPICAL TEMPERATURE CONNECTIONS  
 DETAILS


DRAWING NO.

GAIL-STD-PL-DWG-TP-036

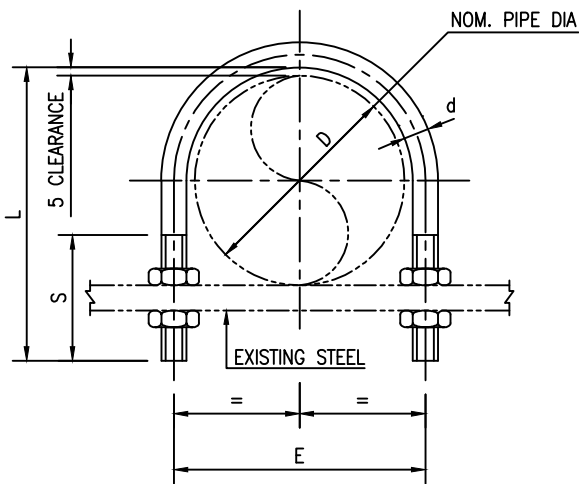
SHEET NO.

1 OF 1

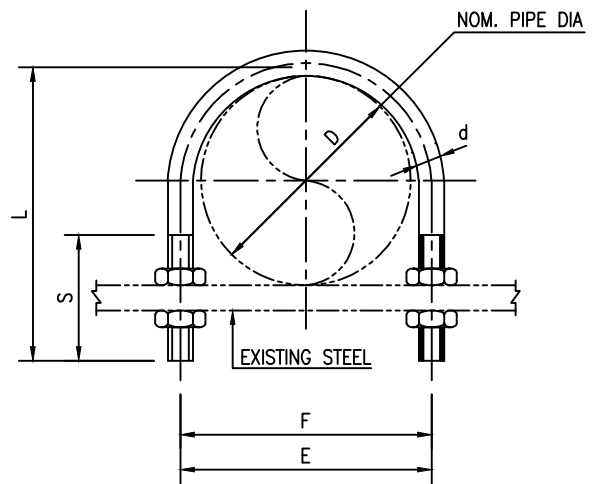


0	10.01.2019	ISSUED FOR TENDER				SS	VKS	JR	
REV.	DATE	SUBJECT OF REVISION				PREPD.	CHKD.	APPD.	
 <b>LYONS ENGINEERING PVT. LTD.</b> NEW DELHI		<b>TYPICAL PRESSURE CONNECTIONS          DETAILS</b>				DRAWING NO. GAIL-STD-PL-DWG-TP-037			
						SHEET NO.		1 OF 1	

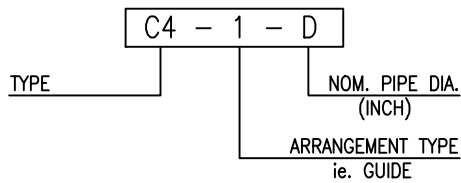




GUIDE  
ARRANGEMENT TYPE-1  
(1/2" TO 24")



FIXED  
ARRANGEMENT TYPE-2  
(1/2" TO 1 1/2")



SYMBOL

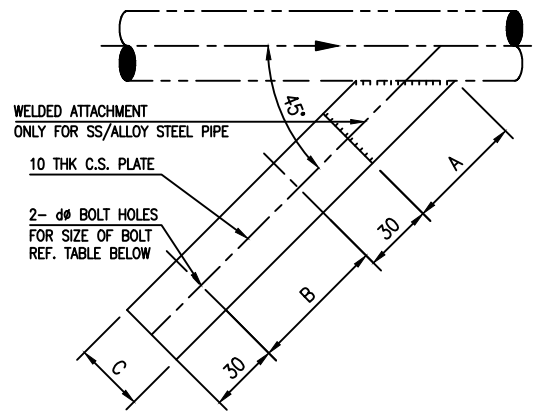
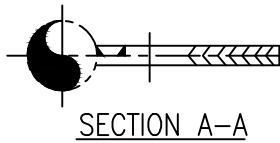
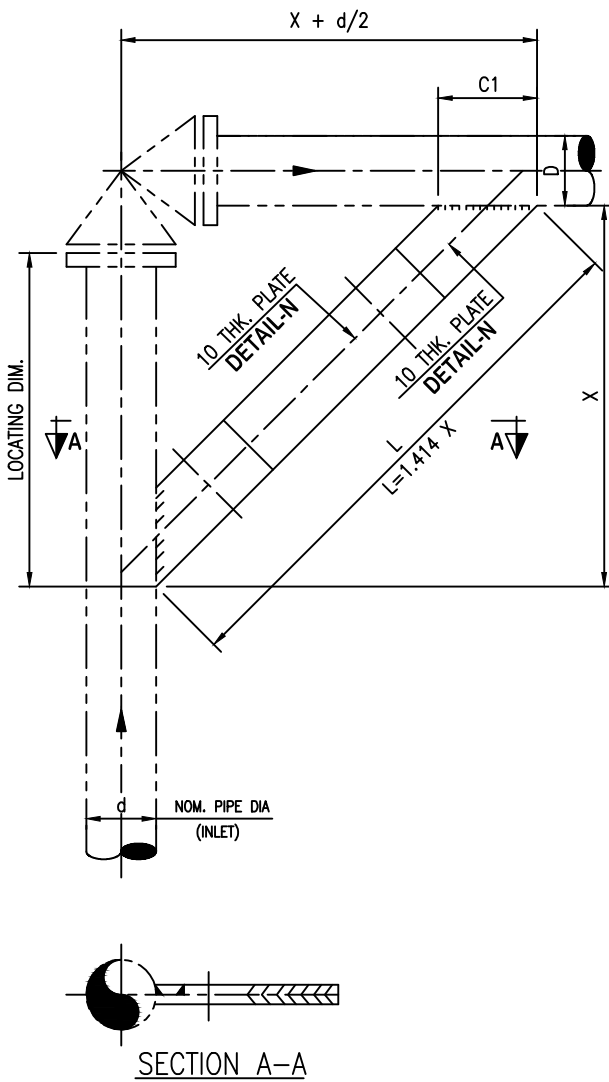
D	O.D. (mm)	'U' CLAMP				
		L	E	S	d	F
1/2"	21	65	30	50	6	24
3/4"	27	70	36	50	6	30
1"	33	75	45	55	8	37
1 1/2"	48	90	60	55	8	52
2"	60	105	72	60	8	64
3"	89	145	106	80	12	94
4"	114	170	130	80	12	119
6"	168	240	190	100	16	173
8"	219	290	242	100	16	226
10"	273	345	296	100	16	280
12"	324	420	351	130	20	331
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

0	10.01.2019	ISSUED FOR TENDER	SS	VKS	JR
REV.	DATE	SUBJECT OF REVISION	PREPD.	CHKD.	APPD.

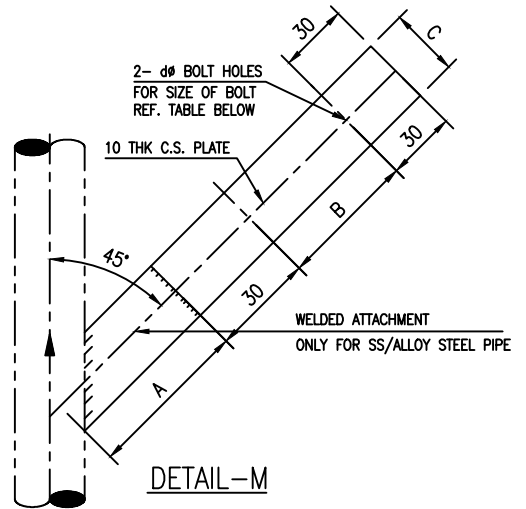


TYPICAL DRAWING FOR  
U-CLAMP SUPPORT

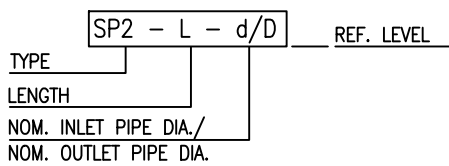
DRAWING NO.	
GAIL-STD-PL-DWG-TP-038	
SHEET NO.	1 OF 1



DETAIL-N



DETAIL-M



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

0	10.01.19	ISSUED FOR TENDER	SS	VKS	JR
REV.	DATE	SUBJECT OF REVISION	PREPD.	CHKD.	APPD.



TYPICAL DRAWING FOR SUPPORTING  
ARRANGEMENT FOR ANGLE  
& RELIEF VALVS.

DRAWING NO.	
GAIL-STD-PL-DWG-TP-039	
SHEET NO.	1 OF 1

HAR EK KAAM DESH KE NAAM



**GAIL INDIA LIMITED**

**CONSTRUCTION OF STEEL PIPELINE AND ASSOCIATED FACILITIES  
FOR CGD CONNECTIVITIES**

**VOLUME II OF II (TECHNICAL) – D**

**PIPING**



**E-TENDER REF :**



**(BID DOCUMENT NO - 034/LEPL/GAIL/22-R0)**

**LIMITED DOMESTIC COMPETITIVE BIDDING**



**Lyons Engineering Pvt. Ltd.**

	<b>DCI - MASTER DELIVERABLE CONTROL INDEX FOR CGD TO M/s TGPL MORADABAD &amp; CGD TO M/s TGPL GORAKHPUR</b>	Doc No.	
		GAIL-ENG-GN-DOC-DL-001	
		Rev. 0	
Sr. No.	Description	Document / Drawing No.	Rev. No.
<b>TECHNICAL VOLUME - II OF II</b>			
<b>D</b>	<b>MECHANICAL / PIPING</b>		
<b>TECHNICAL SPECIFICATION - MECHANICAL / PIPING</b>			
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 specification for erection of equipment and machinery	GAIL-STD-PI-DOC-TS-020	0
20	Technical specification for Ball Valves	GAIL-STD-PI-DOC-TS-021	0
<b>DATA SHEET - MECHANICAL / PIPING</b>			
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
23	Data Sheet of Quick Opening & Closure	GAIL-STD-PI-DOC-DS-004	0
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
26	Data Sheet - Ball Valve (0.75 to 1.5 Inch - Socket Welded Ends)	GAIL-STD-PI-DOC-DS-007	0
27	Data Sheet - Plug Valve (0.75 to 1.5 Inch - Socket Welded Ends)	GAIL-STD-PI-DOC-DS-008	0
28	Data Sheet - Globe Valve (0.75 to 1.5 Inch - Socket Welded Ends)	GAIL-STD-PI-DOC-DS-009	0
29	Data Sheet - Globe Valve (2 to 24 Inch - Flange Ends)	GAIL-STD-IN-DOC-DS-010	0
<b>QAP - MECHANICAL / PIPING</b>			
30	QAP of Flow Tee	GAIL-STD-PI-DOC-QAP-003	0
31	QAP of Station Pipes	GAIL-STD-PI-DOC-QAP-004	0
32	QAP of Fittings	GAIL-STD-PI-DOC-QAP-005	0
33	QAP of Flanges	GAIL-STD-PI-DOC-QAP-006	0
34	QAP of Fastners	GAIL-STD-PI-DOC-QAP-007	0
35	QAP of Gaskets	GAIL-STD-PI-DOC-QAP-008	0
36	QAP - Ball Valve	GAIL-STD-PI-DOC-QAP-009	0
37	QAP - Globe Valve	GAIL-STD-PI-DOC-QAP-010	0
38	QAP - Plug Valve	GAIL-STD-PI-DOC-QAP-011	0
<b>STANDARD DRAWING - MECHANICAL / PIPING</b>			
39	Standard Drawing for spectacle blind flange	GAIL-STD-PI-DWG-TP-001	0
40	Anchor for Bare Pipe Size 2" Thru 24"	GAIL-STD-PI-DWG-TP-002	0
41	Cross Guide support for Bare Pipe Size 2" Thru 24" Type G3	GAIL-STD-PI-DWG-TP-003	0
42	Cross Guide for Bare Pipe Size 2" Thru 24" Type G4	GAIL-STD-PI-DWG-TP-004	0
43	Guide Support for Bare Pipe Size 2" Thru 24" Type G1	GAIL-STD-PI-DWG-TP-005	0
44	Dummy Pipe Support for Bare Pipe Size 2" Thru 24" Type B-39	GAIL-STD-PI-DWG-TP-006	0
45	Low Support Stanchion Type L -16 & L-16A	GAIL-STD-PI-DWG-TP-007	0
46	Low Support Sliding and Fixed for Pipe Size 3/4" Thru 1.5" Type L-15	GAIL-STD-PI-DWG-TP-008	0
47	Low Support Sliding for Bare and Insulated Pipe Size 2" Thru 24" Type L-6	GAIL-STD-PI-DWG-TP-009	0

<b>PMC:</b> 	<b>DCI - MASTER DELIVERABLE CONTROL INDEX FOR  CGD TO M/s TGPL MORADABAD &amp; CGD TO M/s  TGPL GORAKHPUR</b>	<b>Doc No.</b>	<b>CLIENT:</b> 
GAIL-ENG-GN-DOC-DL-001			
Rev. 0			
<b>Sr. No.</b>	<b>Description</b>	<b>Document / Drawing No.</b>	<b>Rev. No.</b>
48	Low Support Sliding for Pipe Size 3/4" Thru 36" Type L-5 & L-5A	GAIL-STD-PI-DWG-TP-010	0
49	Pressure Tappings ( PA,PG,PC,PT,PIC ETC.)	GAIL-STD-PI-DWG-TP-011	0
50	Detail of Pressure Connection Above Ground Pipe	GAIL-STD-PI-DWG-TP-012	0
51	Detail of Pressure Connection Under Ground Pipe	GAIL-STD-PI-DWG-TP-013	0
52	Detail of Temperature Connection Above Ground Pipe	GAIL-STD-PI-DWG-TP-014	0
53	Detail of Temperature Connection Under Ground Pipe	GAIL-STD-PI-DWG-TP-015	0
54	Guide Support for Bare Pipe Size 1/ 2" to 24" Type G2	GAIL-STD-PI-DWG-TP-016	0
55	U-Bolt for Bare Pipe Size ( 1/ 2" to 24")	GAIL-STD-PI-DWG-TP-017	0
56	Vent and Drain on Line 2" and above	GAIL-STD-PI-DWG-TP-018	0
57	Vent and Drain on Line 1.5" and below	GAIL-STD-PI-DWG-TP-019	0
58	Typical Drawing for Flow Tee	GAIL-STD-PI-DWG-TP-020	0
59	Spacer and Blind s (150#,300# & 600)	GAIL-STD-PI-DWG-TP-021	0
60	Typical Piping Arrangement for 30" section	GAIL-STD-PI-DWG-TP-022	0
61	Symbol of Piping Arrangement on Drawings	GAIL-STD-PI-DWG-TP-023	0
62	Gasket Thickness	GAIL-STD-PI-DWG-TP-024	0
63	Supporting Arrangement for Angle and Relief Valve	GAIL-STD-PI-DWG-TP-025	0
64	Low Support Sliding for Bare & Insulated Pipe Size 2" Thru 36" Type L-1 & L1A	GAIL-STD-PI-DWG-TP-026	0
65	Low Support Fixed for Bare & Insulated Pipe Size 2" Thru 24" Type L-6	GAIL-STD-PI-DWG-TP-027	0

# ENGINEERING STANDARD




## PIPING MATERIAL SPECIFICATION

GAIL-STD-PI-DOC-TS-001

0	05.02.2019	Issued for Bid	AP	JR	SB	
<b>REV</b>	<b>DATE</b>	<b>Purpose</b>	<b>Prepared BY</b>	<b>Checked By</b>	<b>Approved By</b>	

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	PIPING CLASS 6A1
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<b>PIPING MATERIAL SPECIFICATION</b>	<b>Document No.</b>	Rev	
	<b>GAIL-STD-PI-DOC-TS-001</b>	0	


**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" thru 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.

<b>PIPING MATERIAL SPECIFICATION</b>	<b>Document No.</b>	Rev	
	<b>GAIL-STD-PI-DOC-TS-001</b>	0	



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

<b>PIPING MATERIAL SPECIFICATION</b>	<b>Document No.</b>	Rev	
	<b>GAIL-STD-PI-DOC-TS-001</b>	<b>0</b>	

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

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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.

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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

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Nuts for stud bolts dia 1 1/8" to 3 1/4" : 8UN-2B

10.4 Threads for stud bolts shall be as per ASME B 1.1, as follows:

Stud bolts dia 1/4" to 1" : UNC-2A

Stud bolts dia 1 1/8" to 3 1/4" : 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 (1 1/2" 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

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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 SPECIALTY 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

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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 Co<sub>2</sub>, H<sub>2</sub>S 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 H<sub>2</sub>S.
- 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.

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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/cm<sup>2</sup> 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)

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## 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 & m/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/2HMs 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.

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- 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.

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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 conducted 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.

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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 ASME B16.5.
- 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, nipplets, 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 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 to, 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 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.

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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

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## TECHNICAL SPECIFICATION FOR PAINTING


GAIL-STD-PI-DOC-TS-004

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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.

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- 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:
- Uninsulated austenitic stainless steel.
  - Plastic and/or plastic coated materials
  - 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.
- Bill of quantities for piping, equipment, machinery and structures etc.
  - Piping Line List.
  - 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

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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.

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## 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

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- 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 law 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.

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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-free with a cloth or a soft brush, washed with an organic solvent and thoroughly dried off with a dry cloth (e.g. with 1.1.1. Trichloroethane 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.

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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 off.

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 primer 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 nck 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

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- 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<sub>Max</sub>.

- 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 after 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 be carried out in dry weather and at a minimum temperature of 10°C, except for special cases 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,

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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 M <sup>2</sup> /Lit/coat

### Primer (P-2)

#### High build chlorinated rubber zinc phosphate primer

Type and Composition	Single pack, Chlorinated rubber medium Plasticised with unsaponifiable plasticiser pigmented with zinc phosphate
Volume solids	35- 40%
DFT	50 MICRONS/COAT (MIT)
Covering capacity	7-8 M <sup>2</sup> /Lit/Coat

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## 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 M <sup>2</sup> /Lit/coat
Heat resistance	Upto 100° 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 M <sup>2</sup> /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 M <sup>2</sup> /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 M <sup>2</sup> /lit/coat

## g) Primer (P-7)

Epoxy high build M10 Paint (Intermediate Coat)

Type and composition	Two pack Poly Polyami de cured epoxy resin medium pigmented with micaceous iron oxide. Volume solids 7-8%
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	Volume Solids	50%
	DFT	100 microns/coat (min)
	Covering capacity	5.0 M <sup>2</sup> /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 M <sup>2</sup> /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 <sup>2</sup> /lit/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 M <sup>2</sup> /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<sup>2</sup> / 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<sup>2</sup> / 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<sup>2</sup> /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<sup>2</sup> / 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

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	Covering capacity	6.0-6.5 M <sup>2</sup> / 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 M <sup>2</sup> / 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 M <sup>2</sup> / 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 <sup>2</sup> / 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 M <sup>2</sup> / lit/ coat
u)	Finish Coat (F-12)	
	Heat Resistant Silicon Paint suitable up to 400° 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 M <sup>2</sup> /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 M <sup>2</sup> /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) Goadlass 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

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**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 be 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 °C

**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.

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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.


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Table – 1

## Colour Coding Scheme for Pipes and Equipment

SI. No.	Content	Ground Color	First Color Band	Second Color Band
1	<b>COMPRESSED AIR</b>			
a)	Plant Air	Sky Blue	Silver Grey	-
b)	Instrument Air	Sky Blue	French Blue	-
2	<i>GASES</i>			
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	<i>ALL EQUIPMENT</i>			
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	<b>External surface of equipment's and piping.</b>						
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)

SI. No.	Description	Temp. Range	Surface preparation	Primer	Finish Coat	Total DFT	Remarks
1.0	<b>External surface of un-insulated and other equipment</b>						
1.1	- 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.
1.3	- 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	<b>External surface of equipment's and piping.</b>						
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-10	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.

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### 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 be used on site for places that are 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 be 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, be 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

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### 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  $\pm$  20 cm above the ground level marker and  $\pm$  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 P E 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.

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### 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 be Called in. The Approved Supervisory Body will then carry out inspections on site whereby the following assessment criteria will 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 D1 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 be 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 be 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.

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- 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.

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# ENGINEERING STANDARD



GAIL INDIA LIMITED

## TECHNICAL SPECIFICATION FOR WELDING OF STATION PIPING

GAIL-STD-PI-DOC-TS-005

Rev	Date	Purpose	Prepared By	Checked By	Approved By
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.

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### 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.

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- 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 conform 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 its 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:

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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 PQR 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

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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.

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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 be preheated to 100°C prior to welding when the ambient temperature is less than 10°C (50 °F).

Preheating shall be 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,

### 3.6.1 Welding Details

3.6.1 All pressure welding shall be performed in accordance with approved and qualified welding procedures as required per code.

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- 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% Nitric) 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 tack 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 be clearly displayed 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.

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### 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 radiographed or by the same method of original defect detection. 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.

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### 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

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and approved by the OWNER quality assurance personnel prior to services being used.

The OWNER will review and approve element's i), ii) & ii i) 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 undercutting 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

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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.	<b>FLATTENING</b> 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.	<b>REDUCTION OF WALL THICKNESS</b> 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.

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- 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 II 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.

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## 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 B 31.8 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 radiographed and all other welds configuration, which does not permit to be radiographed, 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
	<ul style="list-style-type: none"> <li>• Severe cyclic conditions as indicated in the respective isometric drawings, all service.</li> <li>• Carbon Steel material, ASME rating 600# all services</li> <li>• All ASME classes for lethal substances.(Category 'M' fluid service)</li> </ul>
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: <ul style="list-style-type: none"> <li>• Service air</li> <li>• Instrument air</li> <li>• Open Drains</li> </ul>

### Notes:

- (1) Irrespective of category, a II 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.


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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 (Note 5)	100% examination of 1 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) UT trasonic 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 after 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.

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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 it 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 standards 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.

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- 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.

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# ENGINEERING STANDARD



GAIL INDIA LIMITED

## TECHNICAL SPECIFICATION FOR FABRICATION AND INSTALLATION

GAIL-STD-PI-DOC-TS-006

Rev	Date	Purpose	Prepared By	Checked By	Approved By
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

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(Minimum DFT 100 $\mu$ ) and two coat of final painting of high build epoxy paint 125 $\mu$  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 100 $\mu$ ) and two coat of final painting of high build epoxy paint (Min. 125 $\mu$  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-DOCS-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 as per approved as per Welding Procedure Specification (WPS) and

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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, deflection 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:
- 24" NPS and smaller pipe-to-pipe fitting: 1.5mm maximum deviation.
  - Greater than 24" pipe-to-pipe or pipe-to-fitting: 3.2mm maximum Deviation when permitted by the relevant WPS.
  - Dimensional tolerances for the fabrication and installation of piping systems shall be  $\pm 1/8$  inch and  $\pm 2$  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:
- Rotate the pipe or fittings to reduce misalignment to the acceptable tolerances (before attempting any of the following methods) allowing for seam alignment.
  - Use spreaders or internal or external line-up clamps to correct moderate out-of-round Condition.
  - 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.
  - 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.

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- 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 be ground smooth, Welds to be performed on site shall be kept at a maximum distance back 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 be 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 authorized 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<sup>2</sup>. After test, the vent shall be seal welded.
- 6.3 Non-pressure attachments shall be 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

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by the design.

The tolerances for the maximum flatter 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 verify 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 whichever 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 be 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<sup>2</sup> 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

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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

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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.

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**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 material 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

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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<sub>2</sub> 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 socket, 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.

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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, tests 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

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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 vents 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 forms 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

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- 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.

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# ENGINEERING STANDARD



**GAIL INDIA LIMITED**

## TECHNICAL SPECIFICATION FOR NDT

**GAIL-STD-PI-DOC-TS-007**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
0	31.01.19	Issued for Bid	AP	JR	SB



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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 undercutting 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

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- |    |   |   |
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| c) | Incomplete penetration<br>(For other than 100%<br>radiography butt-weld)  | not permitted   |
| d) | Surface porosity and<br>exposed slag inclusions<br>(For nom. wall thickness<br>4.7 mm and less)   | not permitted   |
| e) | Concave root surface (Suck up)  | For single sided welded joints, concavity of the<br>root surface shall not reduce the total thickness<br>of joint, including reinforcement, to less than<br>the thickness of the thinner of the components<br>being joined. |
| f) | Weld ripples irregularities   | 2.5 mm or less.   |
| g) | Lack of uniformity in bead<br>width   | 2.5 mm or less.   |
| h) | Lack of uniformity of leg<br>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,<br>whichever is smaller and there shall not be more<br>than 2 in. (50 mm) of undercutting in any<br>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)<br>shall be fused with and shall merge smoothly into the component surfaces. The height of the<br>lesser projection of external weld reinforcement or internal weld protrusion from the<br>adjacent base material surface shall not exceed the following limits: |   |
|    | Wall thickness of thinner<br>component joined by butt<br>weld (mm)  | Weld reinforcement or internal weld protrusion<br>(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

INSP N. CLAS S	SERVICE	MATERIAL	TEMP (DEG. C)	PRESS. CLASS	TYPE OF EXAMINATION	TYPE OF WELD EXAMINED		
						GIRTH BUTT WELD	SOCKET WELD	ATTACH- MENT/ BRANCH WELD
1	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**  
CS

**Maximum Hardness (BHN)**  
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**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
0	31.01.2019	Issued for Bid	AP	JR	SB



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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.

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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.

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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.

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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<sup>2</sup> (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

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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  $\pm 2\%$  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)

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## 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 Performance provided/approved by the Engineer-in-Charge.

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# ENGINEERING STANDARD



**GAIL INDIA LIMITED**

## TECHNICAL SPECIFICATION FOR QUICK OPENING END CLOSURE

**GAIL -STD-PI-DOC-TS-010**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
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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 conform 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

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### 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 for Carbon 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.

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- 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 INSPECTION 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:

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- 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

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- 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**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
0	30.01.19	Issued for Bid	AP	JR	SB



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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.

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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
<b>ASTM A694</b>	: 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-10204	: 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 cathodically 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 standards mentioned 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:

$$CE = C + Mn/6 + (Cr+Mo+V)/5 + (Ni +Cu)/15$$


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- 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<sub>10</sub>, 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.
- 4.1.3 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.

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- 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<sup>2</sup> and 50 mm<sup>2</sup> 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 defects using dye penetrate prior to welding.

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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 level.

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.

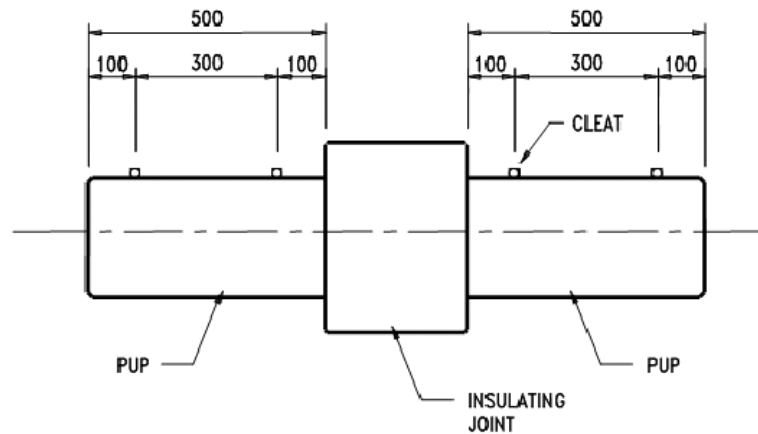



FIG. 4.1

## 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.

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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 shall be 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 with 1000 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**

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- 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**

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 CONTRACTOR 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

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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 possess 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<sub>10</sub>, 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 4.5 of this specification respectively.

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- 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 minutes. 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.

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- 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-I.”  
 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

Rev	Date	Purpose	Prepared By	Checked By	Approved By
0	12.01.19	Issue for Bid	AP	JR	SB



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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.

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## 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. Tests 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 a 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.

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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.

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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 grease and 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: -

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- 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.

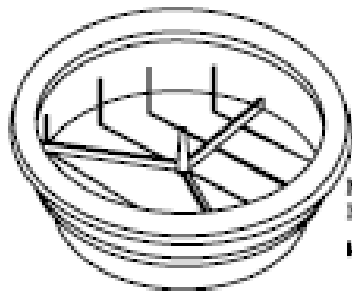
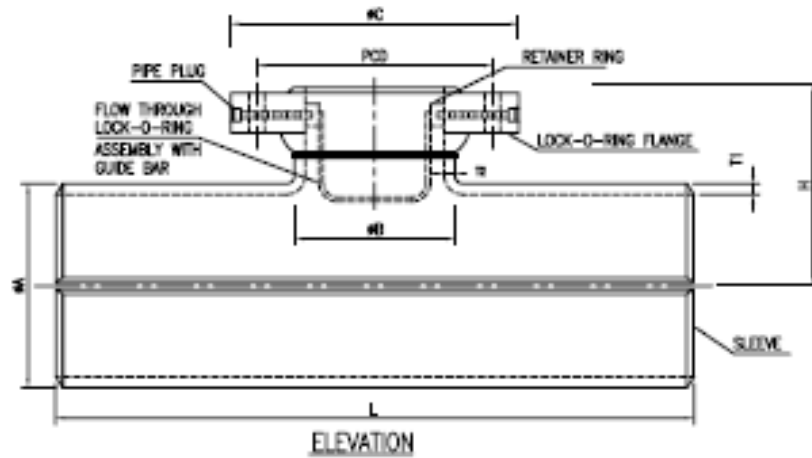
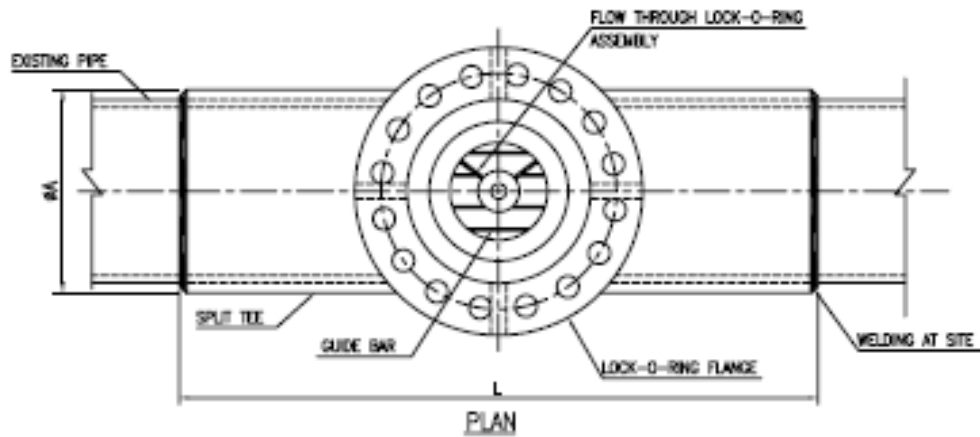
10.4 Prior to shipment, Manufacturer shall submit one reproducible and six copies of test certificates as listed in clause 7.0 of this specification.

10.5 All documents shall be in English Language.


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FLOW THROUGH LOCK-O-RING  
ASSEMBLY WITH GUIDE BAR

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**GAIL INDIA LIMITED**

## **TECNICAL SPECIFICATION FOR CLEAN AGENT SYSTEM IC-SPE-101**

**GAIL-STD-PI-DOC-TS-014**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
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.

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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 <sup>3</sup> /m <sup>3</sup> of vol.
IG-541	N <sub>2</sub> -52% Ar -40% CO <sub>2</sub> -8%	43	52	2175 psi	2575 psi	37.5	0.470
IG-55	N <sub>2</sub> -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 <sub>2</sub> -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 until 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°F by volume unless otherwise specified by the agent manufacturer for clean agent fire extinguishing system.

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Clean Agent concentration requirement shall be computed considering the volume of the hazard as specified.

The quantity of Clean Agents shall be worked out by the bidder, as per NFPA-2001 and in the Performance 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, 54 and 100 435 cu.ft

The vendor shall standardized the capacity of cylinder for better replacement & interchangeability.

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 vendor 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. Converter 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. Converter required to convert 24V shall be in vendor's scope.

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- 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 or 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 or 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.

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## 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, actuation 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.

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- 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**

## TECHNICAL SPECIFICATION FOR CO<sub>2</sub> TYPE EXTINGUISHER


**GAIL-STD-PI-DOC-TS-015**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
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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<sub>2</sub> 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.

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# ENGINEERING STANDARD



**GAIL INDIA LIMITED**

## **TECNICAL SPECIFICATION FOR FIXED CO<sub>2</sub> 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**

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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<sub>2</sub> 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

- 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<sub>2</sub> gas to render the atmosphere inert and non-supporting to combustion.

3.4 CO<sub>2</sub> gas cylinder's capacity provided shall be sufficient to discharge CO<sub>2</sub> 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<sub>2</sub> 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 NFPA-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 NFPA 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.

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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<sub>2</sub> shall be dearly mentioned. The system shall be interlocked with the air conditioning / v entilation system wherever applicable. In case of CO<sub>2</sub> 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 CO<sub>2</sub> battery shall be eq uipped with a discha rge 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 w ay 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<sub>2</sub> SYSTEM CONTROL PANEL**

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- 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<sub>2</sub> system.

**10.0 MATERIAL SPECIFICATIONS**


Material for cylinder body, valve, cylinder body nozzles, spray nozzles, piping and CO<sub>2</sub> 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<sub>2</sub> shall be taken by contractor.

**12.0 INSPECTION TESTING AND APPROVAL OF INSTALLATION**

- 12.1 The completed system shall be inspected and 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

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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, CO<sub>2</sub> 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<sub>2</sub> 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**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
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## 1. INTRODUCTION

This present document covers the technical specification for the procurement of Insulating Gaskets used in high 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 & Commissioning of 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 / Owner Representative 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-ring or 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 thickness including 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 withstand test pressure equal to 1.5 times design pressure 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

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- 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 at the 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 as per specified standard, if relevant, internal test / inspection reports as per Owner Tech. Spec. & specified code 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 the applicable codes at his works prior to shipment. Such inspections and tests shall be, but not be limited to the following:

- 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 in following 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/cm<sup>2</sup> for 10 minutes. The tightness shall be checked by immersion or with a frothing agent. No leakage shall be 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 and this 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 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.
- 4.7 The insulation resistance of 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.
- 4.8 Each Insulating Gasket Assembly shall be Dielectric Tested before and after hydrostatic Test.

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- 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 his obligation 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 each manufacturing batch & have these independently tested. Should the results of these tests fall outside the limits specified in Owner technical specification, then Owner reserves the right to reject all productions supplied 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 for construction 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 marked by 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 of transport (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 changes shall be obtained before the manufacturing.

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# ENGINEERING STANDARD



**GAIL INDIA LIMITED**

## **TECNICAL SPECIFICATION FOR PORTABLE DRY POWDER TYPE EXTINGUISHER**

**GAIL-STD-PI-DOC-TS-018**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
0	31.01.19	Issued For Bid	AP	JR	SB



**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

Rev	Date	Purpose	Prepared By	Checked By	Approved By
0	31.01.2019	Issued for Bid	AP	JR	SB



**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

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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/

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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. EQUIPMENT 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:

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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<sup>3</sup>/ hr; Maximum 1000 m<sup>3</sup>/ hr for 24" and above pipeline  
Minimum 200 m<sup>3</sup>/ hr; Maximum 400 m<sup>3</sup>/ 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

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- 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  $\pm 0.2$  °C
  - g. Two laboratory thermometers of range 0 °C to 60 °C and with accuracy of  $\pm 0.01$  °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 or 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 cleanliness, 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

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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,

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- 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 ( $V_1$ ). This amount measured shall be compared to the theoretical amount ( $V_p$ ) 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  $V_1 / V_0$  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).

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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:

$$V_p = (0.884 r_1/t+A) \times 10^{-6} \times V_t \times \Delta P \times K$$

Where:

$V_p$  = Computed water amount required to raise the pressure by 'ΔP' in the section to be tested (m<sup>3</sup>)


$V_t$  = Geometrical volume of the section (m<sup>3</sup>)

$\Delta P$  = 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<sup>-1</sup>).

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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:

$$\Delta P = B * \Delta T / \{ (0.884 r_1 / t) + A \}$$

Where;

$\Delta P$  = Pressure change resulting from a temperature change (bar).

$\Delta T$  = Algebraic difference between water temperature at the beginning of the test and water temperature as measured at the end of the test ( $^{\circ}\text{C}$ ).

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 ( $^{\circ}\text{C}$ ). Refer Table-1.


A = Isothermal compressibility value of water as estimated at the pressure and temperature values obtained at the end of test ( $\text{bar}^{-1}$ ). 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.

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- 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;

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- 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.

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**Table 1**

Difference between the water thermal expansion factor and the steel thermal expansion factor ( $^{\circ}\text{C}^{-1}$ ) ( $10^{-6}$ )

$^{\circ}\text{C}$ 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 2**

Difference between the water thermal expansion factor and the steel thermal expansion factor ( $^{\circ}\text{C}^{-1}$ ) ( $10^{-6}$ ).

<b><math>^{\circ}\text{C}</math></b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>	<b>13</b>	<b>14</b>	<b>15</b>
<b>Bar</b>							
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
150	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 ( $^{\circ}\text{C}^{-1}$ ) ( $10^{-6}$ ).

$^{\circ}\text{C}$	16	17	18	19	20	21	22	23
<b>Bar</b>								
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
150	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 ( $^{\circ}\text{C}^{-1}$ ) ( $10^{-6}$ )

$^{\circ}\text{C}$ 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	

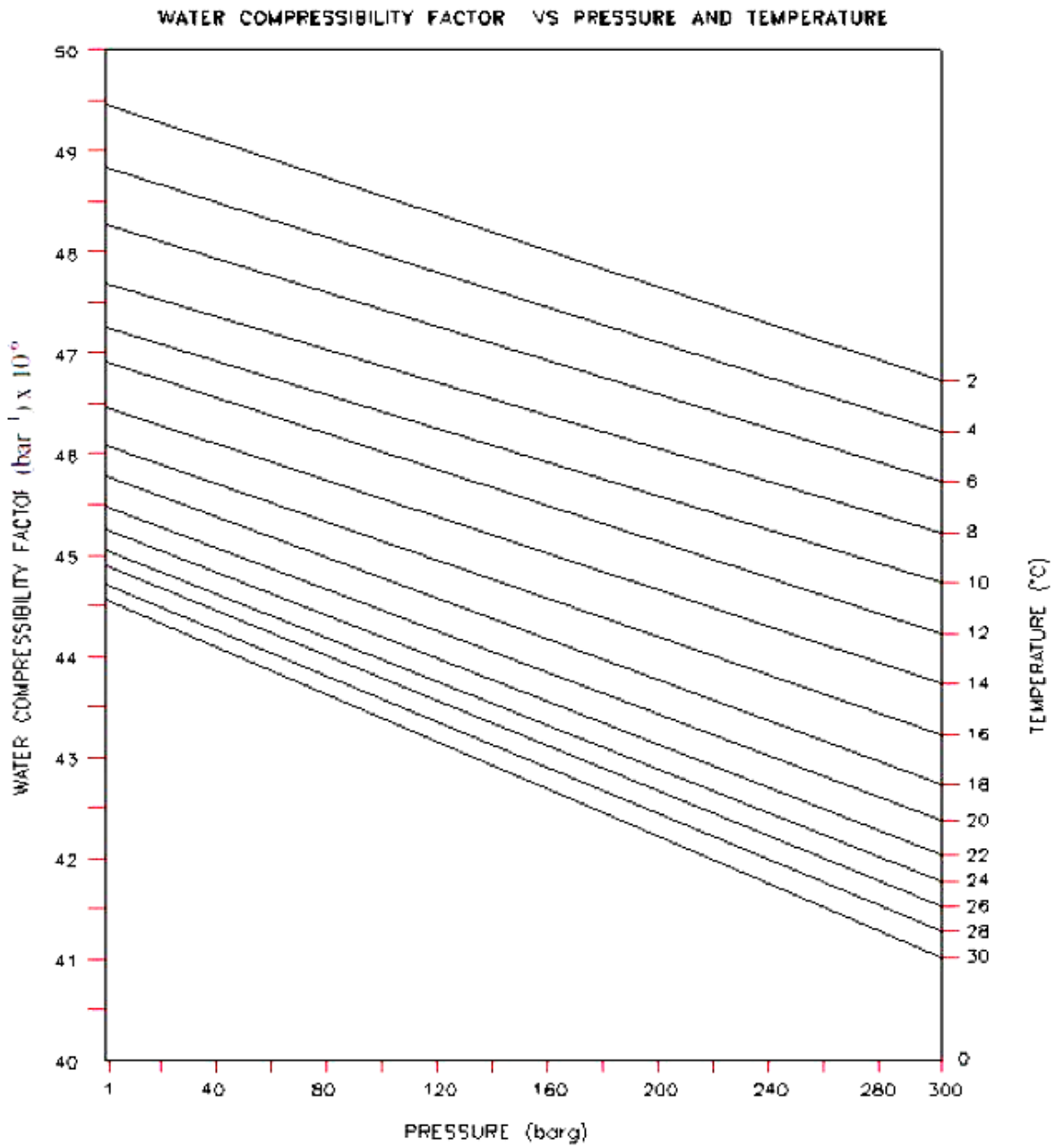


Fig.1 Water Compressibility Factor

# ENGINEERING STANDARD



GAIL INDIA LIMITED

## TECHNICAL SPECIFICATION FOR ERECTION OF EQUIPMENT AND MACHINERY

GAIL-STD-PI-DOC-TS-020

Rev	Date	Purpose	Prepared By	Checked By	Approved By
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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 will 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.

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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

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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

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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/EI, 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.

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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, alignment 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.


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

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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.
- 3.3.18 Ladders, platforms, walkways shall be correctly installed with handrails, and flooring shall be properly secured.
- 3.3.19 Field 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.

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- 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

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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 provided 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.

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### 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 be maintained as specified in the Manufacturer's Instruction Manual. To ensure that piping connections do not induce any undue stresses on the Rotating Equipment, the alignment shall be checked once again by EC after the piping has been connected. Any correction necessary for proper alignment shall be done by EC.

4.3.2.5 EC shall carefully study the vendor drawings, manuals and other data before start of the job to ensure correct erection, alignment and commissioning.

#### 4.3.3 Centrifugal Compressors & Expanders

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4.3.3.1 Centrifugal Compressors are supplied for erection in multiple packages such as,

- Compressor casings
- Drivers (Electrical motors, Steam/Gas turbines -.)
- {∴ 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 to 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 and temperature, starting in current, no load/full load current etc.

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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	<p>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</p> <p>Similar equipment's, steel stack/chimney, furnace etc.</p> <p>Low frequency, medium frequency, high frequency rotating machines like compressors (centrifugal, reciprocating, diaphragm, screw, gear type etc.). Induced draft fan, forced draft fan, air blowers, pumps (centrifugal, reciprocating, diaphragm, 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</p>
2	Epoxy grout	Specifically if requested by the Machine vendor

#### 5.1 Grout (Material)

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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/mm <sup>2</sup>
		30 kN/mm <sup>2</sup>
	at 7 Days :	40 kN/mm <sup>2</sup>
	at 28 Days	
Minimum Tensile Strength	at 28 Days	20 kN/mm <sup>2</sup>
Minimum Bond Strength	at 7 Days :	12 kN/mm <sup>2</sup>
Maximum on strained expansion in	2 Hours :	4%
		2000 kN/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 final 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 :

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Minimum Compressive Strength	at 1 Day	:	75 kN/mm <sup>2</sup>
	at 7 Days	:	85 kN/mm <sup>2</sup>
Minimum Flexural Strength	at 7 Days	:	25 kN/mm <sup>2</sup>

## 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 plate 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


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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

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# ENGINEERING STANDARD



**GAIL INDIA LIMITED**

## TECHNICAL SPECIFICATION FOR BALL VALVES

**GAIL-STD-PI-DOC-TS-021**


Rev	Date	Purpose	Prepared By	Checked By	Approved By
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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
ASME B 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


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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:

$$CE = \%C + \% Mn + \%Cr + \%Mo + \%V + \%Ni + \%Cu \quad 6 \quad 5 \quad 15$$

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- 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 offered by Manufacturer, the Charpy V-notch test requirements of applicable material standard shall 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<sub>10</sub> 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

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- 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 of nominal valve size DN 250 mm (10") & above, shall have provision for secondary sealant injection under full line pressure for seat and stem seals. All sealant injection connections shall be provided with an internal non-return valve. Valve design shall have a provision to replace the sealant injection fitting under full line pressure. Valves shall be provided with vent and drain connections. Drain sizes shall be in accordance with API 6D or MSS-SP-45. Drain sizes 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 arrangement of 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 conform 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:

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- 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.
- $P = 1.5 \times D.P$   
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  $\leq 3$ bar.
- 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

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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 used shall 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) 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 times shall be as indicated in Valve Data Sheet. Valve operating times shall correspond to full close to full open/ full open to full close under maximum differential pressure corresponding to the valve rating. For actuated valves, the actuator's rated torque output shall be 1.25 times the break torque required to operate the ball valve under the maximum differential pressure corresponding to the Valve Class Rating.
- c) For the manual 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

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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 the Manufacturer.
- 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 basis without causing damage to either the valve component or the pig. The full bore, valve shall provide an unobstructed profile for pigging operations in either direction. Full bore valves shall be designed to minimize accumulation of debris in the seat ring region to ensure that valve movement is not impeded. The bore size of 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			
Nominal Valve Size	Reduced Bore Sizes	Nominal Valve Size	Reduced Bore Sizes
DNmm(NPSinches)	DNmm(NPSinches)	DNmm(NPSinches)	DNmm(NPSinches)
50(2)	50(2)	600 (24)	500(20)
80(3)	50(2)	650(26)	550(22)

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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 by self-relieving seat rings/ assemblies. Self-relieving seat rings shall relieve at a body cavity differential pressure not exceeding 50% of the valve class rating pressure.

### 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 ° 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 - 29° C. The average value per series of 3 test specimen shall be equal to 35 J/cm<sup>2</sup>. The minimum value per test specimen

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shall be equal to 35 J/cm<sup>2</sup>; this value may drop to 28 J/cm<sup>2</sup> 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 dye penetrator or wet - 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 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 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 (N<sub>2</sub>), shell and seat testing including extended stem at 1.1 x Design Pressure(300#)
- Air seat test at 7 kg/cm<sup>2</sup>
- Hyd. Shell Test at 1.5 times of rated design pressure

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- 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

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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 this specification.

The certificates shall be valid only when signed by Purchaser's Inspector. Only those valves which have been certified by Purchaser's Inspector shall be dispatched from Manufacturer's works.

## 7.0 PAINTING, MARKING AND SHIPMENT

- 7.1 Valve surface shall be thoroughly cleaned, freed from rust and grease and applied with sufficient coats of corrosion resistant paint. Surface preparation shall be carried out by shot blasting to SP-6 in accordance with "Steel Structures Painting Council - Visual Standard SSPC-VIS-1". For the valves to be installed underground, when indicated in Valve Data Sheet, the external surfaces of buried portion of the valve shall be painted with three coats of suitable 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

Technical Specification for Ball Valves	<b>Doc No.</b>	<b>Rev</b>	
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furnish necessary field welding instructions and post-weld test procedure to 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.

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- 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 manufacture 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.

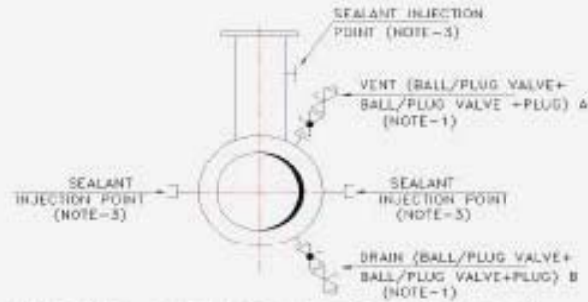
9.5 All documents shall be in English language only.

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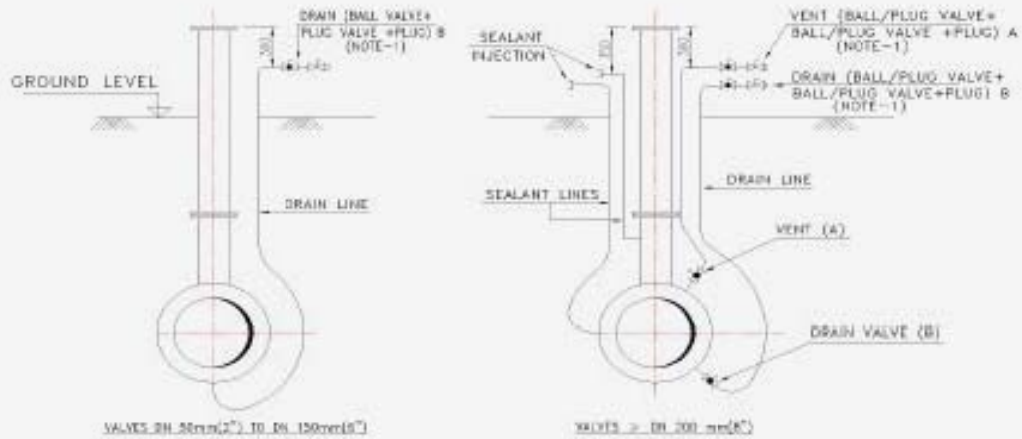
**10.0 GUARANTEE**

- 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.

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**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	25 (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-6D.
  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 BURED SECTION, ALL VENT & DRAIN CONNECTION SHALL BE OF WELDED CONSTRUCTION.

**FIGURE-1**

**VENT, DRAIN & SEALANT INJECTION DETAILS**







**DATA SHEET FOR  
INSULATING JOINT  
FOR 4"**

Doc No.GAIL-034-PL-DS-002

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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

0	30.01.19	Issued for Bid	AP	TR	SB
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**DATA SHEET FOR  
INSULATING JOINT  
FOR 4”**

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**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.

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**DATA SHEET FOR  
INSULATING JOINT  
FOR 4”**

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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.

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**DATA SHEET FOR  
INSULATING JOINT  
FOR 12”**

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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

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**DATA SHEET FOR  
INSULATING JOINT  
FOR 12”**

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**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.

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**DATA SHEET FOR  
INSULATING JOINT  
FOR 12”**

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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.

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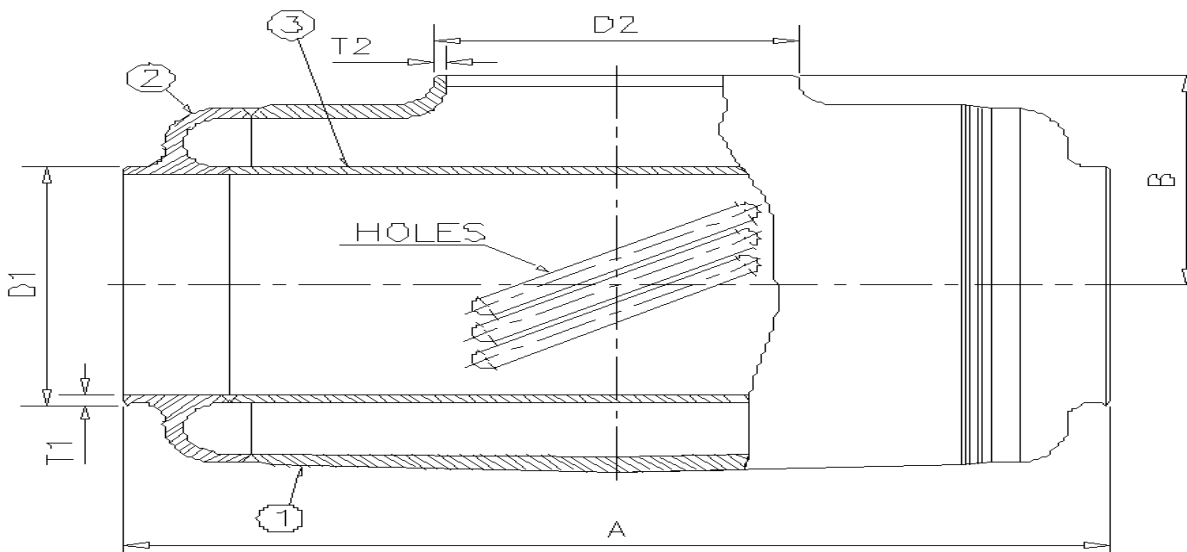
Doc No.  
GAIL-STD-PI-DOC-DS-003

## DATA SHEET OF FLOW TEE



Lyons Engineering Pvt. Ltd.

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<b>DESIGN DATA</b>					
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				
<b>FLOW TEE MATERIAL (Equivalent or superior)</b>					
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			
0	24.12.2018	Issued For Bid	AP	JR	SB
Rev.	Date	Purpose	Prepared By:	Checked By:	Approved By:



Gail India Ltd.

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GAIL-STD-PI-DOC-DS-003**DATA SHEET OF  
FLOW TEE**

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3	Internal sleeve	API 5L Gr B (SMLS) Or Equivalent			
<b>S.NO</b>	<b>CONNECTING PIPELINE DETAILS</b>				
	<b>RUNNING PIPE DETAILS</b>		<b>BRANCH PIPE DETAILS</b>		
	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 deg to 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.

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 <b>Doc No.</b> GAIL-STD-PI-DOC-DS-004	<b>DATA SHEET  OF QUICK OPENING  END CLOSURE</b>	 Page 1 of 1
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<b>QUANTITY</b>	2	<b>SIZE</b>	VTC
SERVICE	NATURAL GAS		
<b>DESIGN CONDITIONS</b>			
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)	Scraprer trap L/R		
ASME U Stamp requirement	Yes		
<b>QOEC MATERIAL DETAIL</b>			
<b>PART</b>	<b>SPECIFIED MATERIAL</b>	<b>MATERIAL OFFERED</b>	
PRESSURE CONTAINING PARTS	VTC		
INSERTS/Door Seal	Viton		
<b>Connecting Major Barrel Material Detail</b>			
S.NO.	O.D.(inch)	MATERIAL	
1	8"	API 5L Gr. X-42/ Equivalent material	
<b>Inspection Testing &amp; Certification</b>			
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.

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## DATA SHEET OF INSULATING GASKET



Page 1 of 2

<b>1. PROCESS DATA :</b>	
PIPE CLASS	6A1
PRESSURE RATING	600 #
<b>FLUID</b>	NATURAL GAS
Fluid Symbol	NG
<b>OPERATING CONDITIONS</b>	
Pressure (barg)	-
Temperature (°C)	-
<b>DESIGN CONDITIONS</b>	
Pressure (barg)	98
Temperature (°C)	-29 TO 65 for A/G
<b>2. CONSTRUCTION DATA :</b>	
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 or G11) 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
<b>INSULATING GASKET KIT</b>	
INSULATING GASKET	One central gasket
INSULATING SLEEVE	One Nos. per bolt
INSULATING WASHER	Two Nos. per bolt
METALLIC WASHER	Two Nos. per bolt
<b>INSPECTION AND TESTING</b>	
HYDROSTATIC TEST	<p>Tested at 1.5 times of Design Pressure in following manner</p> <ul style="list-style-type: none"> <li>• 5 minutes at hydrotest pressure (at 1.5 times the rated pressure at 100°F)</li> <li>• Reduce to Zero.</li> </ul>
PNEUMATIC TEST	<p>Insulating flange assembly shall be tested with air at 5 kg/cm<sup>2</sup> for 10 minutes. The tightness shall be checked by immersion or with a frothing agent. No leakage shall be accepted.</p>
DIELECTRIC TEST	<p>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.</p>
INSULATION RESISTANCE	<p>Each insulating gasket assembly shall be at least 25 mega ohms when checked with 500V – 1000V D.C. This test shall</p>

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	<b>DATA SHEET OF INSULATING GASKET</b>	
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	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
<b>Notes:</b>	
<ol style="list-style-type: none"> <li>1. Manufacture shall guarantee that proposed Insulating Gasket shall withstand test pressure equal to 1.5 times design pressure of Pipeline.</li> <li>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).</li> <li>3. Voltage and leakage shall be recorded and certified. The test shall be carried out in dry conditions for insulations Resistance test.</li> <li>4. Insulating Gasket shall be fitted in Flanges (Weld neck raised face &amp; Blind).</li> <li>5. Flanges Dimension standard shall be as per ASME B 16.5.</li> <li>6. (*) To be indicated by vendor in his bid.</li> </ol>	

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# ENGINEERING STANDARD



GAIL INDIA LIMITED

DATA SHEET - CLEAN AGENT SYSTEM

GAIL-STD-PI-DOC-DS-006


Rev	Date	Purpose	Prepared By	Checked By	Approved By
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**ABBREVIATIONS:**

kg/m<sup>2</sup> : Kilogram Per Square Meter

NFPA : National Fire Protection Association

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**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-2001 separately for each station)

- 1.0 Type of system : Total flooding centralized system (Mention name of agent & manufacturer)
- Normal Charging Pressure : Formula  
: \_\_\_\_C\_\_\_\_

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- 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 : FM/UL/LPC/VSD &  
TAC FM/UL/LPC/ VDS & TAC  
(This must be acceptable to TAC).
- g) Approved-by CCE : YES
- h) Working pressure (kg/cm<sup>2</sup>) : C
- i) Design Pressure (kg/cm<sup>2</sup>) : As per NFPA-2001
- j) Dimension of Cylinder Dia x length x thickness : C
- 3.4 Pipes, valves and fittings.
- a) Manufacturers

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- 
- 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<sup>2</sup>) : As per NFPA
- f) Directional Valve
- i. Make and Type : C
  - ii. Material of Construction : C
  - iii. Test Pressure (kg/cm<sup>2</sup>) : 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 SOCKET  
WELDED BALL VALVE (SIZE  
BELOW 2" - 800#)**





**Doc No.**  
GAIL-STD-PI-DOC-DS-007

Page 1 of 2

DATA SHEET FOR BALL VALVES (BELOW 2" 800#)		
Sr. No.	Description	Specification
<b>GENERAL</b>		
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
<b>SERVICE CONDITIONS</b>		
6	Service	Natural Gas
7	Design Pressure	98 Bar-g
8	Design Temperature	-29°C to 65°C
<b>VALVE CONSTRUCTION DESIGN</b>		
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
<b>VALVE MATERIAL SPECIFICATION</b>		
	<b>Part</b>	<b>Specified Material / Equivalent Material</b>
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
<b>VALVE TESTING REQUIREMENT</b>		
29	Fire Resistant Design Requirement	As per API 6FA/API 607
30	Hydrostatic Test	Body 147 barg& 30 Min

0	01.02.19	Issued For Bid	AP	JR	SB
Rev.	Date	Purpose	Prepared By:	Checked By:	Approved By:

 <b>Doc No.</b> GAIL-STD-PI-DOC-DS-007	<b>DATA SHEET FOR SOCKET  WELDED BALL VALVE (SIZE  BELOW 2”- 800#)</b>	 Page 2 of 2
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		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.

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**DATA SHEET FOR SOCKET  
WELDED PLUG VALVE (SIZE  
BELOW 2" - 800#)**





**Doc No.**  
GAIL-STD-PI-DOC-DS-008

Page 1 of 2

DATA SHEET FOR BALL VALVES ( BELOW 2" 800#)			
Sr. No.	Description	Specification	
<b>GENERAL</b>			
1	Valve Size	Below 2"	
2	ANSI Rating	ANSI 800#	
3	Design Standard	BS5353	
4	Corrosion allowance	1.5MM	
5	Design Factor	0.5	
<b>SERVICE CONDITIONS</b>			
6	Service	Natural Gas	
7	Design Pressure	98 Bar-g	
8	Design Temperature	-29°C to 65°C	
<b>VALVE CONSTRUCTION DESIGN</b>			
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	
<b>VALVE MATERIAL SPECIFICATION</b>			
	<b>Part</b>	<b>Specified Material / Equivalent Material</b>	
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	
<b>VALVE TESTING REQUIREMENT</b>			
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	

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	<b>DATA SHEET FOR SOCKET WELDED PLUG VALVE (SIZE BELOW 2”- 800#)</b>	
<b>Doc No.</b> GAIL-STD-PI-DOC-DS-008		Page 2 of 2

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.

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**DATA SHEET FOR SOCKET WELDED  
GLOBE VALVE  
(Below 2" Size-800#)**



**Doc No.**  
GAIL-STD-PI-DOC-DS-009

Page 1 of 3

**DATA SHEET FOR GLOBE VALVES**

Sr. No.	Description	Specification
<b>GENERAL</b>		
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
<b>SERVICE CONDITIONS</b>		
6	Service	Natural Gas
7	Design Pressure	98 Barg
8	Design Temperature	-29°C to 65°C
<b>VALVE CONSTRUCTION DESIGN</b>		
9	Location	Above Ground
10	End Connections	Socket Welded (As per ASME B 16.11)
11	Body/ Bonnet connection	Bolted
<b>VALVE MATERIAL SPECIFICATION</b>		
	<b>Part</b>	<b>Specified Material or Equivalent Material</b>
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
<b>VALVE TESTING REQUIREMENT</b>		
25	Hydrostatic Test	Body: 147 barg & 30 Min; Seat: 107.8 barg & 30 Min
26	Anti-Static Testing Requirement	As Per Code

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Rev.	Date	Purpose	Prepared By:	Checked By:	Approved By:

	<b>DATA SHEET FOR SOCKET WELDED GLOBE VALVE (Below 2" Size-800#)</b>	
<b>Doc No.</b> GAIL-STD-PI-DOC-DS-009		Page 2 of 3

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.

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	<b>DATA SHEET FOR SOCKET WELDED GLOBE VALVE (Below 2" Size-800#)</b>	
<b>Doc No.</b> GAIL-STD-PI-DOC-DS-009		Page 3 of 3

- 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.

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**GAIL INDIA LIMITED**

**DATASHEET  
FOR  
GLOBE VALVE 2 INCHES TO 24 INCHES**

**GAIL-STD-IN-DOC-DS-010**


0	11.04.2019	Issued for Bid	AP	JR	SB
Rev	Date	Purpose	Prepared By	Checked By	Approved By



<b>Valve Manufacturer</b>		-----	
<b>Actuator Manufacturer</b>		<b>Not Applicable</b>	
<b>Valve Tag No.</b>		-----	
<b>Purchaser's spec.:</b>	GAIL-STD-ME-DOC-TS-016	<b>ANSI Rating:</b>	150#/300#/600#
<b>Design standard:</b>	BS 1873 / API 6D	<b>Piping class:</b>	A1A / B1A/D1A
<b>SIZE, mm (IN) NB:</b>	50 (2") TO 400 (20")		
<b>Ends:</b>	BOTH ENDS FLANGED AS PER ASME B16.5	<b>Face finish of flanges:</b>	125 AARH (Smooth Finish), if FL
<b>VALVE DESIGN CONDITIONS:</b>			
<b>Corrosion Allowance:</b>	1.5 mm	<b>Temperature, °c:</b>	-29 TO 65
<b>Service</b>	Natural Gas	<b>Installation:</b>	Above Ground
<b>Design factor:</b>	0.5		
<b>CONNECTING PIPE DETAILS:</b>			
<b>Diameter (NB) mm</b>	-----		
<b>Wall Thickness, mm</b>	-----		
<b>Grade</b>	-----		
<b>VALVE MATERIAL SPECIFICATION:</b>			
<b>PART DESCRIPTION</b>	<b>SPECIFIED MATERIAL</b>	<b>MATERIAL OFFERED</b>	
<b>Body</b>	ASTM A 216 Gr. WCB		
<b>Bonnet (Bolted)</b>	ASTM A 216 Gr. WCB		
<b>Stem (Rising)</b>	13% Chrome Steel ( No Casting)		
<b>Disc (Loose Plug/ Ball type)</b>	13% Chrome Steel facing / 13% Chrome Steel		
<b>Body Seat Ring</b>	13% Chrome Steel facing / 13% Chrome Steel		
<b>Stem Packing</b>	Graphite Asbestos with sacrificial corrosion inhibitor and inconel wire reinforcement		
<b>Hand Wheel</b>	Malliable Iron/ Cast Steel/Duct Iron/ Fab Steel		
<b>Bonnet Bolts</b>	ASTM A 193 Gr. B7		
<b>Bonnet Nuts</b>	ASTM A 194 Gr 2H		
<b>Bonnet Gasket</b>	Spiral wound SS 304 + CA Filler		

**Note:**

- Charpy V-notch test on each heat of base material shall be conducted for all pressure containing parts such as body, end flange, welding ends as well as bolting material as per ASTM A-370. The test shall be conducted at -29 deg C. The mini. Avg. absorbed energy per set of three specimen shall BE 27J with individual minimum per specimen of 22J.
- Hardness test shall be carried out on each heat of base material for all pressure containing parts of the valve. A full thickness cross section shall be taken for this purpose and the maximum hardness shall not exceed 248 HV10 based on minimum four measurements representing the entire thickness.
- Valves shall be thoroughly cleaned and applied with sufficient coats of corrosion resistant paint. Surface preparation shall be carried out by shot blasting to SP-6 in accordance with "Steel Structures Painting Council – Visual Standard SSPC VIS-1".
- Testing shall be as per BS EN 12266-1.
- 100% Valve castings shall undergo radiographic examination.
- Stem packing shall be renewable with Valve Open on stream.
- Painting of the valves shall be as per Manufacturer's Standard.
- Material Test certificates and hydro test reports shall be furnished prior to dispatch.
- The data sheet shall be read in conjunction with technical notes for valves.


Datasheet for Globe Valve 2"-24"	<b>Doc No.</b>	<b>Rev.</b>	
	GAIL-STD-IN-DOC-DS-010	0	
	Page 2 of 2		



**GAIL INDIA LIMITED**

**DATASHEET  
FOR  
BALL VALVES 2 INCHES TO 24 INCHES**


**GAIL-STD-IN-DOC-DS-011**

						
0	11.04.2019	Issued for Bid	AP	JR	SB	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

Valve Manufacturer		-----	
Actuator Manufacturer		-----	
Valve Tag No.			
Purchaser's spec.:	GAIL-STD-ME-DOC-TS-008	ANSI Rating:	150#/300# /600#
Design standard:	API 6D	Piping class:	A1A / B1A / D1A
SIZE, mm (IN) NB:	50 (2") – 600 (24")	VALVE BORE:	FULL
Ends:	Flanged End as per ASME B16.5 RF/ BW End as per ASME 16.25	Face finish of flanges:	125 AARH (Smooth Finish), if FL
<b>VALVE DESIGN CONDITIONS:</b>			
Corrosion Allowance:	1.5 mm	Temperature, °c:	-29 TO 65
Service	Natural Gas	Installation:	Above Ground/ Below Ground
Design factor:	0.5		
<b>CONNECTING PIPE DETAILS:</b>			
-----			
<b>VALVE OPERATOR REQUIREMENT</b>		<b>STEM EXTENSION REQUIREMENT</b>	
Type of Operator	-----	Stem Extension	NOT REQUIRED
Operator Spec. No.:	-----	Length of Stem extension, m	NA
Operator Data Sheet:	-----		
<b>VALVE MATERIAL SPECIFICATION:</b>			
<b>PART DESCRIPTION</b>	<b>SPECIFIED MATERIAL</b>	<b>MATERIAL OFFERED</b>	
Body	ASTM A 216 Gr. WCB/ ASTM A 216 Gr. WCC/ ASTM A 350 LF2		
Ball	(ASTM A 216 Gr. WCB/ ASTM A 216 Gr. WCC/ ASTM A350 LF2) + 0.003" ENP		
Body Seat Rings	(AISI 4140 + 0.003" ENP) / AISI 410/ A 350 LF2 & PTFE		
Seat Seal (Secondary)	VITON or Superior		
Stem	(AISI 4140 + 0.003" ENP) / AISI 410/ ASTM A 350 LF2 + 0.003" ENP		
Stem seal	PTFE / VITON		
Stud, Bolts	ASTM A 193 Gr. B7/ Gr. B7M		
Nuts	ASTM A 194 Gr. 2H/ Gr. 4/ Gr. 7		

**Note:**

1. The data sheet shall be read in conjunction with technical specification for ball valves Doc.No. GAIL-STD-ME-DOC-TS-008 & Technical Notes for Pipeline Valves Doc. No. GAIL-STD-ME-DOC-TS-016.
2. All inspection and testing shall be carried out as per API 6D.
3. Fire test shall be carried out as per fire testing as specified in API 6FA.

Datasheet for Ball Valve 2"-24"	<b>Doc No.</b>	<b>Rev.</b>	
	GAIL-STD-IN-DOC-DS-011	0	
	Page 2 of 3		

For BW Valve


1. Material of body shall have guaranteed minimum yield strength of 2/3<sup>rd</sup> of pipe strength. In case the same cannot be guaranteed, valve shall be provided with a 300 mm pup piece integrally welded to the valve whose strength shall be equivalent to attached pipe specification.
2. For the welding end, the out of roundness (i.e. difference between maximum and minimum ID at pipe end) shall be maximum 4.5 mm for 36" size and 3.5 mm for up to 30" size. Tolerance on internal diameter at pipe ends shall be same as diameter tolerance for the pipe ends indicated in API 5L Table-10

For BW/ FE Valve

1. All valves shall have provision for local operation as well as remote actuated operation. Refer Datasheet for Gas Powered Valve Actuator.
2. The data sheet shall be read in conjunction with valve specification, actuator specification & actuator data sheet enclosed in the bid.

For Manual Valve

1. Requirement of manual operator (Wrench/ Hand wheel/ Gear Operator) shall be as per Specification for Ball Valve, Spec. No. GAIL-STD-ME-DOC-TS-008.
2. Separate wrench shall be provided with each wrench-operated valve.

Datasheet for Ball Valve 2"-24"	<b>Doc No.</b>	<b>Rev.</b>	
	GAIL-STD-IN-DOC-DS-011	0	
	Page 3 of 3		



**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	
<b>1</b>	<b>Procedure</b>								
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	
<b>2</b>	<b>Material Inspection</b>								
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	
<b>3</b>	<b>In Process Inspection</b>								
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.	
<b>4</b>	<b>Final Inspection</b>								
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	
<b>5</b>	<b>Painting</b>								
5.1	Corrosion protection painting & Color Coding as applicable	Visual Inspection & Color Coding	100%	Refer Note-6	Refer Note-5	Inspection Report	H	R	
<b>6</b>	<b>Documentation &amp; IC</b>								
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), **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:**

- Wherever W/R is indicated, Inspection Engineer shall decide the option to be exercised for the particular stage and supplier.
- 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.
- In case of conflict between purchase specification, contract documents and QAP, more stringent conditions shall be applicable.
- This document describes generally the requirements pertaining to all types of the item. Requirements specific to PO and the item are only applicable.
- 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.
- Reference documents are relevant Specifications/ Data sheets/ Applicable Codes & Standards.
- For all forging materials, The specimen shall be taken from the integral part of the forging.
- 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	<b>RAW MATERIAL</b>							
1.1	REVIEW OF PROCEDURES	REVIEW OF HYDROTEST, NDT PROCEDURES BY TPI	DOCUMENT REVIV	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	<b>INPROCESS INSPECTION.</b>							
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	HYDROSTTIC 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
	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	<b>FINAL INSPECTION</b>							
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



## 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
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
<b>RAW MATERIAL INSPECTION</b>							
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
<b>IN PROCESS</b>							
1	HEAT TREATMENT	Quenching, Normalising and Tempering	ASTM A 234 Gr.WPB	HT Records	Visual & Review of T.C.	P	R
<b>DESTRUCTIVE TESTING - PRODUCT</b>							
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
<b>FINAL</b>							
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 Manufacturer'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 Issue 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	<b>RAW MATERIAL</b>							
	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	<b>IN PROCESS INSPECTION.</b>							
	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

 <b>GAIL INDIA LTD.</b>	<b>QUALITY ASSURANCE PLAN FASTNERS</b>	<b>DOCUMENT NO: GAIL-STD-PI-DOC-QAP-007 Rev:00</b>	
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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.

		REVIEWED & ACCEPTED BY	
PREPARED BY:	APPROVED 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	<b>RAW MATERIAL</b>							
	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	<b>INPROCESS INSPECTION.</b>							
	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	<b>FINAL INSPECTION</b>							
	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	<b>FINAL DOCUMENTS</b>							
	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 STRAIGHT CONDITION SHLL BE APPLICABLE.
  4. QUANTITY AS PER APPROVED P&ID.

REVIEWED & ACCEPTED BY			
PREPARED BY:	APPROVED BY:	CONSULTANT:	CLIENT: GAIL



**QUALITY ASSURANCE PLAN –BALL VALVE**

GAIL-STD-PI-DOC-QAP-009

**QUALITY ASSURANCE PLAN – BALLVALVE**

REV	DATE	DESCRIPTION	PREP	CHK	APPR
0	16.01.2019	ISSUEDFORBID	AP	JR	SB

**1.0 SCOPE:**

This Quality Assurance Plan covers the minimum testing requirements of Ball Valves.

**2.0 REFERENCE DOCUMENTS:**

PO /PR/Standards referred there in /Job specifications/Approved documents.

**3.0 INSPECTION AND TEST REQUIREMENTS:**

SL. NO.	COMPONENT & OPERATION	CHARACTERISTICS/METHOD OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT & ACCEPTANCE CRITERIA	FORMAT OF RECORD	SCOPE OF INSPECTION	
						SUPPLIER	TPIA
1.0	RAW MATERIAL						
1.1	Casting: Body & Bonnet/Connector	Chemical: Chemical Analysis	All Heats	Material & Technical Specification	Vendor Test Certificate	100% R	R
		Mechanical: Mechanical Test	All Heats	Material & Technical Specification	Vendor Test Certificate	100% R	R
		Impact (@ - 29°C) : Impact Test	All Heats	ASME B16.34	Test Report	100% R	R
		Non Destructive Examination (NDT): Radiography (100% Critical Area & BW Ends)	100%	ASME B16.34	RT Report	100% R	R
		Non Destructive Examination (NDT): Magnetic Particle Examination (100% exterior & accessible interior)	100%	ASME B16.34	MPI Report	100% R	R

SL. NO.	COMPONENT & OPERATION	CHARACTERISTICS/METHOD OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT & ACCEPTANCE CRITERIA	FORMAT OF RECORD	SCOPE OF INSPECTION	
						SUPPLIER	TPIA
1.2	Forging: Ball, Seat Ring & Spindle/Stem	Chemical: Chemical Analysis	All Heats	Material & Technical Specification	Vendor Test Certificate	100% R	R
		Mechanical: Mechanical Test	All Heats	Material & Technical Specification	Vendor Test Certificate	100% R	R
		Impact (@ -29°C): Impact Test	All Heats	ASME B16.34	Test Report	100% R	R
		NonDestructive Examination (NDT): Radiography (100% Critical Area & BW Ends)	100%	ASME B16.34	RT Report	100% R	R
		NonDestructive Examination (NDT): Magnetic Particle Examination (100% exterior & accessible interior)	100%	ASME B16.34	MPI Report	100% R	R
		ENP (For Ball): Visual, Thickness & Hardness	100%	25 microns (min) & 50 HRC (min)	Vendor Test Certificate	100% R	R
2.0	INCOMING/ BOF ITEMS						
2.1	Stem	Chemical: Chemical Analysis	All Heats	Material & Technical Specification	Vendor Test Certificate	100% R	R
		Mechanical: Mechanical Test	All Heats	Material & Technical Specification	Vendor Test Certificate	100% R	R

SL. NO.	COMPONENT & OPERATION	CHARACTERISTICS/METHOD OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT & ACCEPTANCE CRITERIA	FORMAT OF RECORD	SCOPE OF INSPECTION	
						SUPPLIER	TPIA
2.2	Fasteners	Chemical: Chemical Analysis	All Heats	Material & Technical Specification	Vendor Test Certificate	100% R	R
		Mechanical: Mechanical Test	All Heats	Material & Technical Specification	Vendor Test Certificate	100% R	R
		Impact (@ -29°C): Impact Test	All Heats	ASME B16.34	Test Report	100% R	R
3.0	MACHINED COMPONENTS						
3.1	Body, Connector, Ball & Seat Ring	Surface examination & Dimension Inspection: Visual & Measurement	100%	Manufacturer's Drawing	GRN	100% R	R
4.0	IN-PROCESS						
4.1	Body & Connector joint welding	Non Destructive Examination (NDT): Magnetic Particle Examination (MPI)	100%	ASME Sec VIII- Appendix V & VI	MPI Report	100% R	R
4.2	Valve & Pup Piece Bevel End joint welding	Non Destructive Examination (NDT): Radiography (100% on weld joint)	100%	ASME B16.34	RT Report	100% R	R

SL. NO.	COMPONENT & OPERATION	CHARACTERISTICS/METHOD OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT & ACCEPTANCE CRITERIA	FORMAT OF RECORD	SCOPE OF INSPECTION	
						SUPPLIER	TPIA
5.0	FINAL INSPECTION						
5.1	Finished Valve Assembly: Pressure Test & Final Inspection	Shell Test: Hydrostatic	100%	Testing Procedure as per Code	Test Record	W	W
		Seat Test: Hydrostatic				W	W
		Seat Test: Pneumatic				W	W
		Functional Test- Actuated Valve @ Atm. Pressure & Max. Diff. Pressure: Operation-Open/Close				W	W
		Double Block & Bleed: Hydrostatic				W	W
		Final Inspection: Visual, Dimension, TC Verification, Special Requirements & Marking as per sale order	100%	Approved GA Drawing (if applicable)	SCN	~	W
		Anti-Static Test	100%	API 6D & Technical Specification	Test Record	W	W
		Fire Safe Test	100%	API-6FA/ISO-10497	Fire safety type test report	~	R
5.2	Painting & Packing	Surface examination & DFT Inspection: Visual & Measurement	100%	As per Tender Specification	Painting Record	100%	W

**Legend:**

H -Hold(Do not proceed without approval), P -

Perform,

RW- Random Witness [As specified or 10% (min. 1 no. of each size and type of Bulk items)], R -Review,

W-Witness(Give due notice, work may proceed after scheduled date).

**NOTES (As applicable):**

1. Supplier Test Certificate to be reviewed by CLIENT/TPIA.
2. This document describes the generic test requirements. Any additional test or inspection scope if specified/required in contract documents shall also be applicable (unless otherwise agreed upon).
3. Acceptance Norms for all the activities shall be as per PO/PR/STANDARDS referred there in/Job Specification/Approved Documents.
4. For orders placed on stockist, items shall be accepted based on manufacturer's TC with EN310204 type 3.2 certification from approved suppliers.



QUALITY ASSURANCEPLAN- GLOBEVALVE

GAIL-STD-PI-DOC-QAP-010

QUALITY ASSURANCEPLAN- GLOBEVALVE

REV	DATE	DESCRIPTION	PREP	CHK	APPR
0	16.01.2019	ISSUED FORBID	AP	JR	SB



**1.0 SCOPE:**

This Quality Assurance Plan covers the minimum testing requirements of Globe Valves.

**2.0 REFERENCE DOCUMENTS:**

PO /PR/Standards referred there in /job specifications/approved documents.

**3.0 INSPECTION AND TEST REQUIREMENTS:**

APPLICABLE CODES AND SPECIFICATIONS WITH AMENDMENTS									SCOPE OF INSPECTION	
SL. NO.	STAGE	COMPONENT	CHARACTERISTICS	METHOD OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD	Vendor	TPI
1a	Incoming Material	Castings, Forgings & b/o Items	Surface Quality & Dimensions	Visual	Each piece	Applicable PO and Specifications	Applicable PO and Specifications	Inspection Report / B/o Certificates	W	R
1b	Incoming Material	----Do----	Chemical, Mechanical Properties & HT requirements (Note special requirement of heat treatment hardness, impact, Bend, tensile etc. for H <sub>2</sub> Service & NACE)	Review of Documents	All Heats	As per applicable PO and Specifications	As per applicable PO and Specifications	Inspection Report / Vendor TC/ HT Records	R	R

APPLICABLE CODES AND SPECIFICATIONS WITH AMENDMENTS									SCOPE OF INSPECTION	
SL. NO	STAGE	COMPONENT	CHARACTERISTICS	METHOD OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD	Vendor	TPI
1c	Incoming Material	Castings/ Forgings of Austenitic Stainless steel	Intergranular Corrosion (IGC) Test & Stabilisation heat treatment	Chart or TC Lab Check	Per solution Annealed lot	Asper applicable PO and Specifications	Asper applicable PO and Specifications	HT Chart or TC	R	R
1d	Incoming Material	RT Castings	Radiography Examination	Review of RT films	Applicable PO and Specifications	Asper applicable PO and Specifications	Asper applicable PO and Specifications	Film and report	R	R
2	WPS, PQR, WPQ Previous Qualifications or Overlay/ Stellite	Body seating / Wedge	Thickness of overlay/ stellite, Hardness	Visual & Hardness	100%	Applicable PO and Specifications	Applicable PO and Specifications	WPS/ PQR/ WPQ	— W	H/ R <sup>[1]</sup>
3	Hydrostatic Test	Finished Valve	Pressure testing for body and seat	Hydrostatic Test	100% by manufacturer and at random by LEPL	Approved drawings, Applicable PO and Specifications	Approved drawings, Applicable PO and Specifications	Test Report	W	H
4	Pneumatic Test	Finished Valve	Pressure Testing for seat/ back seat	Approved drawings, Applicable PO and Specifications	100% by manufacturer and at 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 / operation Test	Approved drawings, Applicable PO and Specifications	100% by manufacturer and at random by LEPL	Approved drawings, Applicable PO and Specifications	Approved drawings, Applicable PO and Specifications	Test Report	W	H

APPLICABLE CODES AND SPECIFICATIONS WITH AMENDMENTS									SCOPE OF INSPECTION	
SL. NO.	STAGE	COMPONENT	CHARACTERISTICS	METHOD OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	RECORD	Vendor	TPI
6	NDT Testing	Forgings & Plate components	UT/ MPT/DPT	UT/ MPT/ DPT	100% by manufacturer and at 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	PMI Check	X-Ray Florescence/ Emission Spectrometer	As per Company specification	Company specification	As per applicable PO and Specifications		W	H
8	Final Inspection	Finished Valve	Visual, Dimensional	Visual & Std measuring instruments	100% by manufacturer and at 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 List as per applicable PO and Specifications	---	Approved drawings, Applicable PO and Specifications	Approved drawings, Applicable PO and Specifications	---	W	R

**Legend:**

H -Hold(Do not proceed without approval),

P -Perform,

RW- Random Witness [As specified or 10%(min. 1 no. of each size and type of Bulk items)],

R -Review,

W-Witness(Give due notice, work may proceed after scheduled date).

**NOTES (As applicable):**

1. Supplier Test Certificate to be reviewed by CLIENT/TPIA.
2. This document describes the generic test requirements. Any additional test or Inspection scope if specified/required in contract documents shall also be applicable (unless otherwise agreed upon).
3. Acceptance Norms for all the activities shall be as per PO/PR/STANDARDS referred there in/Job Specification/Approved Documents.
4. For orders placed on stockist, items shall be accepted based on manufacturer's TC with EN310204 type 3.2 certification from approved suppliers.



**QUALITY ASSURANCE PLAN –PLUGVALVE**

GAIL-STD-PI-DOC-QAP-011

**QUALITY ASSURANCEPLAN–PLUGVALVE**

REV	DATE	DESCRIPTION	PREP	CHK	APPR
0	16.01.2019	ISSUEDFORBID	AP	JR	SB

**1.0 SCOPE:**

This Quality Assurance Plan covers the minimum testing requirements of Plug Valves.

**2.0 REFERENCE DOCUMENTS:**

PO /PR/Standards referred there in /Job specifications/Approved documents.

**3.0 INSPECTION AND TEST REQUIREMENTS:**

SL. NO.	COMPONENT & OPERATION	CHARACTERISTICS/METHOD OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT & ACCEPTANCE CRITERIA	FORMAT OF RECORD	SCOPE OF INSPECTION	
						SUPPLIER	TPIA
1.0	RAW MATERIAL						
1.1	Casting: Body & Bonnet/Connector	Chemical: Chemical Analysis	All Heats	Material & Technical Specification	Vendor Test Certificate	100% R	R
		Mechanical: Mechanical Test	All Heats	Material & Technical Specification	Vendor Test Certificate	100% R	R
		Impact (@ -29°C): Impact Test	All Heats	ASME B16.34	Test Report	100% R	R
		Non Destructive Examination (NDT): Radiography (100% Critical Area & BW Ends)	100%	ASME B16.34	RT Report	100% R	R
		Non Destructive Examination (NDT): Magnetic Particle Examination (100% exterior & accessible interior)	100%	ASME B16.34	MPI Report	100% R	R

SL. NO.	COMPONENT & OPERATION	CHARACTERISTICS/METHOD OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT & ACCEPTANCE CRITERIA	FORMAT OF RECORD	SCOPE OF INSPECTION	
						SUPPLIER	TPIA
1.2	Forging: Ball, Seat Ring & Spindle/Stem	Chemical: Chemical Analysis	All Heats	Material & Technical Specification	Vendor Test Certificate	100% R	R
		Mechanical: Mechanical Test	All Heats	Material & Technical Specification	Vendor Test Certificate	100% R	R
		Impact (@ - 29°C): Impact Test	All Heats	ASME B16.34	Test Report	100% R	R
		Non Destructive Examination (NDT): Radiography (100% Critical Area & BW Ends)	100%	ASME B16.34	RT Report	100% R	R
		Non Destructive Examination (NDT): Magnetic Particle Examination (100% exterior & accessible interior)	100%	ASME B16.34	MPI Report	100% R	R
		ENP (For Ball): Visual, Thickness & Hardness	100%	25 microns (min) & 50 HRC (min)	Vendor Test Certificate	100% R	R
2.0	INCOMING/ BOF ITEMS						
2.1	Stem	Chemical: Chemical Analysis	All Heats	Material & Technical Specification	Vendor Test Certificate	100% R	R
		Mechanical: Mechanical Test	All Heats	Material & Technical Specification	Vendor Test Certificate	100% R	R

SL. NO.	COMPONENT & OPERATION	CHARACTERISTICS/METHOD OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT & ACCEPTANCE CRITERIA	FORMAT OF RECORD	SCOPE OF INSPECTION	
						SUPPLIER	TPIA
2.2	Fasteners	Chemical: Chemical Analysis	All Heats	Material & Technical Specification	Vendor Test Certificate	100%R	R
		Mechanical: Mechanical Test	All Heats	Material & Technical Specification	Vendor Test Certificate	100%R	R
		Impact (@ - 29°C): Impact Test	All Heats	ASME B16.34	Test Report	100%R	R
3.0	MACHINED COMPONENTS						
3.1	Body, Connector, Ball & Seat Ring	Surface examination & Dimension Inspection: Visual & Measurement	100%	Manufacturer's Drawing	GRN	100%R	R
4.0	IN-PROCESS						
4.1	Body & Connector joint welding	Non Destructive Examination (NDT): Magnetic Particle Examination (MPI)	100%	ASME Sec VIII- Appendix V & VI	MPI Report	100%R	R
4.2	Valve & Pup Piece Bevel End joint welding	Non Destructive Examination (NDT): Radiography (100% on weld joint)	100%	ASME B16.34	RT Report	100%R	R



SL. NO.	COMPONENT & OPERATION	CHARACTERISTICS/METHOD OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT & ACCEPTANCE CRITERIA	FORMAT OF RECORD	SCOPE OF INSPECTION	
						SUPPLIER	TPIA
5.0	FINAL INSPECTION						
5.1	Finished Valve Assembly: Pressure Test & Final Inspection	Shell Test: Hydrostatic	100%	Testing Procedure as per Code	Test Record	W	W
		Seat Test: Hydrostatic				W	W
		Seat Test: Pneumatic				W	W
		Functional Test- Actuated Valve @ atm. Pressure & Max. Diff. Pressure: Operation- Open/ Close				W	W
		Double Block & Bleed: Hydrostatic				W	W
		Final Inspection: Visual, Dimension, TC Verification, Special Requirements & Marking as per sale order	100%	Approved GA Drawing (if applicable)	SCN	~	W
		Anti-Static Test	100%	API 6D & Technical Specification	Test Record	W	W
		Fire Safe Test	100%	API-6FA/ ISO-10497	Fire safe type test report	~	R
5.2	Painting & Packing	Surface examination & DFT Inspection: Visual & Measurement	100%	As per Tender Specification	Painting Record	100%	W

**Legend:**

H -Hold(Do not proceed without approval),

P -Perform,

RW- Random Witness [As specified or 10% (min. 1 no. of each size and type of Bulk items)],

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**NOTES (As applicable):**

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3. Acceptance Norms for all the activities shall be as per PO/PR/STANDARDS referred there in/Job Specification/Approved Documents.
4. For orders placed on stockist, items shall be accepted based on manufacturer's TC with EN310204 type 3.2 certification from approved suppliers.

**SPECTACLE BLIND  
 FLANGE**

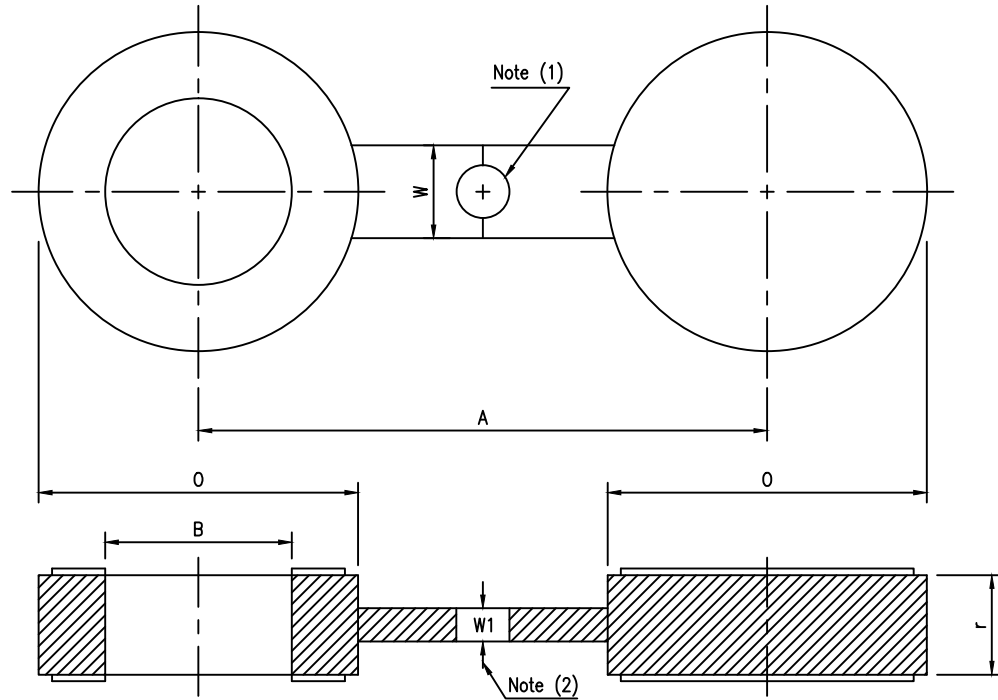


TABLE-4 DIMENSIONS OF CLASS 600 RAISED FACE FIGURE 8 BLANKS

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.

0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED



LYONS ENGINEERING PVT. LTD.  
NEW DELHI

ANCHOR FOR BARE PIPE  
SIZE 2" THRU 24"  
TYPE-G5 (FOR OFFSITE)

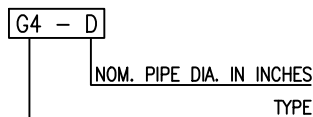
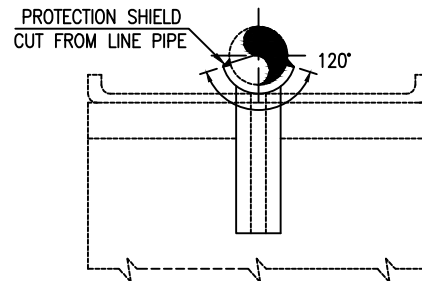
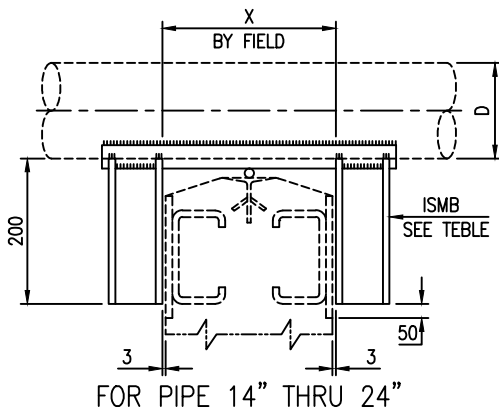
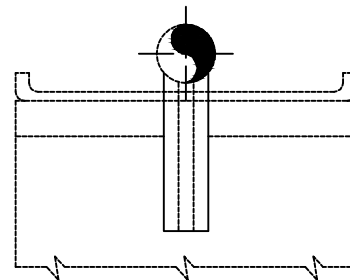
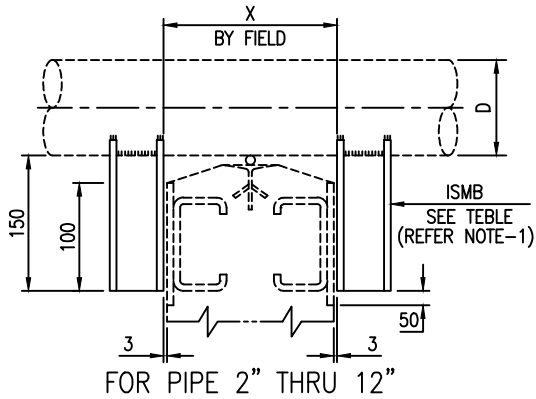
DRAWING NO.

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	



SYMBOL

NOTE:-

- FOR SUPPORTING DETAILS FOR PIPE SIZE 2" THRU 6", REFER STD. 7-44-0753.

0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED



LYONS ENGINEERING PVT. LTD.  
NEW DELHI

CROSS GUIDE FOR BARE  
PIPE SIZE 2" THRU 24"  
TYPE-G4 ( OFFSITE)

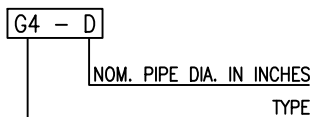
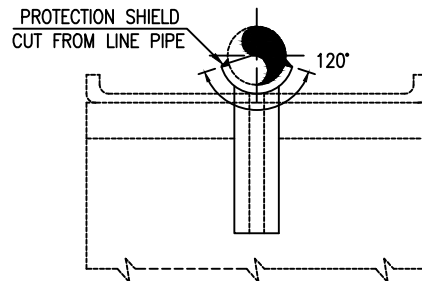
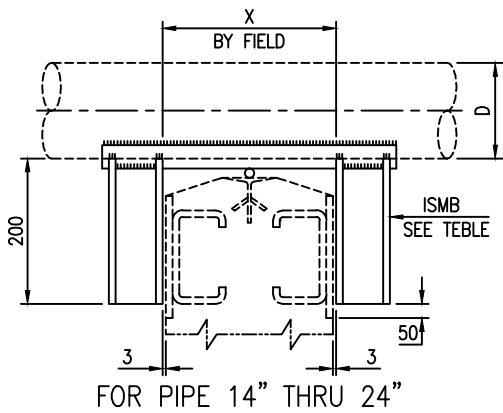
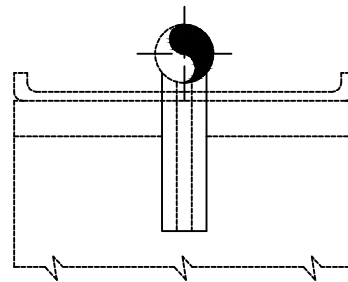
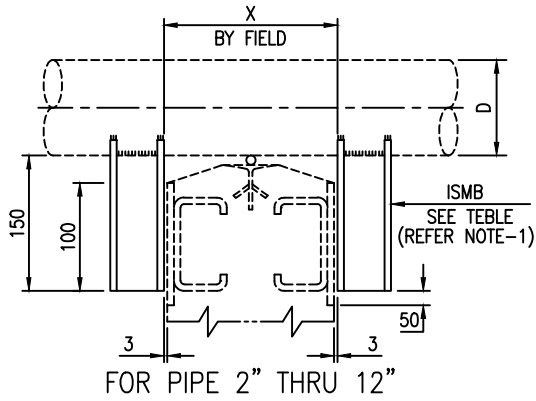
DRAWING NO.

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	



SYMBOL

NOTE:-

1. FOR SUPPORTING DETAILS FOR PIPE SIZE 2" THRU 6", REFER STD. 7-44-0753.

0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED



LYONS ENGINEERING PVT. LTD.  
NEW DELHI

CROSS GUIDE FOR BARE  
PIPE SIZE 2" THRU 24"  
TYPE-G3

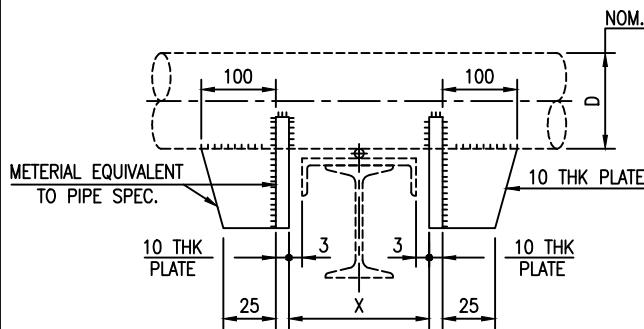
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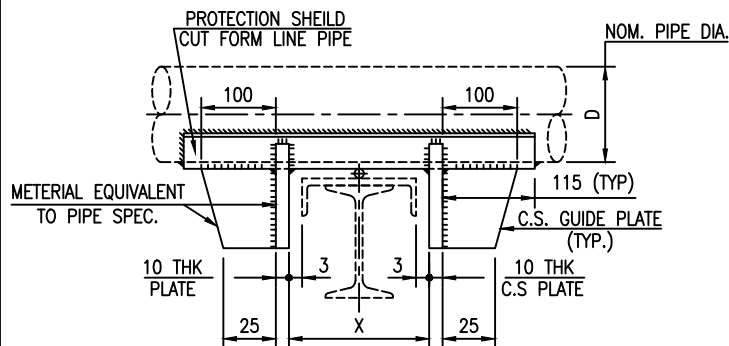
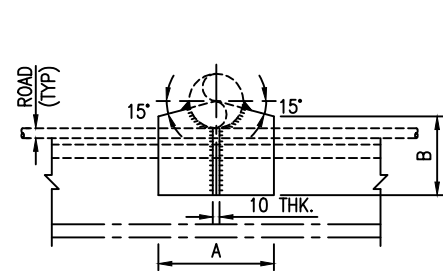
SHEET NO.

1 OF 1

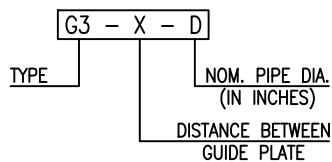
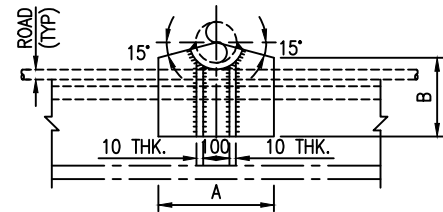
CROSS GUIDE													
D	2"	3"	4"	6"	8"	10"	12"	14"	16"	18"	20"	22"	24"
A	100	130	154	208	280	314	364	396	446	498	548	598	650
B	67	78	86	106	131	145	163	175	193	212	231	248	268



CROSS GUIDE 2" THRU 12"



CROSS GUIDE 14" THRU 24"



SYMBOL

NOTE:-

1. PROTECTION SHIELD SHALL BE CUT FROM LINE PIPE.

0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED



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NEW DELHI

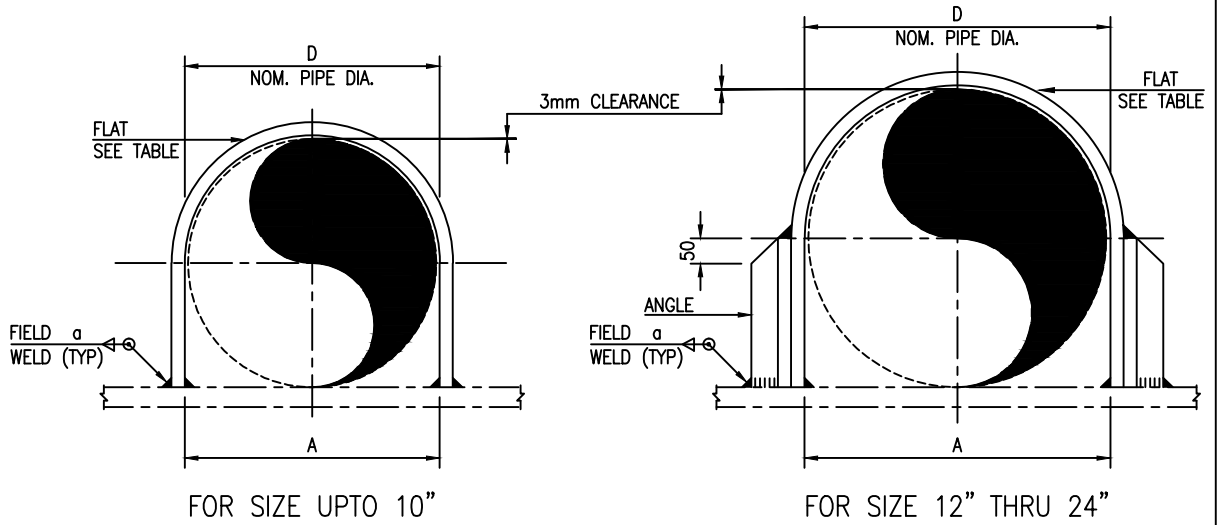
GUIDE SUPPORT FOR BARE PIPE  
SIZE 1/2" THRU 24" TYPE-G1

DRAWING NO.

GAIL-STD-PI-DWG-TP-005

SHEET NO.

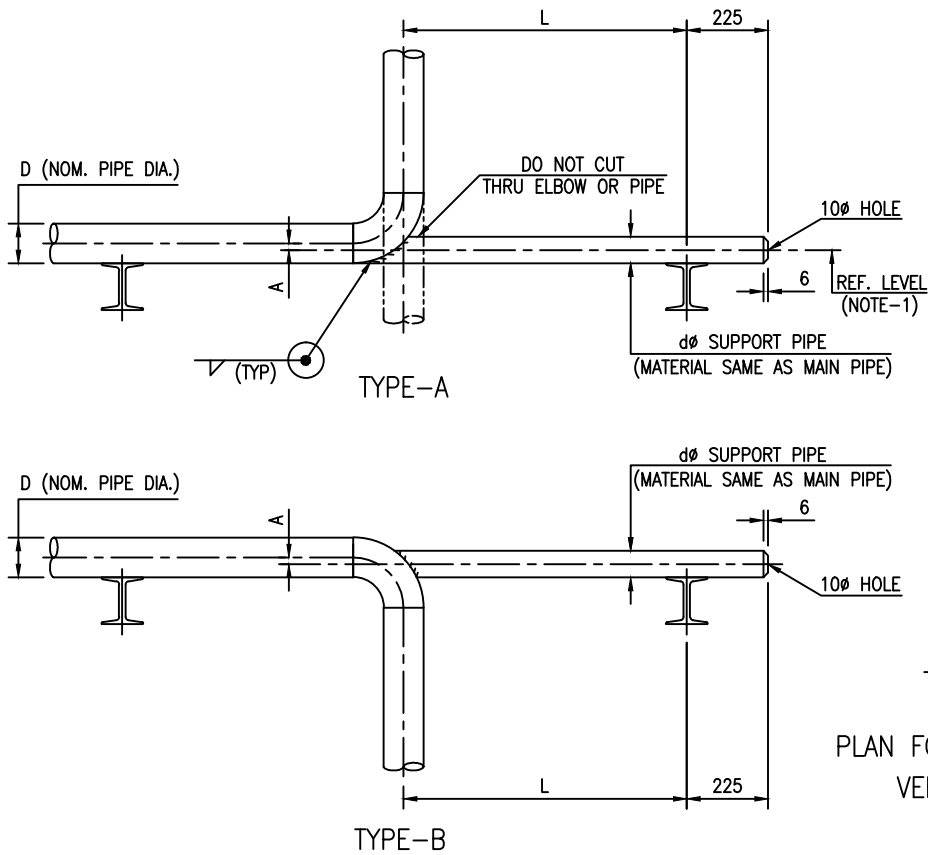
1 OF 1



D	A	$\alpha$	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	10	50 x 10	-
3 1/2"	107			
4"	120			
5"	146			
6"	174			
8"	225	10	65 x 12	75x75x10
10"	278			
12"	328			
14"	362	10	75 x 12	90x90x10
16"	412			
18"	463			
20"	515			
24"	616			

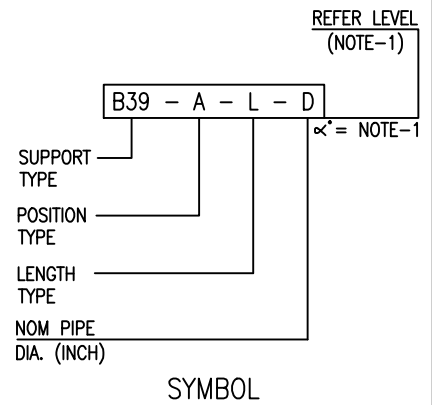
G1 - D  
 TYPE \_\_\_\_\_ NOM. PIPE DIA. (INCH)  
 SYMBOL

0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED



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



**NOTES:-**

1. REF. LEVEL &  $\alpha$ , 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.

0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED





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NEW DELHI

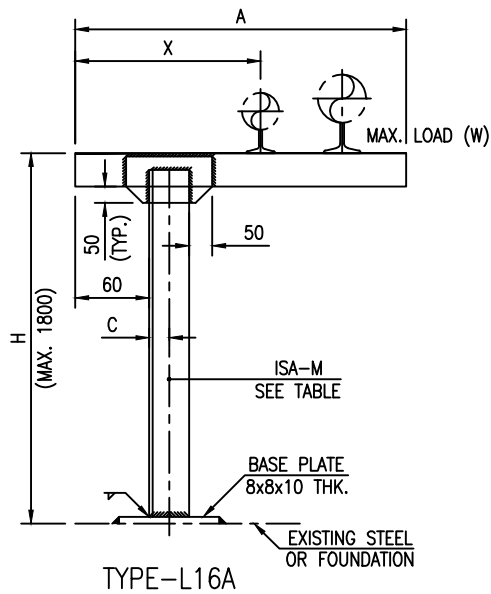
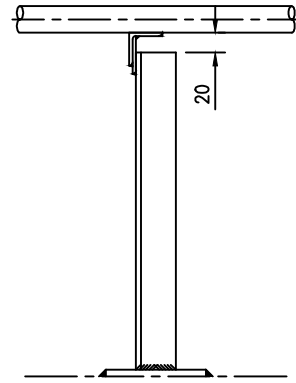
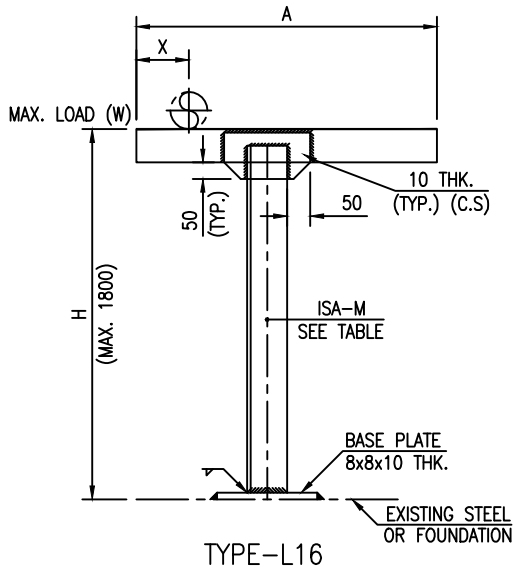
LOW SUPPORT STANCHION  
TYPE-L16 AND L-16A

DRAWING NO.

GAIL-STD-PI-DWG-TP-007

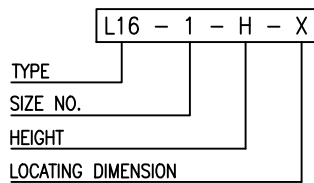
SHEET NO.

1 OF 1



NOTE:-

- DO NOT USE FOR ANCHORING THE PIPE.



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

0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED



LYONS ENGINEERING PVT. LTD.  
NEW DELHI

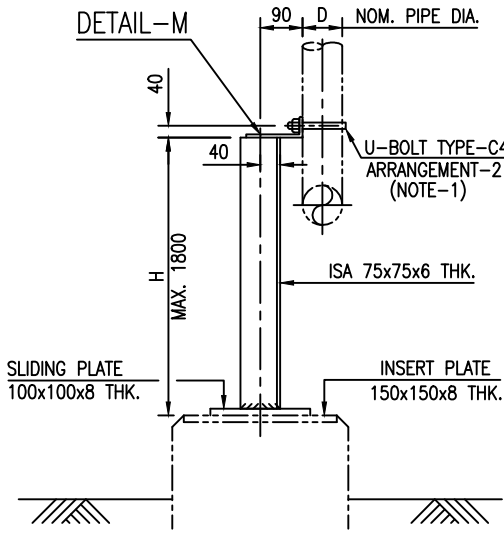
LOW SUPPORT SLIDING AND  
FIXED FOR PIPE SIZE 3/4"  
THRU 1.1/2" TYPE L-15

DRAWING NO.

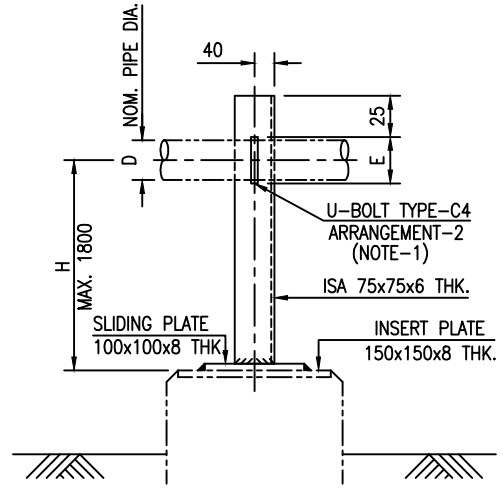
GAIL-STD-PI-DWG-TP-008

SHEET NO.

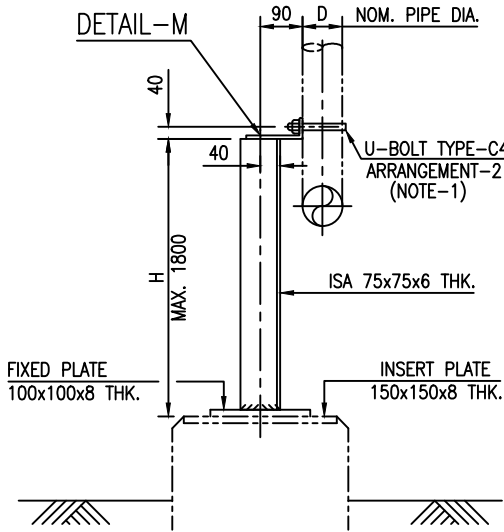
1 OF 1



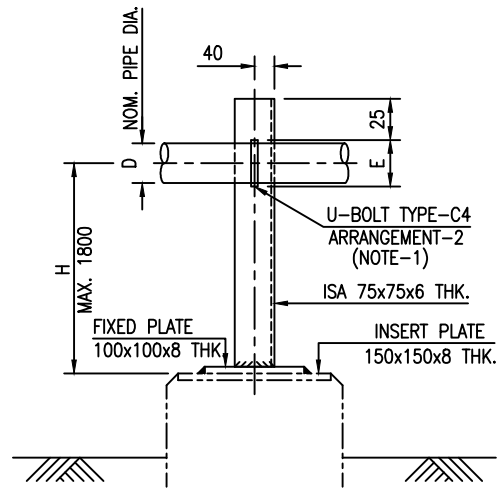
ARRANGEMENT TYPE-1  
(SLIDING)



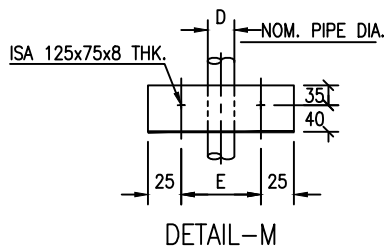
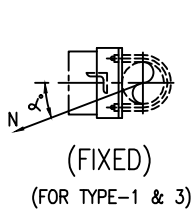
ARRANGEMENT TYPE-2  
(SLIDING)



ARRANGEMENT TYPE-3  
(FIXED)



ARRANGEMENT TYPE-4  
(FIXED)



$\alpha^\circ =$  (FOR TYPE 1 & 3) L15 - 1 - H - D

D	E
3/4"	36
1"	45
1 1/2"	60

TYPE  
ARRANGEMENT TYPE  
HEIGHT  
NOM. PIPE DIA. (INCH)

SYMBOL

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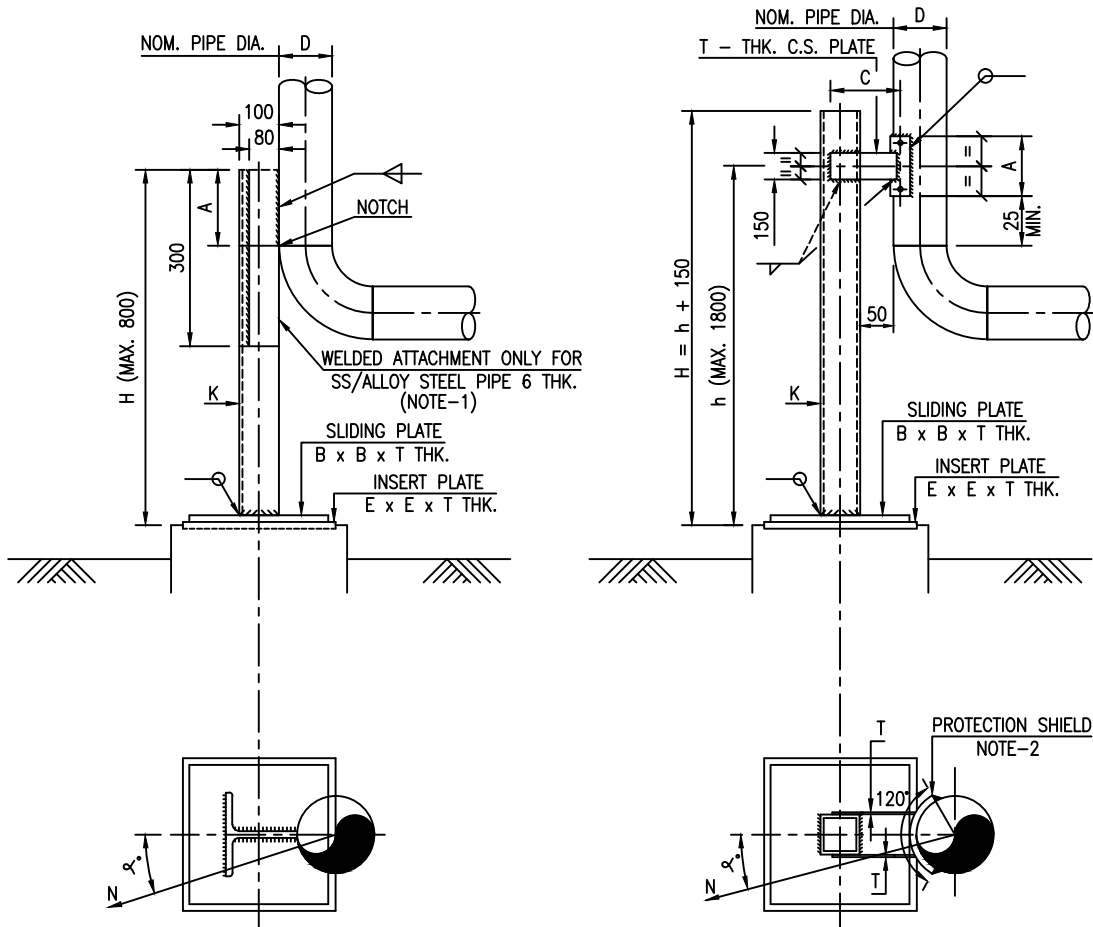
LOW SUPPORT SLIDING FOR BARE  
& INSULATED PIPE SIZE 2"  
THRU 24" TYPE-L6

DRAWING NO.

GAIL-STD-PI-DWG-TP-009

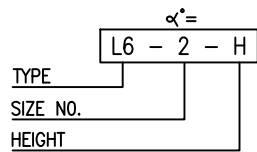
SHEET NO.

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

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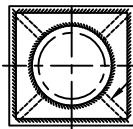
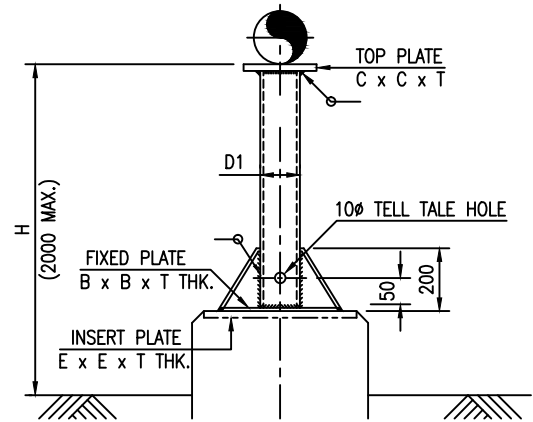
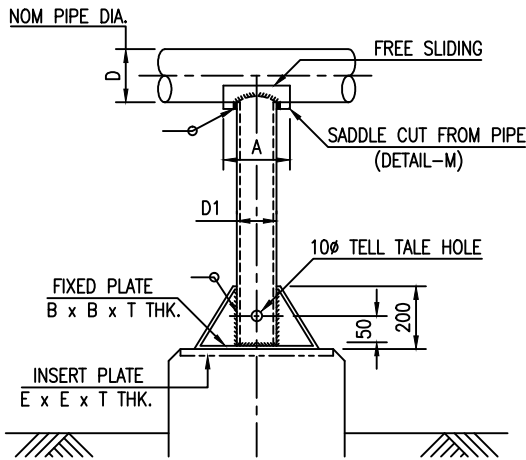
LOW SUPPORT SLIDING FOR BARE  
PIPE SIZE 3/4" THRU 36"  
TYPE-L5 & L-5A

DRAWING NO.

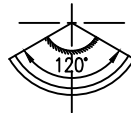
GAIL-STD-PI-DWG-TP-010

SHEET NO.

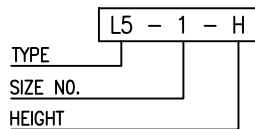
1 OF 1



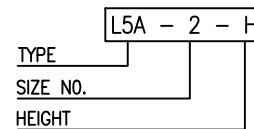
10 THK. PLATE TO BE  
WELDED WHEN H EXCEEDS 1000



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	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"						

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.

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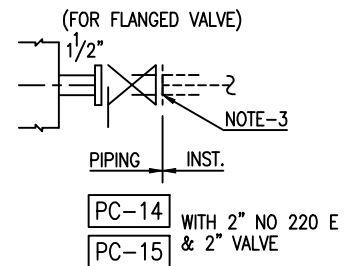
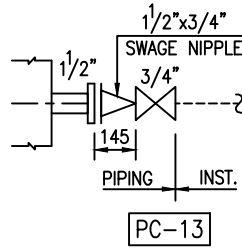
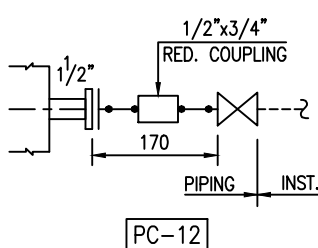
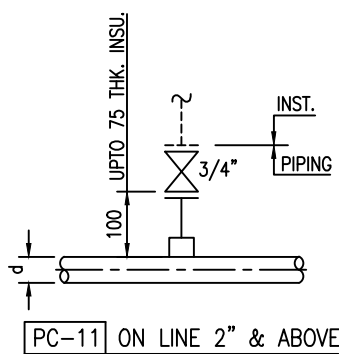
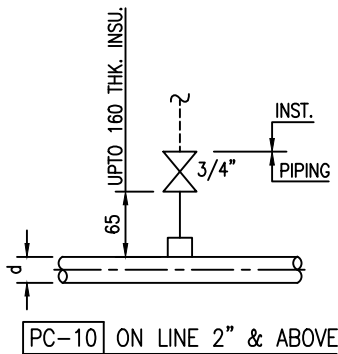
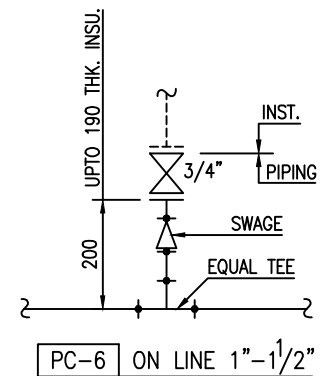
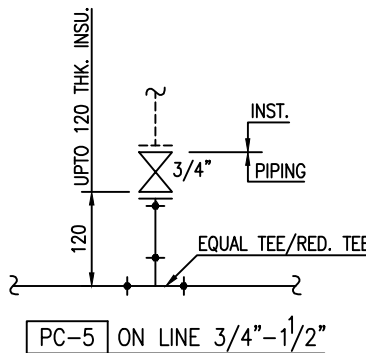
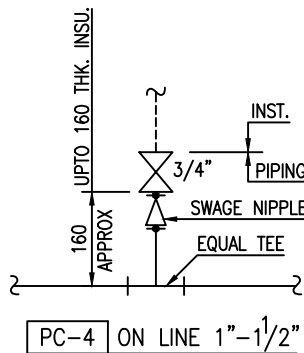
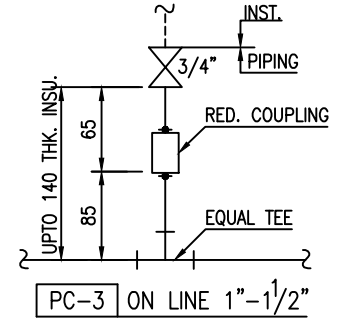
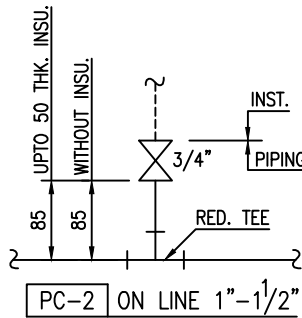
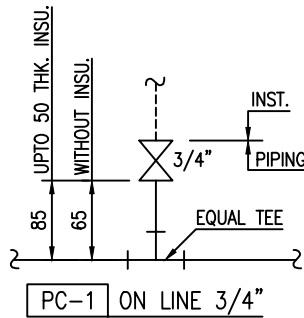
PRESSURE TAPPINGS  
(PA, PG, PC, PT, PIC ETC.)

DRAWING NO.

GAIL-STD-PI-DWG-TP-011

SHEET NO.

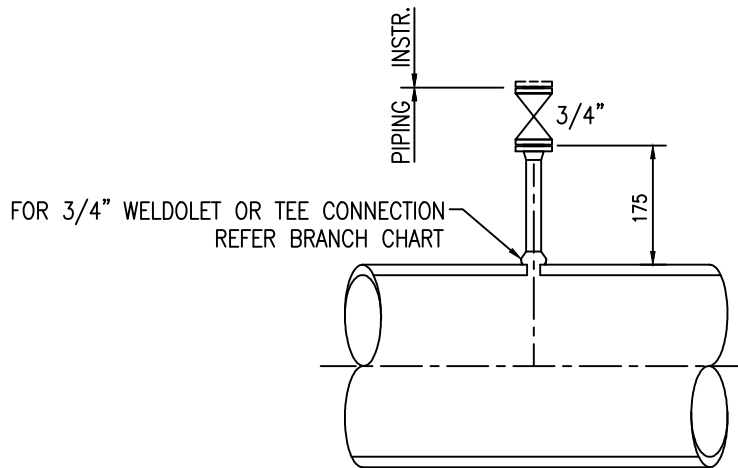
1 OF 1



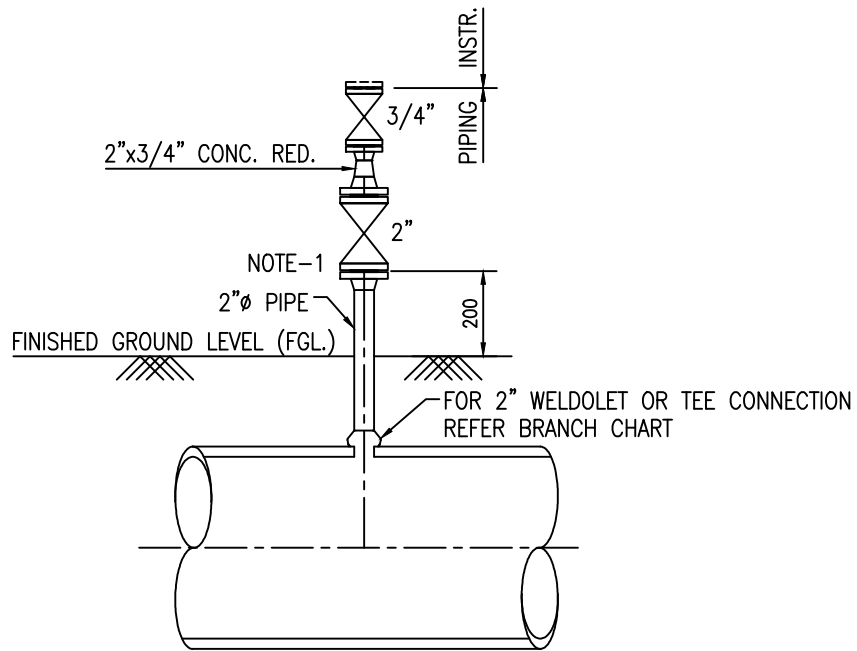
NOTES:-

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.

0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR
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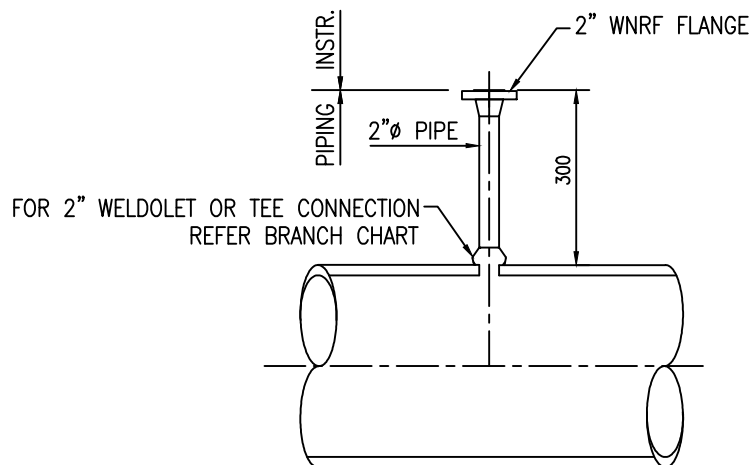
0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED



NOTE:

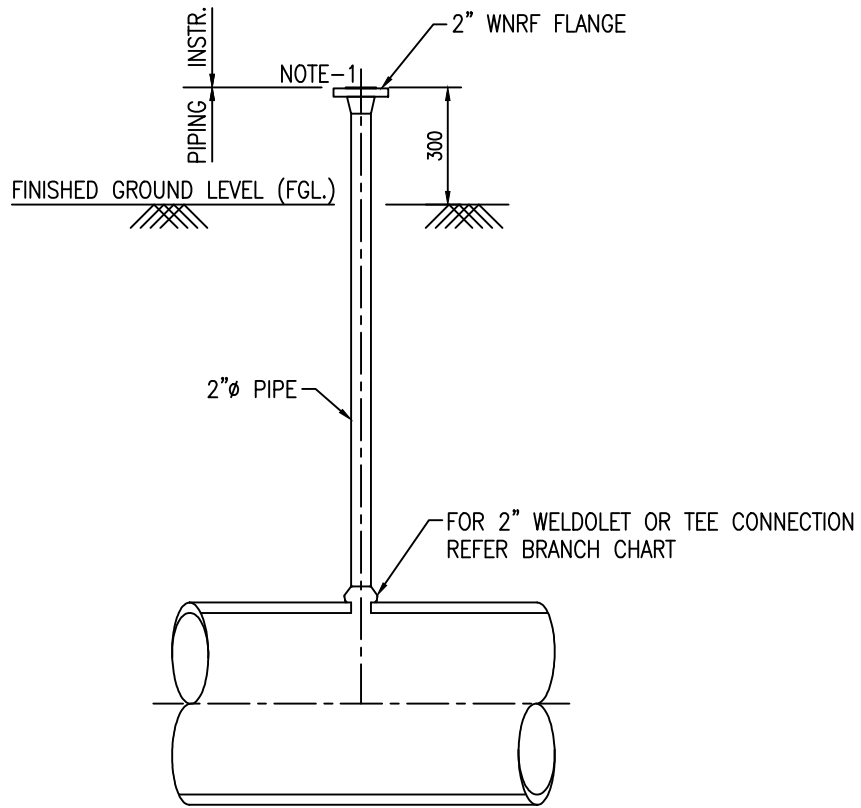
- 1 INSULATION GASKET SHALL BE INSTALLED.

0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED



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NOTE:  
 1 INSULATION GASKET SHALL BE INSTALLED.

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REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED



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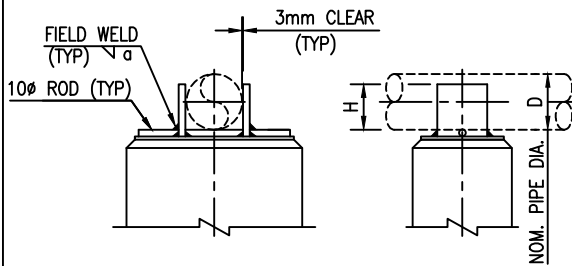
GUIDE SUPPORT FOR BARE PIPE  
(SIZE 1/2" TO 24") TYPE G2

DRAWING NO.

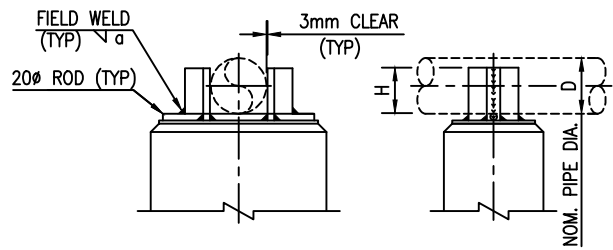
GAIL-STD-PI-DWG-TP-016

SHEET NO.

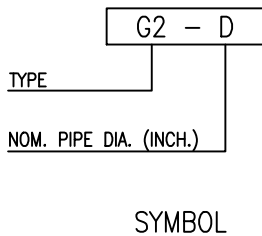
1 OF 1



FOR SIZES UPTO 4"



FOR SIZES 6" THRU 24"

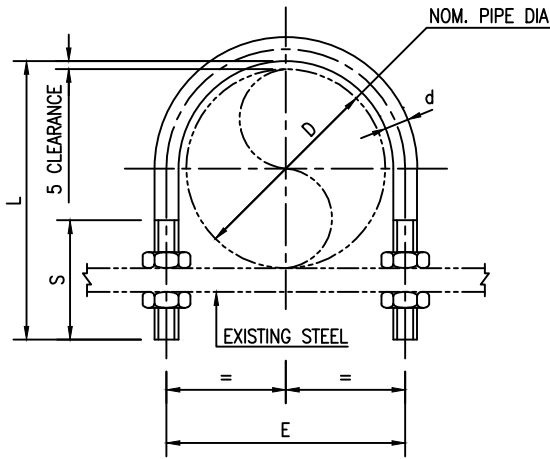


D	H	$\alpha$	METERIAL
2" & SMALLER	40	6	FLAT 60 x 10
3" TO 4"	70	6	FLAT 75 x 10
6" TO 8"	130	6	2 NOS. ISA 50 x 50 x 6
10" TO 18"	230	10	2 NOS. ISA 75 x 75 x 10
20" TO 24"	350	10	2 NOS. ISA 90 x 90 x 10

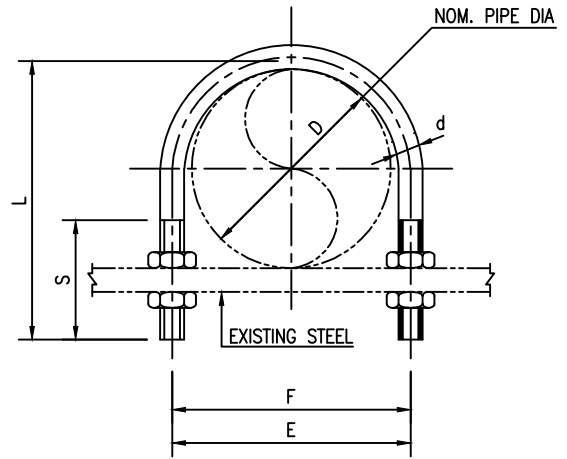
NOTES:-

GUIDE ANGLES SHOULD BE SUITABLY TRIMMED WHEREVER THESE OBSTRUCT ADJOINING GUIDE ANGLES.

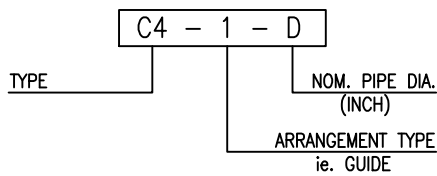
0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR
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**GUIDE**  
**ARRANGEMENT TYPE-1**  
**(1/2" TO 24")**



**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

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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:-

- 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.
- LEGEND : V = VENT; D = DRAIN; C = CAP; F = FLANGE; P = PLUG.

0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED



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VENTS AND DRAINS  
(ON LINES 1 1/2" AND BELOW)

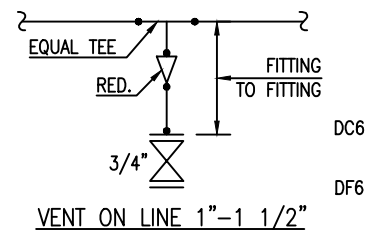
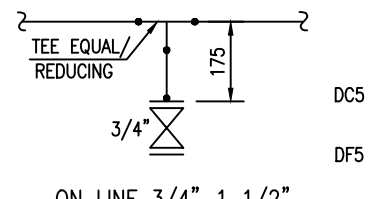
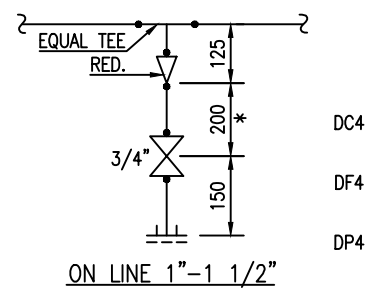
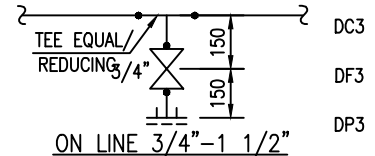
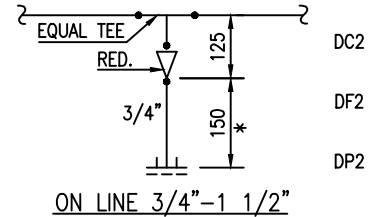
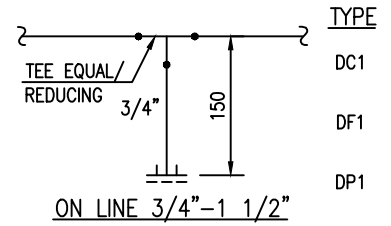
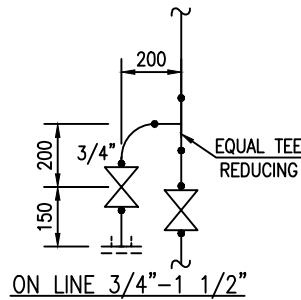
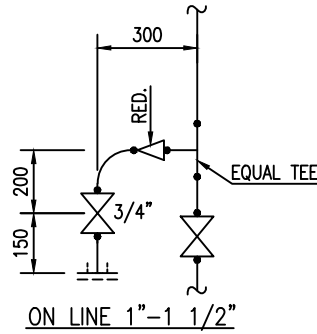
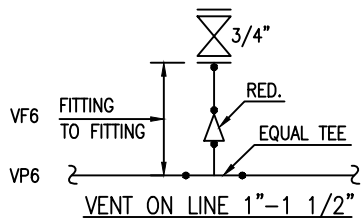
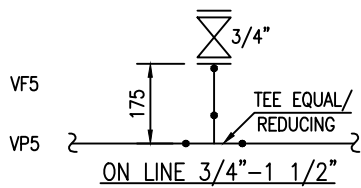
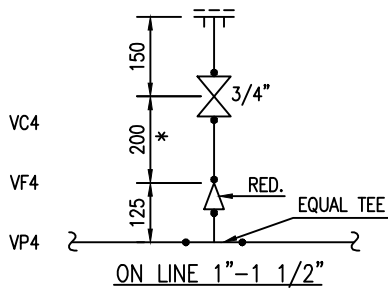
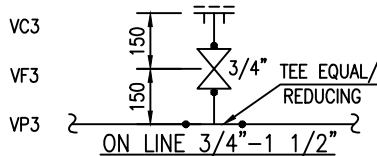
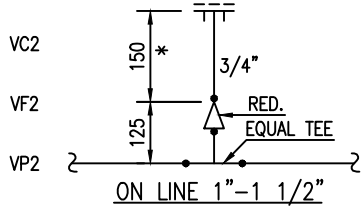
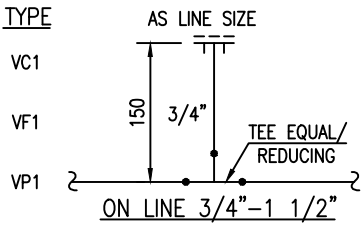
DRAWING NO.

GAIL-STD-PI-DWG-TP-019

SHEET NO.

1 OF 1

TYPE



TYPE

DC1

DF1

DP1

DC2

DF2

DP2

DC3

DF3

DP3

DC4

DF4

DP4

DC5

DF5

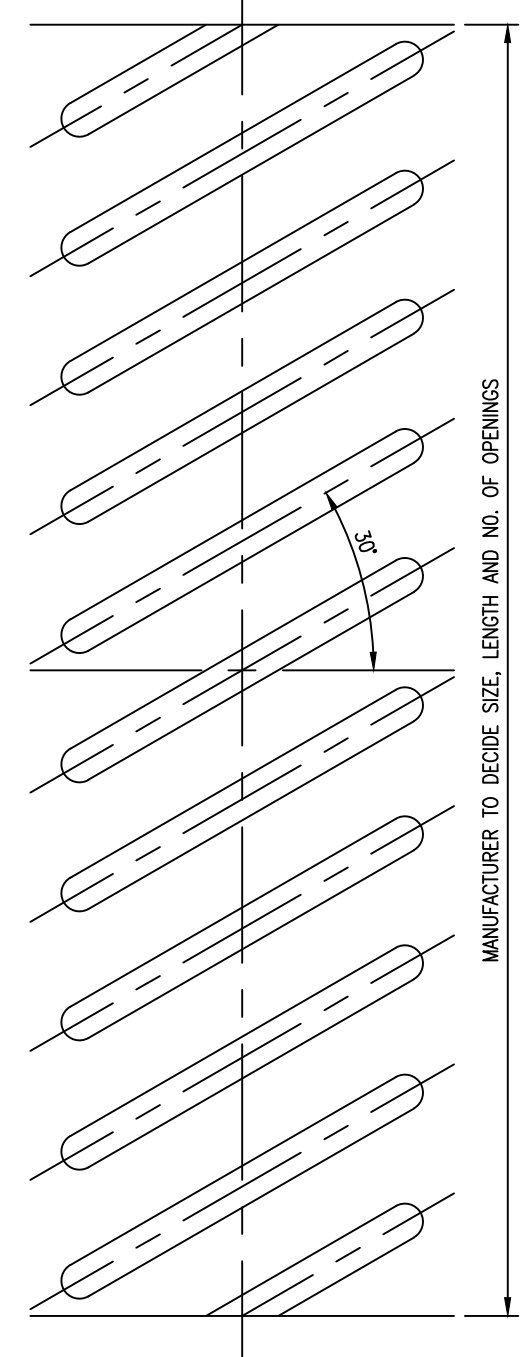
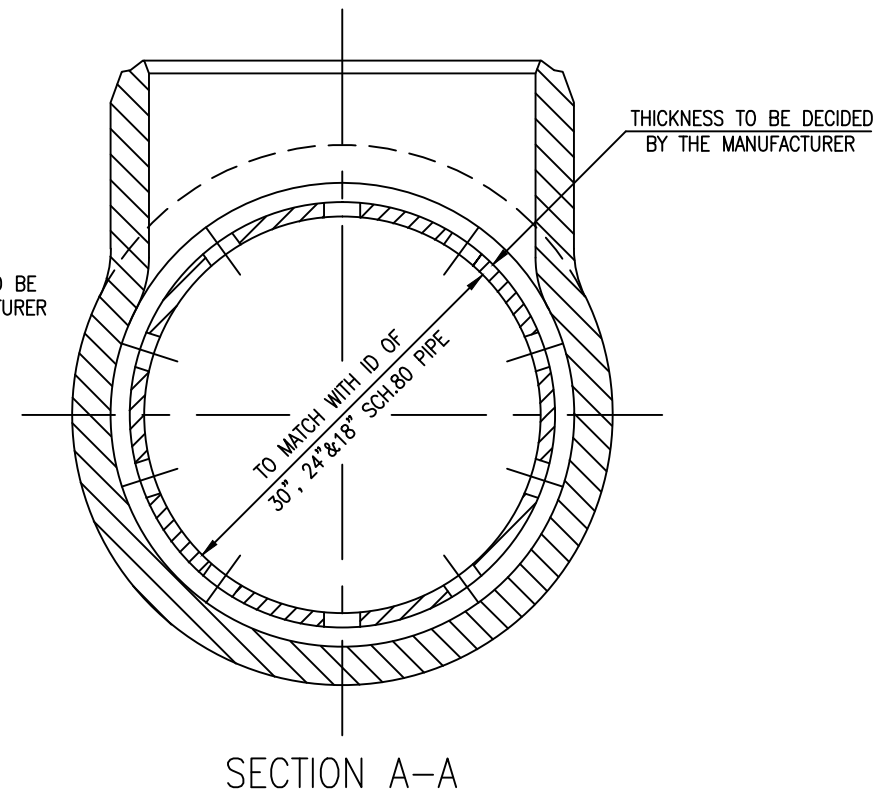
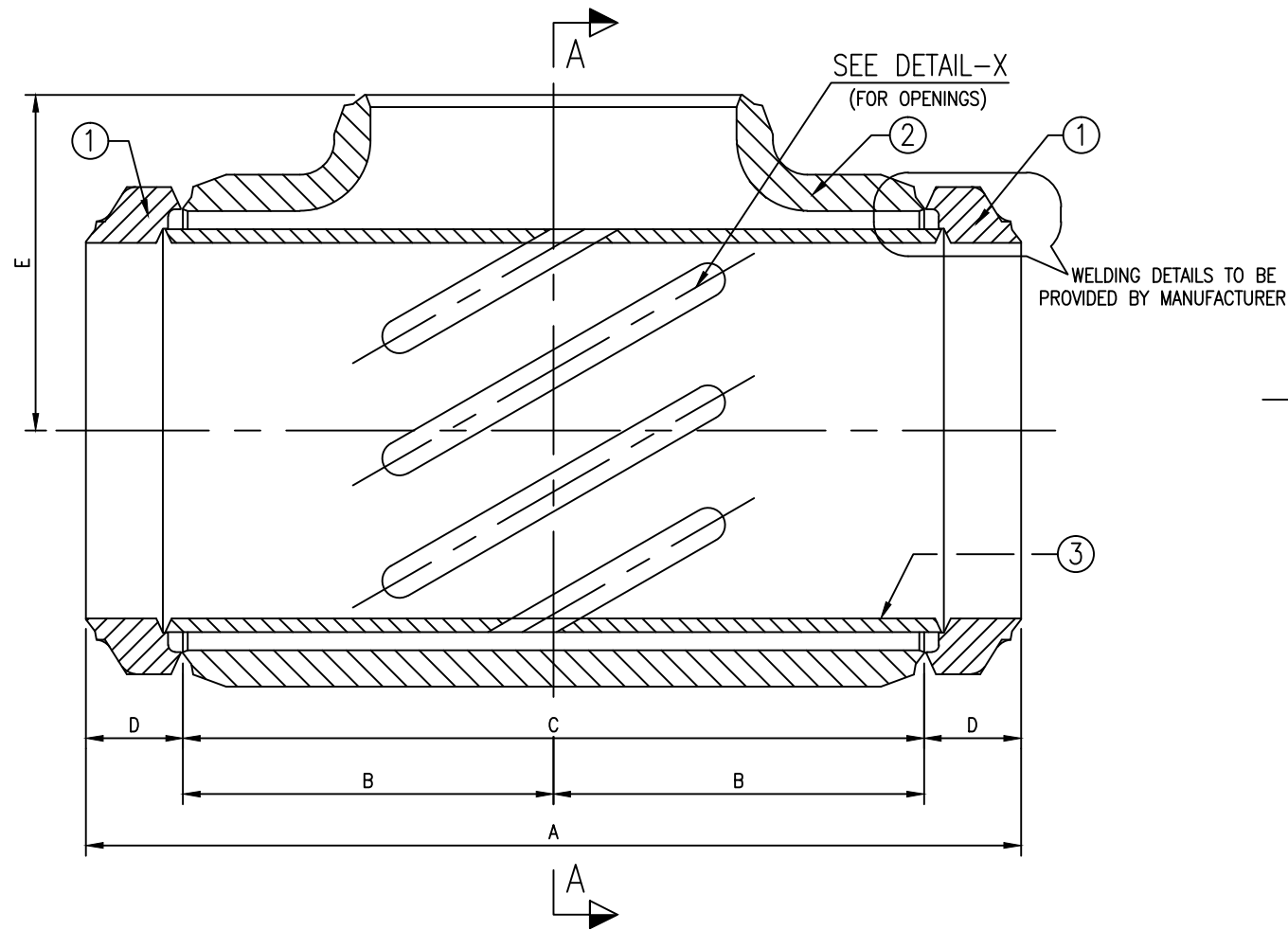
DC6

DF6

NOTES:-

- DIMENSIONS ARE VALID FOR 50mm(MAX) INSULATION THICKNESS, INCREASE DIMENSIONS AS REQUIRED, DIMENSIONS MARKED '\*' ARE MAXIMUM AND MAY BE REDUCED TO SUIT.
- 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.

0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR
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DETAIL-X

PART NO.	DESCRIPTION	SIZE	DIM. STD.	MATERIAL
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

\*\* MATL. ASTM-A240 WPL6 UPTO 16" API5L Gr.X60 OR ASTM A694 F60 OR ASTM A860 WPHY6 ABOVE 16"

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



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REV. NO.	DATE	SUBJECT OF REVISION	PREPD.	CHKD.	APPRD.
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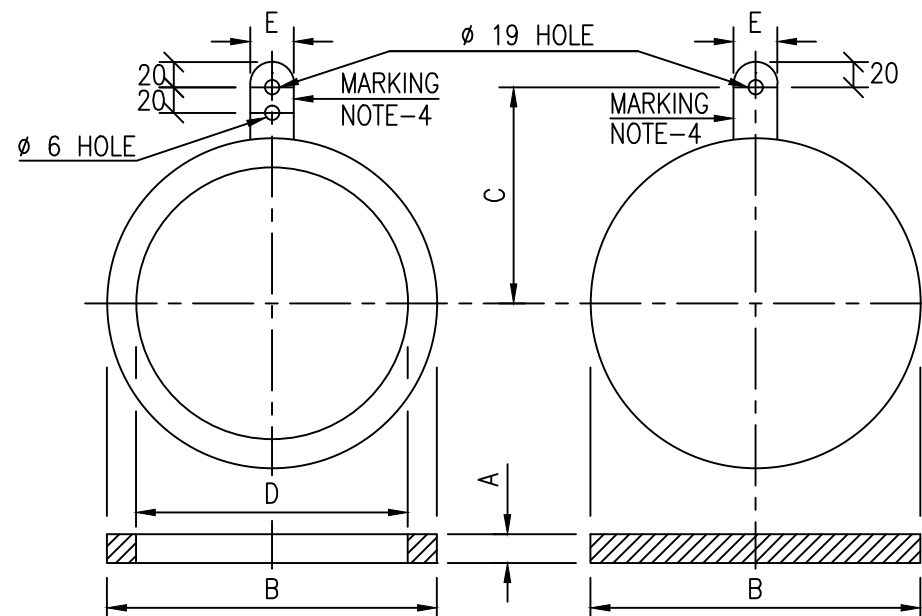
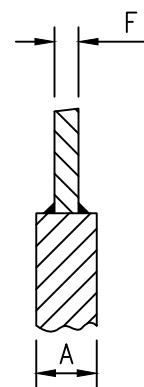
FLOW TEE

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	SPEC ER	A	B	C	D	E	F	BLIND	SPEC ER	A	B	C	D	E	F	BLIND	SPEC ER	
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"
1 1/2"	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	1 1/2"
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"
2 1/2"	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	2 1/2"
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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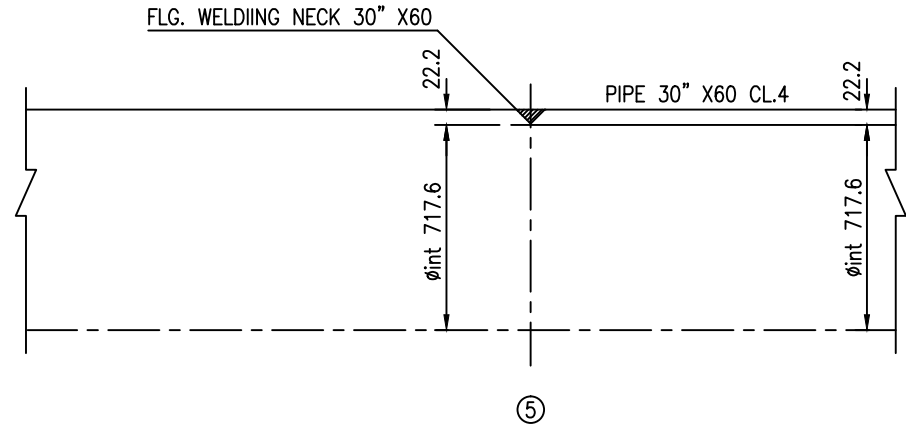
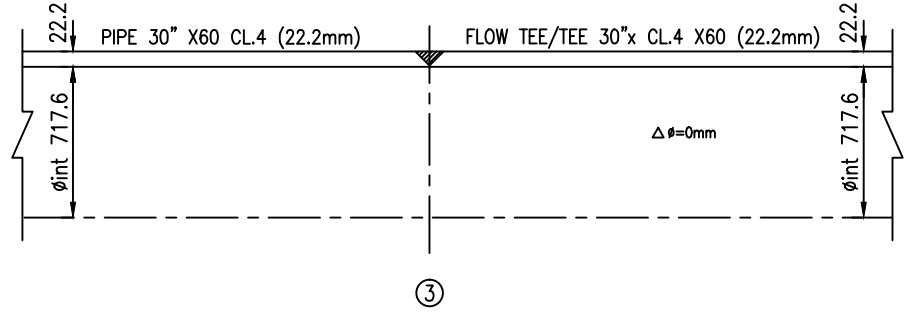
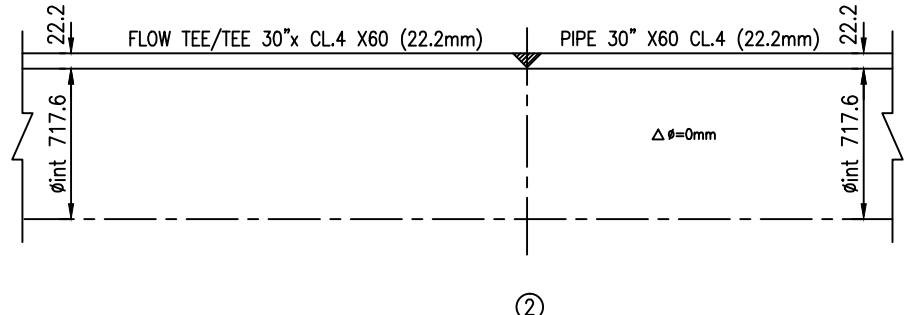
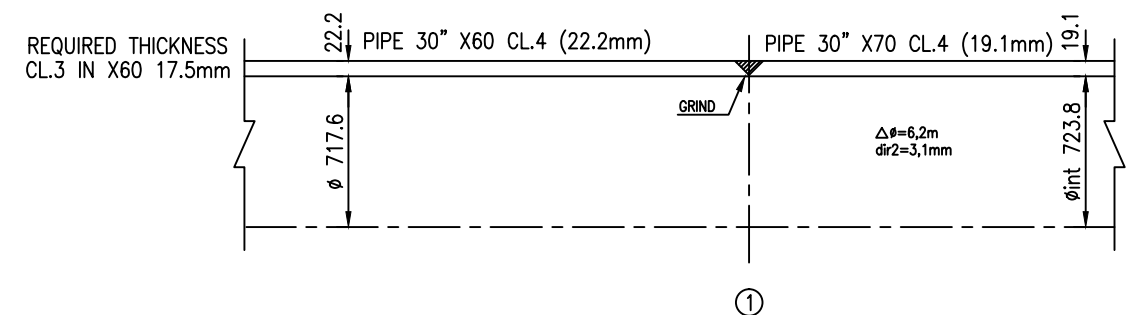
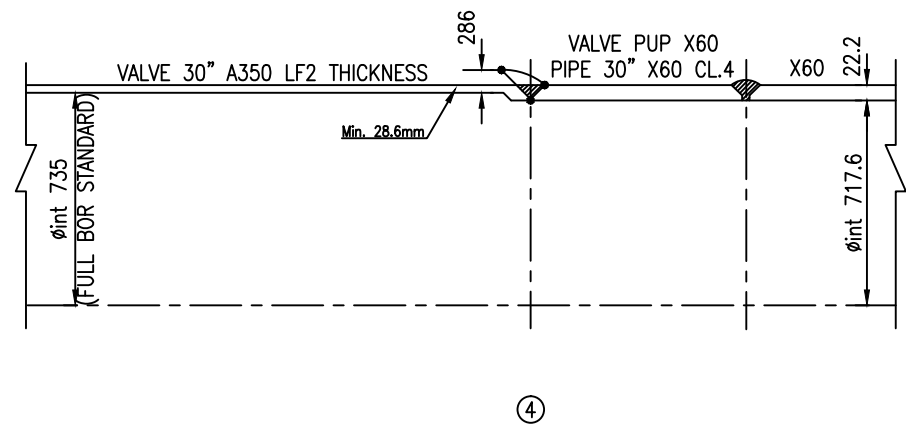
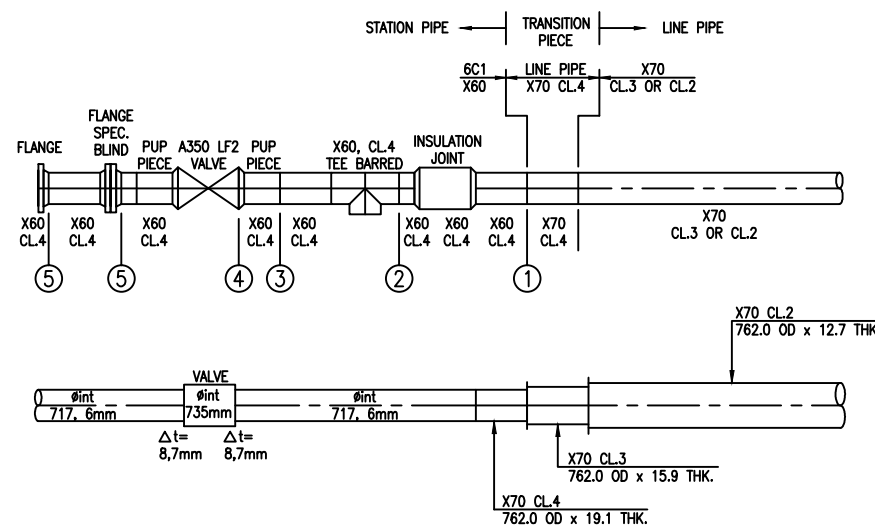
**SPACERS BLINDS**  
150#,300# & 600# FF

**DRAWING NO.**

**GAIL-STD-PI-DWG-TP-021**

**SHEET NO.**

**1 OF 1**



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TYP. PIPING ARRANGEMENT  
FOR 30" SECTION

DRAWING NO.	
GAIL-STD-PI-DWG-TP-022	
SHEET NO.	1 OF 1



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				
TEE (OUTLET UP)				
TEE (OUTLET DOWN)				
CROSS				
CONCENTRIC REDUCER				
ECCENTRIC REDUCER				
DEAD END				
LATERAL				
SIGHT GLASS				
UNION				
HALF COUPLING				
FULL COUPLING				
HOSE COUPLING				

0	10-01-2019	ISSUED FOR TENDER	VKS	AP	JR
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED

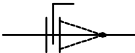
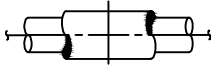
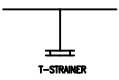
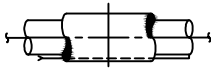
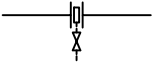
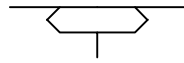
DESCRIPTION	FLANGED	SCREWED	WELDED (NOTE-1)	SOCKET WELD
GATE VALVE (PLAN)				
GATE VALVE (ELEVATION)				
GLOBE VALVE (PLAN)				
GLOBE VALVE (ELEVATION)				
ANGLE VALVE (PLAN)				
ANGLE VALVE (ELEVATION)				
CHECK VALVE (PLAN OR ELEVATION)				
ANGLE STOP CHECK VALVE (PLAN)				
ANGLE STOP CHECK VALVE (ELEVATION)				
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.)				

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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)			
SPECTALE FIG. 8 (OPEN)		INSULATED (LINES 12" AND BELOW)	

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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

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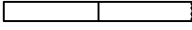
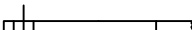


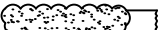

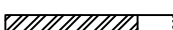
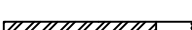



GASKET THICKNESS

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 ANEAELED CORRUGATED METAL FOR RAISED FACE FLANGES.		3.2	1.0

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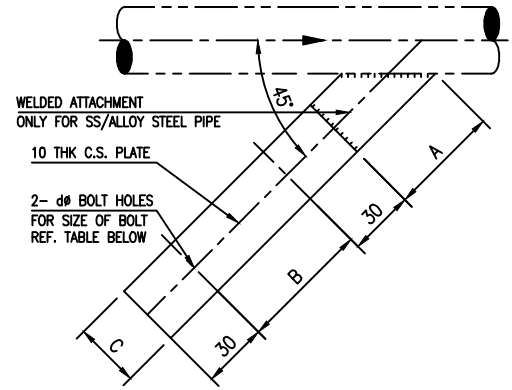
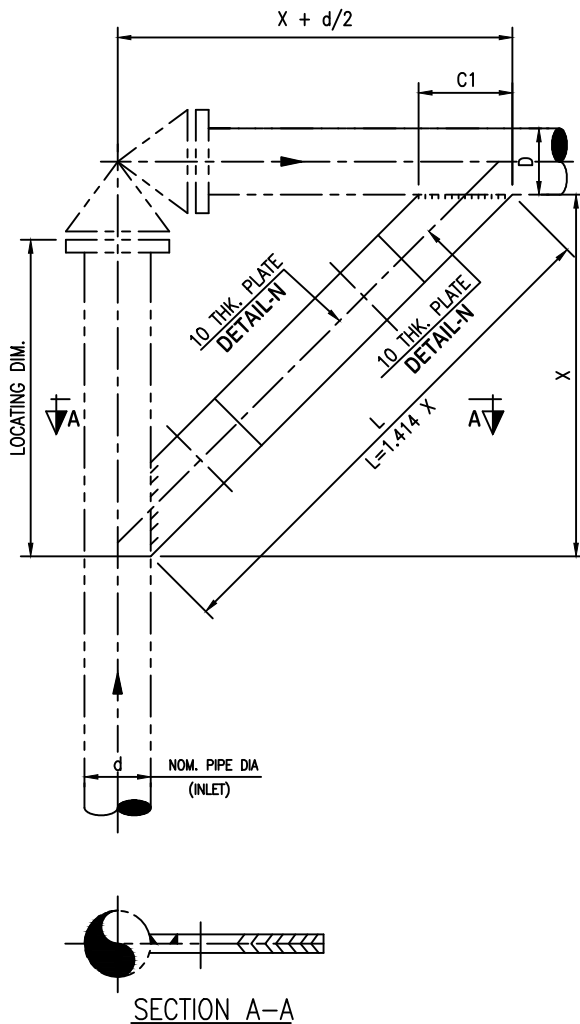
SUPPORTING ARRANGEMENT  
FOR ANGLE AND RELIEF VALVES  
TYPE-SP2

DRAWING NO.

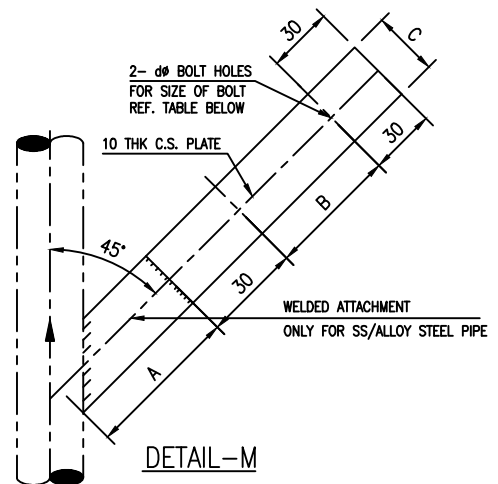
GAIL-STD-PI-DWG-TP-025

SHEET NO.

1 OF 1



DETAIL-N



DETAIL-M

SP2 - L - d/D REF. LEVEL

TYPE  
LENGTH  
NOM. INLET PIPE DIA./  
NOM. OUTLET PIPE DIA.

SYMBOL

NOTES:-

1. MATERIAL FOR WELDED ATTACHMENT SHALL BE EQUIVALENT TO PIPE MATERIAL.

D	BOLT SIZE d $\phi$	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

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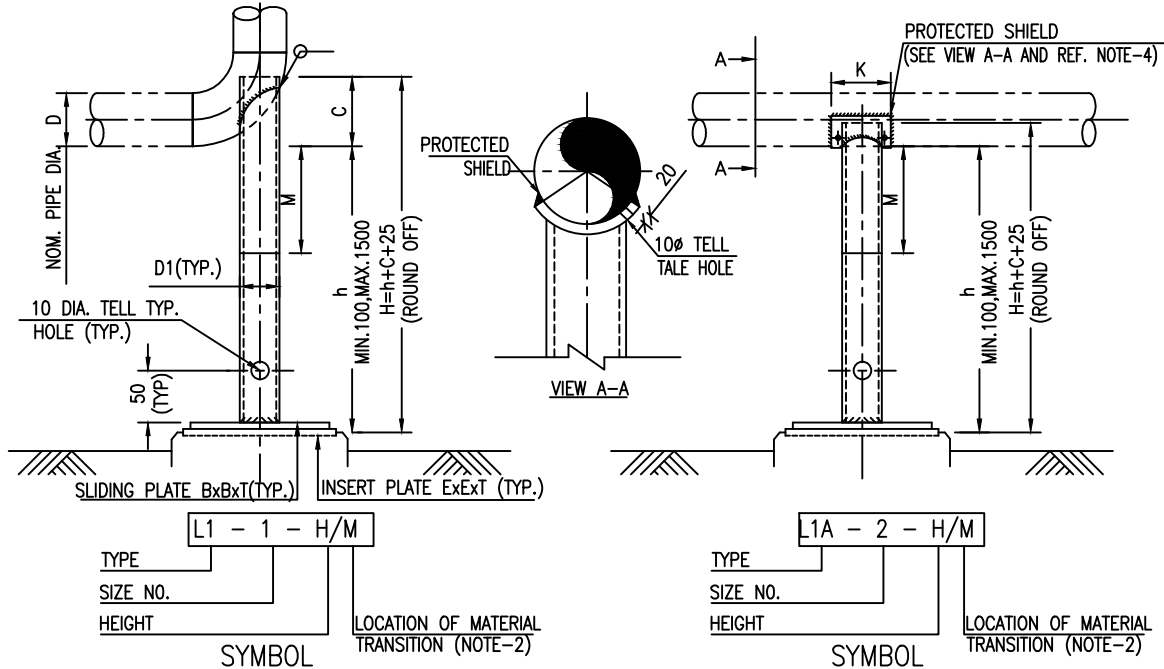
LOW SUPPORT SLIDING FOR BARE  
& INSULATED PIPE SIZE 2"  
THRU 36" TYPE-L1 AND L1A

DRAWING NO.

GAIL-STD-PI-DWG-TP-026

SHEET NO.

1 OF 1

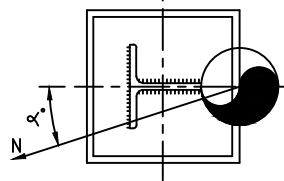
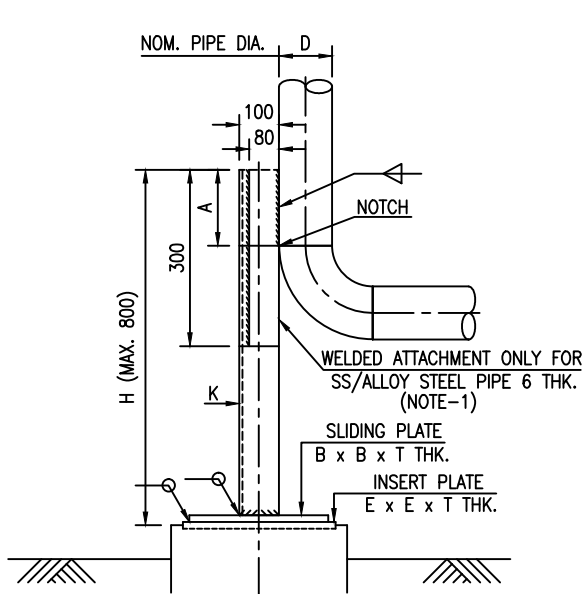


SIZE NO.	D	D1 (NOTE-3)	B	T	C (NOTE-5)	E	K (NOTE-4)
1	2"	2" S40/10S	150	10	70	250	160
	3"				115		
2	4"	3" S40/10S	200	10	137	300	190
	6"				174		
3	8"	4" S40/10S	200	12	205	300	215
	10"				262		
	12"				287		
4	14"	6" S40/10S	250	12	388	350	270
	16"				418		
5	18"	8" S40/10S	300	12	454	400	320
6	20"	10" S40/10S	350	12	554	450	375
	24"				615		
7	26"	12" S40/10S	400	16	675	500	425
	30"				800		
	36"				950		

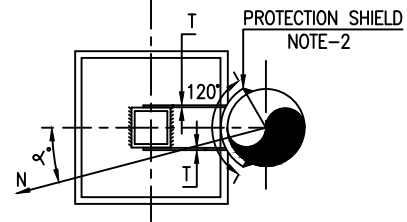
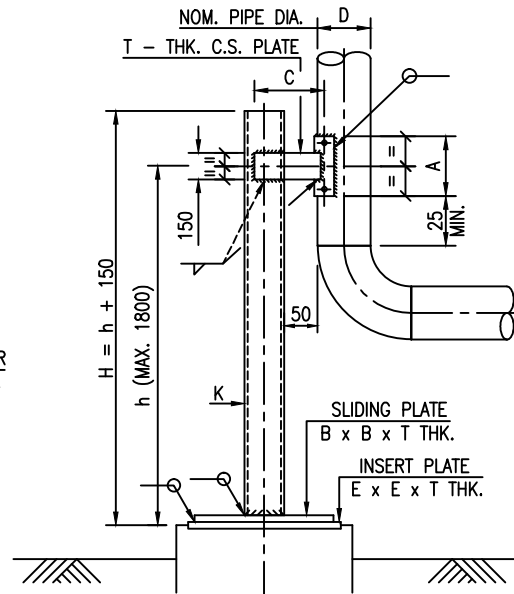
NOTES:-

- INSERT AND SLIDING PLATE MATERIAL SHALL BE CARBON STEEL WHERE DESIGN TEMP. IS  $>345^{\circ}\text{C}$  WITH  $h < 200\text{MM}$ , SLIDING PLATE MATERIAL SHALL BE EQUIVALENT TO PIPE MATERIAL.
- 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".
  - FOR CARBON STEEL(CS) LINE PIPE, THE ENTIRE SUPPORT PIPE SHALL BE CS, THAT IS  $M=0$ .
  - 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 TO THAT OF LINE PIPE, THAT IS  $M=h$ .
    - FOR h GREATER THAN 500MM, SUPPORT PIPE SHALL BE COMPOSITE WITH  $M=\text{INSULATION-THK.}+25\text{MM}$  OR 100MM, WHICHEVER IS GREATER HIGHER THICKNESS AVAILABLE.
- 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.
- PROTECTION SHIELD (LENGTH=KMM) CUT FROM LINE-PIPE OR EQUIVALENT PLATE SHALL BE PROVIDED ON HORIZONTAL LINE AS FOLLOWS-
  - FOR 150# AND 300# CLASS PIPEING
    - CS AND AS LINES - 10" AND ABOVE
    - SS LINES - 2" AND ABOVE
  - FOR 600# AND HIGHER CLASS PIPING
    - CS, AS AND SS LINES - 10" AND ABOVE
- DIMENSION "C" IS TO BE MODIFIED IF OTHER THAN 1.5 D RADIUS ELBOWS ARE USED.
- IN CASE CALCULATED h EXCEEDS THE MAX. VALUE, PEDESTAL SHALL BE RAISED ACCORDINGLY.

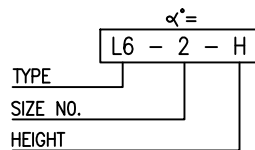
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FOR PIPE SIZES 2" THRU 4"



FOR PIPE SIZES 6" THRU 24"



SYMBOL

NOTES:-

- MATERIAL FOR WELDED ATTACHMENT SHALL BE EQUIVALENT TO PIPE MATERIAL.
- 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

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HAR EK KAAM DESH KE NAAM



**GAIL INDIA LIMITED**

**CONSTRUCTION OF STEEL PIPELINE AND ASSOCIATED FACILITIES  
FOR CGD CONNECTIVITIES**

**VOLUME II OF II (TECHNICAL) – E**

**CIVIL / STRUCTURE**



**E-TENDER REF :**



**(BID DOCUMENT NO - 034/LEPL/GAIL/22-R0)**

**LIMITED DOMESTIC COMPETITIVE BIDDING**



**Lyons Engineering Pvt. Ltd.**

<b>PMC:</b> 	<b>DCI - MASTER DELIVERABLE CONTROL INDEX FOR CGD TO M/s TGPL MORADABAD &amp; CGD TO M/s TGPL GORAKHPUR</b>	<b>Doc No.</b> GAIL-ENG-GN-DOC-DL-001	<b>CLIENT:</b> 
		Rev. 0	
<b>Sr. No.</b>	<b>Description</b>	<b>Document / Drawing No.</b>	<b>Rev. No.</b>
<b>TECHNICAL VOLUME - II OF II</b>			
<b>E CIVIL / STRUCTURE</b>			
1	Civil / Structural Design Basis	GAIL-STD-CV-DOC-DB-001	0
<b>TECHNICAL SPECIFICATION FOR CIVIL / STRUCTURE</b>			
2	Technical Specification for Site Clearing, Area Grading, Excavation & Earth Work	GAIL-STD-CV-DOC-TS-001	0
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
6	Technical Specification for Structural Concrete	GAIL-STD-CV-DOC-TS-005	0
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
9	Technical Specification for Structural Steel Work	GAIL-STD-CV-DOC-TS-008	0
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

PMC:		DCI - MASTER DELIVERABLE CONTROL INDEX FOR CGD TO M/s TGPL MORADABAD & CGD TO M/s TGPL GORAKHPUR	Doc No.		CLIENT: 
			GAIL-ENG-GN-DOC-DL-001		
			Rev. 0		
Sr. No.	Description	Document / Drawing No.		Rev. No.	
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GAIL INDIA LIMITED

**DESIGN BASIS  
FOR  
CIVIL & STRUCTURAL**

**DOCUMENT NO. : GAIL-STD-CV-DOC-DB-001**

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.

- a) In order to supply gas to TGPL Moradabad, GAIL is laying 4” NB Pipeline to connect TGPL Moradabad Receiving Terminal (as per indicative plot plan / P&ID and Schematic attached elsewhere). Work shall include all the interconnecting piping, civil, electrical, Civil, instrumentation works at Customer End and Hook-up.
- b) In order to supply gas to TGPL Gorakhpur, GAIL is laying 4” NB Pipeline to connect TGPL Moradabad Receiving Terminal (as per indicative plot plan / P&ID and Schematic attached elsewhere). Work shall include all the interconnecting piping, civil, electrical, Civil, instrumentation works at Customer End and Hook-up.

**a) SCOPE**

The scope of work to be performed under this contract shall include complete Civil and Structural works as per plans, equipment layout, drawings & technical specifications.

Following Civil & Structural work has been envisaged but not limited to

CUSTOMER END – TGPL MORADABAD

- Topographic and Soil Investigation Survey
- Plot Development including internal drains, RCC Pavements & Approach Road.
- Process Area Development
- Pipe and Valve Support Foundation
- Metering skid Foundation
- Customer plot internal Drainage system

CUSTOMER END – TGPL GORAKHPUR

- Topographic and Soil Investigation Survey
- Plot Development including internal drains, RCC Pavements & Approach Road.
- Process Area Development
- Pipe and Valve Support Foundation
- Metering skid Foundation
- Customer plot internal Drainage system

All items in the Schedule of Rates 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.

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The procurement and supply of all materials, consumables and 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.

Details Scope refer Scope of Work for Civil / Structural.

## 2 DESIGN STANDARDS

Designs shall be based on the latest Indian Standard (IS) Specifications or Codes of Practice. The design standards adopted shall follow the best modern engineering practice in the field based on any other international standard or specialist literature. In case of any variation or contradiction between the provision of the IS Standards or Code and the specifications given with the submitted tender document, the provision as directed by Owner shall be followed.

All analysis work related with civil or structural design shall be carried out as per relevant Codes and Standards. Design of concrete structures shall be as per IS 456. Structural steel shall be designed based on elastic theory in conformation to IS 800. All connections shall be welded connection and it shall confirm to IS 808. Minimum thickness of weld shall be 6 mm for shop weld and 8 mm for field weld.

## 3 CODES & STANDARDS

The following Indian codes and standards shall be used for design of Civil and Structural works. In all cases, latest revisions with amendments, if any, shall be followed. Apart from the specific codes mentioned herein, all other relevant and related codes concerning the specific job under consideration and/or referred to in these codes and technical specifications shall be followed wherever applicable. (All codes shall be latest as on the date of issuing of tender/bid document)

<b>LOADS &amp; FORCES</b>	
IS:875(part I to V)	Code of Practice for Design loads (other than earthquake) for Buildings & Structures.
IS:1893	Criteria for Earthquake resistant design of structure.
<b>FOUNDATION</b>	
IS:1080	Code of Practice for Design and Construction of Shallow Foundations in Soils (other than raft, ring and shell).
IS:1904	Code of Practice for Design and Construction of Foundations in Soils- General Requirements.
IS:2911 (All Parts)	Code of Practice for Design and Construction of Pile Foundation.
IS:2974	Code of Practice for Design & Construction of Machine Foundation
IS:6403	Code of Practice for determination of Bearing Capacity of Shallow Foundations.

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IS:8009 (Part-I)	Code of Practice for Settlement of Foundations.
<b>CONCRETE STRUCTURES</b>	
IS:456	Code of Practice for Plain and Reinforced Concrete.
IS:432	Specifications for Mild Steel and Medium Tensile Steel bars and Hard Drawn Steel Wires for Concrete Reinforcement (Grade-I)
IS:1566	Hard drawn Steel Wire Fabric for Concrete Reinforcement.
IS:1786	High Strength Deformed Steel bars and wires for Concrete Reinforcement.
IS:3370	Code of Practice for Concrete Structures for Storage of Liquids
IS:4326	Earthquake Resistance Design and Construction of Buildings.
IS:13920	Code of practice for ductile detailing of RCC structures subjected to Seismic forces.
<b>MASONRY</b>	
IS:1905	Code of Practice for Structural use of Un-Reinforced Masonry.
<b>STEEL STRUCTURES</b>	
IS:800	Code of Practice for General Construction in Steel.
IS:808	Dimensions for Hot rolled steel beams, Channel and angle sections
IS:806	Code of Practice for use of Steel Tubes in general Building Construction.
IS: 811	Cold formed light gauge structural steel sections
IS:2062	Steel for general Structural Purposes.
IS:3502	Steel Chequered Plates.
IS:1363	Hexagonal head bolts, Screws and Nuts of Product Grade C
IS:1367	Technical Supply conditions for Threaded Steel Fasteners.
IS:2062/5624	Specification for Foundation Bolts.
IS:2016	Plain Washers.
IS:277	Galvanized Steel Sheet (Plain and Corrugated)
IS:1728	Specification for Sheet Metal Rain Water Pipes, normal size gutters, fittings and accessories.
IS:278-1978	Specification for Galvanized Steel Barbed wire for fencing.
IS:2721-2003	Galvanized Steel Chain Link fence (Fabrication Specification)



**4 ENGINEERING DESIGN DATA**

Design will be based on the latest soil investigation report. Life of Structure shall be taken as 50 years for wind load calculation.

**PLOT DEVELOPMENT**

On finalization of the plot area, the location and its surroundings shall be surveyed and Geo-technical investigations shall be carried out for establishing contour plan, coordinates & design bearing capacity of soil for each location by the executing agency as required. Suitable approach roads and other services shall be ensured for the design work.

Finished Ground Level (FGL) shall match with existing finish ground level of customer premises. Top level of internal roads shall be 150 mm above FGL. Floor finish level of process area shall be 300 mm above internal road top level. Water from the proposed plot shall be drained to drain at a slope of 1 in 500 where applicable. The drain shall have a slope 1 in 750.

**DESIGN OF FOUNDATIONS**

Safe bearing pressure shall be based on settlement criteria for dead plus live load conditions. Maximum settlement for foundation for all types of equipments, pipe racks, footings including raft, etc. shall be 25mm.

In case of wind or seismic forces, settlement is not the criteria and safe bearing capacity based on shear criteria shall be considered. While designing foundations at various levels, the bearing capacity at that particular level and also the effect of uplift/sub soil water table shall also be considered.

**5 LOADS AND FORCES**

Design loads shall comply with the requirements of IS: 875 and IS: 1893 as minimum, unless more stringent requirements are specified herein. All buildings, structures shall be in general designed for the worst possible combination of the following loads.

1. Dead load (DL)
2. Live load (LL)
3. Wind load (WL)
4. Seismic load (SL)
5. Equipment Load (E)
6. Impact / Vibrating Load
7. Other Loads

**DEAD LOAD (DL)**

The dead load comprises of weights of all structural and architectural components and

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external loads pertaining to all permanent construction, including walls, floor, roofs, partitions, stairways, and equipment excluding their contents. Self-weight of material may be calculated on the basis of unit weights given in IS: 875 (Part I).

### LIVE LOAD (LL)

Live loads shall comprise of all loads other than dead loads. This shall be in general as per IS: 875 (Part II).

### WIND LOAD (WL)

Wind load shall be in accordance with IS: 875 (Part –III)

### SEISMIC LOAD (SL)

Seismic forces shall be as per IS: 1893. The detailing of reinforcement shall be as per IS: 13920.

### EQUIPMENT LOAD (E)

Equipment loads shall be considered as follows:

#### Equipment Load for Empty Condition E (E)

It is the weight of equipment excluding fire proofing, piping all loose internals, platforms supported from the equipment.

#### Equipment Load for Test Condition E (T)

It is the weight of equipment including fire proofing, piping, all loose internals, insulation, platforms supported from the equipment and weight of water.

#### Equipment Load for Operating Condition E (O)

It is the weight of equipment including fire proofing, piping, all loose internals, insulation, platforms supported from the equipment and liquid/gas contents.

#### Equipment Load (B)

It is the weight of equipment to be considered for maintenance purpose.

### IMPACT LOAD

The live loads shall be assumed to include adequate allowance for ordinary impact conditions. However, for structures carrying loads which induce impact or vibration, calculations shall provide for increase in the imposed load due to impact or vibration as per requirement of IS:875 (Part-2)

### OTHER LOADS

Surcharge Load shall be considered as 1 t/m<sup>2</sup>

Earth pressure

Unit wt. of soil  
shall be taken = As per latest soil report

( $\gamma$ )  
Angle of = As per latest soil report

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repose ( $\phi$ )  
 $K_a$  = As per latest soil report

**6 ANALYSIS AND DESIGN METHODOLOGY**

Limit state method as per IS: 456 shall be followed in the design for concrete structures except for liquid retaining structures. The design of liquid retaining structures shall be carried out using working stress method as per IS: 3370.

Steel structures shall be designed as per IS: 800.

Detailing of reinforcement shall be done according to IS: 4326, IS: 13920 and SP: 34.

Permissible stresses increase in materials shall be as per respective IS code and shall be considered under Wind/Seismic loading.

Appropriate load factor for Limit State Design shall be considered as per code provisions.

Architectural design of Porta Cabin shall fully meet the functional requirement, shall be adequately sized and provided with sufficient ventilation and natural lighting.

**7 LOAD COMBINATION**

The load combinations shall be generally as per IS: 875 (Part 5).

In general, all structures shall be designed for worst effect.

DL ± Wind Load with no increase in allowable stress.

Underground structure shall be designed for the following load cases.

- i) DL ± LL ± Equipment load
- ii) DL ± LL ± Equipment load ± Seismic load.
- iii) DL ± Seismic load.
- iv) Combination I + Earth pressure + Surcharge pressure
- v) Combination II + Earth pressure + Surcharge pressure

**8 CONSTRUCTION MATERIALS**

CONCRETE

Cement concrete used shall comply with provisions of IS: 456-2000 and as specified in the technical specification. All RCC works shall be in design mix concrete of grade M 25 with 20mm and down size aggregate & PCC Works shall be in nominal mix as specified on drawings.

CEMENT

Approved quality of Ordinary Portland Cement of Grade 43 / Grade 53 shall be used for reinforced concrete works; and Portland Pozzalano Cement may be used for non RCC works such as brick masonry and plaster etc. For all underground structure, Sulphate Resistant Cement (SRC) shall be used in accordance with Indian Standards based on detail soil investigation report.

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AGGREGATE

Aggregates shall be from approved sources and shall comply with IS 383. Fine and coarse aggregates shall be considered separate ingredients. Both shall meet the grading requirements of IS 383.

Aggregates shall be clean, hard, durable, chemically inert and impermeable. They shall be free from adherent coatings, laminated particles or admixtures of materials likely to be deleterious to the concrete. Dune and beach sand shall not be used for fine aggregate.

The grading for Sand shall conform to IS: 383-1970 and shall be within the limit of Grading Zone-III. The maximum size of particle shall be 4.75mm and shall be graded down.

WATER

Water used for concrete shall be clean and free from oil, acid, alkali, organic matter or other harmful matter in such quantities as would affect the concrete in the plastic or hardened state. Potable water shall generally be considered satisfactory for mixing of concrete. Tests on water samples shall be carried out in accordance with IS: 3025 and they shall fulfill the guidelines and requirements of IS: 456.

BRICKS

Bricks shall be locally available bricks minimum of class designation 7.5 conforming to IS: 1077.

REINFORCEMENT STEEL

Reinforcement bars for RCC will be High Yield Strength Deformed/TMT steel bars for Grade Fe 415 / Fe 500 D conforming to IS: 1786-2008 and MS bars of Grade I conforming to IS: 432 (Part-I).The maximum spacing of bars shall be as per IS: 456.

STRUCTURAL STEEL

Structural steel is to be used for general structural purposes shall be of grade Fe 415 MPa conforming to IS: 2062. The minimum yield strength of steel shall be 410 MPa. The minimum yield strength for steel structure shall be as follows:

Thickness <20 mm	250 MPa
Thickness 20-40 mm	240 MPa
Thickness >40 mm	230 MPa

Equipment supports, Access / Operating platforms and crossover shall be fabricated from the structural steel as per requirement. All structural supports, operating platforms & cross over shall be protected with suitable paintings as specified.

Minimum thickness for various structural components shall be as follows:

- Stiffeners: 8mm
- Base Plates: 10mm
- Chequered Plate: 6mm
- Grating: 3mm

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**ANCHOR BOLTS**

Materials for anchor bolts shall be of mild steel conforming to IS: 226 and IS:432 grade-I. Materials such as MS bars, washers, nuts, pipe sleeves and plates etc. shall conform to IS : 1363 & IS : 1364 of 1992.

**GROUT**

Approved quality Non Shrink (Premix Type), free flow grout shall be provided for all anchor bolts, sleeves, pockets, & spaces under column bases, shoe plate etc. with a crushing strength of 28 days minimum 40 MPa.

**WELDING**

Welding shall conform to IS 814 -1963. Structural Steel shapes shall conform to IS: 808 (Hot Rolled Steel Beam, Column, Channel & angle Section).

**9 SITE PREPARATION, BOUNDARY WALL AND CHAINLINK FENCING**

Site preparation shall conform to the requirement of the relevant section of this design basis and specification. Salient features of the plot to be developed. The layout and level of plot shall be prepared and the benchmarks shall be set. Suitable provision of drainage system shall be made outside the plot to divert the natural storm water drainage into the nearest existing drainage system.

RCC boundary wall shall be provided (wherever specified) as per the layout drawings. The height of RCC wall is also specified in the layout drawings.

The boundary wall shall be of RCC beam & column structure with filler walls consisting of 230 mm thick brick masonry in Cement Mortar (1:6). The height of brick masonry wall shall be 2.5m above FGL, Y-shaped barbed wire fencing 600mm High arrangement with 9 strings of 12 SWG double strand barbed wire with four point barbs set 75 mm apart shall be provided above the brick masonry work with 610 diameter barbed wire concertina coils spaced @ 400 c/c over the Y-fence.

Below Finished Grade level, the foundation shall be designed to withstand the earth Pressure and Surcharge of 1 t/m<sup>2</sup> and prior approval shall be taken before the execution of the job.

If the difference in the Plot Level and the Surrounding area is greater than or equal to 1.0 m, the R.C.C Retaining Wall shall be provided upto FGL to cater the Earth Pressure along with a Surcharge of 1 t/m<sup>2</sup>.

Inside and outside plaster in coarse sand for boundary wall shall be 15 mm thick with Cement Mortar (1:4).

Minimum two coat of cement base paint of approved color shall be provided on outside face and inside face to get acceptable finish.

Design of boundary wall shall be checked for full submerged soil pressure under choked condition of weep holes.

Chain link fencing of 2.4 m height made from 2.5 mm diameter GI wire with mesh size of

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50x50 mm shall be provided.

## 10 ROADS, DRAINS AND CULVERTS

### ROADS

Roads shall be of RCC and shall be designed for IRC loading.

Road width shall be 3 meter width within the plot area. The minimum radius of curvature of the turnings shall be 6.0m unless otherwise mentioned in the relevant drawings. Roads shall be constructed as per the specified drawings.

Approach road including culverts shall be of RCC and shall also be connected with nearest existing metallic road/approach road outside the customer plot for all stations. Carriageway for approach road shall be 4.5m wide or as per existing road.

Roads must be paved with 150 mm thick M25 concrete with nominal reinforcement of 8mm diameter @ 200mm c/c (both ways at top & bottom) laid over 75 mm P.C.C. (1:3:6). The PCC shall be laid over 200 mm thick compacted boulder layer with sand filling.

### STORM WATER DRAIN

The design of storm water drainage shall be based on maximum hourly precipitation for storm deviation of 20 minutes. The drainage system shall be so designed so that the velocity of flow shall be within 1 m/sec to 2.5 m/sec.

Coefficient for design shall be as follows:

1	Open areas	0.5
2	Road and paved area parking area	0.7
3	Roof surface	1.0

Storm water drain shall be constructed in brick masonry along the periphery of plot to carry storm water from plot area to nearby drain. The drain shall have slope of 1 in 1000 (minimum).

### CULVERTS

RCC Hume pipe NP-3 class has been considered for crossing drains under the roads as per site conditions. Piping culverts under roads shall be of RCC box-shaped.

## 11 PROCESS AREA

Process area consists of valves, equipment's, metering skid etc. Entire process area shall be paved with 150 mm thick M25 concrete pavement with nominal reinforcement of 8mm diameter @ 200 mm C/c (both ways at bottom) laid over 75 mm P.C.C. (1:3:6). The PCC shall be laid over 200 mm sand filled over well compacted sub base. The paving shall be laid in panels and designed joints shall be provided with approved quality separators & joint sealant. Boulders solingto be provided in sub-base based on geotechnical investigation recommendation, if required.

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**EQUIPMENT FOUNDATION**

Equipment foundation supporting lightweight equipment and coming within the process area may be made an integral part of the paved area. However, heavy equipments shall have isolated equipment foundation even if coming within process area.

Loose fills, expansive soil etc if found beneath the equipment foundation shall be removed and back filled either with PCC (1:3:6).

**PIPE SUPPORT FOUNDATIONS**

Pipe supports shall be provided as per mechanical layout drawings for piping. The pipe support may lie within the process area or at any other location. The pipe support foundations shall be designed to take care of the loads and it's fixing details as per standard drawings. Pipe support in process area shall be integral part of pavement. Isolated pipe supports shall however be provided outside the process area.

**12 PORTA CABIN (If applicable)**

The Porta Cabin shall be insulated type steel structure, shall be well ventilated and shall be brought to site in knock down condition and assembled at site or factory assembled condition. All components of the prefabricated cabin shall be reclaimable and reusable. The shell structure shall comprise of side walls, end walls and self draining roof.

RCC M25 foundation shall be constructed up to a height of 450 mm from finished ground level for installation of Porta Cabin.

The floor shall be made up of ISMC (channels) or tubes of required sizes and shall be used to form the floor grid of minimum size 600mm x 600mm. The floor shall be minimum 200mm above bottom level and shall be covered with marine Ply board (IS: 2202/ 1991) of required thickness or cement fiber board of required thickness; finished neatly with floor vinyl (of required thickness), in roll/ tiles by means of neoprene base adhesive as per manufacturer's recommendations.

The structure of the prefabricated Cabin (i.e. all walls, ceiling, floor etc.) shall be tubular steel/ structural steel members. The fully erected and anchored prefabricated Cabin after installation/ placing in position shall be structurally strong enough to withstand wind force of minimum speed 47 m/sec. and earthquake for seismic zone 3, importance factor 1.5.

Walls shall be made up of 'sandwich' insulated panels manufactured using outer side minimum 0.63mm thick profiled pre-coated galvanized steel sheet (Rib Profile) and inner side minimum 0.63mm thick profiled pre-coated galvanized steel sheet (Plain) conforming to IS: 277 with insulation of PUF/ mineral wool/ glass wool/rock wool, of approved make, in between steel sheets. It shall be waterproof, termite proof, heat and fire resistant and comfortable in extreme hot and cold climate. The walls shall be provided with internal paneling of laminated plywood of required thickness. Necessary provisions shall be provided in the walls (at desired locations) for installing split type air-conditioners and exhaust fans.

Fabricated steel steps of detachable type having necessary treads shall be provided at all doors for getting inside.

Windows shall be of aluminum extruded sections with 5.5mm toughened glass and grill. The windows shall be horizontal sliding. Stainless steel fly-proof mesh in suitable frame

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work shall also be provided in the windows. All doors shall be of aluminum extruded sections with partly glazed portion (from lock rail level to top rail; with 5.5mm toughened glass) and partly with 10mm thick cement bound particle board panel (from bottom rail to lock rail level). The doors shall be complete with necessary fittings and fixtures like mortice lock, handles, tower bolt, floor mounted double action floor spring hinges etc. The peripheral edges of the door shall be provided with rubber seal to prevent ingress of water and dust. The door panels shall be outward opening type. The doors shall be provided with manually operating type locking arrangements from both internal and external side.

All the internal walls shall be finished with Oil bound distemper of approved make and shade. The surface preparation of all fabricated steel components shall be done by giving it a coat of approved primer and finished with enamel of approved make and shade.

Roof shall be made up of 'sandwich' insulated panels manufactured using outer side minimum 0.63mm thick profiled pre-coated galvanized steel sheet (Rib Profile) and inner side minimum 0.63mm thick profiled pre-coated galvanized steel sheet (Plain) conforming to IS: 277 with insulation of PUF/ mineral wool/ glass wool)/rock wool, of approved make, in between steel sheets. The roof shall be waterproof, termite proof, heat and fire resistant and comfortable in extreme hot and cold climate. The ceiling shall be provided with internal paneling of laminated plywood of required thickness. Roof shall be supported on suitable trusses and purlins. Roof shall be extended by minimum 600mm on all sides to provide rain/ sun protection to doors and windows.

### 13 VALVE PIT

Valve Pit shall be constructed in RCC of grade M25. High-density rubber pad shall be wrapped around the pipe in contact with RCC. The valve pit shall be filled with river sand with precast concrete on top of pit with hook provision for lifting.

### 14 SIGN BOARDS

Signboards shall be provided at all sites as per direction of Owner.

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GAIL INDIA LIMITED

**TECHNICAL SPECIFICATION  
FOR  
SITE CLEARING, AREA GRADING  
EXCAVATION & EARTHWORK**

**GAIL-STD-CV-DOC-TS-001**

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**1.0 INTRODUCTION**

This specification deals with site clearing, earthwork and excavation, leveling, cutting and grading, area filling and backfilling for area designated in the drawings.

**2.0 SETTING OUT**

Before commencement of earthwork, block levels of existing ground shall be taken by the Contractor jointly with the Engineer. Excavation shall not be commenced until the initial ground levels have been recorded and accepted. Reference lines, bench marks and base lines shall be set out by the Contractor for control of earthwork operation.

Setting out shall be done with pegs, blocks, bamboo poles, marking boundaries or centre lines, as the case may be, and the same shall be maintained for reference and future checking.

Engineer shall be provided with necessary men, material and instruments for checking and approval. However, such checking and approval by the Engineer shall in no way absolve the Contractor of his responsibilities for carrying out the work to the true lines, levels and positions as per drawing and subsequent corrections, if any.

**3.0 SITE CLEARANCE AND DEMOLITION**

The site shall be cleared of all trees, stumps, roots, brush wood, bushes and other objectionable materials. Useful and saleable material, if any shall be the property of the owner and shall be stacked properly as directed by the Engineer.


The areas to be covered with embankments shall be stripped of top soil to required depths to expose acceptable founding strata. Top soil unsuitable for use in embankment construction and other fills shall be disposed off as directed. All combustible materials shall be stacked and burnt in locations sufficiently remote to eliminate all danger of fire hazards. All old concrete, brick works and drains which interfere with construction works shall be dismantled with the approval of the Engineer taking all necessary precautions prescribed in safety specification. Top soil which is suitable for use in construction work shall be stockpiled for later use. Other objectionable materials such as trash, debris, stones, brick, broken concrete, scrap metal etc., shall be disposed off as directed by the Engineer.

**4.0 CLASSIFICATION OF SOIL**

The Engineer will decide the class of any particular soil. Classification of soil shall be as under and the decision of the Engineer shall be binding on the Contractor:

ORDINARY SOIL

Soils which yield to ordinary application of pick and shovel, phawra rake or other ordinary digging implements (including earth moving equipment such as bulldozer, shovels without

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resorting to blasting) without offering much resistance, shall be classified as ordinary soil. This includes organic soil, turf, sand, gravel, loam clay, mud, peat, black cotton soil, soft shale and loose moorum etc.

**HARD SOIL**

This comprises of all soils that cannot reasonably be excavated by the above mentioned digging implements, but can be excavated with close application of pick axe or scarifiers or jumpers to loosen. This includes compact moorum, stiff clay, hard shale, cobble stone etc.,

**SOFT /DECOMPOSED ROCK**

This comprises of rock or boulders which may be quarried or split with crow bars, pavement breakers etc., This include lime stone, sand stone, weathered rocks and hard conglomerates etc .and existing structures embedded in earth and tarred macadam roads, pavements, met in the excavation.

**HARD ROCK**

This comprises of rocks which require blasting for excavation. Where blasting is prohibited, excavation has to be carried out by chiseling, wedging or any other agreed methods.

**5.0 METHOD OF EXCAVATION**


The Contractor may carry out excavations, filling and compaction by any method considered most suitable and befitting the site conditions subject to any stipulations contained in the contract and the specifications. All excavations shall be required to be kept completely free from water, from whatever source it may come during the construction. No foundation work shall be taken up until the surfaces are properly drained.

**6.0 EXCAVATION OF SOILS OTHER THAN HARD ROCK**

Excavation shall be carried out in the most expeditious and efficient manner to the lines and levels as indicated in drawings or as directed by Engineer. Prior approval of the Engineer shall be taken for the method to be adopted for excavation including dimensions, side slopes, dewatering, shoring etc. Approval shall not make the Engineer responsible for any consequent damage or loss caused.

All precautions shall be taken to preserve the material below and beyond line of excavation in soundest condition. All damages done beyond limits of excavation shall be made good by the Contractor at his own cost in a manner approved by the Engineer.

All excavated materials shall be removed to spoil heaps, dumping yards or transported for filling as may be necessary. When soil heaps are formed for future use, heaps shall be protected from washing away due to rain or surface run off. The sides of excavation shall be maintained in stable condition by adequate stepping and batter. To prevent entry of surface water and accumulation of subsoil water in excavated areas, suitable drainage arrangements as may be needed and directed by Engineer shall be provided and maintained. Pumped out

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water shall be drained off properly avoiding damage to other existing works. If any pipelines, cables or service lines are likely to be exposed, excavation around these services shall be carried out manually and all such services shall be adequately supported and protected at no extra cost.

Excavation shall be carried out in any material encountered including road surfaces, pavements, buried parts of old foundations, pits or other structures. Excavated materials shall be placed beyond 1.5 meters of the edge of the excavation pit/trench or half the depth of the pit/trench whichever is more or further away as directed by the Engineer. Sumps made for dewatering must be kept clear of the foundations.

In firm soil the sides of the trenches shall be kept vertical up to a depth of 2.0m from the bottom and for a greater depth, trench shall be widened by allowing steps of 50cm on either side after every 2.0m depth from the bottom, so as to give a vertical side slope of 1/4: 1. Where the soil is soft, loose or slushy, the width of the steps shall be suitably increased or sides suitably sloped or suitable shoring and strutting provided as directed by the Engineer. For trenches deeper than 2.0m, the Contractor shall obtain detailed instruction from the Engineer in writing regarding the stepping, sloping of sides or shoring and strutting to be done. For these by-works, no extra cost will be paid to the Contractor.


**7.0 EXCAVATION IN HARD ROCK**

Where hard rock is met and blasting is considered necessary for its excavation, the Contractor shall intimate the Engineer in writing. Excavation in hard rock shall be done either by blasting or chiseling or by such other agreed methods as may be required. Levels of hard rock surface shall be taken and got approved by Engineer before start of excavation. Blasting shall be permitted only when proper precautions are taken for protection of persons, works and property. The Contractor shall obtain the necessary license for procuring, storing and using explosives.

Blasting operations shall be carried out by a licensed Blaster. The quality and quantity of explosives, size and spacing of holes depth of holes etc. shall be such that they will neither open seams nor damage/shatter the rock beyond the specified lines of excavation. A tolerance of 150 mm will however be allowed beyond the excavation lines. As excavation approaches final stages, the depth of holes and the amount of explosives used shall be reduced progressively to avoid over breakage or damage to founding strata. Any fissures, cracks and voids below prescribed depth of excavation shall be corrected by removing loose pieces, shattered or affected rock and replaced by lean concrete of M-7.5 grade in the case of foundations. Where excavated surface is to receive structural concrete, the surface shall be cleaned of dust and other objectionable materials.

In cases where blasting, though otherwise required is prohibited because of any reason, the excavation shall be carried out by chiseling, wedging or such other agreed methods. All materials excavated from blasting, chiseling or any such methods shall be stacked for measurement as directed by Engineer.

**8.0 CUTTING AND FILLING FOR SITE LEVELING**

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Excavation and filling operations for site leveling shall be so planned and executed, that transportation and re-handling are minimized. The sides of excavation and fills shall be maintained in stable condition by adequate batters, stepping and dewatering. Materials not desirable shall be disposed off in area indicated by Engineer. When it is required to blend the material, it shall be done by selective excavation and filling operation. Wells, ponds, cesspools and water logged areas shall be emptied of water before filling. Filling shall be done in horizontal layers not exceeding 300mm in thickness as specified or as directed by the Engineer. All clods shall be broken before placing the fill. Earth moving equipment shall be allowed to ply over the fill to permit compaction. Adequate allowance shall be made for subsidence of fill material. Levels shall be taken and excess or shortfall shall be made good by appropriate cutting or filling.

**9.0 EXCAVATIONS FOR FOUNDATIONS**

Excavation for foundation shall be done to the lines and levels indicated in the drawings. Excavated material shall be transported and stored at convenient spots for reuse in back filling of foundations and other fills. Surplus material shall be transported, spread and leveled at dumping areas. Side slopes of excavation and/or shoring shall be adequate from consideration of stability and working space. When so required and authorized by Engineer, the sides of excavation shall be protected with proper shoring, strutting, sheeting and sand bags etc. These shall be removed only when work in the pit is completed with the approval of the Engineer. When it is felt that removal of supports may result in side collapse or settlement of adjoining ground or endanger adjoining structures and foundations, they shall be left permanently in position. The last 150 mm of excavation shall be done and the bottom trimmed to the required levels only when concreting is imminent. If at any point the natural ground is disturbed or loosened for any reason, it shall be consolidated by tamping or rolling or made up with concrete of M-7.5 grade cement concrete at no extra cost. Where the soil encountered at depths indicated in drawings is loose or weak, it shall be further excavated to levels of firm strata as may be directed by the Engineer and filled with lean concrete of M-7.5 grade cement concrete or sand as directed.


**10.0 EXCESS EXCAVATION**

All excavation done beyond the specified limits or directions of Engineer shall be considered as excess excavation. They shall be made good as prescribed below by the Contractor at his cost:

- (i). Excess excavation in case of site leveling shall be made good by filling and compacting with material same as the surrounding material. Degree of compaction shall be at least the same as the surrounding material.
- (ii). Excess excavation in case of foundation beyond required depths shall be made good by filling with lean concrete of M-7.5 grade cement concrete.

**11.0 DISPOSAL**

Excavated materials that are unsuitable for use in construction works or in excess of construction requirements shall be disposed off in dumping yards or in locations indicated by Engineer. Waste piles/heaps shall be located in such places where they will not interfere with

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natural flow of rain water access or transport or with the access to nearby structures. When required, they shall be leveled and trimmed to such lines and levels as indicated by Engineer

**12.0 BACKFILLING**

Backfilling of foundations shall be done using suitable soils from excavations. Soil shall be free from organic matter and other materials which would affect the stability of the fill and shall be free from boulders, brick bats wood pieces and other injurious materials, lumps and clods. Before commencement of backfilling of foundations all shoring and formwork, bits of timber, cement bags and all other rubbish shall be removed. Backfilling operation shall not commence without approval of Engineer. Backfilling shall be carried out in well compacted layers of 150 mm thickness. Each layer shall have near optimum moisture content. Layers will extend to the entire width of excavation and shall be sprinkled with water during compaction process. Ramming shall be done to achieve firm compaction. Backfill shall be trimmed and finished to levels indicated in the drawings and/or as directed by the Engineer. Mechanical equipment like vibratory roller, vibro earth rammer or vibratory compactor shall be used for compaction.

**13.0 EARTH FILLING**

Material for filling shall be selected earth obtained from excavations for site leveling, trenches and foundations or from selected borrow areas as may be required. Soil shall be of uniform quality and free from boulders, organic materials and other objectionable matter and shall not be expansive soils. Filling shall be done in well compacted layers not exceeding 150 mm in thickness. Each layer shall be compacted to 95% Standard Procter Density. Sufficient soaking shall be done before compaction. The entire area shall be finally dressed and trimmed to required levels. Mechanical equipment like vibratory roller, vibro earth rammer or vibratory compactor shall be used for compaction.

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**TECHNICAL SPECIFICATION  
FOR  
PLAIN CEMENT CONCRETE & ALLIED WORKS**

**GAIL-STD-CV-DOC-TS-002**


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**1. INTRODUCTION**

This specification covers the general requirements for concrete to be used on jobs using on-site production facilities including requirements in regard to the quality, handling, storage of ingredients, proportioning, batching, mixing and testing of concrete, and also requirements in regard to the quality, storage, bending and fixing of reinforcement. This also covers the transportation of concrete from the mixer to the place of final deposit and the placing, curing, protecting, repairing and finishing of concrete.

**2. PLAIN CEMENT CONCRETE 1:3:6 OR AS SPECIFIED :**

Plain cement concrete shall be in proportion of 1:3:6 or as specified. i. e. in volume by one part of cement, three part of coarse sand and six parts of black stone aggregate of size 40 mm size.

The building materials as stated above shall be mixed in dry condition with power driven concrete mixer. After materials are properly mixed, water shall be added and materials shall again be mixed in concrete mixer. It should be watched that no excessive water is added so that permissible water cement ratio is maintained throughout during the progress of concrete work. Before the concreting work, necessary centering work if so necessary shall be provided for which payment shall be done separately under respective items. All the materials shall be got tested for every lot from govt. approved Engineering testing laboratories as per I.S. code of practice and test certificates shall be submitted to Owner/site engineer.


The concrete so prepared shall be stacked in water tight platform. The concrete should not be thrown from height so that segregation may not take place. The concrete so placed shall be properly compacted with concrete vibrator machine to avoid voids. Moreover concrete shall be compacted in such a way that the surface is become smooth and no honey combing is observed.

After properly setting of concrete, curing shall be done for minimum period of seven days.

**3. M-20 CEMENT CONCRETE :**

The cement concrete shall be in proportion.(1:1.5:3) i.e. in volume by 1 part of cement,1.5 parts of coarse sand and 3 parts of black stone aggregate of size 20 mm size. The stone aggregate shall be of even size and black in color without any white spot. The aggregate shall be got approved from engineer in charge /Owner. The building materials as stated above shall be mixed in dry condition with power driven concrete mixer. After materials are properly mixed, water shall be added and materials shall again be mixed in concrete mixer. It should be watched that no excessive water is added so that permissible water cement ratio is maintained throughout during the progress of concrete work. Before concreting work, necessary centering work and reinforcement as per structural drawing shall be placed for which payment shall be done under respective items. All the materials shall be got tested for every lot from govt. approved Engineering testing laboratories as per I.S. code of practice and test certificates shall be submitted to Owner/Owners representative.

After setting of concrete, sufficient curing shall be done for minimum period of seven days. During concrete work, concrete cube of size 150m.m. x 150 m.m. x 150 m.m. shall be prepared and these concrete cubes shall be got tested for compressive strength from approved engineering testing laboratories and testing certificate should be submitted to Owner/Owners representative. The slump test shall also be carried out on site of work during every concrete work on site.

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**4. APPLICABLE CODES AND SPECIFICATIONS**

The following specification, standards and codes shall form a part of this specification. All standards, tentative specifications, codes of practice, referred to herein, shall be the latest editions including all applicable official amendments and revisions.

In case of discrepancy, if any, between this specification and those referred to in the following, the latter shall govern.


Applicable Specifications and Codes of Practices.

I.S. 269 - Specification for ordinary and low heat Portland cement.

I.S. 383 - Specification for coarse and fine aggregate from natural source for concrete.

I.S. 2386 - Method of test for aggregates for Concrete (Part I to VIII)

I.S. 516 - Method of test for strength of concrete

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GAIL INDIA LIMITED

**TECHNICAL SPECIFICATION  
FOR  
PORTA CABIN**


**GAIL-STD-CV-DOC-TS-003**

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## 1.0 INTRODUCTION

The Porta Cabin shall be insulated type steel structure, shall be well ventilated and shall be brought to site in knock down condition and assembled at site or factory prefabricated. All components of the prefabricated cabin shall be reclaimable and reusable.

## 2.0 DESIGN

The structure of the prefabricated Cabin (i.e. all walls, ceiling, floor etc.) shall be tubular steel/ structural steel members. The fully erected and anchored prefabricated Cabin after installation/ placing in position shall be structurally strong enough to withstand wind force of minimum speed 47 m/sec. and earthquake for seismic zone 3, importance factor 1.5.

## 3.0 FOUNDATION

RCC M25 foundation shall be constructed up to a height of 450 mm from finished ground level for installation of Porta Cabin.

## 4.0 SHELL

The shell structure shall comprise of side walls, end walls and self draining roof.

## 5.0 SKID

The floor shall be made up of ISMC (channels) or tubes of required sizes and shall be used to form the floor grid of minimum size 600mm x 600mm. Materials of structural steel members shall conform to IS: 2062 Grade A. The floor shall be minimum 200mm above bottom level and shall be covered with marine Ply board (IS: 2202/ 1991) of required thickness or cement fiber board of required thickness; finished neatly with floor vinyl (of required thickness), in roll/ tiles by means of neoprene base adhesive as per manufacturer's recommendations.

## 6.0 WALLS


Walls shall be made up of 'sandwich' insulated panels manufactured using outer side minimum 0.63mm thick profiled pre-coated galvanized steel sheet (Rib Profile) and inner side minimum 0.63mm thick profiled pre-coated galvanized steel sheet (Plain) conforming to IS: 277 with insulation of PUF/ mineral wool/ glass wool/rock wool of approved make, in between steel sheets. Average 75 mm thick thermal insulation of the mocol shall be provided on the side walls, end walls and roof with proper fixing arrangement. It shall be waterproof, termite proof, heat and fire resistant and comfortable in extreme hot and cold climate. The walls shall be provided with internal paneling of laminated plywood of required thickness. Necessary provisions shall be provided in the walls (at desired locations) for installing split type air-conditioners and exhaust fans.

## 7.0 STEPS

Fabricated steel steps of detachable type having necessary treads shall be provided at doors for getting inside. These shall be made of checkered plates and formed channel sections.

## 8.0 WINDOWS

The windows shall be provided in the desired location. The windows shall be horizontal sliding type having overall dimensions 1600x1200 mm (H x W). The windows shall be decorated by

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anodized aluminum extruded section fitted with 5.5mm toughened glass and grill. Iron grills made of 20 mm M.S. flats shall also be provided in the windows for safety purpose. Stainless Steel fly-proof mesh in suitable framework shall also be provided in the windows. The windows shall be provided with steel rain-shed made from min. 2 mm thick sheet (IS:1079 Gr.O) from outside.

## 9.0 DOORS

Doors having overall dimensions 2100x900 mm (H x W) shall be of aluminum extruded sections with partly glazed portion (from lock rail level to top rail; with 5.5mm toughened glass) and partly with 10mm thick cement bound particle board panel (from bottom rail to lock rail level). The doors shall be complete with necessary fittings and fixtures like mortice lock, handles, tower bolt, floor mounted double action floor spring hinges etc. The peripheral edges of the door shall be provided with rubber seal to prevent ingress of water and dust. The door panels shall be outward opening type with single leaf closing. The door shall be provided with steel rain-shed made from 2 mm thick sheet ( IS:1079 Gr. O) from outside.

## 10.0 ROOFS


Roof shall be made up of 'sandwich' insulated panels manufactured using outer side minimum 0.63mm thick profiled pre-coated galvanized steel sheet (Rib Profile) and inner side minimum 0.63mm thick profiled pre-coated galvanized steel sheet (Plain) confirming to IS: 277 with insulation of PUF/ mineral wool/ glass wool/rock wool, of approved make, in between steel sheets. Average 75 mm thick thermal insulation of the mocol shall be provided on the side walls, end walls and roof with proper fixing arrangement. The roof shall be waterproof, termite proof, heat and fire resistant and comfortable in extreme hot and cold climate. The ceiling shall be provided with internal paneling of laminated plywood of required thickness. Roof shall be supported on suitable trusses and purlins. Roof shall be extended by minimum 600mm on all sides to provide rain/ sun protection to doors and windows.

## 11.0 SURFACE TREATMENT AND PAINTING

The surface preparation of all fabricated steel components shall be done by manual grit blasting to achieve SA-2 quality finish, followed by one coat of zinc based primer and two coats of enamel of approved make and shade. The under frame and skid shall be painted with bituminous / red lead paint of reputed make. Necessary marking/ logos shall be provided as per the instruction of Owner. All the internal walls shall be finished with Oil bound distemper of approved make and shade.


## 12.0 ELECTRICALS

PVC insulated copper wire of ISI mark shall be used for the wiring. This wiring shall be done in PVC conduits. As a measure of safety, continuous copper earth wire shall be provided as necessary. For lighting circuits 3/1.09 cable shall be used. For connecting power supply, 3 pin input industrial socket of 32 Amps capacity shall be provided. Concealed type (1 x36) roof hanging florescent light shall be provided. In addition, one number each of 15 Amps and 5 Amps 3 pin sockets shall be provided at suitable locations inside the cabin. All electrical points & switches shall be of Anchor or equivalent make.

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### 13.0 HANDLING AND TRANSPORTATION

Necessary arrangement shall be provided at top four corners for safe and easy lifting and transportation of the bunkhouse.

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GAIL INDIA LIMITED

# TECHNICAL SPECIFICATION FOR CHAIN LINK FENCING


**GAIL-STD-CV-DOC-TS-004**

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## 1.0 INTRODUCTION

This specification specifies the requirements of chain link fence for security purposes.

## 2.0 MATERIALS

Material for chain link fencing shall conform to IS: 2721 latest edition. Mesh for chain link fencing shall be of 2.5 mm hot dip galvanized steel mesh wire, the diameter being measured over zinc coating. The diameter of mesh wire shall not vary from the specified diameter by more than 0.05mm. The material for mesh wire and line wire of chain link fencing shall conform to IS: 280-1978. Stretcher bar for erection of mesh shall consist of mild steel flats 25mmx4.75mm. The stirrup wire for securing the line wires to the intermediate post shall be of 2.5mm mild steel wire. Hairpin staples for fastening the bottom line wire to the foundation concrete shall be of 6mm mild steel wire with ends of staples bent outwards for adequate anchorage. The cleats for eyebolts shall be of mild steel plate 10mm thick.


Material for barbed wire shall conform to IS: 278 latest edition. Line wire for the barbed wire shall be made from two strands of galvanized steel wire of nominal diameter 2.5mm twisted together. Barbs shall be made of point wire of galvanized steel of nominal diameter 2.5mm in such a way that four points of the barbs are set and located or locked as far as possible at right angles to each other. The barbs shall have a length of not less than 13mm and not more than 18mm. Droppers for barbed wire shall be of mild steel flat 25mmx4.75mm with 38mmx4.85mm half round staples for fastening the barbed wire.

## 3.0 ERECTION

Straining posts shall be provided at all ends and corners of fences, at changes in direction or acute variations in level and at intervals not exceeding 60m on straight lengths of fence. Intermediate posts shall be spaced at regular intervals not exceeding 3m. Struts shall be fitted to all straining posts behind the chain link fabric in the direction of the line of fence.

There shall be four evenly spaced rows of line wire. The top wire shall be doubled, making five line wires in all. The bottom wire shall be close to the ground. Each line wire shall be strained lightly by means of eyebolt strainer at each straining point. The eyebolt strainer shall consist of bolt with welded eye. The bolt shall be sufficiently threaded and fitted with a nut and washer. Each line wire shall be secured to each of the intermediate posts by a wire stirrup passing through holes in the posts and secured to the line wire by three complete turns on each side of the post. Two-way eyebolt strainers shall have suitable ring nuts fitted after wires have been strained on one side.

The mesh shall be strained between each pair of straining posts and shall be secured to each straining post by means of a stretcher bar. One of the top line wires shall be threaded through the appropriate adjacent rows of mesh, care being taken that no meshes in the rows are bypassed by the line wire except where deviation is necessary at the straining posts. The second top line wire shall be strained in front of the fencing. The mesh shall be attached to top and bottom line wires by wire ties spaced 150mm apart and to other line wires by wire ties spaced 450mm apart. Bottom row of the mesh shall be threaded to the foundation concrete using staples spaced 500mm apart and set in concrete to a depth of 150mm. The top of concrete shall be 50mm above G.L. and 50mm below the fencing.

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GAIL INDIA LIMITED

**TECHNICAL SPECIFICATION  
FOR  
STRUCTURAL CONCRETE**


**GAIL-STD-CV-DOC-TS-005**

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## 1.0 INTRODUCTION

This specification covers the materials, workmanship, special requirements & regulations with which the contractor must comply to achieve dense workable concrete, having the specified characteristic strength.

The mixing, placing, compacting, curing and finishing of concrete shall be done according to IS: 456-2000 "Code of Practice for Plain and Reinforced Concrete".

## 2.0 MATERIALS FOR CONCRETE

### AGGREGATES

Aggregates shall comply with the requirements of IS: 383-1970 "Coarse and Fine Aggregates for Concrete". They shall be hard, strong, dense, durable, clean and free from veins and adherent coating, vegetable matter and other deleterious substances; and shall be obtained from approved sources. Aggregates shall not contain any harmful material such as pyrites, coal, lignite, shale or similar laminated material, clay, alkali, soft fragments, sea shells and organic impurities in such quantity as to affect the strength or durability of concrete. Aggregates which are chemically reactive with alkalis of cement shall not be used. Aggregates which are not sufficiently clean shall be washed in clean fresh water to the satisfaction of the Engineer.

### TESTING

All aggregates shall be subject to inspection and testing. The Contractor shall submit samples for testing as may be required by the Engineer. Sampling and testing shall be carried out in accordance with IS: 2386-1963 "Methods of Test for Aggregates for concrete".

### GRADING


The Contractor shall ensure that the full range of aggregate used for making concrete is graded in such a way as to ensure a dense workable mix. The delivery of aggregates will commence only when the Engineer has approved the samples and the quality and grade shall be maintained consistent and equal to the approved sample. Before construction commences, the Contractor shall carry out a series of tests on the aggregates and on the concrete to determine the most suitable grading of the available aggregates. Once the most suitable grading has been found, the grading shall be adopted for the construction of the works and periodic tests shall be carried out to ensure that it is maintained.

### SIZE AND GRADING OF FINE AGGREGATES

The grading shall conform to IS: 383 and shall be within the limits of Grading Zone-III. The maximum size of particle shall be 4.75mm and shall be graded down. Sand containing more than 10% of fine grains passing through 150 micron sieve or having the fineness modulus less than 2 shall not be used for concrete work.

### SIZE AND GRADING OF COARSE AGGREGATES

The nominal maximum size of the aggregates for each mark of concrete or for each type of

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work shall depend upon the description of the particular item in the Schedule of Items and/or according to relevant clauses of IS: 456-2000. The aggregates shall be well graded and the grading shall conform to relevant requirements of IS: 383 depending upon the maximum nominal size as specified or as required.

#### TYPE OF COARSE AGGREGATES

The type of coarse aggregate viz., stone chips, gravel or broken brick shall be as described in the Schedule of Items. Unless otherwise specified in the Schedule of Items, stone chips shall be used as coarse aggregate.

##### ➤ STONE CHIPS

It shall be crushed or broken from hard stone obtained from approved quarries of igneous or metamorphic origin. The stone chips shall be hard, strong, dense, durable and angular in shape. It shall be free from soft, friable, thin, flat, elongated or laminated and flaky pieces and free from dirt, clay lumps, and other deleterious materials like coal, lignites, silt, soft fragments, and other foreign materials which may affect adversely the strength & durability of concrete. The total amount of deleterious /foreign materials shall not exceed 5% by weight according to relevant clause of IS: 383.

##### ➤ GRAVEL

It can be either river bed shingle or pit gravel. It shall be sound, hard, clean, and irregular in shape and suitably graded in size with or without some broken fragments. It shall be free from flat particles, powdered clay, silt, loam and other impurities. Before using, the gravel shall be screened and washed to the satisfaction of the Engineer. However, the foreign/deleterious materials shall not exceed 5% by weight.

##### ➤ BROKEN BRICKS

These shall be obtained by breaking well burnt or over burnt dense brick bats. They shall be homogeneous in texture, well graded in size, roughly cubical in shape, clean and free from dirt, clay, silt or any other deleterious matter. Before use, these shall be screened.

#### FINE AGGREGATES


Unless specified otherwise it shall either be natural river sand or pit sand.

Sand shall be clean, sharp, strong, angular and composed of hard siliceous material. It shall not contain harmful organic impurities in such form or quantities as to affect adversely the strength and durability of concrete. Sand for reinforced concrete shall not contain any acidic or other impurities which are likely to attack steel reinforcement. The percentage of all deleterious materials including silt, clay etc., shall not exceed 5% by weight. If directed, sand shall be screened or washed before use to the satisfaction of Engineer.

#### CEMENT

Ordinary Portland cement / Portland slag cement complying with the requirements of IS:269-1989 and I.S. 455-1989 respectively shall be used for making plain and reinforced concrete, cement grout and mortar.

Other types of cement may be used depending upon the requirements of certain jobs with the

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approval of the Engineer. These shall conform to the following standards:

The Contractor shall supply a copy of the manufacturer's test certificate for each consignment of cement supplied by him and consignments shall be used on work in the order of delivery. The Contractor shall supply samples of cement to the Engineer as frequently as he may require for testing. The sampling of cement for testing shall be according to IS: 3535-1986. All tests shall be in accordance with the relevant clauses of IS: 4031 (Part-I to Part-15) 1988 to 1991 & IS: 4032-1985.

In order to ensure due progress, the Contractor shall at all times maintain on the site at least such stock of cement as the Engineer may from time to time consider necessary. No cement shall be used upon the works until it has been accepted as satisfactory by the Engineer.

The cement shall be stored in such manner as to permit easy access for proper inspection and in a suitable weather-tight, well ventilated building to protect it from dampness caused by ingress of moisture from any source. Different types of cement shall be stored separately. Cement bags shall be stacked at least 15 to 20 cm clear of the floor leaving a space of 60 cm around the exterior walls. The cement shall not be stacked more than 10 bags high. Each consignment of cement shall be stacked separately to permit easy access for inspection.

### WATER

Water used for mixing concrete and mortar and for curing shall be clean and free from injurious amounts of oil, acid, alkali, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. The pH value of water shall generally be not less than '6'. Water has to meet the requirements mentioned in clause 4.3 of IS: 456-2000. Water shall be obtained from an approved source.

Where it is obtained from a source other than a supply main, it shall be tested to establish its suitability. Water for construction purpose shall be stored in proper storage tanks to prevent any organic impurities getting mixed up with it.

### ADMIXTURE


Admixtures to concrete shall not be used without the written consent of the Engineer. When permitted, the Contractor shall furnish full details from the manufacturer and shall carry out such test as the Engineer may require before any admixture is used in the work.

### REINFORCEMENT STEEL

Reinforcing bars for concrete shall be round steel bars of the following types as may be shown on the drawing:

- Plain mild steel bars conforming to Grade-I of IS: 432-1982 "Mild Steel & Medium Tensile Steel for Concrete Reinforcement".
- "High strength deformed steel bars conforming to IS : 1786-2008 for Concrete Reinforcement".
- Reinforcement fabrics conforming to IS:1566-1982 "Hard Drawn Steel Wire Fabric for Concrete Reinforcement"

All reinforcement bars shall be of uniform cross sectional area and be free from loose mill

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scales, dust, loose rust, coats of paint, oil or other coatings which may destroy or reduce bond. Unit weight of reinforcement bars conforming to I.S. 1786-1985 is given below.

Nominal Size (Dia) (mm)	Mass Per Meter Run (Kg)
6	0.222
8	0.395
10	0.617
12	0.888
16	1.580
20	2.470
25	3.850
32	6.310

Binding wire for reinforcement shall be annealed steel wire 20 BWG conforming to IS : 280 - 1978 "Specification for Mild Steel Wire".

#### FOUNDATION BOLTS

Bolts to be embedded in concrete shall, unless otherwise detailed in drawings, conform to IS : 5624-1970 "Specification for Foundation Bolts". Material for bolts, shall, unless otherwise mentioned in drawings or the schedule of items, be of steel conforming to IS : 2062-1992.

Nuts and locknuts shall conform to IS : 1363 (Part 1 to 3) -1992 "Specification for Black Hexagon Bolts, Nuts and Lock Nuts (Diameter 6-39 mm) and Black Hexagon Screws "Specification for Hexagon Bolts and Nuts (M-42 to M-150)".


Plain washers shall conform to IS : 2016 -1967 "Specification for Plain Washers and spring washers shall conform to IS : 3063 -1972 "Spring Washers for Bolts, Nuts & Screws".

### 3.0 CONCRETE MIX PROPORTIONING

The mix proportion shall be selected to ensure adequate workability when handling and placing. On hardening, concrete shall have the required strength, durability and surface finish. The determination of the proportions of cement aggregates and water to attain the required strength shall be either:

- By determining the concrete mix; such concrete shall be called "Design Mix Concrete", or
- By adopting nominal concrete mix; such concrete shall be called "Nominal Mix Concrete".

Concrete of grade M20 and above shall be 'Design Mix Concrete' unless otherwise specified. In either case, the Contractor shall be solely responsible to ensure that the concrete has all the essential properties, i.e. characteristic compressive strength, and any additional properties that may be specified.

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**MIXES & MIXING**

Concrete for construction shall be as detailed in the table of concrete mixes & as shown by test cube results as specified. This list may be extended by the addition of other mixes as required and to the approval of the Owner/Owner's Representative.

The criteria stated in the table of concrete mixes are designed to produce concrete of the required strength & durability.

The specified characteristics strength is for concrete which has been cured at a temperature of  $20^{\circ}\text{C} \pm 1^{\circ}\text{C}$ . The term "characteristics strength" represents the value of the strength of concrete corresponding to the probability that, for a normal statistics distribution of the test results for determining the strengths by the compression tests, only 5% of the test result have a value lower than the one determined in this way.

The mixes shall be designed mean strengths that are greater than the specified characteristics cube strength by a margin of 1.64 times the standard deviation expected from the concrete batching plant, except that no standard deviation of less than  $3.5\text{N/mm}^2$  shall be used as a basis for designing a mix.

Mixes shall be designed with due regard for minimum workability necessary to allow the contractor to place & compact the concrete as specified with the equipment he proposes to use in any particular situation.

<b>TABLE OF CONCRETE MIXES</b>			
<b>Concrete Grade</b>	<b>Minimum Qty of cement <math>\text{Kg/m}^3</math></b>	<b>Maximum free water-cement ratio</b>	<b>Characteristics strength 150 mm Cube</b>
M20	300	0.55	20
M25	300	0.5	25
M30	320	0.45	30
M35	340	0.45	35
M40	360	0.4	40

Where air-entrainment is specified the average air content as measure in accordance with relevant Indian codes:

- a. Concrete containing 40 mm max. size aggregate  $4.0\% \pm 1.0\%$
- b. Concrete containing 20 mm max. size aggregate  $5.0\% \pm 1.0\%$


These air contents are applicable at the time of concrete placing.

Concrete for paving or non structural pre-cast units shall have minimum flexural beam strength of  $3.5\text{N/mm}^2$  at 28 days.

**DESIGN MIX CONCRETE**

At least two weeks before commencement of concreting of a particular grade in permanent works, the Contractor shall have obtained the Owner/Owner's Representative's approval of the Design Mix for that particular grade.

**TRIAL MIXES****STRUCTURAL CONCRETE**

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The mix(s) shall be designed mixes in accordance with IS SP23 Handbook on Concrete Mixes and IS 10262 and as specified in this document. The relative proportions of the fine and coarse aggregates, the workability and strengths of the mixes shall be determined by production equipment trial mixes. The trial mixes shall be carried out in order to produce a concrete which can be properly placed and compacted, so that a dense impermeable concrete can be produced which shall adequately resist the ingress of damaging salts. If an admixture is proposed it shall be used in the trial mixes. The required workability for large foundations will differ from that for tall thin sections of structural concrete cast above ground and the trial mixes shall allow for both cases.

When the proposed workability and proportion of the aggregates and admixture (if any) for each of the grades of concrete has been established, test concrete shall be produced for approval. The following tests shall be carried out for each grade of concrete:

Four separate test mixes shall be prepared and six test cubes shall be made from each test mix for each grade of concrete. The test cubes shall be made and cured in accordance with IS 516. Testing shall be made in threes or multiples of threes. Only 28-day result shall be considered and the mean strength and standard deviation established for each grade.

The test mixes shall be accepted provided that:

- The mix proportions and workability are in accordance with this Specification.
- The standard deviation for all the different grades shall be worked out as per clause 2.1 of IS: 10262-1982.
- The acceptance criteria shall be in accordance with clause 16 of IS 456.


<b>Maximum Water Cement Ratio in Cement Concrete to Ensure Durability under specified exposure</b>		
<b>Condition of Exposure</b>	<b>Concrete</b>	
	<b>Plain</b>	<b>Reinforced</b>
<b>Mild</b>	0.6	0.55
For Example Completely Protected against weather, or aggressive conditions, except for A brief period of exposure to normal condition during construction		
<b>Moderate</b>	0.6	0.50
For Example Sheltered from heavy and wind driven rain and against freezing, whilst saturated with water, buried concrete in soil and concrete continuously under water		
<b>Severe</b>	0.5	0.45
For Example Exposed to Sea water, alternate wetting and drying and to freezing while wet, subject to heavy condensate or corrosive fumes		

Based on the results of the preliminary test, the contractor shall select a final design mix for the trial mixes and shall furnish the same to the Owner/Owner's Representative. The contractor shall demonstrate that the proposed design mix will produce the grade and quality of concrete required with adequate workability

A fresh mix design shall be arrived at each time there is a change in the quality or source of materials

<b>Minimum Cement Content (Ref IS 456, Table 5)</b>
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<b>Plain Concrete</b>
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Exposure	Min. Grade of Concrete	Min. Cement Content (kg/m <sup>3</sup> )
Mild	-	220
Moderate	M15	240
Severe	M20	250
Very Severe	M20	260
Extreme	M25	280
<b>Reinforced Concrete</b>		
Exposure	Min. Grade of Concrete	Min. Cement Content (kg/m <sup>3</sup> )
Mild	M20	300
Moderate	M25	300
Severe	M30	320
Very Severe	M35	340
Extreme	M40	360

#### NOMINAL MIX CONCRETE


No mix design or preliminary tests are necessary for Nominal Mix Concrete. Nominal Mix Concrete shall be restricted to works of minor nature in which the strength of concrete is not critical as decided by the Engineer. The limit of chloride content of concrete shall be as follows:

Type or Use of Concrete	Max. Total Acid Soluble chloride content expressed as kg/m <sup>3</sup> of concrete
Concrete containing metal and steam cured at elevated temperature and pre-stressed concrete.	0.4
Reinforced or plain concrete containing embedded metal	0.6
Concrete not containing embedded metal	3.0

#### BATCHING

In proportioning concrete, the quantity of both cement and aggregate shall be determined by weight. If fine aggregate is moist and volume batching is adopted, allowance shall be made for bulking in accordance with IS 2386 (Part III). All measuring devices shall be accurate to + 3% and shall be regularly checked.

The water-cement ratio shall be maintained constant at its correct value. To this end, determination of moisture content in both fine and coarse aggregate shall be made by the Contractor at no extra cost. The frequency of tests shall be determined by the Engineer according to weather conditions.

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## 4.0 FORMWORK

The design and construction of the formwork shall be the responsibility of the Contractor. However, if instructed by the Engineer, the drawings and calculations for the design of the formwork shall be submitted to the Engineer for approval. Design of formwork shall take account of safety and surface finish. The formwork shall be sufficiently rigid and tight to prevent loss of grout or mortar from the fresh concrete.

Formwork shall be designed to withstand the worst combination of self weight, reinforcement weight, wet concrete weight, concrete pressure, construction and wind loads together with dynamic effect caused by placing, vibrating and compacting the concrete. Forms shall be designed and constructed to maintain rigidity throughout the placing, ramming, vibration and setting of the concrete to the required shape, position and level and specified class of finish within the allowable tolerances. All joints shall be sufficiently tight to prevent leakage of grout. If movement or deflection of the formwork or loss of grout occurs, the damaged concrete supported by such formwork shall be removed and the concrete re-cast so that the required finish is obtained. Formwork and its supports should be designed to withstand the worst combinations of self-weight, reinforcement and wet concrete weights, concrete pressure, construction and wind loads. Due regard shall be taken to the type of mix when considering the design pressure on the formwork. The formwork shall be precambered by an amount equal to the expected maximum deflection shall be as shown on the drawings.

If timber forms are used they shall be of sound, well-seasoned timber free from loose knots. The forms shall be faced to give the specified class of finish for the structures. The formed surfaces of exposed concrete shall be smooth, true and free from all irregularities.

For below ground concrete except against existing structures, rough formwork, steel pans etc., provided all joints prevent the loss of grout.

The formwork shall be capable of being dismantled and removed from the cast concrete without shock, disturbance or damage. The arrangement shall be such that the soffit forms properly supported on props, can be retained in position for such period as may be required by maturing conditions or specifications.

### CLEANING AND TREATMENT OF FORMS

All rubbish shall be removed from the interior of the forms before the concrete is placed. The faces of the forms in contact with the concrete shall be clean and treated with a suitable release agent, where applicable. Release agent shall be applied so as to provide a thin uniform coating to the forms without contaminating the reinforcement.

### STRIKING OF FORM WORK

In normal circumstances where Ordinary Portland Cement is used, forms shall generally be removed after the expiry of the following periods:

Walls, Columns and vertical faces of all structural members	24 to 48 hours
Slabs (Props left Under)	3 Days
Beam Soffits (Props left Under)	7 Days
Removal of Props under Slabs:	
1) Spanning upto 4.5m	7 Days
2) Spanning over 4.5m	14 Days

Removal of Props under Beams and Arches:	
1) Spanning upto 6.0m	14 Days
2) Spanning over 6.0m	21 Days

For other cements, the stripping time recommended for Ordinary Portland Cement shall be suitably modified. The number, size and position of props left under shall be such as to be able to safely carry the dead load of the slab, beam or arch, together with any live load likely to occur during curing or further construction.

Sleeves for through bolts shall not be provided in formwork for liquid retaining structures as they are potential hazard for leakage. Special devices shall be fabricated using two ordinary M20 nuts separated by two numbers 10 mm rounds welded to opposite flat side of the nuts. The faces of the nuts will have a compressible rubber bushing 20 mm thick. The overall dimension of the assembly shall be 50 mm less than the designed thickness of the concrete. Adjusting bolt shall pass through formwork and will lock into the nuts. While these bolts are tightened, the formwork will travel inwards.

Once the desired dimension is achieved, concrete will be poured. During removal of shuttering, the bolts will be removed to loosen the shuttering plates. The depression will be sealed using suitable concrete sealant.

#### SURFACE FINISHES FROM FORMWORK

Generally formwork shall be specified as either wrought or unwrought depending on the required surface finish.

#### UNWROUGHT FORMWORK

Unwrought Formwork shall consist of sawn boards, brick or concrete block work, sheet metal or other suitable material to give adequate support to the concrete.

Appearance is not of primary importance for this class of formwork.

Surfaces to which plaster, granolithic or other finish is to be applied shall be roughened while the concrete is still green.


#### WROUGHT FORMWORK

Wrought formwork shall be provided for concrete surfaces that are required to be finished smooth.

Wrought formwork shall be lined with metal or plywood having smooth surfaces and edges. Formwork shall be furnished in largest practicable sizes to minimize the number of joints. Care shall be taken that there are no irregularities or roughness between successive sections of shuttering such that finished surfaces shall be free of board or shutter marks. Upon removal of formwork, surfaces of finished concrete shall be rubbed down with carborundum stone where necessary to obtain a uniform and smooth appearance.

The finish shall be such as to require no filling of surface pitting, butt fins, surface discoloration and other minor defects shall be remedied by approved methods.

Rendering of defective concrete as a means of making good will not be permitted except that, in case of minor porosity on the surface, approval may be given for the surface to be treated by rubbing down with a cement mortar of the same fine aggregate/cement ratio as the concrete. The treatment shall occur immediately after removing the formwork. Both cement and aggregate shall be from the same source as the concrete materials.

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Concrete containing honeycombing, major air holes or similar defects shall be cut out and replaced as directed. No repair shall be executed without approval.

## TIES

Where it is required to use internal ties and spacers, their type, spacing and uses shall be approved. No part of any such tie or spacer remaining permanently embedded in the concrete shall be nearer than the specified cover to the finished surface of the concrete. Wire ties projecting through the concrete face shall not be permitted.

## PERMANENT FORMWORK

Permanent formwork for elevated concrete floors in steel structures shall be profiled steel sheet. The sheet shall be of sufficient thickness to sustain all construction loads plus the weight of fresh concrete between supporting beams without excessive deflection. The underside of the sheet shall be coated with an approved corrosive resistant paint. The material shall conform to IS 513. The deflection shall be limited to  $\text{span} / 150$ . The sheet shall be fixed on the supporting beams at every alternate valley by 10 mm dia fusion welding with 22 mm dia x 2.5 mm thick reinforcing washer. Minimum 100 mm overlap shall be provided. The deck sheet end resting on wall shall have a seating of 150 mm minimum. Side laps shall be secured with tack welding to ensure that the slurry does not leak down. End laps shall always be on the supporting walls or on supporting beams. The overhang of the deck sheet shall be limited to 300 mm maximum. Temporary supports, where ever advised by the construction manager, shall be firm, and at the same level as the permanent supports and shall be in place till the concrete attains its full strength. While removing the temporary supports, care shall be taken that the slab is not disturbed.

## FORMWORK FOR VIBRATED CONCRETE

If external vibrators are to be used for compaction of concrete, the type of vibrator, design of the formwork and the method of fixing the vibrators shall all be approved.


## CLEANING AND TREATMENT OF FORMS

Before concreting is commencing the forms and previously cast concrete shall be thoroughly cleaned and free from all sawdust, tie wire, shavings, dust, dirt and other debris. Temporary openings shall be provided where necessary to drain away water and remove rubbish.

Release agents shall be applied and be compatible with the class of finish. Care shall be taken not to contaminate the reinforcement.

## 5.0 CONSTRUCTION JOINTS

The number of construction joints shall be kept to the minimum necessary for the execution of the work. Their location shall be carefully considered and approved by Engineer before concrete is placed. Construction joints shall normally be at right angles to the general direction of the member. The concrete at the joint shall be bonded with that subsequently placed against it, without provision for relative movement between the two. When the work has to be resumed on surface, which has hardened, such surface shall be roughened. It shall then be swept clean and thoroughly wetted. For vertical joint neat cement slurry shall be applied on the surface before it is dry. For horizontal joints the surface shall be covered with a layer of

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mortar about 10 to 15 mm thick composed of cement and sand in the same ratio as the cement and sand in concrete mix. This layer of cement slurry or mortar shall be freshly mixed and applied immediately before placing of the concrete.

Where the concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire brushes, care being taken to avoid dislodgement of particles of aggregate. The surface shall be thoroughly wetted and all free water removed. The surface shall then be coated with neat cement slurry. On this surface, a layer of concrete not exceeding 150 mm in the thickness shall first be placed and shall be rammed against old work, particular attention being paid to corners and loose spots; work thereafter shall proceed in the normal way. The number, size and positions of props left under shall be able to carry safely the dead load of the slab, beam or arch together with any live load likely to occur during curing or further construction. Cambers and chamfers, wherever shown in drawing shall be provided accordingly.

#### EXPANSION JOINTS

Expansion joints and joints around equipment in concrete paving shall be as detailed in the drawing and shall be formed with an approved bitumen impregnated fibreboard. The upper 20 mm shall be sealed with an approved two part, Polysulphide, oil resistant sealant (H.C. grade) or hot applied bitumen sealing compound, applied strictly in accordance with the manufacturer's instructions.

The joint filler shall be fixed firmly to the first placed concrete before the adjoining concrete is placed. The concrete must be thoroughly compacted on both sides of the joint. The location of expansion joints shall be shown on the engineering drawings.

#### CONTRACTION JOINTS

Contraction joints (either complete or partial) shall be located on the drawings and formed with a building paper membrane interface, or equivalent separating membrane and the upper 25 mm depth sealed. The steel reinforcement shall be continuous through partial contraction joints. The use of contraction joints should be kept to a minimum compatible with freedom from cracking.

#### JOINT FILLERS

Joint fillers and sealing compounds shall comply to IS 1834, IS 1838 and IS 11433.


### **6.0 REINFORCEMENT**

Reinforcement shall comply with IS 1786 or IS 432. Different types of reinforcement may be used in the same structural member. Reinforcement shall be cut and bent in accordance with approved bar bending schedules.

#### CUTTING AND BENDING

Reinforcement shall be cut and/or bent in accordance with IS 2502. It is essential that reinforcement shall not be subjected to mechanical damage prior to embedment. In general, reinforcement shall be bent cold.

Bends in reinforcement shall have a substantially constant curvature.

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It is permissible to bend mild steel reinforcement projecting from concrete provided that care is taken to ensure that radius of bend is not less than that specified in IS 2502. Grade Fe.415 bars shall not be re-bent or straightened without the Engineer's approval.

### FIXING

Reinforcement shall be secured against displacement outside the specified limits. Actual concrete cover shall be not less than the required nominal cover minus 5 mm or two third the nominal cover whichever is more. In slabs, the actual concrete cover shall be not more than the required nominal cover plus.

5 mm on bars up to and including 12 mm size

10 mm on bars over 12 mm and up to 25 mm

15 mm on bars over 25 mm

Spacers and chairs shall be used to maintain the specified nominal cover to the steel reinforcement. Spacers or chairs shall be placed at a maximum spacing of 1 meter. Wherever reinforcing bars are intended to be in contact, they shall be securely bound together with 18 gauge annealed soft iron wire.

The mix used for spacer blocks made from cement, sand and fine aggregates shall be comparable in strength, durability and appearance to the surrounding concrete.

The position of reinforcement shall be checked before and during concreting, particular attention being directed to ensure that the nominal cover is maintained within the limits, given, especially in the case of cantilever sections.

### SURFACE CONDITIONS

Concrete shall not be placed around reinforcement unless the reinforcement is free from mud, oil, paint, loose rust, grease or any other substance which can be shown to adversely effect the steel or concrete chemically or reduce the bond.

### LAPS AND JOINTS

Laps and joints shall be made only by the methods specified and at the positions shown on the drawings or as agreed by the Engineer.


### WELDING

Welding on site shall be avoided if possible, but may be permitted where suitable safeguards and techniques are employed. Generally, however, all welding shall be carried out in a workshop. The competence of the welder shall be demonstrated prior to and periodically during welding operations. Welding of mild steel bars shall be carried out in accordance with IS 2751. Welding of high strength deformed bars shall be in accordance with IS 9417. The carbon content of high yield strength deformed bars conforming to IS 1786 shall not be more than 0.25%. If carbon content exceeds the limits specified herein, specifically written down welding and testing procedure shall be followed.

### TOLERANCES ON PLACING

Reinforcement shall be placed within the following tolerances:

1. For effective depth 200 mm or less + 10 mm
2. For effective depth more than 200 mm + 15 mm.

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TYING OF REINFORCEMENT

Bars crossing each other, where required shall be secured by binding wire (annealed) conforming to IS 280. Every compression bar will be tied at least in two perpendicular directions.

**7.0 TRANSPORTING, PLACING, COMPACTING AND CURING OF CONCRETE**TRANSPORTING

Concrete shall be transported from the mixer to the formwork as rapidly as possible by methods that will prevent the segregation, loss of any ingredients or ingress of foreign matter or water and will maintain the required workability. The concrete shall be deposited as close as possible to its final position to avoid handling or moving the concrete horizontally by vibrating. The addition of water at point of discharge is prohibited.

PLACING AND COMPACTING CONCRETE

All placing and compacting shall be carried out under suitable supervision and as soon after mixing as is practicable. Placing of concrete shall commence only after embedment in the concrete is securely fixed in position. Care shall be taken to avoid displacing reinforcement and damage to the faces of formwork, particularly when the concrete is allowed to fall freely through the depth of lift. The concrete shall not be dropped from a height of over 1.5 meters unless it is dropped by a tremie or chute. The bonding medium shall have the same cement-sand content as the concrete to be placed on it. Bonding planes shall generally be horizontal. No concrete shall be placed in flowing water. Under water, concrete shall be placed in position by tremies or by pipeline from the mixer and never allowed to fall freely through the water.

Concrete shall be placed in successive horizontal layers in thicknesses not exceeding 500 mm. Concrete shall be thoroughly compacted by vibration or other means during placing and worked around the reinforcement, embedded fixtures and into corners of the formwork to form a solid void free mass having the required surface finish. When vibrators are used, vibration shall be applied continuously during the placing of each batch of concrete until the expulsion of air has practically ceased and in a manner that does not promote segregation. Over vibration shall be avoided to minimize the risk of forming a weak surface layer.

When internal or immersion type vibrators are used they shall have frequency of 7000 RPM. They shall be inserted in a vertical position at an interval of about 600 mm. Vibrators shall not be used to transport concrete inside the formwork. When external vibration is used, the design of formwork and disposition of vibration shall be such as to ensure efficient compaction and to avoid surface blemishes.


The Contractor shall keep a complete record of the work of concreting showing the time and date of placing. This record shall be available for inspection at any time by the Engineer. Structural concreting against open excavation will not be permitted.

CURING

Curing is the process of preventing the loss of moisture from the concrete while maintaining a satisfactory temperature. The prevention of moisture loss from the concrete is particularly important if the water/cement ratio is low.

Curing and protection shall start immediately after the compaction of the concrete to prevent it from:

Prematurely drying out, particularly by solar radiation and wind,  
Leaching out by rain and flowing water.

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Where members are of considerable bulk or length, the cement content of the concrete is high, the surface finish is critical; the method of curing shall be specified in detail.

Surfaces shall normally be cured for at least for 7 days. The most common methods of curing are:

- Covering the surface with a damp absorbent material like sacking and keeping the material constantly wet.
- By ponding top surface with water (sea water not permitted) for slabs and the like.
- By continuous or frequent applications of water to the surface, avoiding alternate wetting and drying and the application of cold water to warm concrete surfaces.
- Spraying the surface with an efficient curing membrane.

The curing compound shall conform to relevant Indian Standards and shall be applied in accordance with the manufacturer's instructions to provide a water loss not greater than 0.55 kg/ m<sup>2</sup> in 72 hours. Curing compound shall be used where conventional curing by water cannot be accomplished, following approval of construction manager.

## 8.0 CONCRETING IN HOT WEATHER

In hot weather (above 40 deg C) special precautions shall be necessary to avoid the loss of moisture and/or rapid stiffening of the concrete, which prevents its proper compaction, can cause thermal and plastic cracking and a reduction in strength and durability.

During hot weather, the concreting shall be done as per the procedure set out in IS 7861 Part 1. At the time of placing, no part of the concrete shall have a temperature exceeding 35 deg C. The temperature of concrete can be reduced by cooling the water and aggregate.

During hot dry weather at the point of placement the fresh concrete shall be protected from drying winds and solar radiation by the provision of PVC or similar tented shelter, which shall remain to avoid exposure to the sun. Suitable method to shelter the surface shall be adopted such that finishing operations can be carried out whilst it is in place. To prevent early drying and cracking, the relative humidity shall be kept high and the concrete surfaces kept moist by spraying with clean water and covered with wet hessian.


Note: To avoid de hydration of concrete use OPC 43 grade cement.

## 9.0 CONCRETING IN ADVERSE WEATHER

Concreting shall not be permitted when storm or rain appears to be imminent. In the event that the rain storms or other severe weather conditions occur unexpectedly, concreting shall be stopped and appropriate temporary stop ends, vee grooves etc., placed as necessary. To meet such circumstances the contractor shall always have in readiness on site approved framed sheeting or tarpaulins for protection of newly placed concrete. Under water concreting shall be permitted only with the approval of construction manager. Concrete placed under water may be lowered in bottom opening skips or may be fed continuously through an approved tremie pipe. Unless otherwise agreed with the construction manager, the cement content of any concrete mix to be placed under water shall be increased by 20%.

## 10.0 SAMPLING AND STRENGTH OF CONCRETE

Samples from fresh concrete which is to be used in the works shall be taken as per IS 1199 and cubes shall be made, cured and tested at 28 days in accordance with IS 516.

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Facilities required for testing materials and concrete in the field such as testing machine with an operator shall be made available at the Engineer's request.

Frequency of sampling and acceptance criteria for strength tests shall be as per clauses 15 and 16 of IS 456. Concrete test cubes may be cured by accelerated methods as described in IS 9013. Cubes may also be optionally tested at 7 days or at the time of striking the formwork. However, in all cases, the 28 days compressive strength specified in IS 456 shall be the criterion for acceptance or rejection of the concrete.

For pre casting work additional cubes shall be taken and tested at 3 days or prior to lifting. Higher rate of sampling will be required at the beginning of the Construction period in order to establish the level of quality control or where there are critical elements. All samples shall be clearly marked with their identification and accurate records shall be maintained.

The concrete will be deemed to comply with the specified design strength provided the acceptance criteria in IS 456 are met.

If any test results fail to comply with the above then the quantity of concrete represented by the results shall be at risk, and may be required to be removed and replaced. The 28 days cube crushing results shall be grouped consecutively in different groups and each group shall have standard deviation as specified IS 456

If the standard deviation is greater than this, the concrete production shall be reviewed. 7-Day Tests (In situ Concrete)

- Tests shall be carried out at 7 days to establish a relationship between the 7-day and 28 day strengths. The relationship shall be used to interpret further test results in order to predict the probable value of the corresponding 28-day strengths.
- Notice shall be given without delay of any 7 day test results which indicates that the corresponding 28 day test results are likely to fail to meet the specified strength, so that necessary action can be taken to minimize the effect of such possible failure.
- 3 Day Tests (Pre-cast Concrete)
- For pre-cast concrete tests shall be carried out at 3 and 7 days to establish the relationship with the 28 day results.

There shall be no production tests on blinding concrete.

## 11.0 INSPECTION


All materials, workmanship and finished construction shall be subject to the continuous inspection and approval of the Engineer. All materials supplied by the Contractor and all construction performed by the Contractor, rejected as not in conformity with the specifications and drawings shall be immediately replaced by the contractor at no cost to the Owner.

## 12.0 CLEAN UP

Upon the completion of concrete work, all debris, scraps of wood, etc., resulting from the work shall be removed and the premises left clean.

## 13.0 WORKABILITY

The concrete mix shall be designed by varying the relative proportion of fine and coarse aggregates to ensure adequate workability for working it into corners and angles of the

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formwork and around the reinforcement without segregation of the materials or bleeding of the free water at the surface. On striking the formwork, the concrete shall present a face, which is uniform, free from honeycombing, surface crazing or excessive dusting. To confirm the workability of the designed mix for each grade of concrete, a series of workability tests shall be carried out on the preliminary trial mixes, unless acceptable data exists.

#### 14.0 INITIAL SETTING TIME

The initial setting time shall be not less than ½ hour after the production concrete is discharged into the forms and with a maximum time between mixing and completion of placing concrete shall not exceed 1 hour. The total time between mixing and initial set shall be a minimum of 1 hour. There shall be a maximum setting time of 6 hours.

When trial mixes are made to determine the workability of the concrete, the initial setting time of the cement paste shall be determined as per IS 8142.

#### 15.0 SLUMP

The slump of the structural concrete mixes shall be such that the concrete can be transported, placed into the forms, and compacted without segregation. Slump for pumpable concrete shall be determined by site trials and shall at least be 100 mm on site of pouring.

#### 16.0 PRECAST CONCRETE

The requirements of this Specification relating to concrete and reinforcement shall be observed so far as they are applicable to reinforced concrete. In addition the following requirements specifically relating to pre-cast work should be met.

##### RECASTING YARD

The yard in which pre casting work is to be undertaken shall be cleaned and have firm level beds preferably of concrete with drainage channels between the beds. The beds shall have a surface of suitable quality to give the pre-cast units the required class of finish.

Where pre-cast units have projecting reinforcement the moulds shall, if necessary, be raised on stools above the general level of the pre casting yard.

##### MOULDS FOR PRE-CAST CONCRETE


The moulds shall be strongly constructed, closely jointed and true to the required shape with edges, corners and surfaces which comply with the relevant class of finish. Moulds are to be so designed that they can be readily taken apart and reassembled.

##### MARKING

All units shall be marked on the face which will not be exposed in the permanent works, with the date of manufacture and such distinguishing letters or numbers required for erection identification.

##### CURING, MATURING AND STACKING

The production schedules shall allow for proper curing and maturing of pre-cast concrete and shall be carried out as approved. The sides of the moulds may be removed after not less than

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12 hours provided that the concrete has thoroughly set. All concrete surfaces shall be kept covered with thoroughly wetted hessian for at least 7 days.

Slinging, transporting and stacking may take place when designed handling stresses have been attained, but building or setting in the works shall not be permitted until the 28 days cube strength has been reached.

The time periods required for gain of strength of concrete may be reduced where approved special techniques are adopted such as vacuum or pressed concrete, steam curing or when a rapid hardening cement is used. No methods of accelerated curing shall be used without prior approval.

#### CEMENT/SAND MORTAR

Cement/sand mortar for bedding and jointing pre-cast members shall be of equivalent strength, quality and color to that of the concrete member being bedded or jointed. Cement/sand mortar shall be mixed in small quantities and used immediately. Particular attention shall be paid to compacting the cement/sand mortar to prevent the formation of voids and air pockets. The mortar mix shall be determined from tests following the recommendations of Indian Standard, alternatively grouting may be considered.

#### SURFACES FOR STRUCTURAL CONNECTIONS (MARINE STRUCTURES)

The surfaces of pre-cast concrete slabs and other units, which are to be in contact with in situ concrete, shall be prepared to achieve a good bond between the concrete unit and the adjoining concrete. The CONTRACTOR shall submit to the Owner/Owner's Representative his proposals for preparation of a suitable surface.

### **17.0 GROUTING**

Where equipment manufacturer's drawings define a grouting procedure, said procedure shall be followed, subject to the approval of Owner/Owner's Representative. All recommendation and instructions of the grout manufacturer shall be followed by contractor. No grouts shall be placed when the outside temperature is below 5 °C unless special approval provisions are made against freezing. The minimum compressive strength of grout shall be at least equal to the parent concrete.

#### MATERIAL


Sand cement dry pack shall be proportioned at the site, but all non-shrink grouts shall consist of only pre-measured, pre-packaged material supplied by the grout manufacturer, except water. Water to be used for mixing Portland cement grout shall be clean, potable and free from all deleterious materials such as oils, acids, alkalis and organic materials.

#### GROUT TYPES

##### SAND CEMENT DRY PACK AND ORDINARY MORTAR GROUT

Cement shall be Portland cement and shall conform to the requirements of IS 269. Sand shall be mixed at two to one ratio by weight with the cement with a ramming consistency and shall have a minimum compressive strength of 15 N/mm<sup>2</sup> at 7 days.

##### NON-SHRINK CEMENT BASED GROUT

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Non-shrink cement based grout must have a full range of consistencies, including dry pack, plastic and flowable state to be suitable for used in a variety of applications. Grout should be capable of being pumped flowable without segregation. Vibration only when expressly stated by manufacturer. Grout working time shall be minimum of 60 minutes regardless of application consistency used. The grout shall contain no metallic substances (catalyzed or non catalyzed), aluminum powder, water reducing agents, fluidizers, accelerators, super plasticizers, or other materials known to increase drying shrinkage and/ or compromise long term durability. Non-shrink cement based grout shall have a minimum compressive strength of 50 N/mm<sup>2</sup> at 7 days.

#### NON-SHRINK EPOXY GROUT

Grout shall be 100 % solids system with the ability to be placed in flowable state. Non-shrink epoxy shall have a minimum allowable compressive strength of 60 N/mm<sup>2</sup> at 7 days.

#### GROUT TYPE SELECTION

When the application is an unobstructed bearing plate or void which is not subject to impact or vibrations and allows the easy placement of grout without undue man-hour expenditure, used a sand cement dry pack or an ordinary mortar grout.

If one of the criteria cited above is not met (i.e. obstructed bearing plate or void or subject to impact or vibration) then use a pre-packaged, pre-measured, non-shrink, cement based grout.

#### STORAGE

Non-shrink cement based grout and epoxy grout aggregates shall be prepared by contractor in sound, dry bags and epoxy grout liquid components in sealed hardener and resin containers. Contractor shall be responsible for storing the grout in a dry, weatherproof area and within a temperature range of 4 °C to 32 °C.

Any material which becomes damp or otherwise defective shall be immediately removed from the site by contractor at his own expense.

#### SURFACE PREPARATION


All surfaces to be grouted shall be entirely free of oil, grease, dirt, wax, laitance, curing compounds and other foreign substances that may interfere with complete bearing or bonding. When removing laitance, a hand held pneumatic chipping hammer shall be of the largest tool, contractor shall take the utmost care to prevent any possible structural damage that could be caused by improperly or negligently removing the laitance.

When any cement based grouts are used, concrete surfaces shall be saturated with water for 24 hours prior to grout placement. Excess water shall be removed just prior to grouting.

When epoxy grouts are used, all surfaces shall be made completely dry prior to grouting.

#### LEVELLING AND ALIGNMENT

Prior to commencing grouting equipment bases, column bases or anchor bolts, leveling and alignment shall be performed to place and maintain said items in their final position during grouting. A minimum grout space of 25 mm shall be provided unless specified otherwise on the drawing. All metal surfaces which are to be in direct contact with the grout shall be thoroughly cleaned and made free of all grease, oil, dirt, wax or other foreign substance.

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Leveling shims shall be removed when they would prevent uniform bearing under the base support such as tower bases rings. Removal of the shim shall be delayed long enough to ensure against disturbing the grout. Voids where shims have been removed shall be completely packed with grout before finishing.

MIXING


Grout types shall be mixed according to manufacturer’s recommended procedures. Epoxy grout component ratio shall not be changed from that recommended by the manufacturers. No solvent or thinners shall be added to the mix. The amount of water added to a non-shrink cement based grout will determine its consistency. The lowest water/ grout ratio need to get the grout in place should be used.

PLACEMENT

Grout placement shall proceed in a manner that assures the filling of all voids and the intimate contact of grouting materials with surfaces to be grouted. The placement of grout shall be rapid and continuous so as to avoid cold joints under any base plate. All grouting shall be done in one direction only, placing grout on one side and working it to the other. Placement will be such as to provide full and uniform bearing under all foundation bearing surfaces. All exposed grout shall be provided with a 25 mm, chamfer, unless otherwise directed by purchaser’s Owner/Owner’s Representative.

CURING

Grout shall be cured according to manufacturer’s recommendations. Forms shall remain in place with a minimum of 24 hours regardless of whether grout is cement based or epoxy. Cement based grout shall be protected from extreme drying conditions. Epoxy grout shall not be wet cured. The temperature of the base plate, concrete foundations and grouts shall be maintained between 4°C and 32 °C during grouting and for a minimum of 24 hours thereafter.

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GAIL INDIA LIMITED

## TECHNICAL SPECIFICATION FOR BRICK MASONRY WORK

**GAIL-STD-CV-DOC-TS-006**

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## 1.0 INTRODUCTION

This specification deals with masonry and allied works in foundation, plinth and superstructure.

## 2.0 MATERIALS

Bricks for masonry in foundations, walls and other locations shall be common burnt clay building bricks having minimum crushing strength of 7.5 N/sq.mm. or such other strength as may be described in the Schedule of Items, when tested in accordance with IS : 1077-1992 "Common Burnt Clay Building Bricks". They shall be sound, hard and thoroughly well burnt, with uniform size having rectangular faces with parallel sides and sharp straight right angled edges and be of uniform colour with fine compact uniform texture. Bricks shall be of uniform deep red cherry or copper colour. They shall be free from flaws, cracks and nodules of free lime. Water absorption after 24 hours immersion in cold water shall be not more than 20% by weight. They shall not absorb more than 10% by weight of water after immersion for six hours. They shall emit a clear metallic ringing sound when struck by a mallet and shall not break when dropped on their face, from a height of 60 cm.


Fractured surface shall show homogeneous, fine grained uniform texture, free from cracks, air holes, laminations, grits, lumps of lime, efflorescence or any other defect which may impair their strength, durability, appearance and usefulness for the purpose intended. Under burnt or vitrified bricks shall not be used.

Samples of bricks brought to the site shall be tested periodically for compression and other tests according to IS: 3495 (Parts-1 to 4) -1992 "Method of Test for Burnt Clay Building Bricks". Where the size of bricks is not specifically mentioned, it shall be taken to mean conventional sizes as is commonly available in the area. In case modular bricks are to be used, it shall be accordingly specified in Schedule of Items. The bricks shall be classified on the basis of average compressive strength as given in Table 1 of IS: 1077-1992.

Bricks shall be unloaded by hand and carefully stacked and all broken bricks shall be removed from the site.

## 3.0 SAMPLES AND INSPECTION

Representative samples shall be submitted by the contractor and approved samples retained by the Engineer for comparison and future reference. Bricks shall be obtained from approved manufacturer. All bricks shall be subject to inspection on the site and shall be to the approval of the Engineer who may reject such consignment as are considered by him to be inferior to the quality specified. The Contractor shall provide all labour required for inspection and conduct such test as shall be required by the Engineer without additional charges.

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#### 4.0 SELECTION OF MORTARS

Mortar for masonry shall conform generally to IS: 2250-1981 "Code of Practice for Preparation and Use of Masonry Mortars", and proportion shall be as specified in the drawing or in the Schedule of Items.

Cement mortar shall be prepared by mixing cement and sand in specified proportion. It is convenient to take unit of measurement for cement as a bag of cement weighing 50 Kg equivalent to 0.035 cubic meters. Sand is measured in boxes of suitable size (say of 40 x 35 x 25 cm). It shall be measured on the basis of dry volume. In case of damp sand, the quantity shall be increased suitably to allow for bulking in accordance with IS:2386-1963 (part-III) or by any approved method.

The mixing of the mortar shall be done preferably in a mechanical mixer. This condition may be relaxed by the engineer taking into account the nature, magnitude and location of the work. If mixed in the mixer, cement and sand in the specified proportion shall be fed in the mixer and mixed dry thoroughly, water shall be then added gradually and wet mixing continued for at least 3 minutes. In case of hand mixing also after mixing dry on a water-tight masonry platform, water shall be added and the mortar turned over and over, backward and forward several times.

Fresh mixed mortar, in case becoming stiff due to evaporation of water may be re-tempered by adding water as frequently as needed to restore the requirement of the consistency but this shall be permitted only upto a maximum of 2 hours from the time of addition of cement in the mortar.

#### 5.0 STORAGE AND HANDLING


Bricks shall not be dumped at site. They shall be carefully handled and carefully stacked in regular tiers to avoid breakage and defacement of bricks and prevent contamination by mud or other materials. Bricks selected for different situations of work shall be stacked separately.

#### 6.0 SOAKING & CLEANING

Bricks required for masonry shall be cleaned to be free from dirt, dust and sand and fully soaked in clean water by submerging in vats before use, till air bubbling ceases. The bricks shall not be too wet at the time of use. After soaking they shall be removed from the tank sufficiently early so that at the time of laying they are skin dry and stacked on a clean space.

#### 7.0 LAYING

Brickwork in general shall be as per IS 2212-1991. Bricks shall be laid in English bond, unless otherwise specified, with frogs upward over a full bed of evenly laid mortar, and slightly pressed and tapped into final position to the lines levels and shape as shown in the drawing fully embedded in mortar. All joints including inside faces shall be flushed and packed. Not more than 8 courses shall generally be laid in a day. The first course itself shall be made horizontal by providing enough mortar in the bed joint to fill up any undulations. The horizontality of courses and the verticality of wall shall be checked very often with spirit level and plumb bob respectively.

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Horizontal joints shall be truly horizontal and vertical joints shall line up in every alternate course. The joints shall not exceed 10 mm in thickness and shall be well finished and neatly struck. The joints shall be kept uniform throughout the brick work. All the brick joints of the face works shall be neatly raked out to a minimum depth of 15 mm with the help of raking tools and the faces of brick wall cleaned with wire brush to remove any splashes of mortar before the close of the day's work, while the mortar is still green and the last brick layer shall be cleaned with wire brush and the frogs free from mortar.

Walls coming in contact with R.C.C. structures shall perfectly be bonded with M.S. inserts or lugs where shown on drawings and the sides butting against the R.C.C structures neatly and efficiently flashed and packed with rich mortar & cement slurry at no extra cost. Where such lugs are not required to be provided, brick work shall be built tightly against columns, slabs or other structural parts, around door and window frames with proper distance to permit caulked joint. Where drawings indicate structural steel column or beam to be partly or wholly covered with brick work, bricks shall be built closely against all flanges and webs, with all spaces between steel and brick work filled solid with mortar not less than 10 mm thick.

Damaged or broken brick or brick bats shall not be used in brick work. Cut bricks may be used to complete bond or as closers or around irregular openings.

Bricks shall not be thrown from heights to the ground, but shall be handled carefully and put gently in position to avoid damaging the edges. Selected bricks of regular shape and dimension shall be used for face work.

Making of grooves, sleeves and chases shall be done, during the construction, to the lines, levels and position as shown in the drawing or as instructed by the Engineer. Such sleeves shall slope outward in external walls so that their surface cannot form channels for the easy passage of water inside.


Fixtures, plugs, frames, pipes, inserts etc., if any, shall be built in at the right places to the lines & levels as shown in the drawings while laying the course and not later by disturbing the brick work already laid.

Brick walls of one brick thick or less shall have one selected face in true plane and walls more than one brick thick shall have both the faces of wall in true plane.

All connected brick work shall be carried out simultaneously with uniform heights throughout the work, and in exceptional cases, with the approval of the Engineer, the brick work built in any part of the work may be lower than another adjoining wall/connected wall by a maximum of one meter and the difference in height of adjoining wall/connecting wall shall be raked back according to bond by stepping at an angle not steeper than 45 degree, without sacrificing the necessary bond, horizontality of layers, verticality of joints and the wall.

## 8.0 PROTECTION OF BRICK WORK

The brick wall shall be protected and covered with gunny bags or water proof sheets from the effects of inclement weather, rain, frost, etc. during the construction and until the mortar sets. Care shall be taken during construction that the edges of jambs, sills and soffits of openings are not damaged.

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**9.0 CURING**

Masonry in cement or composite mortar shall be kept continuously moist on all faces for a minimum period of 7 days by means approved by the Engineer.


**10.0 SCAFFOLDING**

Necessary and suitable scaffolding shall be provided at all heights to facilitate the construction of brick wall. Scaffolding shall be sound, strong and all supports and other members shall be sufficiently strong and rigid, stiffened with necessary bracings and shall be firmly connected to the walls securing them against swing or sway. Planks shall be laid over the scaffolding at required levels. Scaffolding shall preferably be of tubular steel, although the Engineer may permit other material, depending upon the circumstances.

Scaffolding shall be double, having two sets of vertical supports, particularly for the face wall and all exposed brick work. Single scaffolding may be used for buildings upto two storeys high or at other locations, if permitted by the Engineer. In such case the inner ends of horizontal members shall rest in holes provided in header course only. Such holes shall not be allowed in pillars under one meter in width, or immediately near the skew backs or arches. The holes thus left in masonry shall be filled with bricks set in rich mortar and the surface made good on removal of scaffolding.

If for any reason the Contractor is required to erect scaffolding in property other than that belonging to the Owner, including municipal corporation or local bodies, necessary permission shall be obtained by the Contractor from the appropriate authorities and necessary licensing fees if any shall have to be borne by him.

All scaffoldings once erected shall be allowed to remain in position, efficiently maintained by the Contractor, till all the finishing works required to be done are completed and shall not be removed without the approval of the Engineer. The Contractor shall allow workmen of other trades to make reasonable use of the scaffolding without any extra cost.

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**GAIL INDIA LIMITED**

**TECHNICAL SPECIFICATION  
FOR  
PLASTERING & POINTING**

**GAIL-STD-CV-DOC-TS-007**

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## 1.0 INTRODUCTION

This specification covers the material and workmanship requirements for the Plastering works as applicable.

## 2.0 MATERIALS

### CEMENT

Ordinary Portland cement / Portland slag cement complying with the requirements of IS: 269-1989 and I.S. 455-1989 respectively shall be used.

### SAND

Sand for plaster and pointing shall conform to IS: 1542. Sand shall be hard, durable, clean and free from adherent coatings and organic matter and shall not contain any appreciable amount of silt, clay balls or pellets. Sand shall not contain harmful impurities such as iron pyrites, coal particles, lignite, mica shale etc.

Sand whose grading falls outside the limits of IS: 460 due to excess or deficiency of coarse or fine particles shall be processed to comply with the standards.

Fine sand shall be obtained from river beds not affected by tidal water of the sea and shall be clean, sharp and free from excessive deleterious matter. The sand shall not contain more than 8 per cent of mud and silt as determined by field test with a measuring cylinder.

### WATER


Water used for mixing concrete and mortar and for curing shall be clean and free from injurious amounts of oil, acid, alkali, salts, sugar, organic materials or other substances that may be deleterious. The pH value of water shall generally be not less than '6'. Water has to meet the requirements mentioned in clause 4.3 of IS: 456-2000. Water shall be obtained from an approved source.

### CEMENT MORTAR

Cement mortar shall be prepared by mixing cement and sand in specified proportion. It is convenient to take unit of measurement for cement as a bag of cement weighing 50 Kg equivalent to 0.035 cubic meters. Sand is measured in boxes of suitable size (say of 40 x 35 x 25 cm). It shall be measured on the basis of dry volume. In case of damp sand, the quantity shall be increased suitably to allow for bulkage in accordance with IS:2386-1963 (part-III) or by any approved method.

The mixing of the mortar shall be done preferably in a mechanical mixer. This condition may be relaxed by the engineer taking into account the nature, magnitude and location of the work. If mixed in the mixer, cement and sand in the specified proportion shall be fed in the mixer and mixed dry thoroughly, water shall be then added gradually and wet mixing continued for at least 3 minutes. In case of hand mixing also after mixing dry on a water-tight masonry platform, water shall be added and the mortar turned over and over, backward and forward several times.

Fresh mixed mortar, in case becoming stiff due to evaporation of water may be re-tempered by adding water as frequently as needed to restore the requirement of the consistency but this shall be permitted only up to a maximum of 2 hours from the time of addition of cement in the mortar.

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CEMENT MORTAR WITH WATERPROOFING COMPOUND

Waterproof compound shall conform to IS: 2645 of approved make. The compound shall be well mixed with dry cement in the proportion of 3% by weight or as recommended by manufacturer.

**3.0 WORKMANSHIP**PREPARATION OF BACKGROUND SURFACE

The surface shall be cleaned of all dust, loose mortar droppings, traces of algae, efflorescence and other foreign matter by water or by brushing. Smooth surfaces shall be roughened by wire brushing or hacking for non-hard and hard surfaces respectively. Projections on surfaces shall be trimmed wherever necessary to get even surfaces. In case of brick/stone masonry, raking of joints shall be carried out wherever necessary. The masonry shall be allowed to dry out for sufficient period before carrying out the plaster work. The masonry shall not be soaked but only damped evenly thereafter before applying the plaster.

In case of concrete work, projecting blurs of mortar formed due to the gaps of joints in shuttering shall be removed. Such surface shall be scrubbed clean with wire brushes. The surface shall be pock marked with a pointed tool at spacing of not more than 50 mm centers, the pocks being made not less than 3 mm deep to ensure a proper key for the plaster. The surface shall be washed off and cleaned of all oil, grease etc. and well wetted before the plaster is applied.

SEQUENCE OF OPERATIONS

For external plaster, the plastering operations shall be started from the top floor level and carried downwards. For internal plaster, the plastering may be started wherever the building frame, roofing and brick work are ready.

The surfaces to be plastered shall first be prepared as described in 'Preparation of background surface. The first layer shall then be applied to ceilings. After the ceiling plaster is complete and scaffolding for the same removed, plastering on wall shall be started. After a suitable time interval as detailed under various types of plaster in subsequent paras, depending upon the type of mortar, the secondary layers if required shall be applied. After a further suitable time interval as detailed under various type of plaster in subsequent paras, the finishing coat shall be applied first to the ceiling and then to the walls.


Plastering of cornices, decorative features, etc. shall be completed before the finishing coat is applied. Unless otherwise specified corners and edges shall be rounded off to a radius of 25 mm, such rounding off shall be complete along with the finishing coat to prevent any joint marks showing out later.

SCAFFOLDING

Refer specification for structural concrete

DAMAGE RECTIFICATION

Any cracks, damages, any part of work which sound hollow when tapped or found damaged or defective otherwise shall be cut out in rectangular shape and redone as directed by Owner/Owner's Representative.

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## 4.0 APPLICATION OF PLASTER

### ONE LAYER PLASTER WORK

To ensure even, specified thickness, plaster of 150 mm x 150 mm shall be first applied horizontally and vertically at not more than 2 meter interval over the entire surface to serve as gauges. The surface of these gauged areas shall be truly in the plane of the finished plaster surface. The mortar shall be brought to true surface by working with a wooden straight edge reaching across the gauges with small upward and sideways movements at a time. Finally the surface shall be finished off true with a trowel or wooden float to obtain a smooth texture. Excessive trowelling or overworking the float shall be avoided. All corners, arises, angles and junctions shall be truly vertical/horizontal and shall be carefully finished. Rounding or chamfering of corners, arise s, junctions etc. shall be carried out with proper templates to the size required.

In suspending the work, the plaster shall be left, cut clean to line, both horizontally and vertically. When recommencing the plastering the edge of the old work shall be scrapped clean and wetted before plastering the adjoining area. Plastering work shall be closed on the border of the wall and nearer than 150 mm to any corners or arises and shall not be closed on the body of the features such as plaster bands, cornices nor at the corners or arises.

### TWO LAYER PLASTER WORK

#### FIRST OR UNDER LAYER

The first or under layer of the specified thickness shall be applied as described above or mentioned in drawing. Before the first coat hardens, surface of it shall be beaten up by edges of wooden tapers and close dents shall be made on the surface. The subsequent coat shall be applied after this coat has been allowed to set for 3 to 5 days depending upon weather conditions. The surface shall not be allowed to dry during this period.

#### SECOND OR FINISHING LAYER

The second layer shall be complete to the specified thickness in the same manner as for first layer.

#### CURING

Curing shall be started 24 hours after finishing the plaster. The plaster shall be kept wet for a period of 7 days. During this period the plaster shall be suitably protected from all damages at the Contractor's expense by such means as approved by the Owner/Owner's Representative. The date of execution of plastering shall be marked on the plastering to ensure the proper duration of curing.


## 5.0 POINTING

Pointing shall be of the type specified such as flush, cut or weather struck, raised and cut etc.

### PREPARATION OF BASE SURFACE

The joints shall be raked to such a depth that the minimum depth of the new mortar measured from either the sunk surface of the finished pointing or from the edge of the brick shall be less than 20 mm.

### MORTAR

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Mortar shall be in accordance with the specifications of cement mortar as described above.

#### APPLICATION OF MORTAR AND FINISHING

The mortar shall be pressed into the raked out joints with a pointing trowel according to the type of pointing specified. The mortar shall be spread over the corner edges or surfaces of the masonry. The pointing shall then be finished with the pointed tool. The superfluous mortar shall be cut off from the edges.

#### FLUSH POINTING

The mortar shall be pressed into joints and shall be finished off flush and leveled. The edges shall be neatly trimmed with trowel and straight edges.

#### CUT OR WEATHER STRUCK POINTING

The mortar shall first be pressed into joints. The top of the horizontal joints shall then be neatly pressed back by about 15 mm with the pointing tool so that the joint is sloping from top to bottom. The vertical joint shall also be similarly pointed. The junctions of vertical joints with the horizontal joints shall be at true right angles in case of brick and coursed rubble masonry.

#### RAISED AND CUT POINTING

This type of pointing shall project from the wall facing with its edges cut parallel so as to have a uniformly raised band about 6 mm and width 10 mm more as directed. The pointing shall be finished to a smooth but hard surface.




**GAIL INDIA LIMITED**

# **TECHNICAL SPECIFICATION FOR STRUCTURAL STEEL WORKS**

**GAIL-STD-CV-DOC-TS-008**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
0	22.01.19	ISSUED FOR BID	SS	UN	SKK



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## 1.0 INTRODUCTION

This Specification defines the requirements for the supply, fabrication and erection of structural steel work, design of connections and preparation of fabrication drawings for buildings, plant and equipment supports, stairways, access platforms, steel flooring, ladders and the like. This Specification does not include the requirements of protective treatment like painting, fireproofing, jetty and other marine structures.

## 2.0 MATERIALS

All materials used in the Works shall be new, first quality steel of Indian manufacture free from laminations, seams, blisters and other harmful defects and shall comply with the appropriate Indian Standards.

Manufacturer or Laboratory test certificates in accordance with the requirements of the relevant Indian Standards shall be supplied to the Engineer-In-Charge in respect of all materials to be used in the Works, prior to commencement of fabrication.

### STRUCTURAL STEEL

Unless specified otherwise, structural steel used in the Works shall comply with the requirements of IS 2062 and be of Grade Fe 410WB specified therein. Hot rolled sections shall be Indian Standard Sections in accordance with IS 808. The thickness tolerance for plates and flats shall be as specified in IS 1852. The deviation over or under the nominal thickness shall be equal to half the total thickness tolerance. Steel shall be marked in accordance with IS 2062. Members in steel grades other than Grade A shall have additional marks of a form and in positions to be agreed with the Engineer-In-Charge. When design drawing do not specify grade of steel intended for connections and fittings, IS 2062 Grade Fe 410 WB or BS EN 10025 Grade 430 B shall be used. Steel for cold rolled sections shall be as per IS 801. Hollow rectangular / square sections shall conform to IS 492 3. Steel Tubes shall conform to IS 1161.

### BOLTS, NUTS AND WASHERS

Bolts and nuts shall comply with IS 1363, IS 1367, IS 3757 and IS 6639 as appropriate. Nuts shall be of at least the strength grade appropriate to the grade of bolts or other threaded elements with which they are used.

Plain washers for use with ordinary bolts and nuts shall comply with IS 5369. Tapered washers shall comply with IS 5372 or IS 5374 as applicable.


High tensile bolts of strength grade 8.8 shall comply with requirements of IS 3757 or BS 3692. Dimensional requirements to comply with IS 3757. Bolt shall be of product grade C to IS 1367 part 2 and mechanical properties to IS 1367 part 3.

Nuts shall be heavy hex Grade 4 conforming to IS: 1363 Part 3 and 1367 Part 2 for ordinary strength bolts and heavy hex Grade 8 conforming to IS: 6623 for high tensile bolts.

All Bolts, Nuts and Washers shall be hot-dip galvanized in accordance with IS 1367 (part 13) or in accordance with BS 4921.

### WELDING CONSUMABLES

Welding consumables, used for metal arc welding of steels complying with IS 2062, shall comply with IS 814. Welding consumables and procedures shall be such that the mechanical properties of deposited weld metal are not less than the respective minimum values for the parent metal being welded.

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## STEEL GRATING AND STAIR TREADS

Steel grating and stair treads shall be open grid rectangular pattern complying with Standard drawings.

### **3.0 CONNECTION DESIGN AND FABRICATION DRAWINGS**

Before commencing of job, all related detailed engineering documents shall be approved. Structural steel work shall be designed in accordance with IS 800. The design of ladders, platforms, handrails, stairways and the like shall be in accordance with Standard Drawings.

#### **DESIGN DETAILS**

Connections made in the shop shall be either bolted or welded. Connections made on site shall generally be bolted. Welded site connections shall be permitted only when specified on design drawings or with prior permission of the Engineer-In-Charge. Bolted connections shall contain a minimum of two bolts each. Bolts smaller than M16 shall not be used without prior approval of the Engineer-In-Charge. Tapered washers shall be used for bolts passing through tapered sections.

The thickness of gusset plates and welded end plates shall be not less than 8 mm. Connections shall not generally project above the level of the top of steel work. In the case of pipe racks the top of steel work shall be free from projections within the width of the rack.

All grating floor panels shall be fixed to supporting steel work by means of positive non-slip flooring grips and all panels shall be side-bolted together with two 6 mm diameter galvanised bolts per side.

The design drawing shall show the position on the structure where temporary bracing or restraints are to be provided until walls / floors and other non steel structures are built.

### **4.0 FABRICATION**

Fabrication shall be carried out in accordance with the requirements of IS 800. Fabricated structural steel work shall be within the tolerances specified in IS 7215. The radius of re-entrant flame cuts shall be as large as possible but not less than 20 mm, except in small members where this is impracticable.

Ends of columns shall generally be gas flame cut and ground where steelwork fabrication is carried out on site. For critical and highly stressed structures fabricated in off-site workshops, ends of columns shall be sawn square and base plate surface machined prior to welding, as called for on the design drawings. Joint assembly of column and base plate shall be jugged.


Frames, platforms, stairs and handrails shall be shop assembled in the largest units suitable for handling and transportation. All fabricated frames shall be suitably braced to prevent distortion during transit.

Where fillet welds to very thick column base plates are called for on the design drawings, preheating of the plate may be required to retard cooling rate and reduce shrinkage stresses and shall be incorporated in the welding procedures.

#### IDENTIFICATION

At all stages of fabrication, structural steel members shall be positively identified by a suitable marking scheme.

For the purposes of marking for erection, every part shall be marked with a durable and distinguishing mark in such a way as not to damage the material. For small members which are delivered in bundles or crates, the required marking shall be done on small metal tags securely tied to the bundle.

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## STRAIGHTENING

All materials shall be straight and, if necessary before being worked shall be straightened and/or flattened (unless required to be of curvilinear form) and shall be free from twists.

Rolled Sections and plates shall be clean, free from kinks, bends or twists, and straight within the tolerances allowed by IS 1852 "Specification for Rolling and Cutting Tolerances for Hot Rolled Steel Products".

Where straightening is necessary, it may be carried out by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, measured by methods approved by the Engineer-In-Charge shall not exceed 600°C

Rolled sections and plates with major defects shall be returned to Supplier for replacement.

## CLEARANCES

The erection clearance for ends of members with web cleats or end plates shall be not greater than 2 mm at each end. The erection clearance at ends of beams without web cleats and end plates shall be not more than 3 mm at each end but where for practical reasons, greater clearance is necessary, suitably designed seating approved by the Engineer-In-Charge shall be provided.

## CUTTING

Prior to cutting, all members shall be properly marked showing the requisite cut length/width, connection provisions e.g. location and dimensions of holes, welds, cleats, etc. Marking for cutting shall be done judiciously so as to avoid wastages or joints as far as possible.

Cutting shall be by sawing, shearing, cropping or machine or hand flame cutting. Hand flame cutting shall be used only where it is impractical to use machine flame cutting and for notching, or for the completion of the formation of slotted holes. Electric metal arc cutting shall not be permitted.

Cut edges shall be true to profile and be free from major notches and sharp edges and shall be dressed immediately by grinding.

Where members are notched to fit other members the notches shall be as small as practicable and chamfered at re-entrant corners with a minimum radius of 6 mm.

## HOLES


All holes for fasteners or pins shall be drilled except as permitted otherwise herein. All matching holes for fasteners or pins shall register with each other so that fasteners can be inserted freely through the assembled members in a direction at right angles to the faces in contact.

Holes for ordinary bolts of property class below 8.8 in light roof members or other light framing and in connecting angles and plates other than splices, may be punched full size through material not thicker than the diameter of the hole, provided that the punching does not unduly distort the material.

Slotted holes shall either be punched in one operation or formed by drilling two holes and completed by cutting, grinding or filing the surface smooth.

Burrs shall be removed from holes before assembly except that where holes are drilled in one operation through parts clamped together which would not otherwise be separated after drilling, they need not be separated to remove the burrs.

For bolts not exceeding 24 mm diameter, holes shall be not more than 1.5 mm greater in diameter than the bolt and for bolts over 24 mm diameter, holes shall be not more than 2 mm greater in diameter than the bolts, except in steel base plates and where otherwise specified on the Drawings.

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All matching holes for fasteners or pins shall register with each other so that fasteners can be inserted without undue force through the assembled members in a direction at right angles to the faces in contact. Drifts may be used but holes shall not be distorted. All unused drilled holes shall be plugged by welding.

#### JOINTS IN COMPRESSION

Abutting surfaces dependent on contact for the transmission of load shall be within the specified tolerances.

#### SPLICING

Splicing of built up/compound/latticed sections shall be done in such a fashion that each component of the section is jointed in staggered manner.

Where no butt weld is used for splicing, the meeting ends of two pieces of joint/channel/built up section shall be ground flush for bearing on each other and suitable flange and web splice plates shall be designed and provided for the full strength of the flange/web of the section and bolts/welds designed accordingly.

Where full strength butt weld is used for splicing (after proper edge preparation of the web and flange plates) of members fabricated out of joist/channel/built up section, additional flange and web plates shall be provided over and above the full strength butt welds, to have 40% strength of the flange and web.

Where a cover plate is used over a joist/channel/section the splicing of the cover plate and channel/joist section shall be staggered by minimum 500 mm. Extra splice plate shall be used for the cover plate and joist/channel section.

### **5.0 ERECTION**

Prior to erection, the Contractor shall carry out an inspection of the location and level of the prepared foundations and anchor bolts, and advise the Engineer-In-Charge of his findings.


Erection shall be carried out in accordance with the requirements of IS 800.

All components shall be erected within the specified tolerances and in such a manner so that they are not bent, twisted or otherwise damaged and the specified cambers are provided when required. Drifting to align holes shall not enlarge the holes or distort the metal. Holes which cannot be aligned without distortion shall be a cause for rejection unless enlargement by reaming is specifically approved by the Engineer-In-Charge. Holes shall not be made by gas cutting. Throughout the erection of the structure, the steel work shall be securely bolted or fastened in order to ensure that it can adequately withstand all loadings liable to be encountered during erection, including where necessary, those from erection plant and its operation. Any temporary bracing or temporary restraint shall be left in position until such time as erection is sufficiently advanced so as to allow its safe removal.

All connections for temporary bracings, members, etc. to be provided for erection purposes shall be so made that they do not weaken the permanent structure or impair serviceability.

No permanent bolting or welding shall take place until the steel work has been properly aligned and the erection has been approved by the Engineer-In-Charge.

Connected parts shall be firmly drawn together. If there is a gap remaining which may affect the integrity of the joint, the joint shall be remade after insertion of a suitable pack. Where parts cannot be brought together by drifting without distorting the steelwork, rectification may be made by reaming, provided the design of the connection will allow for larger diameter holes and bolts, and is approved by the design Engineer-In-Charge.

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## WELDING

Welding of structural steel shall be in accordance with IS 9595 and IS 816. For welded parts, all mating surfaces shall be sealed by welding against the ingress of moisture. Welding shall be carried out by suitably qualified welders who have satisfactorily completed the appropriate tests laid down in IS 7310. All welding shall be carried out under the direction of a competent Welding Technologist. The minimum size of fillet weld shall be 6 mm. The Contractor shall make necessary arrangement for providing sufficient number of welding sets of the required capacity, all consumables, cutting and grinding equipment with requisite accessories/auxiliaries, equipment and materials required for carrying out various tests such as dye penetration, magnetic particle, ultrasonic and the like. Adequate protection against rain and strong winds shall be provided to the welding personnel and the structural members during welding operation. Welding shall not be carried out in the absence of such protection. It shall be the responsibility of the Contractor to ensure that all welding is carried out in accordance with this specification and relevant IS Codes. The Contractor shall provide all the supervision to fulfill this requirement.

## PREPARATION OF MEMBER FOR WELDING

### EDGE PREPARATION

Edge preparation/leveling of the fusion faces for welding shall be done strictly in accordance with the dimensions shown in the drawings.

In case, the same are not indicated, edges shall be prepared (depending on the type of weld indicated in the drawing) in accordance with the details given in IS 9595. Leveling of fusion faces shall be approved by the Engineer. The tolerance on limits of gap, root face and included angle shall be as stipulated in IS 9595.

### CLEANING

Welding edges and the adjacent areas of the members (extending up to 20 mm) shall be thoroughly cleaned of all oil, grease, scale and rust and made completely dry. Gaps between the members to be welded shall be kept free from all foreign matter.

### PREHEATING

Preheating of members shall be carried out as per IS 9595 when the base metal temperature is below the requisite temperature for the welding process being used. Preheating shall be done in such a manner that the parts, on which the weld metal is being deposited, are above the specified minimum temperature for a distance of not less than 75 mm on each side of the weld line. The temperature shall be measured on the face opposite to that being heated. However, when there is access to only one face, the heat source shall be removed to allow the temperature equalization (1 minute for each 25 mm of plate thickness) before measuring the temperature.

### GRINDING

Column splices and butt joints of struts and compression members (depending on contact for load transmission) shall be accurately ground and close-butt end over the whole section with a tolerance not exceeding 0.2 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc. shall be accurately ground so that the parts connected butt over minimum 90% surface of contact. In case of connecting

angles or channels, care shall be taken so that these are fixed with such accuracy that they are not reduced in thickness by grinding by more than 2 mm. Ends of all bearing stiffeners shall be ground to fit tightly at both top and bottom. Similarly bottom of the knife edge supports along with the top surface of column brackets shall be accurately ground to provide effective bearing with a tolerance not exceeding 0.22 mm locally at any place.

Slab bases and caps shall be accurately ground over the bearing surfaces and shall have effective contact with the ends of stanchions. Bearing faces which are to be grouted need not be ground if such faces are true and parallel to the upper faces.

### WELDING PROCESSES

Welding of various materials under this specification shall be carried out using one or more of the following processes.

- Manual Metal Arc Welding Process (MMAW)
- Submerged ARC Welding Process (SAW)
- Gas Metal Arc Welding Process (GMAW)
- Flux Cored Arc Welding Process (FCAW)

The welding procedure adopted and consumables used shall be specifically approved by the Engineer.

### NON DESTRUCTIVE TESTING OF WELDS

Visual inspection shall be made in accordance with guidance given in IS 822 or BS 5289 after completion of all welding over the full length of the weld. All NDT shall be performed by personnel qualified to a recognized national or international standard (e.g. PCN, ASNT Level II, etc.) Magnetic particle inspection (MPI) shall be in accordance with the recommendations given in IS 5334 or BS 6072. Dye penetrant inspection (DPI) may be used in accordance with the recommendations given in IS 3658 or BS 6443. The test results shall be recorded and be available for inspection by the Engineer in charge. Where ultrasonic examination is required, it shall be made in accordance with IS 4260 or BS 3923 Part 1, level 2

### BOLTING

Bolts of property class 4.6 shall generally be used for all connections including bracing and column splices. However, for connections resisting large moments and forces, bolts of property class 8.8 shall be used with the prior approval of the Engineer-In-Charge.

Where necessary the connected parts shall be firmly drawn together. Steel packing plates shall be provided where necessary to ensure that the total remaining gap between adjacent surfaces does not exceed 2 mm.


The length of bolt shall be such that at least one clear thread shows above the nut after tightening and at least one thread plus the thread run out is clear between the nut and the unthreaded shank of the bolt. The threaded length shall be clear of the joint mating surfaces.

Washers shall be provided under the element (nut or bolt head) turned during tightening.

Nuts used on connections subject to vibration shall be secured to prevent loosening. Self-locking nuts shall be used or else the nuts shall be secured by the use of locknuts or upsetting of the threads of the bolts after assembly and tightening.

Bolts, nuts and washers used to connect metal sprayed or galvanized steel work shall be spun galvanized.

Where slotted holes are provided for movement connections, the joint shall be free to move. Areas of steel which will form the mating faces of a high strength friction grip joint or are to be concrete cast shall be unpainted and maintained in a clean condition and free from loose rust, oil, loose scale and other deleterious matter.

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High tensile bolts to IS 1367 property class 8.8 shall be tightened in accordance with the manufacturer's recommendations using a torque wrench which shall be calibrated at least once each working day.

The combination of bolts and nuts shall be not less than the following:

4.6 bolts with grade 4 nuts (IS-1363, IS-1367/BS 4190)

8.8 bolts with grade 8 nuts (IS-3757, IS-6623/BS 3692)

Any bolt assemblies which seize when being tightened shall be replaced.

Grade 4.6 and grade 8.8 bolts of the same dia meter shall not be used in the same structure, except for holding down bolts.

The bolt length shall be chosen such that at least one thread plus the thread run-out will be clear between the nut and unthreaded shank of the bolt after tightening and at least one clear thread shall show above nut. When the members being connected have surface protective treatment, a washer shall be placed under the nut or bolt head being rotated. A suitable plate washer shall be used under the head and nut when bolts are used to assemble components with oversize or slotted holes.

When the bolt head or unit is in contact with a surface which is inclined at more than 30° from a plane at right angles to the bolt axis, a taper washer shall be placed to achieve satisfactory bearing.

Galvanized Nuts – Nuts shall be checked after being galvanized for free running on the bolt and re-tapped if necessary to ensure a satisfactory tightening performance.

Ordinarily bolts Grade 4.6 to IS1367 shall be tightened to a "snug tight" fit. "Snug tight" is defined as tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench.

High tensile bolts Grade 8.8 to IS 3757 shall be tightened to a torque of approximately 85% of the proof load of the bolt, by means of a power or hand operated torque wrench. Bolts shall be tightened to the torques given in the following table.

Bolt Diameter	Torque to be Applied (Nm) For Bolt Class 8.8 of IS 3757
M20	476
M24	822
M30	1630
M35	2850

#### PROTECTIVE TREATMENT

Steel shall be pre-treated and painted or galvanized. The protective treatment shall be carried out after fabrication is complete. No welding, holing or other work which may damage the protective treatment shall be carried out following painting.

#### EQUIPMENT

All equipment used in erection shall be provided by the Contractor, and shall be suitable for its purpose and of adequate capacity.

Equipment to be used shall include staging, ladders, and plant including temporary structures necessary to complete the erection.

#### ALIGNMENT

Each part of the structure shall be aligned as soon as practicable after it has been erected. Packs, shims and other supporting devices shall be flat, of adequate strength and rigidity and not larger than necessary. Where packings are to be left in position and subsequently grouted, they shall be placed such that they are totally enclosed by the grout.

## CLEARANCE

The Contractor shall periodically clean up as required by the Engineer-In-Charge to maintain a safe working environment and on completion of the work remove all rubbish, plant and surplus materials from the site of work, storage areas, to the satisfaction of the Engineer-In-Charge.

## SAFETY AND SECURITY DURING ERECTION

The Contractor shall comply with IS 7205 for necessary safety and adhere to safe erection practice and guard against hazardous as well as unsafe working conditions during all stages of erection.

During erection, the steel work shall be securely bolted or otherwise fastened and when necessary, temporarily braced/guyed to provide for all loads including those due to the wind, erection equipment and its operation to be carried by the structure till the completion of erection.

No permanent bolting or welding shall be done until proper alignment has been achieved. Proper accesses, platforms and safety arrangements shall be provided for working and inspection whenever required.

## **6.0 INSPECTION**

Prior to inspection, all slag, loose scale, dirt, grit, weld spatter, paint, oil or other foreign matter shall be removed from the steel work. Welded connections shall not be painted prior to inspection.

The Contractor shall carry out non-destructive testing of welds at his own cost in the presence of the Engineer's Inspector. All welds shall be visually inspected along 100% of their length. NDT testing of welds for general steel structures is not required. For critical structures where connections are highly stressed, NDT inspection shall be performed.

## **7.0 STORAGE AND HANDLING**

Fabricated parts shall be handled and stacked in such a way that permanent damage is not caused to the components. Means shall be provided to avoid damage to the protective treatment on the steel work.


All work shall be protected from damage in transit. Particular care shall be taken to stiffen free ends, prevent permanent distortion and protect all machined surfaces adequately.

## **8.0 PAINTING**

Steelwork shall be prepared, primed and painted in accordance with the project Specification for painting. Steelwork to be galvanized shall be in accordance with IS 4759. Paint shall be excluded from areas within 50mm of joints to be field welded. In order to minimize coating damage, all reasonable care shall be taken: 1) when handling steelwork between stages in painting, and 2) when slinging and loading steelwork which has received its final coat.

No material shall be shipped until the final shop coat of paint is thoroughly dry and clearly colour coded. Adequate packing, crating, blocking and/or bracing shall be provided to prevent damage to the fabricated material while loading, in transit and while unloading.

After complete erection, surfaces, areas damaged subsequent to shop painting shall be repaired in accordance with the Painting Specification. Any damage caused, during delivery and/or erection, to galvanized steel surfaces shall be repaired in accordance with Paint Specification.

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**TECHNICAL SPECIFICATION  
FOR  
ROAD WORK & CONCRETE PAVEMENTS**

**GAIL-STD-CV-DOC-TS-009**

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## 1.0 INTRODUCTION

This specification establishes the requirements of material, laying and finishing of concrete pavements.

## 2.0 MATERIALS

### WATER

Water used for cement concrete, mortar, plaster, grout, curing etc. shall be clear and free from injurious amounts of oils, acids, alkalis, organic matters or other harmful substances. Only natural water suitable for drinking shall be used. It shall conform to IS: 456.

### AGGREGATE FOR CONCRETE

The aggregate for concrete shall comply in all respects with IS: 383 and IS: 456. This should be furnished in at least two separate sizes with separation at 20mm IS sieve when combined material graded from 5 to 38 mm is specified and at 25mm IS sieve when combined material graded from 20 to 50 mm is specified. This shall be obtained from a source approved by Owner/Owner's Representative and shall be chemically inert, strong, hard, durable and of limited porosity. This shall be of the gauge specified in the schedule of rates and approximately cubical in shape. It shall be free from soft or decayed pieces, dirt, clay, leaves or any organic matter. The aggregate shall not have any injurious effect when mixed with cement nor shall it corrode the reinforcement, nor otherwise impair the strength and durability of the concrete. The size of coarse aggregate mentioned in this specification denotes maximum size of aggregate and the same shall be grade downward as per IS: 383.

### SAND FOR CONCRETE AND MORTAR


Fine aggregate shall preferably be natural sands. In case of crushed sand the very fine natural sand amount passing IS: 383. Sand shall consist of clean, hard, strong, sharp, durable uncoated particles free from any mix of clay, dust, vegetable matter, mica, iron pyrites, shells, soft or flaky and elongated particles, alkali organic matter, salts, loam and other impurities which may be considered by the Owner/Owner's Representative as harmful. Sulphate content should not exceed 1%. Total content of all deleterious matter should not exceed 5%. This source of sand shall be approved by the Owner/Owner's Representative. Sand obtained from river bed subject to tidal effect will not be allowed in works. All sand shall be washed before being brought to site.

### STORAGE OF AGGREGATES

The contractor shall at all time maintain at the site of work such quantities of aggregates as are considered by the Owner/Owner's Representative to be sufficient to ensure continuity of work. Each type and grade of aggregates shall be stored separately. This ground on which the aggregates are stored shall be firm and have sufficient slope to ensure adequate drainage of rain water.

Any aggregate delivered to site wet shall be placed in storage for at least 24 hours to ensure adequate drainage before it is used for concreting.

Sand heaps shall be covered with bricks or such other materials to prevent blowing off and to assist in good house keeping.

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CEMENT

The cement used shall be ordinary Portland cement, conforming to IS: 8112, unless otherwise specified. The cement issued to the contractor shall be stored in a suitable weather tight building and in such a manner as to permit easy access for proper inspection. All cement stored at site by the contractor shall be arranged in batches and used in the same order as received from owner. Contractor shall maintain a cement register in which all entries shall be completed day-to-day showing quantities received, date of receipt and daily cement consumption.

REJECTION OF CEMENT

The Owner/Owner's Representative may reject cement which has deteriorated after issue to the contractor owing to inadequate protection against moisture or other causes or in any other case where the cement is not to his satisfaction.

ADMIXTURE

No admixture shall be normally permitted for concrete or mortar. Water proofing compound to be used in concrete, plaster, damp proof course etc. where specified, shall be of approved make. It shall be mixed as per manufacturer's specifications and as approved and directed by the Owner/Owner's Representative.

Joint sealing in pavements and around equipments structural columns shall be approved compound conforming to IS: 1834 TYPE 'b' (SHALITEX or approved equivalent).


**3.0 GRADES AND PROPORTIONING**

The grades indicated in drawings and schedules shall conform to IS: 456, the strengths being indicated below.

Min. Crushing Strength of 15 cm. Cube in Kg/cm<sup>2</sup> at 28 days

<b>Grade</b>	<b>Compressive Strength</b>
M- 10	100
M-15	150
M-20	200
M-25	250
M-30	300

The water cement ratio aggregates and grading for each mix shall be predetermined from the results of cube tests of trial mixes. The mix proportions determined thus shall be followed at site and shall in no way relieve the contractor of his responsibility as regards the prescribed strength of mix. The mix proportions, however, shall be revised if the results of the cube tests during the construction show consistently lower or higher strength than the prescribed one. No claim to alter the rates of concrete work will be entertained due to such changes in mix designs, as the contractor will be responsible to produce the concrete of required grade. The slump of concrete mix for pavements compacted by vibrations should not be more than 25 mm and that for manual compaction not more than 50 mm.

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All concrete shall be controlled concrete conforming to IS: 456. For mud-mat and filling purpose ordinary concrete of 1:4:8 mix proportions may be used or as indicated in drawings.

#### 4.0 EQUIPMENT

All equipment like weighting devices, measuring boxes, mixers, sub-grade templates, hand tempers, vibrating screens, internal vibrators, longitudinal floats, bridges, belts, push brooms, straight edges, edging tools etc. shall be on the worksite in first class working condition and shall have been inspected by the Owner/Owner's Representative before paving operations are permitted to start. Throughout the construction period the contractor shall maintain adequate equipment in first class working conditions to ensure the proper execution of the work.

#### 5.0 PREPARATION OF SUB GRADE

The sub grade or sub base for laying of the concrete slabs shall comply with the following requirements:

- I. No soft spots are present in the sub grade or sub base.
- II. The uniformly compacted subgrade or subbase extends atleast 300mm on either side of the width to be concreted.
- III. The subgrade is properly drained.
- IV. The minimum modulus of subgrade reaction obtained with a plate bearing test shall be 5.54 Kg/cm<sup>2</sup>.
- V. Sub grade shall be prepared to the lines and grades shown on the drawings.
- VI. No concrete shall be placed around manholes or other structure until they have been brought to required grade and alignment.
- VII. The subgrade shall be in moist condition at time of concrete placement.

#### 6.0 FORMWORK


All side forms shall be of mild steel unless uses of wooden sections are specially permitted. The steel forms shall be MS channel sections and their depth shall be equal to thickness of the pavement. The sections shall have a length of atleast 3.0m except on curves, where shorter sections may be used. These forms should be provided with ample bracing and supports to prevent the springing of the forms under the concrete pressure or thrust of machinery operating nearby.

The forms should be in sufficient number and they should not be removed until concrete is hardened sufficiently.

In case wooden forms are permitted, these shall have minimum base width of 100mm for 200mm slabs and 150mm for more than 200mm thickness.

#### 7.0 REINFORCEMENT

All reinforcement work shall conform to IS: 456. Reinforcing steel shall be free from dirt scale or other foreign matter and rust. The number, size, form and position of all the reinforcement shall unless otherwise directed or authorised by Owner/Owner's Representative be strictly as per drawings. The placing of reinforcement shall be such that when properly placed into the work,

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extreme longitudinal bars will be located not less than 50mm nor more than 100mm from the edges of the slab except for dummy joints, the length of reinforcement will keep clear of transverse joints by not less than 50mm nor more than 100mm as measured from the centre of the joint to the ends of longitudinal bars.

While overlapping the bars in either direction the overlap shall be at least equal to spacing between bars in the respective direction.

To prevent displacement before or during concreting, the bars shall be secured to one another with 16 SWG black soft annealed binding wire. Wooden planks provided for labour to move shall be supported independent of reinforcement and the cage shall never be permitted to sag or get displaced during concreting. Concrete blocks shall be used to ensure correct cover of concrete over bars as shown in drawings.

Dowels if used as load transferring device shall be checked for exact position before concreting. Dowels shall be parallel to the surface and perpendicular to the joint and shall not place any restraint on the movement of the joint.

## 8.0 MIXING

Mixing should be carried out in mechanical mixers. Drum of the mixer shall rotate at a peripheral speed of 60 RPM (Rotation per minute). Hand mixing can, however, be permitted by Owner/Owner's Representative in special cases. Water cement ratio shall be rigidly controlled during mixing. Mixers shall be fitted with automatic devices to discharge measured quantity of water directly into the mixing pan. The water shall be introduced into the drum within first 15 seconds of mixing, but not until all the cement and aggregate constituting the batch are thoroughly mixed. Mixing shall continue until the concrete is uniform in colour and for not less than 2 minutes after all the materials and water are in the drum. The entire content of the drum shall be discharged before any materials are placed therein for the succeeding batch.

Correction for Bulking- In volume batching suitable allowance shall be made for the bulking of fine aggregates due to presence of water. For this purpose the bulking shall be determined as directed by Owner/Owner's Representative.

## 9.0 PLACING


The place where concrete is to be poured should be clean and free from all loose dirt, standing water etc.

Walking on reinforcement layers is not permissible. Walkways of wooden planks or similar material can be placed with removable supports and should be independent of the reinforcement. The reinforcement position should not be disturbed nor should it sag during carriage and placement of concrete.

Placing and vibration should not take totally more than 20 minutes from time of mixing. Method of placing should be got approved by Owner/Owner's Representative. Segregation during carriage and placement should be avoided. If during carriage concrete segregates, it should be remixed before placement.

Concrete should not be dropped from a height of over 1.5m.

To ensure bond and water tightness between old concrete surface and fresh concrete to be placed, the surface should be cleaned and roughened by "initial green cut" by wire brushing or

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chipping. The initial green may be done by wire brush after 6 hours of placing concrete in order to facilitate the work. Chipping can be done only after 48 hours. A layer of cement slurry with 1:1 mix (1 cement: 1 sand) should be poured to obtain a uniform coating on old concrete. Immediately thereafter, the fresh concrete should be poured.

Concrete shall be mixed in quantities required for immediate use and shall be deposited on the sub-grade in a single operation to the required depth and width of the pavement. Spreading shall be as uniform as possible to avoid re-handling of concrete. Where however, a certain amount of redistribution is necessary it shall be done with shovels and not with rakes. Concrete shall be vibrated with internal vibrators. Concrete shall be placed continuously until completion of the part of the work between construction joints or as directed by Owner/Owner's Representative continuously until completion of the part of the work between construction joints or as directed by Owner/Owner's Representative.

All precautions shall be taken for concreting in extreme weather in accordance with the relevant clauses of IS: 456. Due protection shall be provided to prevent cement being blown away while proportioning and mixing during windy weather. No concreting shall be carried out in continuous heavy rains. Necessary arrangements to cover the freshly poured concrete shall be provided, to protect it from the direct rays of the sun and from drying winds.

All concreting placement should be co-ordinated with placement of conduits, inserts, embedded parts etc. executed either by same agency or separately.


Concrete in standing water shall be executed strictly as per IS: 456. This shall be paid as a separate item where applicable.

The concrete shall be laid in panels not exceeding 4m x4m as shown in layout drawing or as directed by Owner/Owner's Representative.

**10.0 COMPACTION**

The surface of the pavement shall be compacted either by means of power driven finish machine or a vibrating hand screed. For areas where width of the slab is very small as the corner of street junction etc. hand consolidation and finishing shall be done as follows:

- I. Concrete as soon as placed, shall be struck off uniformly and screeded to the crown and cross-section shown on the plans and to such level above the base that when compacted and finished, the pavement shall conform to the grade and cross section indicated by the plans. The entire surface shall then be tamped until a close knit dense surface is obtained.
- II. The tamper shall rest on the side forms and shall be drawn ahead with a swing motion in combination with a series of lifts and drops alternating with lateral shifts, the aim of this operation being compaction and screeding to the approximate level required. Subsequent tamping should advance 75mm at a time in the direction in which the work is proceeding and in final stages the tamping should be closer about 12mm at a time until a level and dense surface is obtained.
- III. If so directed by Owner/Owner's Representative, hand operated vibrating tamper consisting of normal type of hand tamper attached to a pneumatic or electric vibrating unit shall be used for compaction.

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- IV. Segregated particles of coarse aggregate which collect in front of the tamper shall be thrown outside the forms or thoroughly mixed by hand with a mass; of concrete already on the base.
- V. Compaction by tamping shall be carried on till the mortar in the mix just works up to the surface. The surface shall be examined after compaction correction, if needed, shall be made by adding or removing concrete followed by further compaction and finishing.

**11.0 FINISHING**

FLOATING

As soon as practicable, after concrete has been struck off and compacted, it shall be further smoothed and compacted by means of a longitudinal float 1200 mm long and 75mm wide operated from a foot bridge.

STRAIGHT EDGING

After floating is completed and excess water removed but while concrete is still plastic the slab surface shall be tested for trueness with a straight edge and rectified, if necessary.

BELTING

Just before the concrete becomes non-plastic, the surface shall be belted with a two ply canvas belt not less than 200mm wide and at least 1.0M longer than the width of the slab. Hand belts shall have suitable handles to permit controlled uniform manipulation. The belt shall be operated with short strokes transverse to the carriage way centreline and a rapid advance parallel to the centre line.

BROOMING

After belting and as soon as surplus water has risen to the surface the pavement shall be given a broom finish to produce corrugations of uniform appearance of not more than 1/16 inch in depth.

EDGING


Before the concrete has its initial set the edges shall be carefully finished with an edger of the radius required and pavement edge shall be left smooth and true to line.

**12.0 CURING**

INITIAL CURING

Immediately, after the completion of the finishing operations, the surface of pavement shall be entirely covered with wetted burlap, cotton or jute mats.

FINAL CURING

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Upon the removal of the mats, the slab shall be thoroughly wetted and covered by the following method:

Curing with wet earth- A system of transverse and longitudinal dykes of clay about 50mm high shall be laid over the slab. These dykes shall be blanketed with sandy soils free from stones to prevent drying up. The rest of the slab shall be covered with sufficient sandy soil so as to produce a blanket of earth not less than 37mm depth after wetting. This earth shall be kept thoroughly wet till the concrete has attained the required strength but not less than 14 days.

### 13.0 JOINTS

Wherever called for on the drawings expansion joints, dummy joints and longitudinal joints shall be provided as per details indicated in the drawing and as directed by Owner/Owner's Representative.

After the curing, the temporary seal or other intruded materials of all expansion and contraction joints shall be removed completely and the slots filled with approved joint sealing compound. The edges of the joints shall thoroughly cleaned and primed with a thin bituminous paint which shall be allowed to dry before the sealing compound is applied.

The primer shall be applied with a brush. The composition of primer shall be as follows:

Name of Material	Percent by weight
200 – Penetration Bitumen	66%
Light creosote oil	14%
Solvent Naphtha	20%


The bitumen shall be melted and fluxed with oil. When cold, solvent Naphtha shall be added. Bituminous emulsion shall not be used as primers. Care shall be taken to ensure that the sealing compound is not heated above 200°C and the temperature does not exceed 180°C for long periods.

Sealing compound shall be poured into the joint opening in such a manner that the material will not be spilled on the exposed surface of the concrete. When required to prevent pick up under traffic, the exposed surface of the sealing compound shall be dusted with hydrated lime.

### 14.0 OPENING TO TRAFFIC

Traffic shall not be allowed for a period of 28 days after laying of concrete.

Before opening the roads to traffic all joints shall be filled and trimmed or topped out as required.

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**TECHNICAL SPECIFICATION  
FOR  
DISMANTLING AND DEMOLITION**

**GAIL-STD-CV-DOC-TS-010**

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## 1.0 INTRODUCTION

This specification deals with the procedures to be adopted while demolishing/dismantling of existing concrete, steel and masonry structures.

While the intent is not to specify each and every details of the dismantling activity, the contractor shall take every possible care while executing the works and as per directions of the Owner/Owner's Representative.

## 2.0 SAFETY AND SECURITY

Safety and security of the structures, site or the field personnel shall be solely the responsibility of the Contractor. The Contractor shall take all necessary safety measures to prevent mishaps or accidents during dismantling work.

For important structure/buildings as directed by the Owner/Owner's Representative, an advanced / improved demolition / dismantling technique / control demolition technique shall be adopted after carrying out collapse analysis as and when required. This shall be done such that the ground vibrations caused during demolishing/dismantling shall not unduly disturb/damage the adjacent / neighbouring buildings/structures.

As far as possible for dismantling, core cutting techniques that uses cutting tools which produces less vibration/noise shall be used. Wherever applicable, approval of statutory body/concerned environmental agencies shall be obtained before starting of the dismantling/demolishing work.


## 3.0 WORKMANSHIP

Before taking up any dismantling/demolishing activity, a clear and detailed method statement indicating the detailed procedure adopted shall be prepared and submitted to the Owner/Owner's Representative for approval. The documents approved by the Owner/Owner's Representative do not absolve or dilute the Contractor's responsibilities towards safety precautions. Any liabilities/injuries/accidents arising due to defective safety practices of the Contractor shall be solely to the Contractor's accounts.

All materials obtained from dismantling/demolishing operations shall be the owner property, unless otherwise specified and shall be kept in the safe custody until handed over to the Owner/Owner's Representative

Where it becomes necessary to disconnect any existing service lines such as Electrical, Piping etc. during dismantling/demolishing operation and where so required by the Owner/Owner's Representative suitable alternate arrangement shall be made by the Contractor to maintain the continuity and proper functioning of the affected service linkage.

Dismantling activity implies carefully taking up or down and removing without damage. The articles shall be passed by hand where necessary, and lowered to the ground, and not thrown. Where nails, screws, bolts etc. fix these, these shall be taken out with proper tools and not by tearing or ripping off. Demolition activity implies taking up or down or breaking up. This shall consist of demolishing whole or part of work including all relevant items as specified or shown in the drawings.

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Prior to commencement of activity, the structures to be dismantled shall be studied carefully and the works procedure planned out. The permission to dismantle shall be obtained in writing from the Owner/Owner's Representative. Adequate warning/sign posts shall be provided at locations. The entire area shall be cordoned off after prior intimation. Where the plant is in operation, the operating staff of the plant shall be informed of the dismantling activity.

The demolition shall always be planned before hand and shall be done in reverse order of the one in which the structure was constructed. The scheme of demolition shall be got approved from the Owner/Owner's Representative before starting the work. Necessary propping, shoring and under pinning shall be provided for the safety of the adjoining work or property, which is to be left intact before demolition is taken up and the work shall be carried out in such a way that no damage is caused to the adjoining properties. Necessary precaution shall be taken to keep the dust nuisance down as and where necessary. The dismantling shall be commenced in a systematic manner- Chipping of concrete shall proceed taking adequate care as not to cause damage to the existing structures. Use of sledgehammer shall be limited so as not to cause damage to adjacent structures/equipment. Floor slabs shall be chiseled around the perimeter to enable removal of slabs in units. The area identified for chiseling shall be suitably assessed so as not to cause any damage to floor below, if any. The reinforcement shall be subsequently cut and the debris shall then be moved to the location identified by the Owner/Owner's Representative and as per his instructions. Masonry units shall be dismantled in such a way so that collapse of entire units is avoided. The bricks shall be removed in units. These shall be then moved to a location as directed by Owner/Owner's Representative, Adequate supports wherever necessary shall be provided to the area adjacent to the dismantling activity so as to protect any damage or collapse, Shuttering shall be provided below the slabs where chipping is envisaged. If necessary, blinds shall be erected to avoid dust and flying of the chipped particles.

Any serviceable material obtained during dismantling or demolition shall be separated out and stacked properly as directed by Owner/Owner's Representative within a lead of 100 meters. All unserviceable materials rubbish etc. shall be disposed off as directed by Owner/Owner's Representative.

Where structural steel platforms are to be dismantled, these shall be either carefully cut or if it is a bolted structure such as platforms, be dismantled to enable reuse of these units for a different location.

After the dismantling or demolishing work is complete, all loose debris etc. shall be removed and the area swept clean or washed with water.

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**GAIL INDIA LIMITED**

**TECHNICAL SPECIFICATION  
FOR  
BARRICADES**

**GAIL-STD-CV-DOC-TS-011**

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## 1.0 INTRODUCTION


This specification covers the requirement for site in-situ barricading where the work is commencing along the major and minor roads.

## 2.0 REFERENCE DOCUMENTS

Refer GAIL standard drawing no: - GAIL-STD-CV-DWG-TP-015

## 3.0 GENERAL

- Providing and installing the barricades of size 2.5 m X 2.0 m of the design and type as shown in the standard drawing no:- ENG-STD-CV-DWG-TP-011. Installation plan of Barricades is to be approved by Owner/Owner's Representative. Barricades are to be firmly fixed to the ground and are to be maintained during the progress of work.
- Barricades are to be painted with logo initially and repainting to be done whenever required.
- Wet mopping of Barricades shall be done quarterly in a month.
- In accordance with the requirements of this specification, the contractor shall submit the details specified in the following paragraphs covered by this specification.
- Wet mopping of Barricades shall be done quarterly in a month.
- Ground Space of one-meter width outside barricades shall be cleaned everyday.
- Reflector shall be placed on the barricades.
- Barricades shall have blinking red light for night getting power through generator or electric connection.
- To avoid traffic congestion/accident a trained supervisor shall be deployed as per directions of Owner/Owner's Representative.
- Dismantling of Barricades from the site and cleaning the site as per directions of Owner/Owner's Representative.

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# TECHNICAL SPECIFICATION FOR STANDARD FIELD QUALITY PLAN

## GAIL-STD-CV-DOC-TS-012

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## STANDARD FIELD QUALITY PLAN

Sl. No	Component Operation & Description of Test	Sampling Plan with basis	Ref. Document & acceptance norms	Testing Agency	Remarks	Check
<b>1</b>	<b>CHECKING OF FOUNDATION MATERIALS</b>					
<b>A.</b>	<b>CEMENT</b>	One sample per lot of 100 MT or part thereof from each source for MTCs and one sample per lot of 200 MT or part thereof from each source for site testing.	IS:456, IS:269, IS:8112, IS:12269, IS:4489 & LEPL Specification	Manufacturer approved lab	Review of manufacturers test certificates (MTCs) and laboratory test results by LEPL	$\beta$
i	Initial & final setting time					
ii	Soundness					
iii	Heat of Hydration for low heat cement ( Not Applicable for OPC & PCC)					
iv	Fineness					
v	Compressive Strength					
vi	Chemical Composition of Cement	One sample per lot of 100 MT or part thereof from each source fro MTCs.	IS:456, IS:269, IS:8112, IS:12269, IS:4489 & LEPL Specification	Manufacturer	Review of manufacturers test certificates by LEPL	$\beta$
<b>B.</b>	<b>COARSE AGGREGATES</b>					
i.	Determination of Particle size (Sieve Analysis)	One sample per lot of 100 cubic meter or part thereof from each source for each source for each size	IS: 383, IS: 2386 and LEPL specification	LEPL approved lab. However, Moisture content test for design mix concrete shall be done on all days of concreting at site.	Each source to be approved by LEPL. Review and acceptance of test result by LEPL	B
ii	Flakiness Index					
iii	Crushing Value					
iv	Specific Gravity					
v	Bulk Density					
vi	Absorption Valve					
vii	Moisture Content					
viii	Soundness of Aggregate					
ix	Presence of detections materials					



Sl. No	Component Operation & Description of Test	Sampling Plan with basis	Ref. Document & acceptance norms	Testing Agency	Remarks	Check
<b>C</b>	<b>FINE AGGREGATE</b>					
i	Gradation/Determination of Particle size (Sieve Analysis)	One sample per lot of 100 cubic meter of part thereof from each source	IS:383, IS:2386, IS:456 and LEPL specification	LEPL approved lab. However, Moisture content test for design mix concrete shall be done on all days of concreting at site.	Each source to be approved by LEPL. Review and acceptance of test result by LEPL	$\beta$
ii	Specific Gravity and density.					
iii	Moisture content*					
iv	Absorption Value*					
v	Bulking					
vi	Silt Content Test					
vii	Presence of deleterious materials					
<b>D</b>	<b>BRICKS</b>					
i.	Dimensional tolerance	As per enclosed Annexure-II	CPWD & LEPL specification	LEPL approved Lab.	Approved by LEPL	$\beta$
ii	Compressible Strength					
iii	Water Absorption					
iv	Efflorescence					
<b>E</b>	<b>WATER</b>					
i	Cleanliness (Visual Check)	Random	IS: 456, IS: 3025 and LEPL specification. The water used for mixing concrete shall be fresh, clean and free from oil, acids and alkalis, organic materials, or other deleterious materials.	Contractor	Each source to be approved by LEPL	$\beta$
ii	Chemical and physical properties of water for checking its suitability for construction purposes	One sample per source	IS:456, IS:3025 and LEPL specification	Contractor/ LEPL approved lab.	Approved by LEPL	$\beta$

Sl. No	Component Operation & Description of Test	Sampling Plan with basis	Ref. Document & acceptance norms	Testing Agency	Remarks	Check
2	<b>Reinforcement Steel</b>					
i.	Identification & size	Random	IS:432, IS:1139, IS:1786 & LEPL specification	Contractor	Approved by LEPL	$\beta$
ii.	Chemical Analysis Test	One sample per heat	IS:432, IS:1139, IS:1786 & LEPL specification	Manufacturer	Review of manufacturers test certificates by LEPL	$\beta$
iii	Tensile Test	One sample per lot of 40 MT or part thereof for each size of steel conforming to IS:1139 and 5 MT or part thereof for HDS wire for each size of steel as per IS:432. For steel as per IS:1786 under 10mm 1 sample for each 35 MT or part thereof. Over 16m , 1 sample for each 45 MT or part thereof.	IS:432, IS:1139, IS:1786 & LEPL specification	Manufacturers / LEPL approved Lab	Review of manufacturers test certificates as well as lab test result by LEPL	$\beta$
iv	Yield stress/ proof stress					
v	Percentage Elongation					
vi	Bend/Rebend Test	One sample per lot of 20 MT or part thereof for each size of steel as per IS:432, IS:1139. For steel as per IS:1786 under 10mm-16mm, 1 sample for each 25 MT or part thereof 10mm-16mm 1 sample for each 45 MT or part thereof.	IS:432, IS:1139, IS:1786 & LEPL specification	Manufacturers / LEPL approved Lab	Review of manufacturers test certificates as well as lab test result by LEPL	$\beta$

Sl. No	Component Operation & Description of Test	Sampling Plan with basis	Ref. Document & acceptance norms	Testing Agency	Remarks	Check
vii	Reverse Bend Test for HDS wire.	One sample per lot of 5 MT or part thereof for each size	IS:432, LEPL specification	Manufacturer/ LEPL approved lab.	Review of manufacturers test certificates as well as lab test result by LEPL	$\beta$
<b>3</b>	<b>Structural Steel Used In Cable Trenches &amp; Foundations</b>					
i.	Dimensional Check	Random	LEPL specification & approved drawing	Contractor	Checklist to be prepared and signed jointly.	$\beta$
ii	Visual Check for damages, resting, pitting etc.	100%	LEPL specification & approved drawing	Contractor	Checklist to be prepared and signed jointly.	$\gamma$
iii	Visual Check for welding, defects, primer coating and painting/ galvanizing as applicable	Sample per lot of 40 MT or part thereof for tensile tests and 1 sample per lot of 20 MT or part thereof for bend test for each size.	IS:2062, LEPL Specification & approved drawings	Manufacturer/ LEPL approved lab	Review of Mtgs test certificates as well as lab test results by LEPL	$\gamma$
iv	Physical properties of structural steel	One sample per lot of 40 T or part thereof for tensile tests and 1 sample per lot of 20 T or part thereof for bend test.	IS 2062 ,LEPL Specifications and approved drawings	Manufacturer/LEPL approved lab	Review of Mtgs test certificates as well as lab test results by LEPL	$\beta$
<b>4</b>	<b>EQUIPMENT FOUNDATION/ CABLE TRENCH</b>					
A	<b>BEFORE EXCAVATION</b>					
i	Checking of pegs condition as per line and alignment	100% on each location	IS:4091, IS:3764 & LEPL approved drawing/ specification	Contractor	Approved by LEPL	$\gamma$

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Sl. No	Component Operation & Description of Test	Sampling Plan with basis	Ref. Document & acceptance norms	Testing Agency	Remarks	Check
ii.	Checking of pit making as per drawing & RL.	100% on each location	IS:4091, IS:3764 & LEPL approved drawing/ specification.	Contractor	Approved by LEPL	Y
<b>B</b>	<b>EXCAVATION</b>					
i	Dimensional conformity	Each location	IS:4091, IS:3764 & LEPL approved drawing/ specification.	Contractor	Approved by LEPL	$\beta$
ii	Verticality/slopes & Squareness of each pit	Each location	IS:4091, IS:3764 & LEPL approved drawing/ specification.	Contractor	Approved by LEPL	$\beta$
iii	Verification & classification of foundation wherever application.	Each location	IS:4091, IS:3764 & LEPL approved drawing/ specification.	Contractor	Approved by LEPL	$\beta$
<b>C</b>	<b>FOUNDATION BOLTS/ METALLIC INSERTS</b>					
i	Check for proper identification foundation bolts w.r.t. type of foundation	100%	LEPL specification & approved drawings	Contractor	Checklist to be prepared & signed jointly.	Y
ii	Visual check for mechanical damage and galvanizing/ painting it applicable for metallic insert	100%	LEPL specification & approved drawings	Contractor	Checklist to be prepared & signed jointly.	Y
iii	Alignment & Level	100%	LEPL specification & approved drawings	Contractor	Checklist to be prepared & signed jointly.	$\beta$

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Sl. No	Component Operation & Description of Test	Sampling Plan with basis	Ref. Document & acceptance norms	Testing Agency	Remarks	Check
iv	Grouting/ Underpinning of foundation base plate.	100%	LEPL specification & approved drawings	Contractor	Checklist to be prepared & signed jointly.	γ
D	<b>P.C.C. PADDING</b>	For all locations	IS:456 and LEPL approved foundation drawings & Specification	Joint Inspection by LEPL and Contractor.	Approval by LEPL	β
E	<b>SHUTTERING (Formwork)</b>					
i.	Check for materials, breakage or damage.	100%	IS: 456, LEPL specification / approved drawings.	Joint Inspection by LEPL and contractor	Approval by LEPL	γ
ii	Check for plumb, alignment parallelism, squareness and equidistance from stub.	100% before casting	IS:456, LEPL Specification/ approved drawings.	Joint Inspection by LEPL and contractor.	Approval by LEPL	β
iii	Dimensional check	100% before casting	LEPL Specification/ approved drawings	Joint Inspection by LEPL and contractor	Approval by LEPL	β
iv	Check for level & height.	100% before casting	LEPL Specification/ approved drawings	Joint Inspection by LEPL and contractor	Approval by LEPL	β

Sl. No	Component Operation & Description of Test	Sampling Plan with basis	Ref. Document & acceptance norms	Testing Agency	Remarks	Check
v	Check for rigidity of frame/ tightness	100%	LEPL Specification/ approved drawings	Joint Inspection by LEPL and contractor	Approval by LEPL	β
vi	Cleaning and oiling	100%	LEPL Specification/ approved drawings	Joint Inspection by LEPL and contractor	Approval by LEPL	β
vii	Diagonal bracing if required as per drawings/ site conditions	100%	LEPL Specification/ approved drawings	Joint Inspection by LEPL and contractor	Approval by LEPL	γ
viii	Checking of joints to avoid undue loss of cement slurry.	100%	LEPL Specification/ approved drawings	Joint Inspection by LEPL and contractor	Approval by LEPL	γ
<b>F</b>	<b>Placement of Reinforcement Steel</b>					
i	Check the steel bars for rust, cracks, surface flaws, laminate etc. (Visual check)	100%	IS:456 and LEPL Specification/ approved drawings	Joint Inspection by LEPL and contractor	Approval by LEPL	γ
ii	Check as per the bar bending schedule before placement of concrete.	For all locations	IS:456 IS:2502 and LEPL Specification/ approved drawings	Joint Inspection by LEPL and contractor	Approval by LEPL	γ
iii	Checking cutting tolerance for bars as per check list/ drawings, check whether all the bent bars and lap lengths are as per	For all locations	IS:456 , IS:2502 and LEPL Specification/ approved drawings	Joint Inspection by LEPL and contractor	Approval by LEPL	β

Sl. No	Component Operation & Description of Test	Sampling Plan with basis	Ref. Document & acceptance norms	Testing Agency	Remarks	Check
	approved bar bending schedule.					
iv	Check whether all joints & crossing of bars are tied properly with right guage & annealed wire as per specification	100%	IS:456 , and LEPL Specification/ approved drawings	Joint Inspection by LEPL and contractor	Approval by LEPL	Y
v	Check for proper cover distance spacing of bars, spacers & chairs after the reinforcement cage has been put inside the formwork.	100%	IS:456 , and LEPL Specification/ approved drawings	Joint Inspection by LEPL and contractor	Approval by LEPL	Y
vi	Check whether tapping of bars are tied properly with right guage and annealed wire as per specification.	100%	IS:456 , and LEPL Specification/ approved drawings	Joint Inspection by LEPL and contractor.	Approval by LEPL	β
vii	Anchor bolts if applicable					
a	Level, center-to-center distance of bolts.	100% on each location	LEPL approved pile foundation drawings/ specification.	Joint Inspection by LEPL and contractor.	Checklist to be prepared and signed jointly.	β
b	Visual check for galvanizing.	100% on each location	LEPL approved pile foundation drawings/ specification.	Joint Inspection by LEPL and contractor.	Checklist to be prepared and signed jointly.	β

Sl. No	Component Operation & Description of Test	Sampling Plan with basis	Ref. Document & acceptance norms	Testing Agency	Remarks	Check
<b>5</b>	<b>CONCRETING</b>					
a	APPROVAL OF MIX DESIGN	Each mix	IS: 456 & LEPL drawings/ specification.	LEPL approved by Lab	Approval by LEPL	α
b	BATCHING, MIXING & PLACING OF CONCRETE AND COMPACTING.	100%	IS:456 & LEPL approved pile foundation drawings/ specification	Joint Inspection by LEPL and contractor.	Approval by LEPL	β
c	PLACING CONCRETE AND COMPACTING.	100%	IS:456 & LEPL approved pile foundation drawings/ specification	Joint Inspection by LEPL and contractor.	Min gap between boxes and reinforcement bars should be maintained. Approved by LEPL.	β
<b>D</b>	<b>Concrete testing</b>					
i	Slump Test	One sample per casting	IS:456, IS 516, IS: 1199 and LEPL specification.	Contractor	Approved by LEPL	β
ii	Check for quantities for cement, fine aggregate, coarse aggregate and water while batching	100% on all locations	IS:456, IS 516, IS: 1199 and LEPL specification.	Contractor	Checklist to be prepared and signed jointly.	β
e	<b>Concrete Cube Testing</b>					
i	Compressive Strength	One sample for every 20 Cum of concreting or part thereof for each days concreting ( one sample consists of min. 3 test cubes for 28 days strength)	IS:456, IS 516, IS: 1199 and LEPL specification.	LEPL approved lab	Approval by LEPL Cubes must be tested within a week after 28 days curing period and test results should be approved.	α



Sl. No	Component Operation & Description of Test	Sampling Plan with basis	Ref. Document & acceptance norms	Testing Agency	Remarks	Check
f	CHECK FINISHING, DIMENSIONAL CONFORMITY AND WORKMANSHIP BEFORE & AFTER BOX REMOVAL.	100%	IS:456, IS 516, IA: 1199 and LEPL specification.	Contractor	Approval by LEPL	β
<b>6</b>	<b>BACKFILLING</b>					
i	Check for thickness of layer & watering	100%	LEPL specification and approved drawings.	Contractor	Approved by LEPL	γ
ii	Visual check for correction/ ramming.	100%	LEPL specification and approved drawings.	Contractor	Approved by LEPL	γ
iii	Compaction test (percentage of max. dry density)	Samples for each pit. Equipment & other foundation 20% at random	LEPL Specification	LEPL approved lab	Review of lab test results by LEPL. Elevation for testing to be decided by LEPL.	β
<b>6</b>	<b>BRICK-WORK &amp; TILING WORK</b>					
i.	Mortar mix/ proportion	Random	IS:2250, LEPL specification & CPWD specification.	Contractor	Approval by LEPL	β
ii	Plumb & Alignment	Random	LEPL specification & CPWD Specification	Contractor	Approval by LEPL	β
iii	Joints	Random	LEPL specification & CPWD Specification	Contractor	Approval by LEPL	β

Sl. No	Component Operation & Description of Test	Sampling Plan with basis	Ref. Document & acceptance norms	Testing Agency	Remarks	Check
iv	Water absorption Test	Random	LEPL specification & CPWD Specification	Contractor	Approval by LEPL	$\beta$
<b>7</b>	<b>PLASTERING</b>					
i	Plastering thickness and evenness	Random	LEPL specification & CPWD Specification	Contractor	Approval by LEPL	$\beta$
ii	Mortar mix./ proportion	Random	LEPL specification & CPWD Specification	Contractor	Approval by LEPL	$\beta$
<b>8</b>	<b>SITE SURFACING</b>					
i	Levelling	100%	LEPL specification & CPWD Specification	Contractor	Checklist to be prepared and signed jointly	B

**Section: GENERAL GUIDELINES FOR IMPLEMENTATION**

1. Details of categories of check codes  $\alpha$ ,  $\beta$  &  $\gamma$  including accepting and deviation dispositioning authorities are indicated at Annexure-1.
2. LEPL specification shall mean LEPL technical specification, approved drawings/ data sheets and LOA provisions applicable for the specific contract.
3. Accepting criteria and permissible limits for certain tests are indicated at Annexure-II. For balance tests, site to verify the same with respect to LEPL specification, relevant Indian Standards and/or prevalent code of practice.
4. It is clarified that the tests indicated at column 2 of this F.Q.P. i.e. against column "Component Operation & Description of Test," are only generally required to be conducted. However, LEPL reserves the right to carryout any additional tests at any stage if the situation so warrants.
5. LEPL site representative shall witness all the tests conducted by the contractor as mentioned in this F.Q.P. However, in case of tests conducted in the LEPL approved lab, it is preferred to witness the tests in the lab itself, if possible.
6. LEPL shall approve testing laboratory before accepting the test results from the lab.

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7. LEPL shall approve the sources for cement, coarse aggregate, fine aggregate & water before actual utilization.
8. All the testing & measuring equipment used by the contractor for testing are required to be calibrated. A copy of valid calibration report shall be retained by LEPL as records.
9. Classification of foundations shall be approved by LEPL based on the Joint Inspection Report & Soil investigation reports.
10. Curing of concrete work should be continued for a minimum period of 10 days.
11. ZONE-IV FINE AGGREGATE.
  - a. Zone-IV fine aggregate shall be used for nominal mix. Reinforced cement concreting work.
  - b. Zone-IV fine aggregate shall be avoided for design mix. Reinforced cement concreting work unless tests have been done to ascertain the suitability of proposed mix proportion with the prior approval LEPL site.
12. BRICKS
 

Bricks shall be free from cracks, flaws and modules of free lime. They should have smooth rectangular faces with sharp corners and should be uniform in colour.
13. CEMENT
  - a. In case supply of cement is in the scope of the contractor, the same shall be procured from sources approved by LEPL site and got tested at site on sample basis for specified acceptance tests as specified in the F.Q.P. at a reputed Third Party Lab approved by LEPL site.
  - b. The samples of cement for site testing shall be taken within three weeks of the delivery and all the tests shall be commenced within one week of sampling, if the cement remains in store for a period of more than six month. All the site tests are required to be repeated before usage.
14. REINFORCEMENT STEEL & STRUCTURAL STEEL USED IN CABLE TRENCHES AND FOUNDATIONS.
  - a. In case supply of steel is in the scope of the contractor, the same shall be procured from the main producers i.e. SAIL, TISCO, IISCO or Rashtriya Ispat Nigam Ltd. The steel shall be got tested at site on sample basis of specified acceptance tests as specified in this F.Q.P. at a reputed Third Party Lab approved by LEPL site.
  - b. The results of the testing of cement and reinforcement steel referred to in 13.a and 14.a above shall be got approved from LEPL site before cement and reinforcement steel are put to use. However, in exceptional cases due to exigencies of work. LEPL site may authorize the contractor to use Cement and Reinforcement Steel even before the test results are received. However, in all such cases, if the test results subsequently received are found to be not complying with the specified acceptance criteria, the contractor shall have to dismantle and recast all such foundations cast with such non-conforming materials at his own cost. Confirmation to this effect shall be obtained from the contractor by the Project authorities beforehand in all such cases.
15. The contractor shall submit welding procedure specification (WPS) including the type of electrode used for approval of LEPL site before starting the welding work.

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16. Approval/ acceptance of individual test results by LEPL in the course of execution of contract will not relieve the contractor of his contractual obligations and responsibilities, nor does it limit the Owner's right under the contract.
17. In case, requirement of special items like Super Sulphated Cement, Corrosive Resistant Reinforcement Steel (CRRS) etc arise due to site conditions, the specific approval of LEPL may be obtained before using the same and all the tests as per relevant standards shall be carried out.

All the materials shall be stored by the contractor in a manner affording convenient access for identification and inspection at all times. Storage of material shall be in accordance with IS: 4032 (Latest Edition).

#### ACCEPTANCE CRITERIA AND PERMISSIBLE LIMITS FOR FOUNDATION MATERIALS & CONCRETE

##### A. CEMENT

Description of the Test	33 Grade OPC as per IS:269	43 Grade cement as per IS:8112	PPC as per IS:1489	Low Heat Cement
i) Fineness (min)	225 m <sup>2</sup> /Kg	225 m <sup>2</sup> /Kg	300 m <sup>2</sup> /Kg	225 m <sup>2</sup> /Kg
ii) Compressive Strength (min) 72 ± 1 hours 168 ± 2 hours 672 ± 4 hours	160 kgf/cm <sup>2</sup> 220 kgf/cm <sup>2</sup> -	23 MPa 33 MPa 43 MPa	16 Mpa 22 Mpa 33 Mpa	100 kgf/cm <sup>2</sup> 160 kgf/cm <sup>2</sup> 350 kgf/cm <sup>2</sup>
iii) Initial Setting Time (Min)	30 Minutes	30 Minutes	30 Minutes	30 Minutes
iv) Final Setting Time (Max.)	600 Minutes	600 Minutes	600 Minutes	600 Minutes
v) Soundness ( Le chatelier Method)	Max 10 mm expansion	Max 10 mm expansion	Max 10 mm expansion	Max 10 mm expansion
vi) Heat of hydration (Max.)	-	-	-	Max. 65 cal/gm for 7 days cal/gm for 28 days
vii) Chemical Composition	As per IS	As per IS	As per IS	As per IS

##### B. COARSE AGGREGATE

- (i) Sieve Analysis

IS SIEVE Designation	Percentage passing for Graded aggregate of nominal size		Percentage passing for single sized aggregate of nominal size	
	40 mm	20 mm	40 mm	20 mm
63 mm	-	-	100	-
40 mm	95 to 100	100	85-100	100

IS SIEVE Designation	Percentage passing for Graded aggregate of nominal size		Percentage passing for single sized aggregate of nominal size	
20 mm	30 to 70	95 to 100	0-20	85-100
10 mm	10 to 35	25 to 55	0-5	0-20
4.75 mm	0 to 5	0 to 10	-	0-5

- (ii) Flakiness Index Not to exceed 25%
- (iii) Crushing Value Not exceed 45%
- (vi) Soundness of aggregate applicable for concrete works subject to frost action Loss of weight after 5 cycle to exceed 12% when tested with Sodium sulphate and 18% when tested with magnesium sulphate.
- (v) Deleterious material Not to exceed 5% of the weight of aggregate when tested as per IS:2386 Part-II (1963)

### C. FINE AGGREGATE

- (i) Sieve Analysis Shall confirm to Zone II or Zone III.

IS Sieve designation	Percentage Passing for			
	Grading zone-I	Grading zone-II	Grading zone-III	Grading zone-IV
10 mm	100	100	100	100
4.75 mm	90-100	90-100	90-100	95-100
2.35 mm	60-95	75-100	85-100	95-100
1.18 mm	30-70	55 – 90	75 – 100	90- 100
600 Micron	15-34	35-59	60-79	60-100
300 Micron	15-20	8-30	12-40	15-50
150 Micron	0-10	0-10	0-10	0-15

- (ii) For guidance of adjusting sound in mix of concrete, the following table may be used.

Moisture Content %	Building % by volume
2	15
3	20
4	25
5	30

- (iii) Silt Content Test: Shall not exceed 4% when tested for building work and shall not exceed 10% as per procedure specified CPWD specification when tested.
- (iv) Deleterious Materials: Total deleterious material shall not be more than 5% by weight.
- (D) REINFORCEMENT STEEL: As per relevant Indian Standards.
- (E) CONCRETE CUBE TEST

For nominal (volumetric) concrete mixes, compressive strength for M20 (1:1½:3 (cement: sand: Coarse aggregate) concrete shall be 265 kg/ cm<sup>2</sup> for 28 days.

- (F) ACCEPTANCE CRITERIA BASED ON 28 DAYS COMPRESSIVE STRENGTH FOR NOMINAL MIX CONCRETE.
  - (a) The average of the strength of three specimen be accepted as the compressive strength of the concrete, provided the strength of any individual cube shall neither be less than 70%, nor higher than 130% of the specified strength.
  - (b) If the actual average strength of accepted sample exceeds specified strength by more than 30%, the Owner/Owner's Representative, if he so desires, may further investigate the matter. However, if the strength of any individual cube exceeds more than 30% of specified strength, it will be restricted to 30% only for computation of strength.
  - (c) If the actual average strength of accepted sample is equal to or higher than specified strength upto 30%, than strength of the concrete shall be considered in order and the concrete shall be accepted at full rates.
  - (d) If the actual average strength of accepted sample is less than specified strength but not less than 70% of the specified strength, the concrete may be accepted at reduced rate at the discretion of Owner/Owner's Representative.
  - (e) If the actual average strength of accepted sample is less than 70% of specified strength, the Owner/Owner's Representative shall reject the defective portion of work represented by sample and nothing shall be paid for the rejected work. Remedial measures necessary to retain the structure shall be taken at the risk and cost of contractor. If, however, the Owner/Owner's Representative so desires, he may order addition to tests to be carried out to ascertain if the structure can be retained. All the charges in connection with these additional tests shall be borne by the Contractor.
- (G) ACCEPTANCE CRITERIA FOR DESIGN MIX CONCRETE SHALL BE AS PER IS: 456.
- (H) SAMPLING PLAN FOR BRICK- WORK

Scale of sampling and permissible number of defectives for visual and dimensional characteristics.

No of bricks in the lot	For Characteristics specified for individual bricks		For dimensional characteristics for group of 20 bricks. No. of bricks to be selected.
2001-10000	20	1	40
1001-35000	32	2	60
35001-50000	50	3	60

**Note:** In case the lot contains 2000 or less bricks the sampling shall be as per decision of the Owner/Owner's Representative.

ii) Scale of sampling for physical characteristics

Lot size	Sampling size for compressive strength water absorption and efflorescence	Permissible No. of defectives for efflorescence
2001-10000	5	0
10001-35000	10	0
35001-50000	15	1

**Note:** In case the lot contains 2000 or less bricks, the sampling shall be as per decision of Owner/Owner's Representative.

iii) Water absorption Test.

Water absorption after 24 hours immersion shall not exceed more than 22 percent by weight.



GAIL INDIA LIMITED

# TECHNICAL SPECIFICATION FOR TOPOGRAPHICAL SURVEY

**GAIL-STD-CV-DOC-TS-013**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
0	22.01.19	ISSUED FOR BID	SS	UN	SKK





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## 1.0 INTRODUCTION

This specification deals with the Topographical Survey work for development of terminals. The intent of the survey for the proposed sites is to obtain sufficient topographical data for finalizing all engineering works and establishment of Reference levels and plot extremities for reference during construction of the project.


## 2.0 SCOPE OF WORK

The terminals/plots along with approaches to the plots which are to be surveyed shall be clarified by the Engineer in charge during execution of work.

The Survey agency shall carry out detail survey of the area along with showing:-

- Physical features, spot levels, invert levels of existing drains and culverts in terms of RL with their cross sections, transmission/telephone lines, service lines etc. land survey by triangulation or other suitable method.
- Topographical survey indicating existing permanent and temporary structures including levels & limits.
- Drawing of terrain.
- Detailed levels and coordinates of existing roads and other units.
- Preparation of survey drawings with descriptive note on terrain.
- Setting of reference grid lines and temporary bench marks.
- True North
- Grids at 5m interval shall be established parallel to true north. Working reference point "A" to be fixed at site with reference to some permanent bench mark.
- Check the co-ordinations of existing roads and other units with reference to the details
- Survey of 5m length beyond the periphery of the proposed plot all around the proposed site.
- Establish the HFL while indicating its source of information.
- To identify storm water disposal point with its levels as per existing site condition.
- Plot plan to show all test locations w.r.to plot corner pegs as well as their Reduced Level.

## 3.0 LEVELING WORK

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The leveling work shall be based on the bench marks available in the vicinity or any permanent existing features. Vertical control based on existing bench marks shall be established based on closed level network.

Suitable instruments shall be used for establishing the bench marks and for doing the general leveling work. All survey points, reference grid /corner pillars (of wooden pegs), shall be protected in such a way so that they are not disturbed during the construction period. The size of pegs shall be minimum 100mm diameter of Wooden balli which shall be embedded in ground. Reference point for the grid system shall be nearest to the existing permanent features.

#### 4.0 SURVEY DETAILS

It shall be general survey work to be used for engineering purposes. The survey shall be oriented towards furnishing information for project planning and detailed engineering work. The survey shall show all the existing features along with levels and important dimensions. Existing features such as roads, railway tracks, buildings, drains, manholes, overhead & underground service lines, communication and supply lines, and similar permanent and temporary structures shall be shown. Each survey drawing shall show sets of perpendicular grid lines parallel to actual North, South and East, West with reference to reference point. These are needed for the purpose of orienting and matching the survey drawings with layout of the unit. Ground levels shall be shown on rectangular grid pattern at intervals of 10 meters. Additional levels to show sudden change of levels shall also be indicated. Contours are to be drawn at 0.20 m intervals. Inverts levels of existing drains at regular intervals shall be taken. Top levels of man-holes shall also be taken. Existing levels at regular intervals and at all junctions for roads, top levels, width, curvature at turning points shall be shown. Any other important detail shall also be shown. Bench marks, reference points, triangulation stations, any existing boreholes, oil wells trial pits etc. used shall be clearly identified in the drawing indicating their values/co-ordinates. Co-ordinates mentioned above shall be surveyed with respect to the reference axes N-S and E-W.

All survey data collected during the day shall be plotted on the drawing sheet on the same day. These drawings shall be used for following, day to-day progress of work and for quick reference, if needed.

#### 5.0 SURVEY DRAWING AND SCALE


All survey drawings shall be made in metric units.

Survey drawings that are to be submitted to the Owner shall be in colour on white paper.

Four copies each of drawings shall be submitted to the Owner along with 2 editable copy on a DVD. .

A descriptive note regarding the site conditions and special features shall also be submitted in field reports. These notes will compliment the drawing and will contain information which could not be covered in the survey drawings. The entire survey report shall also be submitted in soft copy on DVD in 2 sets.

The scale of the drawings shall be 1:100. Generally, A-1 size sheets shall be used for drawings.

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## 6.0 INSTRUMENTS, TOOLS AND TACKLES

The use of proper instruments is an important factor in survey work. The Contractor shall arrange his own instruments, accessories, tools and tackles, camping equipment and transport necessary for conducting the survey as per precision required.

Experienced and qualified engineers, surveyors and draughtsmen shall be engaged to carry out the work.

Survey team shall have at least the following survey instruments and accessories.

- Total Station
- Precision Automatic levels with precision leveling staff
- Precision Measuring Tapes

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GAIL INDIA LIMITED

# TECHNICAL SPECIFICATION FOR GEOTECHNICAL SURVEY


**GAIL-STD-CV-DOC-TS-014**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
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## 1.0 INTRODUCTION

This specification deals with the Geotechnical Survey work for development of terminals. The plan for Geo-technical Survey is drawn with a view to obtain sufficient data regarding the engineering properties of soil supporting the foundation for equipment and structures and to plan the various facilities.

## 2.0 SCOPE OF WORK

The scope of services of the contractor for undertaking soil investigation work shall cover all the work connected with soil exploration program at the proposed terminal including the setting out of locations of the various exploration points from reference point, conducting all field investigations at site, collection of soil and water samples, field and laboratory tests and submission of final reports. All field investigation, laboratory tests and reports etc. shall be done in accordance with the latest relevant Indian Standard Codes.

## 3.0 FIELD INVESTIGATION

This specification deals with Field Investigation/ tests and laboratory tests involved in ascertaining soil stratification & engineering properties of the soil at proposed project site. The field investigations/ tests comprise of the following:-

### EXPLORATORY BORE HOLES


There shall be one borehole at specified Terminal / plot. The location of these shall be indicated by Engineer before commencement of field activities. The location and number of these boreholes can be altered at site, if found necessary. All boreholes shall be of 150 mm diameter and shall be sunk into soil to a depth of 10m or up to refusal strata, whichever is earlier. The exploratory work at site shall be carried out by using shell and auger equipment. Disturbed samples for boring shall be collected every 1.5m or change in stratum and representative samples placed systematically for proper logging of the strata. The existing ground level shall be marked in terms of RL. Proper logging shall be done with description of different strata encountered with their reduced levels. All boreholes after completion of work shall immediately be filled in with a mixture of bentonite slurry and clay-sand mixture.

### UNDISTURBED SAMPLING

In cohesive and semi-cohesive soils, undisturbed samples conforming to IS :2132 shall be taken using open tube samples with an area ratio of less than 15% so as to obtain a core of samples of 100mm diameters and 450mm long at every change in stratum or at intervals of 1.5m whichever is less. The tubes shall be marked and the ends of the sample tube shall be sealed properly with wax of thickness not less than 25mm and capped properly immediately after the sample is recovered from the boreholes to ensure no loss of moisture with time while retained in the tube. Sample tubes shall be immediately shifted to the laboratory for testing.

### STANDARD PENETRATION TEST (SPT)

Standard Penetration Test shall be performed at the base of boreholes as per IS: 2131 with the first test at a depth of 0.5 m and thereafter at every change in stratum or at intervals of 1.5 meter whichever is less in both cohesive and non-cohesive soil. The S.P.T. shall also be conducted at termination depth of Borehole. Test may also be required to be carried out in compact sand which in normal terminology will be refusal strata. No. of blows required to penetrate every 150mm shall be recorded in case of normal sand, silt or clay as per IS:2131.

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In case of dense/ hard stratum, the penetration (in mm) for every 20 blows per test shall be recorded. All these field records are to be submitted along with bore logs. Bent rods and damaged/ defective nipples shall not be used for the test and shall be replaced immediately by proper ones. Centering spacers shall be used at every 6 meters or at smaller intervals in depths to reduce the effect of whipping of rods. Samples collected in process of conducting S.P.T. shall be preserved as disturbed sample. Graphs shall be drawn for each penetration test. Collection of undisturbed samples and conducting S.P.T. tests will be done alternatively.

#### DISTURBED SAMPLES

Representative disturbed samples obtained from boring at every 1.5 meter interval in depth or change in stratum shall be placed in suitable jars labeled properly for onward transmission to the laboratory. These samples shall be sent to the laboratory immediately after the boring is complete. All S.P.T. samples shall also be similarly preserved.

#### STANDING GROUND WATER LEVEL

Records shall be maintained of the level at which water is struck and the level of any rapid in flow shall also be recorded. On reaching such level the borehole shall be left open for a period of two hours to observe the rise of water in the casing. Boreholes can be continued thereafter, upto the end of the day. The level of the water in the casing at the end of the day and at the beginning of the next day shall be recorded properly. For studying the ground water table no drilling mud will be permitted for stabilizing the hole.

### **4.0 LABORATORY TESTS**


Laboratory tests shall be conducted on selected samples collected from site to establish the physical and chemical properties of soil. Following tests shall be done as appropriate in accordance with latest relevant Indian code of Practice.

- (i) Natural moisture content
- (ii) Void ratio
- (iii) Liquid plastic and shrinkage limits
- (iv) Specific gravity
- (v) Dry density and bulk density
- (vi) Direct Shear test
- (vii) Consolidation/ swelling test
- (viii) Particle size analysis
- (ix) Chemical properties of the soil

#### ATTERBERG LIMITS

Liquid and plastic limit tests shall be conducted on all cohesive soils for classification purposes and for predicting engineering properties. The results of limit tests shall be plotted on the plasticity chart of A. Cassagrande. Shrinkage limit shall also be determined for a few soil samples.

#### PARTICLE SIZE ANALYSIS

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Particle size analysis shall be done on all clayey and sandy samples. Both sieve and hydrometric analysis shall be conducted and gradation curves shall be plotted to show the particle size distribution.

#### SHEAR TESTS

Shear tests shall be conducted on the undisturbed samples. A few unconfined compression tests shall be conducted on clayey samples but the majority of clayey samples in un-drained condition shall be subjected to tri-axial tests. The cohesion values and angle of internal friction are to be determined either by Mohr's circle or by any other method. Particular attention shall be paid for conducting tri-axial tests, each of which shall be done on a minimum of 3 specimens. Specimens shall be prepared by trimming and not by pushing small tube in a large tube.

#### CONSOLIDATION TESTS

A few consolidation tests shall be carried out on undisturbed samples of clayey soil, to estimate the settlement of foundation from "e-log p" curves, compression index - Cc and coefficient of consolidation - Cu. Consolidation test shall be done in manner that will not allow the sample to swell.

#### SWELLING TEST


For soils of expansive nature, swelling tests on a few samples shall be selected for conducting swelling test to determine swelling pressure and magnitude.

#### SPECIFIC GRAVITY AND BULK DENSITY

These shall be determined as per the standard procedures.

#### CHEMICAL ANALYSIS OF SOIL

Water samples from a few bore holes shall be taken and chemical analysis shall be done for sulphate, chloride content and pH value, particularly to determine the aggressiveness to concrete, steel and GI pipes. Care shall be taken to ensure that they are not diluted with rain or surface water during recovery from the boreholes. Similarly, a few soil samples shall be chemically tested to determine the sulphate contents, chloride content and pH values and other aggressive components as per IS - 2720.

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**TECHNICAL SPECIFICATION  
FOR  
WATER SUPPLY & SANITARY WORKS**

**GAIL-STD-CV-DOC-TS-015**

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## WATER SUPPLY & SANITARY WORKS

### 1.0 REFERENCE CODES

IS: 774: Specification for Flushing Cistern for Water Closets and Urinals.

IS: 2064: Code of Practice for Selection, Installation and Maintenance of Sanitary appliances.

IS: 2548 Part-1: Specification for Plastic Seats and Covers for water closets Part-1: Thermo set seats and covers

IS: 2548 Part-2: Specification for Plastic Seats and Covers for water closets Part-1: Thermoplastic seats and covers

IS: 2326: Specification for automatic flushing cistern for urinals (other than plastic cisterns)

IS: 9758: Specification for flush valves and fittings for water closets and urinals

### 2.0 WATER SUPPLY WORKS

#### I. BIB AND STOP COCKS

Bib cocks and stop cocks of screw down type shall conform to IS: 781. All taps shall be of heavy grade and chromium plated brass. Chromium plating conform to the best quality as per IS: 1068 (latest edition).

#### II. G.I. PIPE & FITTINGS


All G.I. Pipes and fittings shall conform to IS: 1239 and shall be of medium grade (Class-B) for water supply services. All screwed tubes and sockets shall have pipe thread in accordance with the requirement specified in IS: 554.

All fittings shall be of malleable galvanized iron approved by the Engineer-in-Charge. Fittings in G.I. line shall include all couplings, elbows, tees, bends, union, nipples, reducers, rubber insertion etc. No extra payment shall be made for these fittings. Payment shall be made on running meter basis. All pipes above ground shall be fixed with G.I. holder bat clamps clear off the wall at 1 to 2 meters centre to centre as directed. All visible pipes and clamps inside and outside the building shall be painted with two coats of white paints or aluminum paint as directed by the Site Engineer. No extra payment shall be made for clamps, hooks, cutting holes in walls, chasing and making good the same with 1:3 cement mortar (1 cement : 3 coarse sand) and for painting. All couplings, elbows, tees, bends, union, nipples, reducers etc. shall also be deemed to be included and covered by the rates for running meters of G.I. pipes.

All underground pipes shall be laid in trenches of 60 cm depth and 30 cm width with an all round sand cushion of 10 cm. Before laying, the pipes shall be painted with two coats of anticorrosive bitumen mastic paint of approved quality. The excess earth after filling the trenches shall be disposed off as directed by Site Engineer.

After laying and jointing, the pipes and fittings shall be inspected under working conditions of pressure and flow. Any joint found leaking shall be redone and all leaking pipes shall be replaced at no extra cost. The pipes and fittings after laying shall be tested under a gradually applied test hydraulic pressure of 6 kg/sq.cm. The pipe and joints shall be capable of maintaining the above pressure for at least half an hour without any indication of fall of pressure. All expenses in carrying out the test shall be borne by the Contractor.

#### III. POLY PROPYLENE RANDOM CO-POLYMER (PPR) PIPES

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The PP-R is a bonded, multilayer pipe consisting of different layers of the pipe:

- (a) The inner-most layer of the pipe to be an Anti – bacterial to prevent bacteria growth inside pipe surface.
- (b) The middle layer to be of plain PP-R which is neither in contact with Water and nor under direct effect of the atmospheric conditions.
- (c) The outer-most layer to be of U.V. stabilized PP-R to prevent the pipe surface from sunlight under exposed atmospheric conditions.

The pipes should in general be conforming to the requirements of IS: 15801 except that specified with in nomenclature of the item. The pipes should have smooth inner surface with no contracting diameters. The pipes shall be cleanly finished, free from cracks and other defects. The pipes shall be clean and well cut along ends after taking into consideration the desired length, using the pipe scissors.

The Polypropylene used for manufacturing the pipe shall conform to the requirements of IS: 10951 and IS: 10910. The specified base density shall be between 900 kg/m<sup>3</sup> and 910 kg/m<sup>3</sup> when determined at 27°C. The resin should be mixed with sufficient quantity of colour master batches. The colour master batch should be uniform throughout the pipe surface. The standard dimension ratio (SDR) i.e. ratio of the nominal outer diameter of a pipe to its nominal wall thickness should be 7.4/11 as given in the item.

Pipe diameter, wall thickness, ovality, tolerances etc. shall conform to CPWD specifications.

Fittings: Plain fittings, Chrome plated brass threaded fittings and Valves shall be as per nomenclature of item or as directed by Engineer- in- Charge.


(a) The plain fittings shall be Polypropylene Random Copolymer and comply with all the requirements of the pipes. The plain fittings shall comprise of Socket, Elbow, Tee, Cross, Reducer socket, Reduction Tee, End Cap, Crossover, Omega, Threaded Plug and wall clamps in available sizes.

(b) The Chrome Plated Brass threaded fittings shall be Chrome Plated Brass threaded piece molded inside Polypropylene random copolymer fitting. The material shall comply with all the requirements of the pipes. The Chrome plated Brass threaded fittings shall comprise of Socket, Elbow and Tee (Male & Female) in available sizes. These are the fittings for C. P. connections and for continuations from Galvanized Iron Pipes and fittings.

(c) The valves shall be Polypropylene Random Copolymer Valves. The valves comprise of Gate Valve, Ball Valve, Concealed stop valve and Chrome Coated Valve in available sizes.

The other Brass/Bronze Valves can be connected to Polypropylene Random pipes using C.P. Brass threaded fittings of desired sizes.

Laying and Jointing of Pipes and Fittings: The pipes and fittings shall run in wall chase as specified. Pipes shall run only in vertical or horizontal alignment as far as possible. The installation of pipes is similar to that of the metal pipes with the only difference in the jointing procedure. The jointing of the PP-R pipes and fittings shall be done by fusion welding by means of a welding machine by trained/ experienced personnel as per approved welding procedure. The quality of each installation system ultimately depends on the tightness, stability and lifetime of its connections. The pipe of the desired length is cut using the pipe scissors. The proper heating piece is taken and mounted on the welding machine. The welding device is switched on - Control lamp and switch lamp will lit. When ready, control lamp gets off, which means that welding temperature of 260 Degrees ±10 Degrees Celsius has been reached. The pipe end and the fitting to be welded are heated on the welding machine. Before heating the fitting and the pipe, the dirty welding tools, pipe and fitting are cleaned with a cloth. When heated up (with heating time as per the Table shown below), the pipe and the fitting is removed from the welding machine and the two pieces connected together by applying a little pressure without twisting. The joint is allowed to cool down for a few seconds. The welding process is that safe because the properly heated part of Polypropylene create a homogeneous connection. The same procedure shall be adapted for exposed as well as concealed fittings. The Crossovers may be used wherever the overlapping of the PP-R pipes is required. The fixing shall be done by means of Wall Support Clamps

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keeping the pipes about 1.5 cm clear of the wall where to be laid on the surface. Where it is specified to conceal the pipes, chasing may be adopted. For pipes fixed in the shafts, ducts etc. there should be sufficient space to work on the pipes with the usual tools. Pipe sleeves shall be fixed at a place the pipe is passing, through a wall or floor for reception of the pipe and allow freedom for expansion and contraction and other movements. Fixed supports prevent any movement of the pipe by fixing it at some points. Fittings are used in creating the fixed points. Fixed supports must not be installed at bending parts and the direction changes must be done in the pipe itself. In between the fixed supports some arrangements must be done to compensate any potential elongation or shrinkage in the pipe length. For exposed straight pipes having length more than 5 meters, to compensate the expansion an expansion piece must be used.


**Piping Installation Support:** Piping shall be properly supported by means of wall support clamps as specified and as required, keeping in view the proper designing for expansion and contraction. Risers shall be supported at each floor with clamps. Due to high coefficient of thermal expansion the heat losses though the pipes is highly reduced. Therefore, for internal Bathroom hot geyser water distribution lines, the insulation is often not required.

**Installation of Water Meter and Valves:** PP-R lines shall be cut to the required lengths at the position where the meter and Valves are required to be fixed. Suitable C.P. Brass threaded fittings shall be attached to the pipes. The meter and Valves shall be fixed in a position by means of connecting pipes, jam nut and socket etc. The stop cock shall be fixed near the inlet of the water meter. The paper disc inserted in the ripples of the meter shall be removed. And the meter shall be installed exactly horizontally or vertically in the flow line in the direction shown by the arrow cast on the body of the meter. Care shall be taken not to disturb the factory seal of the meter. Wherever the meter shall be fixed to a newly fitted pipeline, the pipeline shall have to be completely washed before fitting the meter.

**Testing:** All water supply system shall be tested to Hydrostatic pressure test. Maximum operating pressure at varying degree of temperature shall be as per CPWD specifications. The pressure test is performed in 3 steps being preliminary test, main test and final test. For the preliminary test a pressure which is 1.5 times higher than the possible working pressure is applied and this is repeated two times in 30 minutes with intervals of 10 minutes. After a test period of 30 minutes, the test pressure must not be dropped more than 0.6 bar and no leak must occur. Main test follows the preliminary test. Test time is two hours, in doing so the test pressure taken from the preliminary test must not have fallen more than 0.2 bar. After completion of these tests, the final test comes which has to be done under a test pressure of 10 bars and 5 bar in the interval of 15 minutes. Between the respective test courses, pressure has to be removed. All leaks and defects in joints revealed during the testing shall be rectified and got approved at site by retest. Piping required subsequent to the above pressure test shall be retested in the same manner. System may be tested in sections and such sections shall be entirely checked on completion of connection to the overhead tanks or pumping system or mains. In case of improper circulation, the contractor shall rectify the defective connections. He shall bear all expenses for carrying out the above rectifications including the tearing up and re finishing of floors and walls as required. After commissioning of the water supply system, contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently. Valves which are not working efficiently shall be replaced by new ones.

#### **IV. GUN METAL WHEEL VALVE**

The wheel valves shall be of heavy pattern and of best approved quality and shall conform to IS: 778 and tested at a pressure of 17.5 kg/sq.cm. The rate shall be per number basis; the rate shall include supplying and fixing valve in position as per drawing or direction of Site Engineer.

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## V. C.I. SLUICE VALVE

The Sluice valve shall be class-I, and inside non-raising screw type double flanged with hand wheel. These shall comply in all respect with Indian Standard specification IS: 780 (1963).

The body, domes, covers, wedge gate and stuffing box shall be of good quality cast iron. The bodies, spindles and other parts shall be truly machined with surfaces smoothly finished. The area of the water way of the fittings shall be not less than the area equal to the nominal bore of the pipe. The valve shall be marked with an arrow to show the direction of turn for closing of the valve. The valve shall be fully examined and cleaned off all foreign matter before being fixed. The fixing of the valve shall be done by means of bolts, nuts and 3 mm rubber insertions or chemically treated compressed fibre board 1.5 mm thickness and weight not less than 0.183 gm/sq.cm. with the flanges of spigot and the socketed tail pieces drilled to the same specification. The tail pieces shall be confirm to IS: 1938. These shall be jointed to the pipe line by means of lead caulked joints.

Rising Stem Type CI Sluice gate valves shall be conforming to IS: 14 846 and as per details given below. The Sluice gate valves shall have extended stem of 2.5 M with limit switches for installation in tank dyke drainage system to isolate each tank dyke area to get 'Open' & 'Close' indication of the tank dyke drain valves in the Control Room.

## VI. BRASS FERRULES

The ferrules for connections with C.I. main shall generally conform to IS: 2692. It shall be of non-ferrous materials with C.I. Bell mouth cover and shall be of nominal bore as specified. The ferrule shall be fitted with screw and plug with valve capable of completely shutting off the water supply to the communication pipe if and when required.

For fixing ferrule, the empty main is drilled and tapped at 45 degree to the vertical and ferrule screwed in. The ferrule must be so fitted that no portion of the projection of the shank shall be left projecting within the main into which it is fitted. Payment shall be made per number of ferrule supplied and fixed. The rate shall include necessary excavation, back filling, drilling, tapping, making connections with the G.I. pipe, including supply of ferrule, tools, testing etc. complete in all respect.

## VII. CAST IRON PIPE CLASS LA

Centrifugally cast C.I. spun pipes shall conform to IS: 1536-1960 and specials shall conform to IS: 1538-1960. The pipes shall be spigot and socket end type class LA and withstand hydraulic test pressure 20 kg/sq.cm. Pipes and specials should be sound with smooth inner and outer surface, and shall ring clearly when struck with light hammer; the end of the pipes and specials shall be reasonably square to their axis. All pipes and special shall be painted with two coats of anti-corrosive paint before laying.

The spigot end of the pipe shall be inserted in the socket and right upto the back. Spun yarn shall be of clean hemp and of good quality. Spun yarn twisted in rope of uniform thickness and soaked in hot coal tar, shall be inserted carefully into the socket in two or three laps. Lead conforming to IS: 782-1962 in molten state shall then be poured into the joint filling same in one pouring. The lead shall be then caulked in by proper tools to make it even all-round. Quantity of lead used for various sizes of pipes shall be as mentioned below:

Pipe size	Quantity of lead in Kg. per joint
100 mm diameter -	2.72
80 mm diameter -	2.00

The pipe shall be laid on an average depth of 1.0 m below ground level as shown in drawing or as instructed by Site Engineer. Earthwork in excavation and back filling shall be done in the manner as specified in the relevant item, covering earthwork in excavation and backfilling. Tees, bends, reducers, end caps etc. shall be provided in the pipeline as per the drawing or as directed by the Site Engineer.

Cement concrete thrust blocks of suitable design as approved by the Engineer-in-Charge shall be provided at 450 and 900 bends of the pipes.

After jointing the pipes, the whole line shall be tested at a pressure of 10 kg./sqm for 24 hours, without pressure drop. The line shall be disinfected with a liquid chlorine solution; hypochlorite of lime (bleaching powder) may be used. The dose should not be less than 50 ppm of available chlorine and time of contact shall not be less than 8-12 hours as residual of not less than 5 ppm shall be produced in all parts of line. The pipe line shall be thoroughly flushed with clean water afterward. Payment shall be made on running meter basis for the actual length of the pipe laid including specials. The rate shall be inclusive of cost of all labour, materials, equipment, transportation, earthwork in excavation and backfilling etc. necessary for laying and jointing pipes and specials, concrete thrust block, hydraulically testing and disinfecting the line as per direction and satisfaction of the Site Engineer.

### VIII. uPVC PIPELINE SYSTEM

All uPVC piping shall conform to IS: 4985-2000 and fittings shall conform to IS: 7634 (Part I). The pipeline shall be laid at a minimum depth of 0.6m from FGL and at road crossings a minimum cover of 1.20m shall be maintained.

The pipe laying and jointing shall be done in accordance with IS: 7634 (Part-III) – 1975. Pipes and fittings shall be jointed joints accurately without any stress to achieve leak proof stress.

The test shall be done in accordance with IS: 2065 – 1983. The test pressure shall be 5 kg/cm<sup>2</sup> or the maximum working pressure + 50%, whichever is greater. The test pressure shall be maintained for at least an hour.

## 3.0 SANITARY WORKS


### I. EUROPEAN TYPE WATER CLOSET

The Water closet shall be floor mounted or wall hung type as indicated in SOR/Scope of Tender.

Water closet shall be of white vitreous china clay or other approved colour and shall be of wash down type conforming to IS:2556 Part VIII and as described in the Schedule of Rates/Tender Scope. The closet shall be of one piece construction and have integral flushing rim of suitable type. For floor mounted type, each water closet shall have four holes with its pedestal for fixing to the floor. The water closet shall have an integral S or P trap outlet with at least 50 mm water-seal. The closet shall be provided with 15 liters vitreous china clay low level flushing cistern of matching colour with all fittings, MS or C.I. brackets and 40 mm diameter flush bend pipe. The closet shall be provided with black plastic seat and lid.

Floor mounted water closet shall be fixed to the floor by means of 75 mm long 6.5 mm diameter counter sunk bolts and nuts embedded in the floor concrete. The cisterns shall be fixed on C.I. cantilever brackets which shall be firmly embedded in the wall in cement mortar 1:4 (1 cement: 4 fine sand). The cistern shall be connected to the closet by means of 40 mm diameter white porcelain enameled flush bend with rubber inlet connection.

### II. INDIAN TYPE WATER CLOSET

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Water closet shall be of vitreous china clay, of approved colour. Each pan shall have an integral flushing rim of suitable type. It shall also have an inlet or supply horn for connecting the flush pipe. The flushing rim and inlet shall be of self draining type. The pan shall be fitted with 100 mm S.C.I. trap 'P' or 'S' type with approximate 50 mm water seal. White glazed foot rest and a high level C.I. flushing cistern of 15 liters capacity with all fixtures.

The pan shall be sunk into the floor and embedded in a cushion of average 15 cm cement concrete 1:5:10 (1 cement : 5 fine sand : 10 graded brick ballast 40 mm nominal size). The concrete shall be left 115 mm below the top level of the pan so as to allow for flooring and its bed concrete. The joint between the pan and trap shall be made leak proof with cement mortar 1:1 (1 cement: 1 fine sand). Fixing of flushing cistern shall be as per clause 1.3.0. The flush pipe shall be of galvanized steel tube of 32 mm nominal internal diameter. The flush pipe from cistern shall be connected to pan by means of cement or putty joint. Cistern bracket flush-pipe and over-flow pipe shall be painted with two or more coats of white zinc paint. Foot rest of size not less than 25 x 13 x 3 cm of white glazed earthenware shall be set in cement mortar 1:3 (1 cement : 3 coarse sand). The position of the foot rest with the pan shall be as per the direction of the Engineer in Charge.

### III. URINALS

Urinals shall be of white vitreous china clay flat back type conforming to IS: 2556 (Part- I). Urinal shall be of one piece construction with integral flushing rim. These shall be mounted on walls. The flushing inlet pipe connection piece shall be of PVC 15 mm diameter with brass union and CP. stop cock for cistern, 25 mm diameter CP. distribution pipe and waste pipe shall be 750 mm long 32 mm dia. G.I. pipe with necessary brass union and CP. brass screws shall be used for fixing the urinals. Fixing shall ensure that no liquid is left over in the pan after flushing. Urinals shall be connected to automatic flushing cistern either individually or in groups. For a set of three urinals one automatic flushing cistern of 15 liters capacity shall be provided.


### IV. SINKS

The sinks shall be of vitreous china clay, of approved colour conforming to IS: 2556 (Part V) and shall be of the size 600mm x 450 mm x 250 mm. They shall be one piece construction including a combined overflow. The floor of the sink shall gently slope towards the outlet. The outlet in all cases shall be suitable for waste fittings having flanges of 88 mm diameter and the waste hole shall have a minimum diameter of 65 mm at the bottom to suit the waste fittings. Each sink shall be provided with a non-ferrous 50 mm diameter waste fitting. The sink shall have overflow of the weir type and the inverts shall be 30 mm below the top edge.

Each sink shall be provided with a waste plug, of suitable chain and stay plug chains shall be of brass wire of 1.8 mm with brazed over links approximately 13 mm in length and shall be chromium plated. It shall have an overall length from the collar to the stay of not less than 30 mm. There shall be triangular or D-shankle at each end, one of which shall be abraded to the plug and the other securely fixed to the stay. The 50 mm long shank of the waste shall be threaded to the full length to the underside of flange in each case. The waste fittings and plug fittings shall be chromium plated. The chromium plating shall be of grade B conforming to IS: 1068.

Sink shall be fitted on C.I. or M.S. brackets (conforming to IS:775) and the Brackets shall be painted white one coat of anti-corrosive priming, the sink shall be fixed at 800 mm above finished floor level or as directed by the Site Engineer.

### V. WASH BASINS

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Wash basins shall be of white vitreous china clay flat back type conforming to IS: 2556 (Part IV). Wash basin shall be of one piece construction including a combined over flow. This shall be fitted on C.I. or M.S. brackets (conforming to IS: 775). The wall side shall be fixed well flushed with the plaster of wall and the joint, if any, shall be properly finished with mortar and painted white. The basin shall be provided with two C.P. brass pillar cocks, 32 mm dia. C.P. brass waste trap, C.P. brass chain, rubber stopper and 32 mm dia. C.P. brass waste pipe. The basin shall be fixed at 800 mm above finished floor level or as directed by the Site Engineer.

#### **VI. BEVELLED EDGE MIRROR**

The bevelled edge mirror shall be of best quality of 'Hindustan Pilkington' or equivalent make approved by Engineer-in-Charge. The size of the mirror shall be 600 x 450 mm and of thickness 6 mm. Mirror shall be provided with a backing of asbestos sheet of 6 mm thickness and fixed to wooden cleat with 4 C.P. brass screws.

#### **VII. TOILET PAPER HOLDER**

The toilet paper holder shall be of C.P. Brass of size 150 mm x 150 mm fixed with C.P. brass, screws over the wooden cleat. Chromium plating shall be of Grade B type conforming to IS: 1068 (latest edition). The payment shall be made on per number basis. The rate is inclusive of providing and fixing of toilet paper holder with screws, and making good the wall complete with all labour and material.

#### **VIII. MARBLE PARTITION BETWEEN URINALS**


The marble partition in between the two urinals shall be 25 mm thick, table rubbed and polished with round edges, light ash, pink on grey in colour. The partitions shall be pushed inside the wall upto 100 mm depth, and shall be fixed in C.M. 1:3 (1 cement : 3 fine sand) and M.S. bracket channel 2 Nos. embedded into the walls, as per drawing and directions. The payment shall be made on square meter basis of exposed portions only. The rate shall be inclusive of cost of all labour, material etc. involved for satisfactory completion of the above mentioned operations, and as per drawings and direction.

#### **IX. TOWEL RAIL**

The towel rail shall be of chromium plated and shall be of 20 mm dia. and upto 600 mm length. Aluminium brackets shall be fixed on both the sides. The rod shall be fixed with screws and wooden batten on the walls as directed. The mode of measurement shall be on number basis.

### **4.0 BRICK MASONRY CHAMBERS FOR DRAINAGE**

Brick masonry chambers shall be constructed as per drawing true to dimensions. The chambers shall be 600 x 600 mm in size and of average 750 mm in depth. The brick work shall be with second class brick in cement mortar 1:4 (1 cement: 4 fine sand). Bed concrete shall be 100 mm thick cement concrete 1:4:8 (1 cement: 4 coarse sand: 8 grade stone aggregate). Brick work shall be plastered inside with cement mortar 1:3 (1 cement: 3 fine sand) finished with a floating coat of neat cement. Benching shall be done with Cement concrete 1:2:4 (1 cement: 2 fine sand: 4 graded stone aggregate 20 mm down) finished smooth with neat cement. The Chamber shall be covered with 100 mm thick slab in 1:2:4 Reinforced Concrete fitted with 540 mm diameter CI light duty cover. Cover shall be made free from casting & other defects. All sharp edges shall be removed and finished smooth. It shall be coated with 2 coats of anti-corrosive paints.

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## 5.0 SEPTIC TANKS

Specifications relating to earth work in excavation and filling, plain and reinforced concrete, brick work, plastering etc. shall be as per the specification mentioned under different clauses. Septic tanks shall be designed, tested and constructed as per IS: 2470 and detailed drawings true to dimension. Access opening shall be provided for de-sludging & inspection. The ventilating pipe shall be provided with pipe of at least 50mm dia. extended 2 meters above the nearest working platform level. For places where water table is at shallow depth and soak pits are not recommended, upflow filters as per drawings shall be constructed.

## 6.0 SOAK PIT

Soak pit shall be constructed as per the drawing. The earthwork in excavation shall be carried out to the exact dimensions as shown in the drawings. In the soak pit a honey comb dry brick shaft 45 x 45 cm and 292.5 cm high shall be constructed. Round the shaft within the radius of 60 cm shall be placed well burnt brick bats. Brick ballast of size from 50 mm to 80 mm nominal size shall be used. The construction of shaft and filling of the bats and ballast shall progress simultaneously. Over the filling shall be place a single matting, which shall be covered with minimum layer of 7.5 cm earth. The shaft shall be covered with 7.5 cm. Thick R.C.C. slab, and 22.5 cm wide and 12.5 cm deep brick edging with brick shall be provided as per drawing. The soak pit shall be connected with the septic tank by 100 mm diameter SW pipe. Relevant specifications for earthwork in excavation, filling, plain and reinforced concrete, brick work, plastering etc. shall be followed as mentioned herein before. However, the rate shall be inclusive of all the above operations.

## 7.0 CEMENT CONCRETE HUME PIPES

The pipes shall be with reinforcement conforming to IS: 458-1961 and class NP-3. The pipes shall be centrifugally cast, true to shape, straight, perfectly sound and free from cracks and flaws. The external and internal surfaces of the pipe shall be smooth and hard. Wall thickness of the pipes shall be 25mm, 30mm, 35mm & 100 mm for 250mm, 300mm, 450mm & 1000 mm diameter pipes respectively.


The pipes shall be laid across the road, pathways and similar locations for drainage purposes as per the drawing and instructions of the Site Engineer. Two adjoining pipes shall be butted against each other and adjusted in correct position. The collar shall be slipped over the joint, covering both pipes equally. The annular space shall be filled with a stiff mixture of cement mortar 1:2 (1 cement: 2 Fine sand).

Earthwork in excavation & back filling shall be done in manner as specified under relevant item covering earth work in excavation & back filling. No separate payment shall be made for excavation & backfilling.

## 8.0 OPEN SURFACE DRAINS

Open surface drains shall be constructed as per drawing. The earth work in excavation shall be carried out to the exact dimensions as shown in the drawings and described in schedule of Rates. Proper longitudinal slope shall be maintained as specified in the drawing or as directed by Site Engineer.

Specifications relating to earth work in excavation, filling, plain and reinforced concrete, brick work, plastering etc. shall conform to the specification described in relevant items herein before.

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## 9.0 STONE WARE GULLY TRAP

Gully trap shall conform to IS: 651-1965. These shall be sound, free from visible defects such as fire cracks or hair cracks. The glaze of the traps shall be free from crazing. They shall give a sharp clear ringing sound when struck with light hammer. There shall be no broken blister.

Each gully trap shall have one C.I. grating of square size corresponding to the dimensions of inlet of gully trap. It will also have water tight. C.I. cover with inside frame dimensions of 300 x 300 mm, the cover weighing not less than 4.52 k g. and the frame not less than 2.72 kg. The grating, cover and frame shall be sound and of good casting and shall have truly square machined seating faces.

Each gully trap shall be fixed on cement concrete foundation of 68 cm. Square, inside the excavated pit done true to level as per drawing or as directed by Site Engineer. The mix of the concrete will be 1:4:8 (1 cement: 4 fine sand : 8 Graded stone aggregate 40 mm nominal size). Joining of gully outlet to the branch drain shall be done as per clause 34.1.3 stated herein before.

After fixing and testing gully and branch drain, a brick masonry chamber 300 x 300 mm (inside) in brick work in cement mortar 1:4 (1 cement : 4 fine sand) shall be built with a 10 cm brick and round the gully trap from the bed of concrete upto ground level. The space between chamber wall and trap shall be filled in with cement concrete 1:4:8 (1 cement: 4 fine sand: 8 graded stone aggregate 40 mm nominal size). The upper portion of the chamber i.e. above the top level of the trap shall be plastered inside with Cement mortar 1:3 (1 cement: 3 coarse sand) finishing with a floating coat of neat cement.

## 10.0 LAYING OF RCC PIPES FOR SEWER SYSTEM

The pipes shall be centrifugal cast concrete pipes, socket and spigot type, with reinforcement and shall conform to IS: 458. Manufacturers Test Certificates of the procured pipes shall be submitted to Engineer-in-Charge based on which the pipes will be accepted. Engineer-in Charge may ask for additional testing of pipes, if required. The class of pipes shall be as specified on drawings.


The pipes should well defined surfaces and edges and their ends shall be perpendicular to longitudinal axis. The pipes shall be laid across the road, pathways and similar locations for drainage purposes as per the drawing and instructions of the Site Engineer. Two adjoining pipes shall be butted against each other and adjusted in correct position. The collar shall be slipped over the joint, covering both pipes equally. The annular space shall be filled with a stiff mixture of cement mortar 1:2 (1 cement: 2 Fine sand).

Earthwork in excavation & back filling shall be done in manner as specified under relevant item covering earth work in excavation & back filling. No separate payment shall be made for excavation & backfilling.

The pipeline shall be tested for water tightness of joints. The test shall be carried out from manhole. Pipe ends shall be closed and filled with water so that water level is up to the top of the manholes. The line shall be kept full for 24 hours. Observations shall be taken at one hour interval and if leakage is within 2.5 liters/km/hr/cm of diameter of pipeline, it shall be deemed to have passed the test. In case joints are found to leak, they shall be repaired or redone and test shall be repeated until the joints are approved by Engineer-in-Charge.

## 11.0 PLUMBING AND BUILDING DRAINAGE

H.C.I. NAHNI TRAP (FLOOR TRAP): Nahni trap shall be of heavy cast iron as per IS: 3989 with 100mm inlet and 80/ 100mm outlet with CP pressed steel grating. It shall be of self cleaning design.

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Grating shall be of either hinged or screwed down type. Nahni trap shall be fixed in cement mortar 1:2 as directed by Engineer-in-Charge.

VALVE CHAMBER, INSPECTION CHAMBER & MANHOLES: The size and type of construction of valve chamber, inspection chamber and manholes shall be as specified in the drawings or items.

C.I. SOIL / WASTE PIPES: CI pipes shall be socket and spigot of standard quality conforming to IS: 1729. The supply shall include all necessary accessories e.g. bends, Y Junction, T- Junction, including plugs, shoes, cowls etc. complete. CI soil / waste pipe below ground or floor shall be encased with 50mm thick PCC M20 Grade concrete.

The spigot of the pipe shall be placed fully resting inside the socket and hemp caulked home to leave space for lead depth as specified. Lead conforming to IS: 782 in molten state shall then be poured into the joint filling the same in one pouring. The lead shall be caulked by proper tools to make it even all round. Depths of lead in the joints from the top of the socket shall be 37mm for 150mm dia. pipes, 25mm for 100 mm and 50mm diameter pipes. All pipes shall be fixed 25mm clear of the wall with MS bat clamps or as approved by the Engineer –in Charge. All holes in walls and floors shall be made good by cement concrete M-15 grade and should be leak proof. All soil and waste pipes shall be tested for leakage by hydraulic test.

All CI pipes shall be painted with two coats of paint of approved make and shade over a coat of primer. Earthwork in excavation, backfilling and removal of surplus earth/ debris shall be considered as a part of the work. No separate payment shall be made for the same.

M.S. RUNGS/ C.I. STEPS: The rungs for pits, manholes and septic tanks etc. shall be made out of M.S. bars conforming to Indian Standard and to the shape and size as shown in drawings. CI steps for manholes, if needed shall be as per IS: 5455. M.S. rungs shall be coated with 2 coats of approved bituminous paint.



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**TECHNICAL SPECIFICATION  
FOR  
ROOF TREATMENT & FLOOR TREATMENT (ANTI-TERMITE)**

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## 1.0 WATER PROOFING

### 1 Water Proofing with Synthetic Felt

- 1.1 The surface to be treated shall have a minimum slope of 1 in 120 or as directed by Site Engineer. Grading shall be carried out with PCC 1:2:4 with 10 mm down aggregate to 40 mm average thickness and finished smooth. Such grading shall be paid separately under appropriate relevant item.
- 1.2 Junction between the roof and vertical face of parapet wall etc. shall be cased by running triangular fillets (gola) 75x75 mm size in PCC 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) admixed with 2% integral water proofing compound (by weight of cement) of approved make conforming to IS: 2645. At the drain mouths the fillets shall be suitably cut back and rounded off for easy application of water proofing treatment and easy flow of water. The fillets shall be measured or paid separately under appropriate relevant item.
- 1.3 For carrying over and tucking in the water proofing felts/ membranes into parapet wall etc. a horizontal groove 65 mm deep and 75 mm wide with its lower edge not less than 150 mm above the graded roof surface shall be left on the inner face of the same during construction if possible. When such groove has not been left, the same shall be cut out neatly. The base and rear of the groove shall be finished smooth with cement mortar 1:4 (1 cement: 4 coarse sand). Such cutting of groove and its finishing smooth shall be deemed to be part of the water proofing item and shall not be measured or paid separately. No deduction shall be made either, for making the groove when the later has already been left in masonry.
- 1.4 Tucking in of the water proofing felt/ membrane will be required where parapet wall exceed 45 cm in height from graded surface. Where the height is 45 cm or less, no groove will be required as the water proofing treatment will be carried over the top of the parapet wall to its full thickness. Edges of the felt or membrane shall be sealed with approved sealant. Such treatment shall not be measured or paid for separately.
- 1.5 The graded surface of the roof and concrete fillets and face of walls etc. shall be thoroughly cleaned with wire brushes & all loose scale etc. removed. The cracked surface shall be cut to 'V' Section, cleaned and filled up flush with cement mortar slurry 1:4 (1 cement : 4 coarse sand). Such cleaning of the surface or treating the crack shall not be paid for separately.
- 1.6 After grouting the crack, if any, with Cement grout, the primer (first layer of roof treatment) shall be brushed over the cleaned and dried surface before the bonding material is applied. The primer conforming to IS: 3384-1986 shall be applied at minimum rate of 0.30 litre/sqm.
- 1.7 The second layer shall consist of straight run bitumen conforming to IS: 73-1961 @ 0.70

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Kg/sqm applied hot (not less than 50 deg. c) as per IS: 7290-1979. The fourth layer shall consist of cold cut back bitumen @ 1 kg/sqm over felt film as per IS:7290. The fifth and final course shall consist of coarse sand @ 0.75 Kg/sqm over bitumen and subsequent preparation of the surface.

- 1.8 The self-finished synthetic felts to be used shall of approved make and shall conform to IS: 7941 (latest edition). It shall have 3 layers of LDPE/HDPE and 1 layer of 2 mm foam insulation. It shall be waterproof, acid resistant and fire resistant.
- 1.9 The felt film forming the 3rd course shall be cut to the required length, brushed clean of dust materials and laid out flat to eliminate cut, and subsequent stitching. The felt shall not be laid in single piece of very long length as they are likely to shrink. Length of 6 to 8 metres is suitable. Each strip shall have overlap of 7.5 cm, with the adjacent strip duly bonded with cold cut back adhesive @ 0.35 kg/sqm. All the overlaps shall be levelled and pressed down to level the unevenness. The felt shall be carried over up to the adjacent parapet wall as per clause 1.3 & 1.4 anchored thereto with cement grout by inserting the felt in the groove on the wall. Chase cutting on the wall for making grooves and anchoring grout shall be done by the Contractor without any extra cost to the owner.

## 2.0 Water Proofing with Atactic Poly Propylene (APP) Membrane

- 2.1 The roof grading shall be carried out as per clause nos.1.1 to 1.5 under above specifications for Water Proofing with Synthetic Felt.
- 2.2 After grouting the crack, if any, with cement grout, bitumen primer (first layer of roof treatment) shall be applied at minimum rate of 0.40 litre/sqm over the cleaned and dried surface before the bonding material is applied.
- 2.3 The second and fourth layer shall consist of blown type bitumen of grade 85/25 conforming to IS: 702 (latest edition) @ 1.20 Kg/sqm.
- 2.4 The third layer shall consist of Atactic Poly Propylene (APP) modified polymeric Membrane of approved make, 2.0 mm thick of 3.0 kg/sqm weight consisting of five layers, prefabricated with centre core as 100 micron HMHDPE film sandwiched on both sides with polymeric mix, protected on both side with 20 micron HMHDPE film. The membrane shall be waterproof, acid resistant and fire resistant.
- 2.5 The APP membrane shall be cut to the required length, brushed clean of dust materials and laid out flat to eliminate cut, and subsequent stitching. Each strip of the membrane shall have overlap of 100 mm with the adjacent strip, bonded with cold appropriate splice adhesive. All the overlaps shall be levelled and pressed down to level the unevenness. The membrane shall be carried over up to the adjacent parapet wall as per clause 1.3 & 1.4, anchored thereto with cement grout by inserting the membrane in the groove on the wall. Chase cutting on the wall for making grooves and anchoring grout shall be done by the Contractor without any extra cost to the owner. 2.0.6 The fifth/ top most layer shall be of 20 mm thick precast cement concrete tiles of mix 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregates 12.5mm nominal thickness), which shall be grouted with cement mortar 1:3 (1 cement: 3 fine sand) mixed with 2% integral water proofing compound by weight of

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cement and laid over 12 mm layer of cement mortar 1:3 (1 cement: 3 fine sand). The top surface of the tiles shall be finished neat. The tiles shall be measured or paid separately under appropriate relevant item.

### 3.0 Brickbat Coba Chemical/ Acrylic Based Water Proofing


- 3.1 Integral cement based roof treatment/ waterproofing-cum-terracing of average 120mm thickness including preparation of surface as required for treatment of roofs, balconies, terraces etc. shall be carried out as follows:
- 3.2 The preparation of the base surface shall be done by thorough cleaning of roof surface with a wire brush and all foreign matter etc. shall be removed. Well defined cracks on the surface shall be cut to "V" section, cleaned and filled up with a paste of one or two component Polyurethane based crack filling compound and white cement in a ratio of 1:2. A layer of chicken wiremesh shall be placed.
- 3.3 A coat of neat cement slurry using 2.75 kg/sqm of cement admixed with proprietary water proofing compound confirming to IS: 2645 shall be applied over the RCC slab.
- 3.4 Laying cement concrete using broken/ brick bats 25mm to 100mm size with 50% of cement mortar 1:5 (1cement: 5 coarse sand) admixed with proprietary water proofing compound confirming to IS: 2645 over 20mm thick layer of cement mortar of mix 1:5 (1 cement: 5 coarse sand) admixed with proprietary water proofing compound confirming to IS: 2645 to required slope and treating similarly the adjoining walls upto 300mm height including rounding of junctions of walls and slabs.
- 3.5 After two days of proper curing applying a second coat of cement slurry admixed with proprietary water proofing compound confirming to IS: 2645.
- 3.6 Finishing the surface with broken china (glazed) laid joint less with cement mortar of mix 1:4 (1cement: 4 coarse sand) admixed with proprietary water proofing compound confirming to IS: 2645 and finally finishing the surface with trowel.
- 3.7 The whole terrace so finished shall be flooded with water for a minimum period of two weeks for curing and for final test. All above operations to be done in order as directed and specified by the Engineer-in-charge.
- 3.8 A Guarantee of minimum 10 years shall be provided against the performance of the finished waterproofing system.

### 4.0 ANTI TERMITE TREATMENT

- 4.1 Anti-termite treatment shall be carried out as per I.S. 6313 (Part II - 1981) and as mentioned herein below:

#### 1.1 Materials

Any one of the following chemicals (as specified) in water emulsion shall be used.

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Name of Chemical Concentration	(Percent) by Volume
Chloropyrifos Emulsifiable concentrate(IS: 8944)	1.0

Chemicals are available in concentrated form in the market and concentration is indicated on the sealed containers. To achieve the percentage of concentration specified above, chemical should be diluted with water in required quantity before it is used. Graduated containers shall be used for dilution of chemical with water in the required proportion to achieve the desired percentage of concentration.

- 1.2 **Example:** To dilute chemical of 30 percent concentration, add 59 parts of water to one part of chemical to achieve 0.5 percent concentration. Chemicals shall be brought to site of work in sealed original containers. The material shall be brought in at a time, in adequate quantity to suffice for the whole or at least a fortnight's work. The material shall be kept in the joint custody of the contractor and the Engineer-in-Charge. The empties shall not be removed from the site of work, till the relevant item of work has been completed and permission obtained from the Engineer-in-Charge.

### 1.3 Pre-construction chemical treatment

This is a process in which chemical treatment is applied to a building in the early stages of its construction. Hand operated pressure pump shall be used for uniform spraying of the chemical. To have proper check for uniform spraying of chemical, graduated containers shall be used. Proper check shall be kept that the specified quantity of chemical is used for the required area during the operation.

### 1.4 Time of Application


Soil treatment should start when foundation trenches and pits are ready to take mass concrete foundations. Laying of mass concrete should start when the chemical emulsion has been absorbed by the soil and the surface is quite dry. Treatment should not be carried out when it is raining or soil is wet with rain or sub-soil water. The foregoing applies also in the case of treatment to the filled earth surface within the plinth before laying the subgrade for the floor.

### 1.5 Disturbance

The treated soil barriers shall not be disturbed after they are formed. If by chance, treated soil barriers are disturbed, immediate steps shall be taken to restore the continuity and completeness of the barrier system.

### 1.6 Treatment for Masonry foundations & Basements

- a) The bottom surface and the sides (upto a height of about 300 mm) of the excavations made for masonry foundations & basements shall be treated with the chemical at the rate of 5 litres per sqm of the surface area as shown in the drawing.

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- b) After the masonry foundations and the retaining walls of the basement come up, the backfill in immediate contact with the foundation structure shall be treated at the rate of 7.5 litre per sq.m. of the vertical surface of the sub-structure for each side. If water is used for ramming the earth fill, the chemical treatment shall be carried out after the ramming operation is done by rodding the earth at 150 mm centres close to the wall surface and spraying the chemical with the above dosage. The earth is usually returned in layers and the treatment shall be carried out in similar stages. The chemical emulsion shall be directed towards the concrete or masonry surfaces of the columns and walls so that the earth in contact with these surfaces is well treated with the chemicals as per drawing.

### 1.7 Treatment for RCC Foundation and Basements

In the case of RCC framed structures with columns and Plinth beams and R.C.C. basements the concrete mix is rich and dense (being 1:2:4 or richer), it is unnecessary to start the treatment from the bottom of excavations for columns and plinth beams. The treatment shall start at the depth of 500 mm below finished ground level. From this depth the back-fill around the columns, beams and R.C.C. basement walls shall be treated at the rate of 7.5 litres/Sqm of the vertical surface. The other details of treatment shall be as laid down in clause (b) above complete as per drawing.

### 1.8 Treatment of Top Surface of Plinth filling

The top surface of the filled earth within plinth walls shall be treated with chemical emulsion at the rate of 5 litres per sqm of the surface before the sand/subgrade is laid. Holes upto 50 to 75 mm deep at 150 mm centres both ways shall be made with crow bars on the surface to facilitate saturation of the soil with chemical emulsion.

### 1.9 Treatment of Junction of Wall and the Floor


To achieve continuity of the vertical chemical barrier on inner wall surfaces from the ground level, small channel 30x30 mm shall be made at all the junctions of wall and columns with the floor (before laying the subgrade) and rod holes made in the channel upto ground level 150 mm apart and the chemical emulsion poured along the channel @ 7.5 litres/sqm of the vertical wall or column surface so as to soak the soil right to bottom. The soil shall be tamped back into place after this operation.

### 1.10 Treatment of soil along external perimeter of building

After the building is complete, provide holes in the soil with iron rods along the external perimeter of the buildings at intervals of about 150 mm and depth 300 mm and filling these holes with chemical emulsion at the rate of 7.5 litres per square metre of vertical surfaces.


### 1.11 Safety precautions

All chemicals used for anti-termite treatment are poisonous and hazardous to health. These chemicals can have an adverse effect on health when absorbed through the skin, inhaled as vapours or spray mists or swallowed. Person using or handling these chemicals should be

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warned of these dangers and advised that absorption through the skin is the most likely source of accidental poisoning. They should be cautioned to observe carefully the safety precautions given below:

- 1.12 These chemicals are usually brought to site in the form of emulsifiable concentrates. The containers should be clearly labelled and should be stored carefully so that children and pets cannot get at them. They should be kept securely closed.
- 1.13 Particularly, care should be taken to prevent skin contact with the concentrates. Prolonged exposure to dilute emulsions should also be avoided. Workers should wear clean clothing and should wash thoroughly with soap and water, especially before eating and smoking. In the event of severe contamination, clothing should be removed at once and the skin washed with soap and water. If chemical splash into the eyes, they shall be flushed with plenty of soap and water and immediate medical attention should be sought.
- 1.14 The concentrates are oil solutions and present a fire hazard owing to the use of petroleum solvents. Flames should not be allowed during mixing.
- 1.15 Care should be taken in the application of chemicals to see that they are not allowed to contaminate wells or springs which serve as sources of drinking water.
- 1.16 A guarantee of minimum 10 years for effectiveness of treatment must be furnished by the Contractor.

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## SEWER DRAINAGE SYSTEM

### 1.0 SCOPE

The specification is intended to establish and define the materials and constructional requirements for sewer drainage system. All materials, fixtures and workmanship shall be in accordance with the relevant IS Codes and good Engineering practices.

### 2.0 REFERENCE DOCUMENTS

IS 456	Code of practice for plain and reinforced concrete
IS 458	Specification for Pre-cast Concrete pipes
IS-1363	Galvanized mild steel hexagonal head bolts and nuts
IS-1536 & 1537	Materials and Laying of cast iron piping & fittings
IS-1538 & 3989	
IS 1742	Code of Practice for Building Drainage
IS 2720 (All parts)	Method of test for soils
IS-3006	Stoneware pipe
IS-8008	HDPE pipe moulded fittings
IS-8360	HDPE fabricated fittings

In the event of conflict between various codes and standards, the most stringent condition will apply.

Unless specified otherwise the International System of metric units (S.I.) is to be used.

### 3.0 GENERAL

In accordance with the requirements of this specification, the contractor shall submit the details specified in the following paragraphs regarding the materials covered by this specification.

### 4.0 DRAINS/SEWER

#### 4.1 GENERAL

Drains and / or sewers shall be laid to the alignment and grades as shown on the drawings, subject to any modifications done from time to time to meet the requirements of the works.

No deviations from the lines, depths of cuttings, gradient of drains or sewers shall be permitted except on the specific permission from the Owner / Consultant.

Before commencement of work, accurate surveys and levels of the grade shall be recorded.

The excavation and filling as required on this grade for the purpose of laying drainage shall be measured on the basis of such records. The levels and surveys shall be related on the benchmarks and reference points decided by the Owner/Owner's Representative. Any instruments and technical assistance by way of manpower, required for such surveys and levels shall be made available whenever required. The materials required for preparation of benchmarks, pegs, pillars shall be furnished by the Contractor.

#### 4.2 SETTING OUT DRAINAGE

Setting out of drainage shall conform to approved drainage plan/scheme and shall be set out with the aid of suitable bearing rods and site rails at intervals not more than 15 meters. Necessary materials for bearing rods and site rails and the instruments required for setting out and fixing such demarcations and reference points shall be provided by the contractor when checking is undertaken.

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All site rails and posts shall be of well-seasoned timber and such sizes as would be required for proper stability. The wooden members used for such purposes shall be planed and no warped or defective material may be used. The posts shall be kept sufficiently away from the edge of trenches and shall be properly embedded in concrete. Site rails shall be fixed to these posts by any approved means so that the same do not get disturbed. The centre lines shall be accurately marked on the site rails either by saw cut or paint marks.

At any time, at least 4 site rails shall be kept at correct level, and alignment along the centre line of drainage lines. Any additional site rails wherever required shall be provided as directed. Checking of levels and other marks on the site rails shall be done at least once a day.

The number of site rails and posts, their tiers material, mode of securing site rails to posts, tiers, sizes of timber to be used for site rails and bearing rods shall be approved by the Owner/Owner's Representative prior to use.

### 4.3 EXCAVATION

The excavation for drainage lines shall be open-cut unless otherwise necessary. The excavated soil shall be stacked at locations approved by the Owner / Consultants, and shall be removed beyond specified lead and brought back for back-fill whenever necessary. Necessary traffic diversions, barriers on the trenches, danger signals, watch and ward shall be provided by the contractor at his own cost.

The excavation carried out shall not be more than 20 meters or the distance between 2 successive Manholes, whichever is less. The least distance to which the trench to be excavated to full depth shall be five meters at a time.

It will be the responsibility of the contractor to clean the site off the shrubs, grass, soil tree roots, stumps and other burdens. The excavated soil shall be sprinkled with water to avoid dust nuisance. The contractor shall utilise half the width of the roads if the drainage work is by the side and / or within the road so that no obstruction is created to usual traffic.

Wherever necessary, the excavation shall be done deeper than required and the depth so made shall be filled with concrete or any other approved material to required level. Such cases, however, shall be dealt with only when permitted by the Owner/Owner's Representative. The sides of excavation shall be supported effectively by means such as timbering, sheet piling, which shall be closely joined in all loose or sandy strata and below sub-soil water level.

Any such temporary supports shall be removed when work is completed unless otherwise specifically called out. In soft or waterlogged areas, timbering shall be done with tongue and groove joint and shall be close driven to such depths below bed levels as ordered by the Owner/Owner's Representative. The timbering shall be done out of adequate section of wooden members, and shall be fully braced and strutted to avoid any falls, side slips, subsidence and all cavities shall be solidly filled-in. The contractor shall be responsible for the sufficiency of all timbering, bracing, sheet piling, strutting, and for all damages to the property and surroundings due to improper quality, strengths, placement, stability of the existing foundations shall be done by the Contractor, wherever necessary at his own cost. The responsibility due to improper shoring shall rest with the contractor.

At all times, during the progress of works, the contractor shall keep the trenches and excavated pits free of water which shall be drained in the most harmless manner. The contractor shall provide all the materials, plant, labour, fuel and other necessities for dewatering of trenches in the manner best suited to the particular condition. Any damages to surrounding structures and / or foundations due to improper dewatering shall be to the Contractor's account.

In addition to the necessities of proper excavation described above, all necessary precautions for the safety of persons and structures shall be taken by the contractor.

### 4.4 BACK-FILL, CONSOLIDATION & REMOVAL OF SURPLUS EARTH

After the drainage lines are constructed and tested, as per requirements, the trenches shall be backfilled in such a manner that it would avoid damages to the line laid. The back-filling shall be

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done in layers of 150 mm thick approved borrow pit earth / sand / murrum and shall be properly watered and compacted to 95% of Procter Density.

The strutting and timbering shall be removed gradually to avoid side collapses.

#### 4.5 LAYING & JOINTING OF RCC PIPES FOR DRAINS

Materials shall conform to relevant Indian Standards. Materials shall be approved by Owner / Consultants prior to placement of the same. RCC pipes shall conform to IS 458.

Pipes shall be laid on concrete bed or cradles, if necessary. Pipes shall be lowered gradually in trenches without causing damage to trenches and bed concrete / cradles. Extra earth at joints shall be scooped out to accommodate the collar. Pipes shall be laid to required levels and alignments throughout the length. In case pipes are laid on cradles, the underside of pipes shall be grouted with cement slurry and clean fine sand to avoid gaps and foreign materials prior to placement of pipes. Cradles shall be cured sufficiently prior to lowering of pipes and any damages caused to the same while lowering pipes shall be made good by the contractor.

Joints shall be made by using Standard Collars which shall have rough surface inside to have proper grip. The jointing material shall be cement mortar in proportion 1:2. Prior to sealing of joints, the joints shall be caulked with tarred hemp. The joints shall be finished with cement paste laid at 45° angle to the length, and shall be finished all round the periphery of the pipe. The interior of the pipes shall be cleaned off prior to testing of the drainage lines. In case of pipe with socket and spigot, the joint should be made with rubber ring conforming to IS 5382.

The joints shall be sufficiently cured and the drains shall be tested under a head of at least 2 meters of water above the crown of pipes. A strong approved colour shall be added to the water for testing. The defective pipes shall be replaced by good ones. All defective joints shall be made good by cutting and redoing. The joints where leakage persists shall be encased in P.C.C. 1:2:4 at the cost of the contractor whenever permitted. The test for leakage shall be conducted at least for an hour after application of water head.

#### 5.0 MANHOLES AND CHAMBERS

Refer Specification for Plumbing & Building Drainage system

#### 5.1 BRICKWORK

Refer Specification for Masonry Work

#### 5.2 PLASTER

Refer Specification for Plastering Work

#### 5.3 COVER

Refer Specification for Plumbing & Building Drainage system

#### 6.0 STONEWARE PIPES

#### 6.1 MATERIALS

The materials shall conform to IS-3006. They shall be of best quality stoneware, salt glazed, thoroughly burnt through the whole length and thickness, free from air-holes, fire blisters, cracks and other blemishes. They shall be of close and even texture. The manufacturer of the same shall be approved by the Owner/Owner's Representative prior to the procurement of these pipes. The pipe shall be stacked at approved locations and protected against all damage. All the pipes shall be close fitted and shall be tested before lowering them into trenches. Barrels, spigots and sockets shall be cleaned, scraped and brushed.

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## 6.2 LAYING

The pipes shall be carefully and gradually lowered into the trenches and shall be laid to correct line level, and to the gradient as shown on the drawings.

The laying shall generally conform to IS-1742. Care shall be taken to prevent any foreign matter getting inside the pipes while lowering.

The pipe lines between the successive manholes shall be without any undulation horizontally and vertically. These pipes shall be laid, sockets facing up the gradient beginning at the lower end up and all sockets laid to levels in the holes or scoops out for the purposes. Each pipe shall be brought upto placement location, one at a time.

## 6.3 JOINTING

This shall be done generally as stated in IS: 1742. This shall be taken up only after the final alignment is made and gradients and inverts are checked by the Owner/Owner's Representative. A gasket of tarred hemp yarn shall be placed around the joint in the annular space between spigot and socket and the same shall be inserted by suitable tools and packed up properly. Additional strands of yarn shall be used if necessary. Such yarn shall be soaked in water prior to placement. Complete caulking operations with cement mortar in proportion 1:1 of cement to sand or as specified, shall be made in suitable quantities with wooden caulking tool to fill up the annular space completely and fully. On completion of sealing of the joints the same shall be struck off at 45 deg to the longitudinal axis of drain using same mortar and finishing the same by neat cement rendering. Whenever necessary, the pipes shall have PCC concrete bedding and / or concrete encasement.

Each joint shall be adequately cured by placing wet cloth or canvas wrapped around the joint and kept wet continuously for 3 days.

## 6.4 TESTING

Post curing the pipeline leakage test shall be carried out for the water head of 2 meters. The testing shall be deemed to be satisfactory if the water level does not fall by more than 12 mm in a length of approximately 90 meters of drain pipes within a period of one hour. Upon application of test head, all the joints shall be inspected for leakages which shall be repaired and the line retested in the similar manner.

After satisfactory tests of such line, the back-filling shall proceed in the similar manner described previously. For the back-filling prior permission shall be obtained from the Owner/Owner's Representative.

## 7.0 CAST IRON PIPES DRAINS

Materials and laying of pipes and fittings shall conform to IS: 1536, 1537, 1538, 3989. The pipes shall be embedded in concrete whenever necessary. The pipes shall be jointed either by cement mortar joints or by lead caulking or rubber ring as specified.

Other operations such as excavation, laying, testing and backfilling shall be as described in the preceding various paragraphs.

## 8.0 HDPE PIPE

HDPE pipes shall conform to IS 4984 with pressure rating of 6 kg / sq. cm. The HDPE pipe moulded fittings shall conform to IS 8008 and fabricated fittings to IS 8360. All fittings shall be fabricated at factory under ideal conditions. The pipe shall be embedded in PCC or sand wherever necessary. Hexagonal head bolts and nuts shall be of galvanized mild steel conforming to IS 1363. The pipe shall be jointed by heated tool welding (with mirror) or hot gas welding (with torch and filler rod) or electro fusion. Hydrotesting at 1.5 times the working

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pressure and spark testing at 20-25 kV shall be carried out. All butt joints of fittings shall have FRP mesh for at least 100 mm on both side of the butt joint.

Contractor shall provide casing pipe of suitable sizes under the road as sleeves. The casing Pipe shall withstand vehicular traffic load. The contractor shall pull or push the pipe through the sleeve, provide required extra field joints and provide jute or ou ter Face hemp packing throughout the circumference of the outer face of HDPE pipe and inner Face of the sleeve pipe. The specification of the pac king material shall be approved by the Owner/Owner 's Representative prior to execution of the job.

**9.0 ACCEPTANCE CRITERIA**

The SEWER & DRAI NAGE SYSTEM shall fulfill the above said crite ria unless otherwise mentioned.

**10.0 PAYMENT**

Payments shall be as per SOR basis.

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GAIL INDIA LIMITED

**TECHNICAL SPECIFICATION  
FOR  
DOORS, WINDOWS AND VENTILATOR**

**GAIL-STD-CV-DOC-TS-018**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
0	23.02.12	ISSUED FOR BID	SS	UN	SKK



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## DOORS, WINDOWS AND VENTILATOR

### 1.0 SCOPE

This Specification defines the requirements regarding materials, sizes, construction, workmanship, finishes and installation for doors, windows, ventilators and rolling shutters.

### 2.0 REFERENCE DOCUMENTS

IS 205	IS- Non-ferrous metal butt hinges
IS 287	IS- Permissible moisture content for timber used for different purposes.
IS 303	IS-Plywood for general purposes.
IS 513	IS-Cold-rolled low carbon steel sheets and strips
IS 710	IS-Marine plywood
IS 733	IS-Wrought Aluminum and Aluminum Alloy Bars, Rods and Sections for General Engineering Purposes.
IS 737	IS-Wrought aluminum and aluminum alloy sheet and strip for general engineering purposes.
IS 848	IS-Synthetic resin adhesives for plywood (phenolic and aminoplastic).
IS 851	IS-Synthetic resin adhesives for construction work (non-structural) in wood.
IS 1003	IS-Timber panelled and glazed shutters (Part 1 & 2)
IS 1038	IS-Steel doors, windows and ventilators
IS 1081	IS-Fixing and glazing of metal (steel and aluminum) doors, windows and ventilators.
IS 1141	IS-Seasoning of Timber – Code of practice
IS 1161	IS-Steel Tubes for Structural purposes
IS 1200	IS-Method of measurement of building and civil engineering works, Part 2: wood work and joinery
IS 1285	IS-Wrought aluminum and aluminum alloy extruded round tube and hollow sections (for general engineering purposes).
IS 1328	IS-Veneered decorative Plywood
IS 1341	IS-Steel butt hinges
IS 1351	IS-Steel door frames
IS 1361	IS-Steel Windows for Industrial Buildings
IS 1477	IS-Painting of ferrous metals in buildings (Part 1 & 2)
IS 1642	IS-Practice for fire safety of buildings (general): Details of construction
IS 1948	IS-Aluminum Doors, Windows and Ventilators
IS 1949	IS-Aluminum Windows for Industrial Buildings
IS 2191	IS-Wooden flush door shutters (Part 1 & 2)
IS 2202	IS-Wooden flush door shutters (Part 1 & 2)
IS 2338	IS-Finishing of wood and wood based materials (Part 1 & 2)
IS 2553	IS-Safety glass. part 1 - General purpose.
IS 2835	IS-Flat transparent sheet glass.
IS 3087	IS-Wood particle boards (medium density) for general purposes.
IS 3097	IS-Veneered particle boards.
IS 3548	IS-Glazing in buildings.
IS 3614	IS-Fire check Doors (Parts 1 & 2)
IS 4020	IS-Door shutters, method of tests, Parts 1 to 17.
IS 4021	IS-Timber door window and ventilator frames- Specifications.
IS 4043	IS-Recommendations for symbolic designations of Direction of Closing and faces of Doors, Windows and Shutters
IS 4218	IS-ISO Metric Screw Threads (Parts 1 to 6)
IS 4351	IS- Steel Door Frames
IS 4454	IS-Steel wires for cold formed springs

IS 4537	IS-Figured, rolled and wired glass.
IS 4835	IS-Polyvinyl acetate dispersion based adhesives for wood
IS 4913	IS-Selection, Installation and Maintenance of timber doors and windows.
IS 5807	IS-Methods of tests for clear finishes for wooden furniture (Part 1 & 2)
IS 5986	IS-Hot rolled steel plates, sheets, strips and flats for flanging and forming operation
IS 6245	IS-Metal rolling shutters and rolling grills.
IS 6248	IS-Metal Rolling Shutters and Rolling Grills.
IS 7452	IS-Hot Rolled Steel Sections for Doors, Windows and Ventilators.
IS 12406	IS-Medium density fiber boards for general purposes.

In the event of conflict between various codes and standards, the most stringent condition will apply.

Unless specified otherwise the International System of metric units (S.I.) is to be used.

### 3.0 GENERAL

In accordance with the requirements of this specification, the contractor shall submit the details specified in the following paragraphs regarding the materials covered by this specification.

### 4.0 TIMBER DOORS, WINDOWS AND VENTILATORS

Refer specification for wood work.

### 5.0 SOLID CORE FLUSH DOOR SHUTTERS

#### 5.1 Core

This shall conform to IS: 2202 (Part I). It shall be made from block board consisting of pinewood strips placed end to end. The width of each strip shall not exceed 25 mm. The strips shall be placed side by side and glued together to form a slab which shall then be glued between two or more veneers. The direction of the grain of the core blocks shall be at right angles to that of the adjacent veneers.

#### 5.2 Plywood Surfacing

Commercial plywood or decorative plywood conforming to IS 303 and Grade I of IS 1328 respectively shall be used. Wherever mentioned, marine grade ply conforming to IS 710 shall be used.

#### Frame

This will be provided for holding the core. The width of the frame including lipping shall be 50 to 100 mm wide.

#### Gluing


Only phenol formaldehyde resin glue shall be used.

#### Vision Panel/Venetians

These shall be provided where specified on the drawings.

#### Hardware

Minimum hardware and fixtures shall be provided as per Table 1. Additional hardware shall be as per drawings.

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## 6.0 STEEL DOORS, WINDOWS AND VENTILATORS

Steel Doors, Windows and Ventilators shall conform to IS 1038, IS 1361, IS 1081 and IS 4351 and shall be as per drawing issued by the EIC. The Contractor shall submit for the EIC's approval the shop drawing covering all dimensions, details of fabrication, construction and installation. After approval of shop drawing, the Contractor shall submit one or more samples of the fabricated item of each for the EIC's approval before mass fabrication. Engineer's comments if any shall be incorporated during mass fabrication.

### 6.1 Frames

#### Frames for Pressed Steel Door

Frames shall be manufactured out of 18 gauge (1.25 mm) Galvanized Steel Sheet. Each door frame shall have hinge jamb, lock jamb, head and, if specified in drawing angle threshold. The entire assembly shall be welded. Where threshold is not specified a temporary base tie shall be screwed to the feet of the frames. The base tie shall be out of 18 gauge MS pressed steel section adjusted within floor finish thickness. The frame shall have a brass lock strike plate with mortar guard. For single leaf door, there shall be a minimum of three rubber buffers fixed to the frame. The middle buffer shall be fixed on centre line of lock strike plate, and the other two 450 mm above and below the middle one. For double leaf door there shall be two rubber buffers in the head frame spaced 300 mm symmetrical about centerline of door, and two buffers in the rebate of the lock jambs.

#### Frames for Steel Windows and Ventilators

These shall conform to IS 1361 and shall be made from rolled sections to IS 7452. The steel shall conform to IS 2830 or IS 2831. The sections shall be cut and mitered. The corners of the frames shall be flash butt welded. The frames shall be square and flat. Neoprene or silicone seal weather strips shall be provided on the jambs.

### 6.2 Shutters

#### Pressed Steel Doors

These are made from 22 gauge (0.8mm) Galvanized Steel Sheets. These shall be provided on both sides of the shutter and reinforced by MS stiffener channels from inside. All four sides of the shutter shall have an MS channel as stiffener. The shutters shall be 45 mm thick unless specified differently on drg. Space between fully flush skin sheets shall be filled with core infill of honeycomb Kraft paper or polyurethane foam (PUF).


Vision panel and Venetians shall be provided, if specified, as indicated in the drawing. The vision panels shall preferably be of flush type – 2 nos, 5 mm thick each clear float glasses with spacer frame all around and desiccants in it. The fixtures shall be provided as specified in Table 2.

#### Windows and Ventilators

Sashes shall be square and flat. Sashes shall be constructed of sections which have been cut to the required length, mitered and welded at corners. All the corners shall be through right angles and welds shall be neatly cleaned off. Tee sections for glazing shall be tenoned and riveted into the frames and where they intersect, the vertical tee shall be broached and the horizontal tee threaded through it, and the intersection closed by hydraulic pressure.

### 6.3 Procedure for Fixing

Doors, Windows and Ventilators shall not be built in at the time the walls are constructed but shall be subsequently fixed into prepared openings, in accordance with IS 1081. Holes for fixing

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lugs are to be left or cut, and the doors and windows fixed after all the rough masonry and plaster work has been finished. The frames of units shall be set in the opening by using wooden wedges at the jambs, sill and head, and shall be plumbed in position. The lugs shall then be grouted into their holes with concrete (1:2:4).

When RCC members (beam or column) form the sides of the opening, rawl plugs shall be fixed in RCC and frames fixed to the members by 63 mm (2 ½”) x No. 10 galvanised wood screws. In the case of steel work openings a mild steel or hard wood fillet shall be provided around the frame to facilitate erection. The height of the unfinished opening shall depend on whether a threshold is required or not. While fixing the door, care shall be taken to see that at least 5 mm space is left between door shutter and finished floor.

#### **Tolerance**

The sizes of doors, windows and ventilators shall not vary by more than +1.5 mm than the size specified on drawings.

#### **Finish – Doors**

Frames and shutters shall be given a thermosetting polyester powder coating to 70 micron DFT or PU paint. Colour shades shall be as specified by architects on drawings.

#### **Finish – Windows & Ventilators**

After the fabrication of units all the steel surfaces shall be thoroughly cleaned free of rust, mill-scale, dirt, oil, etc. and two coats of red oxide zinc chromate primer shall be applied. Two coats of approved synthetic enamel shall be applied after installation of the door, window or ventilator.

### **7.0 ALUMINIUM DOORS, WINDOWS AND VENTILATORS**

Aluminium Doors, Windows and ventilators shall conform to IS:733, IS 1948, IS:1949, and IS:1081 shall be as per drawings issued by the Engineer. The contractor shall submit for EIC's approval the shop drawings covering all dimension details of fabrication, construction and installation. After approval of shop drawings the contractor shall submit one or more samples of the fabricated item of each type for the EIC's approval before mass fabrication.

#### **7.1 Material**

##### **Aluminium Alloy Extruded Sections**

Aluminium alloy used in the manufacture of doors, windows and ventilators shall conform to IS designation HE 9-WP of IS:733 or HV 9-WP of IS 1285. Aluminium Alloy AA 6063 of hardness T5 or T3 which has the following properties is also acceptable,

Density, kg/mm <sup>3</sup>	Modulus of Elasticity, Mpa	Ultimate Tensile Strength, Mpa	Coefficient of Linear Expansion, m/m.k	0.2% Proof Stress, Mpa
2.7 x 10-8	69 x 103	185	23 x 10-8	110

The sectional properties of extruded sections shall be as given in IS 733 or as manufactured by Jindal, Hindalco or Bhoruka. The section shall be uniform in appearance, free from die lines and handling marks.

##### **Glass panes**

Glass panes shall be annealed or float glass as specified in the drawing and shall weigh at least 7.5 kg / m<sup>2</sup>. Glass panes shall also be free from flaws, specks or bubbles. All panes shall have properly squared corners and straight edges. The sizes of glass panes for use shall be in accordance with Table I of IS: 1948.

Thickness of glazing to be used for various pane sizes shall be as follows:

**Size of Pane Thickness of glazing**

up to 1.2 sq.m 4 mm float glass

1.2 sq.m to 2.0 sq.m 5.5 mm float glass

above 2.0 sq.m 8 mm float glass

twin style entrance door 12 mm float glass

Heat strengthening or Toughening of glass wherever required shall be as indicated on drawings.

**Screws, Fasteners**

Screws and fasteners shall be of aluminium alloy or brass oxidised. Screw thread of machine screws used in the manufacture of aluminium doors, windows and ventilators shall conform to the requirement of IS: 4218.

For opaque portion of shutters panels can be of 12 mm thick marine ply clad on both sides with 24 gauge aluminium sheet.

**7.2 Standard sizes, tolerances and designation****Size**

Overall dimension of windows, doors, ventilators, shall be derived from masonry opening minus an allowance of 1.25 cm clearance on all sides for the purpose of fitting. However, type and overall sizes shall be in accordance with IS: 1948.

**Tolerances**

The sizes for doors, windows or ventilator frames shall not vary by more than  $\pm 1.5$  mm from overall size as specified in drawing.

**Designation**

Doors, windows and ventilators shall be designated by symbol denoting their width, type and height in succession as per IS: 1948.

**Sectional dimensions and weights**

Sectional dimensions and weights per unit length of the section shall conform to design drawing. However, uses of specific sections for specified units as per manufacturers' standard may be used with prior approval of Engineer.

**7.3 Fabrication****Frames**


Frames shall be square and flat, the corners of frame being fabricated to a true right angle. Both the fixed and opening frames shall be constructed of sections which have been cut to length, mitered and screwed at the corners.

**Shutters**

All hinges, pivots, etc. shall be provided and fabricated in accordance with provisions given in IS: 1948. However, reference standards and drawings are also to be read in conjunction with the IS code.

**7.4 Finishing**

The aluminum sections to be used shall be properly buffed, cleaned by using mild acids and water. Then the same shall be anodised to have average anodic film thickness of 25 microns. To prevent damage to metal surfaces, a protective tape shall be applied after manufacturing and same shall be removed at site only after completion of rough trades.

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## 7.5 Handling, Storage

The extruded section or the fabricated windows/doors shall be protected against abrasions, waterstains and any other damages caused by acids or alkaline chemicals.

Cold metal shall preferably be placed in a dry storage area avoiding contact between it and other metals. Use of wood face shelving racks is recommended. It shall also be kept away from caustics, nitrates, phosphates, acids and cement.

## 7.6 Installation

The fabricated and assembled windows or door units (without glazing) shall be installed in accordance with IS 1081 being fixed in masonry opening properly plastered and finished.

Straightness and diagonal dimensions of the opening shall not have tolerance more than  $\pm 2$  mm. Aluminium screws or bolts are to be used with teak wood block on the back of the sections to avoid dents and other mechanical damages during tightening of screws/bolts. All gaps between the aluminium section and the masonry surface must be sealed with gun grade polymer based sealant viz., silicone compound, polysulphide compound.

Cement mortar grout or cement mortar finishing of gaps after installation of aluminium units shall strictly be restricted to protect the surface treatments given to the aluminium like anodising, precoating, etc.

All glass panes shall be fixed only after major activities are over in the area. Glazing gaskets for doors and frames shall be EPDM elastomeric extrusions. All screws and miscellaneous fasteners shall be aluminium, stainless steel or zinc plated.

## 7.7 Hardware

Necessary hardware for aluminium doors and windows shall be compatible with the basic material and shall be provided along with the doors, windows and ventilators. Minimum hardware necessary to be provided shall be as specified in Table 3.

## 7.8 Drawings/Documents

Prior to fabrication, Contractor shall submit shop drawing indicating details of all members, sections and hardware for EIC's approval. All certificates against tests for anodizing and other physical properties of material shall be produced to the Engineer for acceptance.

## 8.0 METAL ROLLING SHUTTERS AND ROLLING GRILLS

Metal Rolling Shutters and Rolling Grills shall conform to IS: 6248, and shall be as per drawings issued by the Engineer. The Contractor shall submit for EIC's approval, the shop drawing covering all details of fabrication, construction and installation. After approval of shop drawing the Contractor shall submit one sample for approval before mass fabrication.

Rolling shutters shall be of following alternative types depending on the method of operation.

Sl.No.	Type	Clear Area of Shutter	Remarks
i.	Self Coiling or Pushing Pull Type	Up to 8 sq.m	Without ball bearing
		8 to 12 sq.m	With ball bearing
ii.	Gear Operated	12 to 25sq.m	With ball bearing. Operated by bevel gear box and crank handle
		25 to 35 sq.m	With ball bearing operated by chain wheel and hand chain
iii.	Electrically Operated type	35 to 50 sq.m	

## 8.1 Materials

### Cold Rolled Steel Strips

Cold Rolled Steel Strips used for rolling shutter lath sections shall conform to temper No. 5, Dead soft quality of IS 513.

### Mild Steel Sections

Mild Steel Sheets and Plates used for manufacturing the guide channels, brackets and lock plate shall be of hot rolled steel of thickness not less than 3.15 mm conforming to IS:5986. These shall be free from surface defects and the edges shall be cleanly sheared.

### Steel Pipe

Mild Steel Pipes used for the suspension shaft of the roller shall be heavy duty pipe suitable for mechanical purposes and shall conform to IS: 1161.

### Cast Iron Castings

Cast Iron Castings used for roller pulley wheels, U-clamps and bevel gears shall conform to Grade 15 of IS: 210. These shall be free of blow holes, surface defects such as cracks, burrs etc.

### Springs

The springs used in the roller for counter balancing the rolling shutter shall be made either from high tensile spring steel wire or flat spring steel strip.

The spring steel wire used for helical spring shall conform to Grade 2 of IS: 4454.

Flat spring steel strip used for spiral spring shall be from 0.8 to 1.0 percent carbon steel strip especially hardened and tempered.

### Aluminium Alloy Sheets

Aluminium Alloy Sheets used for curtains in case of rolling grills, shall conform to 52000 (NS4), 53000 (NS5) or 64430 (HS30) of IS: 737.

### Aluminium Alloy Extrusions

Aluminium Alloy Extrusion for the components of rolling shutters of aluminium shall conform to 53000 (NE5) or 64430 (HE30) of IS: 733.

## 8.2 Fabrication

### Curtain

This shall be built up from interlocking lath sections. The lath sections shall be from 18 gauge (1.25 mm) section for curtains up to 9 meters in width. Curtain above 9 meters in width should be divided in two parts with provision of one middle fixed or movable guide channel or supported from the back to resist wind pressure. The lath section shall be rolled so as to have interlocking curls at both edges and a deep corrugation at the centre with a bridge depth of 16 mm to provide sufficient curtain stiffness for resisting manual pressure and normal wind pressure. Each lath section shall be continuous single piece without any welded joint. When interlocked, the lath section shall have a distance of 75 mm between rolling centres. Each alternate lath section shall be fitted with a malleable cast iron or mild steel clips securely riveted at either end, thus locking the lath section at both ends and preventing lateral movement of the individual lath sections. The clips shall be so designed as to fit the contour of the lath sections.

### Lock Plate

The Lock Plate provided at the bottom of the shutter, shall be composed of a mild steel plate 3.15 mm thick, reinforced with mild steel angle 35 x 35 x 5 mm at bottom of the plate. The lock

plate shall be fitted with sliding bolts at either end to engage with suitable receiving pockets at the bottom of the guide channel. The sliding bolts shall be capable of being locked by means of padlocks both from outside and inside. The lock plate shall also be provided with pulling handles, one handle for 2.5 m width and 2 handles for widths above 2.5 m. Pulling handles shall be fixed on both inside and outside faces of the lock plate.

### Guide Channels

These shall be of mild steel deep channel section of rolled, pressed or built up (fabricated) construction. The thickness of the sheet used shall not be less than 3.15 mm. The depth of the guide should be such that there is sufficient clearance between curtain and inner surface of guide. The curtain shall project into the guide at least 40 mm for shutters up to 3.5 m width and 60 mm for greater widths. There shall be a clearance of 10 mm between guide wall and the end clips of the curtain.

Where the shutter is installed in heavy windy zones, special wind locking arrangements shall be provided to prevent the curtain coming out of the guide. The clear gap on either side of the curtain and inner faces of the guide channel shall be 5 mm. The depth and width of the guide channel shall be as follows:

Clear Width of Shutter	Depth of Guide Channel (minimum)
Up to 3.5 M	65 mm
3.5 to 8.0 M	75 mm
8.0 m and above	100 mm

Width of Guide Channel shall be 25 mm for lath sections with bridge depth of about 12 mm and 32 mm for lath sections with bridge depth of 16 mm.

### Fixing Cleats

Each guide shall have a minimum of 3 fixing cleats. The spacing of cleats shall not exceed 0.75 m. Alternatively, the guide channels may also be provided with suitable dowels hooks or pins for embedding in the walls. The guide channel shall be attached to the wall plumb and true.

### Bracket Plate

This shall be fabricated out of mild steel plate of 3.15 mm thick. Thicker plates may be used depending upon the height of the shutter. Dimensions shall be as given in IS: 6248. The bracket plate may be square, circular or hexagonal with a U-shaped cast iron or mild steel clamp riveted or welded to it at the centre. The bracket plate should have sufficient cross sectional area to resist the shear arising out of the weight of the curtain, suspension shaft etc. and shall be held rigidly by suitable foundation bolts.

### Roller

The suspension shaft of the roller shall be made of steel pipe conforming to heavy duty of IS: 1161. The diameter shall be sufficient to limit deflection of shaft under the weight of the rolling shutter. The deflection of the shaft shall not exceed 5 mm per meter width of the shutter. Diameters of the steel pipe for various widths up to 6 m and height 5 m shall be as per IS:6248. Sizing of pipe diameter for greater widths and heights shall be designed giving due consideration for deflection limit mentioned above. The pipes of the suspension shaft which are clamped to the brackets shall be fitted with rotatable cast iron pulleys to which the curtain is attached. The pulleys and the pipe shaft shall be connected by means of pretensioned helical springs to counterbalance the weight of the curtain and to keep the shutter in equilibrium in any partly opened position.

**Hood Covers**

These shall be made of mild steel sheets not less than 0.9 mm thick, and shall be hexagonal, square or circular contour depending on the contour of the bracket plate. The hood cover shall be stiffened with angle or flat stiffeners at top and bottom edges to retain shape. The hood cover shall be fixed to the bracket plate by means of angle cleats. The hood cover shall also be supported all along the top at suitable intervals to prevent sagging.

**Gears, Worms etc**

These shall be machine cut. Worm gear wheels shall be of high grade cast iron or mild steel or phosphor bronze. The worms shall be of mild steel or gun metal or phosphor bronze.

**Security Devices**

For shutter widths exceeding 2.5 m, any one or both of the following security devices may be provided. Anchoring Rods as described in IS: 6248. These shall be provided at the rate of one per extra 2.5 m width or part thereof above a clear width of 2.5 m.

**Central Hasp and Staple**

This shall be provided at the centre of the bottom lock plate. The hasp shall be embedded in the floor at the centre. The staple shall be fitted at the centre of the bottom lock plate outside in an accurate position so that the hasp may properly engage with staple when the shutter is in a closed position. The hasp shall be embedded within the floor so as not to cause any obstruction. Normally one central hasp and outside staple will be sufficient for any width of shutter.

**8.3 Optional Features****Intermediate Posts or Mullions**

These shall be either of fixed, sliding or removable type, and are used for unusually wide openings or for providing multiple door entries. The mullion also forms the guide channels between the various sections of the rolling shutter. The sliding mullion may also be winch operated for large sizes. The fixing of the intermediate post shall be plumb and true when in position before closing the rolling shutter.


**Wicket Door**

Large rolling shutter fixed at the main entrance of mills and factories may also be provided with a subsidiary door known as wicket door. This is a hinged service door allowing pedestrian traffic without the need of rolling up the shutter. The wicket door size shall be 600 x 1200 mm for ordinary use and 900 x 1800 mm for large installations. Sizes larger than these are not recommended as these cause difficulties in installation and operation. The wicket door shall be of good robust construction and shall be fitted with a good lever lock operated by key and lockable from both inside and outside. The wicket door shall be erected in such a way so as not to foul with the main rolling shutter when opening or closing. The wicket door shall be swung clear of the opening before the Rolling Shutter is raised.

**Galvanising**

All components of the rolling shutter may be hot dip galvanized with a zinc coating containing not less than 97.5% pure zinc. The weight of the zinc coating shall be not less than 230 g/sq. m and the coating shall be free from flaking or peeling.

**8.4 Operation****Push Pull Type**

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Push Pull Type shall be operated manually by pulling hooks with appropriate pulling handles in the lock plate. The length of the pulling handle shall be sufficient to push the lock plate up to the top most position.

#### **Gear Operated Type**

These shall be operated by two types of arrangement:

- i. by bevel gear box and crank handle
- ii. by chain wheel and hand chain.

The height of the bevel gear box or the bottom of the hand chain shall be 0.85 m from floor. If specified on drawing, the crank handle operation or hand chain operation shall be provided on both sides of the wall.

The gear reduction shall be calculated to reduce the pressure exerted on the crank handle or the pull exerted on the hand chain to not more than 16 kg.

#### **Electrically Operated Type**

These shall be operated by an electric motor operating on 400/440V, 3 phase 50 cycles A.C. supply. Arrangements shall also be made for emergency mechanical operation of the rolling shutter in the event of failure of the electric equipment or electricity. The emergency mechanical operation shall be by an auxiliary chain wheel and hand chain drive. The motor shall have a push button control, with a minimum of 3 buttons marked "Up", "Down" and "Stop". Limit switches shall also be provided to cut off current to the motor when the shutter reaches the limit of its travel in the "Up" or "Down" directions.

### **8.5 Rolling Grills**

These are similar in design and operation to Rolling shutters. Hence, all provisions of Rolling shutters are applicable to rolling grills except for the curtain. The rolling grill curtain may be manufactured out of 8 mm diameter mild steel or aluminium alloy round bars.

#### **Rolling Shutter cum Grill**

These shall be provided in situation where certain amount of ventilation and safety is called for, e.g. in substations and transformer rooms. The rolling shutter may have a small grill portion as specified in the drawing the height of this grill shall generally be 500 mm.

### **8.6 Painting**

All components of Rolling shutter except springs and inside of guide channel shall be thoroughly cleaned free of rust, mill-scale, dirt, oil etc. and two coats of red oxide zinc chromate paint shall be applied. Two coats of approved synthetic enamel shall be applied after installation. Other painting systems shall be employed if specified on the drawings.

#### **Marking**


Each shutter shall be clearly and legibly marked with the following information:

- i. Manufacturer's Name or Trade Mark
- ii. Size
- iii. Year of Manufacture.

### **9.0 FIRE DOORS**

Fire rated doors shall be for a minimum period of two hours (unless specified otherwise) and shall be approved by Tariff Advisory Committee (TAC). If sourced from outside India, the fire labelled hollow metal doors shall be approved by Underwriters Laboratories (UL). Testing conducted by Central Building Research Institute (CBRI), Roorkee shall be produced on demand. Testing shall be as per BS 476 Part 20 & 24 IS 3614 Part 2 and ISO 834.

The frames shall be made of 16 gauge (1.6 mm) galvanised steel sheets pressed bent to shape using bending machine and mitred with square edges. The shutter shall be formed by machine bending of 18 gauge (1.25 mm) galvanised steel sheets in the form of hollow box making an

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overall thickness of min 45 mm. Other requirements of stiffeners, core infill, finish, etc to be same as for steel doors described in section 5 of this specification. If vision panels are shown, the glass used shall have fire rating for same period as the door.

## 10.0 PVC DOORS AND WINDOWS

PVC doors and window frames shall be a complete system manufactured from acrylic modified high quality impact resistant white (or coloured as specified) non plasticized polyvinyl chloride, reinforced, rigid multi-chamber extrusion by a suitably qualified fabricator. Door and window fabrication shall meet basic performance requirements recommended for climatic and atmospheric conditions of site and in strict accordance with the system supplier's recommendations.

Door/ window type, size and style shall meet requirements specified in relevant door/window schedules.

Door, window design shall include factory finish glazing as required, purpose made thresholds/subsills, trickle ventilators and security/ locking devices as recommended by manufacturer.

All glazing shall meet safety requirements specified by relevant building regulations.

Fabricator shall submit evidence of door, window performance including method of weld finishing, weather tightness exposure category, compliance to relevant regulations, etc for approval prior to award of contract.

## 11.0 ACCEPTANCE CRITERIA

The DOORS, WINDOWS, VENTILATORS AND ROLLING SHUTTERS shall fulfill the above said criteria unless otherwise mentioned.

## 12.0 PAYMENT

All payments shall be made as per SOR basis.

## APPENDIX I

Table 1- Timber Door and Windows (Minimum Hardware)

Fittings	Doors				Windows		
	Double Leaf Flush	Double Leaf Paneled	Single Leaf Flush	Single Leaf Paneled	Double Leaf Shutter	Single Leaf Shutter	Ventilator Shutter
Butt Hinges 100mm Heavy	6	6	3	3	-	-	-
Butt Hinges 75mm Heavy	-	-	-	-	4	2	2
Mortice Lock (7 Lever)	1	-	1	-	-	-	-
Aldrop 300mm	-	1	-	1	-	-	-
Door Latch 300mm	-	1	-	1	-	-	-
Flush Bolt 250mm	3	-	2	-	-	-	-
Tower Bolt 250mm	-	3	-	2	3	2	-
Handle 150mm	-	4	-	2	2	1	1
Hook and Eye Stay 300mm	-	-	-	-	2	1	2
Stoppers (Buffers)	1	1	1	1	-	-	-
Peg Stay					2	1	-

**Notes:**

- i. All the fittings shall be oxidized brass type unless otherwise specified.
- ii. Single leaf door shutters and ventilator shutters of more than 0.80 m width shall be provided with one extra hinge.
- iii. Where height of window shutter and door leaf exceeds 1.2 m and 2.15 m respectively one extra hinge shall be provided for every additional height of 0.5 m or part thereof and length of top bolt shall be increased by the height of the shutter/leaf above 2.15 m from floor level.
- iv. In double leaf shutters of doors, two tower bolts shall be fixed to the first shutter top and bottom and one to the closing shutter at the top. In case of double shutter windows, two tower bolts shall be fixed to closing shutter top and bottom and one to the first shutter at top.
- v. All hardware shall conform to the applicable Indian Standards.

**Table 2- Steel Door and Windows (Minimum Hardware)**

Fittings	Doors		Windows		Ventilators	
	Single Shutter	Double Shutter	Single Shutter	Double Shutter	Top Hung Shutter	Centre Hung Shutter
4" x 4" SS Hinges with two ball bearings	3	6	-	-	-	-
Hinges (Heavy) 75mm Wide	-	-	2	4	2	-
Aldrop 300mm	1	1	-	-	-	-
Push and Pull type Handle (100mm)	2	2	-	-	-	-
SS Tower Bol ts (300mm)	1	3	-	-	-	-
Two Point nose handle with striking plate	-	-	1	2	1	-
Peg Stay 300mm	-	-	1	2	1	-

**Notes:**

- i. All the fittings shall be in S.S. unless otherwise specified.
- ii. Single leaf door shutters and ventilator shutters of more than 0.80 m width shall be provided with one extra hinge.
- iii. Where height of window shutter and door leaf exceeds 1.2 m and 2.15 m respectively one extra hinge shall be provided for every additional height of 0.5 m or part thereof and length of top bolt shall be increased by the height of the shutter/leaf above 2.15 m from floor level.
- iv. Double leaf shutters of doors, two tower bolts shall be fixed to the first shutter top and bottom and one to the closing shutter at the top.
- v. All hardware shall conform to the applicable Indian Standard.
- vi. Door Closure:  
Requirement of door closure, its type – Surface mounted or concealed, with or without Hold Open option shall be as mentioned on Architectural drg.

**Table 3- Aluminium Doors and Windows (Minimum Hardware)**

Fittings	Doors		Casement Windows	
	Single Shutter	Double Shutter	Single Shutter	Double Shutter
Mortice Lock 7 Levers	1	1	-	-
Tower bolts 300mm	1	3	-	-
Butt Hinges (heavy) 75mm	-	-	2	4
Floor Spring (Shutter on Pivot)	1	2	-	-
Two point nose handle with striking plate	-	-	1	2
Peg Stay 300mm	-	-	1	2

**Notes:**

- i. All the fittings shall be anodized aluminium (finish compatible with original frame) type unless otherwise specified.
- ii. Single leaf door shutters and ventilator shutters of more than 0.80 M width shall be provided with one extra hinge.
- iii. Where height of window shutter and door leaf exceeds 1.2 M and 2.15 M respectively, one extra hinge shall be provided for every additional height of 0.5 M or part there of. Length of top bolt shall be increased by the height of shutter / leaf above 2.15 M from floor level.
- iv. In double leaf shutters of doors, two tower bolts shall be fixed to the first shutter at top & bottom and one to the closing shutter at top.
- v. All hardware shall conform to applicable Indian Standards.



GAIL INDIA LIMITED

# TECHNICAL SPECIFICATION FOR FLOOR FINISHING

**GAIL-STD-CV-DOC-TS-019**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
0	23.01.19	Issued As Standard	SS	UN	SKK



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## FLOOR FINISHING

### 1.0 SCOPE

The work covered by this specification shall consist of installing flooring and providing all materials, labour and equipment necessary to complete the work AS PER Indian Standards.

### 2.0 REFERENCE DOCUMENTS

IS: 269	Specification for 33 grade ordinary Portland cement
IS: 383	Coarse and fine aggregates from natural sources for concrete
IS: 456	Code of practice for plain and reinforced concrete
IS: 516	Method of test for strength of concrete
IS: 650	Standard sand for testing of cement
IS: 1199	Method of sampling and analysis of concrete
IS: 1237	Specification of cement
IS: 2185	Specification for concrete masonry unit

In the event of conflict between various codes and standards, the most stringent condition will apply.

Unless specified otherwise the International System of metric units (S.I.) is to be used.

### 3.0 GENERAL

In accordance with the requirements of this specification, the contractor shall submit the details specified in the following paragraphs regarding the materials covered by this specification.

### 4.0 FLOORING

#### 4.1 GENERAL

##### **BRICK SOLING /RUBBLE PACKING (FOR GROUND FLOOR ONLY)**

After the sub-grade has been approved by the Owner/Owner's Representative, the Contractor shall place two layers of bricks in herring bone pattern or rubble packing to required thickness.

Leveling Concrete

The bedding concrete shall be laid in thickness as specified on top of the prepared brick or rubble soling. The cement, sand and aggregate shall conform to the specifications for these materials as detailed in relevant specifications.


##### **BASE CONCRETE**

The cement, sand and aggregate shall conform to specifications for these materials as detailed under relevant specifications and shall be vibrated by a pan type vibrator to attain maximum compaction. All construction joints shall have the dowel bars if required. Expansion joints shall be left wherever called out.

#### 4.2 FLOOR FINISHES

##### 4.2.1 TILED FLOORS

- i. No tile shall be set on surface where the other work is specified or detailed to be embedded in the tile work until such work has been installed and approved by Owner/Owner's Representative.
- ii. Samples - The Contractor shall submit samples of different types of coloured tiles before the start of work to determine their suitability, colour, finish and surface characteristics for a particular job. The samples will be approved by the Owner /Owner's Representative prior to the starting of work.

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- iii. All floor tiling shall be laid from the centre lines outward and adjustment made at the wall. Floor finish shall be sloped to the drains as shown on the drawings.
- iv. In case the dimensions of the room do not fit a multiple of the tiled dimensions, after the border is allowed for, a fractional tile may be used to fill the space. When this extra space is less than 25mm, it may be filled with a mortar of equal parts of cement and sand coloured and finished to match the tile.
- v. All rooms or spaces in which tile floors are being laid shall be closed to human movement or other work and kept closed until the floors are completed and tiles are firmly set and cured as approved by the Owner /Owner's Representative.
- vi. Finished floor levels shall be of true plane surfaces with a tolerance of +2 mm in 3 meters unless otherwise indicated.

#### 4.2.2 GRANOLITHIC FLOOR FINISH

##### BASE SLAB

The surface of the structural base slab shall be left rough and stock off at a level not less than 1 inch below the required finished grade. The P.C.C. floor finish shall generally conform to IS 5491.

##### MATERIALS

- i. Portland Cement  
Portland cement shall be the best local available and shall conform to IS 269.
- ii. Aggregates  
Fine aggregate and Coarse aggregate shall consist of clean, hard, sand or crushed stone screenings, free from dust, clay, loam or vegetable matter and shall be graded from coarse to fine to meet the requirements of IS 383.  
All aggregates shall be selected with care and shall be of an approved character. Samples of proposed material shall be submitted to the Owner /Owner's Representative for approval prior to use.

##### MIXTURE

The nominal mixture shall be 1 part of Portland cement, 1 part of the fine aggregate and 2 parts of coarse aggregate by volume. This nominal mix may be slightly varied, depending upon the local condition as directed. If the aggregate is very coarse, the gravel or stone may be reduced, but in no case shall the volume of the coarse material be less than 1½ times the volume of the fine. The mixture shall be determined and once established shall not be changed except upon written order from the Owner /Owner's Representative.

Not more than 4 gal. of mixing water, including the moisture in the aggregate, shall be used for each 50 kg sack of Portland cement in the mixture when floating is done by machine.


The mixing of the concrete shall continue for at least 1 to 2 minutes after all ingredients are in the mixer.

##### CONSISTENCY

The concrete shall be of the dri est consistency and shall be possible to work it with a sawing motion of the strike-off board on straight-edge. Changes in consistency shall be obtained by adjusting of proportions of fine and coarse aggregate within the limits specified. In no case shall the specified amount of mixing water be exceeded.

##### PLACING AND COMPACTING

Water and laitance, which rise to the surface of the base slab shall be removed before applying the wearing course. After concrete in the base slab has settled sufficiently so that water does not rise to the surface, but within 2 hours of placing the base slab, the wearing course shall be applied and brought to the established grade with straightedge. After striking off the wearing course to the established grade, it shall be compacted by rolling or tamping and then floated with a wood float or power floating machine. The surface shall be tested with a straight edge to detect high and low spots, which shall be eliminated.

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- Following additional points shall also be observed:
- i. Before placing the topping, a slush coat of cement and water mixed to the consistency of thick paint shall be thoroughly broomed into the wet surface of base slab.
  - ii. The topping shall be placed immediately before the slush coat dries. Excess water and grout puddles shall be swept away.
  - iii. Concrete shall be spread over the surface and not heaped to prevent segregation.
  - iv. Concrete should be laid in panels of 2.5 m x 2.5 m by means of formwork over concrete floor. Glass strip 40 x 4 mm thick or aluminium strips of 40 x 2 mm thk. To be laid around each panel edges.
  - v. The finish to be done in differed construction.

#### **FINISHING BY TROWELLING**

Floating shall be followed by steel troweling after the concrete has hardened sufficiently to prevent excess fine material from working to the surface. Floating shall be finished normally within about 3 to 3½ hours of laying the topping. The finish shall be brought to a smooth surface free from defects and blemishes. No dry cement or mixture of dry cement and sand shall be sprinkled directly on the surface of the wearing coarse to absorb moisture or to stiffen the mix.

After the concrete has further hardened, additional trowelling may be required. This shall be done as may be directed. Surfaces to be ground shall be swept with soft brooms after rolling to remove any water and surplus cement paste which may be brought to the surface. The wearing course shall then be floated and lightly trowelled, but no attempt shall be made to remove all trowel marks. The edges of the panels of topping shall be rounded off at proper time, by edging tool, before the concrete finally sets.

#### **CURING AND PROTECTION**

All freshly placed concrete shall be protected from the elements and from all defacement due to building operations. The Contractor shall provide and use tarpaulins when necessary to cover completely or enclose all freely finished concrete.

As soon as the concrete has hardened sufficiently, to prevent damage, it shall be covered with at least 1 inch of wet sand or other satisfactory covering, and shall be kept continuously wet by sprinkling with water for at least 3 days when using high early strength Portland cement. In lieu of other curing methods, the concrete may be covered with a colourless curing compound or with asphalt impregnated, waterproofed paper. All seams of such paper shall be overlapped and sealed with tape.

### **4.2.3 FLOOR HARDENER FINISH**

#### **MATERIAL**

Floor hardener shall be metallic aggregate of approved product. The metallic aggregate shall be specially processed size graded iron particles. Hardener shall be applied to those surfaces indicated on the drawings and shall be applied in accordance with the manufacturer's specifications with prior approval of the Owner /Owner's Representative.


#### **INSTALLATION**

The topping shall be of two layers construction as indicated in the finish schedule. Sprinkling of finish surface with neat cement will not be permitted. The topping will be laid in panels of 2.5m x 2.5m or as directed and preferably be cast in alternate fashion. The base slab shall be leveled below the finishing level as per drawing.

The topping shall be laid in two layers as under:

#### **i. Deferred Construction**

A bed of approximately 40 mm thick screed in the proportion of one part of cement, one part of clean sharp sand and two parts of 6mm-20mm clean granite stone aggregates or gravel.

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A second course of metallic mixture approximately 20mm / 16mm thick, consisting of one part of metallic aggregate, five of cement by weight and two parts crushed stone aggregate or gravel of size 6mm and down, shall be laid monolith with the bottom course. A minimum of 1.2 kg / sq.m. of hardening material shall be provided.

**ii. Integral Construction**

A course of metallic mixture approximately 20mm / 16mm, consisting of one part of metallic aggregate, five of cement by weight and two parts crushed stone aggregate or gravel of size 6mm and down, shall be laid monolith with the base slab. A minimum of 1.2 kg / sq.m of hardening material shall be provided. The floor topping shall be cured for a minimum period of 14 days by impounding 25 mm layer of water by bunding method.

#### 4.2.4 TERRAZZO OR MOSAIC TILE FINISH

##### MATERIALS

The tiles shall conform to IS 1237 and shall be approved by the Owner/Owner's Representative. The tiles shall be uniform in colour and size, true and square, machine cut with sharp edges and free from twist, cracks or other defects. The contractor shall produce the certificates from the manufacturer of the tiles stating that the tiles conform to relevant local specifications. The terrazzo tiles shall be 250 x 250 x 20 mm thick for flooring and 250 x 125 x 20 mm thick for skirting and machine polished in factory.

Maximum size of marble chips shall be No.2 (12 mm base course and 8 mm wearing) and the tile shall be white cement based. Mosaic chequered tiles shall be same as that of floor tiles but pre-chequered in factories

##### INSTALLATION

The floor base to which the tiles are to be fixed shall be roughened and cleaned free of dust, and shall be thoroughly wetted. A layer of cement mortar (1:3) as specified shall be evenly spread over the base slab and sprinkled with fine sand. Before laying, the tiles shall be soaked in water for at least 20 minute and then allowed to dry for about 10 minutes. It is necessary to have tiles damp, but not wet when they are laid. The tiles shall be truly and evenly set in a thin paste of neat cement applied on sides and bottom. As the tiles are placed to the mortar, they shall be tamped down with the handle of hammer or trowel until their elevation is exactly in line with that of the other tiles. The joints in this flooring shall be nearly indistinguishable. Excess cement that oozes that through the joints to the surface shall immediately be wiped clean. The joints shall, after 24 hours, be filled with matching cement paste and allowed to set.

##### CURING

The work shall be kept wet and protected for 7 days before starting the polishing. No one shall be allowed to walk on the floor during the first 24 hours after it is laid. The traffic shall be only allowed after the curing is complete.


##### POLISHING

When ready for polishing, the joints shall first be rubbed with a carborundum stone so that slight projections or edges rising above the surface are leveled. The whole surface shall then be polished by machine, first with a softer variety of carborundum stone and finally washed with a weak solution of soft soap in warm water. Wall skirting shall be ground by hand.

#### 4.2.5 GLAZED CERAMIC TILE FINISH

##### MATERIALS

The glazed ceramic tiles shall be white or coloured, Johnson's / Bell ceramics first quality or approved equal. The floor matt finish tiles (non-skid) shall be 6 mm / 7.2 mm / 10.0 mm thick and wall tiles (light colour) 6 mm to 7 mm thick and shall be of specified sizes. Top surface of the

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tiles shall be perfectly smooth, even and true in all dimensions, free from cracks and crazing. Wall tiles shall be fixed along with angle corner and cove pieces and other specials wherever required to obtain flush surfaces.

### INSTALLATION

The surface on which the tiles are to be fixed shall be rough, clean, free of dust and thoroughly wetted. The tiles shall be soaked in water for a minimum period of 6 hours before fixing. A layer of cement mortar (1:3) and of thickness not less than 18 mm and just enough for about 3 to 4 tiles shall be evenly spread according to the slope required. The wall tiles shall then be laid in neat thin cement paste and pressed into position. All joints shall be uniform and as thin as possible and not exceeding 1.5 mm. They shall run in straight lines or in staggered pattern in floors or in walls as required. Wall tiles shall be of indicated height in the finish schedule. Joints between tile and plumbing or other built-in fixture shall be made with an approved caulking compound as required.

All exposed joints shall be pointed with white or coloured cement as the case may be. If cutting or drilling of tiles is required after the tiles are laid, it shall be done neatly and accurately so that intersections and returns are perfectly formed.

### CURING

The work shall be kept wet and protected with saw dust for 10 days and thoroughly washed and cleaned afterwards.

## 4.2.6 RUBBLE OR BRICK SOLING

### GENERAL

This consists consist of preparing sub-grade for floors and providing all material labour and equipment necessary to complete the work in strict accordance with the drawings and specifications. Source and the materials under the specifications shall be approved by Owner/Owner's Representative.

### MATERIAL

Blue basalt / Granite or bricks wherever called out.


### PREPARATION OF SUB-GRADE

After the sub-grade has been shaped to line, grade and cross section, it shall be well rammed either by manual labour or by pneumatic rammer. Any soft places, vegetation or other debris shall be removed and filled with sand and properly rammed until hard compact surface is obtained. This operation shall include any reshaping and wetting required along with the ramming of the sub-grade, to obtain proper compaction of at least 90% of maximum at optimum moisture as directed. All boulders or ledge stone encountered in the excavation shall be removed or broke off to a depth of not less than 150 mm below sub-grade. The resulting area and all other low sections holes or depressions shall be brought to the required grade.

### RUBBLE PACKING

After preparation of sub-grade and approved by the Owner/ Owner's Representative, the Contractor shall lay uniform size of rubbles or stone average 150 mm / 230 mm high (maximum tolerance 25 mm size or as specified) with broad size as base. The stones shall be of blue or yellow basalt or approved quality hard stone. All interstices shall be filled with stone chips or crushed stone dust. This shall then be properly tamped and flooded with water overnight to make sure that all fine particles are washed down in between the interstices. Any soft place or holes found shall be filled up with sand and all the surfaces properly rammed until the desired grade and proper consolidation is obtained. No concreting shall be done on this surface until it is approved by Owner/Owner's Representative.

If hard laterite stone is used in place of blue or yellow basalt or granite, height of rubble shall be 1'0" (maximum tolerance 1" in size).

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**BRICK SOLING**

Bricks used for soling should be fully burnt or little over burnt and should not absorb more than 4% of the dry weight of water after one-hour immersion and should not show any signs of efflorescence on drying. Bricks should be laid as directed with fine close joints. A cushion of 20 mm average sand filling should be laid prior to packing of bricks. When laid in two layers, joints should be broken with a layer of sand in between.

After packing of bricks, sand shall be spread over the surface to an average thickness of 25 mm to fill up the joints. The top layer may be allowed to remain as a protective layer till further work is taken up. It is essential to wet the brick soling prior to placement of any concrete flooring on the top of it.

**4.2.7 GRAVEL PAVING****SUB-GRADE PREPARATION**

Top surface of sub-grade shall be cleared off any unwanted scrap materials, vegetation, dry grass, large size boulders. Thereafter sufficient quantity of water shall be sprinkled on the top surface, and the same shall be compacted and leveled by hand rollers.

**GRAVEL LAYING**


Gravel shall be clean and round in shapes and standard quality and shall be obtained from riverbeds. Samples shall be approved by the Owner / Owner's Representative. Gravel size shall be minimum 20 mm and maximum 50 mm. Gravel shall be laid to a thickness of 75 mm over the prepared sub-grade or as indicated in engineering drawings. This work shall be carried out for the areas indicated in plot plan and other engineering drawings.

**5.0 ACCEPTANCE CRITERIA**

The FLOOR FINISHING shall fulfill the above said criteria unless otherwise mentioned.

**6.0 PAYMENT**

All payments shall be made as per SOR basis.

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**TECHNICAL SPECIFICATION  
FOR  
PAINTING, COLOUR WASHING AND FINISHING**

**GAIL-STD-CV-DOC-TS-020**

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## PAINTING, COLOUR WASHING AND FINISHING

### 1.0 SCOPE

This specification covers painting, white washing, polishing, wall finishing etc. of both interior and exterior surfaces of masonry, concrete, plastering, plaster of Paris, false Ceiling, structural and other miscellaneous steel items.


### 2.0 REFERENCE DOCUMENTS

- IS: 2395 : Code of practice for painting concrete, masonry and plaster surfaces.  
 IS: 712 : Specification for building limes.  
 IS: 55 : Specification for Ultramarine blue for paints.  
 IS: 63 : Specification for whitening for paint and putty.  
 IS: 5410 : Cement Paint - Specification  
 IS: 384 : Brushes, paints and varnishes, flat  
 IS: 486 : Brushes, sash, tool, for paints and varnishes.  
 IS: 110 : Ready mixed paint, brushing, grey filler enamels for use over primers.  
 IS: 106 : Ready mixed paint, brushing, priming for enamels, for use on metals.  
 IS: 428 : Distemper (Oil Bound), colour as required.  
 IS: 3585 : Ready mixed paint, Aluminum brushing priming water resistant for wood work.  
 IS: 2338 Part-1 : Code of practice for finishing of wood, and wood based materia ls. Part-1: Operations & workmanship  
 IS: 2338 Part-2 : Code of practice for finishing of wood, and wood based materia ls. Part-2: Schedule  
 IS: 2524 Part-1: Code of practice for painting non ferrous metals in buil dings. Part-1: Pretreatment  
 IS: 2524 Part-2 : Code of practice for painting non ferrous metals in buildings. Part-2: Painting  
 IS: 1477 Part-1 : Code of practice for painting ferrous metals in buildings. Part-1: Pretreatment  
 IS: 1477 Part-2 : Code of practice for painting ferrous metals in buildings. Part-2: Painting  
 IS: 2395 Part-1 : Painting of concrete, masonry & plastered surface, code of practice Part-1 : Operations and workmanship  
 IS: 2395 Part-2 : Painting of concrete, masonry & plastered surface, code of practice Part-2 : Schedule

In case any particular aspect of work is not covered specifically by these or any other relevant Indian Standard Specification, any other good engineering practice as may be specified by the company shall be followed.

### 3.0 WHITE WASHING /COLOUR WASHING

Before wash, the surfaces shall be thoroughly brushed free from mortar dropping and foreign matters. The wash shall be prepared from fresh stone shale lime. The lime shall be thoroughly soaked and screened through a clean coarse cloth and admixed with gum and indigo. 3 grams of indigo, 20 grams of gum per kilogram of lime shall be used approximately; one kg of lime will produce 5 liters of white milky solution. The solution shall be got approved by the Site Engineer before application. Number of coats shall be as specified in the Schedule of Rates and each coat shall be allowed to dry before next one is applied. For color washing, pigment as per manufacturer's specification is required.

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**4.0 DRY DISTEMPER**

Dry distemper of approved brand and manufacture shall be used. The shade shall be got approved by the Engineer-in-Charge before application of the distemper. The dry distemper shall be stirred slowly in clean water using 0.6 litre of water per kg. of distemper or as specified by the manufacturer. Warm water shall preferably be used. It shall be allowed to stand at least 30 minutes and the mixture shall then be well stirred before use. The finished surface shall be even and uniform and shall show no brush marks.

**5.0 WATER PROOF CEMENT PAINT**

The water proof cement paint shall be "Snowcem" or equivalent of approved brand and manufacture. The same and the colour of the paint shall be got approved by the Site Engineer before application.

The surface to be coated with water proof cement paint shall be thoroughly cleaned of all dust and falling mortar by washing and scrubbing. The surface shall be thoroughly wetted with clean water before the water proof cement paint is applied. Water proof cement paint shall be mixed in such quantity as can be used up within a hour of its mixing. Curing shall be done as per manufacturer's specifications.

**6.0 OIL BOUND DISTEMPER****Materials**

Oil bound washable distemper of approved shade, brand and manufacture shall be used. The primer shall be of the same manufacture as oil bound distemper. The distemper and primer shall be procured by the contractor in sealed tin in sufficient quantities at a time to suffice for a fortnight's work and the same shall be kept in the joint custody of the contractor and the Site Engineer. The empty tins shall not be removed from the site of work, till this item of work has been completed and passed by the Site Engineer.

**Preparation of Surface**


The surface shall be thoroughly cleaned of dust, old white or colour wash if any by washing and scrubbing and then be allowed to dry for at least 48 hours. It shall then be sand-prepared to remove any unevenness. Depressions if any shall be made up with plaster of Paris putty.

**Application**

The primer coat shall be applied first horizontally and then vertically immediately afterwards. The surface shall be finished as uniformly as possible leaving no brush marks. It shall be allowed to dry for at least 48 hours before oil bound distemper is applied. The surface thus prepared shall be lightly sand papered to make it smooth for receiving distemper, taking care not to rub out the primer coat. One coat of distemper properly diluted with thinner (as stipulated by manufacturer) shall be applied with brush in horizontal strokes followed immediately by vertical ones which together constitute one coat. The subsequent coat shall be applied in the same way, so as to obtain an even shade. A time interval of at least 24 hours shall be allowed between consecutive coats to permit proper drying of the preceding coat.

**Painting**

Paints, Oil etc. of approved brand and manufacturers shall be used. Paints manufactured by M/s. Johnson & Nicholson, Asian Paints, Berger Paints, ICI, Nerolac shall only be approved. Primer and thinner used shall also be of same manufacture and brand. Ready mixed paints as received from the manufacturer without any admixture shall be used as per manufacturer's

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instructions. If for any reason thinning is necessary (in case of ready mixed paint) the brand of thinner recommended by the manufacturer or as instructed by the Site Engineer shall be used. The surface shall be thoroughly cleaned and dusted. All the rust, dirt, scales, smokes and grease shall be thoroughly removed before painting is started. The prepared surface shall have received the approval of the Site Engineer after inspection, before painting is commenced. The wood work to be painted shall be dry and free from moisture. The unevenness shall be rubbed down with smooth sand paper and shall be well dusted. Knots, if any, shall be covered with preparation of red lead made by grinding lead in water and mixing with strong glue, sized and used hot.

## 7.0 PAINTING WITH PLASTIC EMULSION PAINT

Plastic emulsion paint conforming to IS: 5411 of approved brand and manufacture and of the required shade shall be used. Plastic Emulsion Paint shall be applied on internal surface s (other than wood or metallic surface) of buildings as per schedule of finishes/AFC drawings/Tender Scope.


Paint shall be applied after thorough cleaning and preparation of surface. The surface shall be thoroughly cleaned and dusted off. All rust, dirt, scales, smoke splashes, mortar droppings and grease shall be thoroughly removed before painting is started. The prepared surface shall have received the approval of the Engineer-in-Charge after inspection, before painting is commenced. The number of coats shall be as stipulated in SOR/Scope of Tender. The Paint will be applied with brush, spray or roller. The Paint dries by evaporation of the water content and as soon as the water has evaporated the film gets hard and the next coat can be applied. The time of drying varies from one hour on absorbent surfaces to 2 to 3 hours on non-absorbent surfaces. The thinning of emulsion is to be done with water. Thinning with water is required for the under coat which is applied on the absorbent surface. The quantity of water to be added shall be as per manufacturer's instructions. The surface on finishing shall present a flat velvety smooth finish. If necessary more coats will be applied till the surface presents a uniform appearance.

## 8.0 ACRYLIC POLYMER TEXTURED EXTERNAL PAINT

Acrylic polymer textured paint is of approved brand and manufacture and of the required shade shall be used. It shall be an acrylic polymer based textured wall coating consisting of mineral aggregate/crystals, inorganic pigments and other additives to form a crack free, flexible, tough, UV resistant coating of External Ruff 'N' tuff of ICI/ NITCO or equivalent make.

Acrylic polymer textured paint shall be applied on external surfaces (other than wood or metallic surface) of buildings as per schedule of finishes/AFC drawings/Tender Scope. Paint shall be applied after thorough cleaning and preparation of surface. The surface shall be thoroughly cleaned and dusted off loose mortar etc. Before painting all rust, dirt, scales, smoke splashes, mortar droppings and grease shall be thoroughly removed with the help of wire brush, water and sandpaper in accordance with the manufacturer's specifications.

Growths of fungus, algae or moss should be removed by wire brushing with water. In case of cracks, shall be filled with crack seal. The prepared surface shall have received the approval of the Engineer-in-Charge after inspection, before painting is commenced. Application of any primer coat, putty etc. may not be required. In case of application on old surface, one coat of primer shall be applied as per manufacturer's recommendation. Acrylic paint with Two coats shall be applied as final finish. The paint/finish shall be of desired shade and pattern as selected by the Owner / Consultant. The paint will be applied by Honeycomb or Pile roller to get the desired texture and pattern. The finished surface shall be left to dry for 4 hours.

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**9.0 CLEANING UP**

The contractor shall, upon completion of painting etc. remove all marks and make good surfaces, where paint has been spilled, splashed or splattered. Including all equipment, fixtures, glass furniture, fittings, and site to the satisfaction of the Owner/Owner's Representative.


**10.0 ACCEPTANCE CRITERIA**

All painted surfaces shall be uniform and pleasing in appearance. The colour, texture, etc. shall match exactly with approved samples.

All stains, splashes and splatters of paints shall be removed from surrounding surfaces.

**11.0 PAYMENTS**

Payment shall be as per SOR basis.

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GAIL INDIA LIMITED

# TECHNICAL SPECIFICATION FOR BOUNDARY WALL, RETAINING WALL

## GAIL-STD-CV-DOC-TS-021

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## 1.0 BOUNDARY WALL

Boundary wall/ Compound wall shall be of RCC frame type (constituting columns and plinth beams) for difference in elevation between NGL and FGL upto and inclusive of 1.8m. For difference more than 1.8m, RCC retaining wall shall be designed. The compound wall shall be of following types depending upon the difference in elevation between FGL & NGL:

- a) Upto & inclusive of 0.8m level difference, single plinth beam shall be used.
- b) For level difference > 0.8m but < 1.3m, two plinth beams shall be designed with 345mm brick wall thickness between plinth beams.
- c) For level difference > 1.3m but < 1.8m, two plinth beams shall be designed with 460mm brick wall thickness between plinth beams.
- d) For level difference > 1.8m, RCC retaining wall shall be designed.

The filler wall material shall be bricks, Fly-Ash bricks, Stones or Concrete blocks depending upon their availability and as per the directions of Owner/ Consultant.

The Expansion Joint shall be filled with bitumen impregnated fibre board conforming to IS: 1838 and 12mm deep sealing shall be done on face with Polysulphide sealing compound (two part liquid containing) conforming to IS: 12118.


### Latest Edition of following IS Codes:

- a) IS: 278 Specification for galvanized steel barbed wire for fencing
- b) IS: 280 Specification for mild steel wire for general engineering purposes
- c) IS: 383 Specification for coarse and fine aggregates from natural sources for concrete
- d) IS: 456 Plain and Reinforced Concrete — Code of Practice
- e) IS: 800 Code of practice for General Construction in Steel
- f) IS: 814 Covered electrodes for Manual Metal Arc Welding of Carbon and Carbon Manganese Steel Specification
- g) IS: 816 Codes of Practice for use of Metal Arc Welding for General Construction in mild steel
- h) IS: 1597 Code of Practice for construction of Stone masonry.
- i) IS: 2062 Steel for general structural purposes — Specification
- j) IS: 2212 Code of Practice for Brickwork.
- k) IS: 2250 Code of Practice for preparation and use of masonry mortar.

## 2.0 EARTHWORK, PCC, RCC, BRICK MASONRY WORKS, PLASTERING & POINTING

Earthwork shall conform to the specification of site clearing, area grading excavation & earthwork covered in Standard Specifications.


Refer Standard Specifications of Plain and Reinforced Cement Concrete work, Brick Masonry Works and Plastering & Pointing.

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Plain and Reinforced Cement Concrete work shall conform to Indian Standard for Plain and Reinforced Concrete-Code of practice (Fourth Revision), IS: 456.

### 3.0 BARBED WIRE, CONCERTINA COIL AND STRUCTURAL STEEL FOR ANTICLIMBING DEVICE OVER BOUNDARY WALL

- 1) Structural steel shall conform to IS: 2062.
- 2) Structural steel work shall be fabricated and erected as shown in the drawings, Fabrication and Erection shall conform to IS: 800.
- 3) All materials used for fabrication shall be of new and unused stock and shall be free from twist, kinks, buckles or any defects. Maker's test certificate shall be made available to the Engineer-in-Charge when called for.
- 4) Electrodes for welding shall conform to IS: 814. Welding shall be carried out as shown in the relevant drawing and shall conform to IS: 816.
- 5) The Engineer-in-Charge reserves the right to test at any time any welding and the cost of test shall be borne by the contractor.
- 6) All materials tools and plants required for fabrication shall be provided by the contractor and the rates quoted shall make the allowance for the same.
- 7) M.S. angle posts shall be installed on top pilasters as line posts and corner posts.
- 8) Changes in direction where the angle of deflection exceeds 20° shall be considered corner and corner angle post shall be installed.
- 9) Painting shall not commence till it has been inspected by Engineer-in-Charge.
- 10) All loose scales, dirt, rust etc. shall be removed by short blasting / mechanical or power tool cleaning or with steel wire brushes (before applying a priming coat).
- 11) All Primers and paints used shall be supplied as per Painting specification and of approved manufacturer.
- 12) The surface after applying primer shall be made absolutely dry before applying paint.
- 13) Two coats of specified thickness of approved paint over a priming coat (suitable for temperature range of -1 to 60° C, in corrosive environment — off site areas) shall be applied as per Painting Specification.
- 14) Each coat shall be allowed to dry for sufficient time as per manufacturer's directions.
- 15) Barbed wire shall conform to IS: 278. The galvanized barbed wire shall be manufactured from galvanized mild steel wire conforming to IS: 280. The coating on the wire shall be smooth and relatively free of lumps, globes or points, wires with excessive roughness, blisters and Sal ammoniac spots shall be rejected. A galvanized steel barbed wire of Type A- IS: 278 shall be made from two strands of galvanized, twisted 2.5 mm steel wire with 4 points of barbs. Each barb shall have two turns tightening around both line wires making altogether four complete turns. The barbs shall be so finished that four points are set and looked at right angles to each other.
- 16) Bracing of the rows of barbed wire shall be as shown in the standard drawing.
- 17) All miscellaneous material, the staples, straining bolts etc. shall be galvanized. Minimum length of staples shall be 40 mm.
- 18) The fencing shall be plump, taut, true to line and complete in all respects.
- 19) The barbs shall have a length of not less than 13 mm and not more than 18 mm.

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- 20) Punched tape concertina coil shall be of 50 turns per coil having core wire of 2.6 mm dia made of high carbon spring steel of high tensile strength as per IS: 4454 part - I grade II having minimum galvanising coating thickness equivalent to 230 grams per square metre and low carbon steel strip of 0.5 mm thickness having a series of barbes punched all along the length on both sides of the strip at regular interval as per IS: 513, DD quality having minimum galvanising coating thickness of 12 microns. Hardness of tape should be between 137-180 VPN (Victor Penetration Number).
- 21) The coil should be clipped sufficiently at regular intervals. The coil should not be stretched for more than 6.0 Metre length and the minimum diameter of the coil in the closed condition should not be less than 600 mm. All other materials not specified, but required to complete the work shall be of approved type, make as per relevant Indian Standard Specification (if applicable) and shall be approved by the Engineer-in-Charge before Procurement.


#### 4.0 BARBED WIRE FENCING PUNCHED TAPE CONCERTINA COIL

##### 4.1 Barbed Wire Fencing

1. The barbed wire shall be of G.I. wire and in general conform to IS: 278-1962. Line wire and point wire shall be of 2.5 mm, 2.24 mm diameter respectively. Distance between the barbs shall be 75 mm nominal. The barb shall have a length not less than 13 mm and points shall be sharp and well pointed. The barbs shall carry four points and shall be formed by twisting two point wires. Each two turns, lightly round on line wire making altogether 4 complete turns. The barbs shall be so finished that the 4 points are set and locked at right angles to each other.
2. The line wire shall be in continuous length and shall be generally free from welds. The barbed wire shall be formed by twisting two line wires.
3. The barbed wire shall be stretched tight and fixed in the manner (horizontal & diagonal) as shown in the drawing and fitted in slots of angle iron post and held by binding with G.I. binding wires or with G.I. staple or nibs in case of R.C.C. posts. Turn buckles and straining bolts shall be used at the end posts.

##### 4.2 Punched Tape Concertina Coil


1. Punched tape concertina coil shall be of 50 turns per coil having core wire of 2.6mm dia made of high carbon spring steel of high tensile strength as per IS: 4454 Part - I grade II having minimum galvanising coating thickness equivalent to 230 grams per square metre and low carbon steel strip of 0.5 mm thickness having a series of barbes punched all along the length on both sides of the strip at regular interval as per IS: 513, Deep Drawn quality having minimum galvanising coating thickness of 12 microns. Hardness of tape should be between 137-180 VPN (Victor Penetration Number).
2. The coil should be clipped sufficiently at regular intervals. The coil should not be stretched for more than 6.0 Metre length and the minimum diameter of the coil in the closed condition should not be less than 600 mm.

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## 5.0 SPECIAL CONSIDERATIONS FOR CONSTRUCTION OF RETAINING WALL

In addition to the requirements as indicated in the above documents, the followings shall also be taken into considerations for design and construction of retaining walls:

1. Excavation for retaining wall shall be undertaken to the width of the wall footing including necessary margins for construction operation as per drawing or directed otherwise. Where the nature of soil or the depth of the trench and season of the year, do not permit vertical sides, the contractor at his own expense shall put up the necessary shoring, strutting and planking or cut slopes with or without steps, to a safer angle or both with due regard to the safety of personnel and works and to the satisfaction of the Engineer-in-Charge.
2. In area where water is likely to accumulate, weep holes, 50 to 75 mm square shall be provided at 2 m vertically and horizontally unless otherwise specified. The lowest weep hole shall be at about 30 cm above the ground level. All weep holes shall be surrounded by loose stones and shall have sufficient fall to drain out the water quickly.
3. The water table shall not be allowed to rise above base of raft level until completion of outer retaining walls including water proofing of vertical surface of walls and back filling along the walls upto ground level and until the structure attains such height to counter balance the uplift pressure. However, the contractor should inspect the site and make his own assessment about sub-soil water level likely to be encountered at the time of execution.

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GAIL INDIA LIMITED

**TECHNICAL SPECIFICATION  
FOR  
SAND FILLING  
MOORUM FILLING  
BORROWED EARTH FILLING  
GRAVEL FILLING**

**GAIL-STD-CV-DOC-TS-022**

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**1.0 SAND FILLING**

1.1 Sand shall be clean and free from dust, organic and foreign matter and shall be corresponding to grading zone II or as specified in the Schedule of Rates and as directed by Engineer-in-Charge. The following specifications and steps of work shall be followed for sand filling in large areas with sand supplied by the contractor. Under no circumstances black cotton/expansive type of soil shall be used for filling. Samples of fill material shall be got approved from the Engineer-in-Charge prior to use/supply. Laboratory test of the fill material shall be conducted to decide optimum moisture content and the Proctor density and record should be maintained.

**1.2 Setting out, making profiles & measurements**


Setting out and making necessary profiles shall be as specified in clause no.2.0.0 of specification for site clearing, area grading excavation & earthwork.

**1.3 Sand filling in plinth and under floors etc.**

Sand filling in plinth and under floors shall be done in layers, not exceeding 15 cm in depth. Each layers of sand shall be spread with adequate water and then be compacted by ramming. The surface shall then be flooded with water for atleast 24 hours and allowed to dry and then refilled, rammed and consolidated to avoid settlement at a later stage. The surface of the consolidated sand shall be dressed to required level or slope. Concreting of floor shall not be started till the Engineer-in-Charge has inspected and approved of the sand filling.

**1.4 Sand filling in foundations & Tank pad foundation**

Sand used shall be river sand obtained from a source approved by the Owner before commencement of work. It shall be well graded medium to coarse sand free from any vegetation, organic, clay or other impurities. Fineness modulus of sand shall be not less than 2.2 or falling in grading Zone-II as per table given here in below. It shall be tested in an approved laboratory to ascertain its relative density, optimum moisture content for compaction and its suitability for use in foundation/tank pad constructions supporting a design load intensity of 16 T/ sq.m (max.). All expenses for the test shall be borne by the contractor. Sand shall be spread in layers not exceeding 15 cm in loose thickness. Each layer shall be adequately watered, mixed and rolled till it gets evenly and densely compacted. The compaction shall be done by vibratory roller, vibrorammer, vibrators, road rollers of 8 to 10 tonne capacity, mechanical rammers and vibrators so as to achieve relative density of minimum 90%. The compaction shall be done under supervision of competent technical personnel. Adequate arrangement of testing for degree of compaction achieved shall be provided by the contractor at site. A minimum number of 5 tests per layer shall be conducted to ascertain the degree of compaction achieved. In addition to these tests, site engineer, whenever desires may ask contractor to conduct such tests and the contractor shall do so to satisfy the site engineer about the achieved degree of compaction. All expenses to conduct these tests shall be borne by the contractor. Before placing successive layers of sand, top surface of previous layer (the under layer) shall be moistened and

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scarified thoroughly to obtain a rough surface which shall provide a satisfactory bond with the subsequent layer. Necessary cables if any to be laid shall also be embedded in the sand pad as directed by site engineer. Sand pad shall be properly compacted and graded true to the dimensions and levels as shown in the drawings.

#### GRADING OF FINE AGGREGATES AS PER IS: 383

IS Sieve Designation	Percentage Passing for			
	Grading Zone I	Grading Zone II	Grading Zone III	Grading Zone IV
9.5mm	100	100	100	100
4.75mm	90-100	90-100	90-100	95-100
2.36mm	60-95	75-100	85-100	95-100
1.18mm	30-70	55-90	75-100	90-100
600micron	15-34	35-59	60-79	80-100
300 micron	5-20	8-30	12-40	15-50
150 micron	0-10	0-10	0-10	0-15

#### 1.5 Setting out, making profiles & measurements

Setting out and making necessary profiles shall be as specified in clause no.2.0.0 of specification for site clearing, area grading excavation & earthwork.

#### 2.0 MOORUM FILLING

2.1 Moorum shall be of best quality available and free of all foreign matter. The source of moorum shall be got approved from Engineer-in-Charge before procuring. Filling, compaction, finalising of levels & measurement shall be done in the manner as specified for earthwork in compound filling under specifications for Earthwork.

#### 3.0 GRAVEL FILLING


##### 1.0 Scope

The specification for gravel filling over HDPE film to be carried out in station works and other location as per scope of work / drawings of the tender is covered in this document.

##### 1.1 Material

1.2 The gravel shall conform to IS: 383. The size of gravel/ crushed stone shall range from 27mm to 50 mm. Gravel or hard durable crushed stone from source/ quarries approved by Engineer-in-charge shall be used for gravel filling. The gravel shall be free of any fissures; elongated, flat, soft and disintegrated particles, clay and weathering action.

1.3 Stacking of gravel/crushed stone shall be done in uniform stacks, free from contamination by earth or other foreign matters. Gravel stacks shall be located adjacent to the area in

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which gravel filling is to be done as per direction of Engineer-in-Charge. The ground shall be firm, well drained.

- 1.4 The HDPE film shall be HDPE Grade-I conforming to IS: 10889 having following properties:

<b>Density (mass)</b>	940 — 952.4 Kg/m <sup>3</sup> @ 27° + 2°C
<b>Film thickness</b>	150 Micron (0.15mm) minimum or more to achieve above density.
<b>Tensile strength at break</b> - Machine direction - Transverse direction	Minimum 300 kgf /cm <sup>2</sup> Minimum 250 kgf /cm <sup>2</sup>
<b>Elongation at break</b> - Machine direction - Transverse direction	Minimum 300 % Minimum 300 %
<b>Carbon black content</b>	2.5+0.5% by mass
<b>Joint breaking strength</b>	10KN/m

## 2.0 Execution

- 2.1 The surface preparation of the area to be filled with gravel shall be by clearing the area of all loose materials and exposing of virgin soil. The exposed surface shall be consolidated properly to obtain 90% of maximum laboratory dry density of the soil as per IS: 2720 (Part VII). All soft patches shall be worked out to remove the soft soil and selected approved earth shall be filled back and compacted. The sub grade shall be free from sharp objects such as stone, weed roots etc. and shall be smooth without any depressions and humps etc. The surfaces so prepared shall be levelled and sloped as per drawings, for effective drainage.
- 2.2 The film shall be unrolled, spread and laid over the prepared sub grade. The film shall be laid loose so as to provide for the thermal contraction etc. Spreading of the film shall be loosely over the Sub grade so that it attains the contours of sub grade and compensate for thermal variations during the day. An extra length in both the directions on this account shall be provided. The loose ends of the film shall be firmly anchored at the ends with the adjacent area. The adjacent layer of film should be joined fully with a minimum of 200 mm overlap and jointing by thermal sealing. Thermal sealing shall be done as per manufacturer's recommendations. The joints of the film shall be kept to the minimum.
- 2.3 A 75 mm layer of clear, hard and durable sand shall be spread over the firmly spread film. The gravel / crushed stone aggregate in required quantities (from stacks) shall be spread uniformly and evenly, on the prepared base covered with film and sand. Care shall be taken such that the gravels spread to proper profiles and slopes / gradients, in such a way that it will not damage or pierce the film. The thickness of layer of gravels so spread shall be 100mm. The surface of the aggregate spread shall be carefully dressed up and all high and low spots corrected by removing or adding aggregates, as may be required.

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# TECHNICAL SPECIFICATION FOR PIPE CULVERTS & BOX CULVERTS

GAIL-STD-CV-DOC-TS-023

Rev	Date	Purpose	Prepared By	Checked By	Approved By
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## 1.0.0 SCOPE

This specification describes the construction of RCC pipe culverts at crossing of Electrical and Instrumentation cable/conduit across roads.

## 2.0.0 REFERENCE CODES, STANDARDS AND SPECIFICATIONS

- Standard Specifications
- Latest Edition of following IS Codes:
  - a) IS: 383 Specification for coarse and fine aggregates from natural sources for Concrete
  - b) IS: 456 Plain and Reinforced Concrete — Code of Practice
  - c) IS: 458 Precast Concrete Pipes (with and without reinforcement)
  - d) IS: 783 Code of practice for laying of RCC pipes
  - e) IS: 4985 Unplasticised PVC pipes for potable water supplies

## 3.0.0 MATERIALS

- Cement, Sand, Coarse and Fine aggregate and water etc . shall conform to as mentioned in Standard Specifications for Plain & Reinforced Concrete
- All pipes must be new and perfectly sound, free from cracks, cylindrically straight and of standard nominal diameter and length, with even texture. PVC Pipes shall be Class-I as per IS: 4985.
- For pipe culverts, class of RCC pipe shall be NP3 / NP4 or as mentioned in the drawings.
- The Contractor shall submit manufacturer's test certificate for acceptance of RCC/PVC pipes.
- Spun yam for pipe joints shall be of best quality. It shall be free from dust etc.

## 4.0.0 TRANSPORTATION AND STACKING

- The transportation of materials to the worksite and stacking shall be done in a manner to cause minimum inconvenience to the traffic and other construction work.
- The pipe shall be protected during handling against impact, shocks and free fall to avoid cracks and damage.
- The Contractor shall be fully responsible for the safety and security of materials transported and stacked in the field.

## 5.0.0 EARTHWORK


Earthwork shall conform to the specification of earthwork covered in Standard Specifications

## 6.0.0 LOWERING AND LAYING OF RCC PIPES

The laying and jointing of RCC pipes shall confirm to IS: 783. The trench shall be checked for proper level, grade and alignment before lowering the pipes.

### LOWERING

The RCC pipe shall be lowered cautiously to prevent disturbance to the bed and sides of the trench. The heavy RCC pipes shall be lowered by means of proper tripods, chain pulley blocks or as directed by Engineer-in-charge. Great care should be taken to prevent sand etc. from entering the pipes.

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**LAYING**

Laying of RCC pipes shall proceed upgrade of slopes. The error of grade shall not be rectified by packing up earth underneath the pipe. If required, concrete shall be used for packing. The end of RCC pipes shall be kept closed to keep dirt, mud and foreign materials out. Adequate provision shall be made to prevent floating of pipes in the event of flooding of trenches. The body of RCC pipe, for its entire length, shall rest on an even bed in the trench.

**JOINTING OF RCC PIPES**

Cement mortar 1:2 (1 cement: 2 sand) shall be slightly moistened and must on no account be soft or sloppy and shall be carefully inserted by hand into the joint. The mortar shall then be punched and caulked into the joint and more cement mortar added until the space of the joint have been filled completely with tightly caulked mortar. Any surplus mortar projecting inside the joint is to be removed and guarded against any damage. Sack or gunny bags shall be drawn past each joint after completion.


**CURING**

The Cement mortar joints in RCC pipes shall be cured at least for seven days.

**TESTING**

All joints in culvert pipelines shall be tested to a head of 1.5 m of water above the top of the highest pipe, if required, by Engineer-in-Charge.

For Box Culvert refer relevant Standard Drawing.

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**TECHNICAL SPECIFICATION  
FOR  
EARTHWORK IN SITE GRADING**

**GAIL-STD-CV-DOC-TS-024**

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**1.0 SCOPE**

This specification and the method of measurements described thereon are applicable for earthwork involved in Site Grading & Rock Cutting.

**2.0 REFERENCES****2.1 BIS CODES**

- IS: 2720 Part IV - Methods of tests for soils.
- IS: 2720 Part V - Methods of tests for soils-Part 5, Determination of liquid & plastic limit.
- IS: 2720 Part VII - Methods of tests for soils Part 6, Determination of shrinkage factors.

**2.2 VCS SPECIFICATIONS**

- SS-CV-003 Earthwork for underground piping
- SS-CV-022 Earthwork in Foundations


NOTE: - Latest Edition of all Codes and Standards shall be followed.

**3.0 GENERAL**

- 3.1 CONTRACTOR shall maintain adequate drainage facilities at SITE at all times during the execution of work. Additional ditches, drains & such other temporary means to achieve this, over and above what is shown in the drawings, shall be provided and maintained by CONTRACTOR at his own cost.
- 3.2 Adequate dewatering facilities like dewatering pumps and piping etc. shall also be provided by the CONTRACTOR for this work, including dewatering during excavation etc. as required, at his own cost.

**4.0 MATERIAL FOR EARTHWORK**

- 4.1 Only soil considered suitable by the Engineer-in-charge shall be deployed for the construction and that considered unsuitable shall be disposed off, as directed by Engineer-in-charge, at his own cost and no claim for compensation will be entertained.
- 4.2 The CONTRACTOR shall give the samples of soil he proposes to use for filling, along with the following characteristics of the samples, to Engineer-in-charge for approval, prior to collection and use. The tests for these characteristics shall be done in a laboratory / test house as approved by Engineer-in-charge.
- Mechanical analysis or grain size analysis as per IS: 2720 Part IV.
  - Liquid limit as per IS: 2720 Part V.
  - Plastic limit as per IS: 2720 Part V.
  - Moisture density relationship as per IS: 2720 Part VII.

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- 4.3 The soil used for filling shall be free from boulders, lumps, tree roots, rubbish or any organic deleterious matter.
- 4.4 Soil having plasticity index less than 20 shall be used for filling purpose.
- 4.5 Soil having laboratory maximum dry density of less than 1.5 gm/cc shall not be used.
- 4.6 Care shall be taken to see that unsuitable waste material is disposed off in such a manner that there is no likelihood of its getting mixed with the material, proposed to be used, for filling.
- 4.7 The work shall be so planned and executed that the best available soil are reserved for the top portion of Embankments.

**5.0 CUTTING TREES**

- 5.1 All trees having girth above 30 cms, which are not marked for preservation, shall be cut down and their roots dug up to a depth of 1 metre from the existing ground level.
- 5.2 All holes or hollows produced by digging up roots shall be carefully filled with approved soil, including all leads and lifts, rammed and compacted to obtain 90% of maximum laboratory dry density of soil and levelled as directed.
- 5.3 All uprooted trees shall be stacked or disposed off as directed by Engineer-in-charge.

**5.4 PAYMENT**

This clause shall apply to item rate tenders only.


Cutting of trees above 30 cms girth shall be paid per number. The rate quoted shall include cutting, uprooting removing the trees within plant boundary as directed, including filling holes or hollows produced by removal of roots etc. as per specifications.

**6.0 CLEARING AND STRIPPING**

- 6.1 All the areas, including depressions, where filling or cutting is to be carried out shall be cleared and stripped completely of bushes, roots, vegetation, plantation trees, shrubs, trees upto 30 cms girth, organic and other objectionable materials. All these shall be completely uprooted and virgin soil exposed and not merely scrapped at the surface. The roots of trees of girth upto 30 cms shall be removed to a minimum depth of 1m below existing ground level and holes, hollows filled up with selected approved available soil within all leads and lifts and compacted to obtain 90% of laboratory dry density of soil as per IS: 2720, Part VII and leveled as directed by Engineer-in-charge. All soft patches must be worked out to remove soft soil and selected approved earth must be filled back and the areas (areas coming under filling) compacted to obtain 90% of maximum laboratory dry density of soil, as per IS: 2720 Part VII. The depth of stripping shall be generally 50 to 150 mm as decided by Engineer-in-Charge.
- 6.2 Material obtained from clearing shall be stacked or disposed off as directed by Engineer-in-charge within a lead as per directions of Engineer-in-Charge.

**6.3 PAYMENT**

This clause shall apply to item rate tenders only.

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No separate payment shall be made for clearing, stripping and disposal of materials obtained from clearing. This shall be considered as part of cutting work in areas of cutting and filling work in areas of filling and the rates quoted under the respective items of

- a. Earthwork in Excavation/ Cutting
- b. Earthwork in filling (both with available earth & earth obtained from approved borrow areas), shall be inclusive of clearing and stripping with all operations described above in clause no.9.0 in respective areas of cutting and filling.

No separate payment shall be made for clearing, stripping and disposal of materials obtained from clearing of borrow areas for earth. This shall be considered as part of filling work in area of filling and the rate quoted under the respective items.

## **7.0 EARTHWORK IN EXCAVATION/CUTTING**

- 7.1 After clearing and stripping of areas as specified above in clause No.6.0, spot levels at intervals and pattern as decided by the Engineer-in-charge, shall be taken jointly by CONTRACTOR and Engineer-in-charge. Excavation / cutting shall commence only after the levels are signed by the contractor as a token of his acceptance.
- 7.2 Excavation/ cutting shall be carried out strictly as per the instruction of Engineer-in-charge.
- 7.3 If the contractor excavates/ cuts beyond the required level, additional quantity of earthwork shall not be paid for. The excavation taken below the specified level shall be made good by filling with approved material, to the required compaction, at Contractor's cost.
- 7.4 The final bed and sides of excavation must be levelled, dressed and compacted. In case of areas under excavation for site grading, the final surface shall be levelled, dressed and consolidated by means of sheep foot / power driven rollers to obtain maximum compaction. However, no test control is required in such areas.
- 7.5 Shoring and strutting shall be adopted only with the permission of Engineer-in-charge in writing. Such shoring and strutting shall follow the necessary specification.
- 7.6 Provisions for dewatering shall be governed by the relevant clauses.


## **7.7 PAYMENT**

This clause shall apply to item rate tenders only.

Payment for Excavation shall be on the basis of volume of excavation calculated on the basis of joint level taken as per clause 7.1 and the final finished grade levels, the volume being calculated by the Trapezoidal rule including dewatering, if required. Intermediate payment will be on the basis of volume calculated based on spot levels taken during the time of the billing. Reference is also invited to clause 7.3.

## **8.0 EARTHWORK IN FILLING**

- 8.1 After clearing, stripping and consolidation of areas as specified in clause 6.0, spot levels at intervals and pattern as decided by Engineer-in-charge shall be taken jointly by the CONTRACTOR and Engineer-in-Charge and filling shall commence only after the levels are

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signed by the CONTRACTOR as a token of his acceptance. Approved fill Material shall be spread in uniform layers not exceeding 30 cms in loose depth.

The contractor has to make his own approach and access roads from the borrow area to the demarcated filling areas. While the CONTRACTOR may make use of such short cuts as may be available to him for earth movement from borrow areas to the filling areas, the OWNER does not guarantee any passage way or right of way for the CONTRACTOR'S work other than available at site. No claim shall also be admissible to the CONTRACTOR on account of his having to take longer leads or routes for earth movement, than envisaged by him, either due to any road cuttings, non-availability of routes, or any other grounds whatsoever.

In case total filling required in any area consists of soil both from borrow areas and available approved excavated material from within plant area, then joint levels, shall be taken before commencing filling with earth from borrow area.


However, earth available from borrow areas required for filling can be used only after the available earth from excavation within demarcated area has been utilised and clearance to this effect obtained from the Engineer-in-charge.

- 8.2 All clods, lumps etc, shall be broken before compaction.
- 8.3 Successive layers of filling shall not be placed until the layer below has been thoroughly compacted and tested to satisfy the requirements laid down in this specification.
- 8.4 Prior to rolling, the moisture content of material shall be brought to within plus or minus 2% of the Optimum Moisture Content as described in IS: 2720 Part VII. The moisture content shall preferably be on the wet side for potentially expansive soil.
- 8.5 After adjusting the Moisture Content as described in clause 8.4, the layers shall be thoroughly compacted by either sheep foot roller or power driven roller or vibratory roller, as approved by Engineer-in-charge, till the specified maximum laboratory dry density is obtained.
- 8.6 Each layer shall be tested in field for density and accepted by Engineer-in-charge, subject to achieving the required density, before laying the next layer. A minimum of one test per 500m<sup>2</sup> for each layer shall be conducted.
- 8.7 If the layer fails to meet the required density, it shall be reworked or the material shall be replaced and method of construction altered as directed by Engineer-in-charge to obtain the required density.
- 8.8 The filling shall be finished in conformity with the alignment, levels, cross-section and dimensions as shown in the drawing.

Earthen embankment shall be filled 300mm more on both sides, where height is more than 1M and this extra filling shall be dressed, after compaction, in conformity with alignment, level, cross-section and dimension as shown in the drawing, to achieve proper compaction in the slope. No extra payment shall be made in this regard.

- 8.9 Extra material shall be removed and disposed off as directed by the Engineer-in-charge.

#### 8.10 TOLERANCES

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General site grading, including cutting and filling in depressions, shall be carried out to within up down tolerance of +5 cms of final lines, grades and slopes.

### 8.11 EARTH WORK IN FILLING IN OPEN LINED/UNLINED WELLS

For earth work in filling in open lined/unlined wells, only locally available coarse sand shall be used, in layers of 500 mm thickness. Each layer shall be thoroughly wetted by sprinkling water, before next layer is filled up. Filling shall be done upto 1m depth below NGL as above. Layers from a depth of 1m below NGL, upto NGL, shall also comprise of locally available coarse sand and compacted with suitable Mechanical / manual means, to obtain same level of compaction as required for filling above NGL. Filling above NGL shall be done as per Cl. 8.1 to 8.10 above.

### 8.12 PAYMENT

This clause shall apply to item rate tenders only.

- a. Payment for filling shall be made on cubic metre of volume calculated on the basis of cross section plotted from the levels of ground, where filling is to be carried out and the levels reached after filling is duly consolidated, volume being calculated by Trapezoidal method.
- b. In case of simultaneous cut and fill operation, wherever specified, payment shall be made on the basis of one composite rate for cutting and filling. All other details about measurement etc. remaining same as above.
- c. Payment for filling in open wells, lined or unlined, shall be made on the basis of volume calculated on the basis of average area multiplied with depth of open well
- d. No extra payment shall be made towards testing.

### 9.0 REMOVAL OF SURPLUS EARTH


- 9.1 Surplus earth and soil from excavation and general site grading shall be removed from the construction areas to the area demarcated by the Engineer-in-charge.

### 9.2 PAYMENT

This clause shall apply to item rate tenders only.

Payment shall be made only for lead beyond initial lead from construction area. Rate shall include loading, transportation, dumping, stacking the surplus earth and soil in the area demarcated by the Engineer-in-charge.

Payment shall be made on cubic metre basis of the difference of measurements of the volumes of the excavation and the measurement of the filling with the excavated earth. However, the contractor's entitlement to payment shall be restricted to the actual quantity of earth removed. Quantity generated due to void in back filled volume of earth shall also be removed by the contractor at no extra cost and this disposal of earth shall not be measured and paid under any item.

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# TECHNICAL SPECIFICATION FOR EARTHWORK FOR UNDERGROUND

**GAIL-STD-CV-DOC-TS-025**

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**1.0 SCOPE**

This specification deals with earthwork in trenches and pits (for valves, manholes, catch pits etc.) for underground piping.

**2.0 REFERENCES****2.1 BIS CODES**

IS: 783 Code of practice for laying of RCC pipes.

IS: 1200 (Part-I) Method of measurement of building and civil engineering works.

IS: 3764 Excavation work - code of safety.

**ABBREVIATIONS:**

m : Metre

cm : Centimetre

mm : Millimetre

km : Kilometre

U/G : Underground

**3.0 MATERIAL**

All workmanship and materials shall conform to the provisions of IS: 1200 (Part-1) and IS: 3764.

**4.0 EARTHWORK IN EXCAVATION FOR TRENCHES / PITS FOR PIPELINES****4.1 EXCAVATION**


Plant, machinery and equipments for excavation shall be selected and deployed to provide optimum mechanization in excavation of trenches and pits. The selection for excavation and earth movement machinery etc. shall take into account type of materials to be excavated, method of excavation, prevailing weather conditions and type of transport to be used.

The excavation of area of cut shall be so timed that the bottom level is not exposed to the deteriorating influence of the weather for longer duration.

Excavation and earth moving equipment shall be deployed such that minimum damage is caused to the natural sub-soil structure of exposed formations.

The monitoring of soil deformations, ground water levels during and possibly after construction work shall be taken into consideration.

In the event, when excavation works are carried out in the vicinity of structures of any importance, the above monitoring shall be carried out within a distance, from the edge of the


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excavation of 5 to 15 times the excavation depth, depending upon the subsoil conditions and the stability of the neighboring structures.

- 4.2 Trenching work shall be carried out in all classes of soil including soft rock and excluding hard rock and shall be for all depths.
- 4.3 The trench shall be cut true to the line and level as per drawings.
- 4.4 If the trench is excavated below the required level than that indicated in the drawing, the extra depth shall be filled with concrete 1:5:10 or approved equivalent materials, as directed by the Engineer-in-Charge, at no extra cost to the owner.
- 4.5 In case of pressure piping, the trench shall be excavated generally as to provide a cover of 1000 mm or dia of pipe whichever is more. In case of gravity sewers/ pipes, the trench shall be excavated to conform to invert levels as per drawings. However in certain cases, the pipes may run at shallower levels or at deeper levels depending upon drawing, site condition etc. No rebate for lesser excavations, nor extra payment due to deeper excavations, shall be admissible in those cases where pipeline laying rates are inclusive of earthwork items. The rates quoted shall be deemed to cover all works connected with trenching, whether trenches are with single pipeline or have multiple pipelines in common trenches including road cutting and making good the same.
- 4.6 The width of the trench shall be sufficient to give free working space of personnel, equipment, supports and ancillaries on each side of the pipe. The free working space shall conform to IS: 783. Generally it shall not be less than 150 mm on either side or 1/3 dia of outer diameter of the pipe, whichever is greater.
- 4.7 When pipelines are running parallel, whether the trenching shall be individual or common, shall be decided by the Engineer-in-Charge and such decision shall be final and binding on the contractor. No extra shall be payable for common excavations.
- 4.8 All earthwork involved in excavations of all types of manholes, catch pits, valve chambers, inspection chambers, chambers for instrumentation tapping etc., which are coming on the alignment of U/G piping or as defined by drawing as a part of U/G piping work, shall be paid extra under Earth work in excavation, back filling and removal of surplus earth etc. under relevant clauses of the SOR.
- 4.9 Aspects such as variations in the soil conditions and the geological structure, depth of excavation, the existence of ground water and surface water, the type and extent of excavation, the topography of site, the proximity of items such as roads, buildings and buried services, construction traffic and activities near the excavation eg. stock piling shall be taken into account when determining whether the sides of excavation should be free standing, sloping or temporary supported.

Suitable drainage and / or dewatering system like Well Point method / Bore well method etc. shall be provided to prevent or limit ingress of surface or sub surface water into excavation.

Serviceable materials intended for reuse should be used as soon as possible after excavation otherwise they should be stock piled at a location beyond 1.5m from the top edge of the excavation or beyond a distance equal to the depth of the excavation whichever is higher at a location approved by the Engineer-in-charge. If excavated serviceable material is not possible to be stacked within the limits specified above, due to some constraint, it shall be stacked away at a location approved by Engineer-in-Charge and paid separately under relevant item.

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Areas used for temporary stockpiling of excavated material shall be kept clean and orderly, with excavated material kept by the side of road to avoid traffic movement. Excavated areas shall be restored to their original condition before completion of works. All types of shoring and strutting, wherever necessary, shall be adopted to withhold the face of earth or cutting in slope, as per site requirements and direction of Engineer-in-Charge. Supports shall be maintained such that the integrity of the sides of the excavation is not impaired.

- 4.10 Any obstacle encountered during excavation shall be reported immediately to the Engineer-in-Charge and shall be dealt with as instructed.
- 4.11 The contractor shall maintain all excavated trenches and pits, in a dry and trim condition.
- 4.12 Necessary barricading and protection of slopes against slips due to traffic movement shall be provided to the satisfaction of Engineer-in-Charge. Necessary warning flags and lights shall be provided to caution traffic in the areas where trenches and/ or pits are provided.
- 4.13 In case of road cutting, all road material i.e. metal etc., shall be taken out carefully and kept separately for reuse and road work shall be redone up to the original level, as it was prior to cutting the road, with the excavated road materials after laying and testing of the pipeline, within 10 days from the date of starting this work, at the cost of the contractor. The contractor shall provide suitable warning signs and barricades to prevent accidents.

Contractor shall also provide reasonable bye pass at his own cost when a road is cut for laying pipeline. Tankage dykes cut due to laying of the pipes, shall be redone conforming to the original specifications, by the Contractor at his own cost. Secondary dykes, to take care of any eventuality during construction, shall be provided by the Contractor at his own cost.

- 4.14 Dewatering shall be done in advance of the installation of the pipe to allow adequate inspection of padding of the bottom, if required. Dewatering shall be continued throughout during installation and backfilling.

The trench shall follow the gradient of pipeline as specified in the drawing. The contractor shall keep the trench in good condition, until the pipe is laid and tested. No extra claim shall be entertained due to its caving or setting down, either before or after the pipe is laid.


In case, pipe is lowered in caved trench and backfilled before being inspected by the Engineer-in-Charge, the Contractor shall re-excavate the trench for inspection and backfill it at his own cost.

## **5.0 BACKFILLING AND COMPACTION IN TRENCHES AND AROUND VALVE PITS, MANHOLES ETC.**

### **BACKFILLING**

Trenches shall be back filled with suitable materials which should be compacted to the same degree or better as the surrounding soils.

- 5.1 The soil used should be selected and approved by Engineer-in-Charge. Suitable material can be extracted from available excavated material. The soil should be free from rubbish, grass, organic matter, stones, building waste and Black Cotton Soil etc. It should be free from clods and hard lumps. In case good soil is not available from excavated material for back filling, trench shall be filled back with locally available coarse sand upto 30 cm. thick above the pipe and rest of trench shall be filled back with excavated soil upto required level.'

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- 5.2 The filling should commence only after approval of Engineer-in-Charge is obtained and after the structures or pipes to be buried are tested and approved. Otherwise, if required, contractor shall uncover buried portion and refill at his own cost.

Temporary excavation supports should be removed as back filling and compaction proceeds, such that unacceptable movement of the supported ground does not occur.

Voids caused by extracted supports should be filled and compacted.

- 5.3 Filling should be done in layers. Each layer should be not more than 15 cm thick when loose and should be well rammed, with necessary watering, to obtain at least 90% of maximum laboratory dry density.

Compaction trials should be carried out on each soil type to be placed in backfill, in order to confirm the type of machine and number of passes required to obtain optimum compaction for given soil moisture contents. These trials should also be used to determine the variability of the proposed fill material for different weather conditions.

- 5.4 Care must be exercised to protect cables, pipes, joints, and other features from damage due to backfilling and consolidation.
- 5.5 Filling should extend up to the level of original ground surface or as per drawing or as directed by Engineer-in-Charge. The finished surface should be properly trimmed and dressed. The adjoining area should be cleaned and no heaps of surplus earth should be left out.

**6.0 TRANSPORTATION OF SURPLUS EARTH**


Unserviceable materials and serviceable materials not intended for re-use shall be removed from the work site and disposed off at a location as approved by Engineer-in-charge.

The surplus earth is generated due to pipe laying, valve chambers, and manhole construction etc. Surplus earth is also generated due to voids in the back filled volume of earth. The removal of surplus earth shall include excavation, loading, transportation, dumping, stacking or spreading, as per the directions of Engineer-in-charge.

**7.0 PAYMENT**

This clause shall be applicable for item tender rate only.

- 7.1 Unless specifically stated in the schedule of rates, no separate payment for earthwork in excavation, backfilling, transportation, dewatering etc. shall be admissible and the payment for the same is deemed to have been included in the relevant items of the contract.
- 7.2 In case payment for earthwork is specified separately in the Schedule of Rates, the payment shall be based on the actual quantity of excavation, backfilling and transportation done, taking into consideration the slopes authorized by the Engineer-in-Charge for excavation, volume of backfilling calculated on the basis of excavation reduced by the volume of pipes.
- 7.3 In cases where hard rock excavation is involved, the matter shall be referred to Engineer-in-Charge, before proceeding with the work.

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GAIL INDIA LIMITED

**TECHNICAL SPECIFICATION  
FOR  
SOIL INVESTIGATION FOR STATIONS**

**GAIL-STD-CV-DOC-TS-026**

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<b>Rev</b>	<b>Date</b>	<b>Purpose</b>	<b>Prepared By</b>	<b>Checked By</b>	<b>Approved By</b>



**ABBREVIATIONS:**

m : Metre  
 mm :  
     Millimetre  
     : Centimetre  
 kg/cm<sup>2</sup>: KilogramPer Square Centimetre  
 IS : IndianStandard  
 kg : Kilogram  
 °/sec : Degree /second

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**1.0 SCOPE**

- 1.1 Thesespecificationscovertheprocedureforsoilinvestigationsforfoundation
- 1.2 Theworkshallbe carriedoutinaccordancewiththe specificationssetoutbelow andas directedbytheEngineer-in-Charge,wherevernecessary.

**2.0 REFERENCE**

- 2.1 Thesespecificationsconform totheIndianStandardsonSoilsandFoundationsasgiven inANNEXURE-A.
- 2.2 Referencetoany codeintheseprecificationsshallmeanthelatestrevisionofthecode unlessotherwisementioned.Inthe eventofany conflict betweenthe requirementsin thesespecificationsandthereferredcodes,theformer shallgovern.


**3.0 SOIL INVESTIGATIONS**

**3.1 Boring**

Boringshallbe carriedoutinaccordancewiththe provisionsofIS:1892 andasper the specificationsgivenbelow:

**3.1.1 AUGER BORING**

- 3.1.1.1 Augersshallbeofhelicalorposttypeandmaybemanuallyorpoweroperated.Beyond 5metersdepth,below ground,onlypoweroperatedrigshallbeused.The diameterof the holeshallbeminimum100mmandpreferably 150mm.
- 3.1.1.2 Uncasedholeshallbepermittedonly uptoadepth wherethe sidesofthe hole can stand unsupported.In caseside fallis noticed,steps shall be taken immediately to stabilize the holes by usingbentonite slurryor by casingpipesas directedby the Engineer-in-Charge.
- 3.1.1.3 No watershallbe addedwhile boring through cohesivesoilsandcohesionlesssoil abovewater table.Whileboring throughcohesionlesssoilbelow watertable, waterin thecasingshallalwaysbemaintainedatorabovethewater table.
- 3.1.1.4 Thecuttingsbroughtupbytheaugersshallbecarefullyexaminedandsoil descriptions dulyrecord.Representativesampleshallbepreservedforlaboratorytesting.
- 3.1.1.5 Whereverin-situtestsare conductedandundisturbedsamplesareobtainedatspecified depthsfrom the borehole,careshallbetakento ensurethat theboreholeis properly cleanedandfreefromforeignmattersatthetimeofconductingtheseoperations.
- 3.1.1.6 Watertable intheboreholeshallbecarefullyrecordedandreported.One ofthefollowing methodsshallbeadoptedformeasuringthewatertable:

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a. The water table in the boreholes shall be allowed to stabilize after depressing the water level adequately by bailing. Stability of the borehole sides and bottom shall be ensured at all times.

b. The boreholes shall be filled with water and then bailed out to various depths. Observations shall be made at each depth to see if the water level is rising or falling. The depth at which neither a fall nor a rise is observed, shall be considered as the water table depth. This shall be established by three successive readings of water levels taken at intervals of 2 hours.

c. Hvorslev's Method

The water level shall be depressed by bailing (to say  $D$  below ground level) and shall then be allowed to rise. Water rise at suitable equal intervals of time shall be recorded. The distance of depressed water level from the actual water table shall be obtained by the following formula:

$$H_0 = \frac{h_1^2 - h_2^2}{2(h_1 - h_2)}$$

Where

$H_0$  - distance of the depressed water level from actual water table, and  $h_1$  and  $h_2$  are two successive rises of water level in the borehole for the same time interval.

The water table depth ( $H_d$ ) from ground level shall be determined as under:  $H_d = D - H_0$

Three sets of observations shall be made and the average value of  $H_d$  determined.

Method (a) is suitable for permeable soil while methods (b) and (c) are suitable for both permeable and impermeable soils. The Engineer-in-Charge shall indicate the method to be followed.

3.1.1.7 Immediately on completion of a borehole, bore log shall be prepared in an approved form as given in ANNEXURE B to these specifications and submitted to the Engineer-in-Charge in triplicate.

3.1.2 SHELL AND AUGER BORING

3.1.2.1 Augers shall be of helical or post-hole type and may be manually operated. The diameter of the hole shall be minimum 100mm and preferably 150mm.

3.1.2.2 Specifications set forth in clauses 3.1.1.2 to 3.1.1.7 for Auger Borings shall apply to Shell and Auger borings also.

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3.1.2.3 Auger shall be used for soft to firm clay and for silty deposits at upper depths of 10 metres or up to the water table whichever is deeper. For deeper depths in such deposits and for every stiff to hard clays and dense sands located at any depth, use of shell may be made.

3.1.2.4 While boring in soft clays and in sandy deposits below water table, it shall be ensured that, the shell diameter shall be at least 25 to 50 mm less than the casing diameter. This is to ensure that suction is not created in the bore hole during withdrawal of the shell with consequent "Caving in and blowing" in the bore holes.

3.1.3 ROTARY MUD CIRCULATION DRILLING

3.1.3.1 The drillings shall be carried out manually (as per IS: 1892) or by use of a suitable mechanical rig.

3.1.3.2 Drillings up to water table shall be done by auger and provisions of clauses 3.1.1.1 to 3.1.1.7 shall apply. Below the water table drilling by rotary and circulation shall be adopted.

3.1.3.3 Use of percussion tools may be permitted in very stiff to hard clays and dense sandy deposits.

3.1.4 BACKFILLING OF BOREHOLES

On completion of boreholes, backfilling shall be carried out with approved materials as and when directed by the Engineer-in-Charge. Unless otherwise specified, the excavated soil shall be used for the purpose.

3.1.5 TERMINATION CRITERIA


If very hard strata are met within the bore hole at depths shallower than specified in tender documents, the bore hole shall be advanced by chiseling. If in the opinion of the Engineer-in-charge, the rate of advancement of bore hole is still low, coring may be resorted to subsequently.

3.2 TRIAL PITS

3.2.1 Trial pit shall be of min. 3m x 3m size at base so as to permit easy access for a visual examination of the walls of the pit and to facilitate sampling and in-situ testing operations.

3.2.2 Precautions shall be taken to ensure the stability of pit walls, if necessary even by the provision of shoring. Arrangements shall be made for dewatering, if the pit is extended below water table.

3.2.3 In-situ tests shall be conducted and undisturbed samples obtained immediately on reaching the specified depths, so as to avoid substantial moisture changes in the subsoil.

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3.2.4 To ascertain the thickness of the black cotton soil layer existing at the top, trial pits shall be examined visually. Usually it is found that immediately after the black cotton soil, there exists a layer of calcareous (lime) nodules or the white patches which helps to determine the exact thickness of expansive clay layer. Generally, below this layer the possibility of existence of black cotton soil does not exist.

3.2.5 After completion of tests and examination the pits shall be suitably backfilled as directed, by the Engineer-in-charge. Unless otherwise specified the excavated soil shall be used for this purpose.

**3.3 IN-SITU TESTING**

**3.3.1 STANDARD PENETRATION TEST**

3.3.1.1 The tests shall be conducted at specified intervals or at a depth where the strata changes, whichever occurs earlier.

3.3.1.2 The tests shall be carried out by driving a standard split spoon by means of 63.5 kg hammer with a 75 cm free fall. Detailed procedure of testing, as specified in IS:2131, 'Method of Standard Penetration Test in Soils' shall be followed. The samples obtained in the split spoon shall be labeled and preserved for identification tests in the laboratory.

3.3.1.3 The standard penetration test shall be discontinued when N is greater than 75 blows for 30 cm of penetration.

**3.3.2 VANESHEAR TESTS**


3.3.2.1 These tests shall be conducted in soft to firm clays and sensitive clays. These tests shall also be conducted in case of stiff fissured clays where samples cannot be taken.

3.3.2.2 Tests may also be conducted by direct penetration from ground surface.

3.3.2.3 The apparatus used for vane shear tests shall satisfy the requirements as per IS:4434. a.

For test from bottom of borehole

- i. Vane shall consist of four mutually perpendicular blades as illustrated in Fig.1. The height of the vane should be twice the overall diameter. It is recommended that the overall diameter of the vane should be 37.5, 50, 65, 75 or 100 mm. The design of the vane shall be such that it causes as little remoulding and disturbance as possible to the soil when inserted into the ground for a test. The blades shall be as thin as possible, consistent with the strength requirements. The vane should not deform under the maximum torque for which it is designed. The penetrating edge of the vane blades shall be sharpened having an included angle of 90°. The vane blades shall be welded together suitably either directly or to a central

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rod, the maximum diameter of which should preferably not exceed 12.5 mm. The area ratio of the vane shall be kept as low as possible and shall not exceed 18 percent for the 37.5 mm vane and 12 percent for the 50, 65, 75 and 100 mm diameter vanes. The area ratio may be calculated using the following formula.

$$A_s = (8t(D-d) + \pi d^2) / \pi d^2 \times 100(\%) \text{ Where } A_s$$

= area ratio in percent

t = thickness of vane blades in mm.

D = overall diameter of vane in mm and

d = diameter of central vane rod including any enlargement due to welding in mm.

**Note1:** The vane selected should be the largest size suitable for the general soil conditions at site.

The vane rod (the rod to which the vane blades are fixed) may be enclosed in a suitably designed sleeve from just above the blades and throughout the length it penetrates the soil to exclude the soil particles and the effects of soil adhesion. This sleeve shall commence above the blades at a distance equivalent to about two diameters of the vane rod.

**Note2:** The vane shall be frequently checked for straightness.

- ii. Torque applicator - The torque applicator shall have a clamping device to rigidly secure it to the anchor casing and shall have an attachment to securely hold the string of rods connecting the vane.

The instruments shall be capable of applying torque to the vane through the string of rods and to measure the same. It should also have a device to read the angular rotation of the upper end of the extension rod. The torque applicator shall be provided with speed control so that the rate of rotation may be maintained at 0.1°/sec. Friction exerted by the torque applicator shall be of negligible magnitude and shall be checked periodically. Depending upon the estimated shear strength of the soil the following table (Table I) may be used as a guide for the selection of torque applicator of capacity 60 N.m (600 kgf.cm)

**TABLE-1**  
**SELECTION OF TORQUE APPLICATOR**

Estimated Shear Strength in KN/m <sup>2</sup> (kgf/cm <sup>2</sup> )	Vane size (dia) suitable for use with 600kgf. Cm torque applicator
10(0.1)	All sizes
20(0.2)	All sizes except 100mm size
30(0.3)	All sizes except 100mm size
40(0.4)	All sizes except 75mm and 100mm size
50(0.5)	All sizes except 75mm and 100mm size
60(0.6)	37.5mm and 50mm size.
70(0.7)	37.5mm and 50mm size.

The capacity and accuracy of the instruments shall be one of the following as may be specified by the purchaser:

1. Measure torque upto 60 N.m (600 kgf.cm) to an accuracy of 1 N.m (10 kgf.cm),
- or
2. Measure torque upto 200 N.m (2000 kgf.Cm) to an accuracy of 2.5 N.m (25 kgf.cm)

iii. Rod system- The string of torque rods connecting the vane to the torque applicator, called the rod system may be of quick coupling type or of the threaded type. The length of the rod shall preferably be 1m with a few of smaller lengths. These rods shall have sufficient diameters such that their elastic limit is not exceeded when the vane is stressed to its capacity (see note 3). The threaded rods shall be so coupled that the shoulders of the male and female ends shall meet to prevent any possibility of the coupling tightening when the torque is applied during the test. If vane housing is used, the torque rods shall be equipped with well-lubricated bearings where they pass through the housing. These bearings shall be provided with seals to prevent soil from entering them. The torque rods shall be guided so as to prevent soil so as to prevent friction from developing between the torque rods and the walls of casing or boring.

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**Note3:** If torque versus rotation curve is to be determined, it is essential that the torque rods be calibrated (prior to the use in the field). The amount of rod twist (if any) shall be established in degree per metre per unit torque. This correction becomes progressively more important as the depth of test increases. The calibrations shall be made at least to the maximum depth of testing anticipated.

- iv. Dummy Rod- of dimension equal to that of the vane rod of the vanes used.
- v. Guides for Rod-of suitable type provided with ball bearing attachments so as to enable the rod to rotate freely (see Note iv.)

**Note4:** During the test, it is essential that the rods and vane are placed centrally in the bore-hole. For this purpose guides shall be used at an interval in depth of not more than 5m.

- vi. Drilling equipment - the equipment shall provide a clean hole of the required diameter for insertion of the vane to ensure that the vane test is performed on undisturbed soil.
- vii. Jacking Arrangement - for pushing the shoe and vane (where required)

**Note5:** The apparatus shall be checked and calibrated as and when required. b.

For tests by Direct Penetration from Ground Surface

- i. Vane - as specified in 3.3.2.3(a). In addition the vane shall be suitably protected by a shoe (see Fig. 2)
- ii. Rod System - as specified in 3.3.2.3 (a) and of suitable type.
- iii. Extension Pipes - about one metre length with coupling on the outer face to ease the hole.
- iv. Torque Applicator - as specified in 3.3.2.3(a)

**Note6:** The apparatus shall be checked and calibrated as and when required.


3.3.2.4 Tests from the bottom of a Bore Hole

- a. Sink the bore-hole up to the depth required and extend the casing up to the full depth. If the casing is loose, secure it so that it does not move during the tests. Fix the torque applicator or anchor plate to the casing.
- b. Connect the vane of suitable size (see Note 1) to the rods and lower it to the bottom of the bore-hole, putting guides at suitable intervals but not more than

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about 5m the rods are extended. Push the vane with a moderately steady force up to a depth of 5 times the diameter of the borehole below the bottom of the borehole or shoe. Take precautions to make sure that no torque is applied to the torque rods during the thrust. No hammering shall be permitted. Fix the torque applicator with a frame to the anchor plate and connect the rods to it. Tighten the torque applicator to the frame properly. A diagrammatic vane test arrangement for test from bottom of bore-hole is shown in Fig. 3

- c. Allow a minimum period of 5 minutes after insertion of the vane. Turn the gear handles so that the vane is rotated at the rate of 0.1°/s. Note the maximum torque reading attained. If necessary, note the torque indicator dial gauge readings at half minute intervals and continue rotating the vane until the reading drops appreciably from the maximum.
- d. Just after the determination of the maximum torque, rotate the vane rapidly through a minimum of ten revolutions. The remoulded strength should then be determined (see c. above) within one minute after completion of the revolutions.
- e. Remove the vane testing assembly, continue boring and collect soil sample from the level of the vane testing for laboratory analysis to ascertain whether the deposit will behave as a purely cohesive soil.
- f. In case where a sleeve is not provided for the vane rod and the soil is in contact with the rod, determine the friction between the soil and the vane rod by conducting tests at appropriate depths using the dummy rod corresponding to that of the vane used in the test. The tests should be conducted as with the vane except that the vane is replaced by dummy rod. The tests should be conducted in an adjacent bore-hole at the same depth at which the vane tests were conducted. The dummy rod should be pushed into the ground to the same distance as the vane rod at that depth.
- g. Following points shall, however, be carefully supervised in the field;
  - i. Straightness of vane shall be checked while the entire assembly of vane connected with rod is being lowered to the bottom of boreholes. Vane shall be pushed with a moderate steady force up to a depth of five times the borehole diameter below the bottom of boreholes. Precautions shall be taken to ensure that no torque is applied to the torque rods during the thrust. No hammering shall be done.
  - ii. An interval of 5 minutes shall be allowed to lapse after insertion of vane.
  - iii. Torque indicator readings shall be noted at intervals of 30 seconds until the vane readings drop appreciably from the maximum.

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iv. Samples shall be collected from the levels at which the tests have been conducted.

3.3.2.5 Tests by Direct Penetration from Ground Surface-Rods shall remain tight when vane is lowered. Guides shall be placed at every 3m to centralize and reduce friction between rods and extension pipe.

3.3.2.6 Records-Records of vane tests shall be maintained in the form given in ANNEXURE- C

3.3.3 DYNAMIC CONE PENETRATION TESTS:

3.3.3.1 Dynamic Cone penetration tests shall be conducted by driving a standard size cone attached loosely or screwed to a string of drill rods. The driving system shall comprise of 65kg weight having a free fall of 75cm.

3.3.3.2 The method of conducting the test and details of the equipment shall conform to one of the two alternatives given below. The particular method to be followed is indicated under specific requirements:

- a. The test shall be conducted in accordance with IS:4968 (Part I)-The cone size shall be 50mm.
- b. The test shall be conducted in accordance with IS:4968 (Part II). A continuous flow of bentonite slurry shall be maintained through the rods and the cones as to avoid friction between the rods and the soil. The cone size shall be 65mm and provided with vents for flow of bentonite slurry.

The test shall be reported in a suitable tabular form giving blow counts for every 30cm. Penetration, supplemented by a graphical plot of blow counts versus depth.

3.3.3.3 Dynamic cone penetration tests shall be terminated when blow counts ( $N_c$ ) exceed 150 for two successive penetrations of 30cm each.

3.3.4 STATIC CONE PENETRATION TEST.

3.3.4.1 The equipment used for this test shall conform to the requirements of IS:4968 (Part-III)

3.3.4.2 The capacity of the equipment to be used for test shall not be less than 3.0 tones but preferably 10.0 tones.

3.3.4.3 The test shall not be carried out on gravelly soils and for soils with standard penetration value 'N' greater than 50.

3.3.4.4 Test Procedure-Test procedures shall meet the requirements of IS:4968 (Part III). Some of the important points of the procedure are given below:

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- a. The cone is pushed through a distance in accordance with the design of the equipment and the need for the sub-strata and the cone resistance noted. The cone and the friction jacket are pushed together subsequently for a distance depending upon, the design of the cone and friction jacket assembly and the combined value of cone and friction resistance noted. This procedure is repeated at predetermined intervals.
- b. Equipment shall be securely anchored to the ground at the test point for obtaining the required reaction.
- c. The rod of the driving mechanism shall be brought to the top most position. The cone-friction jacket assembly shall be connected to the first sounding rod and the mantle tube. The assembly shall be positioned over the test point through the mantle tube guide and held vertically. The plunger of the driving mechanism shall be brought down so as to rest against the protruding sounding rod.
- d. To obtain the cone resistance, this sounding rod only shall be pushed. Switching the gear clutch to the slow position, the drive handle shall be operated at a steady rate of 1 cm per sec approximately, so as to advance the cone only to a depth which is possible with the cone assembly available. During the pushing, the mean value of resistance as indicated by pressure gauges shall be noted ignoring erratic changes.
- e. For finding combined cone and friction resistance of the soil the sounding rod, shall be pushed to the extent, the cone has been pushed at the rate of 1 cm per sec noting mean resistance on the gauges.
- f. Above procedure shall be repeated after pushing the combined cone-friction jacket and mantle tube assembly to the next depth at which the test is to be performed.
- g. This sequence of operation of the equipment is shown in the figure 4.

3.3.4.5 The performance record of results of static cone penetration test shall be as given in ANNEXURE-D.

### 3.3.5 PLATE LOAD TEST

#### 3.3.5.1 Plate size and thickness

- a. For clayey and silty soils and for loose to medium compact sandy soils ( $N < 15$ ) normally met with, chequered plate of 60cm x 60cm shall be used. Alternatively, circular plate of equivalent area also may be used.
- b. For dense sandy or gravelly soils ( $15 < N < 30$ ) the smallest size shall be 30cm square and largest 75cm square. Circular plates of equivalent area may also be used.
- c. The minimum thickness of the chequered plate shall be 25mm.

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## 3.3.5.2 Test pit

- a. Test pit shall be at least five times as wide as the test plate and the depth of the pit shall be the same as the depth of actual foundations.
- b. If the test is to be done on strata water table, the water level shall be maintained at the plate level, if necessary, throughout the test by dewatering, especially in sandy soils.
- c. The test shall be conducted immediately after examination of soil.

## 3.3.5.3 Placing of test plate

Plates shall be added to the soil by spreading fines and a layer not exceeding 5mm carefully levelled and set horizontally at the bottom of the pit. The ground shall be protected from rain and a minimum sealing pressure of  $70\text{g/cm}^2$  shall be applied and removed before starting the load test.

## 3.3.5.4 Method of loading

The reaction method of loading shall be employed. In this method loading is done by a jack against suitable reaction, such as a well as designed truss anchored to the ground at the two ends by soil anchors, loaded platform or any other suitable device. A typical arrangement is shown in Figures 5 and 6.

## 3.3.5.5 Application of load

- a. Loading shall be carried out in increments of  $1/5$  design load or about  $0.3\text{kg/cm}^2$  whichever is lower.
- b. Loading shall be carried out till one of the following conditions occurs:
  - i. Soil under the plate fails.
  - ii. Total settlement of the plate exceeds 40mm.
  - iii. Load intensity equal to thrice the design load is reached.
  - iv. Load intensity  $6.5\text{kg/cm}^2$  is reached.

## 3.3.5.6 Settlement and Observation

- a. Settlements shall be recorded with four dial gauges.
- b. Settlements shall be observed for each increment of load after an interval of 1, 4, 9, 16, 25, 36 and 64 minutes and thereafter every one hour.

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- c. Thenextloadincrementshallbeappliedwhenthe rateofsettlementislessthan 0.05 mm/hourwithaminimumperiodoftwo hours.For computingtherate of settlementitsextrapolationforperiodslessthan onehourshallnotbepermitted.

3.3.5.7 Unloading


- a. Unloading shallbedoneinstagesinthesamemanneraswasdone duringthe applicationof load.Rebound observationsduring the unloading alsoshallbe noted.
- b. Rebound shallbe noted during unloading stagesuntilthe readings become reasonablyconstant.

3.3.5.8 Record

- a. Recordshallconsistofthefollowing:
  - i. Load-settlementreadingintabular form.
  - ii. Time-Settlementcurveforeachloadstage.
  - iii. Load-settlementcurve innaturaland log-logscale. iv. Modulusofsub-gradereactionevaluatedfromtest.
- b. Inadditiontoabovetherecordshallalso containthefollowing:
  - v. Date
  - vi. Listofpersonnel
  - vii. Weatherconditions
  - viii. Irregularityinroutineprocedure,ifany.

3.3.5.9 Posttestrequirements

- a. Backfillingofthe pitshallbecarried outinan approvedmannerand asper the directionsofEngineer-in-Chargeoncompletionoftest.
- b. Anaugerborehole shallbemadefromthedepthoftest extendingtodepthof 6.0m belowtestdepth so asto ascertainthe natureof sub-soiltestdepth.If required,undisturbedsampleshallbeobtainedat suitabledepths from bore hole.

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### 3.4 PERCOLATION TEST

Percolation test to determine the soil absorption capacity shall be conducted in accordance with IS:2470(Part-I)-Appendix A.

### 3.5 DYNAMIC SOIL TESTS

#### 3.5.1 GENERAL

The following tests shall be conducted for the determination of elastic modulus and shear modulus of the soil and their variation with confining pressure for use in the design of foundations subject to vibratory loads:

##### 3.5.1.1 Wave velocity measurements

##### 3.5.1.2 Resonance tests

##### 3.5.1.3 Cyclic plate load test

##### 3.5.1.4 Repeated triaxial shear test.

#### 3.5.2 WAVE VELOCITY MEASUREMENTS:

The test setup and method of conducting the tests shall conform to IS: 5249 (latest edition). Concrete block shall be cast at a minimum depth of 0.5 m in virgin soil. Backfilling of the pits shall be carried out in an approved manner and as per the directions of the Engineer-in-Charge after removing the concrete block on completion of the test.

#### 3.5.3 RESONANCE TEST:

The block size and test depth be the same as laid out in 3.4.2 above. The equipment set up and method of conducting the tests set up and method of conducting the tests shall conform to IS:5249 (latest edition).

#### 3.5.4 CYCLIC PLATE LOAD TEST

The test setup and plates shall conform to that for plate load tests. After stabilisation of settlements for each load increment, load shall be removed and elastic rebound & residual settlements recorded. Where necessary, more than one cycle of loading and unloading shall be applied until a steady state of settlements is reached.

#### 3.5.5 REPEATED TRIAXIAL SHEAR TEST:

This test shall be carried out for confining pressure ranging from 0.5 kg/cm<sup>2</sup> to 4.0 kg/cm<sup>2</sup>. The triaxial sample shall first be subjected to an initial load equal to the anticipated static working load, which shall be indicated at the time of testing. Positive and negative values of a small increment of load shall then be applied to the sample in

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cycles and a graph plotted of stress against strain. E-values shall be obtained from this plot after obtaining a stable state.

- 3.5.6 Results of all the above tests shall be incorporated in the form of a plot of shear modulus  $V/s$  confining pressure for a range of pressure up to  $4.0 \text{ kg/cm}^2$ .

### 3.6 FOOTING LOAD TEST

- 3.6.1 This test shall be conducted on a concrete footing reinforced with 10 bars of 16 mm dia at 20 cm spacing both ways and having a size of 2m x 2m and a minimum overall thickness of 0.50 m provided with a suitably reinforced pedestal of size 60 cm x 60 cm.

- 3.6.2 Method of loading, recording of settlement observations and reporting of results shall be as specified for plate load test (clause 3.3.5). Loading shall be carried out in stages of  $0.5 \text{ kg/cm}^2$  or as specified up to a net loading intensity of  $2.5 \text{ kg/cm}^2$  (including weight of foundation).

### 3.7 FIELD CBR TESTS

This test shall be done as per IS: 2720 part XXXI at specified depth after removing top soil, vegetation and organic matter.

### 3.8 SAMPLING

#### 3.8.1 SAMPLING RECORD

All samples (disturbed and undisturbed) collected from the pit/bore hole shall be labeled in a manner shown in the ANNEXURE E. Label shall be attached to the top of sampler, in case of undisturbed samples. In case of samples collected in jar or other containers, the label should be properly pasted to the Jar/container.

#### 3.8.2 UNDISTURBED SOIL SAMPLES FROM BORE HOLES

- 3.8.2.1 Samples for recovering undisturbed samples from cohesive soils at the specified depth shall conform to IS: 2132. However, use of samplers less than 70 mm diameters shall not be permitted.

- 3.8.2.2 The sampling procedure shall conform to IS: 2132. Both the area ratio of the cutting edge, as well as recovery ratio of the cutting edge, as well as recovery ratio of the sample shall be measured and reported. For normal soils, area ratio of the sampling tubes, shall conform to IS: 2132, that is, it may vary from 10.9 percent to 12.4 percent but for sampling in very hard and dense soils, use of thick walled sampling tubes with area ratio not exceeding 20% may be permitted subject to the approval of the Engineer-in-charge.

- 3.8.2.3 In order to reduce the wall friction, suitable precautions such as oiling inside and outside the sampling tubes shall be observed. The sampling tube shall have smooth finish.

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3.8.2.4 In soft to firm clays, undisturbed samples shall be collected by pushing the tube continuously without impact or twisting. Driving of sampling tubes shall be permitted only if stiff to very stiff and hard deposit exists.

3.8.2.5 For highly sensitive soils, piston samples shall be employed.

3.8.2.6 For soft clay exceeding more than 15m depth from the ground level, collection of undisturbed samples shall be supplemented by the in-situ Vane Shear test.

3.8.2.7 The top and bottom of the sample shall be clearly marked on the sampling tube.

3.8.2.8 Undisturbed samples shall be tested within a period of two weeks of taking them from the borehole or trial pit.

3.8.2.9 If any space is left between the end of the tube and top of wax, the same shall be tightly packed with raw dust or any other suitable material. A close fitting lid or screwed cap shall then be placed on each end of the tube and held in position by adhesive tape.

3.8.3 UNDISTURBED SOIL SAMPLES FROM TRIAL PITS

3.8.3.1 Samples shall be obtained at specified depths from trial pits in a timber or steel box as under:

A benching shall be made at the level where it is proposed to take the sample. A cube of 30cm size shall be formed by careful trimming with knife or any other suitable sharp instrument. A timber box having dimensions slightly larger than the soil cube shall be slipped on it so as to act as a container and the sampler removed from the pit without causing any disturbance.

3.8.3.2 After recovery of the sample, all exposed faces shall be sealed with wax to prevent moisture loss and the sample shall be properly labeled and transferred to the laboratory immediately.

3.8.4 Disturbed Soil Samples - Disturbed soil samples shall be collected at every half a metre and at every change of strata from boreholes as well as from trial pits. Identification labels indicating depth, borehole number and visual soil classification shall be affixed on the containers.

3.8.5 WATERSAMPLES

3.8.5.1 Samples of ground water shall be obtained from the specified boreholes at the depths specified by Engineer-in-Charge.

3.8.5.2 At the specified depth water shall be bailed or pumped out so that fresh ground water flows into the borehole. Care shall be taken in avoiding any contamination with surface

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water at any time. Water samples shall be collected in a five litre polythene or glass container and labeled properly.

**3.9 PIEZOMETERS**

3.9.1 These may be installed in minimum 100 mm dia bore holes drilled by any suitable method.

3.9.2 INSTALLATION OF PIEZOMETERS:

Piezometers of Casagrande open stand pipe type shall be supplied and installed at locations and depth as indicated in the specific requirements. The piezometers shall be properly tested before installation to the entire satisfaction of Engineer-in-Charge. The details of the piezometer tips, size and diameter of stand pipe, RLs of tops of the stand pipe and the tip of the piezometer and procedure of installation etc. shall be furnished in the report along with a sketch.

If the piezometers fail to show results or malfunction the contractor shall replace them at a specified location without any extra charge to the owner.

The contractor shall provide each piezometer with permanent enclosure/chamber made of steel or concrete or brick of plan area 50cm x 50 cm and height suitable for the projection of the piezometer with a lock and key system to protect the open end of the stand pipe. The arrangement shall also ensure that readings can be taken at regular intervals. The contractor shall arrange a qualified person to take readings of all these piezometers at regular intervals as directed by the Engineer-in-Charge till all other works covered in the scope of this tender are completed.

The item rates shall be inclusive of all those mentioned above and no extra cost is permissible on any account.

**3.10 PRESSURE METER**

3.10.1 PRESSURE METER TESTS/SUBSOIL DEFORMETER TESTS

The tenderers shall furnish, along with the bids, the details of the equipment and the procedure of testing.

The results of each test, necessary graphs and plots, and interpretation of results shall be included in the report.

The depth of each test shall be indicated at the time of conducting the tests.

The pressure meters should have the following minimum limiting pressure ranges for different types of soils.

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Silt	0-7kg/cm <sup>2</sup>
Clay	0-12
StiffClay	18-40
DenseSilt	12-30
LooseSand	4-8
Softorweatheredrock	10-30
Sand&Gravel	10-20
DenseSand&Gravel	30-60

**4.0 LABORATORY TESTING OF SOILS**

**4.1 SAMPLING RECORD**

Detailsof samplingshallbeenteredinthepforma given in ANNEXURE - F. The performashallbesubmittedintriplicatetoEngineer-in-Charge.Oneofthecopiesshall bereturned byEngineer-in-Chargeindicatingtheteststobe performed.

**4.2 STORING OF SOILS SAMPLES IN LABORATORY**

- 4.2.1 Soilsampleshallbeinspectedandtestedshortly after their arrival atthelaboratory. Properarrangementforstoringshallbe madeincaseswheretesting ofsamplesisnot immediatelyaftertheyarebrought tothelaboratory.
- 4.2.2 Bagsof canvas,cansand binscanbe usedfor storinglarge quantities ofsoil.The containersshould have alabelortagwhichgivessuchdata assoiltype,project location, samplingdata,boringnumber,sampleddepth,etc.
- 4.2.3 Ifthe undisturbedclay samples are takenfrom pit, theyshould be covered witha protectivecoating. The coatingshallpreferably be withwax havingmelting point between120° to 160°F. Thewaxcoating canbeappliedby eitherdipping the soil sampleinthe meltedwaxorusingasoftbrushtospreadthemeltedwax.Waxshould not beheatedto morethan a few degrees aboveitsmeltingtemperature,sinceto heatingtohighertemperatures,tendtodriveoff morevolatilehydrocarbons,thusmaking thewaxmorepermeableand morebrittleupon coating.
- 4.2.4 Ifthe soilsampleistobestoredformorethan 15days,aprotectivecoatingofwax,in more than onelayer,isrecommendedwithatotalthicknessof12mmto18mm.
- 4.2.5 A few selectedsoilsamples shallbe storedinthelaboratorytill the soilinvestigation reportisfinalisedandapprovedbytheEngineer-in-Charge.



#### 4.3 HANDLING OF UNDISTURBED SAMPLES IN LABORATORY

- 4.3.1 The undisturbed samples shall be handled in the laboratory with due precaution to avoid disturbances and loss of moisture content which may adversely affect the test results.
- 4.3.2 Unprotected samples shall never be handled with bare hands because the hands foster disturbance and loss of moisture. The samples shall be protected by using Aluminium cellophane or wax paper before handling it.
- 4.3.3 When transporting a specimen it should be supported over its entire length by using a mould, plate or paper sling.
- 4.3.4 A chunk from an undisturbed sample collected from pits shall be cut with a wire saw which consists of a frame with a piano wire stretched tightly across it. Any wax or other covering used to protect the samples shall be cut with a knife or hacksaw. Care shall be taken when trimming the finished specimen. The wire in the wire saw used for final trimming shall be smaller in diameter than that used for preliminary cutting and the wire shall be cleaned prior to each cut.
- 4.3.5 In case of samples taken in sample tubes, the samples shall be extruded from the tubes by a steady pushing process and not by a jerky or driving one. Prior to extrusion the plug, which protects the end of the soil, shall be removed by scraping it with a knife or sawing off that portion of the tube which contains the plug. The extrusion shall employ the same direction of motion or motion of the soil with respect to the tube as existed during sampling, because a reversal of stress tends to cause disturbance.

#### 4.4 PROCEDURES OF TESTING

All apparatus used for laboratory testing shall conform to the specifications laid down in the relevant Indian Standards.

- 4.4.1 All testing procedures shall conform to those laid down in relevant Indian Standards.
- 4.4.2 For proper interpretation, results of each laboratory test shall be presented either as given in relevant Indian Standard or as specified in specific requirements.

#### 5.0 REPORT


- 5.1 The report shall state in brief the description of the test procedure employed.
- 5.2 The report shall also include wherever required a sample calculation with reference to formulae used to evaluate the various parameters.
- 5.3 Report shall also contain the summary of various soil parameters evaluated, in a format as shown in ANNEXURE-G.
- 5.4 Character and genesis of soil.

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- 5.5 Procedure of investigation employed.
- 5.6 Detailed bore logs, subsoil sections, laboratory and field test results both in tabular as well as graphical form and a plot plan showing locations and reduced levels of bore holes and other tests.
- 5.7 Results obtained and their interpretation.
- 5.8 Recommendation for type, depth, ultimate and safe bearing pressure and settlement of foundation for the following structures.
- Process units, power plant setc. which carry a heavy unit load.
  - Non-plant structures such as administrative buildings setc, which are lightly loaded.
  - Storage tanks and other structures founded at or near ground surface.
- 5.9 Recommendations shall also be given for allowable bearing pressure and settlements for foundations of sizes ranging from 1 to 10 metres placed at different depths ranging from surface to 3 metres below the ground surface.
- 5.10 Aggressiveness of soil and soil water to reinforced concrete and steel and other building materials.
- 5.11 Suitability of soil and degree of compaction of fill for the pavement and tank farms & recommendation for thickness of pavement for class AA and Class A loadings.
- 5.12 Modulus of subgrade reaction for pressure ranging up to  $3\text{kg/cm}^2$ . The recommended values shall include the effect of size, shape and depth of foundation.
- 5.13 In case of poor soil conditions recommendations are to be made for the following.
- Ground treatment method if considered necessary. If so type(s) of treatment method (s) recommended, depth of treatment and settlements and bearing capacity estimates after treatment.
  - Pile foundations if considered necessary, If so, type(s) of pile recommended, depth of pile, safe load capacity for different sizes of piles, p-y curves for lateral pile analysis shall also be submitted if specifically asked. Contractors shall also provide the ultimate pile load capacity curve with depth for various sizes of piles.
  - All recommendations shall be supported by back up calculations.
- 5.14 Any other information of special significance encountered during investigation and likely to have a bearing on design and construction.

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5.15 Interim reports based on the data available shall be supplied to the Engineer-in-Charge on demand.

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**ANNEXURE- A****LIST OF INDIAN STANDARDS REFERRED**

- |     |                  |  |
|-----|------------------|--|
| 1.  | IS:1498          | Classification and Identification of Soils for General Engineering Purposes.                 |
| 2.  | IS:1888          | Method of Load Tests on Soils  |
| 3.  | IS:1892          | Code of practice for Site Investigations for Foundations.                                    |
| 4.  | IS:2131          | Method for Standard Penetration Test for Soils   |
| 5.  | IS:2132          | Code of Practice for Thin Walled Tube Sampling of Soils.                                     |
| 6.  | IS:2470-Part-I   | Code of Practice for Design and Construction of Septic Tanks- Small installations.           |
| 7.  | IS:2720          | Method of Test for Soils (Relevant Parts)  |
| 8.  | IS:4434          | Code of practice for in situ Vane Shear Test for Soils.                                      |
| 9.  | IS:4968-Part-I   | Method for subsurface sounding for soils Dynamic Method Using Cone without Bentonite Slurry. |
| 10. | IS:4968-Part-II  | Method for subsurface sounding for soils Dynamic Method Using Cone and Bentonite Slurry.     |
| 11. | IS:4968-Part-III | Method for subsurface sounding for soils static cone penetration test.                       |
| 12. | IS:5249          | Method of Tests for Determination of in situ Dynamic Properties of Soils.                    |

**ANNEXURE -B**

**RECORD OF BORING**

Client..... Location.....  
 Ground Surface Level..... Boring No.....  
 Type of Boring..... Date Started.....  
 Diameter of Boring..... Date Completed.....  
 Ground Water Level..... Site Engineer.....

Describe of strata	Soil Classification	Strata Thickness	Depth from G.L	R.L. of Layer	Samples			Insitu Test			Remarks
					Type	No.	Depth	Type	Depth	Value	

**ANNEXURE-C**

**PROFORMA FOR FIELD VANESHEAR TEST**

**GENERAL**

Project

Bore-hole No.

Date of test

---

**DETAILS OF BORING (IF ANY)**

location

Reference elevation

or

Ground elevation

Method of making the hole

Cased/Uncased

Level of ground water table

at the time of test

---

**DETAILS OF VANE TEST**

**(a) Test from bottom of Borehole**

Vane size

Dia. of dummy rod (if used)

Conversion factor for torque measuring equipment

**(b) Test by Direct Penetration from Ground Surface**

Vane Constant

Depth

---

**TIME-ROTATION READINGS**

Time in Minutes	Depth					
	D	U	R	D	U	R

	D	U	R	D	U	R
Depth of vane tip below bottom of borehole or vane shoe						
Time of failure						
Maximum reading in torque measuring equipment						
Maximum torque						
Number of revolutions for remoulding						
Shear strength of undisturbed soil KN/m <sup>2</sup> (kgf/cm <sup>2</sup> )						
Shear strength of remoulded soil KN/m <sup>2</sup> (kgf/cm <sup>2</sup> )						
Sensitivity						

D=Test with dummy, if used, or any other test for determination of friction of vane rod/torque rod.

U=Test with vane in undisturbed soil.

R=Test with vane in remoulded soil.

**PROFORMA FOR STATIC CONE TEST**

Project : Test point location  
 Site : Ground elevation  
 Borehole Reference : Ground water level

**Static Cone Resistance**

- Correction:
1. Mass of cone =  $m$
  2. Mass of each sounding rod =  $m_1$
  3. Cone area at base,  $b = \text{cm}^2$
  4. \*Plunger area
  5. Correction factor (to be added to the gauge reading)  

$$= (m + nm_1) \times 10 \text{ KN/m}^2$$

$$= (m + nm_1) / 10 \text{ Kg/cm}^2$$

\*The gauge readings shall be multiplied by the ratio of plunger area to the area of the base of cone

Depth below Ground level	Gauge reading  (KN/m <sup>2</sup> )	Corrected value of cone penetration resistance  (KN/m <sup>2</sup> )
-----------------------------	--	--

Frictional resistance measured at particular depths with the help of friction jacket attached to the static cone.

Correction:

- 1) Mass of friction jacket =  $m_f \text{ kg}$
- 2) Area of surface of friction jacket,  $a = \pi dh \text{ cm}^2$   
 Where  $d$  = outer diameter of friction jacket and  
 $h$  = length of friction jacket



- 3) Cone area at base,  $b = cm^2$
- 4) Correction factor (to be added)  $= 100m_f/a \text{ KN/m}^2$   
 $= 1 \text{ KN/m}^2 (.01 \text{ kgf/cm}^2)$

Depth below ground level (m)	Total resistance $\text{KN/m}^2$ ( $\text{kgf/cm}^2$ )	Cone resistance (uncorrected) $\text{KN/m}^2$ ( $\text{kgf/cm}^2$ )	Total resistance-cone resistance $\text{KN/m}^2$ ( $\text{kgf/cm}^2$ )	Frictional resistance in $\text{KN/m}^2$ ( $\text{kgf/cm}^2$ )	Corrected frictional resistance $\text{KN/m}^2$ ( $\text{kgf/cm}^2$ )
m	X	y	x-y	$((x-y)b)/a = Z$	$Z + (100/a)m_f(Z + m_f/a)$

**ANNEXURE-E**  
**SAMPLELABEL**

Project\_\_\_\_\_

Location\_\_\_\_\_

Date\_\_\_\_\_

SampleNo.\_\_\_\_\_

SoilDescription\_\_\_\_\_

Boring/Trial  
No.\_\_\_\_\_

Depthofsampletop\_\_\_\_\_

Elevationofgroundsurface\_\_\_\_\_

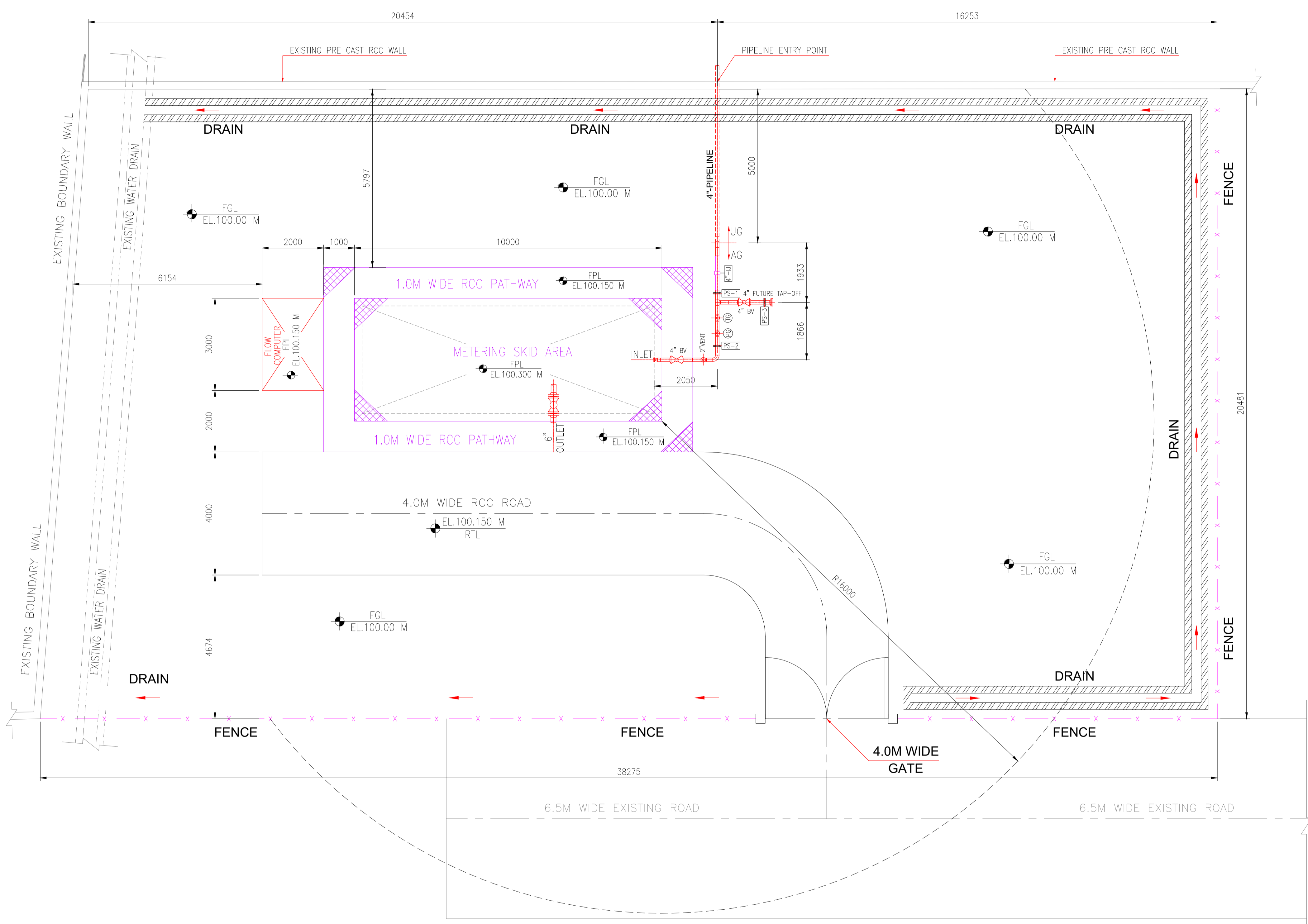
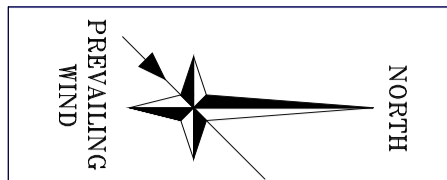
Typeofsample\_\_\_\_\_

Disturbed/Undisturbed\_\_\_\_\_

Remarks\_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_





INTER DISTANCE FOR VARIOUS STATION FACILITIES (METER)

SL.NO.	FROM /TO	OISD/PNGRB			ACTUAL AS PER DRAWING		
		1	2	3	1	2	3
1	GAS HANDLING SYSTEM	-	15	5	-	25.4	5.8
2	CONTROL ROOM	15	-	5	25.4	-	-
3	COMPOUND WALL	5	5	-	5.8	-	-

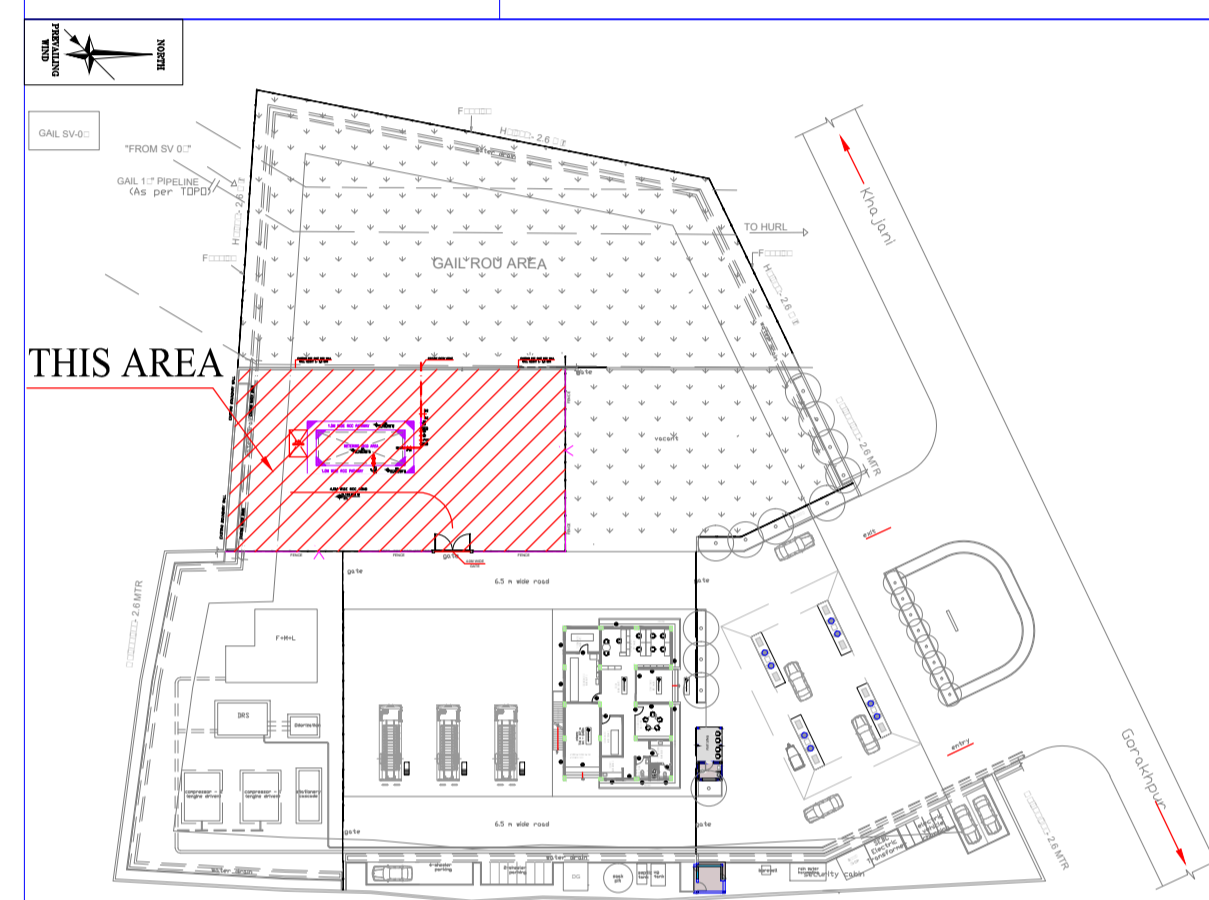
CONNECTING DRAWING/DOCUMENTS:-

S.NO.	DOCUMENTS/DRAWING NAME	DRAWING NO.
1	EXISTING LAYOUT OF CGS FACILITY AT GORAKHPUR	01-00-00-01
2	P&ID OF CGD TO TORRENT GAS PRIVATE LIMITED AT GORAKHPUR	GAIL-034030-PR-DWG-003
3	SCHEMATIC DIAGRAM OF CGD TO TORRENT GAS PRIVATE LIMITED AT GORAKHPUR	GAIL-034030-PL-DWG-002
4	GAD FOR METERING SKID	NI-GAIL-CGDARC-18-20-GAD-100

- NOTES:-
- ALL DIMENSION ARE IN MM AND CO-ORDINATES AND LEVELS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
  - FGL EL.100.00M CORRESPOND TO EXISTING ROAD LEVEL EL. 74.70M.+0.300 MM.
  - PIPING GENERAL ARRANGEMENT DRAWING SHOWN IN THE DRAWING IS FOR INFORMATION ONLY.
  - DRAIN SLOPE MAINTAINED AT 1:750 AND GROUND SLOPE MAINTAINED AT 1:500.
  - RCC ROAD IN M-20 AND FOOTPATH WITH PAVER BLOCK SHALL BE PROVIDED.
  - NO BUILDING/FACILITIES SHALL BE LOCATED WITHIN 15.0M OF ANY LEAK POINT (FLANGE/VENT).
  - THE DRAIN AS SHOWN IN THE LAYOUT IS TENTATIVE, FOR DETAILED DRAWING OF DRAIN KINDLY REFER DWG.NO.GAIL-034030-CV-DWG-010.

LEGEND:-

RTL	ROAD TOP LEVEL	LEVEL/ELEVATION
TOS	TOP OF STEEL	PAVED AREA
AG	ABOVE GROUND	BOUNDARY WALL
FGL	FINISHED GROUND LEVEL	ABOVE GROUND PIPE
FPL	FINISHED PAVED LEVEL	BELOW GROUND PIPE
TOP	TAP OF POINT	UG
TOP	TOP OF FOUNDATION	UNDER GROUND
HPP	HIGHEST PAVEMENT POINT	RCC PAVEMENT/ROAD IN PROCESS AREA



KEY PLAN

REV.	DATE	DESCRIPTION	PREP.	CHKD.	APPD.
0	16.06.20	ISSUED FOR REVIEW	VKS	SY	TR

CLIENT: **GAIL (INDIA) LIMITED**

PMC: **LEPL LYONS ENGINEERING PVT. LTD.**

PROJECT: **CGD TO TORRENT GAS PRIVATE LIMITED AT GORAKHPUR**

SCALE: 1:60 TITLE: **PLOT PLAN FOR TORRENT GAS PRIVATE LIMITED AT GORAKHPUR**

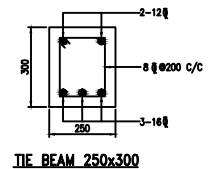
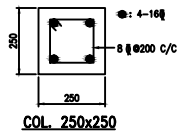
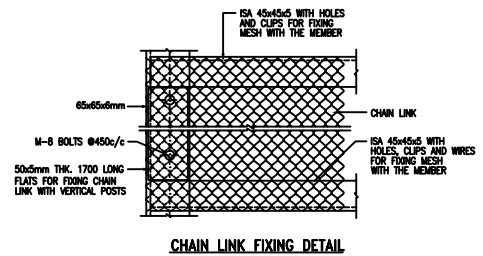
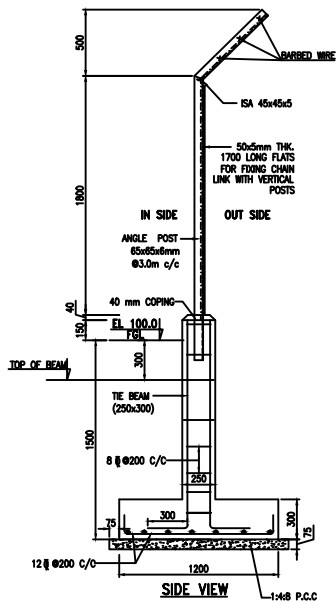
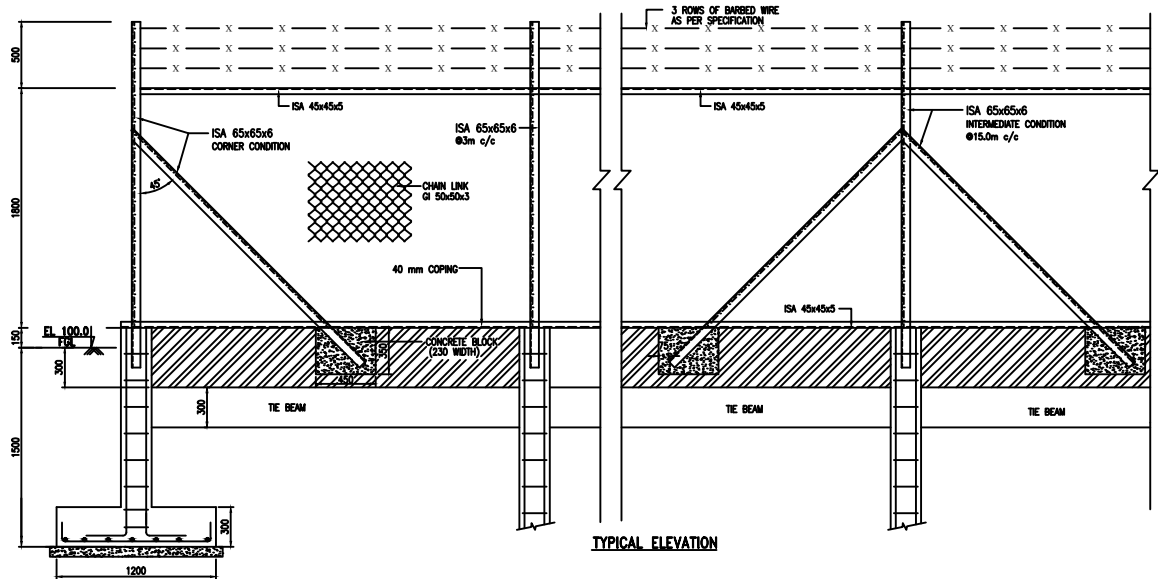
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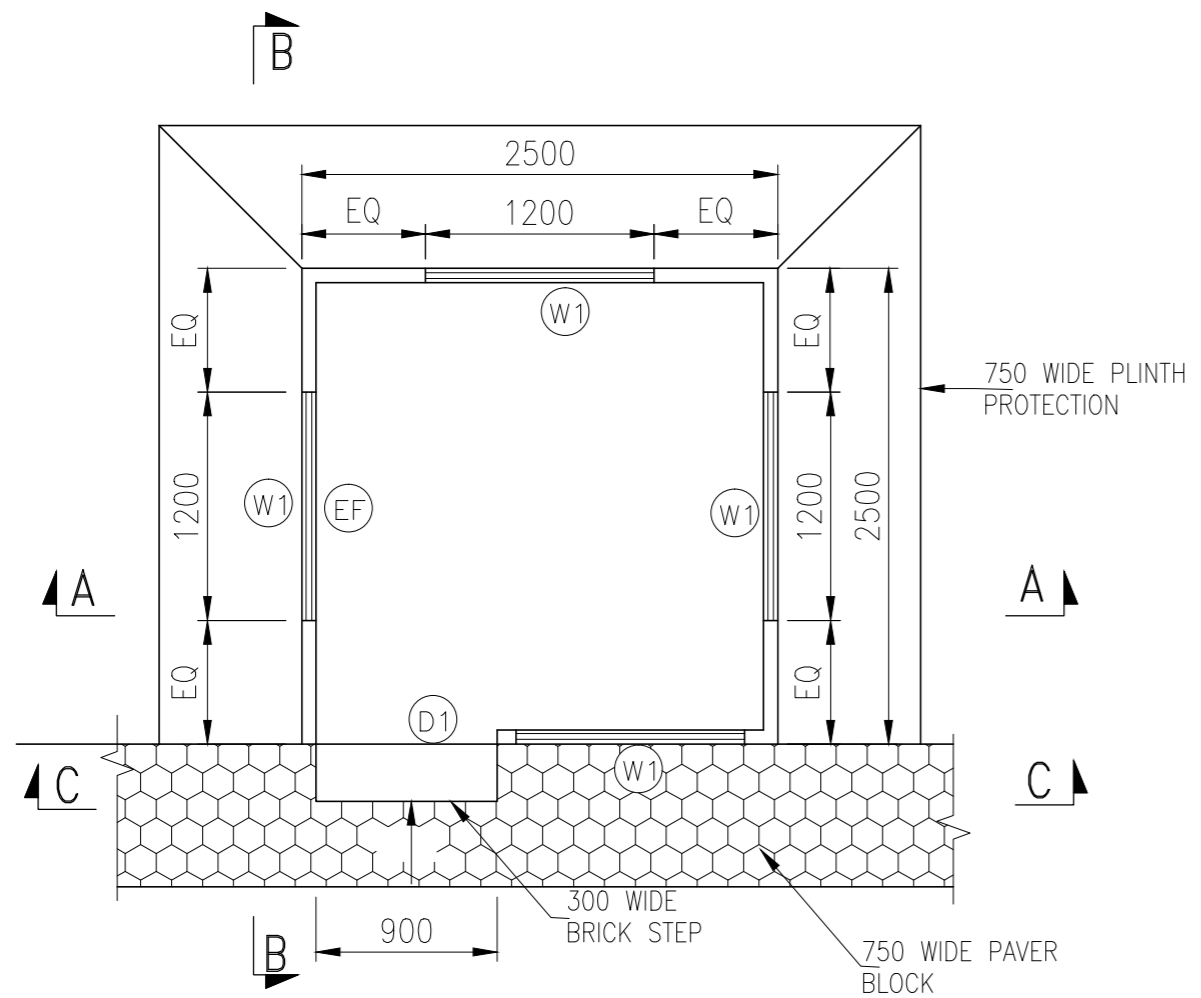
LYONS ENGINEERING PVT. LTD.  
NEW DELHI

TYPICAL DETAIL OF  
CHAIN LINK FENCING

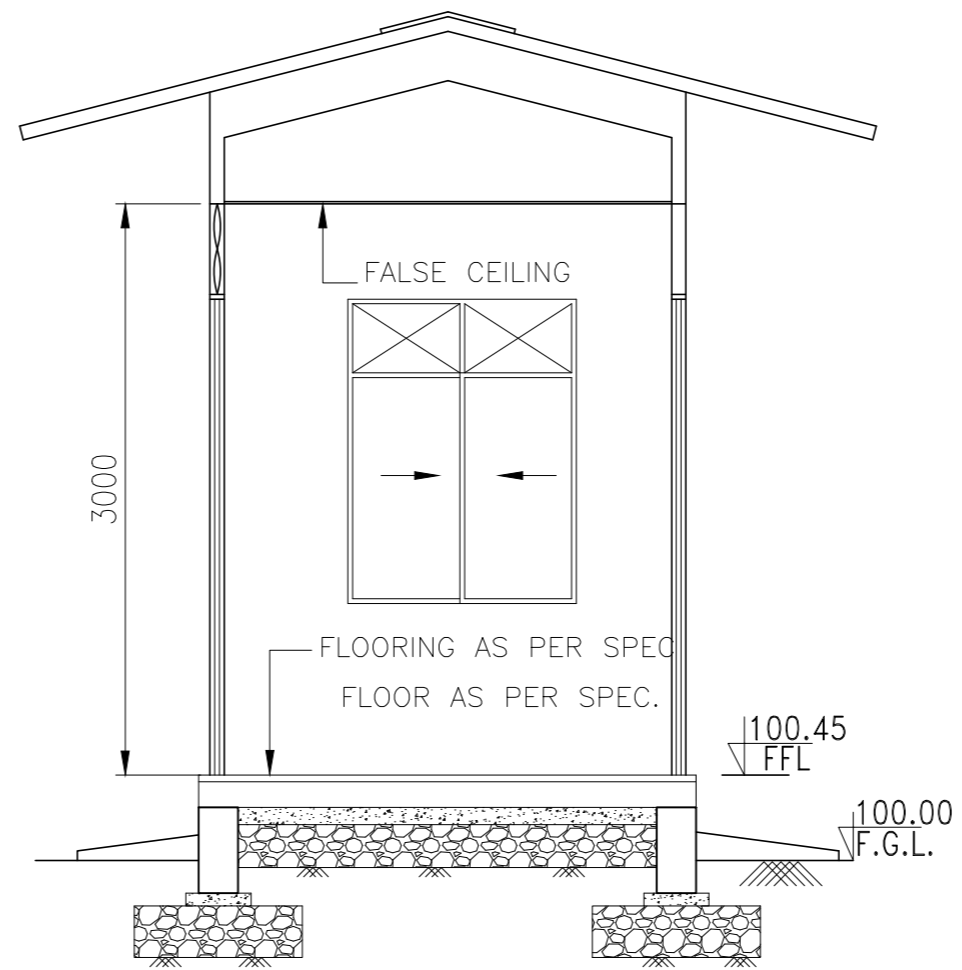
DRAWING NO.  
GAIL-STD-CV-DWG-TP-001  
SHEET NO. 1 OF 1



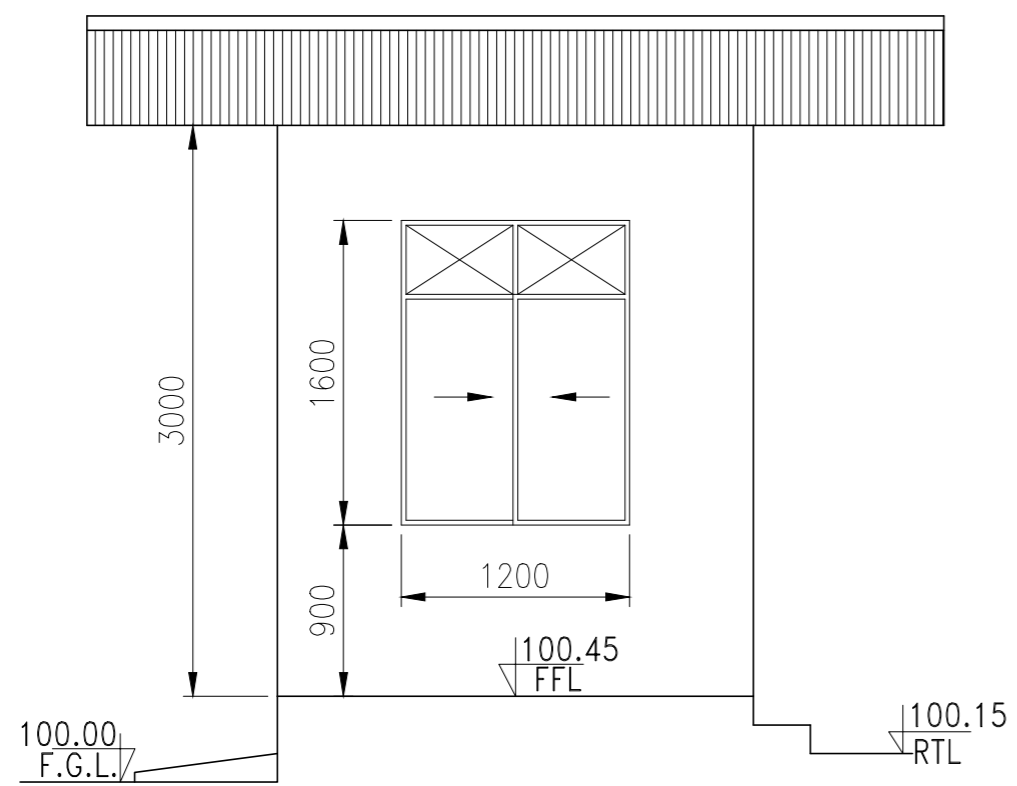
0	10-01-2019	ISSUED FOR TENDER	DV	VKS	SK
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED



**GROUND FLOOR PLAN**  
(PRE FABRICATED CABIN)





**SECTION A-A**

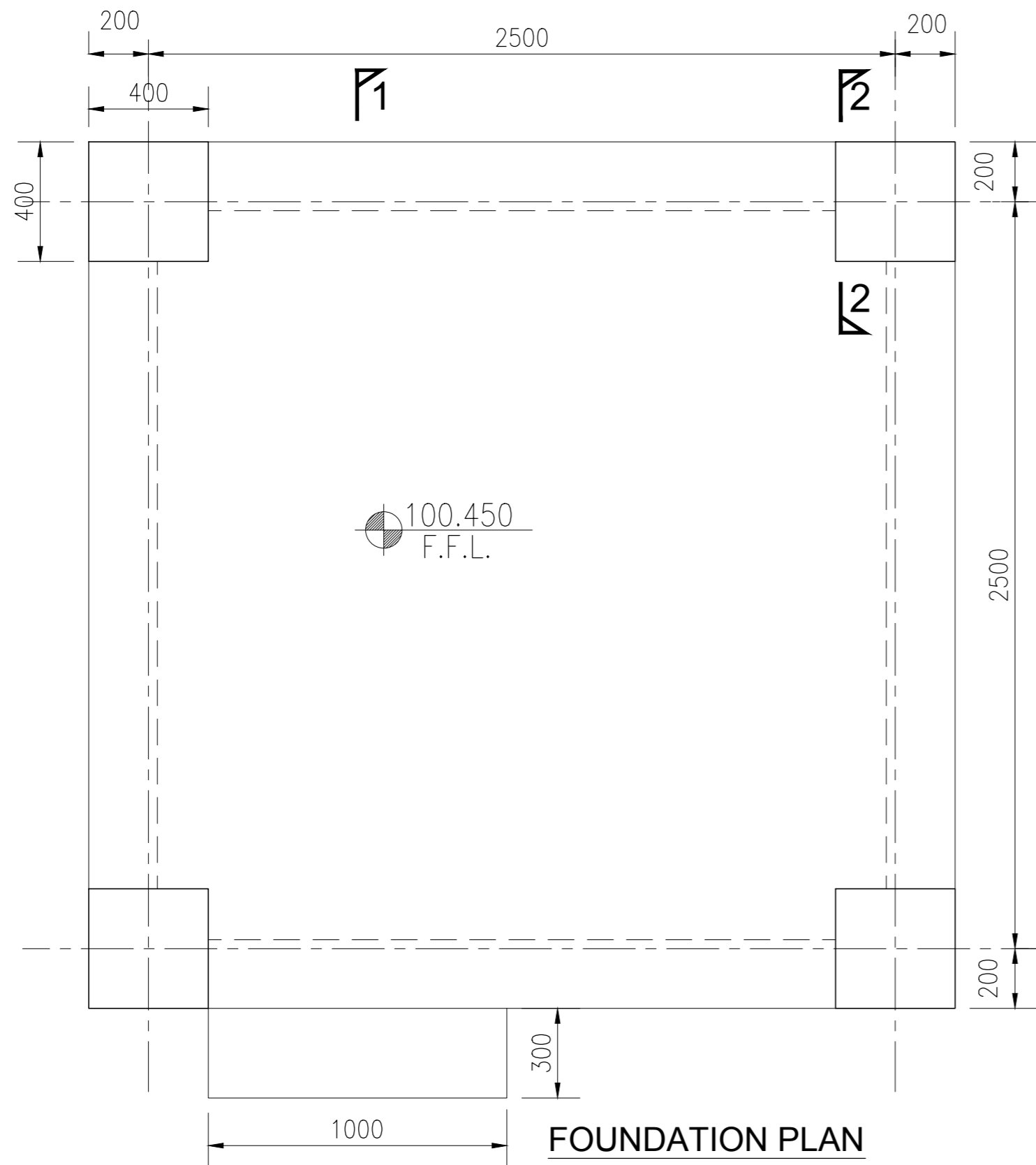


**ELEVATION B-B**

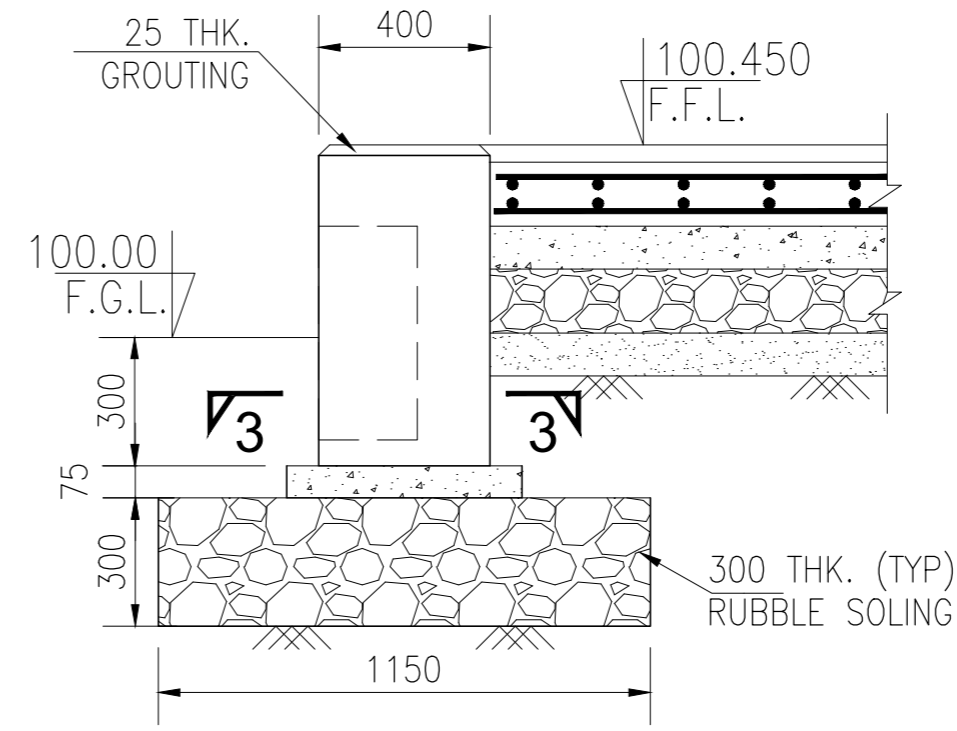


**ELEVATION C-C**

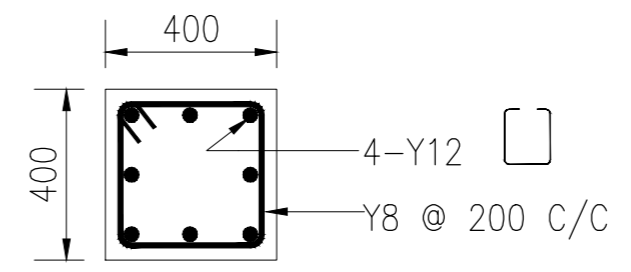
0	10.01.19	ISSUED FOR TENDER	DV	VK	JR
REV.	DATE	DESCRIPTION	PREP.	CHKD.	APPD.
CLIENT:		 <b>GAIL (INDIA) LIMITED</b>			
PMC:		 <b>LYONS ENGINEERING PVT. LTD.</b>			
SCALE	TITLE:				
1:100	TYPICAL DETAIL OF GUARD ROOM				
SIZE	DRAWING NUMBER	SHEET	REV.		
A2	GAIL-STD-CV-DWG-TP-002	1 OF 2	0		



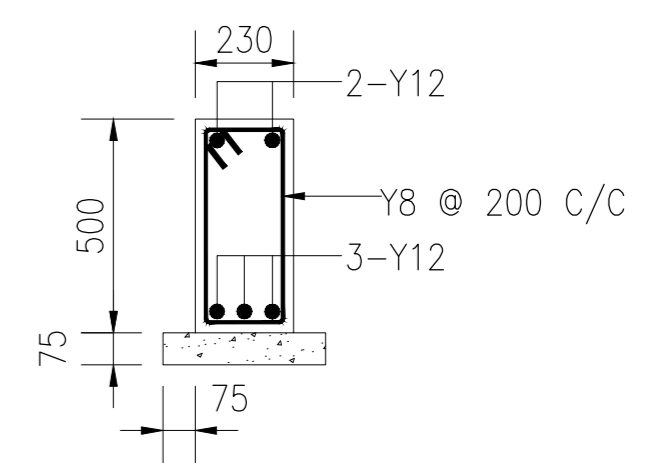
**FOUNDATION PLAN**



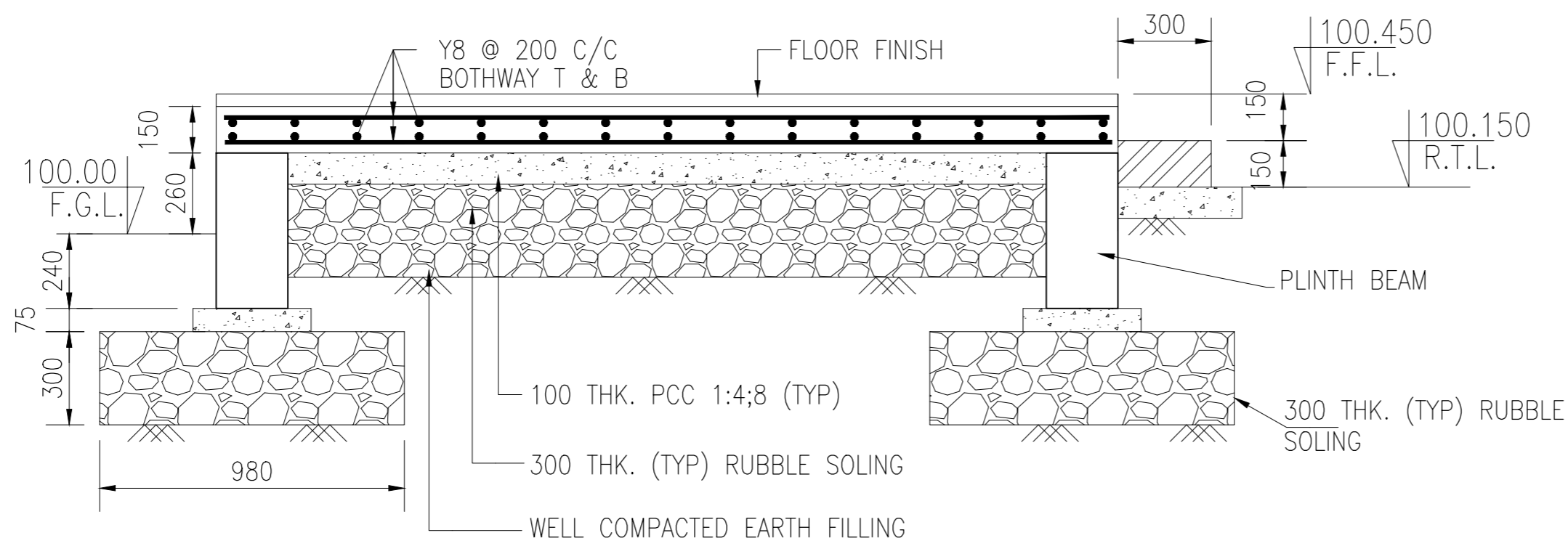
**SECTION 2-2**



**SECTION 3-3**



**R/F DETAIL OF PLINTH BEAM**



**SECTION 1-1**

0	10.01.19	ISSUED FOR TENDER	DV	VK	JR
REV.	DATE	DESCRIPTION	PREP.	CHKD.	APPD.
CLIENT:		<b>GAIL (INDIA) LIMITED</b>			
PMC:		<b>LYONS ENGINEERING PVT. LTD.</b>			
SCALE	TITLE:				
1:100	TYPICAL DETAIL OF GUARD ROOM				
SIZE	DRAWING NUMBER		SHEET	REV.	
A2	GAIL-STD-CV-DWG-TP-002		2 OF 2	0	



LYONS ENGINEERING PVT. LTD.  
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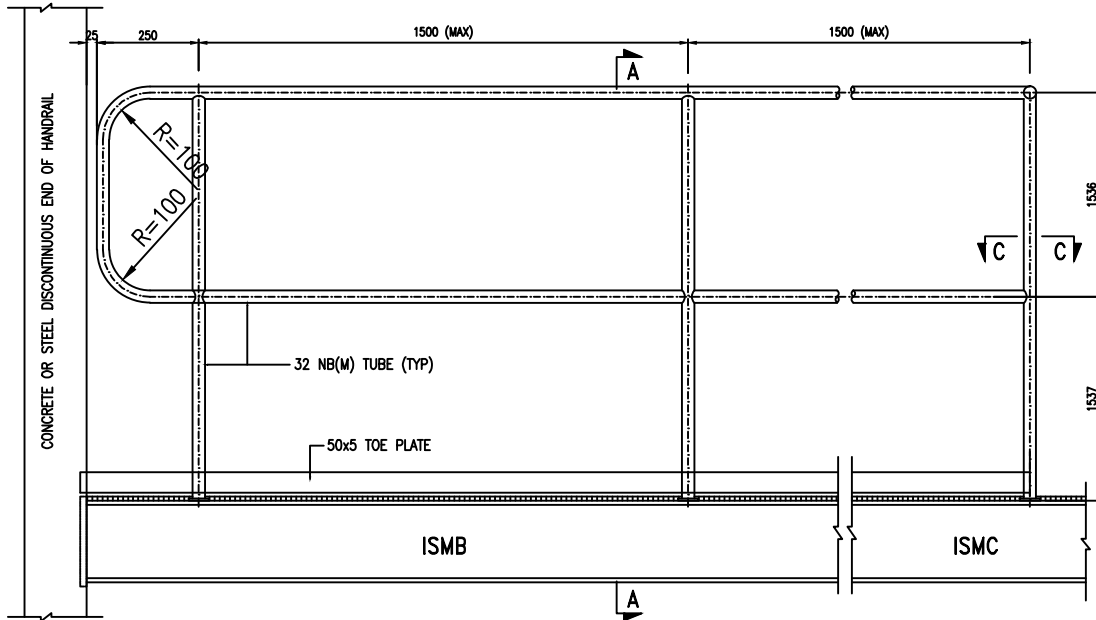
TYPICAL DETAIL OF  
HANDRAIL ON STEEL  
PLATFORM

DRAWING NO.

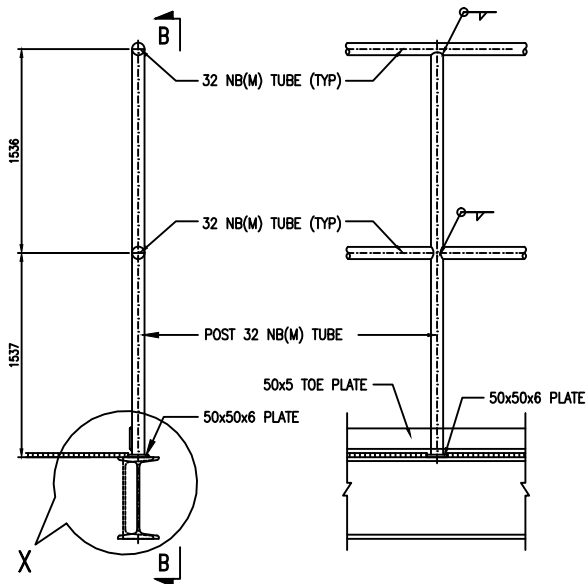
GAIL-STD-CV-DWG-TP-003

SHEET NO.

1 OF 1

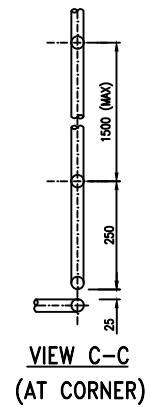


HORIZONTAL HANDRAIL ON STEEL PLATFORM

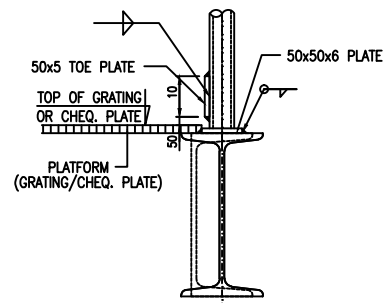


SECTION A-A

VIEW B-B



VIEW C-C  
(AT CORNER)



DETAIL X

0	10-01-2019	ISSUED FOR TENDER	DV	VKS	SK
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED





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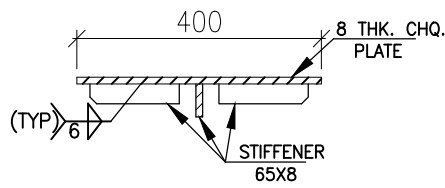
TYPICAL DETAIL OF  
CHEQUERED PLATE

DRAWING NO.

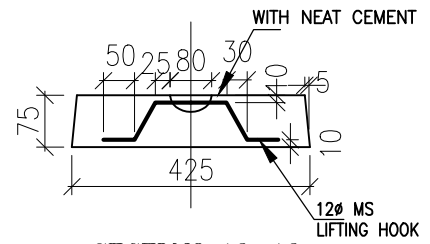
GAIL-STD-CV-DWG-TP-004

SHEET NO.

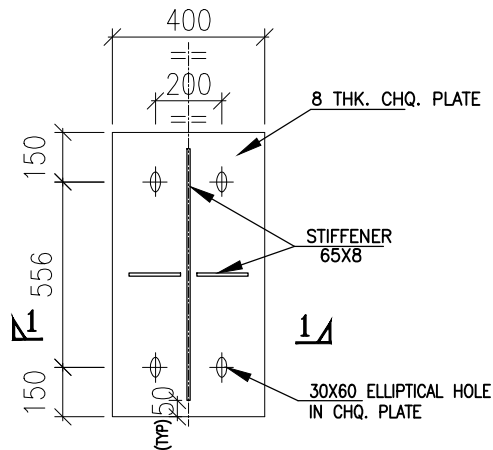
1 OF 1



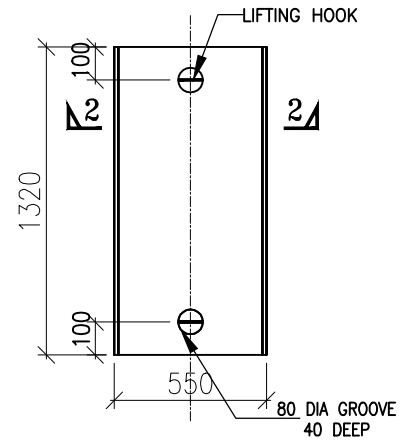
**SECTION 10-10**



**SECTION 12-12**

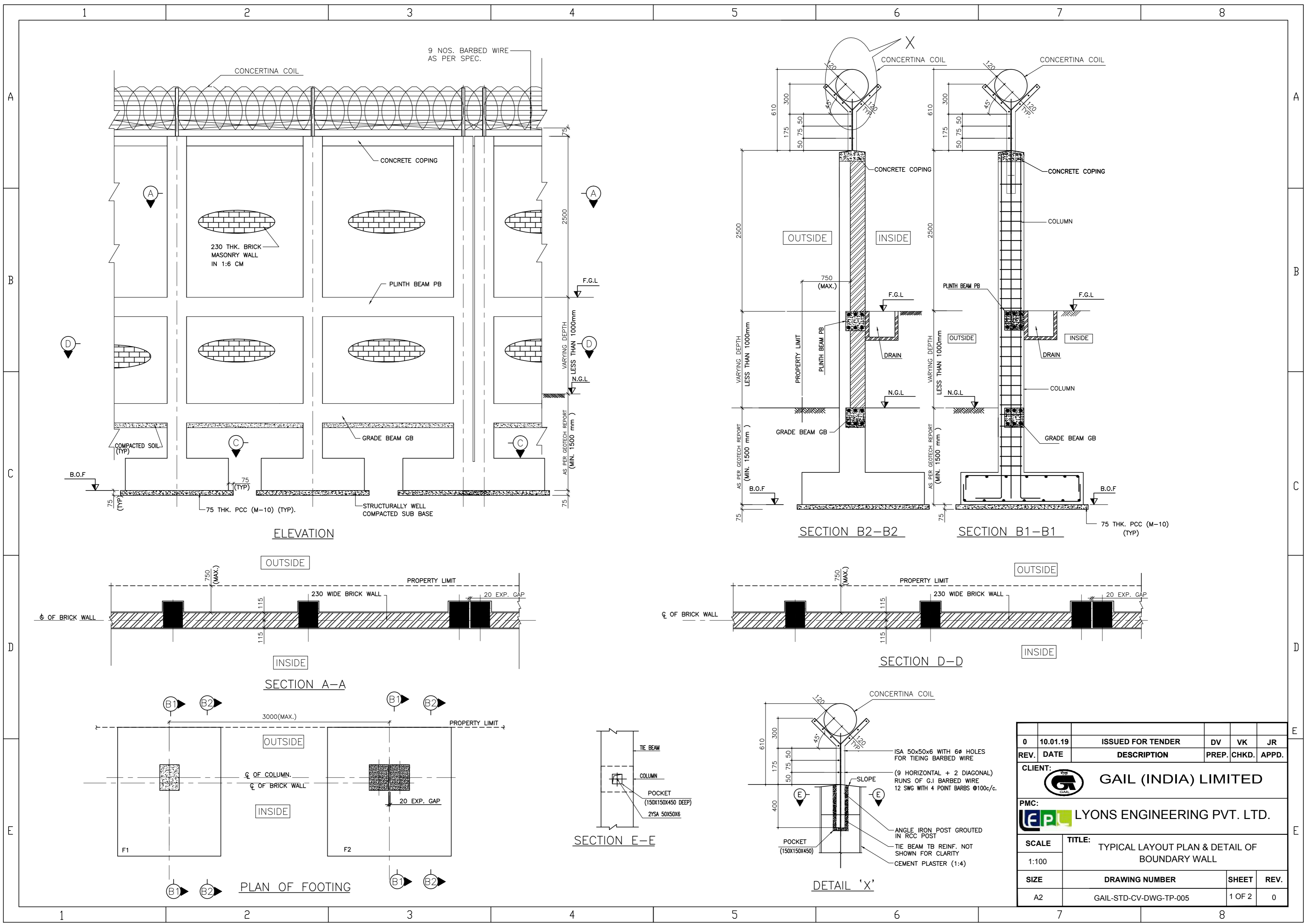


**TYPICAL DETAIL OF  
CHEQUERED PLATE MKD. CHQ-I**



**DETAIL OF PRECAST  
SLAB PS-1**

0	10-01-2019	ISSUED FOR TENDER	DV	VKS	SK
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED



0	10.01.19	ISSUED FOR TENDER	DV	VK	JR
REV.	DATE	DESCRIPTION	PREP.	CHKD.	APPD.
CLIENT:		<b>GAIL (INDIA) LIMITED</b>			
PMC:		<b>LYONS ENGINEERING PVT. LTD.</b>			
SCALE	TITLE: TYPICAL LAYOUT PLAN & DETAIL OF BOUNDARY WALL				
1:100					
SIZE	DRAWING NUMBER	SHEET	REV.		
A2	GAIL-STD-CV-DWG-TP-005	1 OF 2	0		



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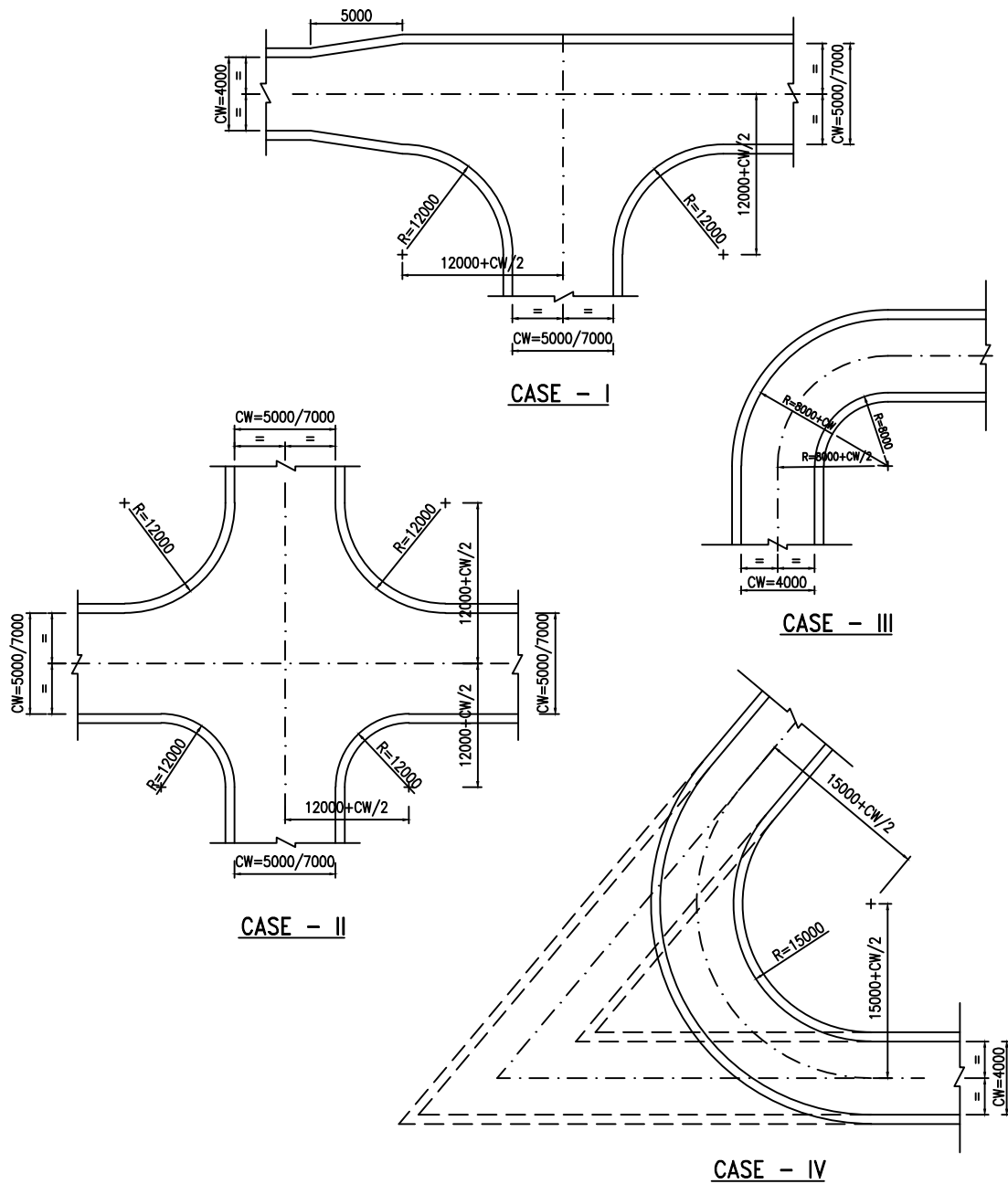
TYPICAL DETAIL OF  
ROAD CURVES  
AND CROSSINGS

DRAWING NO.

GAIL-STDCV-DWG-TP-006

SHEET NO.

1 OF 1



**NOTES:-**

1. ALL DIMENSIONS ARE IN MM. UNLESS OTHERWISE MENTIONED.
2. MINIMUM RADIUS OF CURVES FOR ROADS WITH CW=4.0m
3. MINIMUM RADIUS OF CURVES FOR ROADS WITH CW>4.0m SHALL BE 12m.
4. RADIUS OF CURVES FOR APPROACH ROADS TO BUILDINGS AND OTHERS AREAS MAY BE REDUCED AS PER SERVICES REQUIRMENTS.
5. FOR ROAD CURVES WITH ACUTE ANGLE TURNING. THE MINIMUM RADIUS SHALL BE 15m AND ANGLE NOT LESS THAN 50°.

6. RADIUS OF CURVES AND CROSSING WHEN DIFFERENT FROM THOSE GIVEN IN THIS STANDARD TO MEET ANY SPECIAL REQUIREMENT SHALL BE SO MARKED IN THE AREA DRAWINGS.

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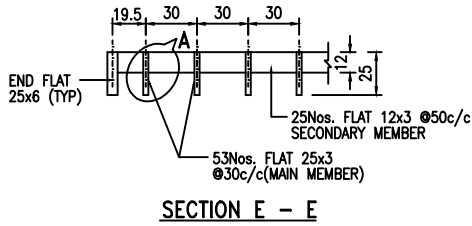
TYPICAL PLATFORM DETAIL

DRAWING NO.

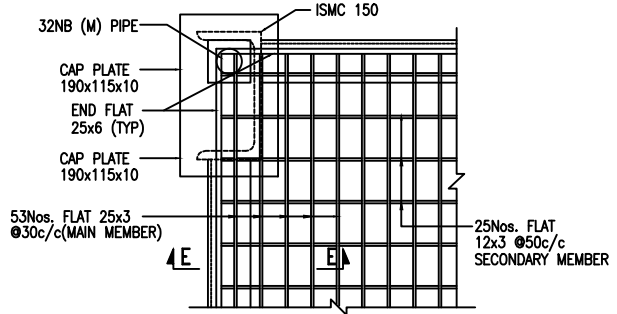
GAIL-STD-CV-DWG-TP-007

SHEET NO.

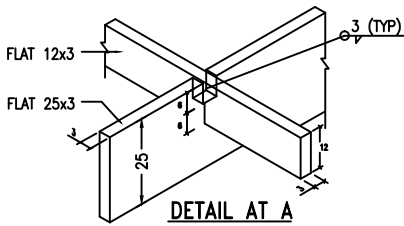
1 OF 1



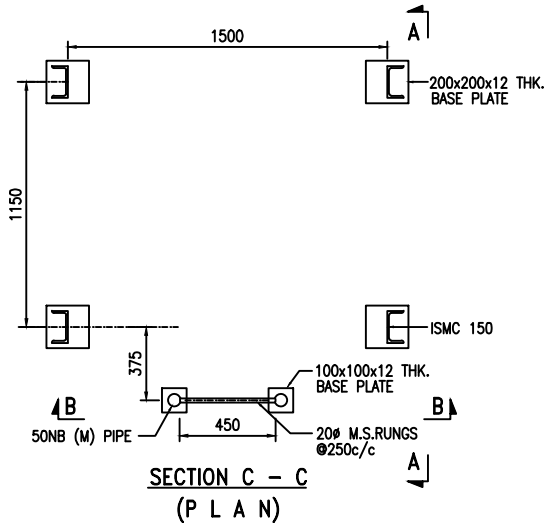
SECTION E - E



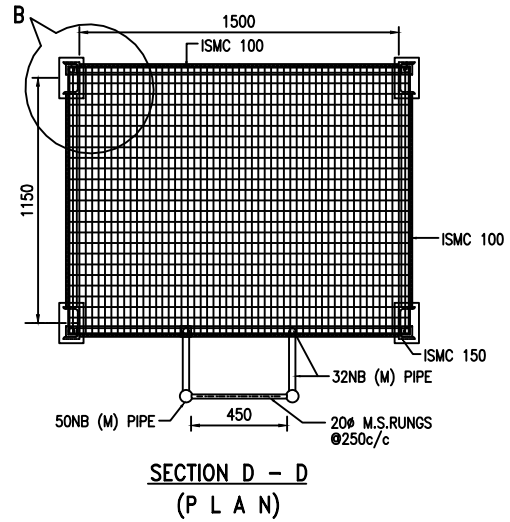
DETAIL AT B



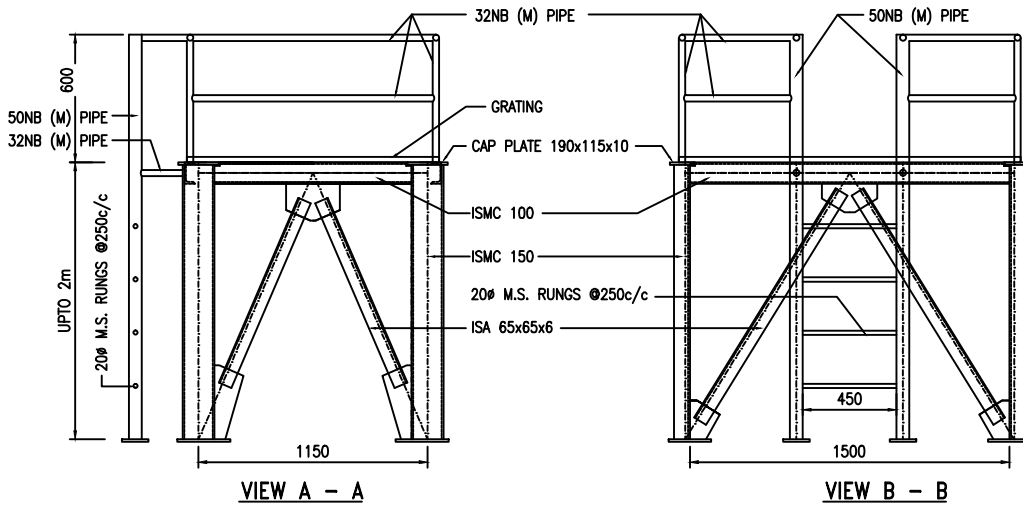
DETAIL AT A



SECTION C - C  
(PLAN)



SECTION D - D  
(PLAN)



VIEW A - A

VIEW B - B

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TYPICAL  
CONCRETE BEDDING

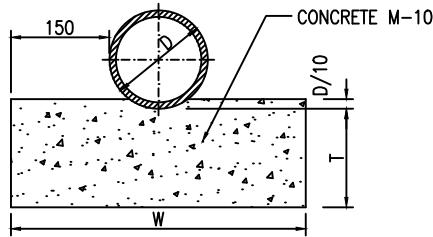
DRAWING NO.

GAIL-STD-CV-DWG-TP-008

SHEET NO.

1 OF 1

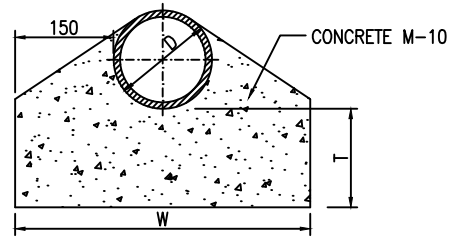
**TYPE-I**



**SECTION ELEVATION OF BEDDING**

(FOR C.S PIPE SEWER WHERE SUPPORT IS REQUIRED)

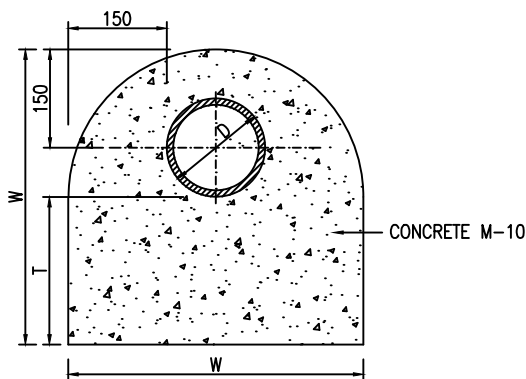
**TYPE-II**



**SECTION ELEVATION OF HAUNCHING**

(FOR HDPE, SW PIPE SEWERS)

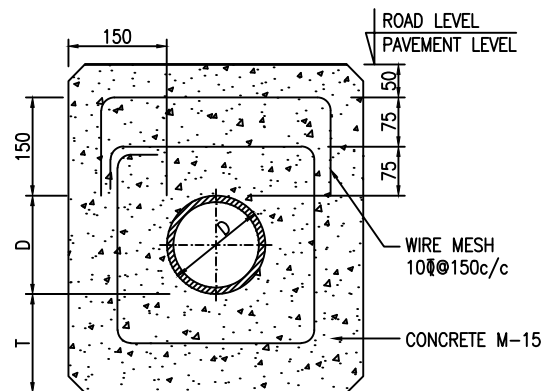
**TYPE-III A**



**SECTION ELEVATION SURROUND OR ENCASING**

(FOR SEWERS UNDER ROADS COVER > 600mm)

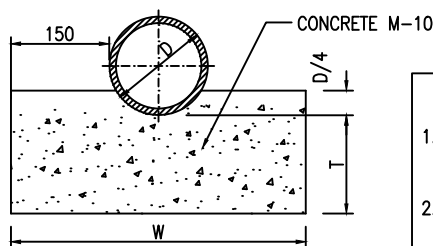
**TYPE-III B**



**SECTION ELEVATION SURROUND OR ENCASING**

(FOR SLEEVES/PIPES CULVERTS UNDER ROADS FOR COVER < 600mm)

**TYPE-IV**



**SECTION ELEVATION CONCRETE GRADE BEDDING**

(FOR SEWERS - CONCRETE PIPE)

**LEGEND**

- D = EXTERNAL DIA OF PIPE
- W = D+300
- T = 100 FOR PIPES UNDER 150 NOMINAL DIA.
- T = 150 FOR PIPES OF 150 NOMINAL DIA AND ABOVE.

**NOTES:-**

1. BEDDING:- WHERE BEDDING IS USED, THE CONCRETE SHALL BE BROUGHT UP TO ATLEAST TO THE INVERT LEVEL OF THE PIPE TO FORM A CRADLE & TO AVOID LINE CONTACT BETWEEN THE PIPE AND BED.
2. HAUNCHING:- THE FULL WIDTH OF THE BED SHALL BE CARRIED TO THE LEVEL OF THE HORIZONTAL DIAMETER OF THE PIPE AND SPLAYS FROM THIS LEVEL CARRIED ON BOTH SIDES OF THE PIPE TO MEET THE PIPE BARREL TANGENTIALLY.
3. SURROUNDED OR ENCASING TYPE-III A:- THE SURROUND OR ENCASING SHALL BE SIMILAR TO HAUNCHING UP TO THE HORIZONTAL, DIA OF THE PIPE & THE PORTION OVER THIS SHALL BE FINISHED IN A SEMI-CIRCULAR FORM TO GIVE A UNIFORM ENCASING FOR THE TOP HALF OF THE PIPE.  
TYPE-III B:- IT IS SIMILAR TO TYPE-III A ABOVE EXCEPT THAT THE TOP PORTION OVER THIS SHALL BE FINISHED RECTANGULAR AS SHOWN AND THE SECTION PROVIDED WITH REINFORCEMENT AS PER REQUIREMENTS.
4. CONCRETE CRADLE BEDDING:- IS THE METHOD OF BEDDING PIPES IN WHICH THE LOWER PART OF THE PIPE EXTERIOR IS BEDDED IN CRADLE CONSTRUCTION OF CONCRETE WITH DIMENSION AS SHOWN.
5. CONCRETE WORK SHALL BE CONFORM TO IS: 456.

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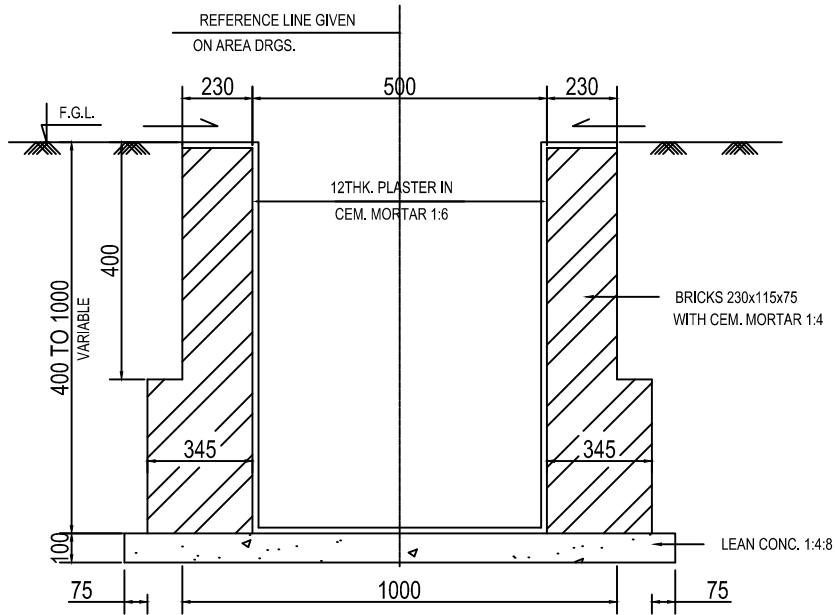
TYPICAL STORM  
WATER DRAIN (OPEN)

DRAWING NO.

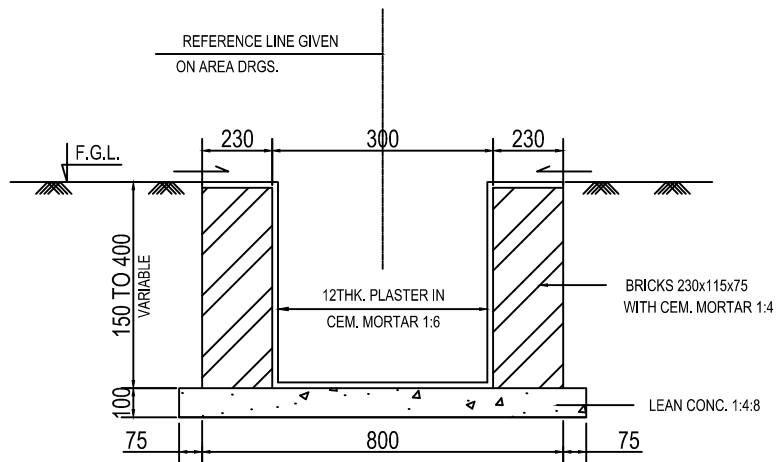
GAIL-STD-CV-DWG-TP-009

SHEET NO.

1 OF 2



RECTANGULAR DRAIN  
(TYPE-1)



RECTANGULAR DRAIN  
(TYPE-2)

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### TYPICAL TRENCH SAND BEDDING

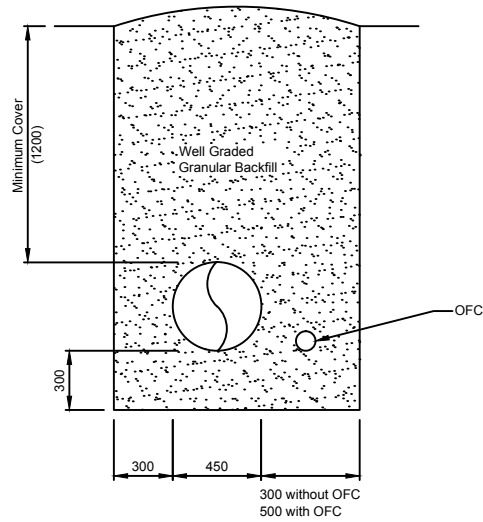
DRAWING NO.

GAIL-STD-CV-DWG-TP-010

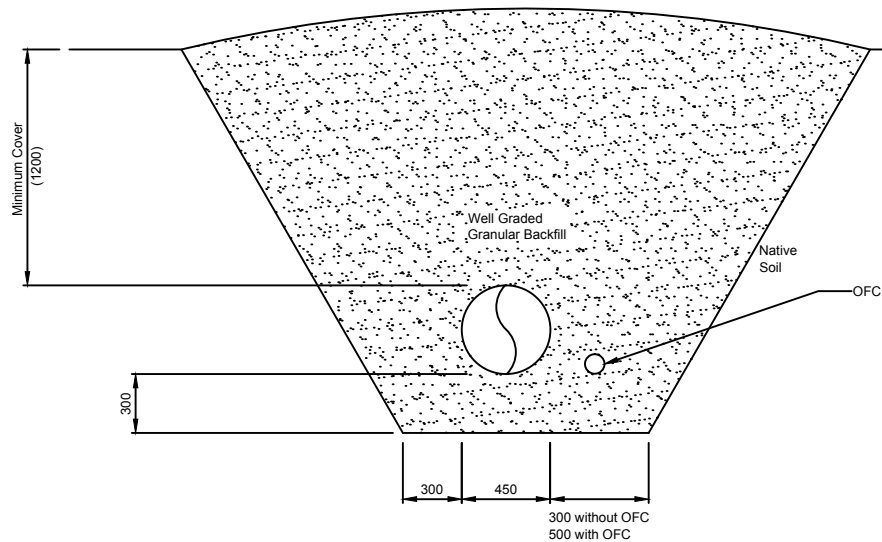
SHEET NO.

1 OF 1

FOR ROCKY STRATA / GRAVEL AREA :



FOR CLAY SOIL :



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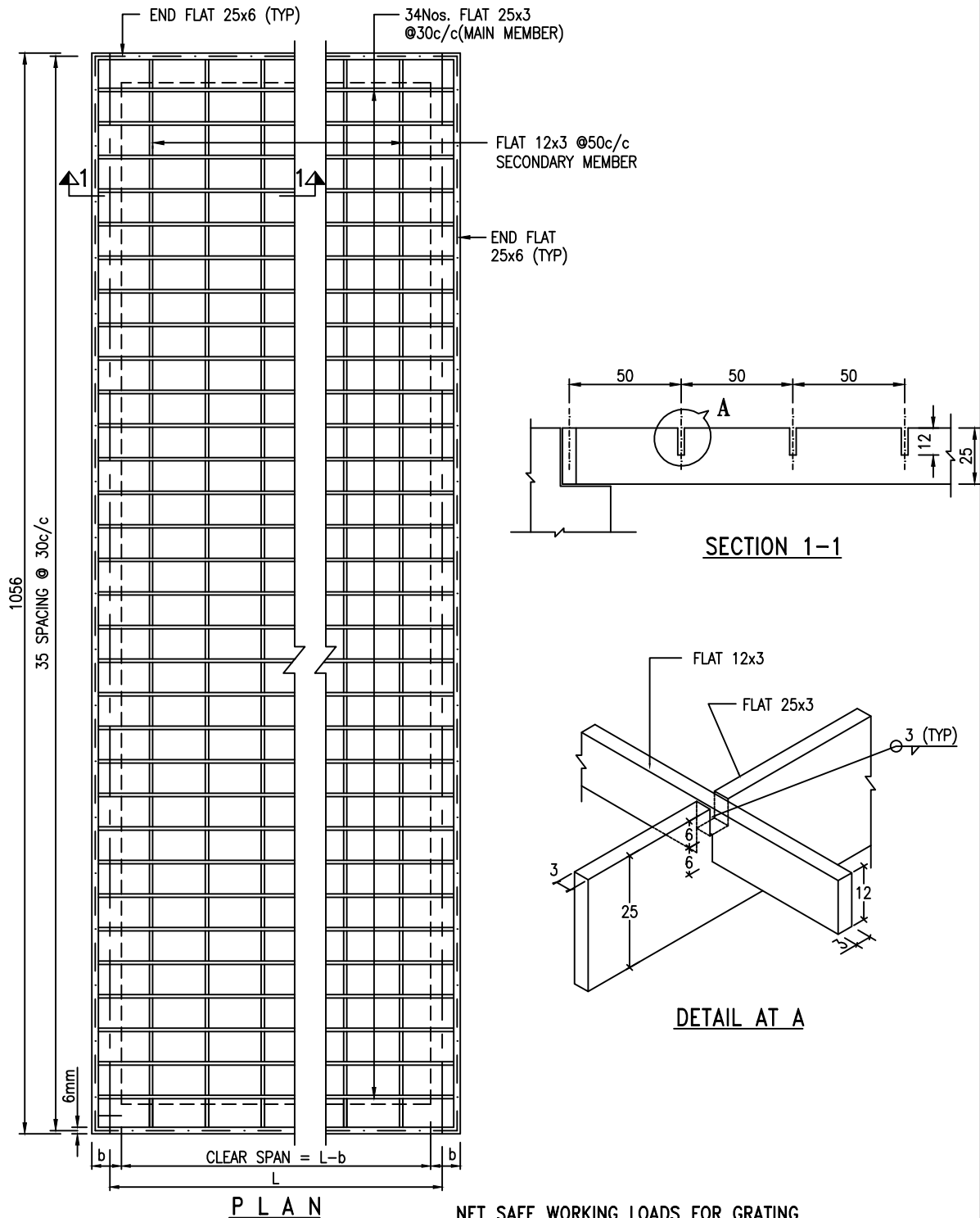
TYPICAL DETAIL  
OF GRATING

DRAWING NO.

GAIL-STD-CV-DWG-TP-011

SHEET NO.

2 OF 2



PLAN

NET SAFE WORKING LOADS FOR GRATING

PROPERTIES			TYPE-I	L	500	600	700	800	900	1000	1100	1250	1400
Lxx(cm <sup>4</sup> )	Zxx(cm <sup>3</sup> )	MR(kgm)		Δd	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.0
14.84	11.87	195.94	W	> 2000			1515	1105	830	540	345		
			P	1475	1225	1050	915	810	670	550	400	275	

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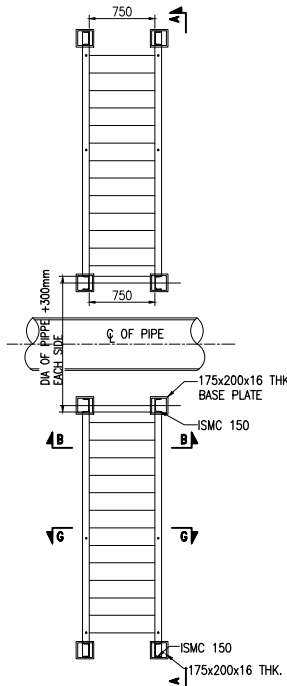
TYPICAL DETAIL OF  
CROSS-OVER

DRAWING NO.

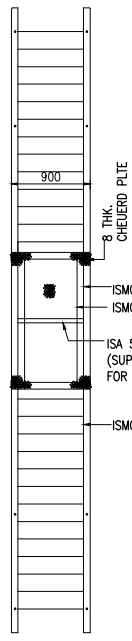
GAIL-STD-CV-DWG-TP-012

SHEET NO.

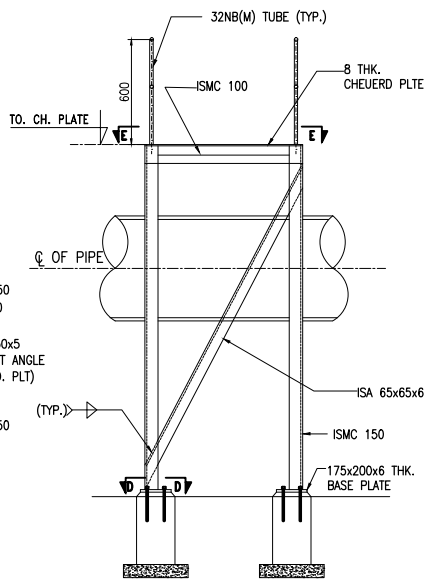
1 OF 1



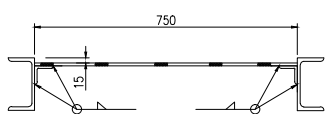
PLAN AT FOUNDATION LEVEL



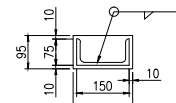
VIEW E-E



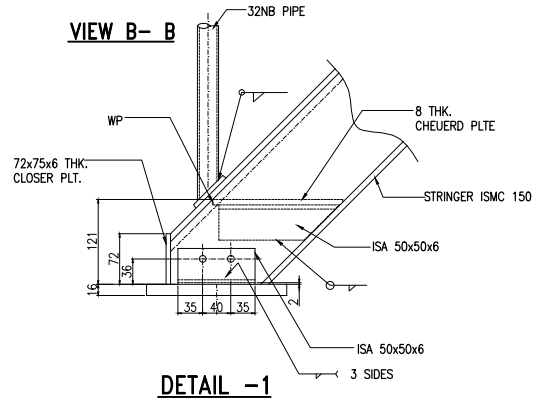
VIEW B-B



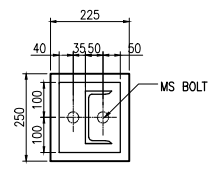
SECTION G-G  
(BOTTOM PLATE)



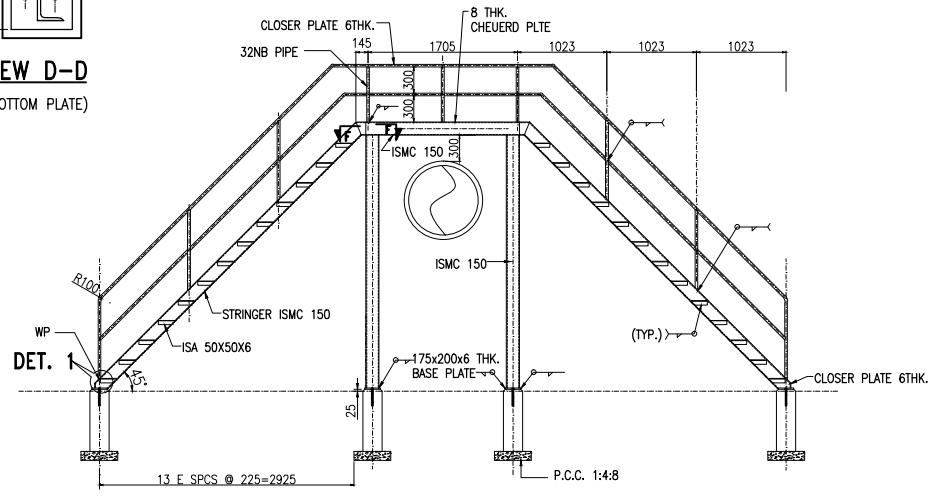
VIEW F-F  
TOP PLATE



DETAIL -1



VIEW D-D  
(BOTTOM PLATE)



VIEW A-A

0	10-01-2019	ISSUED FOR TENDER	DV	VKS	SK
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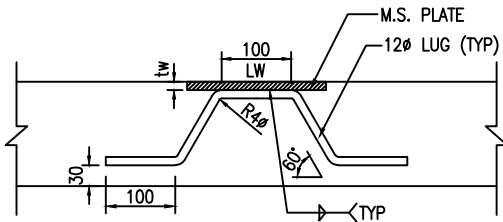
TYPICAL DETAILS OF  
INSERT PLATE  
(LUG BENDING DETAILS)

DRAWING NO.

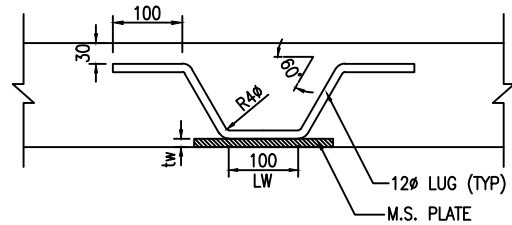
GAIL-STD-CV-DWG-TP-013

SHEET NO.

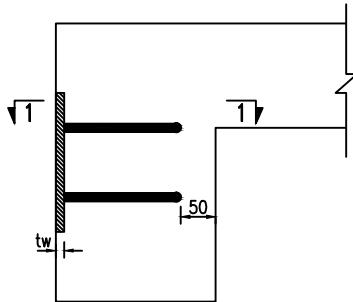
1 OF 1



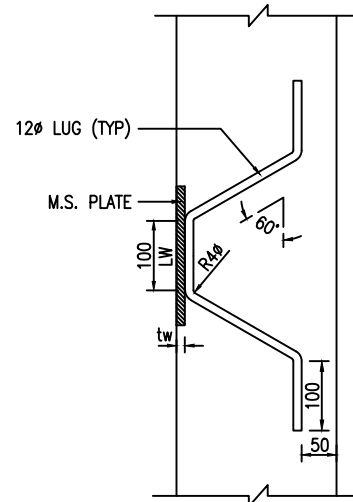
INSERT PLATE DETAIL ON TOP OF SLAB



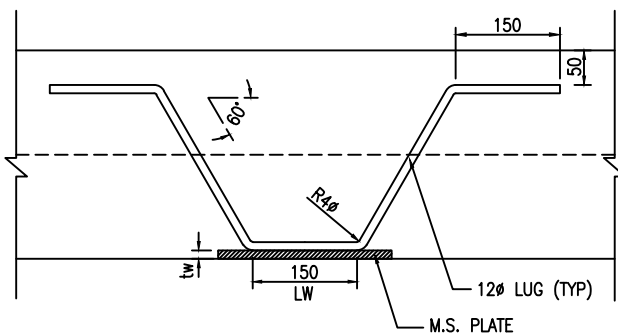
INSERT PLATE DETAIL ON BOTTOM OF SLAB



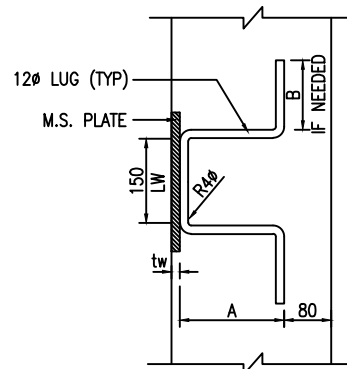
INSERT PLATE DETAIL ON SIDE OF BEAM



PLAN AT 1-1



INSERT PLATE DETAIL ON BOTTOM OF BEAM



INSERT PLATE DETAIL ON COLUMNS

LW = WELD LENGTH AVAILABLE  
tw = THICKNESS OF M.S. PLATE  
A+B = LUG EMBEDMENT REQUIRED

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NEW DELHI

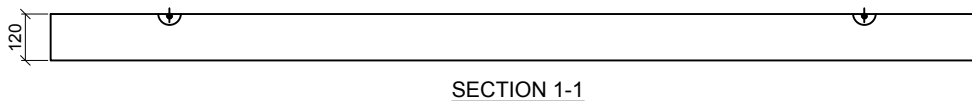
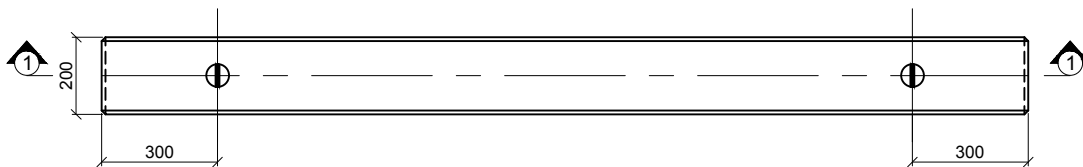
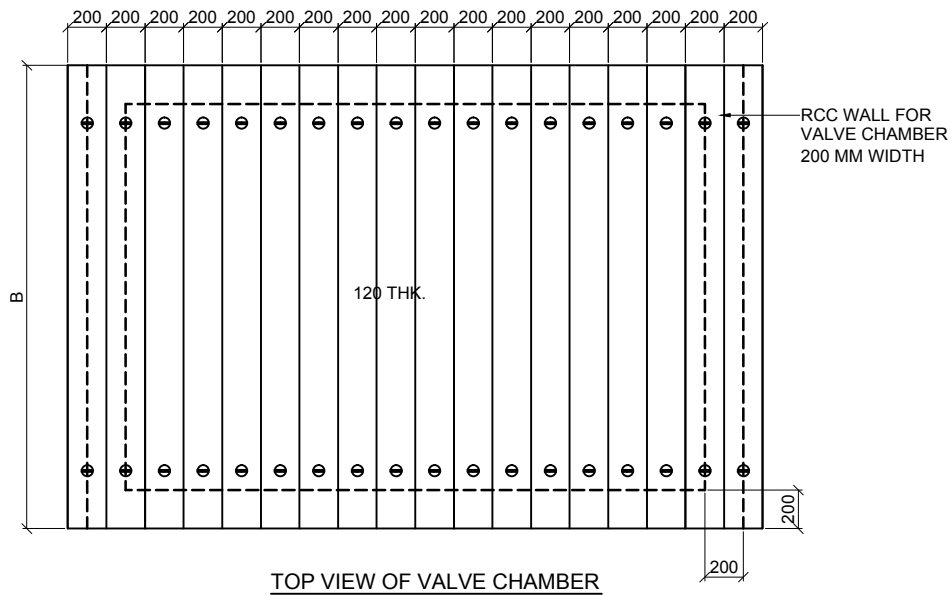
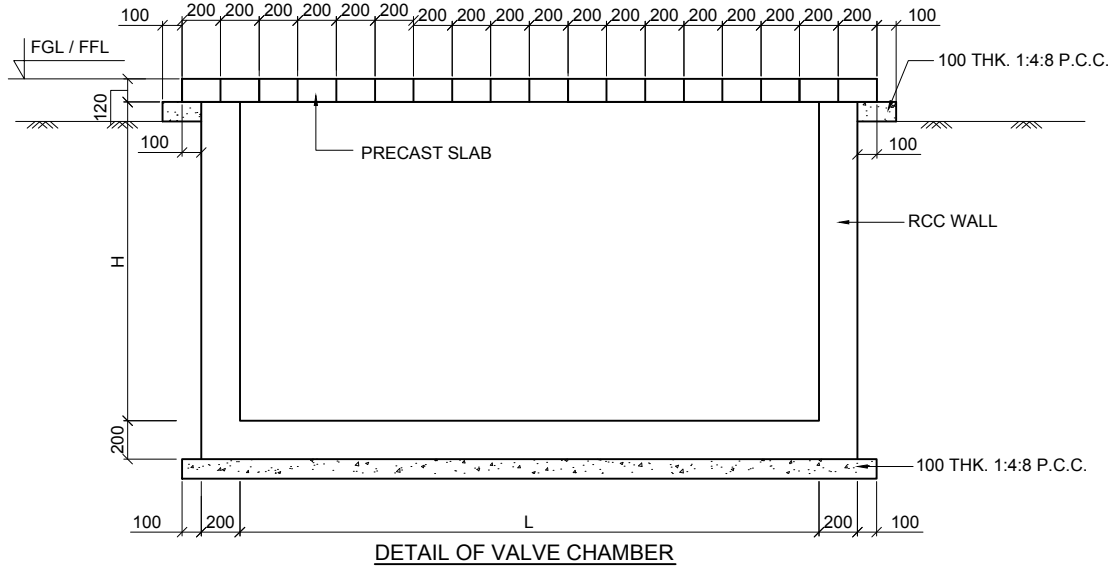
TYPICAL DETAIL OF  
G.A. OF VALVE PIT

DRAWING NO.

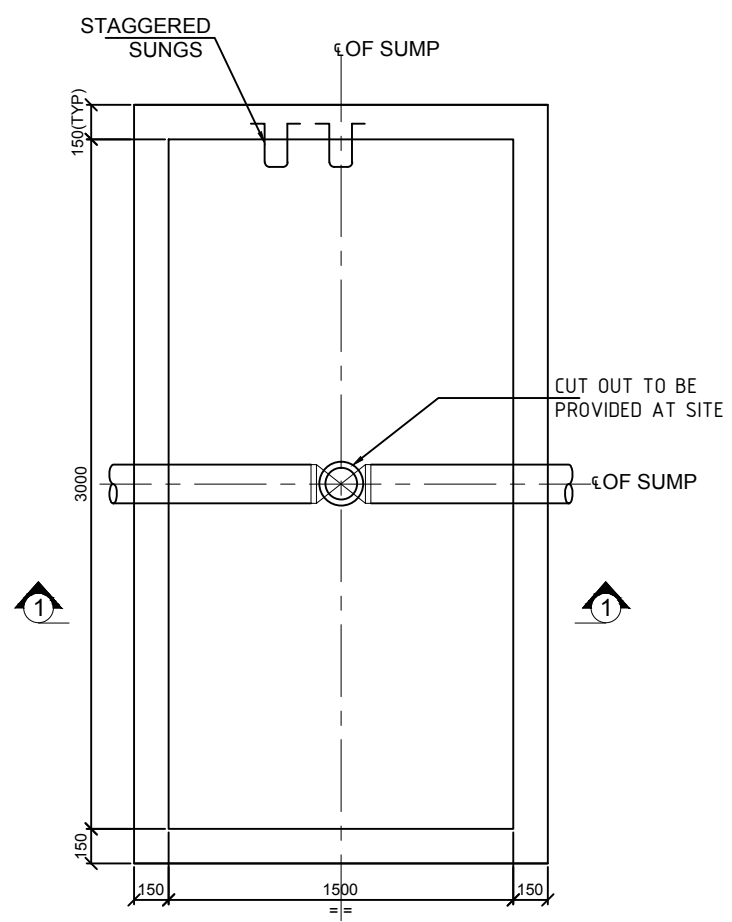
GAIL-STD-CV-DWG-TP-014

SHEET NO.

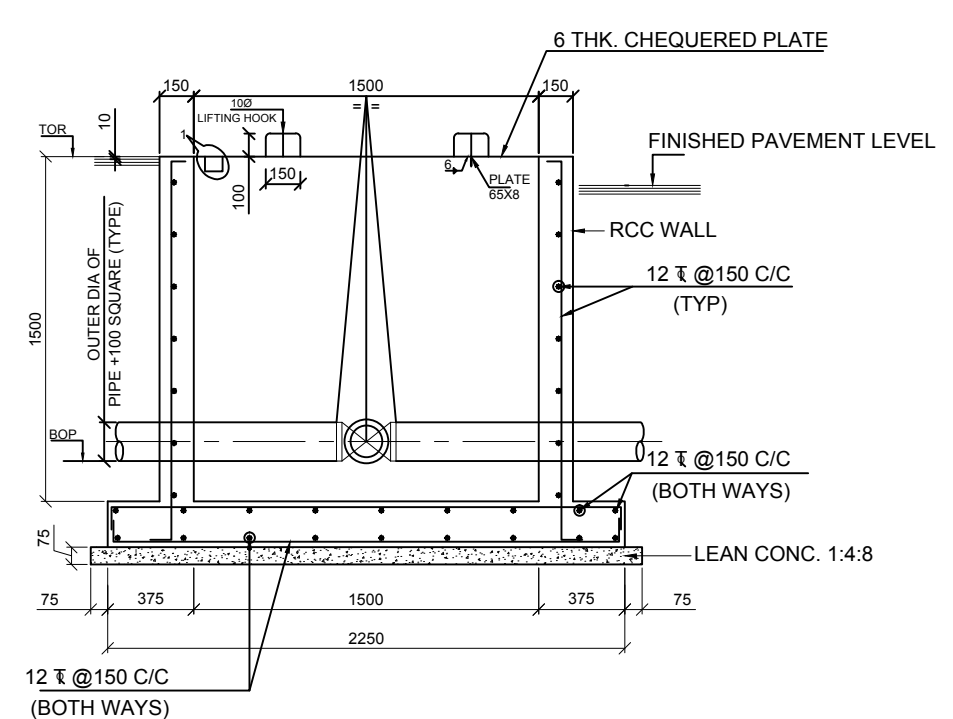
1 OF 2



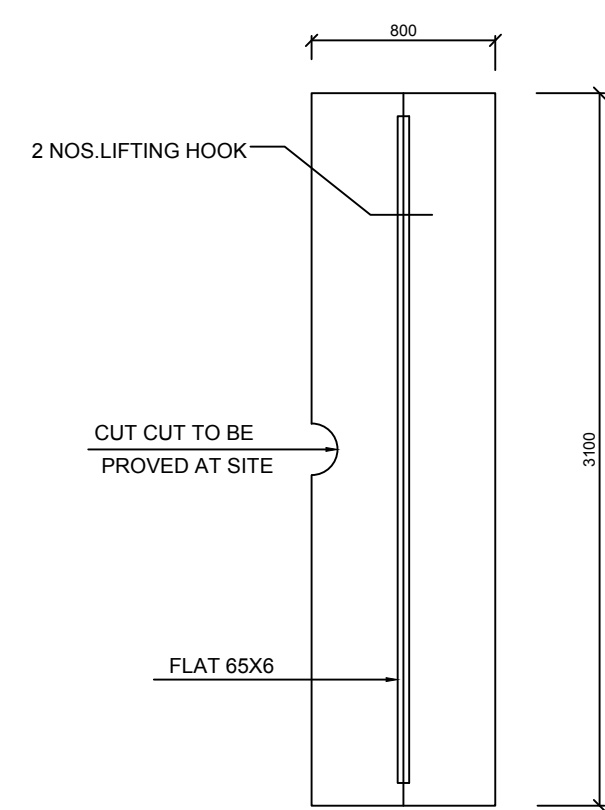
0	10-01-2019	ISSUED FOR TENDER	DV	VKS	SK
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED



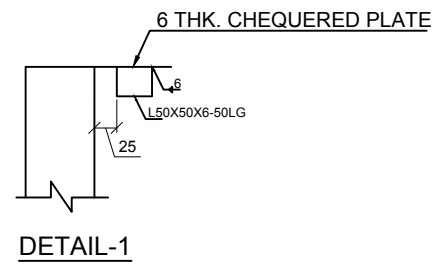
PLAN OF VALVE PIT



SECTION 1-1



PLAN CHEQUERED PLATE (2 NOS. AS PER VALVE PIT)



DETAIL-1

- NOTES:-
1. ALL DIMENSIONS ARE IN MM MILIMETER (mm) & LEVEL ARE IN METERS.
  2. BUNDING CONCRETE/PCC SHALL BE OF MIX 1:4:8 AND 75MM THICK 75MM PROJECTION BEYOND THE FOUNDATION EDGE UNO ON THE DRAWING THE GRADE OF CONCRETE FOR RCC WORK SHALL BE M-25 CONFORMING TO IS-456
  3. REINFORCEMENT SHALL BE HYSD BARS OF GRADE Fe415 CONFORMING TO IS-456
  4. CLEAR COVER TO MAIN REINFORCEMENT PROVED AS FOLLOW  
FOOTING = 40mm.  
WALL = 40mm.

- LEGEND:-
- FGL = FINISHED GROUND LEVEL
  - TOR = TOP OF ROAD
  - BOP = BOTTOM OF PIPE

0	10.01.19	ISSUED FOR TENDER	DV	UN	UN
REV.	DATE	DESCRIPTION	PREP.	CHKD.	APPD.
CLIENT:  GAIL (INDIA) LIMITED					
PMC:  LYONS ENGINEERING PVT. LTD.					
SCALE	TITLE: TYPICAL DETAIL OF GA & RC OF VALVE PIT				
NTS					
SIZE	DRAWING NUMBER	SHEET	REV.		
A2	GAIL-STD-CV-DWG-TP-014	2 OF 2	0		



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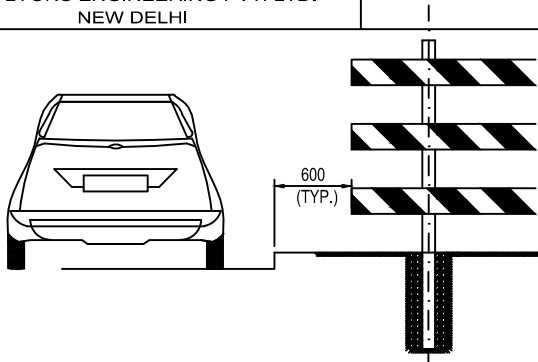
## TYPICAL BARRICADES DRAWING

DRAWING NO.

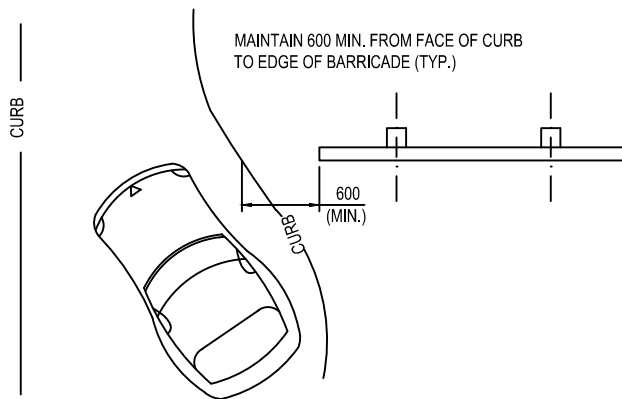
GAIL-STD-CV-DWG-TP-015

SHEET NO.

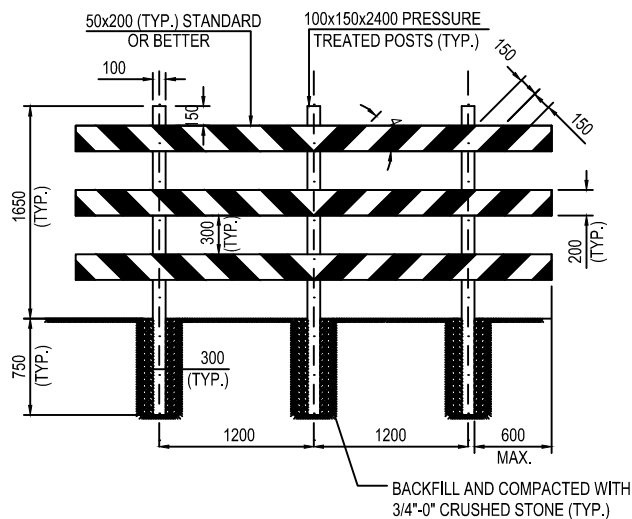
1 OF 1



TYPICAL NARROWING OF DRIVING AREA BARRICADE (USW DIMENSIONS BELOW)  
ORIENT DIAGOINAL BARS TO CHANNEL TRAFIC AS SHOWN

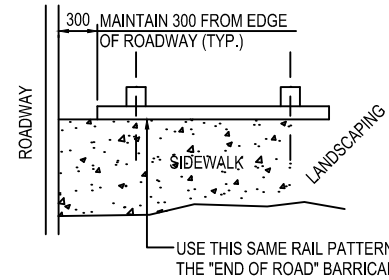


### NARROWING OF DRIVING AREA

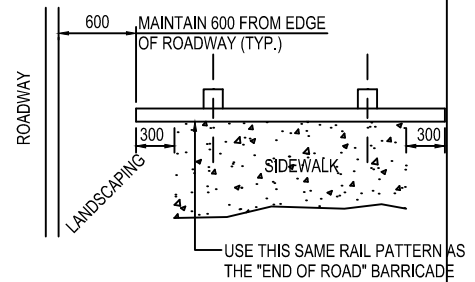


### END OF ROAD BARRICADE

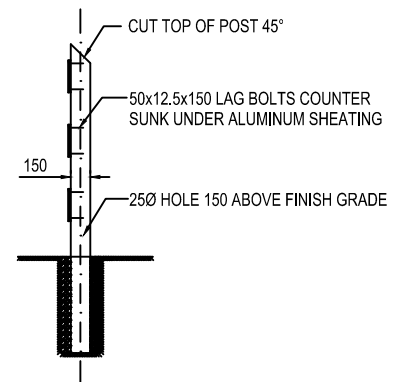
(TYPICAL DIMENSIONS AND LAYOUT)



### END OF SIDEWALK ('TYPE B')



### END OF SIDEWALK ('TYPE A')



### SECTION

NOTES:-

ALL WOOD SHALL BE PAINTED WHITE.

ALTERNATING RED & WHITE HIGH INTENSITY PRISMATIC 0.80. ALUMINUM SHEATING SHALL BE SCREWED TO THE HORIZONTAL RAILS

ALL FASTENERS TO BE STAINLESS STEEL OR RUST PROOF HEAVY GALVANIZED

FOR STREET BARRICADES HORIZONTAL RAIL LENGTH SHALL EQUAL THE DISTANCE BETWEEN THE FACE OF CURB PLUS 600. (EG. 1000 CURB 1600 RAILS).

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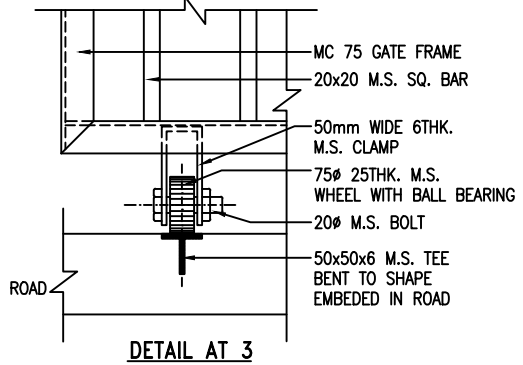
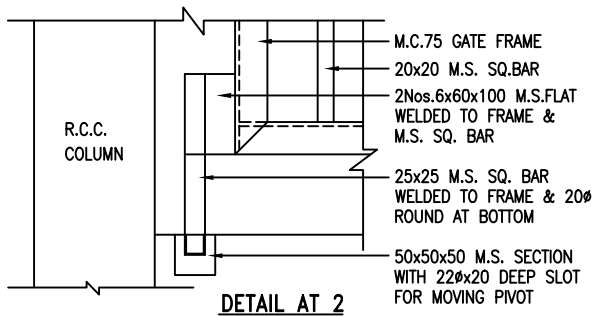
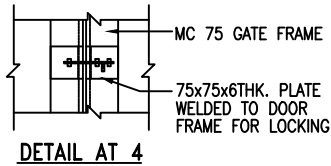
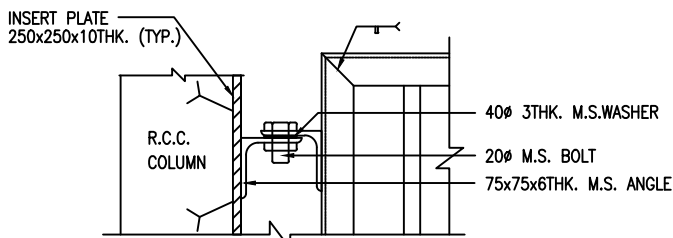
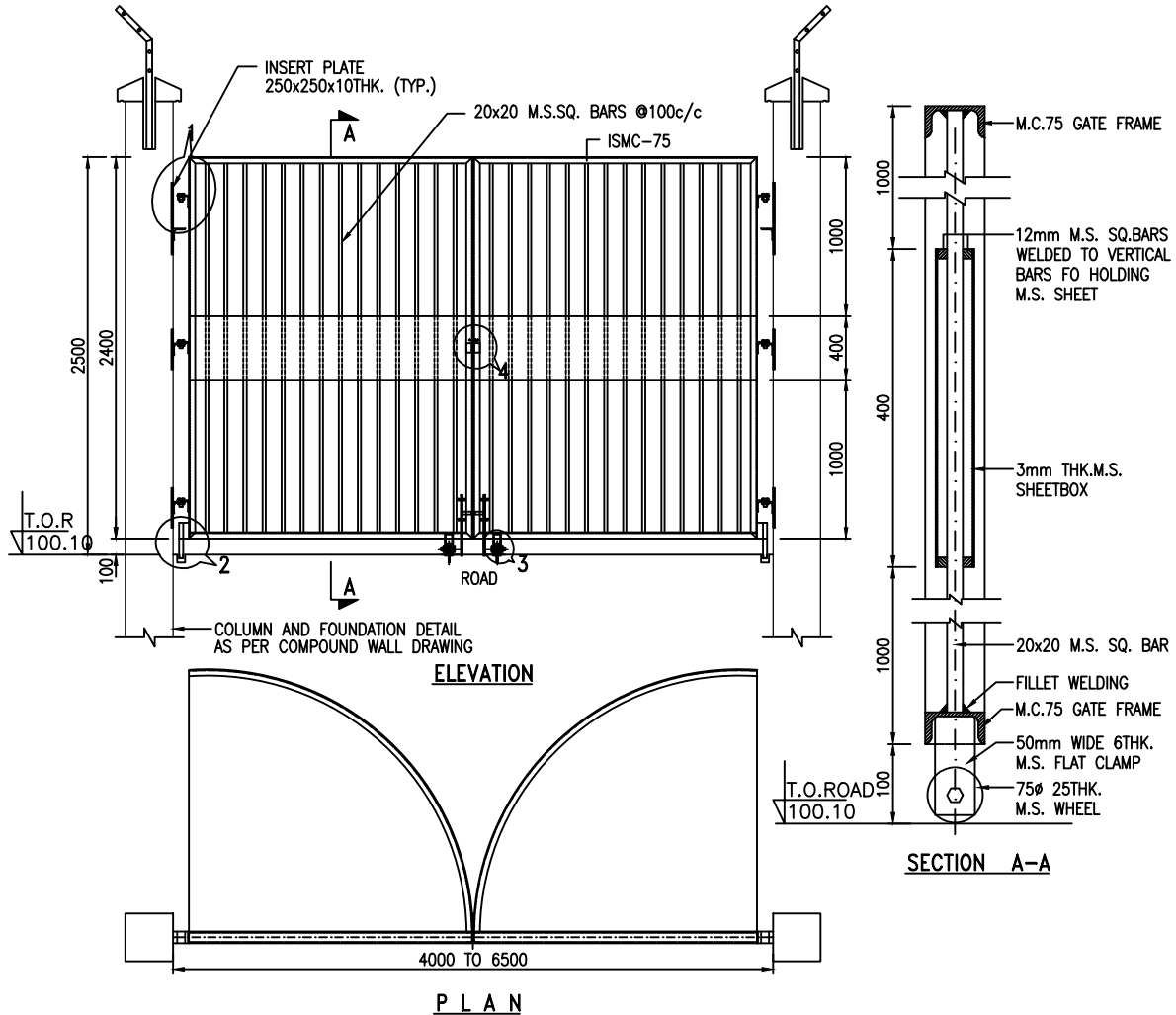
TYPICAL DETAIL OF  
HUNG GATE

DRAWING NO.

GAIL-STD-CV-DWG-TP-016

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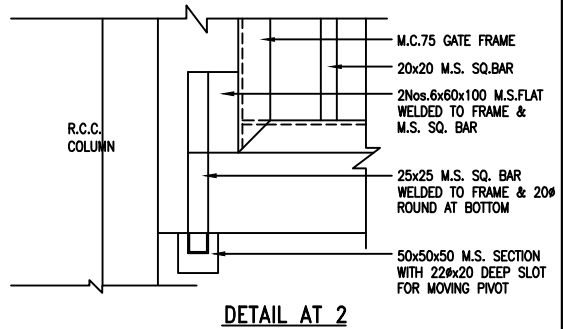
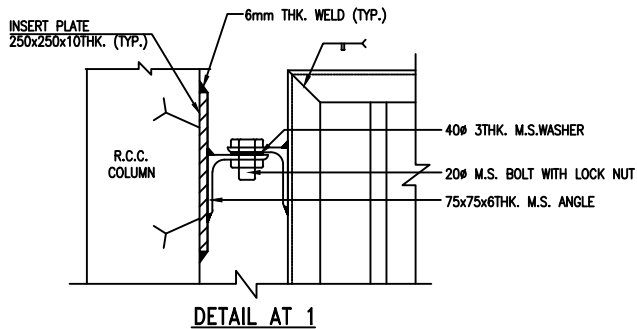
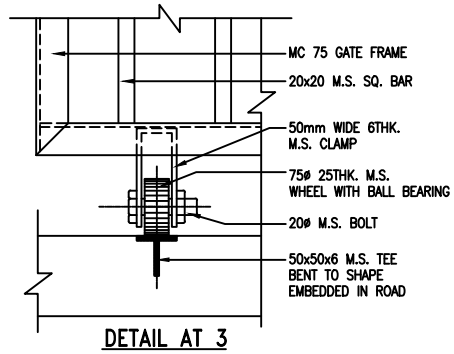
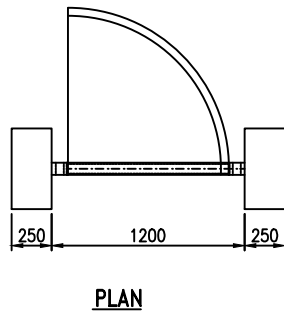
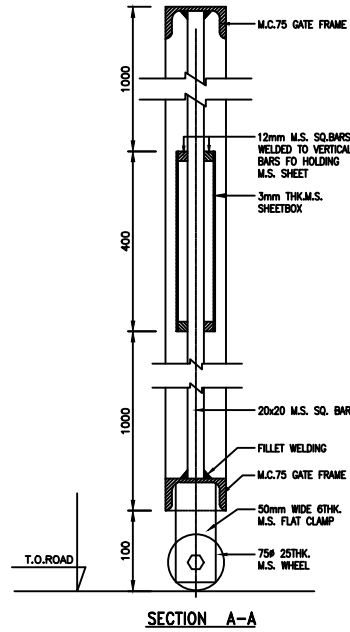
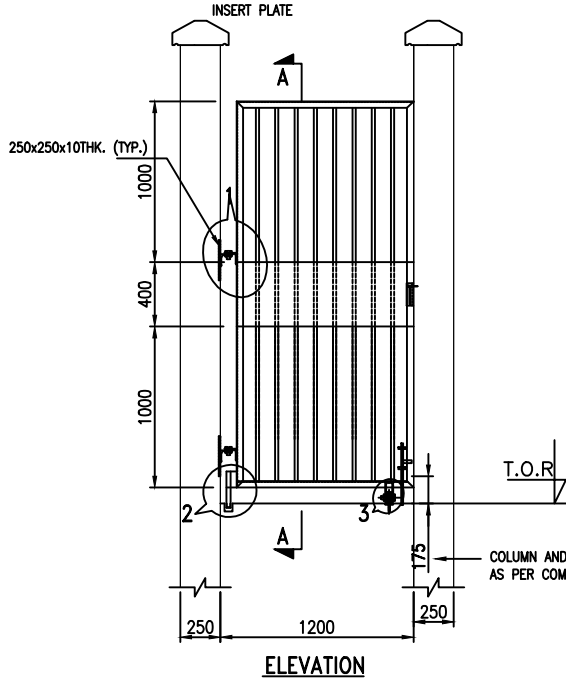
TYPICAL DETAIL OF  
HUNG GATE

DRAWING NO.

GAIL-STD-CV-DWG-TP-016

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0	10-01-2019	ISSUED FOR TENDER	DV	VKS	SK
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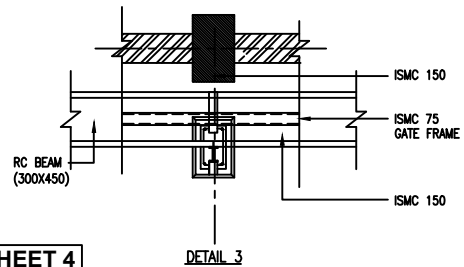
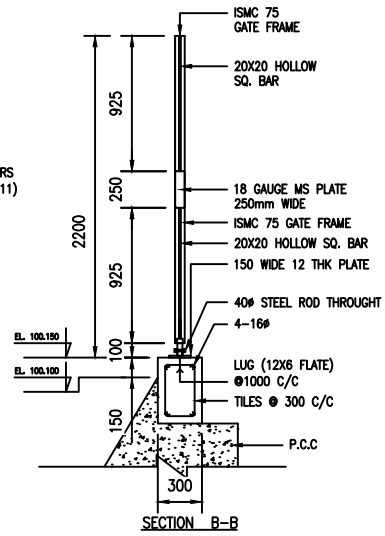
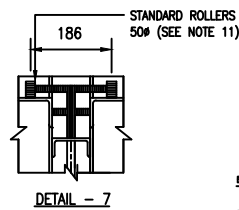
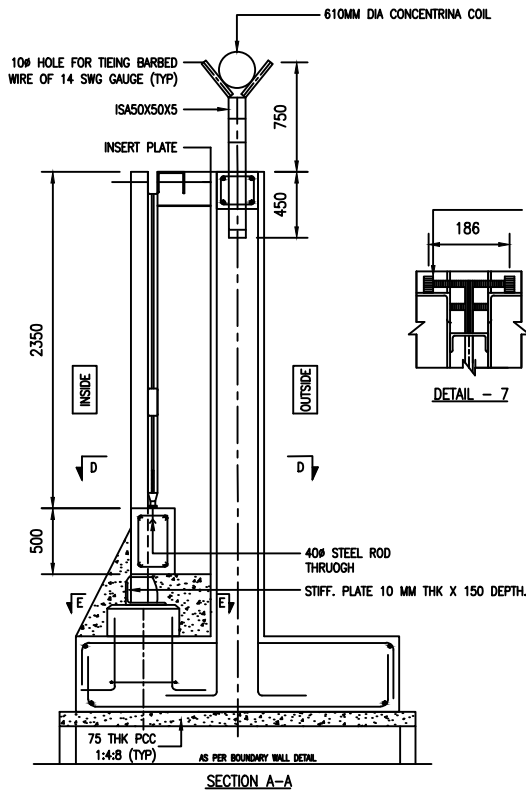
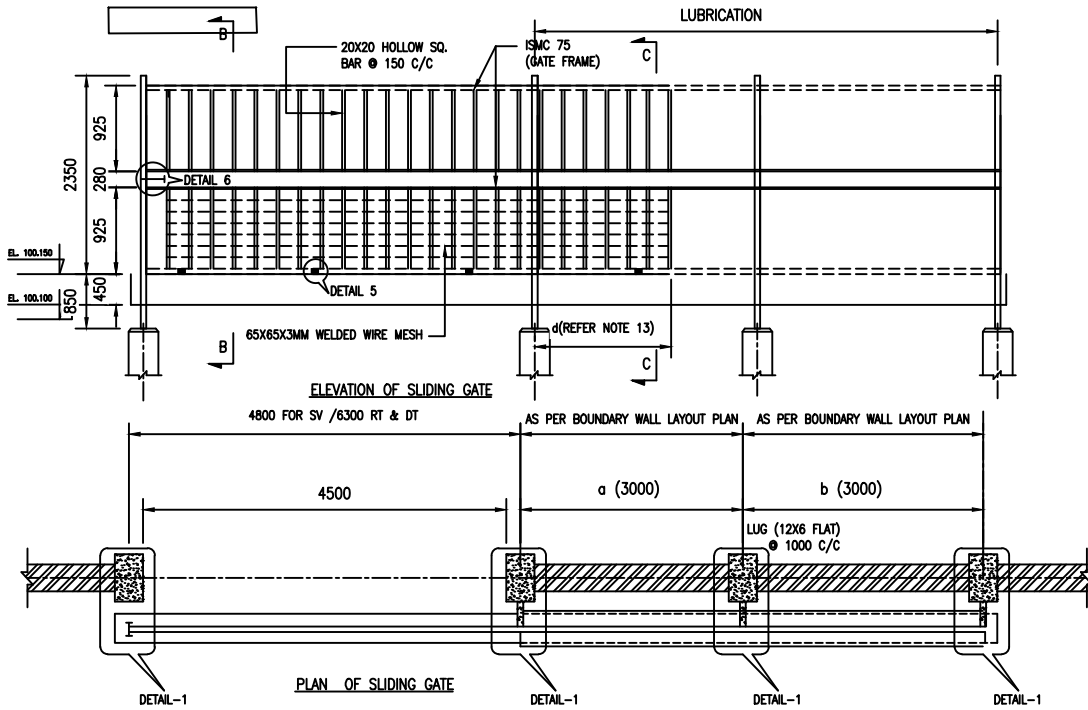
TYPICAL DETAIL OF  
HUNG GATE

DRAWING NO.

GAIL-STD-CV-DWG-TP-016

SHEET NO.

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CONTINUED ON SHEET 4

0	10-01-2019	ISSUED FOR TENDER	DV	VKS	SK
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED





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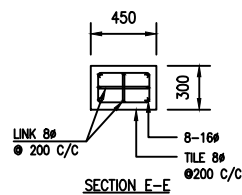
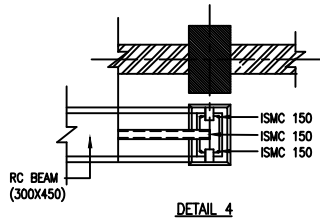
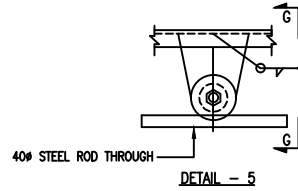
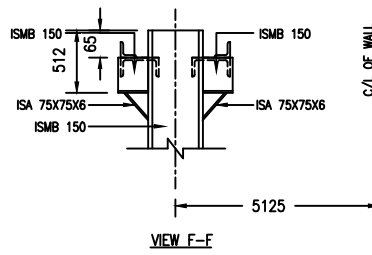
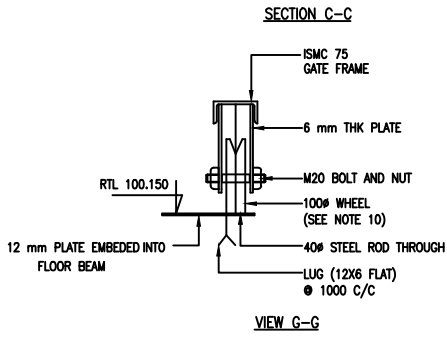
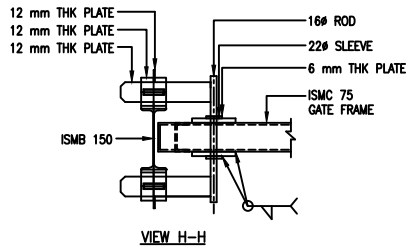
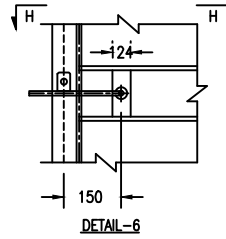
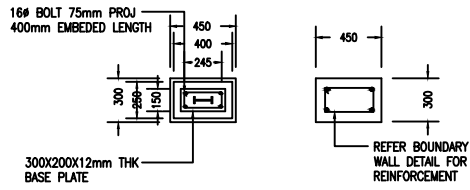
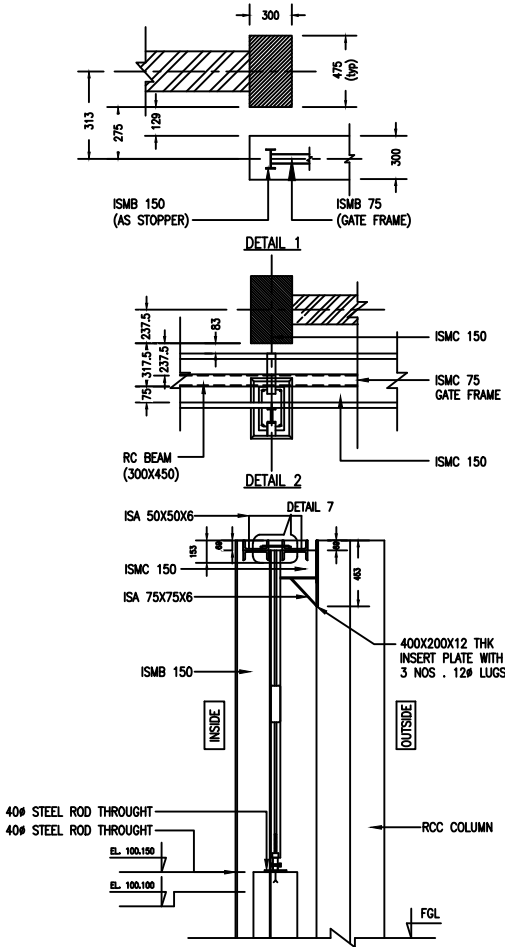
TYPICAL DETAIL OF  
SLIDING GATE

DRAWING NO.

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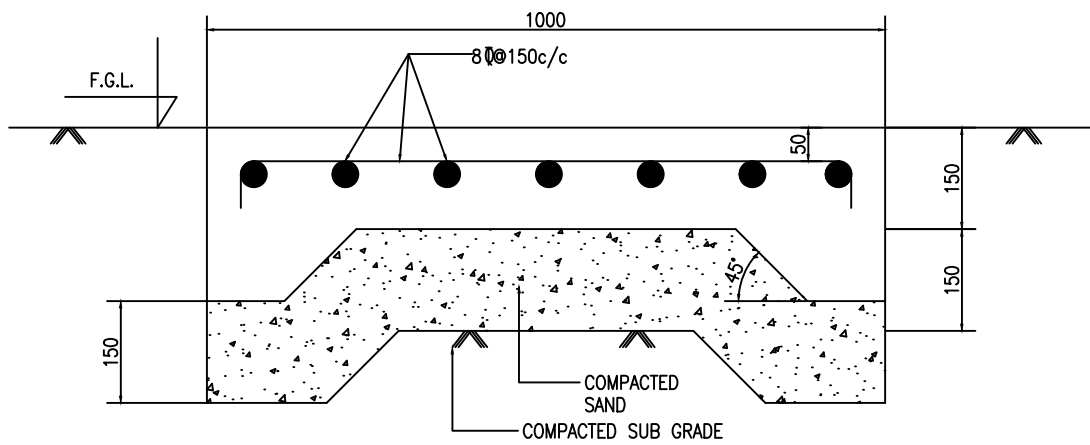
TYPICAL DETAIL  
OF FOOTPATH

DRAWING NO.

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TYPICAL DETAIL OF FOOTPATH

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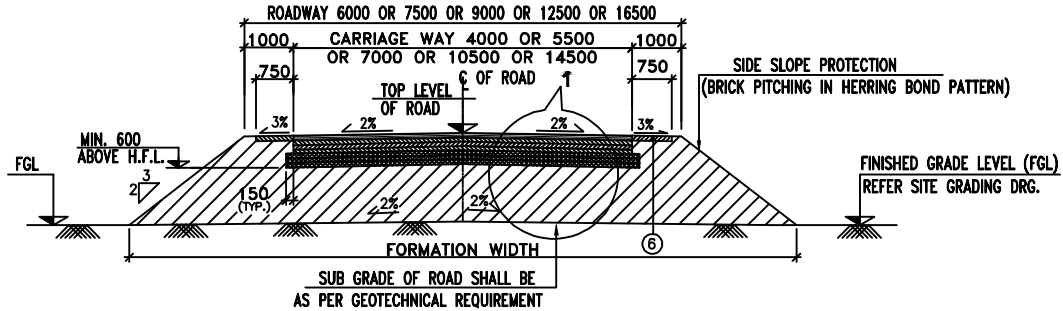
TYPICAL  
CROSS SECTION OF ROAD  
( BITUMENOUS)

DRAWING NO.

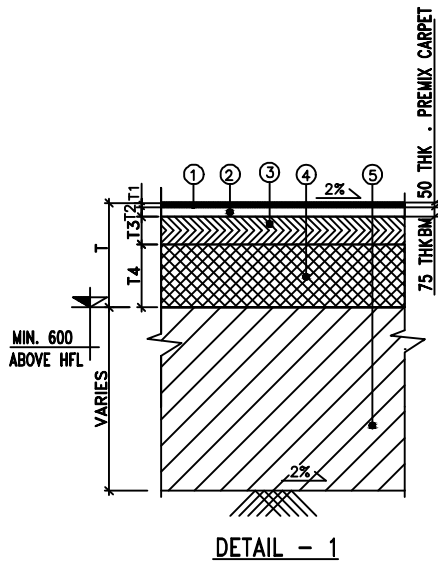
GAIL-STD-CV-DWG-TP-018

SHEET NO.

1 OF 2



CROSS SECTION OF ROAD



LEGEND :-

- ① 50 mm THK. PREMIX CARPET WITH PREMIXED SEAL COAT (PC) (T1)
- ② 75 mm THK. BITUMENOUS MACADAM (BM) (T2)
- ③ BASE COURSE (T3)  
MINIMUM 2 LAYERS (EACH LAYER 75mm THICK) OF WATER BOUND MACADAM (WBM) WITH GRADE-II AGGREGATE (63mm TO 45mm) REFER NOTE-2.
- ④ SUB BASE COURSE (T4)  
MINIMUM 2 LAYERS (EACH LAYER 100mm THICK) OF WATER BOUND MACADAM (WBM) WITH GRADE-I AGGREGATE (90mm TO 45mm) REFER NOTE-2.
- ⑤ FILLING AND COMPACTION SHALL BE AS PER GEOTECH RECOMMENDATION. (REFER NOTE-3)
- ⑥ 75 mm THK. WATER BOUND MACADAM COURSE (WBM) WITH GRADE-II AGGREGATE (63mm TO 45mm).

(TOTAL CRUST THICKNESS)  $T = T2+T3+T4$

(T1- PREMIX CARPET IS ONLY A WEARING COURSE AND IS NOT CONSIDERED IN TOTAL CRUST THICKNESS)

GEOTECHNICAL RECOMMENDATION SHALL BE FOLLOWED FOR ROAD SUBGRADE AND EMBANKMENT PREPARATION.

NOTES:-

1. ALL DIMENSIONS ARE IN MM, UNLESS MENTIONED OTHERWISE.
2. THE CROSS-SECTION OF CRUST SHOWN HERE ARE MINIMUM & INDICATIVE ONLY AND PREPARE FOR BID PURPOSE ONLY HOWEVER, THE CONSTRUCTION SHALL BE EXECUTED AS PER APPROVED FOR CONSTRUCTION DRG.
3. FOR SUBGRADE & EMBANKMENT PREPARATION OF ROAD, GEOTECHNICAL'S RECOMMENDATION SHALL BE FOLLOWED.

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REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED



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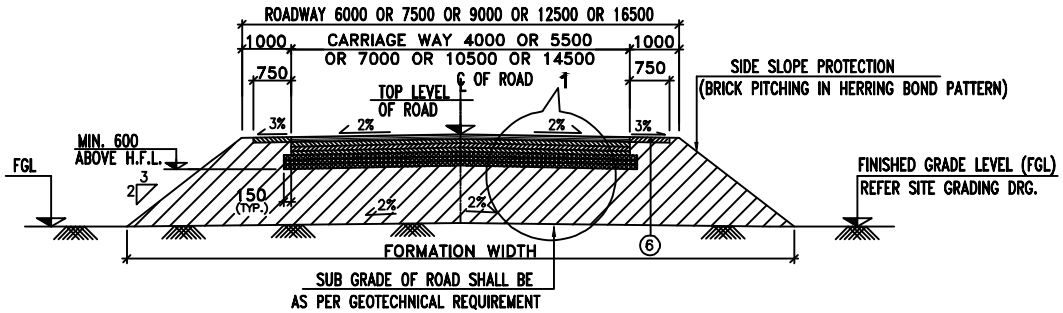
TYPICAL  
CROSS SECTION OF ROAD  
(RCC)

DRAWING NO.

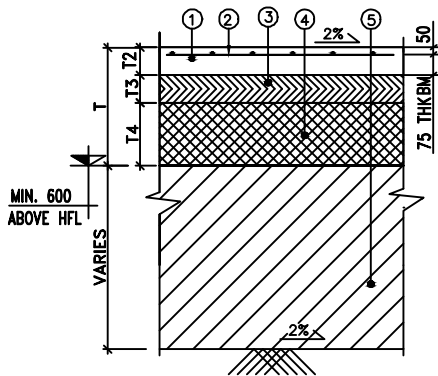
GAIL-STD-CV-DWG-TP-018

SHEET NO.

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CROSS SECTION OF ROAD



DETAIL - 1

LEGEND :-

- ① R.C.C. M-25 150 MM THK. (T2)
- ② HYD REINF. 8 ϕ 150 C/C BOTHWAYS
- ③ BASE COURSE (T3)  
MINIMUM 2 LAYERS (EACH LAYER 75mm THICK) OF WATER BOUND MACADAM (WBM) WITH GRADE-II AGGREGATE (63mm TO 45mm) REFER NOTE-2.
- ④ SUB BASE COURSE (T4)  
MINIMUM 2 LAYERS (EACH LAYER 100mm THICK) OF WATER BOUND MACADAM (WBM) WITH GRADE-I AGGREGATE (90mm TO 45mm) REFER NOTE-2.
- ⑤ FILLING AND COMPACTION SHALL BE AS PER GEOTECH RECOMMENDATION. (REFER NOTE-3)
- ⑥ 75 mm THK. WATER BOUND MACADAM COURSE (WBM) WITH GRADE-II AGGREGATE (63mm TO 45mm).

(TOTAL CRUST THICKNESS)  $T = T2+T3+T4$

(T1- PREMIX CARPET IS ONLY A WEARING COURSE AND IS NOT CONSIDERED IN TOTAL CRUST THICKNESS)

GEOTECHNICAL RECOMMENDATION SHALL BE FOLLOWED FOR ROAD SUBGRADE AND EMBANKMENT PREPARATION.

NOTES:-

1. ALL DIMENSIONS ARE IN MM, UNLESS MENTIONED OTHERWISE.
2. THE CROSS-SECTION OF CRUST SHOWN HERE ARE MINIMUM & INDICATIVE ONLY AND PREPARE FOR BID PURPOSE ONLY HOWEVER, THE CONSTRUCTION SHALL BE EXECUTED AS PER APPROVED FOR CONSTRUCTION DRG.
3. FOR SUBGRADE & EMBANKMENT PREPARATION OF ROAD, GEOTECHNICAL'S RECOMMENDATION SHALL BE FOLLOWED.

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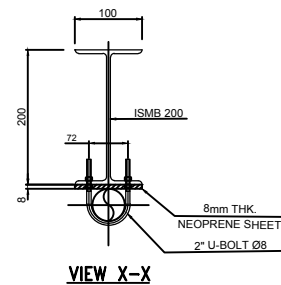
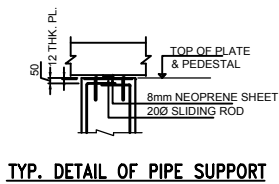
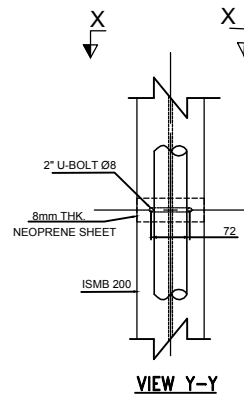
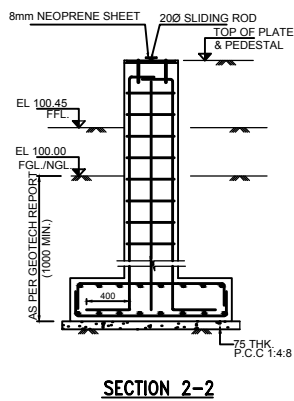
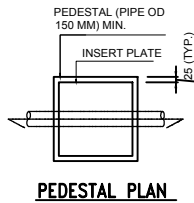
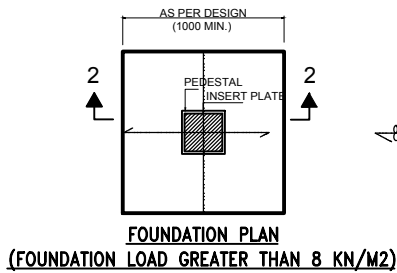
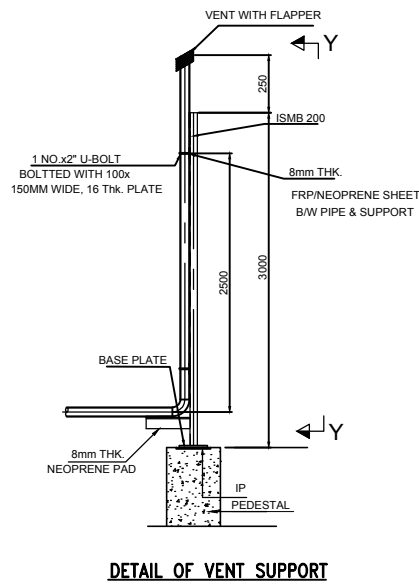
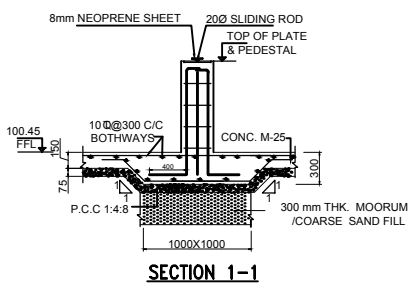
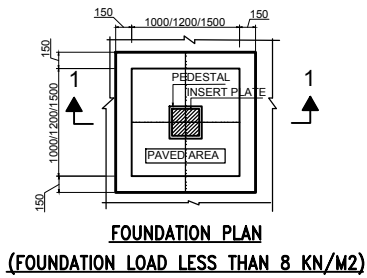
TYPICAL DETAIL OF  
RCC PIPE SUPPORT

DRAWING NO.

GAIL-STD-CV-DWG-TP-019

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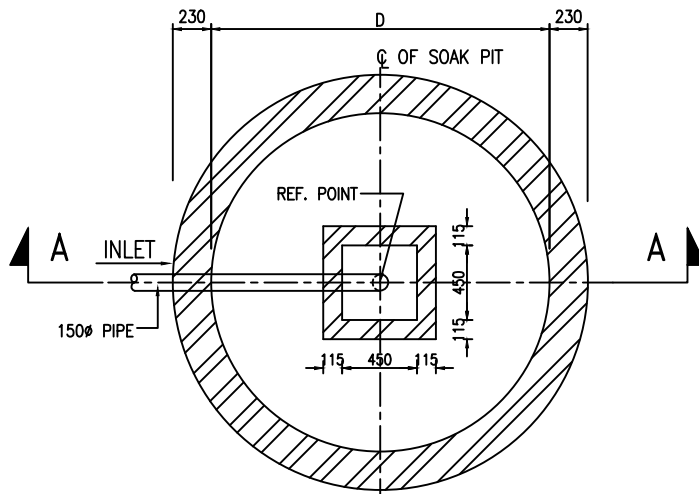
TYPICAL DETAIL  
OF SOAKPIT

DRAWING NO.

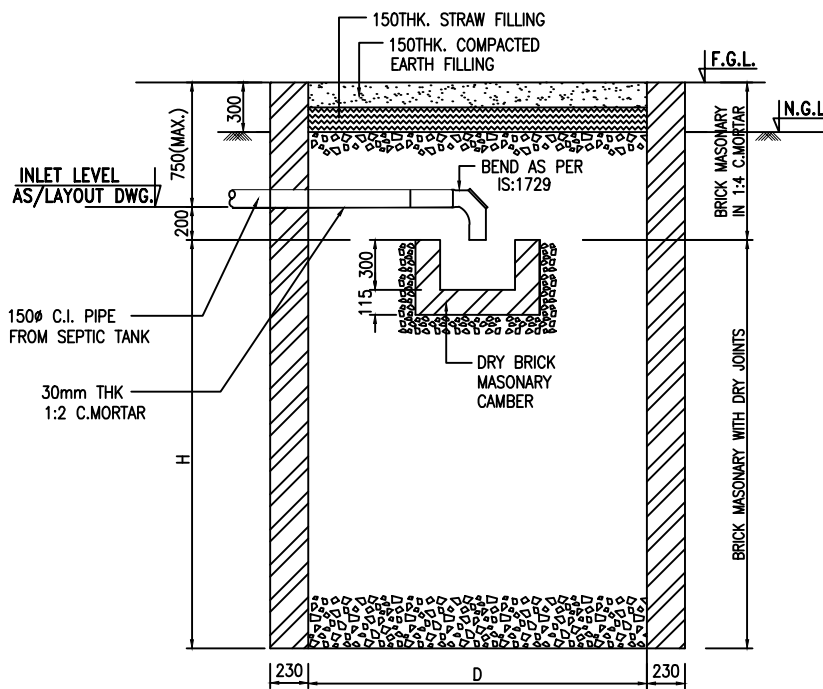
GAIL-STD-CV-DWG-TP-020

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PLAN OF SOAK PIT



SECTION A-A

TABLE

TYPE	NO. OF USERS	DEPTH IN METERS	DIA IN METERS	AREA OF ABSORPTION
1	10	2.5	2.5	24.53
2	25	5.0	3.25	59.35
3	50	7.0	3.6	89.30
4	100	10.0	5.0	196.25

NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETERS EXCEPT LEVELS AND CO-ORDINATES WHICH ARE IN METERS.
2. THE FILLING OF BRICK BATS IN SOAKPIT SHALL BE DONE SIMULTANEOUSLY WITH CONST. OF BRICK WALLS AS WORK PROGRESS.
3. C.I. PIPE SHALL CONFORM TO IS: 3486.
4. DEPTH AND DIA CAN BE SUITABLY ADJUSTED TO GIVE THE ABSORPTIVE AREA DEPENDING UPON THE SUB SOIL WATER TABLE.
5. BOTTOM OF THE SOAKPIT SHOULD NOT BE LESS THAN 600mm ABOVE THE SUB SOIL WATER.

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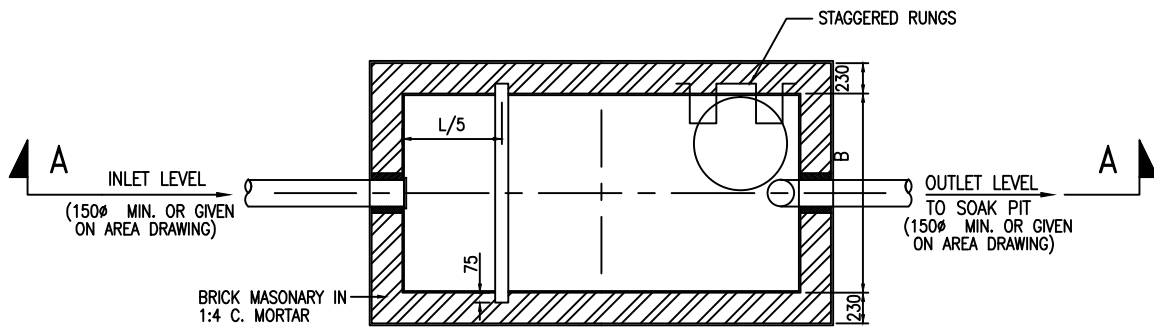
## TYPICAL DETAIL OF SEPTIC TANK

DRAWING NO.

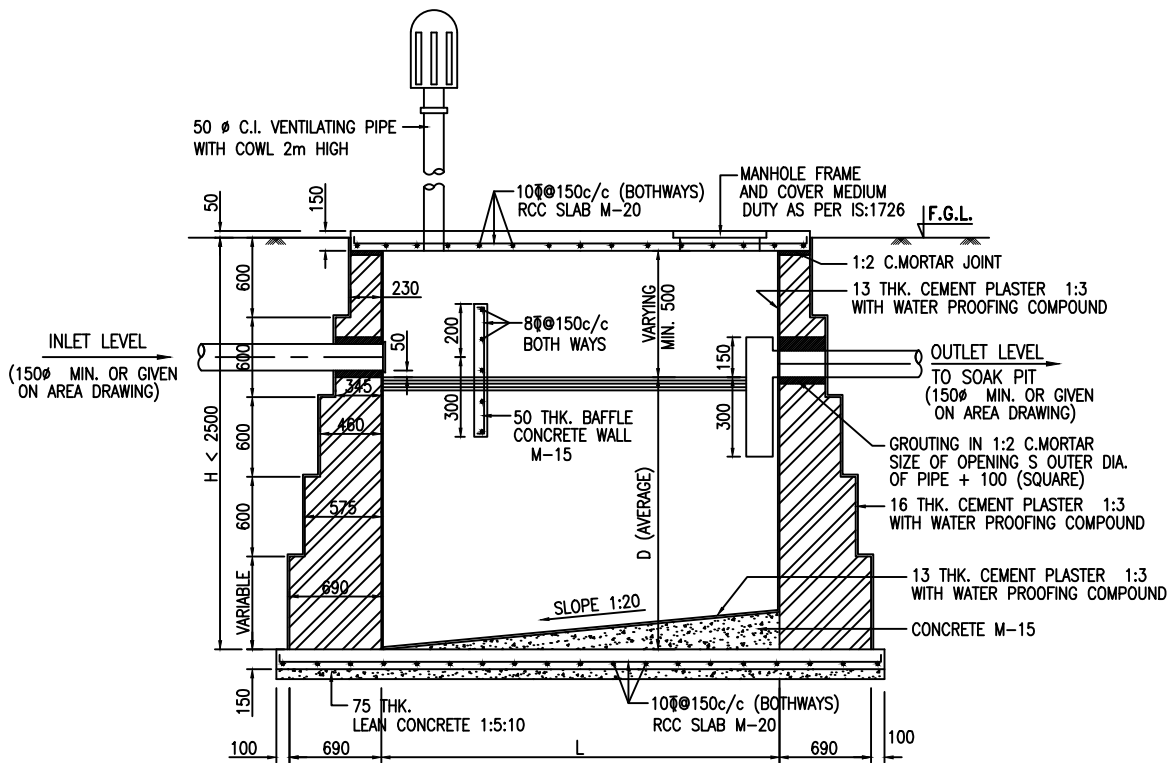
GAIL-STD-CV-DWG-TP-021

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PLAN OF SEPTIC TANK



SECTION A-A

### RECOMMENDED DIMENSIONS OF SEPTIC TANK

TYPE	NO. OF USERS	LENGTH (L)	BREADTH (B)	LIQUID DEPTH (D)
1	10	2000	900	1000
2	20	2300	1100	1300
3	30	4000	1400	1300
4	50	4750	1700	1500

### NOTES:-

1. ALL DIMENSIONS ARE IN MM. & LEVEL IN METRES.
2. FOLLOW WRITTEN DIMENSIONS ONLY. DO NOT SCALE.
3. CLEAR COVER TO MAIN REINF. SHALL BE: (a) SLAB = 25mm
4.  $\Phi$  DENOTES HIGH YIELD STRENGTH DEFORMED BARS CONFORMING TO IS -1786 (LATEST)
5. DESLUDGING SHALL BE DONE PERIODICALLY EVERY YEAR PREFERABLY BY A PORTABLE NON CLDG. PUMP.

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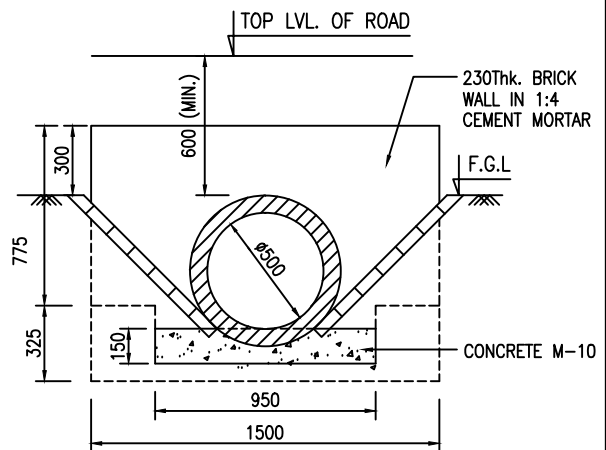
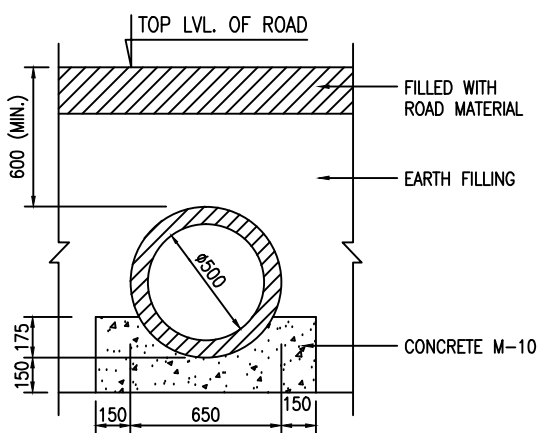
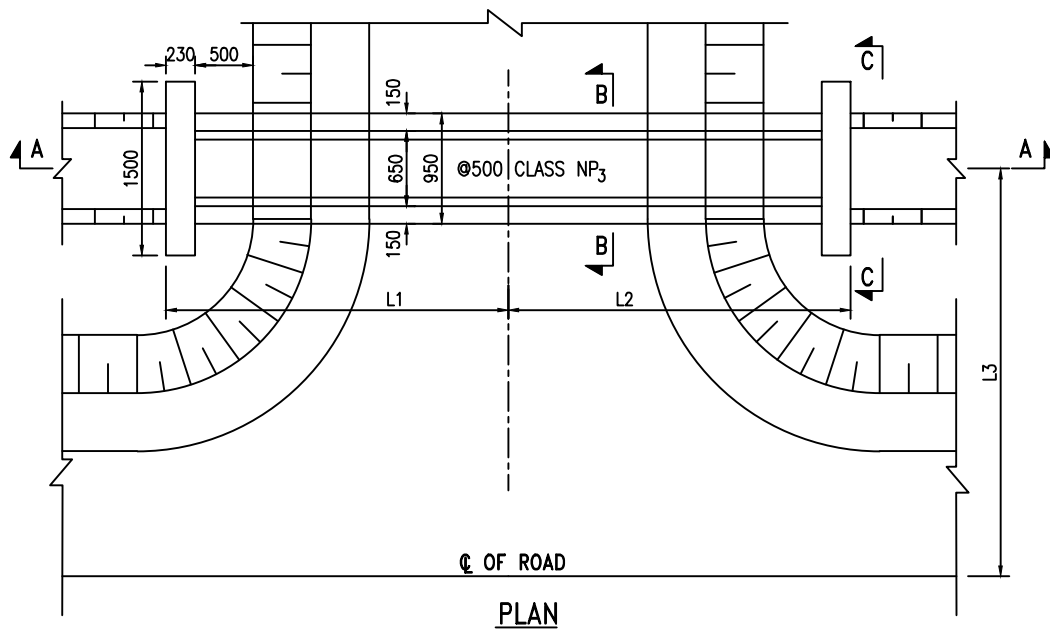
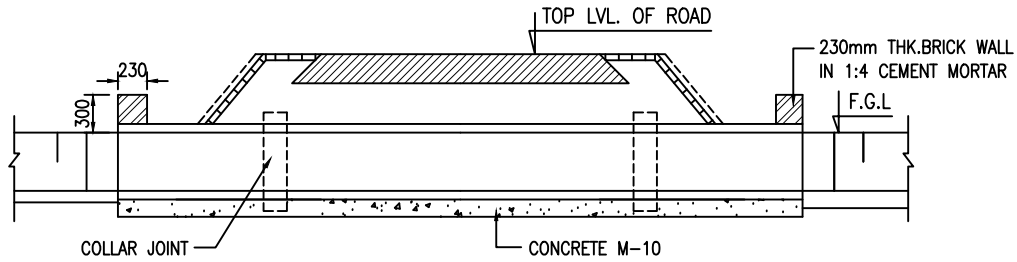
LYONS ENGINEERING PVT. LTD.  
NEW DELHI

TYPICAL DETAIL OF  
PIPE CULVERT FOR STORM  
WATER DRAINAGE

DRAWING NO.  
GAIL-STD-CV-DWG-TP-022

SHEET NO.

1 OF 2



0	10-01-2019	ISSUED FOR TENDER	DV	VKS	SK
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED





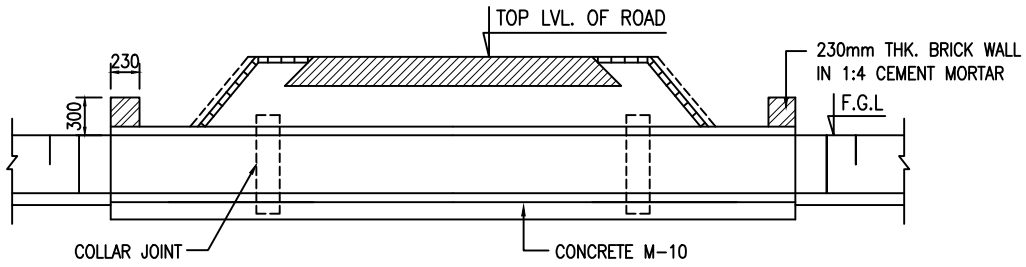
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TYPICAL DETAIL OF  
PIPE CULVERT FOR STORM  
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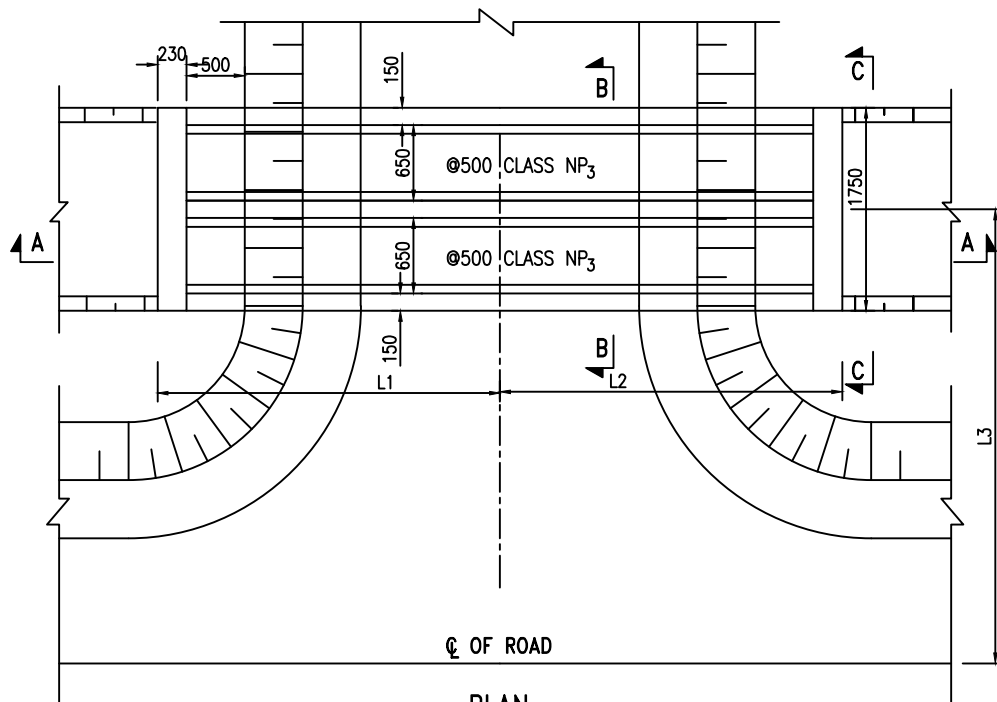
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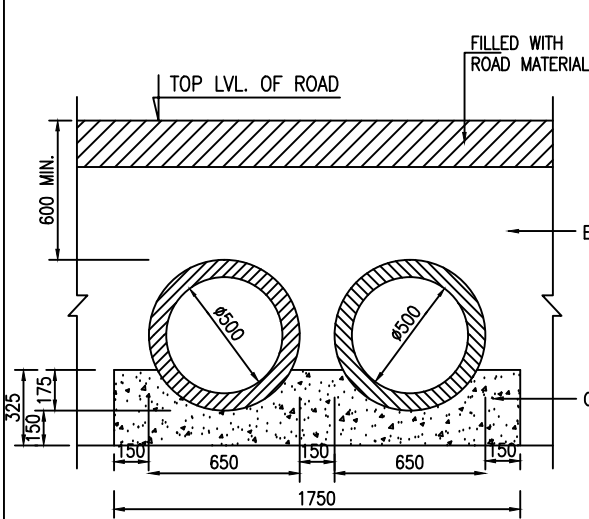
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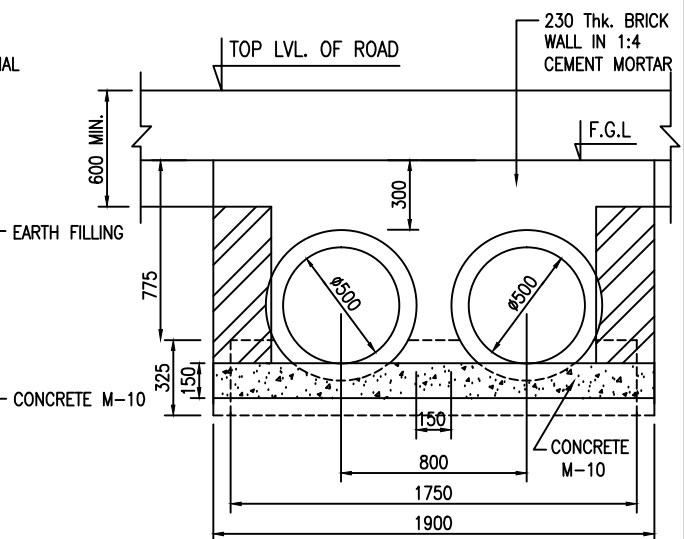
SECTION A-A



PLAN



SECTION B-B



SECTION C-C

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REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED



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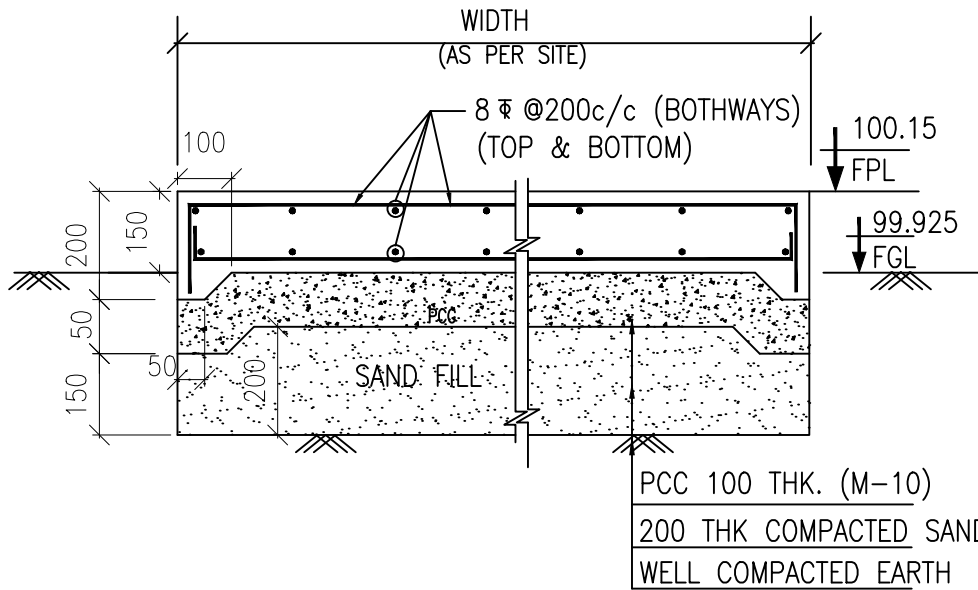
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DRAWING NO.

GAIL-STD-CV-DWG-TP-023

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1 OF 1



### TYPICAL DETAIL OF RCC PAVEMENT

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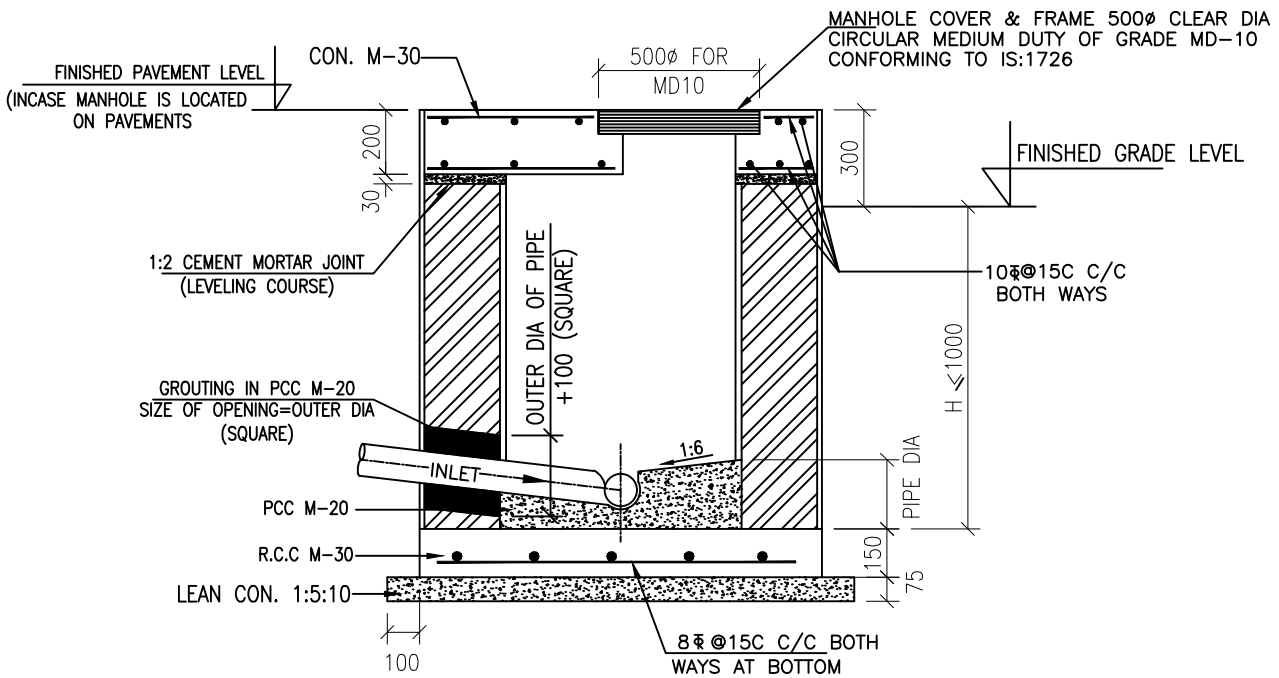
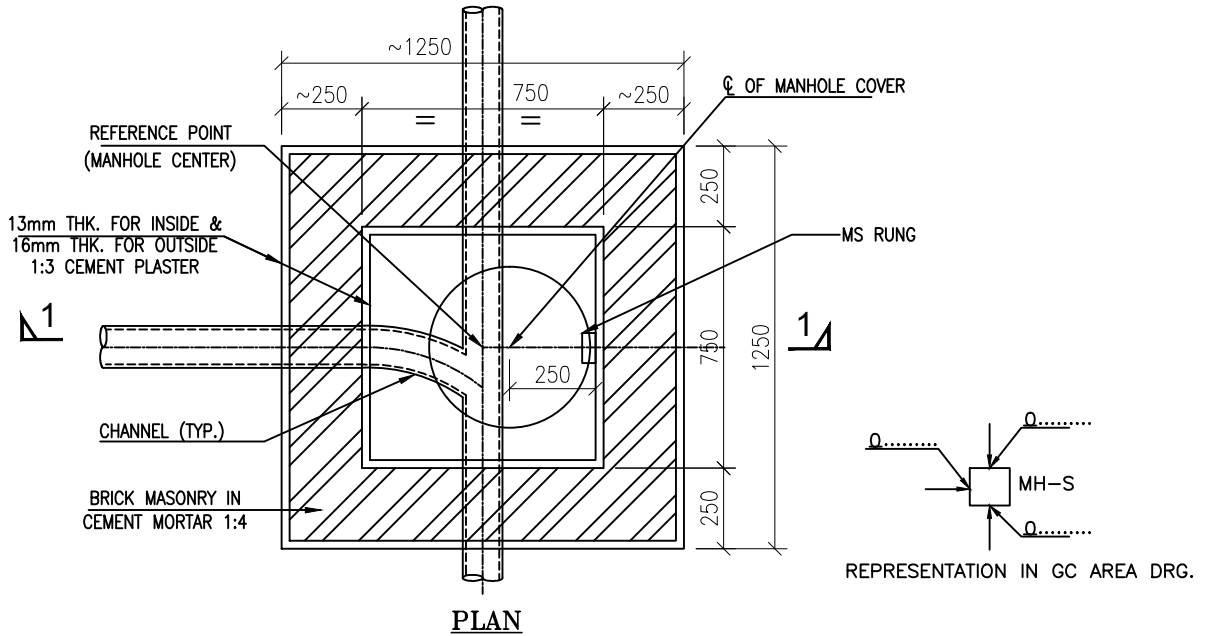
LYONS ENGINEERING PVT. LTD.  
NEW DELHI

TYPICAL DETAIL FOR MANHOLE

DRAWING NO.

GAIL-STD-EL-DWG-TP-024

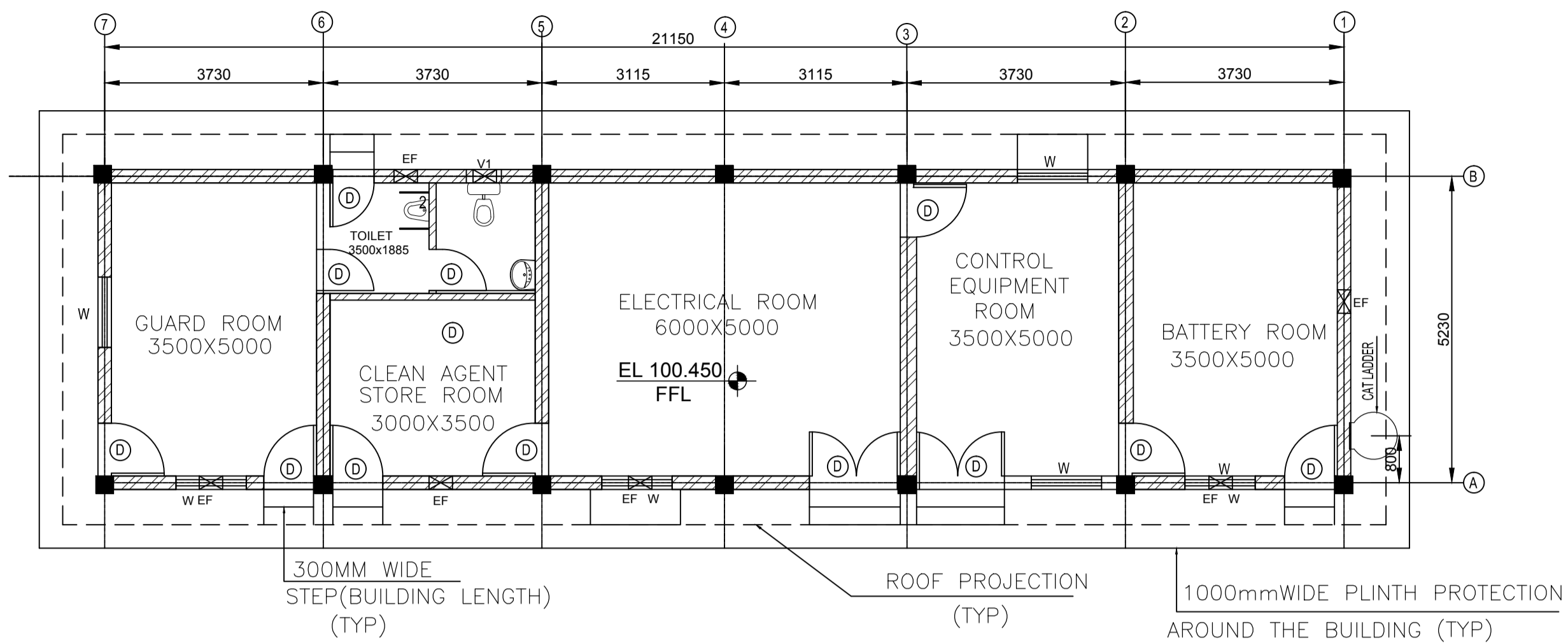
1 OF 1



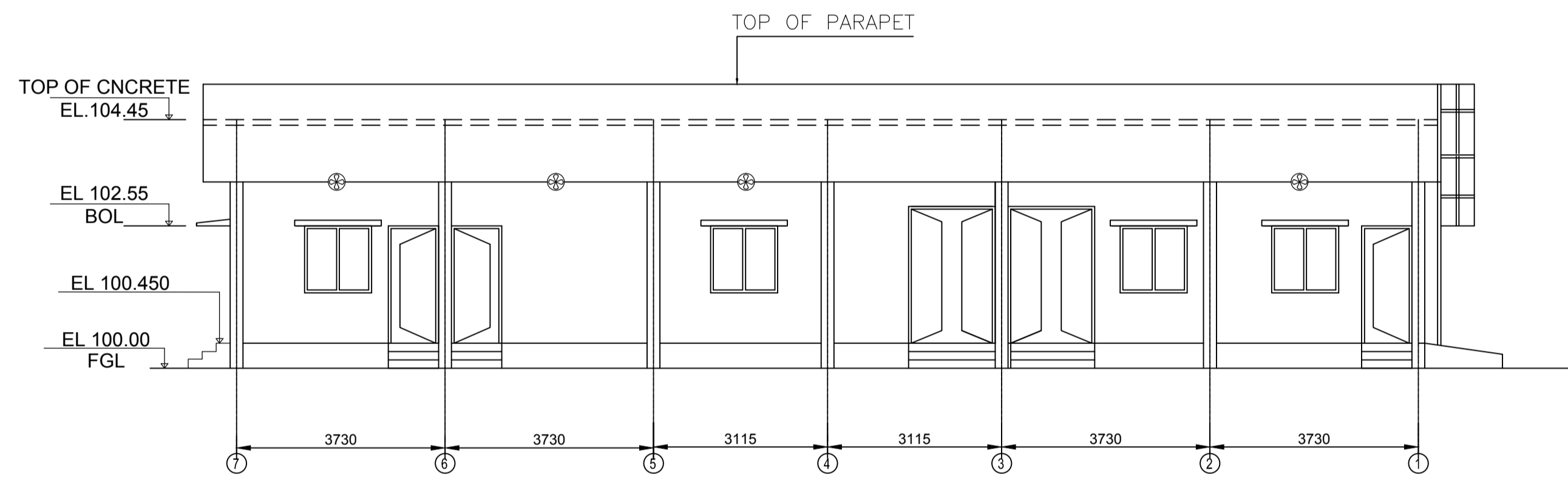
SECTION 1-1

1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. ALL REINFORCEMENT SHALL BE OF GRADE Fe415 CONFORMING TO IS:1786
3. EXACT THICKNESS OF BRICK MASONARY SHALL BE ACCORDING TO SEZE OF LOCALLY AVAILABLE BRICKS.
4. FOR AGGRESSIVE SOIL CONCRETE GRADE M-35 SHALL BE PROVIDED.

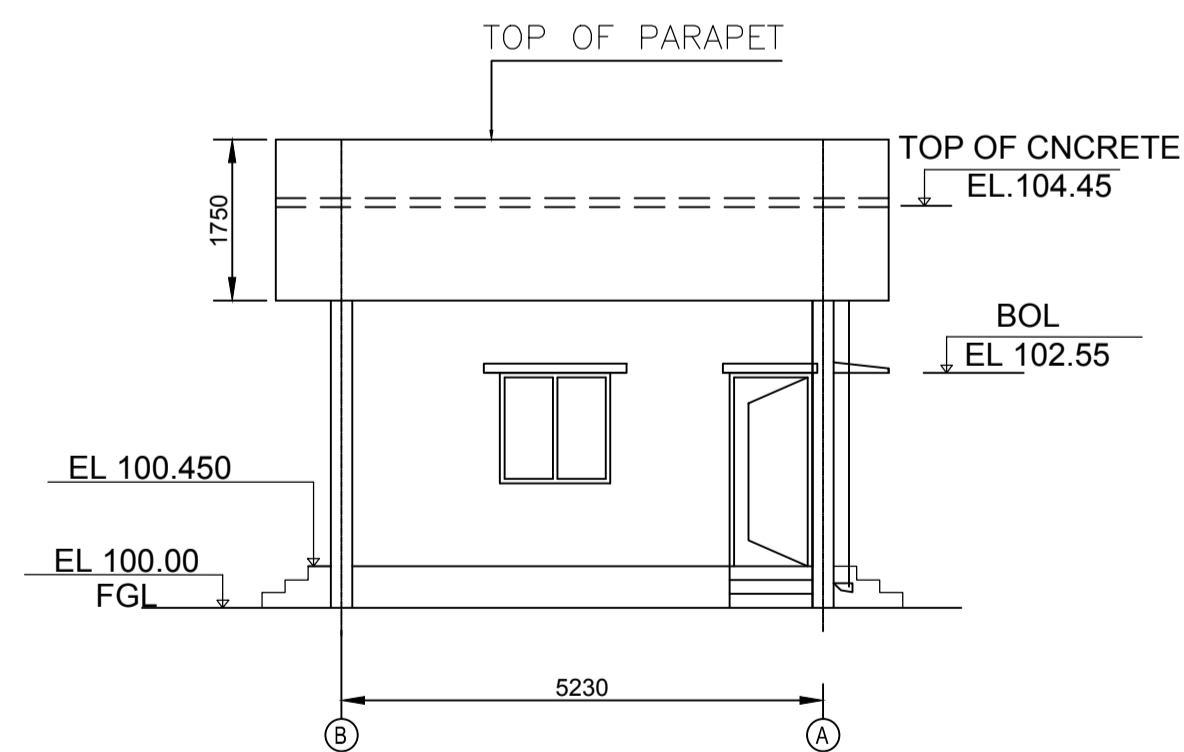
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REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED



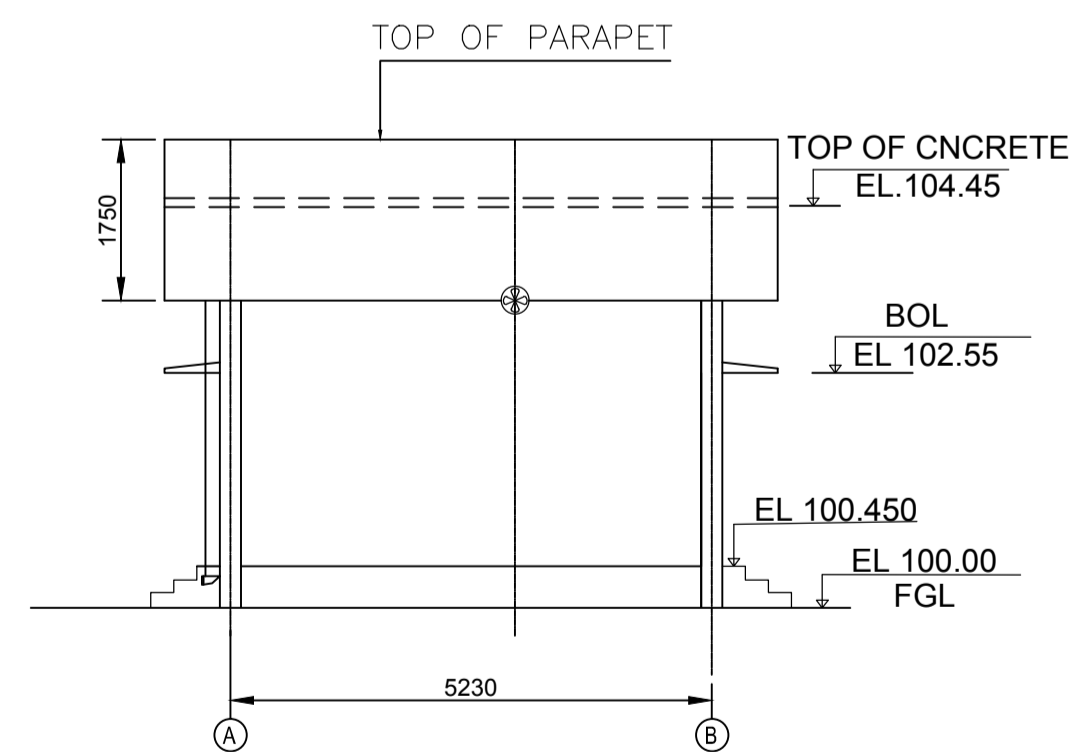
**PLAN**



**FRONT ELEVATION**



**ELEVATION ON GRID -(7)**



**ELEVATION ON GRID -(1)**

REFERENCE DRAWING

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

NOTES:-

- ALL DIMENSIONS ARE IN MILLIMETRES AND LEVELS ARE IN METERS.
- FOLLOW WRITTEN DIMENSION ONLY DO NOT SCALE THE DRAWING.
- FINISHED GROUND LEVEL (FGL): e EL. 100.00 SHALL BE 300mm ABOVE THE CENTER LINE OF NEAREST ASPHALTED ROAD OR HFL WHICHEVER IS HIGHER.
- ALL ELECTRICAL CONDUITS SHALL BE CONCEALED TYPE EXCEPT IN AREAS WHERE FALSE CEILING IS PROVIDED CONDUITS SHALL BE LAID BEFORE CONCRETING AS PER ELECTRICAL DRAWING.
- B/W AND PLASTERING SHALL BE AS PER SPECIFICATION AND DESIGN BASIS DOCUMENT
  - ORDINARY PLAIN PLASTER SHALL CONSIST OF 18mm THK. 1:6 CEMENT MORTAR
  - 12mm THK. 1:6 CEMENT MORTAR FOR ALL PLUMB OF THE INTERNAL MASONRY WALLS & RCC COLUMNS COMING IN LINE (FLUSH) WITH THIS SIDE OF WALL
  - 6mm THK. 1:4 CEMENT MORTAR FOR ALL RCC CEILING BEAM etc. HOWEVER IF THE UNDULATION IN CEILING IS BEYOND 6mm THK. PLASTER EXTRA THICKNESS OF PLASTER SHALL BE APPLIED.
- ALL CHAJJAS, CANOPIES AND GUTTER PROJECTION SHALL HAVE DRIP MOULD GROOVES UNDERNEATH ALL ALONG PERIPHERY.
- ALL THE BRICK MASONRY AND RCC JOINTS SHALL BE PROVIDED WITH 20 GAUGE CHICKEN WIRE MESH STRETCHED TIGHT AND FIXED WITH G.I "U" TYPE NAILS BEFORE PLASTERING.
- CONTROL ROOM SHALL BE DESIGNED SUCH THAT IT SHALL HAVE PROVISION FOR ONE ADDITIONAL FLOOR FOR FUTURE AND ADEQUATE REINFORCEMENT DOWELS SHALL BE LEFT ON EACH COLUMNS EMBEDDED WITH C.C. (1:5:10).
- FLOOR FINISHED, DADOES, PAINTS, DOORS, WINDOW, ELECTRICAL FITURES, SANITARY & TOILET FIXTURES SHALL BE AS PER RESPECTIVE SCHEDULES/SPECS.
- COLOR SCHEMES SHALL BE DECIDED BY OWNER / OWNER'S REPRESENTATIVES.

LEGEND

- |                          |                               |
|--------------------------|-------------------------------|
| 1. FC - FALSE CEILING    | 2. BOB - BOTTOM OF BEAM       |
| 3. AC - AIR CONDITIONED  | 4. FFL - FINISHED FLOOR LEVEL |
| 5. TOS - TOP OF SLAB     | 6. BOL - BOTTOM OF LINTEL     |
| 7. TOC - TOP OF CONCRETE | 8. RTL - ROAD TOP LEVEL       |

NO	DATE	ISSUED FOR TENDER	SS	HM	HM
0	14.02.2019	ISSUED FOR TENDER	SS	HM	HM
NO	DATE	REVISION	PREPD	CHKD	APPD

CLIENT



**GAIL (INDIA) LIMITED**

CONSULTANT



**LYONS ENGINEERING PVT. LTD.**  
NEW DELHI

TITLE **TYP. ARCHITECTURAL DRAWING FOR CONTROL BUILDING**

SCALE	SIZE	DRAWING NUMBER	SHEET	REV
1:80	A 1	GAIL-STD-CV-DWG-TP-025	1 OF 1	0

HAR EK KAAM DESH KE NAAM



**GAIL INDIA LIMITED**

**CONSTRUCTION OF STEEL PIPELINE AND ASSOCIATED FACILITIES  
FOR CGD CONNECTIVITIES**

**VOLUME II OF II (TECHNICAL) – F**

**CATHODIC PROTECTION**



**E-TENDER REF :**

**(BID DOCUMENT NO - 034/LEPL/GAIL/22-R0)**

**LIMITED DOMESTIC COMPETITIVE BIDDING**



**Lyons Engineering Pvt. Ltd.**

<b>PMC:</b> 	<b>DCI - MASTER DELIVERABLE CONTROL INDEX FOR CGD TO M/s TGPL MORADABAD &amp; CGD TO M/s TGPL GORAKHPUR</b>	<b>Doc No.</b>		<b>CLIENT:</b> 
		GAIL-ENG-GN-DOC-DL-001		
		Rev. 0		
<b>Sr. No.</b>	<b>Description</b>	<b>Document / Drawing No.</b>		<b>Rev. No.</b>
	<b>TECHNICAL VOLUME - II OF II</b>			
<b>F</b>	<b>CATHODIC PROTECTION</b>			
1	Cathodic Protection Design Basis	GAIL-STD-CP-DOC-DB-001		0
	<b>SPECIFICATION FOR CATHODIC PROTECTION</b>			
2	Technical Specification for Temporary Cathodic Protection(TCP) and Permanent Cathodic Protection (PCP)	GAIL-STD-CP-DOC-TS-001		0
	<b>DATA SHEET FOR CATHODIC PROTECTION</b>			
3	Data Sheet for Cathodic Protection System	GAIL-STD-CP-DOC-DS-001		0
	<b>QAP FOR CATHODIC PROTECTION</b>			
4	QAP for Cathodic Protection System	GAIL-STD-CP-DOC-QAP-001		0
	<b>STANDARD / TYPICAL DRAWINGS FOR CATHODIC PROTECTION</b>			
5	Standard Drawing for Cathodic Protection	GAIL-STD-CP-DWG-TP-001 TO 011		0



GAIL INDIA LIMITED



CATHODIC PROTECTION DESIGN BASIS

TOTAL SHEETS

08

DOCUMENT NO.:

GAIL-STD-CP-DOC-DB-001

REV	DATE	DESCRIPTION	PREP	CHK	APPR
0	08.07.2020	ISSUED FOR BID	SR	SB	SB

**1.0 INTRODUCTION :**

The purpose of this document is to define the basic design concepts and philosophies as required for the Cathodic Protection system [TCP] & [PCP] and equipment of the GAIL intend to take up implementation of a 4" natural gas pipeline as mentioned in SOR / Pipeline Schematics etc.

The cathodic protection system shall be provided as required. Insulating flanges shall be provided as required to isolate above ground piping systems from buried pipelines and to sectionalize. In general, the system will be based on the " impressed current" principle for all pipe lines. The sacrificial anode Principle can be applied for small sections of pipelines, remote from electric Facilities.

**2.0 PIPELINE DETAILS:**

2.1 The indicative Pipeline details are:

- Line Size : 4" NB
- Line Length : As per SOR or Schematic diagram
- Class : 600 #
- Design Pressure : 92.0 Bar (g)
- Material of Pipe : API 5L Gr. X42 PSL2
- Coating Material : 3 LPE
- Wall Thickness : 6.4 mm API 5L X42 PSL2

**3.0. Cathodic Protection System:**

It is envisaged to provide cathodic protection to the externally coated carbon steel pipeline from ravages of soil side corrosion in following two steps:

**3.1 Temporary Cathodic Protection [TCP]:**

Using sacrificial [Mg or Zn] anodes pre-packed in back-fill for the design life of the TCP system shall be (2) years or till PCP commissioning whichever is earlier.

**3.2 Permanent Cathodic Protection System [P-C-P]:**

Impressed current Cathodic Protection [ICCP] System Using Mixed Metal Oxide [MMO] anodes [LIDA single] in specified carbonaceous back-fill, for a design life of Forty (40) years and Powered by AC Input and DC Output Transformer Rectifiers or DC input and DC output CPPSM.

**4.0 Codes & Standards & Recommended Practices:**

4.1 Latest edition of:

- Bureau of Indian Standards [BIS]
- National Association Of Corrosion Engineers [NACE]
- British Standard [BS]
- American Petroleum Institute [API]
- Indian Electricity Rules [IER]
- Indian Petroleum Rules [IPR] Safe Practices

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## CATHODIC PROTECTION DESIGN BASIS

Institute Of Electronics & Electrical Engineers [IEEE]  
Indian Electricity Act [IEA]  
National Fire Protection Agency [NFPA]  
Chief Controller of Explosives [CCE] Regulations  
Oil Industry Safety Directorate [OISD] Norms  
PNGRB Regulations

4.2 In case of conflict the most stringent will apply. However, the order of priority will be :

Statutory Rules  
Project Specifications  
Codes & Recommended Practices

### 5.0. Site Conditions:

The equipment to be used for this project shall conform to following site Requirements / Conditions:

- ❖ Temperature - Maximum 60°C & Minimum -20°C
- ❖ Design Temperature - 65°C
- ❖ Relative Humidity - 100%
- ❖ Altitude Above Sea Level - Less ≤ 1,000M
- ❖ Atmospheric Pollution - Tropicalized to Withstand the site Conditions, dust, vapor etc.
- ❖ Hazardous Area Classification - Zone2, Gas Gr.IIA & IIB  
Temperature Class T3
- ❖ Battery, TRU room - Safe Area(If applicable)

### 6.0 Hazardous Area Classification & Equipment Classification:

All Electrical equipment installed in Hazardous area will be in accordance with API 500, BIS 5571, 5572, & OISD 149.

6.1 Flame Proof equipment shall be CMRI or Owner Approved Agency Certified.

### 7.0 Design Life & Basis:

- 7.1 Design Life of [TCP] system to be two (2) years or till commissioning of [P-C-P] whichever is earlier.
- 7.2 Design Life of [PCP] system to be forty (40) Years. Soil/Water Chemical & Microbial Analysis.

### 8. Electrical Equipment:

Following equipment are envisaged for this project:

Equipment required in both [TCP] & [PCP] are to be designed and installed during [TCP] installation.

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CATHODIC PROTECTION DESIGN BASIS

S.No.	[TCP]	[PCP]	Remarks
1	Sacrificial [Mg or Zn] Anode pre-packed in Back-fill	MMO [LIDA Single] Anodes in Carbonaceous back-fill & Cable	
2	Test Lead Points[TLP] with shunt & resistors	Junction Boxes [JB],[AJB],[CJB]	IP55 Enclosure
3	Corrosion Coupons with Magnetic Reed switch & Copper Sulphate Reference electrode	AC Input & DC Output Transformer Rectifier Unit [TRU]	IP55 Enclosure
4	Surge Diverters at Insulation Mono blocks		
5	Permanent Copper Copper Sulphate Reference Electrode	Earthing for TRU And Distribution Board	
6	Pipe to Cable connection –Pin Brazing, Epoxy Encapsulated		
7	Solid State DC De-coupling device		
8	Grounding cell for H.T. overhead Lines		
9	Zn or Mg Anode Grounding for MOV/SV	ER Probes for corrosion monitoring	
10		[P-S-P] Converter	To Be Installed away from CP Stations, in Instrumentation Panel
11	Coated Casing Protection with Sacrificial anodes		Separate from [ICCP] more than 10M
12	Carrier Inside Casing Protection with Ribbon Anodes		Additional Carrier Protection inside casing more than 20M

**9.0 Cathodic Protection Criteria :**

- 1) [P-S-P] Minimum (-) 0.95 V "On" and Maximum (-) 1.5 V "On" both "On" potentials w.r.t. CSE
- 2) [P-S-P] Minimum (-) 0.95 V "Off" and Maximum (-) 1.2 V "Off" both "Off" potentials w.r.t. CSE, the maximum remaining the same (-) 1.5 V "On" w.r.t. CSE
- 3) Corrosion Coupons [P-S-P] "Off" Minimum (-).95 V and Maximum (-)1.2V "Off" w.r.t. CSE
- 4) In exceptional circumstances a swing of 100mV in Polarization potential may also be acceptable with Sole discretion of Owner.

**10.0 Protective Current Density :**

For the 3 layer polyethylene [3XLPE] coated pipeline following protective current density to be used:

	Marshy Soil	Normal Soil
For TCP & PCP	- 125 $\mu$ A/M <sup>2</sup>	50 $\mu$ A/M <sup>2</sup>

**11.0 PERMANENT REFERENCE ELECTRODE :**

- 11.1 In Soil – copper copper sulphate electrode will be provided.
- 11.2 Three (3) numbers to be installed, at each CP Station.

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- 11.3 One (1) number to be installed ,midway between two CP Stations, if one (1) C.P station install one CSE (PSM) at other end.
- 11.4 To be installed at extremely vulnerable locations.
- 11.5 In water –silver silver chloride [Ag-AgCl] Reference to be installed / Used.

### 12.0 Insulation mono block joints (I/J) :

I/J Numbers will be provided between under ground pipe and above ground pipe to sectionalize electrically the protected and unprotected pipe.

### 13.0 SPARK GAP ARRESTOR :

- 13.1 To be installed at every insulation mono block joint for grounding surges, if any.

### 14.0 POLARIZATION CELLS – SOLID STATE TYPE :

- 14.1 To mitigate A.C. Interference, solid state type Polarization Cells to be installed at as required for A.C. interference mitigation in the section where interference is detected.

### 15.0 TR UNITS :

- 15.1 TR unit will receive power from the AC feeder or Battery Back-up (available from UPS).

### 16.0 OPERATING REQUIREMENTS :

- 16.1 UPS Power supply:

Voltage	-	230V $\pm$ 1%
Frequency	-	50 Hz $\pm$ 5%
Phase & Wire	-	1P, N & 2W
Fault level	-	10KA for 1 sec
Neutral Earthing	-	Solidly earthed

- 16.2 Transformer Rectifier unit:

- 16.3 Output

Voltage	-	50V/25 V $\pm$ 10% DC
Current	-	50A/25A $\pm$ 10% DC

- 16.4 Alternative Input DC From UPS System [when AC Trips]

- 16.5 Any other control supply if required,will be arranged by the contractor as per equipment requirement.

- 16.6 TR unit will be capable of giving online data to SCADA system with-in built current interrupter and potential free contacts. The TR should have inbuilt GPS current interrupter and GPS antenna for time synchronization. TR units are to be integrated with SCADA system.

- 16.7 TR unit will be weather proof enclosure ,with hinged lockable shutter and degree of protection IP-55 .

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**17 CASING PROTECTION :**

- 17.1 All the casing Annulus shall be filled with Bentonite + sand mixture or Paraffin wax or Petroleum jelly to control ingress of moisture in the annulus . This will not apply to casing under Railways.
- 17.2 Only For casing longer than 20 M,Carrier inside Casing shall be provided Additional cathodic protection with Ribbon anodes.

**18 CABLE CONNECTION TO PIPE :**

- 18.1 Cable will be connected on pipe by carrying out pin brazing with low contact resistance. At every location at least two cable from pipe to be pin brazed & brought to [TLP].

**19 SPECIAL REQUIREMENT :**

- 19.1 Permanent Anode Bed will be deep well type(only if ROU for locating deep well anodebed 100 m away is not available ) or alternatively the land 100 m away from ROW.Land required for deep well anodebed shall be provided by GAIL. The area of anodebed will be fenced with single gate.The area required will be sufficient for C P installation & checking the facilities at each anodebed location and will not be less than 8 m x 8m in size.

CP contractor will also arrange permission from owner of the land for use by GAIL,for laying anode head cable from Anodebed to TRU at CP station and right to access to this,as and when required,for O&M purposes.

- 19.2 PSP converter and reference CSE will be provided at all location wherever SCADA , RTU available.

**20.0 Computerized Test Station Unit [CTSU] :**

CTSU(04 Nos) data logger with built in non volatile memory for logging min 45000 data reading and inbuilt battery capable of functioning one year at the logging & broadcasting rate of one SMS per day on the internal battery without changing/charging. Computerized Test Station Unit [CTSU] (alongwith Reader Unit) to be supplied and CSE Permanent type to be installed at all CTSU.

Maximum 4 nos. of CTSU to be installed in the pipeline section.

**21.0 Corrosion Coupons :**

Made from pipe material to be installed at two (2) locations along ROW.Magntic reed switch to be installed in circuit for "Off" Potential measurements.

**22.0 Test Station [TLP] & Junction Boxes [JB] :**

Test station to be installed approx. every 1 Km. maximum all along the pipeline ROW.These [TLP] to be provided with Shunt & Resistors for individual Anode current output control.All [TLP] to have IP 55 Protection and are to be installed at accessible locations along ROW to facilitate CP System adequacy Monitoring.[TLP] to be installed at Rail,River,Canal,Road,Overhead High Tension Transmission Power lines,Pipeline and other line/cable crossings as well as Insulation

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Joints. Accordingly [TLP] to be named Type A,B,C,D,E,F etc. Minimum two(2) nos. Line current Measurement [TLP] to be installed.

CTSU to be installed in [TLP], wherever [P-S-P] convertor is to be installed and no C P Station is nearby, it will be installed inside of Instrument panel. [AJB] & [CJB] having IP 55 Protection to be installed at each [ICCP] CP Station.

### 23.0 Post Commissioning Surveys :

To be conducted after one month of CP Commissioning. Pearson Survey, Coating Conductance survey, CAT Survey, DCVG Survey, Close Interval Computerized Potential Logging [CIPL] ["On" & "Off"] and AC,DC Interference survey with 24hours data logging at obstacle crossing & Mitigation.

Any defects or in-adequacy detected during post commissioning surveys should be rectified by CP contractor to handover Interference free adequately protected pipeline to GAIL.

### 24.0 Periodic Monitoring Of Installed C P System :

The Installed C P System will be periodically Monitored for Protection Adequacy & Methodology of Monitoring & Formats & frequency for Monitored data Recording to be prepared by C P Contractor.

Periodic Monitoring of installed CP system, coating repair shall be in EPC scope in consultation with CP agency.

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GAIL INDIA LIMITED



**TECHNICAL SPECIFICATION FOR TEMPORARY CATHODIC PROTECTION (TCP) AND PERMANENT CATHODIC PROTECTION (PCP)**

TOTAL SHEETS

46

**DOCUMENT NO.:**

GAIL-STD-CP-DOC-TS-001

REV	DATE	DESCRIPTION	PREP	CHK	APPR
0	20.11.2019	ISSUED FOR BID	SR	SB	SB

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5	CATHODIC PROTECTION DESIGN CRITERIA.
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26	APPROVED MAKE OF EQUIPMENT / COMPONENTS FOR CP SYSTEM
27.	ANNEXURES



## 1. INTRODUCTION

It is envisaged to protect the external surface of by Cathodic Protection [CP] System: Temporary CP System [TCP] using sacrificial [Mg or Zn] Anodes for an initial One (1) year construction period, followed by Jumper connection from existing pipeline ICCP or Impressed Current Cathodic Protection [ICCP] system [PCP] using [MMO] Anodes & external Power source [AC Input DC Output TRU at Receipt Terminal or 24V DC input and DC output CPPSM at SV1] for a Design Life of forty (40) years.

- 1.1 This specification defines the requirements of site surveys for design data generation, CP design, detailed engineering, supply of materials, quality assurance (QA) and quality control (QC), installation, testing and pre-commissioning, commissioning of temporary Cathodic protection system [TCP] and permanent Cathodic protection system [PCP] for protecting throughout the design life [1+40 years] the external surface of cross-country 3LPE coated underground pipeline including detection of A.C & D.C. interference / interaction with neighbouring structures all along the pipeline ROW, as well as Installation of requisite Mitigative measures for the [A.C/D.C.] interaction / Interference mitigation. Also included in the scope of work are post-commissioning surveys such as CIPL ("On" & "Off") computerized logging along ROW and Coating conductance measurements along the pipeline ROW, Pearson detection followed by DCVG [for defect classification] at defect locations evinced .
- 1.2 This specification defines the basic guidelines to develop a suitable temporary Cathodic protection [TCP] system followed by permanent [PCP] Cathodic protection [ICCP] system for the underground pipeline [external surface coated with 3LPE required to be protected from ravages of soil side corrosion. All data required in this regard including site surveys to verify the design data shall be taken into consideration by the CP contractor to develop an acceptable state of the art [TCP],[PCP] design and for proper engineering & detailing of the [TCP],[PCP] systems.
- 1.3. Compliance with these specifications and/or approval of any of the contractor's documents shall in no case relieve the contractor of his contractual obligations of providing adequate Cathodic protection [TCP],[PCP] system suitable for desired number of service [1+40] years free of interference.
- 1.4. Activities of permanent [PCP] system which are common to temporary [TCP] system shall be completed as part of temporary [TCP] system. The facilities installed for [TCP], if useful & required in [PCP] system (such as TLP, permanent Reference CSE electrodes, Cable to Pipe connection, Corrosion coupons, etc.) shall be utilized for [PCP] also & hence are to be designed & installed as per [PCP] requirements.
- 1.5 All works to be performed and supplies to be effected as part of this contract shall require specific approval of owner or his authorised representative. Major activities requiring approval shall include, but not be limited to, the following:



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- a) Methodology of **Corrosion survey site data generation** and interpretation report and design basis for [TCP],[PCP] system.
- b) **CP System design package** including formulae used, design calculations, BOQ, Technical Specifications, Installation work procedure, and Post Commissioning Monitoring Methodology, Data Recording Formats etc.
- c) Quality Assurance Control [QA/QC] methodology.
- d) Procedure for field testing and commissioning.
- e) Procedures for A.C and D.C. interference testing and mitigation.
- f) Procedure for Post Commissioning surveys.
- g) As-Built Documentation.
- h) O&M Manual.

1.6. The Intending Bidder shall be deemed to have visited the Site pipeline ROW and Familiarized before Submitting the tender. **Non familiarity with site conditions will not be accepted as a reason either for extra claims or for not carrying out the work in total conformity with these tender specifications.**

1.7. The CP contractor will have to accordingly mobilize work and deploy adequate skilled & trained manpower conversant with work procedure, adequate number of tools, tackles, testing and Construction Equipments requisite for smooth work progress so that CP work could also be completed within Schedule specified for the project. The CP contractor shall work in close coordination with the main pipeline contractor.

**1.8 TECHNICAL DATA - MAINLINE**

1.8.1 The indicative Pipeline details shall be as mentioned in design basis.

1.8.2. The system design, performance and materials to be supplied shall unless otherwise specified, conform to the requirements of latest relevant applicable standards:

- ❖ BIS Standards
- ❖ BS Standards and codes of practice
- ❖ ANSI Standards
- ❖ NFPA Standards
- ❖ NACE Standards and Recommended practices
- ❖ IEC Standards
- ❖ DNV Standards
- ❖ IEEE Standards
- ❖ DIN Standards
- ❖ ASTM Standards



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- ❖ OISD Standards & CCE Norms
- ❖ API Model code of safe practices
- ❖ GAIL Safety Standards
- ❖ All statutory, state, local requirements and norms  
[All latest available editions only.]

In case of conflicting requirements amongst any of the above standards, the publication having most stringent requirement shall be governing. However, the priority in such instance shall be as follows:

- Statutory Regulations and norms
- This Specification
- Codes & Standards, Recommended practices

## 2. CORROSION SURVEY DATA

**Corrosion Survey Data** collected already from site [pipeline ROW & Anodebed locations] viz: **Soil Resistivity, Soil Chemical analysis for chemical and microbial loading** is enclosed:

- i. Soil Chemical Analysis - As per Annexure-1.
- ii. Soil Resistivity - As per Annexure-2.

However, verification of its veracity and Adequacy shall be the entire responsibility of the CP contractor.

**In addition the CP contractor shall have to generate/collect additional Data** from site such as:

The CP contractor shall carry out a site survey along pipeline ROW and at proposed Anode bed locations, in order to verify design data, prior to the final design of the [TCP], [PCP] system. The site survey shall generally include the following:

### **General information [Topographic] of terrain along which the pipeline is to be routed.**

Measurement of soil resistivity [  $\rho$  ] along ROW and at Anode bed plots. Each selected Anode bed plot shall be sub-divided into sub-plots. Size of the sub-plots shall depend upon investigation of soil resistivity upto requisite depth. Each of these sub-plots shall be investigated individually. Sufficient observations at each of these plots shall be recoded as recommended hereunder:

- 1) Soil Resistivity at every 2 Kms along ROW to be carried out at 1,2,3 M depths. Wherever, abrupt changes are observed additional readings to be recorded in between.
- 2) Soil Resistivity at Anode-bed plots to be recorded at 1,3,5,7M for shallow Anode beds and 1,3,5,7,10,15,20,25,30,35,40... M for Deep well Anode beds.



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Chemical Analysis of Soil / Water samples collected from two depths [1.0M] and [2.0M] of pipeline ROW at every 5 Kms. and at each intersection of a grid from sub-plots for each anode beds location. The air dried soil samples to be quartered, coned and aqueous extract prepared for chemical and microbial analysis of following:

S. No.	Sample from Locations Kms.	0	0	5	5		
1	Depth in M	1	3	1	3		
2	pH						
3	Redox Potential V						
4	Total Dissolved Solids ppm						
5	Chloride ppm						
6	Sulphate ppm						
7	Sulphide ppm						
8	Carbonate ppm						
9	Bi-carbonate ppm						
10	Nitrate ppm						
11	Nitrite ppm						
12	Phosphate ppm						
13	Sodium ppm						
14	Potassium ppm						
15	Calcium ppm						
16	Magnesium ppm						
17	Sulphate Reducing Bacteria (SRB) Counts						



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This data to be used for calculating soil/water corrosivity based on which and clause 5.1 of this specification, the protective current density and Anode material shall be selected/decided.

### **Stray Current Survey:**

Survey for investigating possible sources of stray currents along ROW so that requisite Mitigative measures are included in the CP design. The CP contractor carrying out CP Interference survey due to DC current will have to get necessary permissions from other utilities such as underground pipelines of ONGC, IOCL, HPCL, BPCL, GAIL, etc., over ground water pipeline running parallel on concrete pedestal, and DC rail traction etc. so that composite studies for interference detection are done and recommended Mitigative measures are installed. At the time of handing over the interference free system to owners (GAIL), the contractor will hand over these permissions of other utility owners, for further needful by GAIL.

Where a site survey is not possible the C P contractor shall ensure that requisite data is available for him to fulfil requirements of the work order.

Survey for knowing the location of **Existing Cathodic Protection system** to maintain appropriate clearance between the existing and upcoming C P Systems. CP contractor, prior to CP Design for, shall carry out extensive site surveys and attenuation calculations and data collection, from pipeline ROW and proposed Anode bed locations. Likely interfering elements along ROW, survey for sources of stray currents likely to cause interference, and shall base the CP System Design on this Data collected from site.

Ground Water Table Data to be collected either from GSI [Geological Survey of India] by CP contractor or measured at site to ensure Anode bed location in appropriate perennially moist environment round the year throughout service life.

In addition contractor shall have to collect/ generate additional Data as required for completeness of the C P job for GAIL as follows:

### **3.0 ADDITIONAL DATA TO BE COLLECTED**

The following data shall be collected to generate design data for evaluation of interaction/ interference possibilities due to presence of other services in ROW/ in close vicinity:

- i. Route and types of foreign service/pipeline in and around or crossing the right of way (including those existing and those which are likely to come up during contract execution or any abandoned pipelines).



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- ii. Diameter, wall thickness, pressure, pipeline coating against corrosion, soil cover used in case of pipelines.
- iii. Details of the existing pipeline Cathodic protection systems protecting the services i.e. location, rating, type of protection, anode beds, test station locations and their connection schemes.
- iv. Graphical representation of existing structure/pipe-to-soil potential [P-S-P] records, T/R unit current/ voltage input/output ratings, present current/Potential Input/Output Data etc for the existing pipelines.
- v. Remedial measures existing on foreign pipeline/ services to prevent interaction.
- vi. Possibility of integration/ isolation of existing CP systems, which may involve negotiations with owners of other existing pipeline services.
- vii. Crossing and parallel running of electrified and non-electrified traction (along with information regarding operating voltage, type AC/DC etc.) as well as abandoned tracks near ROW having electrical continuity with the tracks in use.
- viii. Crossing or parallel running of any HT AC/DC overhead line (existing/proposed) along with details of distance from pipeline, voltage, type AC/DC, distance from pipeline of earthing of towers etc.
- ix. Voltage rating, number of cores and sheathing details of underground power cables, along ROW or in it's vicinity.
- x. Information on existing and proposed DC/AC power sources and system having earth as return path, in the vicinity of the entire pipeline route such as HV DC sub stations, fabrication yards with electric welding etc.
- xi. Any other relevant information that may be needed in designing and implementing proper protection scheme for the proposed pipeline.

Unless otherwise mentioned, CP contractor shall conduct necessary potential gradient survey for any existing anode ground bed that may interfere with the CP system of the pipeline covered under this project.



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## CP DESIGN REPORT

On completion of all field work a composite report incorporating all the results generated from site surveys for data generation and details of additional data collected and complied with in the attached Compliance Report format clause wise as above shall be furnished to owner for Approval. The report shall also contain detailed interpretation of survey results and resistivity data enclosed, probable interference prone areas etc. to form design basis for the scheme of Cathodic protection [TCP] & [PCP] system. This report shall also include various drawings prepared in connection with the above work. The soil resistivity values shall be plotted on semi-log graph sheets and in Histograms. Log mean resistivity values to be calculated and used for the Design of CP system.

The Cathodic Protection Design of [TCP] and [PCP] systems should be part of this composite Report. The Bill Of Materials [B.O.M.], Technical Specifications, Vendor list [from listed herein] etc. will be included in this Report for Approval of Owner. The Drawings for Owners Approval shall be part of this composite report.

### 4. CATHODIC PROTECTION DESIGN PARAMETERS

Unless expressly varied and otherwise specified in the project specifications, following parameters shall be used for design of temporary Cathodic protection [TCP] system and permanent Cathodic protection [PCP] system.

4.1 Those parts of sacrificial anode Cathodic protection [TCP] system which will be integrated with permanent CP system [PCP] such as Reference Cu-CuSO<sub>4</sub> electrodes, Test Lead Points, Junction Boxes, Thermit welds epoxy encapsulation, Markers, Polarization coupons etc. shall be designed based on permanent CP parameters.

### 4.2. PROTECTION CURRENT DENSITY

Pipelines having polyethylene coating.

Pipeline surrounding	Protection Current density *	
	Temporary CP ( $\mu\text{A}/\text{m}^2$ )	Permanent CP ( $\mu\text{A}/\text{m}^2$ )
Normal soil	35	35
Marshy area	45	45
High resistivity area (more than 100 $\Omega\text{m}$ )	-	-



However, the Protective Current Density to be chosen at site as per measured Environmental conditions obtained as per Detailed Chemical & Microbial Analysis and presence or absence of interfering elements in close vicinity of GAIL pipeline ROW.

**Pipe to soil potential shall not be more negative than (-) 1.5V (“ON”) or (-) 1.18V (“Off”) w.r.t. Cu-CuSO<sub>4</sub> Reference electrode.**

\*Actual current density to be adopted shall be decided based upon soil/water corrosivity and other environmental conditions, proximity of foreign pipelines and structures resulting in interference. Where considered necessary for satisfactory protection of pipeline the current density shall be suitably increased by contractor with appropriate justifications.

**4.3. OTHER PARAMETERS FOR DESIGN**

Other parameters to be considered for [TCP] and [PCP] design:

- 4.3.1. Safety Factor for Current Density : **1.3**
- 4.3.2. Anode Utilization Factor : 0.85 for centre connected Anode  
: 0.5 for Ribbon Anode
- 4.3.3. Pipeline natural potential (-) 0.45V [as measured from existing /upcoming structure in the same soil matrix].
- 4.3.4. Unless otherwise specified in project specification the design life of the TCP system shall be (2) years or till PCP commissioning whichever is earlier and that of [PCP] permanent CP shall be (40) Forty years.
- 4.3.5. Along the ROW where soil resistivity is higher than 100 Ω m temporary CP for the pipeline may not be necessary subject to Owner’s Approval.
- 4.3.6. Steel Resistivity 2.2 X 10<sup>-7</sup>Ω M
- 4.3.7. Maximum Loop Resistance 1 Ω

**5. CATHODIC PROTECTION DESIGN CRITERIA**

Cathodic protection system shall be designed to meet the following criteria.

**5.1 TEMPORARY CATHODIC PROTECTION [TCP]**

5.2. The pipe to soil potential measurements shall be between -0.95V (“On”) and -1.5V (“On”) both “On” Potentials w.r.t. Cu-CuSO<sub>4</sub> reference electrode. In case sulphate reducing bacteria [SRB] are present in soil the minimum protective potential shall be (-) 0.95V (“On”), the maximum remaining the same (-) 1.5V (“On”) w.r.t. Cu-CuSO<sub>4</sub> reference electrode. At the location of Polarization coupons, the coupon to soil potential measurement shall be between (-) 0.95 (“Off”) minimum and (-) 1.18 V(“Off”) maximum w.r.t. CuCuSO<sub>4</sub> reference electrodes, both being “Off” potential. During [TCP] monitoring using Reed Magnetic switch “Off” potentials to be recorded.

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5.3. In rare circumstances a minimum polarisation shift of (-) 100 millivolts w.r.t. Cu-CuSO<sub>4</sub> reference electrode shall indicate adequate levels of cathodic protection for the pipeline.

**Discretion to use any of the criteria, listed above, shall solely rest with the Owner/ Owner's representative.**

5.4. A positive potential swing of >20 mV [P-S-P] shall be considered as the criteria for presence of an interaction situation requiring investigation and incorporation of suitable mitigation measures by the C P Contractor.

#### **PERMANENT CATHODIC PROTECTION [ P C P ]**

5.5. The pipe to soil potential measurements [PSP] shall be between (-) 0.95V ("Off") minimum and (-) 1.18V ("Off") maximum [both "Off" Potentials] w.r.t. Cu-CuSO<sub>4</sub> reference electrode, the maximum remaining the same (-) 1.5V ("On") w.r.t. Cu-CuSO<sub>4</sub> reference electrode. At the location of Polarization coupons, the coupon to soil potential measurement shall be between (-) 0.95 ("Off") minimum and (-) 1.18 V ("Off") maximum w.r.t. CuCuSO<sub>4</sub> reference electrodes [both being "Off" potential].

5.6. In rare circumstances a minimum polarisation shift of (-) 100 millivolts w.r.t. Cu-CuSO<sub>4</sub> reference electrode shall indicate adequate levels of Cathodic protection for the pipeline.

Discretion to use any of the criteria, listed above, shall solely rest with the Owner/ Owner's representative.

5.7. A positive potential swing of >20 mV [P-S-P] shall be considered as the criteria for presence of an interaction situation requiring investigation and incorporation of suitable mitigation measures by the C P Contractor.

### **6. SYSTEM DETAILS**

#### **6.1 Temporary Cathodic Protection [TCP]**

The [TCP] system unless specified otherwise, may include the following major equipment/ sub-systems.

- Sacrificial anodes [Zn or Mg] ground beds in carbonaceous back-fill
- Test stations [TLP]
- Junction Boxes with shunts and resistors [AJB] & [CJB]
- Permanent Reference Cu-CuSO<sub>4</sub> Electrodes [CSE]
- Pin Brazing epoxy encapsulated





- Surge diverter/ Grounding cell at Insulation Mono – blocks, or
- Grounding cell at Insulation mono - blocks
- Solid state DC Decoupling device at A.C. Interference locations
- Earthing of Motor Operated Valve [MOV] and other Electrical equipments without disturbing CP System through Sacrificial anodes
- Polarization ER Coupons for corrosion monitoring
- Interconnecting cables
- Cable to pipe connections-Pin Brazing.
- Markers for Cable,Anode bed etc.
- CP System at Cased Railway Crossings

**6.2 PERMANENT CATHODIC PROTECTION [P C P]**

The [PCP] system may include the following major equipment/ sub-systems unless otherwise specified.

- Digital Power Source AC Input DC Output [TRU] with built-in Current interrupter and GPS based timer.
- Distribution Board [dB]
- MMO [LIDA Single] anodes and anode ground beds in carbonaceous back-fill
- Test stations [TLP]
- Computerized Test Stations [CTSU]
- CPPSM
- Junction Boxes with shunts and resistors [AJB] [CJB]
- Permanent Reference Cu-CuSO4 Electrodes [CSE]
- Pin Brazing for pipe to cable connection [ epoxy encapsulated ]
- Surge diverter/ Grounding cell across Insulation Mono - blocks
- Grounding cell at Insulation mono - blocks
- Solid state DC De-coupling device at A.C. Interference locations
- Polarization ER Coupons for Corrosion monitoring
- Interconnecting cables
- Cable to pipe connections.
- Markers [for cable route, anodebed etc.]



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- Insulating fittings

### 6.3 SITE CONDITIONS

The equipment will be designed for the following site conditions:

Min/Max. Temperature	0° C to 60° C
Design Temperature	65° C
Relative Humidity	90%
Height above MSL	< 1,000 M
Atmospheric Pollution	To withstand the site conditions, dust, vapour
Hazardous area classification for plant	Zone 2, Gas Group IIA, IIB
	Temp. Class T3
Control Room/Electrical Room/	
D.G.Room / Guard Room/Battery Room	Safe Area

### 6.4 EQUIPMENTS

All equipment shall be new and supplied by CP contractor sourcing from approved manufacturers of repute with proven track record and approved by the owner for the supply for this project. Equipment offered shall be field proven. Equipment requiring specialised maintenance or operation shall not be acceptable hence should be avoided, as far as possible, and prototype equipment shall not be accepted. Make and construction of all the material shall be as per GAIL Vendor list and Standard specification of this document.

The detailed specification of each system and equipment shall be furnished by the contractor.

However, certain minimum requirements for the major equipment are highlighted in this document.

#### 6.4.1 Equipment Location In Hazardous / Non Hazardous Area

As far as possible equipment including Power source, test stations, anodes, junction boxes, TLP etc. shall be located in safe area. However, **all equipment located in hazardous areas shall be of flame proof type as per BIS: 2148, IEC 79 for gas groups IIA & IIB and temp. Class T3 (200° C).**All equipment to be located in Hazardous area should conform to and comply with BIS 2148 and IEC 79 (or equivalent) code requirements. All indigenous flame proof equipment should be certified by **CMRI**. All flame proof equipment of indigenous origin should also be **BIS** marked.



**7. ANODE GROUND BEDS**

**7.1 TEMPORARY CATHODIC PROTECTION [TCP]**

- 7.1.1 Along ROW where soil resistivity predominantly remains low and ranges from 0-10  $\Omega$  m Zinc (Zn) anodes shall be provided. However, at locations where soil/water pH is more than 9, Zn anodes not to be used as these get Passivated.
- 7.1.2 Along ROW where soil resistivity is predominantly higher than 10  $\Omega$  m Magnesium (Mg) anodes shall be provided.
- 7.1.3 At high resistivity area where resistivity is of the order of 50  $\Omega$  m and above Magnesium (Mg) ribbon anodes shall be provided.
- 7.1.4 Anodes shall be installed along the pipeline at suitable intervals as per pipeline protection voltage attenuation calculations and ground bed resistance/current output of anode installations.
- 7.1.5 Each electrically continuous section of pipeline shall preferably be protected totally by one type (material) of anodes [either Zn or Mg] to avoid inter-anode [Zn  $\leftrightarrow$  Mg] circulation currents. Grounding cell should also conform to this specific requirement.
- 7.1.6 The anodes shall be installed at sufficient depth to reach perennially moist soil [ascertained by ground water table data] but minimum 2M depth from grade level and shall be separated linearly from the pipe line by at least 5m and 2m for Magnesium (Mg) and Zinc (Zn) anodes respectively. The ribbon anodes should be laid at least 0.5 M away from pipe. The anode connections to pipe line shall be routed through test stations.
- 7.1.7 However, environment suitability [such as pH, excessive carbonate, bi-carbonates, sulphates, chlorides, nitrates etc. which could result in anode passivation] should be checked prior to lowering of sacrificial anodes suitability in the anodebeds. Zn should not be used if soil/water pH is over 9.
- 7.1.8 At the temporary CP anode ground bed, the leads of all the anodes shall be connected individually through Shunt and Resistor [for controlling each anode output individually] in the TLP/ junction box. The junction boxes should contain 20% extra terminals points.
- 7.1.9 For sacrificial anode ground beds which shall be integrated with permanent CP system the leads of all the anodes shall be brought up to the test station and shall be terminated individually with shunts inserted in between so that individual anode current output can be regulated & measured as required.
- 7.1.10 For Sacrificial anode CP system the Anodes shall be supplied with Tail cable [6 mm<sup>2</sup> PE PVC copper conductor single core multistrand cable] of sufficient length so as to reach Junction box, for termination, without difficulty. No joints are permissible on the cable run from anode tail to junction box.
- 7.1.11 The tail cable connection with the Iron Insert of Cable should be tightly done followed by Epoxy encapsulation so as to ensure that no Necking takes place which could result in snapping of cable connection due to spark. Anode cap of heat shrinkable PE material should be able to ensure this.

**7.2. PERMANENT CATHODIC PROTECTION [P C P]**

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- 7.2.1. Anodebeds To be installed at every CP Station and located at least 100 M away from pipeline ROW to ensure adequate remoteness which should also be calculated.
- 7.2.2. All [MMO] Anodes to be placed in Petroleum coke breeze, in appropriate [deep –horizontal or vertical, or semi-, deep well, deep well] configuration as per design to achieve requisite circuit resistance and protective Current output throughout the [40 years] service life. However, anode bed configuration selected should be technically justified.
- 7.2.3. The MMO anode should be supplied with sufficient length of 10 mm<sup>2</sup> XLPE PVC cable so as to run up to junction box for termination in the junction box without in-between joints. No joints are permitted in cable run from Anode tail to junction box. This cable size is minimum only and wherever necessary, for appropriate operation of the CP system, higher sized cables should be provided.
- 7.2.4. Appropriate tamping of carbonaceous backfill [petroleum coke breeze ] should be done so as to ensure appropriate compaction around [MMO] anode.
- 7.2.5. Anodebed Plot: CP contractor shall acquire[for GAIL] & anode bed plot to be as per design requirement) & at least 100 M away from pipeline ROW for locating anodebed, at each Anodebed location along the pipeline ROW. CP Contractor to indicate the location of anodebeds along pipeline ROW and mark it on As-Built Drawings and handover the requisite ownership documents to GAIL at the time of Handing over of the system.

## 8. ANODES

### ❖ SACRIFICIAL ANODES

#### 8.1 MAGNESIUM ANODE

The anode shall be of low voltage (-) 1.5 V type Magnesium [Mg] alloy packed in special back fill and suitable for use with three layer extruded polyethylene coating. The anode to conform to ASTM B 843 specifications such as the metallurgical composition, potential and consumption rate of anode shall be as below:

xii. Composition:

Element	Weight
Manganese	0.15 – 0.7%
Copper	0.02% max.
Silicon	0.10% max.
Zinc	2.5 – 3.5%% max.
Aluminium	5.3 – 6.7% max
Iron	0.003% max
Nickel	0.002% max
Other metallic elements - Each	0.05% max.



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- Total 0.3% max.

Magnesium (Mg) Balance

xiii. Anode open circuit potential (-)1.5 volts. W.r.t. CSE

xiv. Anode consumption rate 7.9 kg / (A Yr) Max.

## 8.2 ZINC ANODE

The Zinc [Zn] anode shall conform to ASTM B 418 standard. The anode (other than ribbon anode) shall be packaged with special back fill. The metallurgical composition of anode, potential and consumption rate shall be as below:

Composition:

Element	Weight
Aluminium	0.3 – 0.5% max.
Cadmium	0.075-0.1% max.
Copper	0.005% max.
Iron	0.002% max.
Silicon	0.005% max.
Lead	0.005% max.
Zinc	Remainder

Anode open circuit potential (-) 1.1 volts w.r.t. CSE

Anode consumption rate 11.24 kg / (A yr) Max.

8.3 Contractor shall furnish spectrographic analysis from each heat both for Zinc (Zn) and Magnesium (Mg) anodes along with electrochemical test results .CP Contractor shall mention specifically the method of Spectrography (Atomic Absorption/Emission Spectrometry/Photometrics) for Owner's Approval.

## 8.4 SPECIAL BACKFILL FOR SACRIFICIAL ANODES

The composition of special backfill for sacrificial anodes shall be as below:

Gypsum	75%
Bentonite	20%
Sodium sulphate	05%

8.5 Some Specific Requirements for sacrificial anodes are as follows:



The anodes shall be provided with cable tail of sufficient length to reach junction box/test station [TLP] as applicable in single run without tension and without in between joints.=

### 8.5.1. TOLERANCE IN FABRICATION OF SACRIFICIAL ANODES

Visual Inspection shall be carried out on all the Anodes regarding surface finish, excessive shrinkage, cracks, cable joint to anode core etc.

- The anode surface shall be free from cracks (which may reduce the performance of the anode.).
- Any cracks which follow the longitudinal direction of elongated anodes shall not be acceptable.
- Small cracks in the transverse direction of elongated anodes and in anodes of other shapes may be accepted provided the cracks would not cause any mechanical failure during service of the anode considering that the combination of cracks and lack of bond to the anode core is detrimental.
- For transverse cracks the acceptable limits shall be furnished by the bidders along with the offer.
- The anode shall be free from excessive shrinkages. The following limits shall be used.

Maximum 10% of the depth of anode or 50% of the depth of the anode core whichever is less. The depression may be measured from the edges of one side.

- The surface of the anodes shall be free from coatings and slag/ dross, inclusions etc.
- The maximum deviation from straightness shall not exceed 2%.
- The weight tolerance on individual anodes may be taken as  $\pm 5\%$ . The total weight of the anodes shall not have negative tolerance.
- Recommended dimensional tolerance shall be as follows:

Length	$\pm 2.5\%$
Width/ thickness	$\pm 5\%$

- One Anode per heat shall be radiographed to evaluate slags, voids, inclusion etc.
- At least 10% number of Anodes from each heat to be checked for conformity to Dimensions & Weight.
- One Anode, at least shall be Tested Destructively to check bond between Anode material and steel insert, slag, inclusion etc. Failure of one anode during the test shall make the entire anode lot liable for rejection.



**FOR PERMANENT CATHODIC PROTECTION [P C P]**

**8.6 Mixed Metal Oxide [MMO] Anodes: LIDA SINGLE**

The Permanent Cathodic Protection [PCP] system will have Mixed Metal Oxide [MMO] Strip Anodes also known as LIDA [Linear Distributed] Anodes and LIDA single. The [MMO] LIDA single anodes shall be centre connected sealed tubular type. These Anodes shall be of Noble metals [group VIII] Mixed Metal Oxide coated Titanium [having Ti substrate composition conforming to ASTM B 338 Grade I and/or Grade II]. The LIDA [MMO] anodes shall be dimensionally stable.

The characteristics of the [MMO] LIDA single anodes are as follows:

- Shape and Dimension
  - 1,000 mm ± 5 mm long
  - 25 mm ± 0.2 mm wide
  - 3 mm ± 0.1 mm thick
- Weight 0.27 Kgs ± 0.020 Kgs. Recommended Maximum

**OPERATING CURRENT DENSITY**

- With Carbonaceous Backfill 75 Amp / M<sup>2</sup>
- Current Output with Carbonaceous Backfill 3 Amp /M<sup>2</sup>
- Electrical Resistivity 6 x 10<sup>-5</sup> Ω cms.
- Type of Joint Epoxy Splicing
- Contact Resistance of Anode to Cable joint 9 x 10<sup>-5</sup> Ω {maximum}
- MMO Coating thickness ≥ 6 gms/M<sup>2</sup>
- Anode Consumption Rate 1 mg/Amp. Yr.
- Type of Cable XLPE PVC 10 mm<sup>2</sup>
- Length of Cable As Required so as to reach JB
- Design Life 40 Years
- The Anodes shall be provided Bare for Deep well, and with sheet steel canisters and petroleum coke breeze for deep bed configuration
- The Anodes to be Installed at a distance of 5m (Minimum) apart and shall be **electrically remote to the pipeline [to be ascertained by calculations]**. Normally the nearest part of anode for deep horizontal/vertical type of anode beds shall not be less than 100M from the pipeline. However, the actual distance will be as per site conditions. For Deep well anode bed the first anode should be at least more than 15 M deep [as per NACE RP 0572 Standard] and the actual depth shall be as per Approved Design. However, for Deep well Anode bed also LIDA Single [MMO] anodes (& not LIDA String Anodes) shall be used.



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- Anode LIDA [MMO] Single to cable [XLPE PVC 10 mm<sup>2</sup>] jointing and insulation shall be done by anode manufacturer at MMO anode fabrication shop.
- Dimension & weight of all anodes to be checked & recorded. Negative tolerance will not be acceptable.
- Routine & type test certificates of cable manufacturer to be furnished for anode lead cable as per IEC 502 – 1983 or relevant BIS code. Length and identification tag to be verified by measurement
- Each anode to cable joint shall be tested for it's electrical contact resistance & its value in  $\Omega$  shall be recorded.
- First Anode to cable joint shall be subjected to accelerated ageing test & destructive test to determine pullout strength of cable to anode joint as well as effectiveness of the joint insulation.
- Manufacturer shall furnish detailed dimensioned fabrication drawing of anodes as well as details of cable connection & it's insulation sealing to owner for approval. Manufacturer of anode will commence only after this Approval from owner.
- Vendor shall furnish, for Owner's Approval, the following information
  - type & make of Heat Shrink cap & it's properties
  - procedure for making the joint
  - procedure for accelerated ageing test
  - Vendor shall submit all test reports for Owners review.

**9.0 PETROLEUM COKE BREEZE**

Lubricated calcined petroleum coke breeze backfill material for use with LIDA Single [MMO] Anodes in [PCP] system shall have a carbon content of 91.77% minimum and a bulk density of 74 pounds per cubic ft. Zero percent shall be retained by a screen size of 16 mesh.

The coke breeze shall have low resistance carbon lubricant added for lowering the combined resistance while developing the pumping qualities. Earth contact resistance shall be 0.1  $\Omega$  cm at 150 PSI.

**BACKFILL DATA SHEET**

Carbon	91.770%
Volatiles	00.700%
Ash	02.230%
Sulphur	05.850%
Silicon	00.060%
Iron	00.020%
Moisture	00.000%



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### TYPICAL PARTICLE ANALYSIS

Screen Size	% Retained	% Retained (Cumulative)
16 Mesh	00.000	000.00
28 Mesh	02.100	002.10
48 Mesh	21.100	023.20
100 Mesh	60.300	083.50
200 Mesh	15.000	099.50
200+Mesh	01.500	100.00

### TYPICAL PHYSICAL ANALYSIS

Bulk Density	54 lb/cu ft.
Real Density	02 gm/ml
Porosity	40.8%

- ❖ The Petroleum Coke Breeze Material shall be tested for chemical composition, bulk density, real density, particle size and resistivity, sieve analysis.

## 10.0 AC OPERATED AUTO/MANUAL TRANSFORMER RECTIFIER UNIT [TRU]

The TRU shall be supplied in accordance with the following specifications and Data sheets:

### 10.1 GENERAL DESCRIPTION

This specification covers the requirements of design, manufacture, inspection, testing and supply of Automatic Controlled Transformer Rectifier Unit for Cathodic Protection of underground structures. Reliability of equipment and ease of maintenance is of utmost importance. The workmanship shall be of highest grade and entire design and construction in accordance with the best modern practice. The C.P. Units shall be capable of continuous trouble free operation at full load rating specified. The protection devices and control components shall be of standard design and carefully chosen to meet the requirements of the sets.

All similar materials and parts of similar equipments shall be interchangeable with each other. Special care shall be exercised in the design and manufacture for aging effects, low input voltage, DC voltage fluctuations, high forward current through the rectifying elements and high temperature conditions during operation.



Apart from the derating for site conditions an additional derating of 20% shall be considered for the specific use. The components of the units shall be designed for maximum operating efficiency. The C.P. Units shall be provided with all the necessary protections required as detailed in the following pages. The C.P. Units shall have Automatic/Manual control and shall be metal clad, compact, indoor installation type, air natural cooled, dust and vermin proof systems exactly confirming to the following specifications and no deviations shall be allowed.

**10.2 TECHNICAL REQUIREMENT**

10.1.1 The CP Transformer Rectifier Units' scheme for protection, monitoring, control, metering and indication shall be designed to meet requirements of this specification. The control shall be achieved using thyristors and fully solid state logic only. The various features of the unit will be as per the details provided in the data sheet in this specification.

10.1.2 Transformer shall be of double wound, air cooled type with an electrostatic shield between the windings. The transformer insulation shall be Class F. The winding size shall be based on maximum current density of 1.6 Amps/sq. mm of copper conductor.

10.1.3 Rectifier shall be silicon type of approved make with adequate cooling arrangement and with moisture and humidity resistant finish. It shall be mounted on spindles or other suitable supports. It shall have configuration suitable for full wave rectification. Adequate filtering in the form of L-C filtering circuit shall be provided on output side to smoothen out the D.C. output to limit ripple content to less than 5% at rated output.

The input and output of rectifier shall be protected by fast acting fuses of suitable ratings. Lightning Arrestors/Surge Suppressors shall also be provided across D.C. output terminals and A.C. input terminals to protect the rectifier against surges. Each diode and SCR shall be provided with suitable surge suppressers.

**10.2 OPERATION OF THE CP TRANSFORMER RECTIFIER UNIT**

The T/R unit shall be provided with two modes of working as under. A mode selector switch shall be provided to select the desired mode of operation. Both the modes shall be independent of each other and failure of the unit in one mode shall not affect working of the unit in other mode. A brief description of these modes is given below.

**A) Auto Ref. Mode**

The unit will be generally working in this mode. The operation of the unit in this mode shall be controlled by a reference signal. The output D.C. voltage of the unit in this mode shall vary right from 0V to rated voltage and from 0A to rated current to maintain the reference signal within  $\pm 20$  mV of the set value under all operating conditions. The response of the unit shall be instantaneous to suppress extremely fast acting external stray currents if present. The typical reference regulation in this mode shall be within  $\pm 20$  mV under all conditions.

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Fully solid state Automatic Reference Selector logic shall be provided to select the lowest of the Three Reference Inputs automatically. Facility shall also be provided for Manual selection of any one out of the three reference inputs for control. Suitable metering arrangement shall also be provided to monitor all the three external reference signals as well as the internal reference signals independently.

In the event of failure of all the reference signals, the unit will provide alarm - "All Reference Fail" and the output of the unit shall get adjusted to a preset value, which will be operator adjustable from 0V to rated voltage.

Independent ultra fast acting electronic current limit circuit shall be provided to limit the output current of the unit in Auto mode to any value from 0 A to rated value as desired by the operator. The current limit circuit will be capable of protecting the unit even under dead short circuit across output. The unit will be capable of sustaining dead short circuit across output indefinitely without degrading or damaging any internal components in this mode.

**B) Automatic Voltage-Current Control mode (AVCC mode)**

This will be the second mode of operation. The working of this mode shall be totally independent of the Auto mode and failure of the unit in Auto mode shall not affect operation in this mode.

The output voltage of the unit shall be adjustable to any value from 0V to rated voltage by means of a stepless voltage setter. The set voltage shall be maintained within  $\pm 0.25V$  of the set value for change in DC input voltage within specified limits and change in load from 0A to full load.

The output current of the unit shall also be adjustable to any value from 0A to rated current by means of a stepless current setter. The current shall be regulated within  $\pm 0.5A$  of the set value for change in DC input voltage within specified limits and change in load from zero to the rated value. The response of both current controller and voltage controller shall be ultra fast, instantaneous type. The current limit circuit will be capable of protecting the unit even under dead short circuit across output. The unit will be capable of sustaining dead short circuit across output indefinitely without degrading or damaging any internal components in this mode.

**10.3 LOCAL & REMOTE MONITORING & CONTROL**

The unit will be capable of working in Local Mode of control as well as Remote mode of control. For this purpose a mode selector switch will be provided on the unit. With this switch in 'Local Mode' it will be possible to control the various parameters of the unit by means of local controls located in the unit. With this switch in 'Remote Mode' it will be possible to control the various parameters of the unit remotely thru the RTU/SCADA system.

**10.3.1 Local Monitoring & Local Control**



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Facility will be provided for monitoring and control of various parameters by means of controls provided on the front panel of the unit. The details of the parameters to be monitored and controlled locally are as under:

**10.3.1.1 Local Monitoring**

Facility will be provided for local monitoring of following:

**A) Metering on Panel**

- AC Input Voltage - Digital Voltmeter
- AC Input Current - Digital Ammeter
- DC Output Voltage - Digital Voltmeter
- DC Output current - Digital Ammeter
- PSP (Set & Actual) - Digital Voltmeter with 10 Meg Impedance

**B) LED Indications on Panel**

- AC Supply ON - LED indication
- Pipeline Underprotection - LED indication
- Pipeline Overprotection - LED indication
- Reference 1 Lowest - LED indication
- Reference 2 Lowest - LED indication
- Reference 3 Lowest - LED indication
- Reference 1 Fail - LED indication
- Reference 2 Fail - LED indication
- Reference 3 Fail - LED indication
- All Reference Fail - LED indication
- Overcurrent (Current Limit) - LED indication
- Unit Working in Auto Mode - LED indication
- Unit Working in AVCC Mode - LED indication
- Unit Working in Local Mode - LED indication
- Unit Working in Remote Mode - LED indication



### 10.3.1.2 Local Control

Facility will be provided for local control of following:

- O/P Voltage - By means of potentiometer on panel
- DC O/P Current - By means of potentiometer on panel
- PSP - By means of potentiometer on panel
- Selection of Auto/AVCC Mode - By means of selector switch on panel
- Start/Stop of Current Interrupter - By means of Keypad on Timer
- 

### 10.3.2 REMOTE MONITORING & REMOTE CONTROL

The T/R unit will be suitable for Remote Monitoring & Remote Control through the RTU/SCADA system. For this purpose Programmable Logic Control system (PLC) shall be provided in the existing TR unit. The PLC shall interface all the remote control and monitoring signals of the TR with RTU/SCADA. The PLC shall be of a reputed and proven brand like Allen Bradley, Siemens, GE, Schneider, and Mitsubishi. PLC of any unknown and non-proven make will not be acceptable.

The system shall comprise of Processor, I/O system, communication sub-system, power supply and serial link communications to RTU, including 10 meters of serial interface cables along with all necessary connectors at both ends for communication to RTU. The system shall include all accessories like isolators, relays, terminals, etc as per the specifications along with software and all other necessary hardware, etc required for proper operation of the PLC system.

The design and the component used for the PLC system shall provide maximum reliability, maximum on-line performance and minimum maintenance. All items shall be field proven. No prototype item shall be supplied.

The PLC shall not be damaged due to power failure. In case of power failure the PLC shall be able to retain the control settings prior to power failure and set accordingly on resumption of power.

The system shall be modular in construction and expandable in future by adding additional modules, which shall be easily accessible for maintenance and repair. The types of modules shall be kept to minimum possible in order to have inter-changeability and low spares inventory.

The PLC shall have a very high noise immunity in order to ensure safe and reliable operation when subjected to electrical radio frequency interference and electro magnetic disturbances expected from other electrical/electronic equipment located near by and inside the TR unit panel.



The communication subsystem shall be a digital communication bus that provides reliable and high speed data transfer between the processor subsystem, I/O subsystem, PLC display, or other devices connected to the system.

**10.3.2.1 SYSTEM SOFTWARE**

The vendor will supply the necessary system software such as all programs for the PLC, PLC display etc. which are required to perform all the PLC functions including communication and self-diagnostics. Logic program with necessary instructions shall be recorded on compact disc (CD) and shall be delivered with the system.

The PLC system shall be rated for 24 V DC power supply voltage. The 24 V DC power supply shall be derived from 230V AC power supply for the TR unit, through a suitably rated 24 V DC Power supply module.

The PLC and the DC for power supply module for the PLC shall be mounted inside the TR Unit panel.

**10.3.2.2 PARAMETERS FOR REMOTE MONITORING**

Facility will be provided for remote monitoring of following:

**A) Analog Signals**

- DC Output Voltage - Hardwired
- DC Output current - Hardwired
- Lowest/Selected PSP - Hardwired

**B) Digital Status Signals**

- Pipeline Underprotection - Through PLC / RS 485
- Pipeline Overprotection - Through PLC / RS 485
- All Reference Fail - Through PLC / RS 485
- Unit Working in Auto Mode - Through PLC / RS 485
- Unit Working in AVCC Mode - Through PLC / RS 485
- Unit Working in Local Mode - Through PLC / RS 485
- Unit Working in Remote Mode - Through PLC / RS 485



### 10.3.2.3 PARAMETERS FOR REMOTE CONTROL

Facility will be provided for Remote control of following:

- Setting of DC O/P Voltage - Through PLC / RS 485
- Setting of DC O/P Current - Through PLC / RS 485
- Setting of PSP - Through PLC / RS 485
- Selection of Auto/AVCC Mode - Through PLC / RS 485
- Start/Stop of Current Interrupter - Through hard wired potential free contact from RTU/SCADA

### 10.4 RELIABILITY AND FACTOR OF SAFETY

Due to very harsh conditions under which the units are going to operate, prime importance shall be given to ensure reliability and trouble-free operation. To take care of high transient voltages and high peak current demands adequate factor of safety shall be provided in choosing all the components. Minimum factor of safety to be provided for critical components is as under.

Components	Factor of Safety
All wound components	: 50% additional capacity
Thyristor & diodes	: PIV : 1200V minimum I <sub>av</sub> : At least 3 times actual max. average current at full load.
Passive components like switches, resistors	: 50% safety margin in current rating.
Overall system	: The unit shall be capable of delivering 125% rated current output at rated voltage for 1 hour.
Electronic Control	: The entire electronic circuitry shall be assembled on plug-in type glass epoxy PCBs. The control circuit shall be designed using the latest advanced ICs to minimize the component count. Status indicator LEDs shall be provided on each control card to indicate functioning of the card. All the control cards shall be completely sealed using protective coatings.  The control circuit shall be capable of operating at elevated



**Components****Factor of Safety**

temperatures of upto 70 °C without any degradation in performance or life expectancy.

**10.5 WORKING LIFE**

The TR Unit shall be designed for a working life of minimum 35 years.

**10.6 TECHNICAL SPECIFICATIONS AND DATA SHEET – TR Unit**

- |   |   |   |
|---|---|---|
| A) A. C. Input Voltage                        | : | 230V $\pm$ 10%, 1Ph, 50 Hz $\pm$ 5%, AC   |
| B) A. C. Input Current                        | : | 8.0 A (max)   |
| C) D. C. Power Output                         | : | 625W  |
| D) D. C. Output Voltage                       | : | 0 to 25V DC   |
| E) D. C. Output Current                       | : | 0 to 25A DC   |
| F) Controls                                   | : | 1. Auto PSP<br>2. AVCC (Manual)   |
| G) Full load efficiency of the TR unit        | : | Not less than 70%   |
| H) Power Factor at full load                  | : | Better than 0.8 Lag   |
| I) Insulation Level                           | : | 2 KV for 1 minute   |
| J) Cable entry                                | : | A.C. input, D.C. output, Ref. Cells and Alarm cables. From the bottom plate of the unit, thru suitable cable glands.              |
| K) Filtering circuit                          | : | L. C. Filter  |
| L) Ripple & Hum                               | : | Less than 5% at rated load  |
| M) Surge Diverters for diodes/SCRs/Transistor | : | Metal oxide varistors / capacitors / R-C Networks   |
| N) Lightning Arrestor                         | : | At both input & output side of the unit<br>R.M.S. Voltage Rating : 500V<br>R.M.S. Current Rating : 1.5KA<br>Type : LT 0.5 or Eqv. |
| O) Protection                                 | : | - 2 pole MCB in AC input for overload   |



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protection & Isolation.

- 2 pole MCB in DC output.
  - HRC fuses in input & output.
  - Glass cartridge fuses in the live line of all lamps, auxiliary power lines to control circuit.
  - Built in electronic current limit and short circuit protection feature.
- Current limit adjustable from 0 to rated value.
- All reference fail indication and automatic setting of O/P DC voltage to preset value.

P) Ref. Fail Safe Feature

In the event of failure of all the Reference Electrodes the unit will provide "All Reference Fail" indication and the DC O/P voltage will get adjusted to a programmable preset value.

Q) Reference Electrode  
[Permanent]

: 3 Nos. Cu/CuSo4  
Automatic Reference Selector Logic shall be provided to automatically select the lowest (least protected) reference signal out of three reference signals fed to the unit simultaneously.  
Facility shall also be provided to select one out of three ref. Electrodes by means of a Manually operated Reference Selector switch.

R) Control element

: The DC output will be controlled using latest solid state SCRs.  
These SCRs will be controlled by the commands from the control circuits.  
All the electronic circuits will be assembled on plug-in type control cards.

S) Modes of operation

: Following modes of control shall be provided.  
a) Auto Ref. Mode:  
The operation of the unit in this mode will be fully Automatic and will be controlled by the Reference electrode feedback (PSP). The unit will automatically maintain Reference voltage or P.S.P. within  $\pm 20\text{mV}$  of the set value under all conditions.  
b) AVCC Mode:  
This will be the second mode of operation. In this mode the unit can be operated in either constant voltage or constant current mode.



- The output voltage will be adjustable from 0 to rated value by means of stepless voltage setter potentiometer.  
The output current will be adjustable from 0 to rated value by means of stepless current setter potentiometer.
- T) Voltage Setting Range in AVCC Mode (Manual) Mode : 0 to 25V
- U) Current Limit setting Range : 0 to 25A
- V) P. S. P. setting Range : -0.8V to -2.5V
- W) Ref. Regulation in Auto Mode : Better than  $\pm 20\text{mV}$
- X) DC Voltage regulation in AVCC (Manual) Mode : Better than  $\pm 0.25\text{V}$
- Y) Current Regulation in current limit mode : Better than  $\pm 0.5\text{A}$
- Z) Indications : a) Underprotection  
b) Overprotection  
c) Reference cell 1 Lowest  
d) Reference cell 2 Lowest  
e) AVCC mode of operation
- AA) Annunciations : a) Underprotection  
b) Overprotection  
c) Reference cell 1 Lowest  
d) Reference cell 2 Lowest  
e) Reference cell 3 Lowest  
f) Reference cell 1 fail  
g) Reference cell 2 fail  
h) Reference cell 3 fail  
i) Reference cell All fail  
j) Overcurrent (Current Limit Mode)
- AB) Meters/Instruments : Digital Meters as under:  
AC Input Voltage : 0 to 300V AC  
AC Input Current : 0 to 10A with CT  
3-1/2 Digit Digital Meters as under:



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Output Voltage : 0 to 50V DC

Output Current : 0 to 50A with shunt PSP & Set PSP :  
0 to + 19.99 V DC

AC) Local control Mode : Following controls will be provided in local mode from local control panel.

1. Setting of Ref. PSP through Potentiometer
2. Setting of Output Voltage through Potentiometer.
3. Setting of output current limit through Potentiometer.
4. Auto/AVCC Mode Selection
5. START/STOP of Current Interrupter

AD) Remote Monitoring and control through PLC through RS 232C / RS 485 Serial Link : Following features will be provided by means of PLC and RS232C / RS 485 Serial Link with MODBUS RTU Protocol.

Digital Input status to RTU/SCADA.

1. Under Protection
2. Over protection
3. All Ref. Fail
4. TR unit in Auto mode
5. TR unit in AVCC mode
6. TR unit in Local mode
7. TR unit in Remote mode

Digital control signal from RTU/SCADA

1. TR unit Operation in AUTO mode
2. TR unit Operation in AVCC mode

Analog Input status to RTU/SCADA

1. Lowest/selected PSP value
2. Output DC voltage



3. Output DC current

Analog Set points from RTU/SCADA

1. Setting of PSP

2. Setting of DC output voltage

3. Setting of DC output Current

AE) Current Interruption : Current interruption facility will be provided by means of a built-in contactor & microprocessor based fully programmable and GPS enabled Synchronisable digital timer with real time clock & ON/OFF time display. The timer will have facility for adjusting the ON time & OFF time from 0 to 999 sec. by means of front panel keypad. Timer will have START, STOP & RESET facility thru local keypad or thru remote potential free contacts.

The Timer will have typical time accuracy of + 5 PPM

Facility for interconnection of an external timer shall also be provided.

A removable bypass link will be provided for bypassing the interrupter contactor contacts.

AF) Enclosure/Construction : Floor mounted Indoor type.

Fabricated from 1.5mm/2.0mm CRCA sheet.

Confirming to IP42 degree of protection.

Lockable doors shall be provided in the front and back.

AG) Cooling : Natural air cooled

AH) Painting : Baked epoxy paint/Powder Coating of shade RAL 7032 Siemens grey with proper pre-treatment and primer application as per standard Industrial Practice.

AI) Earthing : 2 Nos. M6 earthing bolts and 1 no. nickel plated copper earth bus bar shall be provided.

**10.6.1 MANUFACTURER'S TECHNICAL EXPERTISE & EXPERIENCE IN THE FIELD OF CATHODIC PROTECTION RECTIFIERS**



The manufacturer should be a reputed and established manufacturer of CP Rectifier & CPPSM Units and should have experience in manufacturing of C.P. rectifiers & CPPSM units of similar specifications. The manufacturer will have to submit a list of C.P. Rectifier & CPPSM installations having similar specifications executed in the past 5 years, giving present working status of various units.

**10.6.2 TESTING AND INSPECTION**

The Manufacturer/Contractor shall provide all the necessary facilities to carry out full performance tests on the AC operated DC Output TR Units at his works.

**10.6.3 GUARANTEE**

The manufacturer/Contractor will have to guarantee the successful working of the units for a period of 12 months from date of Installation & commissioning.

**11 REFERENCE ELECTRODE [CuCuSO4] PERMANENT TYPE**

Permanent Copper Copper sulphate reference electrodes three (3) numbers at each CP Station and one at middle of two consecutive CP Stations are to be installed for [P-S-P] Monitoring. One number CSE (Permanent type at each ER Probe to be installed.

**12 TEST STATIONS [TLP]**

12.1 Test stations [TLP] shall be provided along the pipeline ROW for monitoring the performance of the cathodic protection system at intervals not exceeding 1,500 meters unless otherwise specified. In addition to above, test stations of requisite type [A, B, C, D, E or Combination of any two of these Viz: DE] shall be provided at the following locations:

- a. At both sides of major road crossings
- b. At all insulating joints
- c. At vulnerable locations with drastic changes in soil resistivity.
- d. At connections of surge diverters, grounding cells and polarisation cells.
- e. At HT AC/DC overhead line crossings and selected locations where HT overhead line is in the close vicinity of the pipeline.
- f. At railway line crossings and running parallel to the pipeline.
- g. At both sides of major river crossings.
- h. At high voltage cable crossings or along routes where HV cables are running in parallel.
- i. In the vicinity of DC net works or grounding system where interference problems are suspected.



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- j. At crossings/parallel running of other pipelines/ structures.
- k. At both sides of cased crossings.
- l. At any other locations considered vulnerable/locations where interference is expected.
- m. At any other locations considered necessary by owner/ owner's representative.

Besides, every 10 Kms. Computerized Test station shall be installed for remote monitoring of the Protective Potential and Current profile.

Non Metallic [TLP] to be installed at every 1Kms. Of Salt Pan Area.For Other Areas metallic [TLP] may be provided.

- 12.2 Between the pipeline and foreign pipelines or structures that may exist in common ROW. Test stations for bonding shall be provided with shunt and resistor as a means to monitor and control current to ensure zero net flow of Current from one to the other.
- 12.1 Test stations used for sacrificial anodes shall have shunt for measurement of individual anode current, and provision of resistance to limit & control the anode current output.
- 12.2 Test station with current measuring facility shall be provided at each intermediate CP station drainage point ( to measure pipeline current on any one or both side of the pipeline from drainage point), at interference prone areas, on both sides of major river crossings and at least at two additional locations along the pipeline ROW between two CP stations.
- 12.3 All test stations shall have weather proof enclosure, having degree of protection IP55 with hinged lockable shutter. Enclosure shall be made of sheet steel of at least 3 mm thickness and shall be suitable for M.S. post mounting. The test stations shall be designed with terminals required for both temporary [TCP] and permanent CP system [PCP] and shall be suitable for total life of permanent CP system.
- 12.4 The test stations shall be installed with the front of the test station facing the pipeline. The name plate of test stations shall in minimum carry following information.
  - Test station number
  - Chainage in km
  - Test station connection scheme type
  - Distance from pipeline in meters
  - Direction of product flow
- 12.5 Terminal blocks and different scheme of wiring as required shall be provided in the test station as per the test station connection scheme sketch.
- 12.6 The location of all the test stations shall be marked with their connection schemes and other relevant information on alignment sheets. A detailed test station schedule shall be prepared.
- 12.7 Computerized Test Stations [CTSUs] to be installed at pre-identified locations along pipeline ROW for Monitoring the CP System adequacy from these locations. Readers three (2) numbers at least to be supplied with two CTSUs.

**13 SURGE DIVERTER, GROUNDING CELL AND POLARISATION CELL**

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13.1 At the crossing or parallel run of pipeline and overhead HT line of 66 KV and above, the pipeline shall be grounded through solid state polarisation cell/device. Alternatively, grounding could also be done with galvanic anodes [grounding cells] at the discretion of the owner. The grounding shall be done at regular intervals where transmission line run parallel within 25 m of the pipeline, to ground any surges in the pipeline potential that may appear in case of faults [phase to phase or phase to ground] in overhead transmission line.

Locations along pipeline where continuous induced over-voltage due to HT line etc. is expected &/or observed during commissioning, the pipeline shall be earthed through solid state polarisation cell/device to the HT tower earth system causing the voltage induction to ground or through a separate earthing system. Alternatively the pipeline shall be grounded with galvanic anodes [Grounding cells] at the discretion of the owner.

13.2 The solid state polarisation cell/device shall be installed in a vandal proof steel housing by the contractor.

13.3 Spark gap surge diverter shall be connected across each insulating joint to protect it from high voltage surges.

Alternatively, Zinc or Magnesium grounding cell may be provided across insulating joints along ROW where the pipelines on both sides of the insulating joint are Cathodically protected and difference of protection voltage is not more than 0.4 volts.

13.3.1 Surge diverter shall be provided for the protection of insulating joints located at the ends of the pipe line/at terminals & in between. Alternatively owner on his own discretion may permit use of Magnesium (Mg)/Zinc (Zn) galvanic anodes [grounding cells] appropriately sized for protection of insulating joints. Choice between Zn & Mg anodes will depend up on the potential values on either side of the insulating joint locations. These anodes shall be sized for the specified design life of permanent cathodic protection system [PCP].

13.3.2 The total system including cable, cable termination, anodes/surge diverters shall be suitable for the anticipated fault current magnitude at the location of its installation.

13.3.3 Unless otherwise specified the minimum rating of grounding cell, polarisation cell and surge diverter shall be as below:

i. **Grounding Cell**

- Type : 2 or 4 plate type
- Current rating : Suitable to pass more than 10 kA surge

ii. **Polarisation Cell**

- Type : *Solid state device*
- Current rating : The rating shall be based on actual fault current expected at site.

iii. **Surge Diverter**



- Type : Spark gap
- Current 8/20  $\mu$ s) : 100 kA
- Spark over AC voltage :
- 50 Hz 1 KV
- Impulse ( 1.2/50  $\mu$ s) : 2.2 KV

13.4 The grounding cell, surge diverter and the solid state polarisation cell/device system shall be sized for the design life of permanent CP system. The Zinc (Zn) or Magnesium (Mg) anodes meant for pipeline grounding shall also be sized for the life of the permanent CP system and the surge magnitude taking into account the current discharge from the anodes. The grounding system shall have minimum resistance to earth to restrict the pipeline voltage [PSP] as per NACE protection criteria.

**14 CP AT CASED CROSSING**

At all cased crossings the casing shall be coated using 2 pack epoxy, 750 micros thick, both on internal and external surface of the casing. The casing shall be protected additionally by independent [from carrier pipe protection system] sacrificial anode installations. The sacrificial anode installations shall be provided at both ends of casing. The anode installation shall be sized based on the permanent CP design parameters specified for the main pipeline.

The carrier pipe inside casing shall be protected by Zn or Mg ribbon anodes well connected to the outer surface of bottom of carrier pipe extending between hour hand positions of 4 and 8 o' clock. The anodes shall be placed at close intervals as per design calculations and sized based on the permanent CP design parameters. Casings upto 20 mts in length may not be provided additional cathodic protection to carrier pipe bottom inside casing. More than 20 mts length casing additional cathodic protection to carrier pipe bottom shall be provide.

The annulus between the casing and the carrier pipe shall be filled with graded sand/ betonite.

The HDD contractor will arrange an agency to check the coating condition of the casing pipe post erection of HDD so that requisite repairs(if required) are done to the damaged coat.

**15 PAINTING**

The sheet steel used for fabrication shall be thoroughly cleaned and degreased to remove mill scale, rust, grease and dirt. Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The under surfaces shall be prepared by applying a coat of phosphate paint and a coat of yellow zinc chromate primer. The under surfaces shall be free from all imperfections before undertaking the finished coat. After preparation of the under surface, spray painting with two coats of final paint shall be done. The finished panel shall be dried in oven in dust free atmosphere. Panel finish shall be free from imperfections like pin holes, orange peels, run off paint etc.

All unpainted steel parts shall be cadmium plated to prevent rust formation.

**16 CABLES**



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Cables shall be annealed high conductivity, tinned, stranded copper conductor, PE insulated 650V grade, and PVC sheathed FRLS. The size of the copper conductor shall be 6 sq mm for anode cable from anode to junction box, 10 mm<sup>2</sup> from junction box to test station, 10 mm<sup>2</sup> from test station to pipeline. The size of the conductor shall be 4 mm<sup>2</sup> for potential measurement and 25 mm<sup>2</sup> for bonding, polarization cell / grounding cell and surge diverter connection purpose. The anode cable from anode to junction box shall be unarmored. The length of anode tail cable shall be sufficient enough to reach junction box (buried) in case of temporary CP anode and up to test station in case of permanent CP anodes.

**17 INSTALLATION**

**17.1 CABLE LAYING**

17.2 Cables shall be laid in accordance with approved layout drawings to be prepared by the contractor. No straight through joint shall be permitted in a single run of cable. Cable route shall be carefully measured and cables cut to required length.

17.3 All cables inside station/plant area shall be laid at a depth of 0.75 M. Cables outside station/plant area shall be laid at a depth of 1.5 m . Cables shall be laid in sand under brick cover back filled with normal soil. Out side the station/ plant area the routes shall be marked with polyethylene cable warning mats placed at a depth of 0.9 m from the finished grade.

17.4 All underground unarmoured cables forming part of permanent CP system shall run through PE sleeves. Cables along the pipeline shall be carried along the top of the pipe by securely strapping it with adhesive tape or equivalent as required.

17.5 RCC or GI pipes of proper size shall be provided for all underground cables for road crossings.

17.6 Cables shall be neatly arranged in trenches in such a manner that crisscrossing is avoided and final take off to equipment is facilitated.

17.7 Cable root markers shall be installed overground at suitable intervals.

17.8 In no case cables shall pass from below underground pipeline. All cables shall be placed above underground pipeline and tightened with tape.

**17.9 CABLE TO PIPE CONNECTIONS**

All cable connections to the pipeline including charged foreign pipeline shall be made using an (owner) approved exothermic process e.g.: Pin Brazing.

The Pin Brazing to have

- |                                     |  |
|-------------------------------------|--|
| 1. extremely low Contact Resistance | ≤ 0.1 Ω.                               |
| 2. Low transition resistance        | 7.5 to 14 μΩ per brazed joint          |
| 3. High mechanical strength         | Binding strength 490 N/mm <sup>2</sup> |
| 4. Shear Strength                   | 245 N/mm <sup>2</sup>                  |
| 5. Brazing Temperature              | 650 <sup>o</sup> C                     |
| 6. Time per Braze                   | 2 Seconds                              |
| 7. Weather Effect                   | Suitable for all weather operation     |
| 8. Life                             | 40 Years + 1                           |



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Field Test Cable Connection through Pin Brazing to be field tested for contact resistance & Temperature etc.

**18 CIVIL WORKS**

All civil works associated with the complete cathodic protection work shall be included in the scope of CP contractor. This shall include providing cable trenches, foundation for equipment and all test stations etc.

**19 TESTING AND INSPECTION AT WORKS**

19.1 Owner/ Owner's representative shall visit the works during manufacture of various equipment [Anodes, Cables, Junction Boxes, Test Lead Points etc.] to assess the progress of work as well as to ascertain that only quality raw material and fabrication technology is used for the same. All necessary assistance during such inspections shall be provided by the contractor/fabricator to owner's representative.

19.2 The minimum testing, inspection requirements for all components/ equipment shall conform to the requirements as defined in the relevant codes and standards. Detailed inspection and testing procedures along with the acceptance criteria, including various stages where hold points, review etc shall be for owners inspection, shall be prepared by CONTRACTOR for Owner's approval.

19.3 Test certificates including test records, performance curves etc. shall be furnished. All test certificates shall be endorsed with sufficient information to identify equipment to which the certificate refers to and must carry project title, owner's name and purchase order details etc.

19.4 Owner reserves the right to ask for inspection of all or any item under the contract and witness all tests and carry out inspection or authorise his representative to witness test and carry out inspection. CONTRACTOR shall notify the Owner or Owner's representative at least 20 days in advance giving exact details of tests, dates and addresses of locations where the tests would be carried out.

**20 PACKING AND TRANSPORT**

All equipment/ material shall be protected for inland/ marine transport, carriage at site and outdoor storage during transit and at site. All packages shall be clearly, legibly and durably marked with uniform block letters giving the relevant equipment/ material details. Each package shall contain a packing list in a water proof envelope. Copies of the packing list, in triplicate, shall be forwarded to owner prior to despatch. All items of material shall be clearly marked for easy identification against the packing list.

**21 SYSTEM TESTING, COMMISSIONING AND INTERFERENCE MITIGATION**



**21.1 SYSTEM TESTING AT SITE**

21.2 Contractor shall furnish the detailed field testing and commissioning procedure for approval. Field tests as per the approved procedures shall be carried out on the equipment/ systems before being put into service. The acceptance of the complete installation shall be contingent upon inspection and field test results being satisfactory.

21.3 Before the CP facilities are placed in operation all necessary tests shall be carried out to establish that all equipment, devices, wiring and connection, etc. have been correctly installed, connected and are in good working condition as required for intended operation.

21.4 Owner/Owner's representative may witness all the tests. At least one week's notice shall be given before commencing the tests.

21.5 All tools, equipment and instruments required for testing shall be provided by C P CONTRACTOR.

21.6 Generally following tests shall be carried out and recorded in perform given in subsequent clauses.

Checking: Visual inspection, comparison with drawings and specifications.

Inspection: Detailed physical inspection & Dimensions measurement

Testing: Simulation tests of equipment to determine its operational fitness.

i. **Cables**

- Cable no.
- Voltage grade
- Conductor cross section
- Continuity check
- Voltage test
- Insulation resistance values between core and earth.
- All cables shall be tested by 500 V megger.

ii. **Insulating Joints**

Checking of insulating joint for leakage, before and after energisation of C.P.by means of insulating joint tester. Structure-to-electrolyte potential of both protected and non-protected sides of insulating joint shall be checked before and after energisation of CP system. Grounding cell/Surge diverter shall be connected thereafter.

iii **Polarisation cell**

- Location/ identification number
- Rating
- Check for continuity
- Check for wiring
- Check for standby current drain with CP energisation (current drain with respect to voltage across the device/cell shall be recorded).

iv. **Grounding Cell**



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- Location
- Type (no. of anodes)
- Ratings

v. **Surge diverter**

- Location/ identification number
- Ratings
- Check for healthiness

vi **Anode ground beds**

- Location/ test station number
- Current Output of each Anode
- Current output of the ground bed

**21.7 COMMISSIONING**

21.7.1 Natural pipe to soil potential [P-S-P] shall be measured at each test station [TLP] location prior to connecting anodes to pipeline. The pipe to soil potential observation shall be repeated after connecting the anodes and allowing sufficient time for polarisation. The current output of the anode installation shall also be measured to ensure that it does not exceed the output current capacity of the anodes. In case the anode output current exceeds the rated capacity it shall be controlled by insertion of resistance element in the anode circuit inside test station and the pipe to soil potential shall be rechecked for adequacy of protection. Additional anodes shall be provided where required to achieve desired level of protection [PSP].

Each anode installation shall become individually operational as above.

21.7.2 After connecting all the anode ground beds to pipe line, measurement of pipe to soil potentials shall be taken at each test station [TLP] to ensure adequate conformity to protection criteria.

21.7.3 In case of insufficient protection as per the NACE CP design criteria on any portion of the pipe line, CONTRACTOR shall carry out necessary additions/ modifications to the provided protection in consultation with the ENGINEER so that NACE criteria is met.

**21.8 INTERFERENCE MITIGATION**

Investigation shall be made by an expert agency with prior experience for stray current electrolysis of the pipeline. Interference due to high voltage DC lines, electric traction & installed CP System of existing underground utilities and make suitable Recommendations so that recommended D.C. Interference Mitigative measures could be installed.

The C.P. Contractor to carry out Interference due to overhead AC lines and install suitable Mitigative measures for AC Interference.

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Measurements including pipe to soil potential [PSP] and pipe line current etc. on the pipeline/ structure being CP protected shall be made to investigate the current discharge [into surrounding soil electrolyte] and collection locations.

In case of fluctuating stray currents investigation shall be made continuously over a period of time and if required simultaneously at different locations to find out the stray current source. For long line measurements, data loggers shall preferably be used.

Where foreign pipeline (unprotected or protected by independent CP system) runs in parallel to the pipeline in same trench or very near to the pipeline, and is not bonded to the pipeline then investigation shall be made for current pickup & discharge points on both the pipelines.

Mitigation measures shall be provided depending on type of interference. These shall include installation of bond with variable resistor and diodes, installation of galvanic anodes for auxiliary drainage of current, adjustment/ relocation (if possible) of offending interference source, provision of electrical shield etc. depending on the type of interference.

Between an existing pipeline & upcoming pipeline a concrete raft [size to be approved by owner as per OISD] is to be provided as a barrier. The new pipeline will pass below the existing U/G Pipeline. Bonding with foreign pipeline/ structure as a mitigation measure shall be provided where the owner of the pipeline/ structure has no objection, otherwise alternative mitigation measure shall be provided.

Wherever bonding is provided for mitigation the bonding resistor shall be adjusted for optimum value for minimum / no interference so that no net current flows from one to the other pipeline. Galvanic anodes installed as a mitigation measure shall be sized for the life specified for permanent CP.

**22 SYSTEM MONITORING**

23.1 The temporary CP system provided shall be monitored at all test stations once in a month for healthiness/ adequacy of protection till commissioning of permanent CP or for design life of temporary CP specified, whichever is less. During this period if any deficiency/ interference in protection system is noticed the same shall be rectified / augmented by additional anodes as required. The monitoring report shall be submitted regularly to owner for his review / information.

23.2 P-C-P system after commissioning shall be monitored by the CP contractor for One Year once a month and During this period if any deficiency/ interference in protection system is noticed the same shall be rectified / augmented by additional fixtures as required.

**23 DRAWINGS AND DOCUMENTS**

**23.1 GENERAL**

23.2 Within three weeks from the date of issue of PURCHASER ORDER, CONTRACTOR shall submit four copies of the list of all drawings/ data manuals/procedures for approval, identifying each by a number and descriptive title and giving the schedule date. This list shall be revised and extended, as



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23.3 All drawings and documents shall be in English and shall follow metric system. Number of copies of each submission shall be as per Scope of work document.

**23.4 CONTRACT DRAWINGS AND DOCUMENTS**

23.5 As a part of the contract, drawings and documents shall be furnished which shall include but not be limited to the following:

- a. Report on corrosion survey
- b. Basis of system design and design calculations, equipment selection criteria and sizing calculations.
- c. Bill of material, material requisitions, purchase requisitions.
- d. Quality assurance / Quality control procedures

23.6 Detailed construction drawings (including as built status)

- a. Sacrificial anode fabrication drawings
- b. Typical layout drawing for anode ground bed installation and connection.
- c. Equipment layout, cable layout and schedules.
- d. TLP & Junction Box Erection / Installation Details Drawing
- e. Permanent Cu-CuSO<sub>4</sub> reference electrode installation Drawing
- f. Fabrication, installation details of surge diverter, grounding cell and polarisation cell with its enclosure and housing.
- g. Cable- to-pipe joint details for charged and non charged pipelines.
- h. Incorporation of anode beds, polarisation cell, surge diverters, test stations, etc. and other relevant features of CP system-design in Pipeline alignment sheet and other related drawings.
- i. Identification of section of pipeline affected by interference, source of interference and details of interference mitigation arrangements provided. Various measurement data at all relevant test stations with and without mitigation measures provided.
- j. Detailed commissioning report including various measurement data at all test stations etc.
- k. Vendor drawings and catalogues, test certificates.
- l. Operation and maintenance manual.
- m. Miscellaneous
  - Equipment inspection and testing procedure
  - Construction, installation procedures
  - Field testing and commissioning procedures
  - Procedure for monitoring of Cathodic protection after commissioning
  - Quality control procedures.
  - Post Commissioning Testing/Monitoring Periodicity and Methodology

**24 INSTRUMENTS, TOOLS AND SPARES**

24.1 CONTRACTOR shall include a List of all instruments, tools and tackles necessary for proper operation and maintenance [O&M], Monitoring of complete Cathodic protection [TCP] [PCP] systems and associated equipment that are to be deployed at site, such as Corrosion Voltmeter, Multi-combination Meter, CPL Survey Data Logger, DCVG Meter, Holiday Detector, Pipe Locator, Elcometer for Coating thickness measurement, CAT survey, Soil resistivity meter etc. duly calibrated by an Owner Approved agency in last six (6) months.

24.2 CONTRACTOR shall provide number of spares and consumables being provided for proper operation and maintenance of part of Cathodic protection [TCP] system to be integrated with permanent CP system [PCP] designed on the basis of permanent CP design parameters and associated equipment, for two (2) years un-interrupted operation of the system.

**25 INFORMATION REQUIRED WITH THE BID**



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Bidders are advised in their own interest to provide the following information along with the bid without which the bids are liable for summary rejection.

- A. Work Experience, in detail, Project wise, giving Job content, Year, Status for client etc.
- B. List of Equipments, Tools, Tackles, etc. likely to be deployed at site
  - a. Basis and calculations for preliminary system design for Cathodic protection system [TCP] and [PCP]  
 Viz: Surface Area, Protective Current Required, Anode Weight and size required/provisioned, Anode bed type, Coke Breeze/Backfill required/provisioned, Anode bed Loop Resistance, Remoteness adequacy, Surge Re dressal calculated/provisioned, etc.
  - b. List of formulae with legends to be used for detailed system design calculations.
  - c. Basis of system design, design calculations, equipment selection criteria, sizing calculations along with characteristic curves for various equipment.
  - d. Preliminary bill of material [B O M] for major equipment for [TCP] and [PCP].
  - e. Details of the equipment/ material offered along with technical leaflets / related literatures/ catalogues, make, rating, type test certificates.
  - f. Dimension, weight and general arrangement drawings for each offered equipment.
  - g. List of instruments, tools and tackles offered for maintenance and operation.
  - h. List of recommended maintenance / operation spares.
  - i. Clause-wise deviations, if any, to the specifications along with justifications.
  - j. List & Credentials of Crew to be deployed at site and contractors home office.



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## APPENDIX A

### COMPUTERISED TEST STATION UNITS (CTSUs) FOR CATHODIC PROTECTION PERFORMANCE MONITORING

Each CTSU (Computerised Test Station Unit) is a Microprocessor based low CMOS circuitry with built in RTC, installed near a Computerised Test Station to acquire and store the complete CP System performance data available for each Test station. CTSUs are typically designed for outdoor applications and are NEMA4 protected.

Once stored, the data can be downloaded as under:

- a) By a remote computer by telephone, cellular phone or radio link/OFC.
- b) By portable handheld data reader using local communication port.

Key features of the CTSU are as under:

1.	Recording Rate	To be configured from 1 reading per second to 1 reading per 365 days.
2.	Battery backup	Lithium battery back up option allowing CTSU ECU to retain data for 10 years on a single charge.
3.	Timing	Status input sampling time 10m sec to 2.5 m-sec.
4.	Power requirement	The CTSU to be powered by 24 ±15% Volts DC
5.	The CTSU shall be able to read and record.	PSP and current data of pipeline & foreign pipeline/pipelines upto 10,000 sets to be stored till downloaded
6.	Inputs available	Minimum 10 nos. [5 inputs for PSP & 5 inputs for current.]
7.	Protection against	Voltage/current surges expected along the pipeline & foreign structure.
8.	Test Station Reader (TSR)	Portable type suitable for field transport & handling. Unit enclosure is weather proof, IP55.
9.	Input battery for TSR	Internal rechargeable battery provided.

**To be installed at pre-identified locations**



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## APPENDIX-B

### POST C.P. COMMISSIONING SURVEYS

#### 1. COATING CONDUCTANCE SURVEYS

For evaluation of the electrical strength of the coating, post commissioning of the C.P. System, after one (1) Month, Coating Conductance surveys to be conducted, to serve as Reference for future comparison. Although same coating specifications are used throughout the length of the pipeline, effective electrical strength thereby it's ability to resist flow of current would reasonably vary on account of terrain, construction defects, soil resistivity along the Pipeline length.

For conducting coating conductance surveys, Potential ( $\Delta V$ ) & ( $\Delta I$ ) Current are to be measured at two consecutive "B" type Test Lead Points [TLP], w.r.t remote earth using  $CuCuSO_4$  reference electrode, alternatively with current interrupter "On" & "Off" at each measurement point.

The difference of the two  $\Delta I$  will be the C.P. Current being collected by this section of the pipeline. The difference of the two  $\Delta V$  will be the average change in pipeline potential within the test section owing the current received from C.P. System.

The above procedure to be repeated for all "B" type TLP for evaluating coating conductance value for different sections along the pipeline. All the Data obtained is to be handed over to the owner & will form part of final Technical Documentation.

Before commencement of site surveys the survey procedure shall be got duly approved from the Owner.

#### 2. CURRENT ATTENUATION TEST (CAT) SURVEY

Current attenuation test (Cat) survey for impressed current cathodic protection service for underground Gas pipelines. To identify of pipeline sections where coating is good and bad, To pinpoint coating defect in pipeline sections where coating is bad with Use of 'PCM'- A frame equipment, To give accurate coating defect locations for future coating repairs, To size the defects by standard method, Classify defects as Anodic or Cathodic.

Vendor shall carryout Pipeline current mapping followed by A frame survey at pipeline sections where coating is suspected to be damaged. Vendor shall also make coating defect co-ordinates drawing for subsequent coating repairs.

The survey need to be carried out by the Instrument "Pipeline Current Mapper" or any other equivalent equipment.

The survey along the pipeline should be carried out after duly identifying the pipeline alignment using the instrument's peak and null modes of operation. The pipeline alignment should be identified using temporary markers, at defined distance intervals. This shall facilitate retracing back high current attenuation locations for PCM-'A' frame survey.

Distance of survey traverse - survey Chainage shall be accurately measured with tape for accurate demarcation of the coating fault. The same shall be re matched with Pipeline marker Chainage /TLP Chainage, at regular intervals to avoid accumulation of error of measurement.

Prior to commencement of **CAT** survey, the survey procedure to be got approved from the Owner. Only Good & Proven survey equipment and trained, experienced manpower to be used. All survey Data to be submitted to Owner as part of Technical Documentation.



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**3. DCVG SURVEY**

Post commissioning of the C.P. System, after 30 days of Line polarization, CPL Survey will be conducted for evaluation of coating condition to serve as future Benchmark for comparative evaluation.

Any finding of coating defect in particular, where coating defects and holidays are high, have to be further established through a separate **DCVG** survey for the defective stretch delineated as above from CPL survey findings.

Prior to commencement of **DCVG** survey, the survey procedure to be got approved from the Owner. Only Good & Proven survey equipment and trained, experienced manpower to be used. All survey Data to be submitted to Owner as part of Technical Documentation.

**3. COMPUTERIZED POTENTIAL LOGGING [CPL] SURVEY**

Post commissioning of the C.P. System, after 30 days of Line polarization, a Computerized Potential Logging [CPL] survey will be conducted, as per procedure, already got approved by the Owner. The "On"/"Off" Potential survey. For the survey, Data Logger of repute & Current interrupter [if not available in the TRU] will be used by experienced and trained manpower. All the survey data and findings of under-protected, over-protected zones, short etc. shall be handed over to the owner as part of final technical Documentation. Suitable remediation measures to be recommended for achieving adequacy of protection throughout the pipeline length. This CPL survey Data will serve as base Data for future comparative evaluations of the Protective system adequacy.

**4. A.C. /D.C. INTERFERENCE DETECTION & MITIGATION**

Post commissioning of the C.P. System, after 30 days of Line polarization, an AC / DC Interference survey to detect presence (or absence) of induced AC Voltages [which in certain circumstances may be fatal] on the underground pipeline that run parallel to AC transmission systems [having voltages greater than or equal to ≥11KV] shall be carried out. Measurement of P-S-P shall be taken at every TLP of the pipeline that run parallel to overhead AC transmission lines and are within 20 M of transmission line alignment. On detection of AC induced Hazardous voltages suitable Mitigative measures such as grounding of the pipeline with Zn / Mg Grounding cell, installation of Polarization cell etc. shall be resorted to dissipate Ac induced hazardous voltages to ground in controlled manner. Type "A" TLP shall be provided at these locations having AC induced Hazardous voltages on the pipeline.

DC Interference Detection from existing CP system in close vicinity of ROW and any other DC source such as electric traction, switching yard, welding shop etc. Appropriate measures for mitigation to be recommended for installation by CP contractor.

Prior to site survey commencement, the Approval for survey procedure, from the Owner, shall be taken.

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## APPENDIX-C

### INTERFACING WITH SCADA

Cathodic Protection (CP) panel shall be properly interfaced with RTU through RS 485 serial link for various signals like pipeline under protection, pipeline overprotection, all reference fail, unit working in auto mode, unit working in AVCC mode, unit working in local / remote mode, setting of DC O/P voltage, setting of DC output current, setting of Pipe soil potential (PSP), setting of auto / AVCC mode. CONTRACTOR to note that SCADA vendor shall provide RS 485 serial link at the RTUs for interfacing with CP system. Hence, CONTRACTOR shall also provide RS 485 serial link (Modbus ASCII & Modbus RTU protocol which shall be user selectable). The digital and analog data shall be made available to RTU (SCADA) and it shall be mapped in the contiguous registers so that data can be fetched / written in minimum transactions.

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

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

The following hardwired signals shall be taken from CP system to SCADA system (however hardwired cables shall be routed through PLC cabinet):

- PSP Value
- Impressed Voltage
- Impressed Current
- Start / Stop of Current Interrupter





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DATA SHEET FOR CATHODIC SYSTEM

TOTAL SHEETS

04

DOCUMENT NO.:

GAIL-STD-CP-DOC-DS-001

REV	DATE	DESCRIPTION	PREP	CHK	APPR
0	20.11.19	ISSUED FOR BID	SR	TR	SB

**TECHNICAL DATA SHEET  
FOR  
CATHODIC PROTECTION SYSTEM**

**1.0 E/R Probes :**

- 1.1 Make and model no. of E/R probe : -----  
 1.2 Material of E/R probe : -----  
 1.3 Size of the exposed area of the probe : -----  
 1.4 Make and mode no. of E/R probe : -----  
 reading instrument

**2.0 Permanent reference electrodes :**

- 2.1 Make & model no. : -----  
 2.2 Design life of electrode under burial condition : ----- Years

**3.0 Polarisation cells :**

- 3.1 Type : -----  
 3.2 Make & model no. : -----  
 3.3 Maximum DC leakage current at 40 degree C at  
     - 1V DC across the Polarisation cell : \_\_\_ mA  
     - 1.5V DC across the Polarisation cell: \_\_\_ mA  
     - 2.0V DC across the Polarisation cell: \_\_\_ mA  
 3.4 50 Hz AC current rating at 40o C  
     - Continuous : \_\_\_ A  
     - Short time : \_\_\_ KA for \_\_\_ sec  
 3.5 Rated no. of operations over life time  
     under maximum ratings \_\_\_ Nos.

**4.0 Polarisation Coupons :**

- 4.1 Exposed area of metal : -----  
 4.2 Metal type : -----  
 4.3 Make and model no. of reed switch : -----  
 4.4 Make and model no. of  
     reed switch operator  
     magnet :  
 4.5 Rating of reed switch :  
     -Continuous current rating : \_\_\_ A DC, at \_ V DC  
     -Breaking current : \_\_\_ A DC, at \_\_\_ V DC



**5.0 Surge Diverters :**

5.1 Type : -----

5.2 Ratings : -----

5.2.1 Current, 8/20 micro second wave :

5.2.2 AC spark over voltage

-50Hz AC :

-Impulse(1.2/50 micro second) :

5.3 Make :

**6.0 Cables :**

6.1 Type and voltage grade :

-For anode tail cables : \_\_\_ / \_\_\_ V

-For other CP cables : \_\_\_ / \_\_\_ V

6.2 Make :

-For anode tail cables :

-For other CP cables :

**7.0 Cable to pipe connection :**

- For charged pipeline :

- For non charged pipeline :

-7.1 Make and model number of

- Cad weld Material :

- Pin brazing equipment :

**8.0 Anode type and make :**

8.1 Impressed current anodes

- Type :

- Make :

8.2. Sacrificial anodes make –

- Zinc anodes :

-Zinc ribbon anodes :

**9.0 TR Unit :**

9.1 CPTR unit :

9.2 CPPSM :

9.3 Test stations :

9.4 Anode junction box :

9.5 Cathode junction box :



9.6 Calcined petroleum coke breeze :

9.7 Permanent reference

electrodes -

CuCuSO<sub>4</sub> type :

-Ag-AgCl type :

9.8 Special Backfill for sacrificial anodes:

9.9 Make :



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	QUALITY ASSURANCE PLAN FOR TEST STATIONS					
PROJECT						
OWNER	GAIL INDIA LIMITED					
PROJECT NO					DATE:-	
TPIA						
CONSULTANT						
CONTRACTOR						
CP CONTRACTOR						
QAP NO.	GAIL-STD-CP-DOC-QAP-001	REV.	0			
REFERENCE SPECIFICATION						
REFERENCE DESIGN DOCUMENT						
REFERENCE DATA SHEET						
REFERENCE DRAWING						
VENDOR						
DESCRIPTION / TYPE OF INSPECTION	REFERENCE DOCUMENT	FORMAT OF RECORD	INSPECTION BY			Remarks
			M	TPIA	GAIL	
Compliance with approved Drawing & Data sheet (Manufacturer, type &Model)	Approved Drawing & Data Sheet	Inspection Report	P	W	W	
Visual Inspection: 100%	Approved Drawing & Data Sheet	Inspection Report	P	W	W	
Dimensional Check: 25%	Approved Drawing	Inspection Report	P	W	W	
fitness test, terminal to body resistance. Randomly	Approved Drawing & Data Sheet	Inspection Report	P	W	W	
Thickness Check :25%	Approved Drawing	Inspection Report	P	W	W	
Terminals to TS Body	Approved Drawing & Data Sheet	Inspection Report	P	W	W	
Manufacturer Test Certificate (IP 55)	Approved Drawing & Data Sheet	IP 55 Test Certificate	S	R	R	
Document / Marking	Approved Drawing & Data Sheet	IRN	H	P	R	
<b>LEGEND: P-PERFORM, W-WITNESS ALL, S-SUBMITTED BY, R-REVIEWED BY, H-HOLD M-Manufacturer C-Contractor TPIA-Third Party Inspection Agency H-Hold</b>						





		QUALITY ASSURANCE PLAN FOR CP CABLE				
<b>PROJECT</b>						
<b>OWNER</b>		GAIL INDIA LIMITED				
<b>PROJECT NO</b>				<b>DATE:-</b>		
<b>TPIA</b>						
<b>CONSULTANT</b>						
<b>CONTRACTOR</b>						
<b>CP CONTRACTOR</b>						
<b>QAP NO.</b>		GAIL-STD-CP-DOC-QAP-001		<b>REV.</b>		0
<b>REFERENCE SPECIFICATION</b>						
<b>REFERENCE DESIGN DOCUMENT</b>						
<b>REFERENCE DATA SHEET</b>						
<b>REFERENCE DRAWING</b>						
<b>VENDOR</b>						
DESCRIPTION / TYPE OF INSPECTION	REFERENCE DOCUMENT	FORMAT OF RECORD	INSPECTION BY			Remarks
			M	C	TPIA	
Compliance with approved Data sheet (Manufacturer, type )	Approved Data Sheet	Inspection Report	P	W	W	
Visual Inspection: 100%	Approved Data Sheet	Inspection Report	P	W	W	
Voltage Test, Conductor Cross Section, Insulation Test -100%	Approved Data Sheet	Inspection Report	P	W	W	
Continuity Check- Randomly	Approved Data Sheet					
Voltage Grade - Randomly	Technical specification	Test Report	P	W	W	
Type Test -100%	As per ref. Standard	Test Report	P	W	W	
Manufacturer Test Reports	Approved Data Sheet	Test Report	P	W	P	
Document / Marking	Approved Data Sheet	IRN	H	P	R	
<b>LEGEND: P-PERFORM, W-WITNESS ALL, S-SUBMITTED BY, R-REVIEWED BY, H-HOLD M-Manufacturer C-Contractor TPIA-Third Party Inspection Agency H-Hold</b>						



**QUALITY ASSURANCE PLAN FOR POLARISATION  
CELL**



<b>PROJECT</b>							
<b>OWNER</b>		<b>GAIL INDIA LIMITED</b>					
<b>PROJECT NO</b>				<b>DATE:-</b>			
<b>TPIA</b>							
<b>CONSULTANT</b>							
<b>CONTRACTOR</b>							
<b>CP CONTRACTOR</b>							
<b>QAP NO.</b>		<b>GAIL-STD-CP-DOC-QAP-001</b>		<b>REV.</b>		0	
<b>REFERENCE SPECIFICATION</b>							
<b>REFERENCE DESIGN DOCUMENT</b>							
<b>REFERENCE DATA SHEET</b>							
<b>REFERENCE DRAWING</b>							
<b>VENDOR</b>							
<b>DESCRIPTION / TYPE OF INSPECTION</b>		<b>REFERENCE DOCUMENT</b>	<b>FORMAT OF RECORD</b>	<b>INSPECTION BY</b>			<b>Remarks</b>
				<b>M</b>	<b>TPIA</b>	<b>GAIL</b>	
Compliance with approved Drawing & Data sheet (Manufacturer, type & Model)		Approved Data Sheet & Design Specification  Inspection Report	Inspection Report	P	W/R	W/R	
Manufacturer Test Report		Approved Data Sheet & Design Specification  Test Certificate	Test Certificate	P	R	R	
Inspection Release Note		IRN		H	P	R	
<b>LEGEND: P-PERFORM, W-WITNESS ALL, S-SUBMITTED BY, R-REVIEWED BY, H-HOLD M-Manufacturer C-Contractor TPIA-Third Party Inspection Agency H-Hold</b>							

	<b>QUALITY ASSURANCE PLAN FOR PERMANENT REFERENCE CELL (Ag/Agcl)</b>					
<b>PROJECT</b>						
<b>OWNER</b>	<b>GAIL INDIA LIMITED</b>					
<b>PROJECT NO</b>		<b>DATE:-</b>				
<b>TPIA</b>						
<b>CONSULTANT</b>						
<b>CONTRACTOR</b>						
<b>CP CONTRACTOR</b>						
<b>QAP NO.</b>	<b>GAIL-STD-CP-DOC-QAP-001</b>	<b>REV.</b>	<b>0</b>			
<b>REFERENCE SPECIFICATION</b>						
<b>REFERENCE DESIGN DOCUMENT</b>						
<b>REFERENCE DATA SHEET</b>						
<b>REFERENCE DRAWING</b>						
<b>VENDOR</b>						
<b>DESCRIPTION / TYPE OF INSPECTION</b>	<b>REFERENCE DOCUMENT</b>	<b>FORMAT OF RECORD</b>	<b>INSPECTION BY</b>			<b>Remarks</b>
			<b>M</b>	<b>TPIA</b>	<b>GAIL</b>	
Compliance with approved Drawing & Data sheet (Manufacturer, type & Model)	Approved Data Sheet & Drawing	Inspection Report	P	W / R	W/R	
Visual Inspection 100%	Approved Data Sheet & Drawing/ Technical specification		P	W / R	W/R	
Manufacturer Certificates	Approved Data Sheet & Drawing	Test Certificate	Submission	R	R	
Inspection Release Note	IRN		H	P	R	
<b>LEGEND: P-PERFORM, W-WITNESS ALL, S-SUBMITTED BY, R-REVIEWED BY, H-HOLD M-Manufacturer C-Contractor TPIA-Third Party Inspection Agency H-Hold</b>						



**QUALITY ASSURANCE PLAN FOR COMPUTERIZED  
TEST STATION UNIT**



<b>PROJECT</b>			
<b>OWNER</b>	<b>GAIL INDIA LIMITED</b>		
<b>PROJECT NO</b>		<b>DATE:-</b>	
<b>TPIA</b>			
<b>CONSULTANT</b>			
<b>CONTRACTOR</b>			
<b>CP CONTRACTOR</b>			
<b>QAP NO.</b>	<b>GAIL-STD-CP-DOC-QAP-001</b>	<b>REV.</b>	<b>0</b>
<b>REFERENCE SPECIFICATION</b>			
<b>REFERENCE DESIGN DOCUMENT</b>			
<b>REFERENCE DATA SHEET</b>			
<b>REFERENCE DRAWING</b>			
<b>VENDOR</b>			

DESCRIPTION / TYPE OF INSPECTION	REFERENCE DOCUMENT	FORMAT OF RECORD	INSPECTION BY			Remarks
			M	C	TPIA	
Compliance with approved Drawing & Data sheet (Manufacturer, type & Model)	Approved Data Sheet & Drawing	Inspection Report	P	W / R	W/R	
Manufacturer Certificates	Approved Data Sheet & Drawing	Test Certificate	Submission	R	R	
Inspection Release Note	IRN		H	H	P	

**LEGEND: P-PERFORM, W-WITNESS ALL, S-SUBMITTED BY, R-REVIEWED BY, H-HOLD M-Manufacturer C-Contractor TPIA-Third Party Inspection Agency H-Hold**

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**QUALITY ASSURANCE PLAN FOR MMO ANODE**



<b>PROJECT</b>			
<b>OWNER</b>	<b>GAIL INDIA LIMITED</b>		
<b>PROJECT NO</b>		<b>DATE:-</b>	
<b>TPIA</b>			
<b>CONSULTANT</b>			
<b>CONTRACTOR</b>			
<b>CP CONTRACTOR</b>			
<b>QAP NO.</b>	<b>GAIL-STD-CP-DOC-QAP-001</b>	<b>REV.</b>	<b>0</b>
<b>REFERENCE SPECIFICATION</b>			
<b>REFERENCE DESIGN DOCUMENT</b>			
<b>REFERENCE DATA SHEET</b>			
<b>REFERENCE DRAWING</b>			
<b>VENDOR</b>			

DESCRIPTION / TYPE OF INSPECTION	REFERENCE DOCUMENT	FORMAT OF RECORD	INSPECTION BY			Remarks
			M	TPIA	GAIL	
Compliance with approved Drawing & Data sheet (Manufacturer, type & Model)      ALL	Approved Data Sheet	Inspection Report	P	W	W	
Dimensional Check      ALL	Approved Drawing & Data Sheet	Inspection Report	P	W	W	
Electrical Test , coating consumption rate      ALL	Approved Drawing & Data Sheet	Inspection Report	P	W	W	
Leak proof test (Helium Test), cable length, coating resistivity & Coating thickness      Randomly	Approved Drawing & Data Sheet	Inspection Report	P	W	W	
Inspection as per below attached vendor's ITP      ALL	Vendor's ITP is attached below	Inspection Report	P	R	R	
Document / Marking      ALL	Approved Drawing & Data Sheet	IRN	H	P	R	



**LEGEND: P-PERFORM, W-WITNESS ALL, S-SUBMITTED BY, R-REVIEWED BY, H-HOLD M-Manufacturer C-Contractor TPIA-Third Party Inspection Agency H-Hold**





QUALITY ASSURANCE PLAN FOR PIPE CONNECTION






<b>PROJECT</b>						
<b>OWNER</b>	<b>GAIL INDIA LIMITED</b>					
<b>PROJECT NO</b>		<b>DATE:-</b>				
<b>TPIA</b>						
<b>CONSULTANT</b>						
<b>CONTRACTOR</b>						
<b>CP CONTRACTOR</b>						
<b>QAP NO.</b>	<b>GAIL-STD-CP-DOC-QAP-001</b>	<b>REV.</b>	<b>0</b>			
<b>REFERENCE SPECIFICATION</b>						
<b>REFERENCE DESIGN DOCUMENT</b>						
<b>REFERENCE DATA SHEET</b>						
<b>REFERENCE DRAWING</b>						
<b>VENDOR</b>						
<b>DESCRIPTION / TYPE OF INSPECTION</b>	<b>REFERENCE DOCUMENT</b>	<b>FORMAT OF RECORD</b>	<b>INSPECTION BY</b>			<b>Remarks</b>
			<b>M</b>	<b>C</b>	<b>TPIA</b>	
Compliance with approved Drawing & Data sheet (Manufacturer, type & Model)	Approved Data Sheet & Drawing	Inspection Report	P	W / R	W/R	
Manufacturer Certificates	Approved Data Sheet & Drawing	Test Certificate	Submission	R	R	
<b>LEGEND: P-PERFORM, W-WITNESS ALL, S-SUBMITTED BY, R-REVIEWED BY, H-HOLD M-Manufacturer C-Contractor TPIA-Third Party Inspection Agency H-Hold</b>						

		QAP FOR TRANSFORMER UNIT									
PROJECT											
CLIENT		GAIL INDIA LIMITED						REV. NO.-		0	
PMC								RATING AND QUANTITY			
CONTRACTOR								DATE:-			
MANUFACTURER											
P.O NO.								P.O DATE			
QAP NO.		GAIL-STD-CP-DOC-QAP-001									
REF. DOC.											
Sr.No.	Item/ Component	Characteristics	Type of Check	Extent of Work	Reference Document	Acceptance Norms	Format of Record	Agency			REMARKS
								M	TPIA	GAIL	
1	<b>BOUGHT OUT ITEMS</b>										
1	Receiving Inspection for Fabricated	1. Physical Check	Measuring Tape	100%	Approved Drawing Manufacturer specification	Incoming Test Certificate	Incoming Test Certificate	P	R	R	
		2 Physical damage if any.	Physical Test	1 in Lot				P			
		3 Verification with Manufacturer specification.	Verification of Test Certificate			Approved Drawing			P	R	R
1.2	Receiving Inspection of Meters,PCB'S,Semiconductor & Electrical Items	1. Dimensions, Size	Functional test 2.Mechanical/Ele ctrical Measurement	sampling 10%	Approved Drawing Manufacturer specification	Test Report	1.Manufacturer Test Report 2.Incoming Test Report	P	R	R	
		2. Electrical Parameters		1 in Lot				P	W	W	
1.3	Sub assembly-Transformer,Choke,	1. Insulation Test 2. No Load Test		100%	Approved drawing	Test Certificate	Test Certificate	P	R	R	
1.4	Sub assembly- Timer-Inspection & Test	1. Visual inspection 2. Functional Test 3. Internal settings	Functional test 2.Mechanical/Ele ctrical	100%	Approved drawing	Test Certificate	Test Certificate	P	R	R	
1.5	Assembly Process	1. Electrical wiring and tightness of all connections 2. Labeling and Marking	Measurement Visual	100%	Approved drawing	Test Report	Test Report	P	R	R	
1.6	Auxiliary device check	Verification as per BOM	Visual	100%	Approved Drawing	Test Report	Test Report	P	R	R	
1.7	Insulation Test	Insulation and High Voltage Test between primary to Earth,Secondary to Earth and/or Primary to secondary	Electrical Measurement	100%	Approved Drawing	Test Report	Test Report	P	R	R	
1.8	Sub/assembly-control card Inspection & Test	1. Visual inspection 2. Functional Test	Functional Test	100%	Approved Drawing	Test Report	Test Report	P	R	R	
1.9	Heat Run Test	Heat run at at rated Load for at least 12/16 Hrs with Temperature measurement on all power devices and Magnetics at the end of test	Electrical Test & Inspection	100%	1.Approved Drawing 2.Approved Specification	Test Report	Test Report	P	R	R	

		<b>QAP FOR TRANSFORMER UNIT</b>									
<b>PROJECT</b>											
<b>CLIENT</b>		GAIL INDIA LIMITED					<b>REV. NO.-</b>		0		
<b>PMC</b>							<b>RATING AND QUANTITY</b>				
<b>CONTRACTOR</b>							<b>DATE:-</b>				
<b>MANUFACTURER</b>											
<b>P.O NO.</b>							<b>P.O DATE</b>				
<b>QAP NO.</b>		GAIL-STD-CP-DOC-QAP-001									
<b>REF. DOC.</b>											
Sr.No.	Item/ Component	Characterstics	Type of Check	Extent of Work	Reference Document	Acceptance Norms	Format of Record	Agency			REMARKS
								M	TPIA	GAIL	
<b>FINAL TEST</b>											
		6. Continuity (ON-OFF)	Electrical	100%				P	R	R	
2	Functional Test of Unit	1. Visual Inspection 2. Insulation Test 3. Operation in Manual Mode 4. Operation in AVCC & Voltage/current. 5. Regulation 6. Operation in Auto and PSP regulation 7. Ripple content in DC Output 8. Indication and alarm 9. Remote signal and Potentrial free contacts Conveter and Timer(if any)10.HV 11. Annuciation	Inspection	100%	1.Approved Drawing. 2. Approved Specification.	Test Report	Test Report	P	W	W	
2.1	Heat Run Test	10.Efficiency/power factor Heat run at at rated Load for at least 8 Hrs with Temperature measurement on all power devices and Magnetics at the end of test	Electrical Test & Inspection	40%	1.Approved Drawing 2.Approved Specification	Test Report	Test Report	P	W/R	W/R	
5	Inspection Release Note					GAIL Specificati on	GAIL Specificati on	H	P	R	
6	Documents to be Sumitted at time of Dispatch and Packing	10.1Warranty Certificate						P	R	R	
		10.2 Operation Manual						P	R	R	
<b>LEGEND: P-PERFORM, W-WITNESSE, S-SUBMITTED, R-REVIEW OF RECORDS, H-HOLD, M-MANUFACTURER, C-CONTRACTOR, TPIA-THIRD PARTY INSPECTION AGENCY</b>											



	<b>QUALITY ASSURANCE PLAN FOR PLAN SURGE DIVERTER</b>					
<b>PROJECT</b>						
<b>OWNER</b>	<b>GAIL INDIA LIMITED</b>					
<b>PROJECT NO</b>					<b>DATE:-</b>	
<b>TPIA</b>						
<b>CONSULTANT</b>						
<b>CONTRACTOR</b>						
<b>CP CONTRACTOR</b>						
<b>QAP NO.</b>	<b>GAIL-STD-CP-DOC-QAP-001</b>				<b>REV.</b>	<b>0</b>
<b>REFERENCE SPECIFICATION</b>						
<b>REFERENCE DESIGN DOCUMENT</b>						
<b>REFERENCE DATA SHEET</b>						
<b>REFERENCE DRAWING</b>						
<b>VENDOR</b>						
<b>DESCRIPTION / TYPE OF INSPECTION</b>	<b>REFERENCE DOCUMENT</b>	<b>FORMAT OF RECORD</b>	<b>INSPECTION BY</b>			<b>Remarks</b>
			<b>M</b>	<b>TPIA</b>	<b>GAIL</b>	
Compliance with approved Drawing & Data sheet (Manufacturer, type & Model)	Approved Data Sheet & Drawing	Inspection Report	P	W / R	W/R	
Manufacturer TEST Report	Approved Data Sheet & Drawing	Test Certificate	P	R	R	
Inspection Release Note	IRN		H	P	R	
<b>LEGEND: P-PERFORM, W-WITNESS ALL, S-SUBMITTED BY, R-REVIEWED BY, H-HOLD M-Manufacturer C-Contractor TPIA-Third Party Inspection Agency</b>						



	<b>QUALITY ASSURANCE PLAN FOR ER PROBE &amp; ER PROBE READER</b>					
<b>PROJECT</b>						
<b>OWNER</b>	<b>GAIL INDIA LIMITED</b>					
<b>PROJECT NO</b>		<b>DATE:-</b>				
<b>TPIA</b>						
<b>CONSULTANT</b>						
<b>CONTRACTOR</b>						
<b>CP CONTRACTOR</b>						
<b>QAP NO.</b>	<b>GAIL-STD-CP-DOC-QAP-001</b>	<b>REV.</b>	<b>0</b>			
<b>REFERENCE SPECIFICATION</b>						
<b>REFERENCE DESIGN DOCUMENT</b>						
<b>REFERENCE DATA SHEET</b>						
<b>REFERENCE DRAWING</b>						
<b>VENDOR</b>						
<b>DESCRIPTION / TYPE OF INSPECTION</b>	<b>REFERENCE DOCUMENT</b>	<b>FORMAT OF RECORD</b>	<b>INSPECTION BY</b>			<b>Remarks</b>
			<b>M</b>	<b>C</b>	<b>TPIA</b>	
Compliance with approved Drawing & Data sheet (Manufacturer, type & Model)	Approved Data Sheet & Drawing	Inspection Report	P	W / R	W/R	
Manufacturer Certificates	Approved Data Sheet & Drawing	Test Certificate	Submission	R	R	
Inspection Release Note	IRN		H	H	P	
<b>LEGEND: P-PERFORM, W-WITNESS ALL, S-SUBMITTED BY, R-REVIEWED BY, H-HOLD M-Manufacturer C-Contractor TPIA-Third Party Inspection Agency</b>						







**QUALITY ASSURANCE PLAN FOR PERMANENT  
REFERENCE CELL (Cu/CuSo4)**



<b>PROJECT</b>						
<b>OWNER</b>	GAIL INDIA LIMITED					
<b>PROJECT NO</b>		<b>DATE:-</b>				
<b>TPIA</b>						
<b>CONSULTANT</b>						
<b>CONTRACTOR</b>						
<b>CP CONTRACTOR</b>						
<b>QAP NO.</b>	GAIL-STD-CP-DOC-QAP-001	<b>REV.</b>	0			
<b>REFERENCE SPECIFICATION</b>						
<b>REFERENCE DESIGN DOCUMENT</b>						
<b>REFERENCE DATA SHEET</b>						
<b>REFERENCE DRAWING</b>						
<b>VENDOR</b>						
DESCRIPTION / TYPE OF INSPECTION	REFERENCE DOCUMENT	FORMAT OF RECORD	INSPECTION BY			Remarks
			M	C	TPIA	
Compliance with approved Drawing & Data sheet (Manufacturer, type & Model)	Approved Data Sheet & Drawing	Inspection Report	P	W / R	W/R	
Manufacturer Certificates	Approved Data Sheet & Drawing	Test Certificate	Submission	R	R	
Inspection Release Notee		IRN	H	H	P	
<b>LEGEND: P-PERFORM, W-WITNESS ALL, S-SUBMITTED BY, R-REVIEWED BY, H-HOLD M-Manufacturer C-Contractor TPIA-Third Party Inspection Agency</b>						

	QUALITY ASSURANCE PLAN FOR SECRIFICIAL ZINC ANODE					
PROJECT						
OWNER	GAIL INDIA LIMITED					
PROJECT NO					DATE:-	
TPIA						
CONSULTANT						
CONTRACTOR						
CP CONTRACTOR						
QAP NO.	GAIL-STD-CP-DOC-QAP-001				REV.	0
REFERENCE SPECIFICATION						
REFERENCE DESIGN DOCUMENT						
REFERENCE DATA SHEET						
REFERENCE DRAWING						
VENDOR						
DESCRIPTION / TYPE OF INSPECTION	REFERENCE DOCUMENT	FORMAT OF RECORD	INSPECTION BY			Remarks
			M	TPIA	GAIL	
Compliance with approved Drawing & Data sheet (Manufacturer, type & Model)	Approved Drawing & Data Sheet	Inspection Report	P	W/R	W/R	
<b>Inspection</b>	Approved Drawing & Data Sheet	Inspection Report	P	W/R	W/R	
a. Surface 100 %, Length $\pm$ 2.5 %, Width/ Thickness $\pm$ 5%						
b. Visual : Longitudinal cracks of more than 40 mm long and 3 mm deep not acceptable						
c. Weight tolerance: + %5 (Total weight of all anodes shall not have negative tolerance)						
<b>Radiographic Test</b>	Approved Drawing & Data Sheet	Test Report	P	W/R	W/R	
One anode per heat shall be subjected to radiography to evaluate cracks, voids, slack inclusion etc.						
<b>Destructive Testing</b>	Approved Drawing & Data Sheet	Test Report	P	R	W	
One anode per heat shall be subjected to destructive testing for slag inclusions, bond between anode and insert.						

	QUALITY ASSURANCE PLAN FOR SACRIFICIAL ZINC ANODE					
PROJECT						
OWNER	GAIL INDIA LIMITED					
PROJECT NO		DATE:-				
TPIA						
CONSULTANT						
CONTRACTOR						
CP CONTRACTOR						
QAP NO.	GAIL-STD-CP-DOC-QAP-001		REV.	0		
REFERENCE SPECIFICATION						
REFERENCE DESIGN DOCUMENT						
REFERENCE DATA SHEET						
REFERENCE DRAWING						
VENDOR						
DESCRIPTION / TYPE OF INSPECTION	REFERENCE DOCUMENT	FORMAT OF RECORD	INSPECTION BY			Remarks
			M	TPIA	GAIL	
be subjected to destructive testing for slag inclusions, bond between anode and insert.	Approved Drawing & Data Sheet	Test Report	P	R	R	
<b>Chemical Analysis;</b> One anode sample per heat by Spectrography Sample in the beginning for first heat, end of second heat, at the beginning of third heat and so on.	Approved Drawing & Data Sheet	Test Report	P	R	R	
Mass per liner meter    ALL	Approved Drawing & Data Sheet	Test Report	P	R	W	
Anode to core resistance    Randomly	Approved Drawing & Data Sheet	Test Report	P	R	W	
<b>Electrochemical Test</b>	Approved Drawing & Data Sheet	Test Report	R	R	W	
a.)Open circuit potential shall lie within (+) 10 mV and (-) 50 mV of the guaranteed value.						
b.)Consumption rate by weight loss method (consumption rate shall not be more than the specified value).						
All the above Manufacturer Test Reports	Approved Drawing & Data Sheet	Test Report	Submission	R	W	
Document / Marking	Approved Drawing & Data Sheet	IRN	H	P	R	
<b>LEGEND: P-PERFORM, W-WITNESS ALL, S-SUBMITTED BY, R-REVIEWED BY, H-HOLD M-Manufacturer C-Contractor TPIA-Third Party Inspection Agency</b>						

	<b>QUALITY ASSURANCE PLAN FOR CATHODE JUNCTION BOX</b>					
<b>PROJECT</b>						
<b>OWNER</b>	<b>GAIL INDIA LIMITED</b>					
<b>PROJECT NO</b>					<b>DATE:-</b>	
<b>TPIA</b>						
<b>CONSULTANT</b>						
<b>CONTRACTOR</b>						
<b>CP CONTRACTOR</b>						
<b>QAP NO.</b>	<b>GAIL-STD-CP-DOC-QAP-001</b>				<b>REV.</b>	<b>0</b>
<b>REFERENCE SPECIFICATION</b>						
<b>REFERENCE DESIGN DOCUMENT</b>						
<b>REFERENCE DATA SHEET</b>						
<b>REFERENCE DRAWING</b>						
<b>VENDOR</b>						
<b>DESCRIPTION / TYPE OF INSPECTION</b>	<b>REFERENCE DOCUMENT</b>	<b>FORMAT OF RECORD</b>	<b>INSPECTION BY</b>			<b>Remarks</b>
			<b>M</b>	<b>C</b>	<b>TPIA</b>	
Compliance with approved Drawing & Data sheet (Manufacturer, type & Model)	Approved Drawing & Data Sheet	Inspection Report	P	W	w	
Visual Inspection ALL	Approved Drawing & Data Sheet	Inspection Report	P	W	W	
Dimensional Check, Physical verification, locking , painting ALL	Approved Drawing & Data Sheet	Inspection Report	P	W	W	
Fitness Test Randomly	Approved Drawing & Data Sheet	Inspection Report	P	W	W	
Thickness check, Terminal to body check ALL	Approved Drawing & Data Sheet	Inspection Report	P	W	W	
Manufacturer Test Certificate (IP 55) ALL	Approved Drawing & Data Sheet	Test Report	Submission	R	R	
Document/Marking	Approved Drawing & Data Sheet	IRN	H	H	P	
<b>LEGEND: P-PERFORM, W-WITNESS ALL, S-SUBMITTED BY, R-REVIEWED BY, H-HOLD M-Manufacturer C-Contractor TPIA-Third Party Inspection Agency</b>						



**QUALITY ASSURANCE PLAN FOR ANODE JUNCTION  
BOX**



<b>PROJECT</b>							
<b>OWNER</b>	<b>GAIL INDIA LIMITED</b>						
<b>PROJECT NO</b>					<b>DATE:-</b>		
<b>TPIA</b>							
<b>CONSULTANT</b>							
<b>CONTRACTOR</b>							
<b>CP CONTRACTOR</b>							
<b>QAP NO.</b>	<b>GAIL-STD-CP-DOC-QAP-001</b>				<b>REV.</b>	<b>0</b>	
<b>REFERENCE SPECIFICATION</b>							
<b>REFERENCE DESIGN DOCUMENT</b>							
<b>REFERENCE DATA SHEET</b>							
<b>REFERENCE DRAWING</b>							
<b>VENDOR</b>							
<b>DESCRIPTION / TYPE OF INSPECTION</b>		<b>REFERENCE DOCUMENT</b>	<b>FORMAT OF RECORD</b>	<b>INSPECTION BY</b>			<b>Remarks</b>
				<b>M</b>	<b>TPIA</b>	<b>GAIL</b>	
Compliance with approved Drawing & Data sheet (Manufacturer, type & Model)	ALL	Approved Drawing & Data Sheet	Inspection Report	P	W	W	
Visual Inspection	ALL	Approved Drawing & Data Sheet	Inspection Report	P	W	W	
Dimensional Check, Physical verification, locking, painting	ALL	Approved Drawing & Data Sheet	Inspection Report	P	W	W	
Fitness Test	Randamly	Approved Drawing & Data Sheet	Inspection Report	P	W	W	
Thickness check, Terminal to body check	ALL	Approved Drawing & Data Sheet	Inspection Report	P	W	W	
Manufacturer Test Certificate (IP 55)	ALL	Approved Drawing & Data Sheet	Test Certificate	P	R	R	
Document / Marking		Approved Drawing & Data Sheet	IRN	H	P	R	
<b>LEGEND: P-PERFORM, W-WITNESS ALL, S-SUBMITTED BY, R-REVIEWED BY, H-HOLD M-Manufacturer C-Contractor TPIA-Third Party Inspection Agency</b>							



**QUALITY ASSURANCE PLAN FOR SACRIFICIAL  
MAGNESIUM ANODE**



<b>PROJECT</b>						
<b>OWNER</b>	<b>GAIL INDIA LIMITED</b>					
<b>PROJECT NO</b>		<b>DATE:-</b>				
<b>TPIA</b>						
<b>CONSULTANT</b>						
<b>CONTRACTOR</b>						
<b>CP CONTRACTOR</b>						
<b>QAP NO.</b>	<b>GAIL-STD-CP-DOC-QAP-001</b>	<b>REV.</b>	<b>0</b>			
<b>REFERENCE SPECIFICATION</b>						
<b>REFERENCE DESIGN DOCUMENT</b>						
<b>REFERENCE DATA SHEET</b>						
<b>REFERENCE DRAWING</b>						
<b>VENDOR</b>						
<b>DESCRIPTION / TYPE OF INSPECTION</b>	<b>REFERENCE DOCUMENT</b>	<b>FORMAT OF RECORD</b>	<b>INSPECTION BY</b>			<b>Remarks</b>
			<b>M</b>	<b>TPIA</b>	<b>GAIL</b>	
Compliance with approved Drawing & Data sheet (Manufacturer, type & Model)	Approved Drawing & Data Sheet	Inspection Report	P	W	R	
<b>Inspection</b>	Approved Drawing & Data Sheet	Inspection Report	P	W	W/R	
a. Surface 100 %, Length $\pm$ 2.5 %, Width/ Thickness $\pm$ 5%						
b. Visual : Longitudinal cracks of more than 40 mm long and 3 mm deep not acceptable						
c. Weight tolerance: + %5 (Total weight of all anodes shall not have negative tolerance)						
<b>Radiographic Test</b>	Approved Drawing & Data Sheet	Test Report	P	W	W	
One anode per heat shall be subjected to radiography to evaluate cracks, voids, slack inclusion etc.						
<b>Destructive Testing</b>	Approved Drawing & Data Sheet	Test Report	P	R	R	
One anode per heat shall be subjected to destructive testing for slag inclusions, bond between anode and insert.						





**QUALITY ASSURANCE PLAN FOR SACRIFICIAL  
MAGNESIUM ANODE**



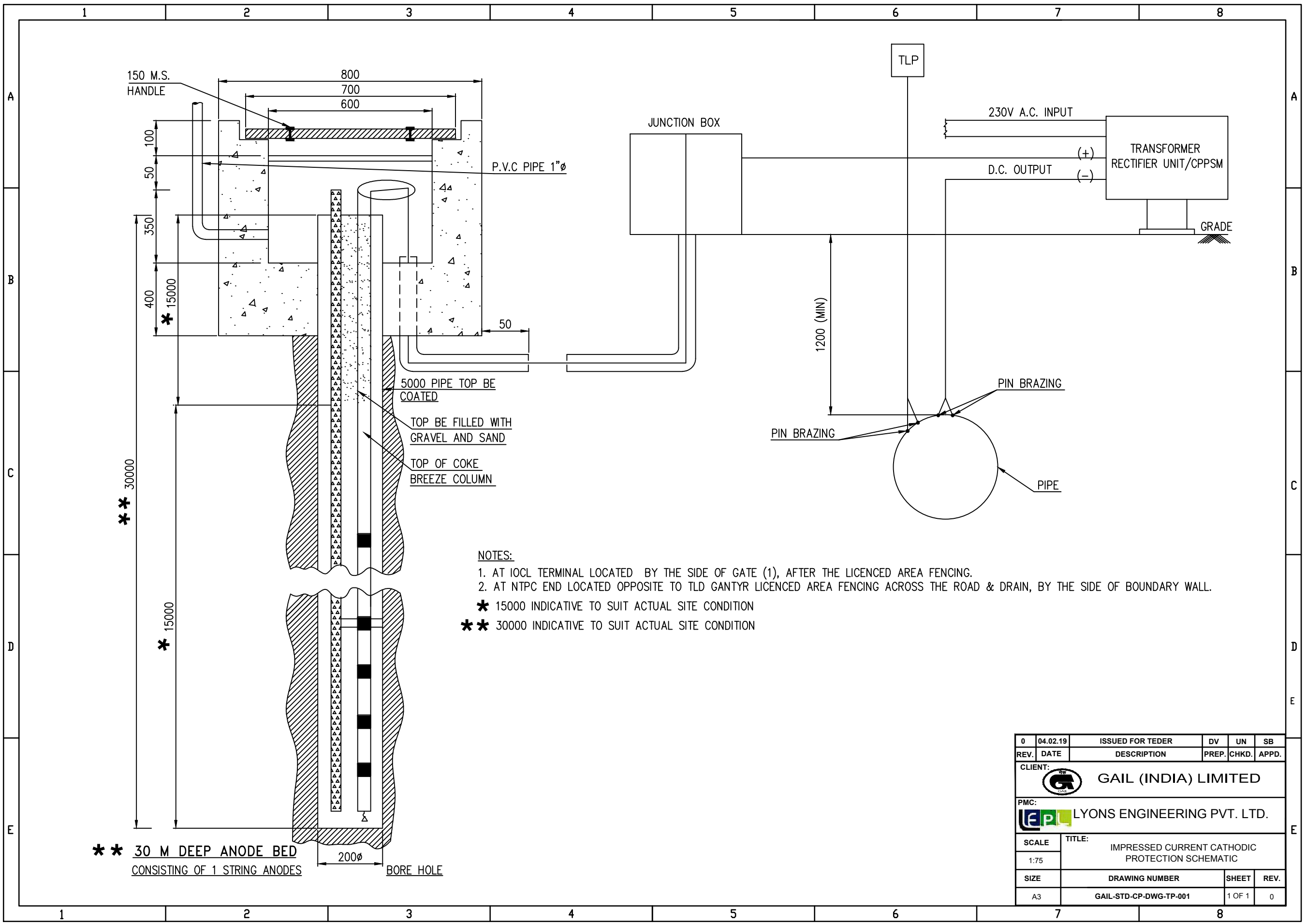
<b>PROJECT</b>							
<b>OWNER</b>		<b>GAIL INDIA LIMITED</b>					
<b>PROJECT NO</b>				<b>DATE:-</b>			
<b>TPIA</b>							
<b>CONSULTANT</b>							
<b>CONTRACTOR</b>							
<b>CP CONTRACTOR</b>							
<b>QAP NO.</b>		<b>GAIL-STD-CP-DOC-QAP-001</b>		<b>REV.</b>		<b>0</b>	
<b>REFERENCE SPECIFICATION</b>							
<b>REFERENCE DESIGN DOCUMENT</b>							
<b>REFERENCE DATA SHEET</b>							
<b>REFERENCE DRAWING</b>							
<b>VENDOR</b>							
<b>DESCRIPTION / TYPE OF INSPECTION</b>		<b>REFERENCE DOCUMENT</b>	<b>FORMAT OF RECORD</b>	<b>INSPECTION BY</b>			<b>Remarks</b>
				<b>M</b>	<b>TPIA</b>	<b>GAIL</b>	
<b>Chemical Analysis</b> ; One anode sample per heat by Spectrography Sample in the beginning for first heat, end of second heat, at the beginning of third heat and so on.		Approved Drawing & Data Sheet	Test Report	P	R	R	
Mass per liner meter	ALL	Approved Drawing & Data Sheet	Test Report	P	R	W	
Anode to core resistance	Randomly	Approved Drawing & Data Sheet	Test Report	P	R	W	
<b>Electrochemical Test</b>			Test Report				
One anode per heat shall be tested for							
a.)Open circuit potential shall lie within (+) 10 mV and (-) 50 mV of the		Approved Drawing & Data Sheet		R	R	R	



**QUALITY ASSURANCE PLAN FOR SACRIFICIAL  
MAGNESIUM ANODE**



<b>PROJECT</b>						
<b>OWNER</b>	GAIL INDIA LIMITED					
<b>PROJECT NO</b>		<b>DATE:-</b>				
<b>TPIA</b>						
<b>CONSULTANT</b>						
<b>CONTRACTOR</b>						
<b>CP CONTRACTOR</b>						
<b>QAP NO.</b>	GAIL-STD-CP-DOC-QAP-001	<b>REV.</b>	0			
<b>REFERENCE SPECIFICATION</b>						
<b>REFERENCE DESIGN DOCUMENT</b>						
<b>REFERENCE DATA SHEET</b>						
<b>REFERENCE DRAWING</b>						
<b>VENDOR</b>						
DESCRIPTION / TYPE OF INSPECTION	REFERENCE DOCUMENT	FORMAT OF RECORD	INSPECTION BY			Remarks
			M	TPIA	GAIL	
b.)Consumption rate by weight loss method (consumption rate shall not be more than the specified value).						
All the above Manufacturer Test Reports	Approved Drawing & Data Sheet	Test Report	Submi sion	R	R	
Document / Marking	Approved Drawing & Data Sheet	IRN	H	P	R	
<b>LEGEND: P-PERFORM, W-WITNESS ALL, S-SUBMITTED BY, R-REVIEWED BY, H-HOLD M-Manufacturer C-Contractor TPIA-Third Party Inspection Agency</b>						



150 M.S. HANDLE

800

700

600

P.V.C PIPE 1"φ

100

50

350

400

\* 15000

5000 PIPE TOP BE COATED

TOP BE FILLED WITH GRAVEL AND SAND

TOP OF COKE BREEZE COLUMN

50

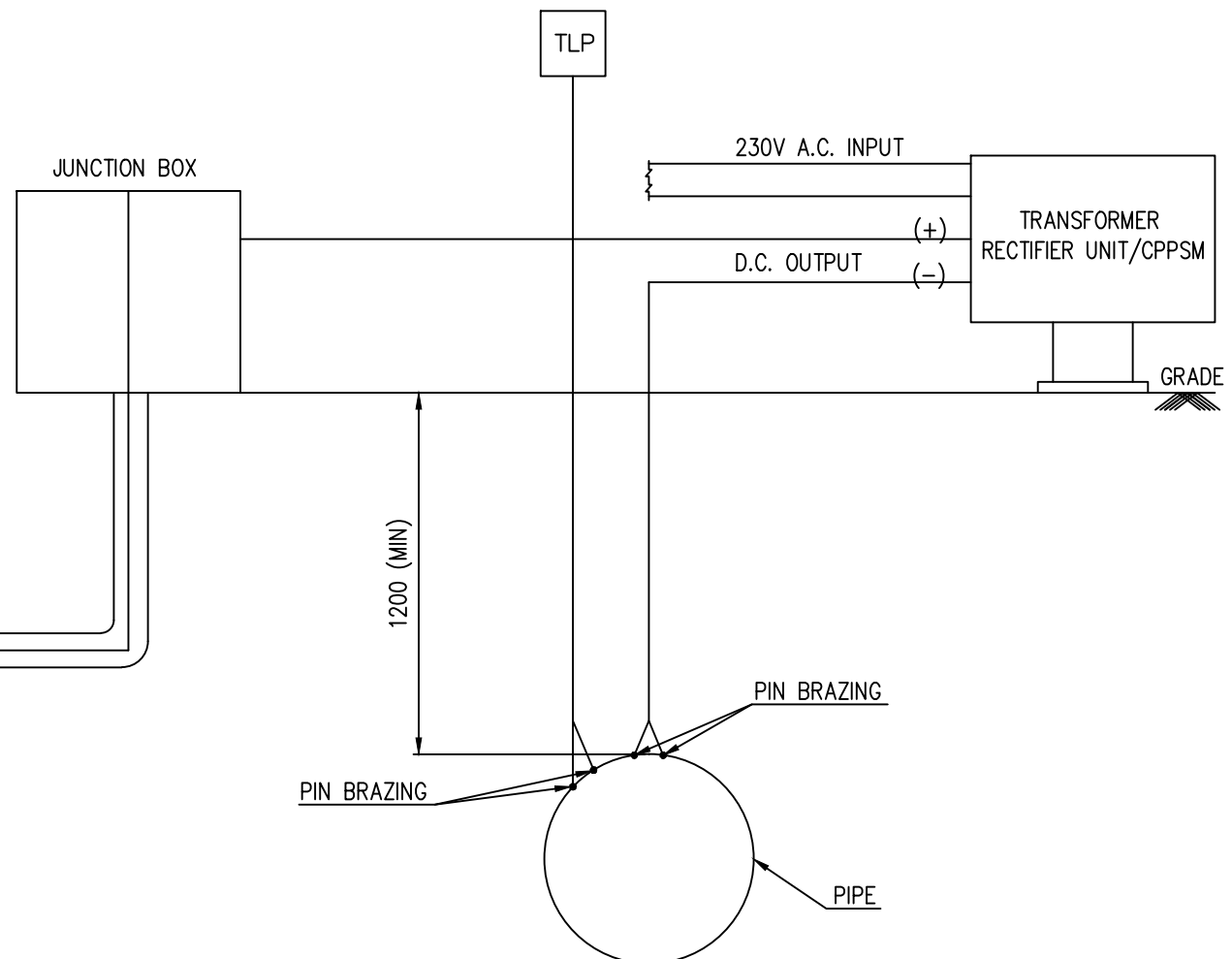
30000

\* \*

15000

\* \*

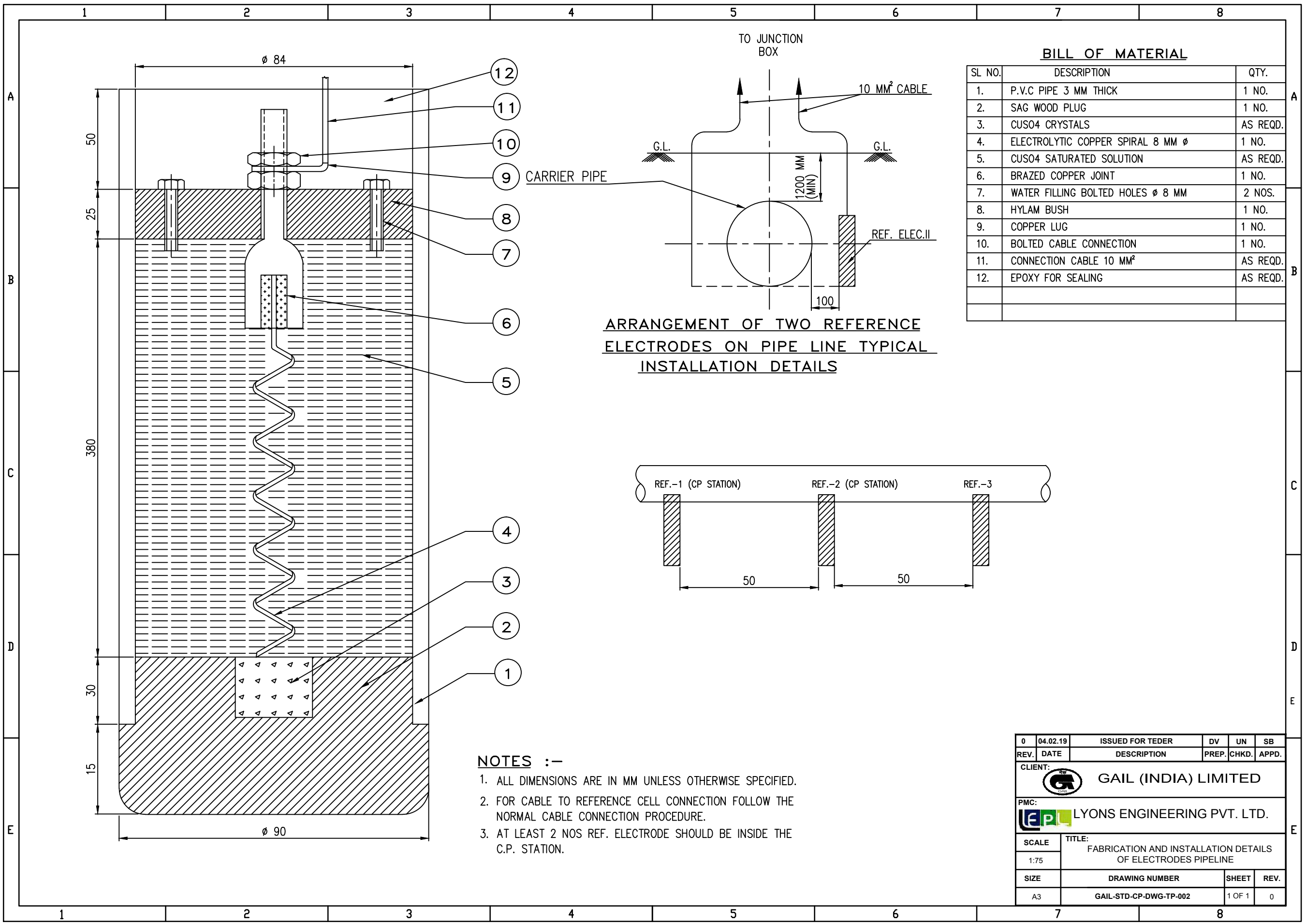
200φ BORE HOLE



- NOTES:
1. AT IOCL TERMINAL LOCATED BY THE SIDE OF GATE (1), AFTER THE LICENCED AREA FENCING.
  2. AT NTPC END LOCATED OPPOSITE TO TLD GANTYR LICENCED AREA FENCING ACROSS THE ROAD & DRAIN, BY THE SIDE OF BOUNDARY WALL.
- \* 15000 INDICATIVE TO SUIT ACTUAL SITE CONDITION
- \* \* 30000 INDICATIVE TO SUIT ACTUAL SITE CONDITION

\* \* 30 M DEEP ANODE BED  
CONSISTING OF 1 STRING ANODES

0	04.02.19	ISSUED FOR TEDER	DV	UN	SB
REV.	DATE	DESCRIPTION	PREP.	CHKD.	APPD.
CLIENT:					
PMC:					
SCALE	TITLE:				
1:75	IMPRESSED CURRENT CATHODIC PROTECTION SCHEMATIC				
SIZE	DRAWING NUMBER	SHEET	REV.		
A3	GAIL-STD-CP-DWG-TP-001	1 OF 1	0		



**BILL OF MATERIAL**

SL NO.	DESCRIPTION	QTY.
1.	P.V.C PIPE 3 MM THICK	1 NO.
2.	SAG WOOD PLUG	1 NO.
3.	CUSO4 CRYSTALS	AS REQD.
4.	ELECTROLYTIC COPPER SPIRAL 8 MM $\phi$	1 NO.
5.	CUSO4 SATURATED SOLUTION	AS REQD.
6.	BRAZED COPPER JOINT	1 NO.
7.	WATER FILLING BOLTED HOLES $\phi$ 8 MM	2 NOS.
8.	HYLAM BUSH	1 NO.
9.	COPPER LUG	1 NO.
10.	BOLTED CABLE CONNECTION	1 NO.
11.	CONNECTION CABLE 10 MM <sup>2</sup>	AS REQD.
12.	EPOXY FOR SEALING	AS REQD.

**ARRANGEMENT OF TWO REFERENCE ELECTRODES ON PIPE LINE TYPICAL INSTALLATION DETAILS**

**NOTES :-**

1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. FOR CABLE TO REFERENCE CELL CONNECTION FOLLOW THE NORMAL CABLE CONNECTION PROCEDURE.
3. AT LEAST 2 NOS REF. ELECTRODE SHOULD BE INSIDE THE C.P. STATION.

0	04.02.19	ISSUED FOR TEDER	DV	UN	SB
REV.	DATE	DESCRIPTION	PREP.	CHKD.	APPD.
CLIENT:		<b>GAIL (INDIA) LIMITED</b>			
PMC:		<b>LYONS ENGINEERING PVT. LTD.</b>			
SCALE	TITLE:				
1:75	FABRICATION AND INSTALLATION DETAILS OF ELECTRODES PIPELINE				
SIZE	DRAWING NUMBER		SHEET	REV.	
A3	GAIL-STD-CP-DWG-TP-002		1 OF 1	0	

1 2 3 4 5 6 7 8

A

B

C

D

E

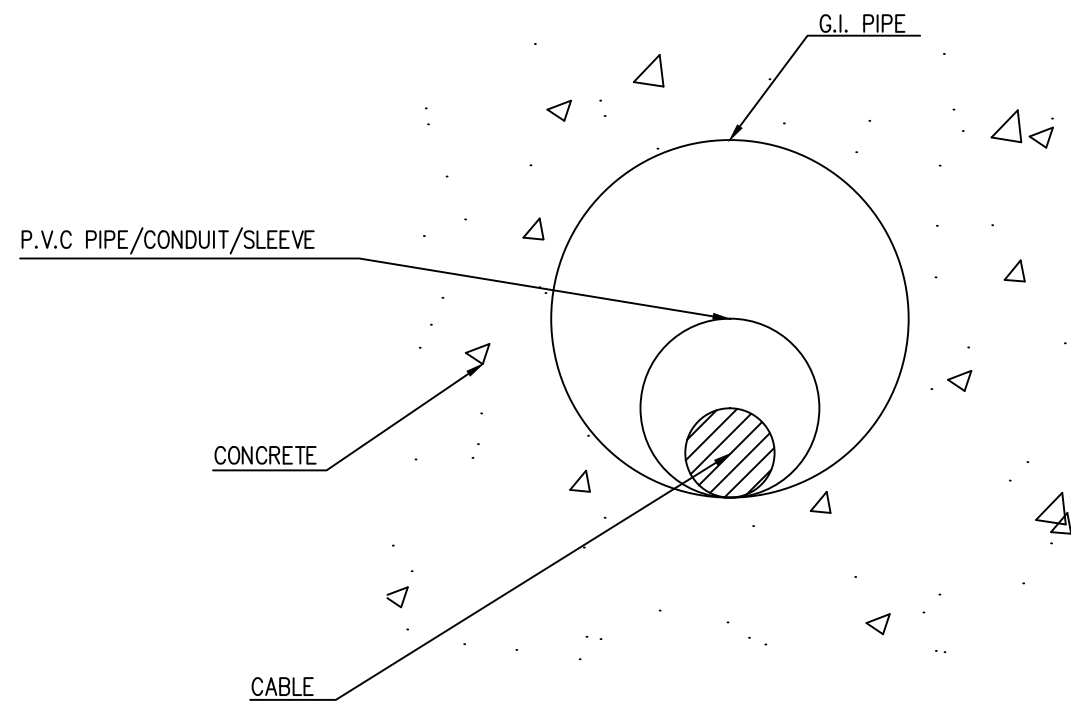
A

B

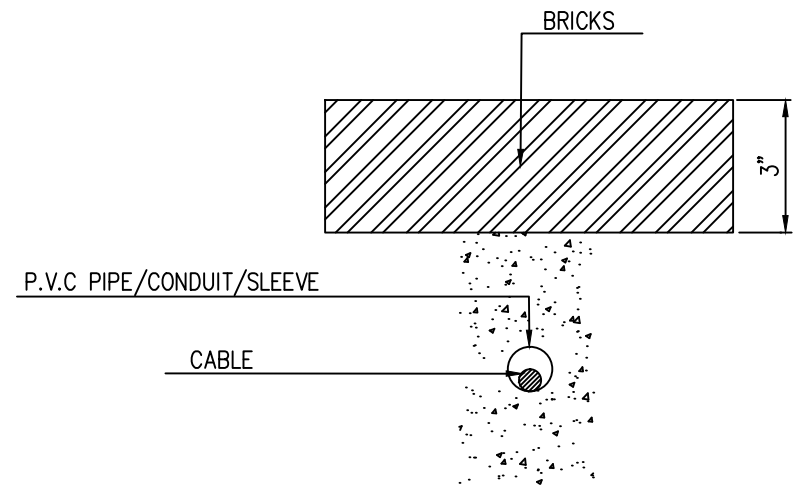
C

D

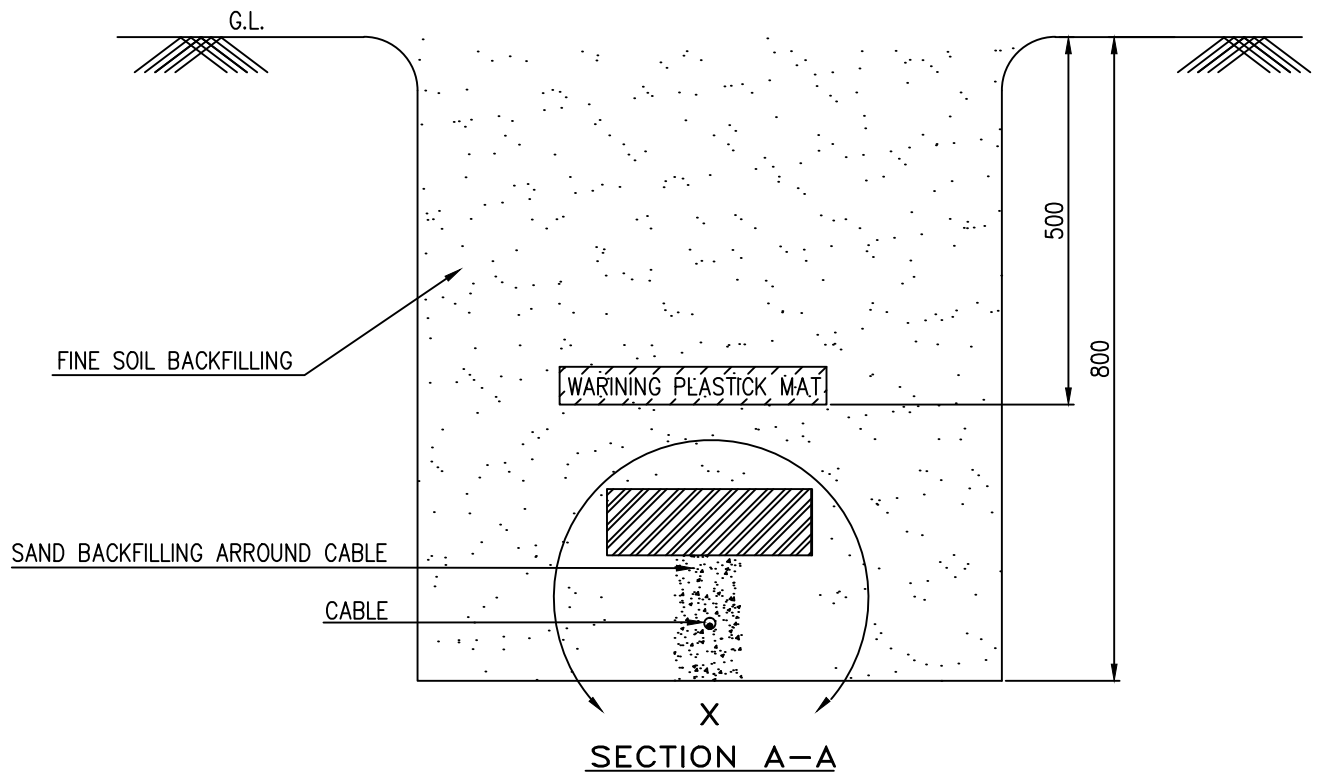
E



**SECTION VIEW OF CABLE LAYOUT IN CONCRETE**



**ENLARGED DETAIL-X FOR NORMAL LAYING IN EARTH**

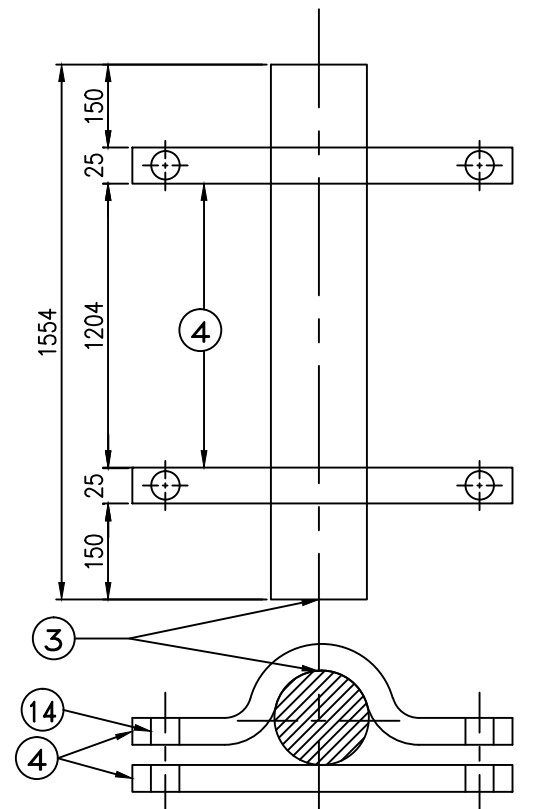
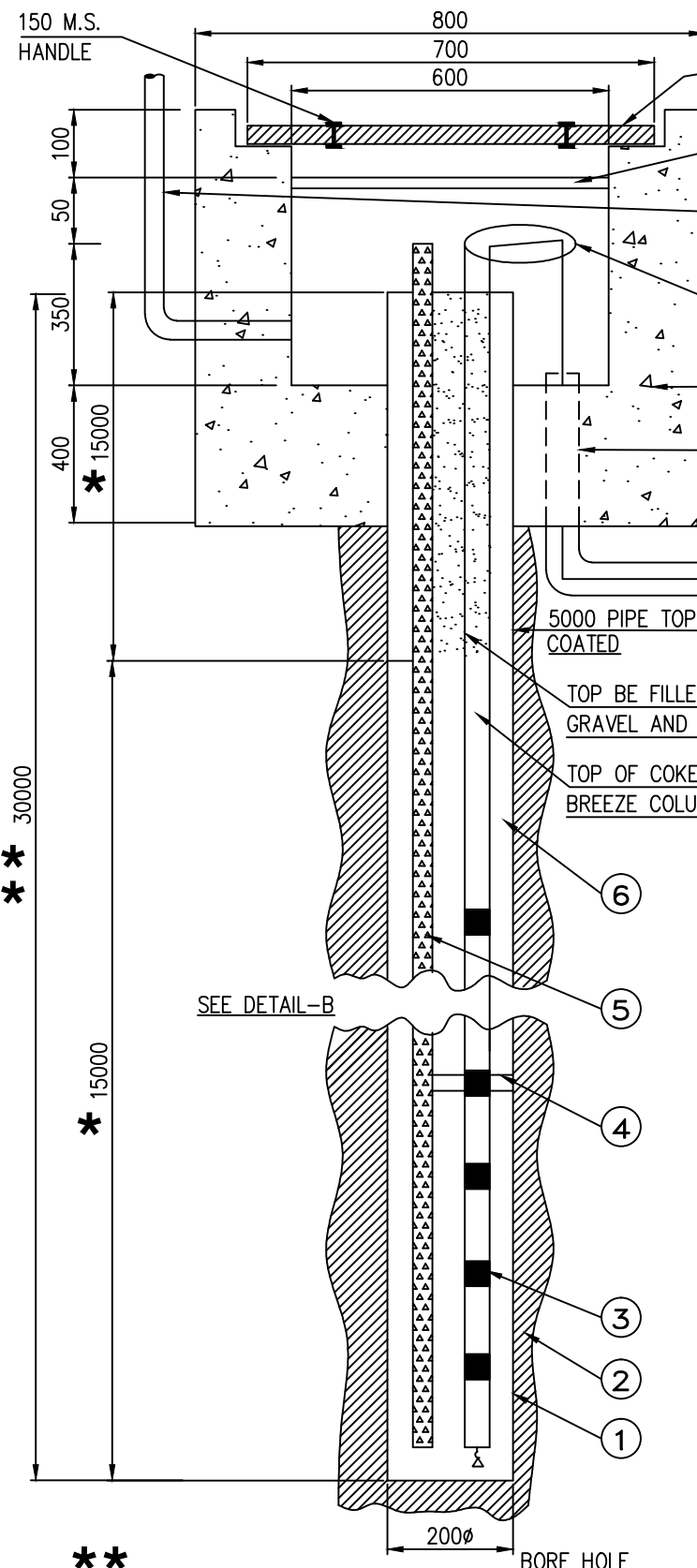
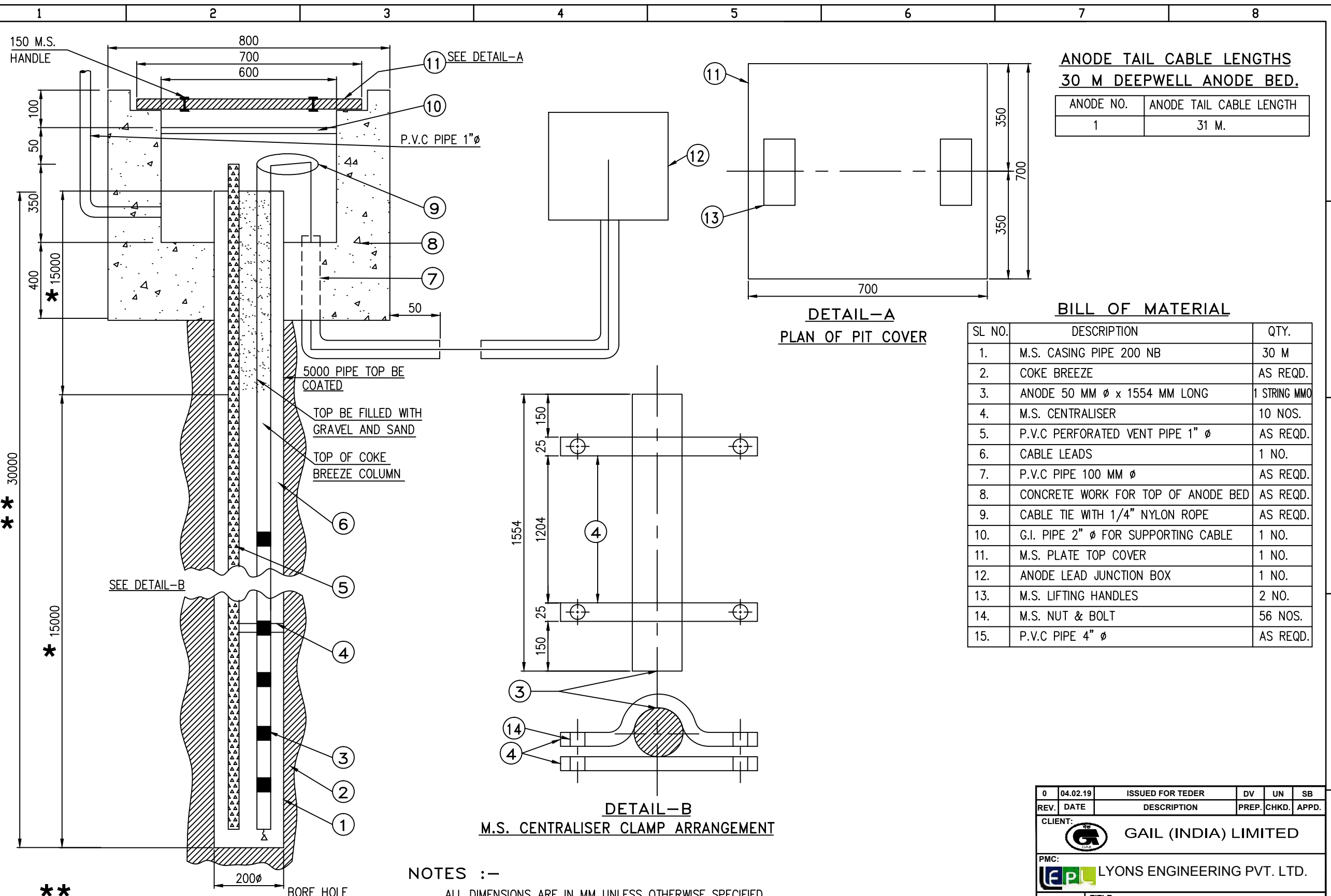


**NOTES :-**

1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. ALL UNDERGROUND CABLE SHALL BE LAID IN BRICK COVERING WITH SAND BACKFILL.
3. FOR MORE THAN ONE CABLE IN THE SAME CABLE TRENCH CABLE SHALL BE LAID SIDE BY SIDE IN SEPARATE BRICK COVERING.
4. AT BOTH ENDS OF CABLE TERMINATION A LOOP OF ONE METER (MINIMUM) SHALL BE KEPT AS SPARE.
5. WHEREVER TERMINATION IN BETWEEN IS REQUIRED T-JOINTS OR ELBOWS SHALL BE PROVIDED.
6. AT ROAD/NALA CROSSINGS, G.I. PIPE CONDUIT SHALL BE USED.

0	04.02.19	ISSUED FOR TENDER	DV	UN	SB
REV.	DATE	DESCRIPTION	PREP.	CHKD.	APPD.
CLIENT:		<b>GAIL (INDIA) LIMITED</b>			
PMC:		<b>LYONS ENGINEERING PVT. LTD.</b>			
SCALE	TITLE:				
1:75	FABRICATION AND INSTALLATION DETAILS OF CABLE LAYING (TYPICAL)				
SIZE	DRAWING NUMBER		SHEET	REV.	
A3	GAIL-STD-CP-DWG-TP-003		1 OF 1	0	

1 2 3 4 5 6 7 8



**ANODE TAIL CABLE LENGTHS  
30 M DEEPWELL ANODE BED.**

ANODE NO.	ANODE TAIL CABLE LENGTH
1	31 M.

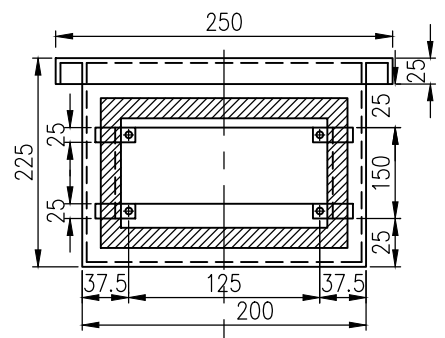
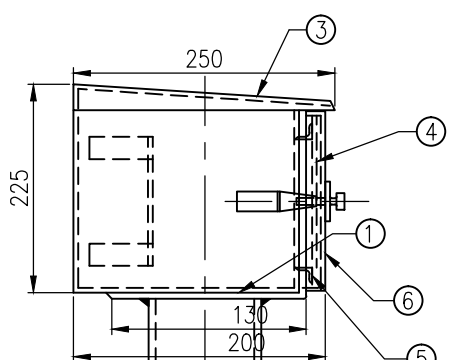
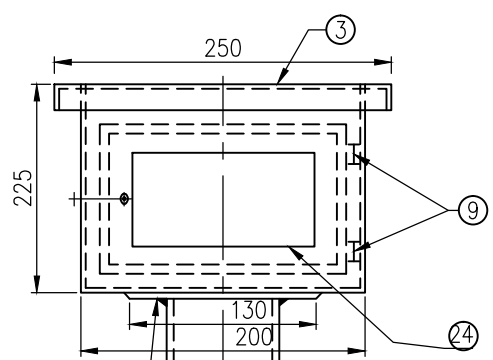
**BILL OF MATERIAL**

SL NO.	DESCRIPTION	QTY.
1.	M.S. CASING PIPE 200 NB	30 M
2.	COKE BREEZE	AS REQD.
3.	ANODE 50 MM $\phi$ x 1554 MM LONG	1 STRING MMO
4.	M.S. CENTRALISER	10 NOS.
5.	P.V.C PERFORATED VENT PIPE 1" $\phi$	AS REQD.
6.	CABLE LEADS	1 NO.
7.	P.V.C PIPE 100 MM $\phi$	AS REQD.
8.	CONCRETE WORK FOR TOP OF ANODE BED	AS REQD.
9.	CABLE TIE WITH 1/4" NYLON ROPE	AS REQD.
10.	G.I. PIPE 2" $\phi$ FOR SUPPORTING CABLE	1 NO.
11.	M.S. PLATE TOP COVER	1 NO.
12.	ANODE LEAD JUNCTION BOX	1 NO.
13.	M.S. LIFTING HANDLES	2 NO.
14.	M.S. NUT & BOLT	56 NOS.
15.	P.V.C PIPE 4" $\phi$	AS REQD.

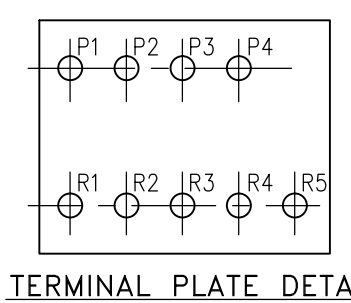
**\*\***  
**30 M DEEP ANODE BED**  
CONSISTING OF 1 STRING ANODES

**NOTES :-**  
ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.  
\* 15000 INDICATIVE TO SUIT ACTUAL SITE CONDITION.  
\*\* 30000 INDICATIVE TO SUIT ACTUAL SITE CONDITION.

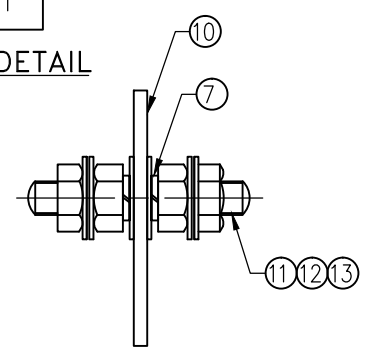
0	04.02.19	ISSUED FOR TENDER	DV	UN	SB
REV.	DATE	DESCRIPTION	PREP.	CHKD.	APPD.
CLIENT:					
PMC:					
SCALE	TITLE: FABRICATION AND INSTALLATION DEEP ANODE GROUND BED DETAILS				
1:75					
SIZE	DRAWING NUMBER	SHEET	REV.		
A3	GAIL-STD-CP-DWG-TP-004	1 OF 1	0		



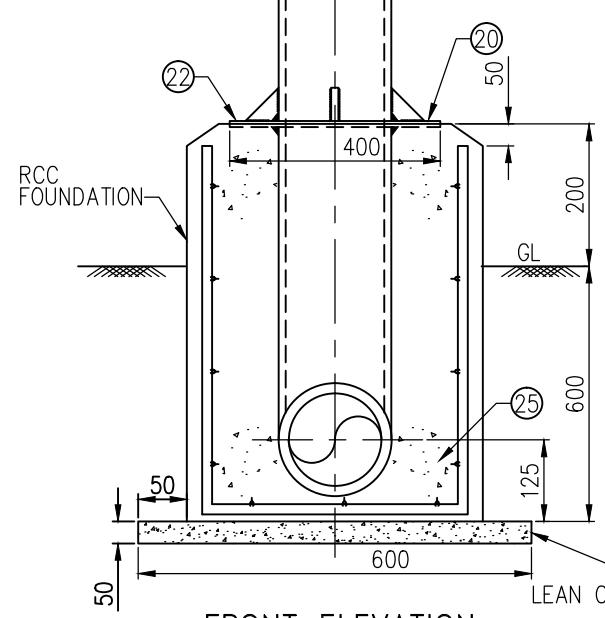
FRONT VIEW DOOR REMOVED



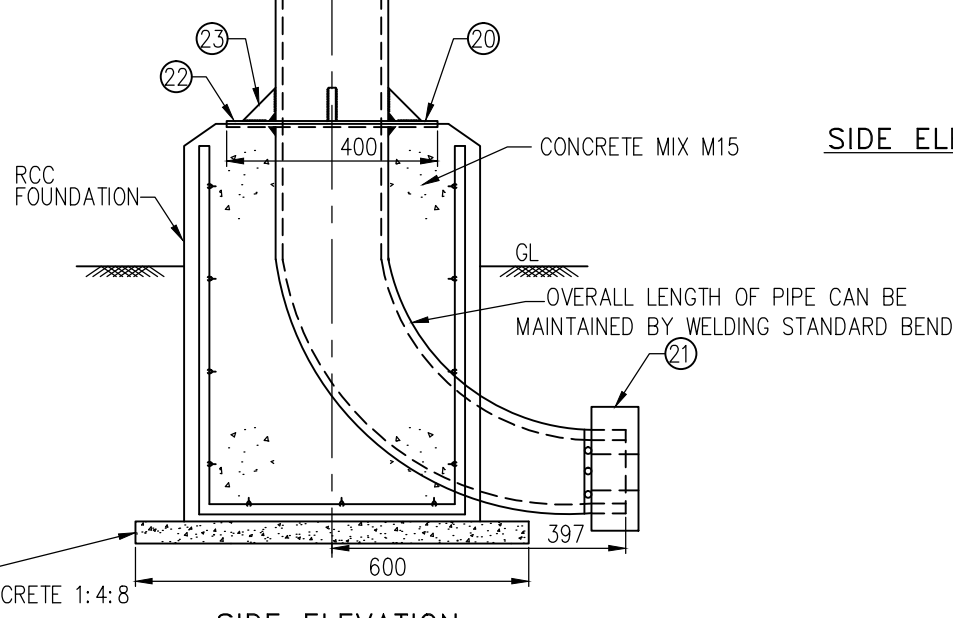
TERMINAL PLATE DETAIL



SIDE ELEVATION



FRONT ELEVATION

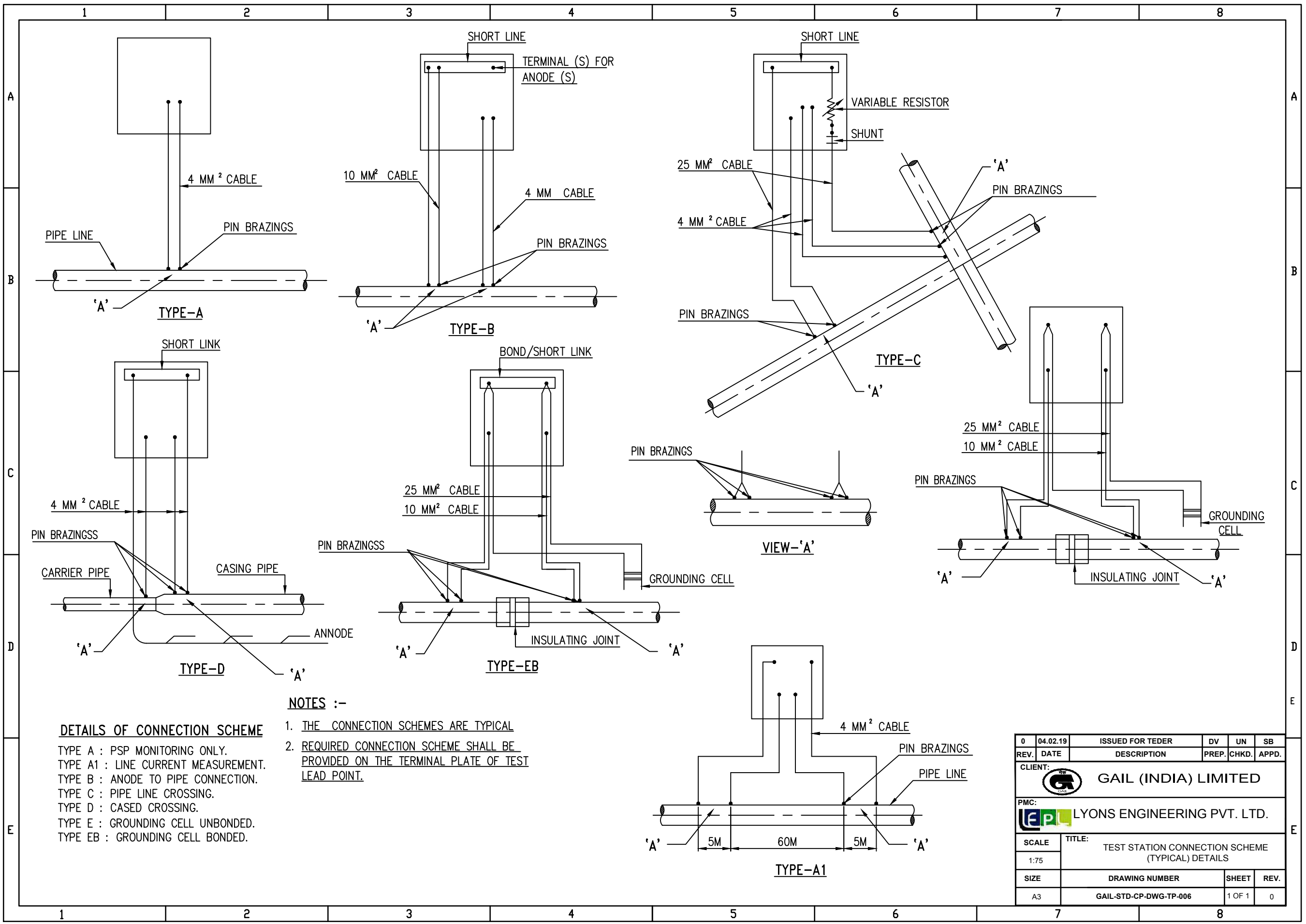


SIDE ELEVATION

**BILL OF MATERIAL**

SL NO.	DESCRIPTION	QTY.
1.	BOTTOM PLATE, 5TKx194 MS PLATE	001
2.	REAR & SIDE, 2.67x217x704 MS	001
3.	TOP, 2.67x250x300 MS	001
4.	FRONT TOP 2.67 x190x81 MS	001
5.	FRONT BOTTOM, 2.67x190x81 MS	001
6.	SHUTTER 2.67x234x234 MS	001
7.	SPRING WASHER SC. B.6	066
8.	CASTLE LOCK WITH MASTER KEY (3NOS. KEY)	001
9.	HINGE FOR SHUTTER	002
10.	TERMINAL PLATE, 8x150x150 PHENOLIGE LAM SHT.	001
11.	BRASS STUD M6x50LG (FOR TERMINALS)	001
12.	BRASS NUT M6	044
13.	BRASS WASHER	044
14.	MS. ANGLE 5TKx50x50x30	004
15.	STEEL SCREW, M6x16	004
16.	LATCH FOR SHUTTER	001
17.	MS COUPLING PLATE, STKx130x130 MS PLATE	001
18.	MS PIPE, 100 NB x 5.4 TKx 1275MM	001
19.	NEOPRENE RUBBER GASKET 6 TK.	001 SET
20.	FOUNDATION PLATE 6TKx400x400 AA 10108	002
21.	RUBBER BUSH	001
22.	FOUNDATION BOLT M14x125 LG WITH SPRING WASHER AND NUT	001
23.	STIFFENER PLATE 6TKx100x100	001
24.	NAME PLATE ANNODISED AL 0.9x120x160	001

0	04.02.19	ISSUED FOR TEDER	DV	UN	SB
REV.	DATE	DESCRIPTION	PREP.	CHKD.	APPD.
CLIENT:  GAIL (INDIA) LIMITED					
PMC:  LYONS ENGINEERING PVT. LTD.					
SCALE	TITLE: TEST LEAD POINTS & JUNCTION BOX WITH FOUNDATION DETAILS				
1:75					
SIZE	DRAWING NUMBER		SHEET	REV.	
A3	GAIL-STD-CP-DWG-TP-005		1 OF 1	0	



**DETAILS OF CONNECTION SCHEME**

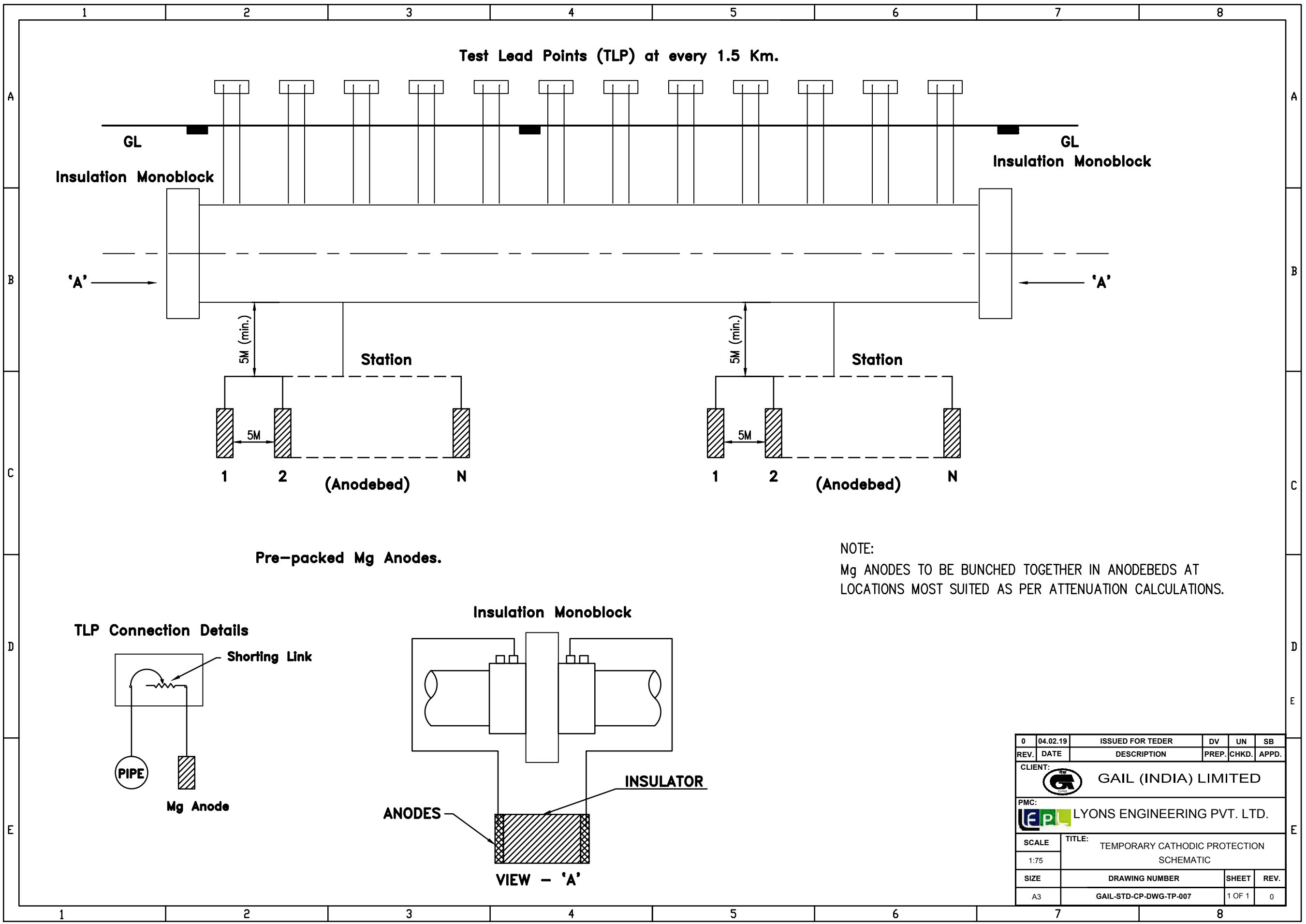
- TYPE A : PSP MONITORING ONLY.
- TYPE A1 : LINE CURRENT MEASUREMENT.
- TYPE B : ANODE TO PIPE CONNECTION.
- TYPE C : PIPE LINE CROSSING.
- TYPE D : CASSED CROSSING.
- TYPE E : GROUNDING CELL UNBONDED.
- TYPE EB : GROUNDING CELL BONDED.

**NOTES :-**

1. THE CONNECTION SCHEMES ARE TYPICAL
2. REQUIRED CONNECTION SCHEME SHALL BE PROVIDED ON THE TERMINAL PLATE OF TEST LEAD POINT.

0	04.02.19	ISSUED FOR TENDER	DV	UN	SB
REV.	DATE	DESCRIPTION	PREP.	CHKD.	APPD.
CLIENT:		<b>GAIL (INDIA) LIMITED</b>			
PMC:		<b>LYONS ENGINEERING PVT. LTD.</b>			
SCALE	TITLE: TEST STATION CONNECTION SCHEME (TYPICAL) DETAILS				
1:75					
SIZE	DRAWING NUMBER	SHEET	REV.		
A3	GAIL-STD-CP-DWG-TP-006	1 OF 1	0		





Test Lead Points (TLP) at every 1.5 Km.

Insulation Monoblock

Insulation Monoblock

'A'

'A'

5M (min.)

Station

5M (min.)

Station

1

2

(Anodebed)

N

1

2

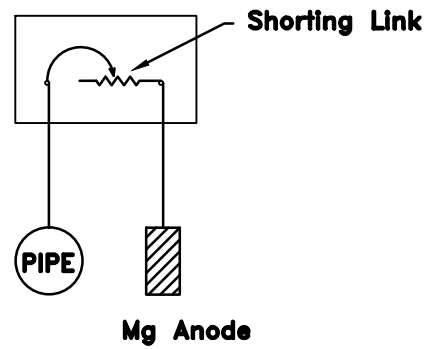
(Anodebed)

N

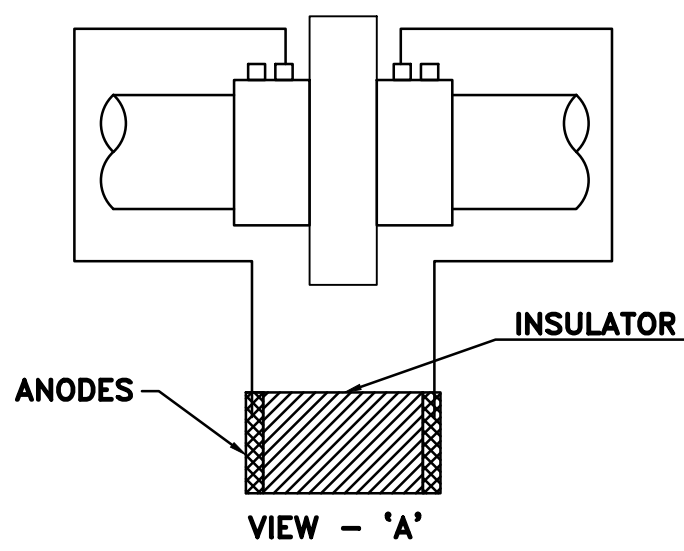
Pre-packed Mg Anodes.

NOTE:  
Mg ANODES TO BE BUNCHED TOGETHER IN ANODEBEDS AT LOCATIONS MOST SUITED AS PER ATTENUATION CALCULATIONS.

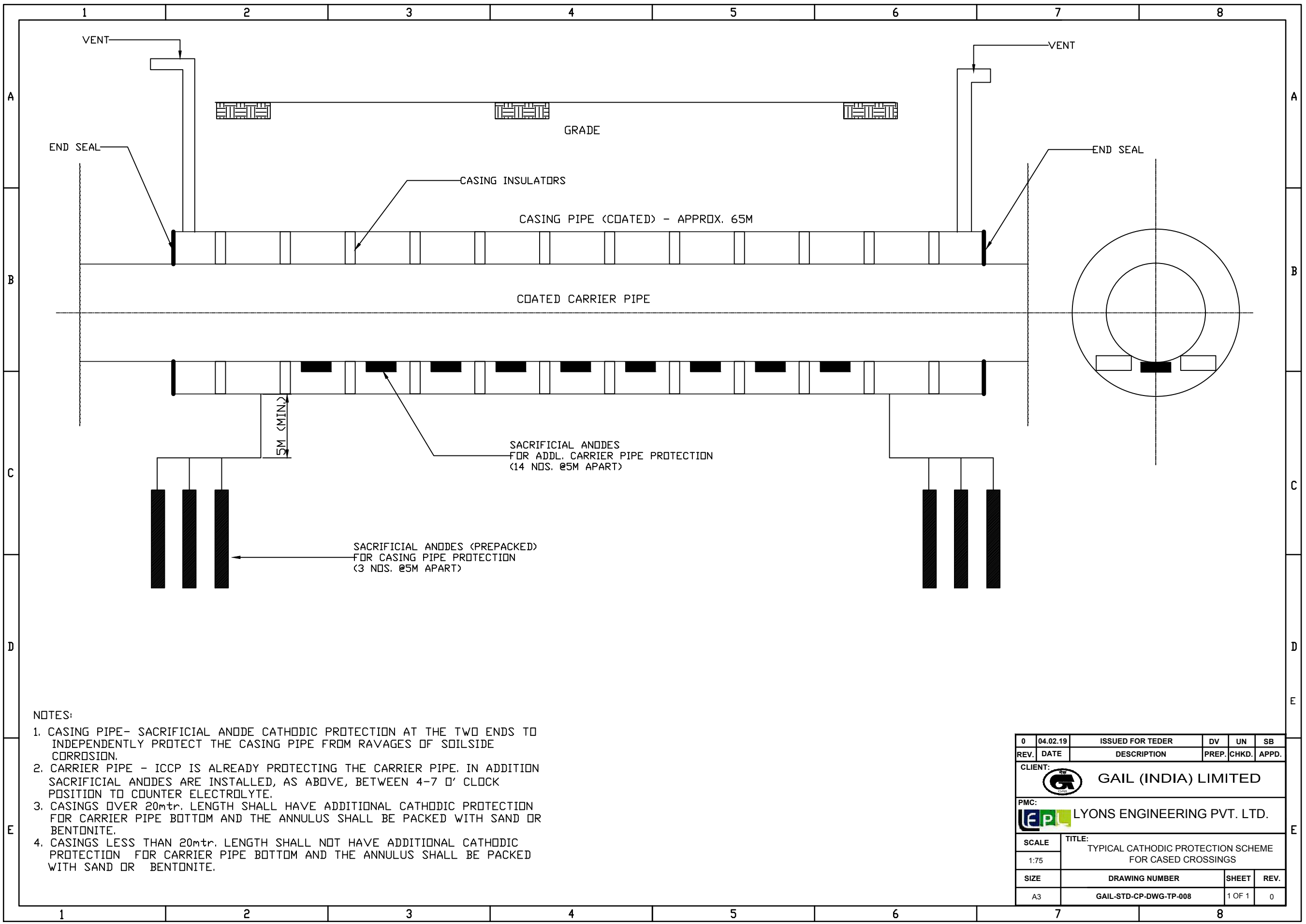
TLP Connection Details



Insulation Monoblock





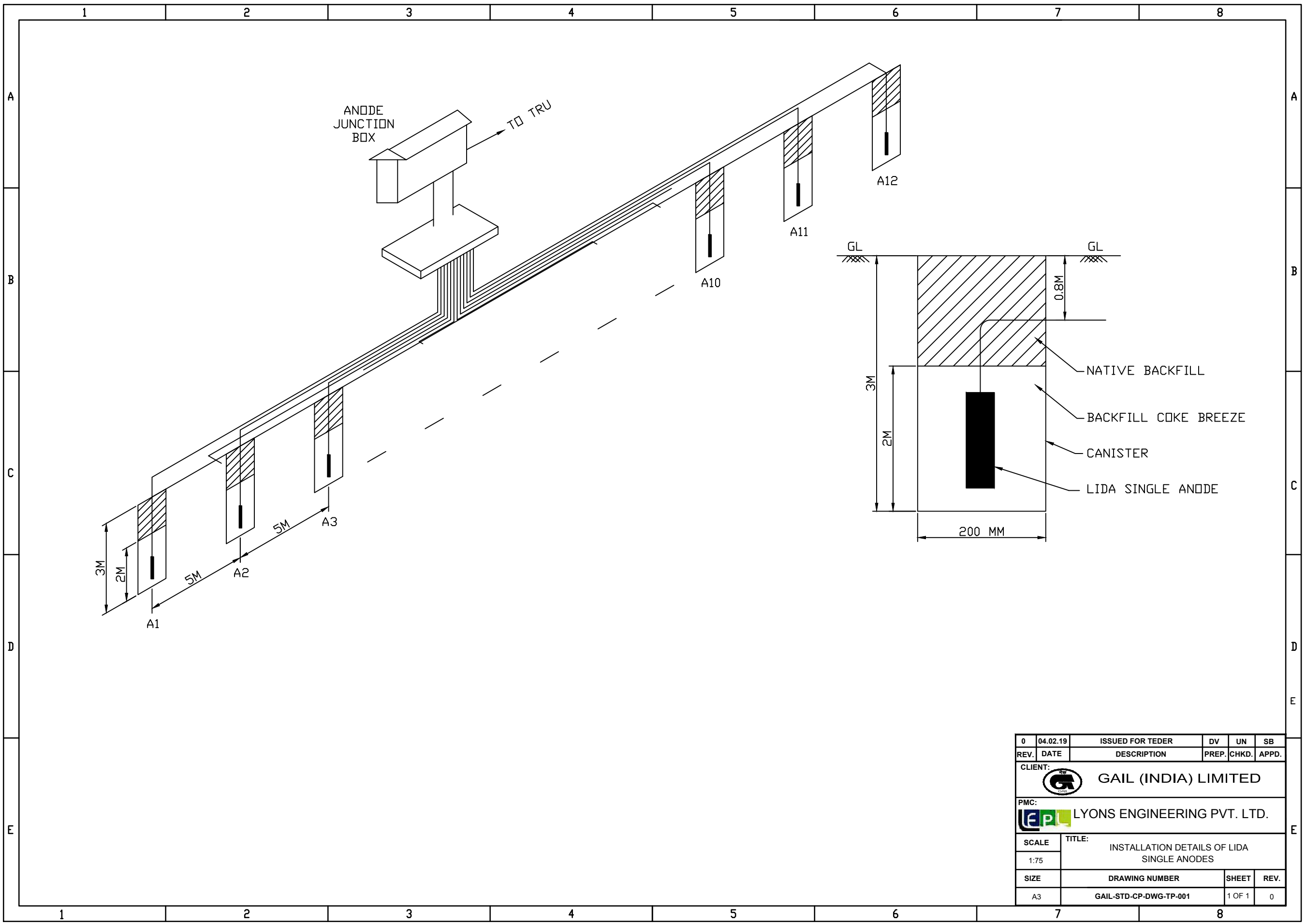
0	04.02.19	ISSUED FOR TENDER	DV	UN	SB
REV.	DATE	DESCRIPTION	PREP.	CHKD.	APPD.
CLIENT:					
PMC:					
SCALE	TITLE: TEMPORARY CATHODIC PROTECTION SCHEMATIC				
1:75					
SIZE	DRAWING NUMBER	SHEET	REV.		
A3	GAIL-STD-CP-DWG-TP-007	1 OF 1	0		



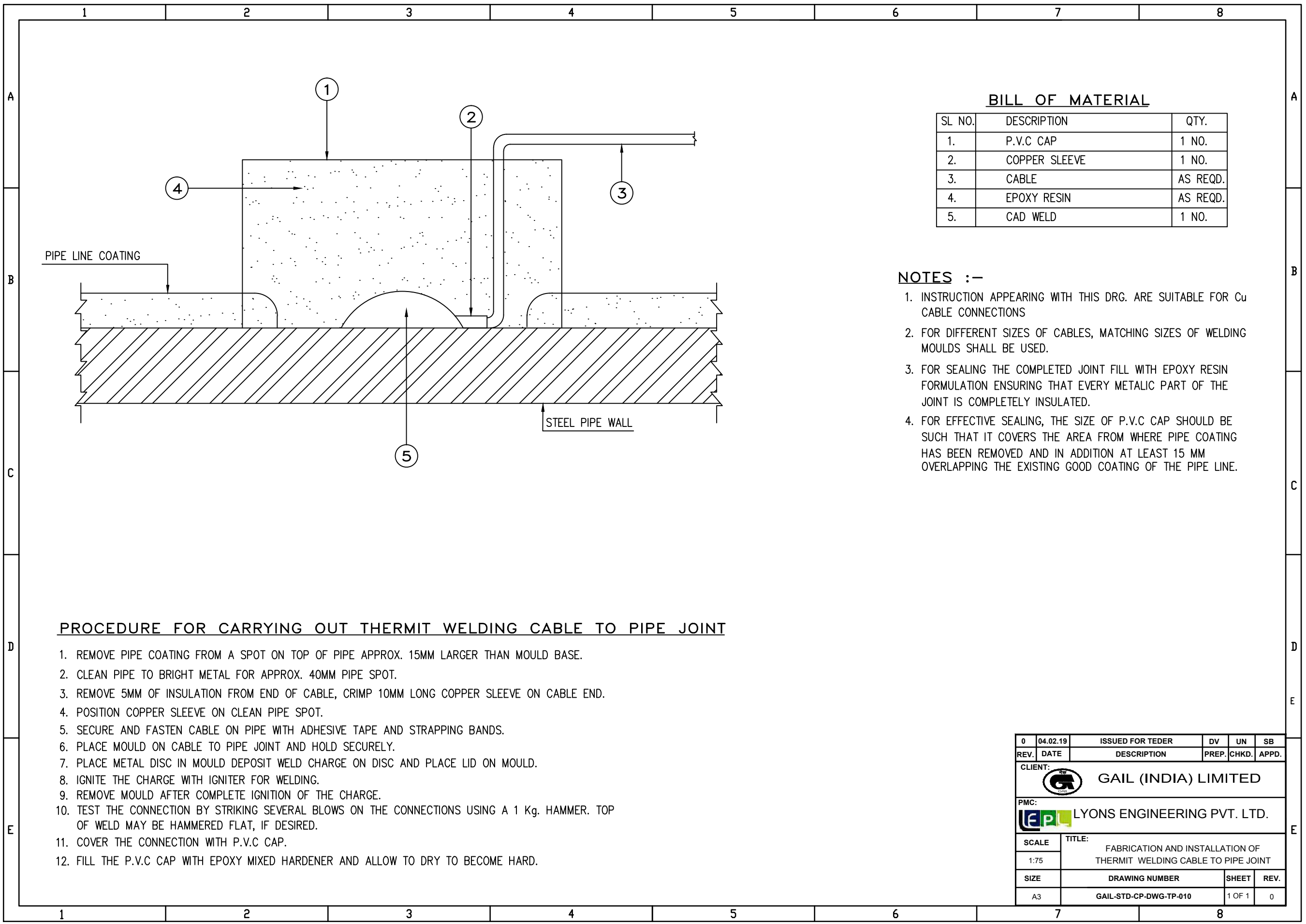
NOTES:

1. CASING PIPE- SACRIFICIAL ANODE CATHODIC PROTECTION AT THE TWO ENDS TO INDEPENDENTLY PROTECT THE CASING PIPE FROM RAVAGES OF SOILSIDE CORROSION.
2. CARRIER PIPE - ICCP IS ALREADY PROTECTING THE CARRIER PIPE. IN ADDITION SACRIFICIAL ANODES ARE INSTALLED, AS ABOVE, BETWEEN 4-7 O' CLOCK POSITION TO COUNTER ELECTROLYTE.
3. CASINGS OVER 20mtr. LENGTH SHALL HAVE ADDITIONAL CATHODIC PROTECTION FOR CARRIER PIPE BOTTOM AND THE ANNULUS SHALL BE PACKED WITH SAND OR BENTONITE.
4. CASINGS LESS THAN 20mtr. LENGTH SHALL NOT HAVE ADDITIONAL CATHODIC PROTECTION FOR CARRIER PIPE BOTTOM AND THE ANNULUS SHALL BE PACKED WITH SAND OR BENTONITE.

0	04.02.19	ISSUED FOR TEDER	DV	UN	SB
REV.	DATE	DESCRIPTION	PREP.	CHKD.	APPD.
CLIENT:		 <b>GAIL (INDIA) LIMITED</b>			
PMC:		 <b>LYONS ENGINEERING PVT. LTD.</b>			
SCALE	TITLE:				
1:75	TYPICAL CATHODIC PROTECTION SCHEME FOR CASSED CROSSINGS				
SIZE	DRAWING NUMBER	SHEET	REV.		
A3	GAIL-STD-CP-DWG-TP-008	1 OF 1	0		



0	04.02.19	ISSUED FOR TEDER	DV	UN	SB
REV.	DATE	DESCRIPTION	PREP.	CHKD.	APPD.
CLIENT:					
PMC:					
SCALE	TITLE:				
1:75	INSTALLATION DETAILS OF LIDA SINGLE ANODES				
SIZE	DRAWING NUMBER	SHEET	REV.		
A3	GAIL-STD-CP-DWG-TP-001	1 OF 1	0		



**BILL OF MATERIAL**



SL NO.	DESCRIPTION	QTY.
1.	P.V.C CAP	1 NO.
2.	COPPER SLEEVE	1 NO.
3.	CABLE	AS REQD.
4.	EPOXY RESIN	AS REQD.
5.	CAD WELD	1 NO.

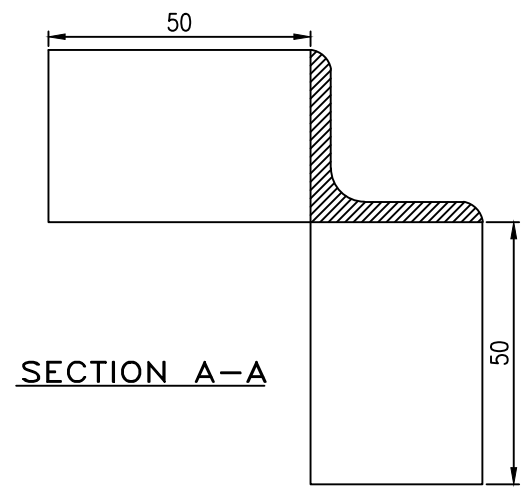
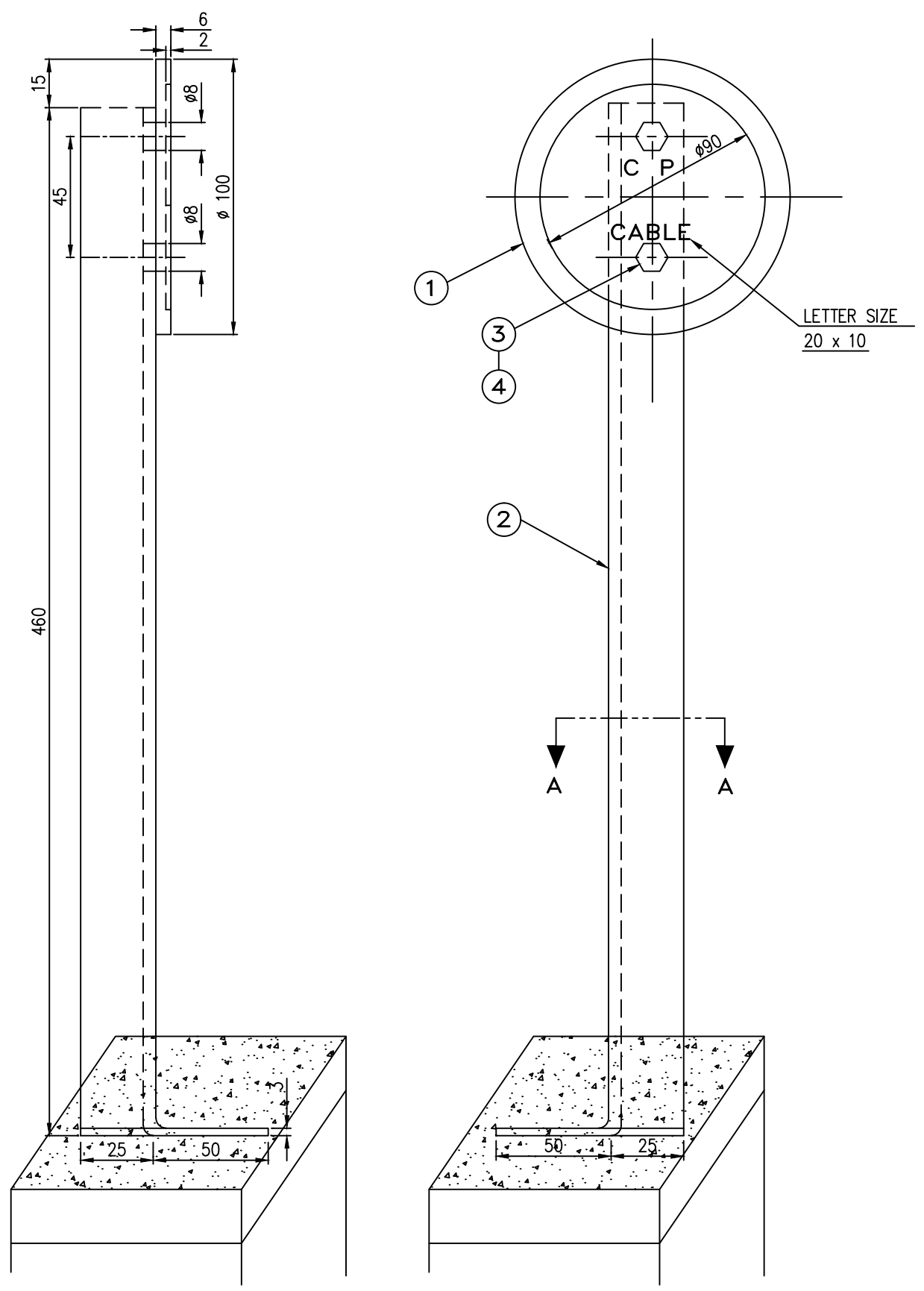
**NOTES :-**

1. INSTRUCTION APPEARING WITH THIS DRG. ARE SUITABLE FOR Cu CABLE CONNECTIONS
2. FOR DIFFERENT SIZES OF CABLES, MATCHING SIZES OF WELDING MOULDS SHALL BE USED.
3. FOR SEALING THE COMPLETED JOINT FILL WITH EPOXY RESIN FORMULATION ENSURING THAT EVERY METALIC PART OF THE JOINT IS COMPLETELY INSULATED.
4. FOR EFFECTIVE SEALING, THE SIZE OF P.V.C CAP SHOULD BE SUCH THAT IT COVERS THE AREA FROM WHERE PIPE COATING HAS BEEN REMOVED AND IN ADDITION AT LEAST 15 MM OVERLAPPING THE EXISTING GOOD COATING OF THE PIPE LINE.

**PROCEDURE FOR CARRYING OUT THERMIT WELDING CABLE TO PIPE JOINT**

1. REMOVE PIPE COATING FROM A SPOT ON TOP OF PIPE APPROX. 15MM LARGER THAN MOULD BASE.
2. CLEAN PIPE TO BRIGHT METAL FOR APPROX. 40MM PIPE SPOT.
3. REMOVE 5MM OF INSULATION FROM END OF CABLE, CRIMP 10MM LONG COPPER SLEEVE ON CABLE END.
4. POSITION COPPER SLEEVE ON CLEAN PIPE SPOT.
5. SECURE AND FASTEN CABLE ON PIPE WITH ADHESIVE TAPE AND STRAPPING BANDS.
6. PLACE MOULD ON CABLE TO PIPE JOINT AND HOLD SECURELY.
7. PLACE METAL DISC IN MOULD DEPOSIT WELD CHARGE ON DISC AND PLACE LID ON MOULD.
8. IGNITE THE CHARGE WITH IGNITER FOR WELDING.
9. REMOVE MOULD AFTER COMPLETE IGNITION OF THE CHARGE.
10. TEST THE CONNECTION BY STRIKING SEVERAL BLOWS ON THE CONNECTIONS USING A 1 Kg. HAMMER. TOP OF WELD MAY BE HAMMERED FLAT, IF DESIRED.
11. COVER THE CONNECTION WITH P.V.C CAP.
12. FILL THE P.V.C CAP WITH EPOXY MIXED HARDENER AND ALLOW TO DRY TO BECOME HARD.

0	04.02.19	ISSUED FOR TEDER	DV	UN	SB
REV.	DATE	DESCRIPTION	PREP.	CHKD.	APPD.
CLIENT:		 <b>GAIL (INDIA) LIMITED</b>			
PMC:		 <b>LYONS ENGINEERING PVT. LTD.</b>			
SCALE	TITLE:				
1:75	FABRICATION AND INSTALLATION OF THERMIT WELDING CABLE TO PIPE JOINT				
SIZE	DRAWING NUMBER	SHEET	REV.		
A3	GAIL-STD-CP-DWG-TP-010	1 OF 1	0		



**BILL OF MATERIAL**

SL NO.	DESCRIPTION	QTY.
1.	MARKER PLATE (CAST IRON)	1 NO.
2.	M.S. ANGLE 25x25x510 LONG	1 NO.
3.	BOLTS M6x20 LONG	2 NOS.
4.	NUTS M6	2 NOS.

**NOTES:**

1. ALL DIMENSION ARE IN MM
2. IN CASE OF POWER CABLE REPLACE "C.P" WITH "POWER"
3. THE CABLE MARKER SHALL BE PAINTED WITH APPROVED GRADE ALUMINIUM PAINT.

0	04.02.19	ISSUED FOR TEDER	DV	UN	SB
REV.	DATE	DESCRIPTION	PREP.	CHKD.	APPD.
CLIENT:  GAIL (INDIA) LIMITED					
PMC:  LYONS ENGINEERING PVT. LTD.					
SCALE	TITLE: FABRICATION AND INSTALLATION DETAILS CABLE ROUTE MARKER				
1:75					
SIZE	DRAWING NUMBER		SHEET	REV.	
A3	GAIL-STD-CP-DWG-TP-0011		1 OF 1	0	

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**GAIL INDIA LIMITED**

**CONSTRUCTION OF STEEL PIPELINE AND ASSOCIATED FACILITIES  
FOR CGD CONNECTIVITIES**

**VOLUME II OF II (TECHNICAL) – G**

**ELECTRICAL**

**E-TENDER REF :**

**(BID DOCUMENT NO - 034/LEPL/GAIL/22-R0)**

**LIMITED DOMESTIC COMPETITIVE BIDDING**



**Lyons Engineering Pvt. Ltd.**

	<b>DCI - MASTER DELIVERABLE CONTROL INDEX FOR CGD TO M/s TGPL MORADABAD &amp; CGD TO M/s TGPL GORAKHPUR</b>	<b>Doc No.</b>		
		GAIL-ENG-GN-DOC-DL-001		
		Rev. 0		
Sr. No.	Description	Document / Drawing No.	Rev. No.	
<b>TECHNICAL VOLUME - II OF II</b>				
<b>G</b>	<b>ELECTRICAL</b>			
1	Electrical Design Basis	GAIL-STD-EL-DOC-DB-001	0	
<b>TECHNICAL SPECIFICATION FOR ELECTRICAL SYSTEM</b>				
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	
5	Technical Specification for Earthing & Lightning Protection system	GAIL-STD-EL-DOC-TS-005	0	
6	Technical Specification for Installation, Testing and Commissioning of Electrical Equipments.	GAIL-STD-EL-DOC-TS-06	0	
<b>DATA SHEET FOR ELECTRICAL SYSTEM</b>				
7	Data Sheet for MEDB	GAIL-STD-EL-DOC-DS-001	0	
8	Data Sheet for Cables	GAIL-STD-EL-DOC-DS-002	0	
<b>QAP FOR ELECTRICAL SYSTEM</b>				
9	QAP of Distribution Board	GAIL-STD-EL-DOC-QAP-001	0	
10	QAP of Power Cables	GAIL-STD-EL-DOC-QAP-002	0	
11	QAP of Lighting Panels	GAIL-STD-EL-DOC-QAP-003	0	
<b>STANDARD / TYPICAL DRAWINGS FOR ELECTRICAL SYSTEM</b>				
12	Standard Cu Plate Electrode in Test Pit	GAIL-STD-EL-DWG-TP-001	0	
13	Standard GI Pipe Electrode in Test Pit	GAIL-STD-EL-DWG-TP-002	0	
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	
16	Typ. Installation of Lighting Fixture at Ground Level	GAIL-STD-EL-DWG-TP-009	0	
17	Typ. Installation of Post Top Lantern on Gate	GAIL-STD-EL-DWG-TP-010	0	
18	Typ. Earthing Connection for Lighting Pole	GAIL-STD-EL-DWG-TP-011	0	
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	



CONSTRUCTION OF STEEL PIPELINE AND  
ASSOCIATED FACILITIES FOR CGD TO M/S TGPL  
MORADABAD & CGD TO M/s TGPL GORAKHPUR



<b>ELECTRICAL DESIGN BASIS</b>				<b>CLIENT JOB NO.</b>		034
				<b>TOTAL SHEETS</b>		17
<b>DOCUMENT NO</b>	GAIL	STD	EL	BD	001	

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REV	DATE	DESCRIPTION	PREP	CHK	APPR
0	08.07.2020	ISSUED FOR BID	SR	TR	SB





**CONSTRUCTION OF STEEL PIPELINE AND ASSOCIATED FACILITIES  
FOR CGD TO M/s TGPL MORADABAD & CGD TO M/s TGPL  
GORAKHPUR**

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# CONSTRUCTION OF STEEL PIPELINE AND ASSOCIATED FACILITIES FOR CGD TO M/s TGPL MORADABAD & CGD TO M/s TGPL GORAKHPUR

## 1.0 INTRODUCTION

The Electrical design basis broadly outlines the minimum requirements for the design, selection, sizing and installation of the electrical equipments and associated systems of the cross country gas pipeline & terminals.

The electrical system shall be designed to ensure:

- Main Power Distribution System
- Substation design philosophy i.e. trenches, clearances, thickness, RCC, materials and entries
- Safety to personnel and equipments.
- Reliability of service.
- Minimum fire risk.
- Ease of maintenance and convenience of operation.
- Adequate provision for future expansion and modification.
- Maximum interchangeability of equipments.
- Automatic protection of all electrical equipments through selective relaying system.
- Fail safe features.
- Hook-up provisions with existing facilities, wherever required.
- Adequate provision for future expansion and modification.

- 1.1 GAIL is currently implementing Laying of buried pipeline API 5L grade X42 (or higher) from Proposed tap-off point to proposed metering skid with TCP/PCP.

## 2.0 CODES AND STANDARDS

Electrical equipment and system design, manufacture, testing, installation and commissioning will comply with all latest applicable standards, regulations and codes.

BIS	Bureau of Indian Standards
CMRI	Central Mines Research institute
IEEE	Institute of Electrical & Electronics Engineers
IER	The Indian Electricity Rules
IEA	The Indian Electricity Act.
API	American Petroleum Institute
OISD	OIL Industry Safety Directorate.
DGMS	Director General of Mines Safety
NEC	National Electric Code
IEC	International Electromechanical Commission
NEMA	National Electrical Manufacturers Association
NACE, CCE, BS, PNGRB	

## 3.0 OPERATING REQUIREMENTS

- 3.1 The electrical equipment and material shall be in accordance with the LEPL Technical

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## CONSTRUCTION OF STEEL PIPELINE AND ASSOCIATED FACILITIES FOR CGD TO M/s TGPL MORADABAD & CGD TO M/s TGPL GORAKHPUR

Specifications, BIS and suitable for the following power supply system and site conditions.

### 3.2 Site Conditions:

The equipment shall be designed for the following site conditions.

Max / Min. Temperature	60°C /4°C
Design Temperature	55°C
Relative Humidity Max / Min.	90%/ 41%
Altitude above Sea level	Less than 1000 Meters.
Atmospheric condition	Tropicalised to withstand the Site condition, dust, vapour etc.
Hazardous Area classification for Plant	Zone-1 or Zone-2, Gas group IIA, IIB. Temp class T3
Electrical Room/Control Room / Guard Room/Battery room	Safe area(If applicable)

### 3.3 Power Source:

It is presumed that all the stations have Grid Power as Main Power Supply and UPS/Solar power supply as emergency / critical Power Source (to feed the Instrumentation Critical Loads etc).(if applicable)

### 3.4 Power System Design:

The distribution system shall be designed in accordance with project specification taking into account all possible factors affecting the choice of the system to be adopted such as required continuity of supply, flexibility of operation, operational costs and reliability of supply from available Power sources, total load and the concentration of individual loads.

### 3.5 Capacity of Electrical System:

All the components of the electrical system shall be sized to suit the maximum load, under the most severe operating conditions. Accordingly, the maximum simultaneous consumption of power required by continuously operating loads shall be considered and an additional margin shall be taken into account for intermittent service loads, if any. The amount of electrical power consumed by each process unit shall be calculated for its operation at the design capacity.

Total Running load of a Station = 100% of Continuous Load + 50% of the Intermittent Load + 20% of the Stand-by Load.

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### 3.6 Protection and Metering Schemes:

The protective system shall be selected and coordinated to ensure the following:

- i) Protection of equipment against damage which can occur due to internal or external short circuits or atmospheric discharges.
- ii) Uninterrupted operation of those parts of the system, which are not affected by the fault.
- iii) Personnel and plant safety.

Metering shall be provided to keep a record of power consumption and supervision of all concerned parameters like current, voltage, power, frequency, power factor etc.

### 3.7 Power Supply Voltage:

Voltage	415V $\pm$ 10%
Frequency	50 Hz $\pm$ 5%
Combined voltage & frequency variation	$\pm$ 10%
Phase & Wire	3 Ph, N & 4W
Fault level	25 KA for 1 Sec
Neutral Earthing	Solidly earthed

- Voltage selection is based upon economic considerations, taking the following factors into account:
  - a. Size and location of loads.
  - b. Provision of future extension.
  - c. Short-circuit level.
  - d. Availability of switchgear with suitable current rating and rupturing capacity.
- Possibility of keeping the number of different voltage levels to a minimum.

### 3.8 Control Supply Voltage:

Voltage	230V $\pm$ 10%
Frequency	50 Hz $\pm$ 5%
Combined voltage & frequency variation	$\pm$ 10%
Phase & Wire	1 Ph, N & 2W
Fault level	10 KA for 1 Sec

Any other control supply voltage will be arranged by the contractor as per equipment requirement. Lighting, small power, etc.: 415 / 240 V, 50Hz; 24 V

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## CONSTRUCTION OF STEEL PIPELINE AND ASSOCIATED FACILITIES FOR CGD TO M/s TGPL MORADABAD & CGD TO M/s TGPL GORAKHPUR

### 3.9 Electrical Control:

Digital and analogue monitoring and control signals as required for Solar Electric Power Source, Normal power source, CP system shall be provided in various electrical equipment for connection to SCADA system.

### 3.10 LV Switchgear / Switchboard:

Switchgear and associated equipment fed from generators and transformers(existing) shall have rating at least equal to the rating of respective generators and transformers feeding it, under any circuit configuration. Generator incomer shall be rated w.r.t. maximum power output of the generator set over entire operating temperature range.

Bus tie circuit breakers shall have same rating as the incomer.

All other switchgears / switchboards not directly fed from generator and transformers shall have rating at least equal to the maximum demand under any circuit configuration plus a provision for 25% future load growth. Incomers of these switchgears / switchboards shall be designed to cater to the complete load including 25% margin for future load growth.

Spare outgoing feeders shall be provided in all MV switchgears / switchboards as indicated in SLD. For other switchboards at least one number of each type of outgoing feeder or 20% of same feeder type.

### 3.11 Equipment Clearance:

The control building shall be sized to maintain adequate clearances between equipment for ease of maintenance. The following minimum clearances around various electrical equipment shall be maintained:

Sl. No.	LOCATION	CLEARANCE
a)	Front clearance for MV switch boards/ all other panels	Minimum 1500 mm
b)	Rear clearance for panels having maintenance access from front only	Minimum 750 mm
c)	Rear clearance for panels having maintenance access from rear	1000 mm
d)	Side clearance between two switch boards or nearest obstruction	1000 mm after considering space for future panels
e)	All around clearance for transformers	1000 mm
f)	Battery rack to wall clearance for <ul style="list-style-type: none"><li>- Single row, single/double tier</li><li>- Double row, single tier</li><li>- Double row, double tier</li></ul>	100mm 100mm 750mm

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## CONSTRUCTION OF STEEL PIPELINE AND ASSOCIATED FACILITIES FOR CGD TO M/s TGPL MORADABAD & CGD TO M/s TGPL GORAKHPUR

g)	Battery rack to rack clearance	100 mm or $\geq 750$ mm
h)	Front clearance for wall mounted equipment	750mm
i)	Front clearance for operation station / annunciation / control panel	2000 mm

### 4.0 AREA CLASSIFICATION AND EQUIPMENT SELECTION

- 4.1 Classification of hazardous area will be in accordance with API 500 /IS-5572 and OISD: 113(2001)-Classification of area for Electrical Installation at hydrocarbon processing and handling facilities whichever is stringent.
- 4.2 Following factors will be considered for proper selection of electrical equipment for use in hazardous areas:
- Area Classification - Zone-1, Zone-2
  - Gas Group - IIA and IIB
  - Temperature Classification - T3
- 4.3 All electrical equipment for hazardous area shall be certified by CMRI or equivalent independent testing agency.
- 4.4 Approval certificate from Chief Controller of Explosives (CCOE) is mandatory for all electronic / electrical instruments / equipment to be installed in India, irrespective of country of origin.

4.5

S.No.	Adequate Type of Protection	Area Classification	Description (Symbol)
1	Zone 0	* Intrinsic safe category	"ia"
		* Other electrical apparatus, specifically designed for zone 0	"ia", "s"
2	Zone 1	* Any type of protection adequate for zone 0 (not preferred)	
		* Flameproof enclosure	
		* Intrinsic safe category	"ib"
		* Oil immersion (see note 2)	
		* Pressurization (see table 2)	
		* Sand filling	
		* Other electrical apparatus specifically designed for zone 1	"d", "ib", "o", "p", "q", "s"
3	Zone 2	* Any type of protection adequate for zone 0 or zone 1 (not preferred).	
		* Increased safety (see note 1)	
		* Non sparking apparatus (see note 1)	"e", "n"

**Notes:**

1. For all outdoor installations, including the apparatus with type of protection "e" and type of protection "n", the degree of protection shall be in accordance with section 6.
2. Oil-immersed apparatus may be used only in case its security will not be impaired by tilting or vibration of the apparatus.

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## CONSTRUCTION OF STEEL PIPELINE AND ASSOCIATED FACILITIES FOR CGD TO M/s TGPL MORADABAD & CGD TO M/s TGPL GORAKHPUR

### 5.0 LIGHTING SYSTEM

5.1 Illumination level in the plant area for calculation of lighting fixtures are as follows:

Control room	500 Lux
Electrical room	150 Lux
Office room	300 Lux
Process area	50 Lux
Battery room	100 lux
Other rooms	100 lux
Road area	20 lux
Open area	10 Lux

Utilization factor	As per manufacturer's catalogue
Maintenance factor -	0.6 for outdoor / 0.7 for indoor

5.2 Type of Lighting Fixtures :

Battery Room	2x26 W LED Decorative Flame Proof Surface Mounted Fixtures
Control room	2x36 W LED Decorative Recess mounted Fixtures
Local area Near the field Instrument in Process area	250 W HPMV FLP well glass fixtures or Equivalent LED FLP Light Fixture
Electrical room	2x36 W LED decorative surface mounted Fixtures
Guard Room/Store room	2x26 W LED Decorative Recess mounted Fixtures
Toilet/ Veranda	1x26 W LED Recess mounted Fixtures
Gate Light	1x26 W LED Gate Top mounted Fixtures
Process area	250 W HPMV FLP well glass fixtures or Equivalent LED FLP Light Fixture
Road	250 W HPMV or Equivalent LED Street Light Fixtures
Outdoor Area	2x250 W HPMV Flood Light Fixtures.

5.5 All cables (Power & control) shall be armoured only including Lighting Cables.

5.6 All type of Battery should be accommodated in battery room only.

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## CONSTRUCTION OF STEEL PIPELINE AND ASSOCIATED FACILITIES FOR CGD TO M/s TGPL MORADABAD & CGD TO M/s TGPL GORAKHPUR

5.7 2 nos. 450mm dia exhaust fan shall be provided in Battery Room and Electrical Room, 1 no. 300 mm dia Exhaust fan shall be provided in store/Toilet. Blade shall be FRP type. Exhaust fan in battery room shall be flameproof type.

5.8 1200 mm sweep Ceiling fan shall be provided in Electrical Room, Store Room & Guard Room.

### 6.0 ENCLOSURE PROTECTION OF EQUIPMENT

#### 6.1 Weather Protection

The electrical equipment installed indoor / outdoor shall have the following enclosure protection:

IP for all station – Indoor control room – IP-42,  
Indoor Switchgear Room – IP-52  
Outdoor – Ex-d  
Flood Light, Street Light – IP-55  
Other Outdoor-IP-55

The above enclosure protection shall be in accordance with the Indian standard.

#### 6.2 Safety enclosures in hazardous areas

The types of enclosures that shall be used in the plants are the following:

Flame proof (Ex-d)  
Pressurized Electrical Equipment – Ex-p

6.3 Key Single-Line Diagram shall define the power distribution system, showing voltage levels, fault level of the bus, bus current rating, frequency, power supply sources, emergency distribution systems and system earthing methods, as well as protection and metering aspects of state electricity board. The document will be set up based on preliminary load data available at the start of the activity and the power distribution philosophy.

### 7.0 EARTHING SYSTEM :

7.1 All non – current carrying metal enclosures shall be bonded for earth continuity to the main earth Grid/earth bus.

7.2 The minimum of two earth studs must be provided on the skid base, diagonally Opposite to each other, for connection to the main plant earth system.

7.3 No. of earth pits shall be provided as per IS : 3043. All earthing materials shall be supplied as per Technical Specification.

- i) 600 x 600 x 3 mm thick copper plate earth electrodes for UPS, RTU, Telecom, Instrument Control Panel, metering panel.
- ii) 65 mm dia X 3000 mm (L ) GI Pipe electrode for other

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## CONSTRUCTION OF STEEL PIPELINE AND ASSOCIATED FACILITIES FOR CGD TO M/s TGPL MORADABAD & CGD TO M/s TGPL GORAKHPUR

- 7.4 All equipment earthing shall be carried out as per IS : 3043, Minimum size of earth conductor to be used shall be as given below:

<u>Equipment</u>	<u>Conductor size</u>
Main Grid & equipment such as main Electrical Distribution Board etc	50 X 6 mm GI Flat
Switch Socket DB, UPS, DB, Lighting DB	25 x 6 mm GI flat / 16 sq. mm GI rope
Motors up to 15 KW Other equipment	2.5 sq mm Copper PVC Wire 2.5 sq mm Copper PVC Wire
Mechanical equipment / Vessels, tanks, Pipe/cable racks, structure, fencing	50 X 6 mm GI Flat
UPS, Telecom, RTU	10 Sq. mm Cu cable
Field Instruments	2.5 sq mm copper PVC Wire

10 sq. mm Cu armoured cable shall be used for Cu plate electrode interconnection of two earth pits

- 7.5 Earthing electrode shall be GI pipe/ copper plate.
- Minimum 2 Nos. Copper Plate Electrodes will be provided for RTU/SCADA/Control Panel equipment at new station.
  - Minimum 2 Nos. Copper Plate Electrodes will be provided for Telecommunication System at new station.
  - Minimum 2 Nos. Copper Plate Electrodes will be provided for UPS system at new station.
  - GI pipe electrodes for new stations will be provided as per IS-3043 and as per site requirement, ( 2nos for neutral earthing of transformer as applicable ,4 Nos. near building & 2 nos. for process area and 2 nos. separate earthing for lightning protection system ). All these earth electrodes will be interconnected.
  - Minimum 2 Nos GI pipe electrodes for Earthing fence for Customer End and Existing station.
  - Minimum 2 Nos Cu electrodes for Earthing of Metering skid at Customer End station.

- 7.7 A board of 250 X 250 mm, 3mm thick GI plate shall be provided adjacent to all earth pits. Board shall display earth pit number, date of testing, test values & next due date, as per guide line of CEA.

### 8.0 CABLES

Cables shall be supplied as per Technical Specification. Scope shall cover Design, manufacturing, testing at works, laying and commissioning at site.

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### 8.1 Power Cable

- 1 Stranded Annealed Copper Conductor up to 16 mm<sup>2</sup>
- 2 Stranded Aluminium Conductor from 16 mm<sup>2</sup> and above
- 3 XLPE insulation
- 4 Inner and outer Sheath will be extruded
- 5 Inner sheath will be ST2
- 6 Steel strip/wire armoured
- 7 Outer sheath of cable will be FRLS PVC, ST2 Type
- 8 Voltage grade- 1100 V
- 9 IS 7098, IS: 5831

### 8.2 Control Cable

- Stranded Annealed Copper Conductor 2.5 sq mm
- PVC insulation type A.
- Inner and outer Sheath will be extruded
- Inner sheath and outer sheath will be ST1
- Steel strip/wire armoured
- Outer sheath of cable will be FRLS PVC, ST1 type
- Voltage grade - 1100 V
- IS-1554 Part I, IS: 5831

### 8.3 Lighting Cable/Wire in conduit

- 4 core 6 mm<sup>2</sup> stranded Copper will be used from outdoor lighting DB to junction box on the lighting poles.
- 3 core 2.5 sq. mm stranded copper cable (YWY) will be used from junction box on the lighting pole to lighting fixture. .

### 8.5 Voltage Drops

The maximum voltage drops in any feeder of the electrical system under steady state conditions at full load shall be within the limits as stated follows:

- Cable between transformer secondary and MV Switchboard/PCC/PMCC - 0.5%
- Cable between MV Switchboard/PCC/PMCC and motors - 5%

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GORAKHPUR**

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- Cable between MV Switchboard /Auxiliary Switchboard and Lighting Panel / Power Panel	- 1 to 1.5%
- Circuit between lighting panels and lighting points	- 3%
- UPS outgoing circuit	- 5%
- Cable between Switchboard and motor during starting maximum	- 15%



GAIL INDIA LIMITED

# TECHNICAL SPECIFICATION OF MAIN ELECTRICAL DISTRIBUTION BOARD (MEDB)

(Doc. No. GAIL-STD-EL-DOC-TS-002)

Rev	Date	Purpose	Prepared By	Checked By	Approved By
0	29.01.2019	Issued As Standard	RKS	SB	SB



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- 2.0** CODES AND STANDARDS
- 3.0** GENERAL REQUIREMENTS
- 4.0** SITE CONDITIONS
- 5.0** DESIGN AND FABRICATION REQUIREMENTS
- 6.0** EQUIPMENT SPECIFICATION
- 7.0** INSPECTION, TESTING AND ACCEPTANCE
- 8.0** PACKING AND DESPATCH

## 1.0 Scope

This specification covers the requirement of design, fabrication, testing, packing and supply of Medium voltage fixed type distribution board in single front execution required for receipt, control and distribution of power to various medium voltage consumers of the package equipment.

## 2.0 CODES AND STANDARDS

2.1 The equipment shall comply with the requirements of latest revision of following standards issued by BIS unless otherwise specified.

IS: 772 AC Electricity Meters

IS: 1248 Direct acting electrical indicating instruments

IS: 2705 Current transformers

IS: 2824 Method for determining the comparative tracking index of solid Insulating materials under moist conditions

IS: 3156 Voltage transformers

IS: 3231 Electrical relays for power systems protection.

IS: 3618 Phosphate treatment of iron and steel for protection against corrosion.

IS: 5082 Material data for aluminium bus bars.

IS: 5578 Guide for marking of insulated conductor.

IS: 6005 Code of practice of Phosphating of iron and steel.

IS: 8623 Factory built assemblies of switchgear and control gear for voltages upto and including 1000 V A C and 1200 V DC. Part -II particular requirements for bus bar trucking systems (bus ways).

IS: 11353 Guide for uniform system marking and identification of conductors and apparatus terminals.


IS: 13703 Low voltage fuses.

IS: 13947 LV Switchgear and control gear. (Part-1 to Part-5)

2.2 In case of imported equipment standards of the country of origin shall be applicable if these standards are equivalent or stringent than the applicable Indian standards.

2.3 The equipment shall also conform to the provisions of Indian Electricity rules and other statutory regulations currently in force in the country.

2.4 In case Indian standards are not available for any equipment, standards issued by IEC/BS / VDE/ IEEE/ NEMA or equivalent agency shall be applicable.

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- 2.5 In case of any contradiction between various referred standards / specifications / data sheet and statutory regulations the following order of priority shall govern:
- Statutory regulations
  - Data sheets
  - Job specification
  - This specification
  - Codes and standards

### 3.0 GENERAL REQUIREMENTS

- 3.1 The offered equipment shall be brand new with state of art technology and proven field track record. No prototype equipment shall be offered.
- 3.2 Vendor shall ensure availability of spare parts and maintenance support services for the offered equipment at least for 15 years from the date of supply.
- 3.3 Vendor shall give a notice of at least one-year to the end user of equipment and LEPL before phasing out the product/spares to enable the end user for placement of order for spares and services.


### 4.0 SITE CONDITIONS

- 4.1 The switchboards shall be suitable for installation and satisfactory operation in a pressurized substation or in substation with restricted natural air ventilation in tropical, humid and corrosive atmospheres. The switchboards shall be designed to operate under specified site conditions. If not specifically mentioned a design ambient temperature of 50° C and altitude not exceeding 1000 meters above mean sea level shall be considered.
- 4.2 All the equipment described in this specification is intended for continuous duty at the Specified ratings under the specified ambient conditions unless indicated otherwise.

### 5.0 DESIGN AND FABRICATION REQUIREMENTS

Medium voltage distribution board shall meet the requirements of medium voltage distribution board data sheet, and following requirements of this specification in addition to the general requirements as per latest editions of applicable Indian standards.

- 5.1 The distribution board shall be free standing, suitable for wall/floor mounting, with complete front access for operation and maintenance. The distribution board shall be fixed type in single front execution, assembled in single line up, metal enclosed, fully compartmentalised, totally segregated compartments for feeders, cables and bus bar, dust and vermin proof suitable for indoor installation.
- 5.2 Distribution board enclosure shall provide a degree of protection not less than IP-42 as per applicable IS.
- 5.3 The switchgear shall be assembled out of vertical panels of uniform height not exceeding 2450 mm. The maximum height of the operating handle/switches shall not exceed 1900 mm and the minimum height not below 300 mm.
- 5.4 The distribution board shall be designed to ensure maximum safety during operation, inspection, and connection of cables, relocation of outgoing circuits and maintenance


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- with the energized bus bar system and without taking any special precautions. The switchgear shall permit maximum interchangeability and shall be extensible on either side.
- 5.5 The distribution board shall be sheet steel clad with the frame fabricated out of 2mm cold rolled sheet steel and doors/covers out of 1.6mm cold rolled sheet steel, having heavy duty integral base frame for each vertical panel.
  - 5.6 All hardware shall be corrosion resistant. All joints and connections of the panel members shall be made of galvanised, zinc passivated or cadmium plated high quality steel bolts, nuts and washers, secured against loosening.
  - 5.7 All openings, covers and doors shall be provided with neoprene gaskets around the perimeter to make the distribution board dust and vermin proof. Suitable lifting hooks shall be provided and each shipping section for ease of lifting of switchboard.
  - 5.8 All metal surfaces shall be thoroughly cleaned, degreased to remove mill scale, rust, grease and dirt. Fabricated structure shall be pickled and then rinsed to remove any trace of acid. The under coat shall be prepared by applying a coat of phosphate paint and a coat of yellow zinc chromate primer. The distribution board shall be powder coated. Pre-treatment of the distribution board shall be done by 7 tank process before powder coating. The final paint shade shall be as per manufacturer standard unless specified otherwise.
  - 5.9 The distribution board shall be suitable for bottom cable entry unless specified otherwise and shall be provided with removable gland plates unless otherwise specified. The distribution board shall have a separate cable alley for each vertical panel with cable tying arrangement. The width shall be sufficient to accommodate the required number of cables. However, in any case it shall not be less than 200mm width. The cable alley shall be provided with a suitable hinged door. Required number of single compression nickel plated brass cable glands and tinned copper compression type lugs for all power and control cables shall be included in the vendor's scope of supply.
  - 5.10 The distribution board shall comprise of incoming load break switch/MCCB/Switch Fuse Unit Panel, Contactor, outgoing switch fuse/MCCB, MCB/ contactors feeders, motor starter feeders, control supply transformers, both power and auxiliary/control bus bars, cable termination compartment etc. All these shall be housed in independent compartments separated from each other by metallic barrier.
  - 5.11 Main horizontal bus bars shall be provided at the top in separate compartment. Vertical bus bars required for connection between main bus bars and outgoing feeders shall be in separate vertical chamber. One set of vertical bus bars can be provided for feeding outgoing feeders in two panels on either side of the vertical bus bar.
  - 5.12 All components including bus bars and cable termination shall be accessible only from the front side for repair and maintenance.
  - 5.13 Each outgoing feeder shall be in multitier arrangement having minimum height of individual module as defined in distribution board data sheet. All feeders shall be of modular design with height in multiple of standard unit size.
  - 5.14 Number and rating of feeders shall be as per package vendor's electrical load list/single



line diagram. The components rating and type for various types of outgoing feeders such as motor feeders shall be selected based on package requirement and shown in data sheets.


- 5.15 All auxiliary devices for control, indication, measurement and protection except the bimetallic relays shall be mounted on the front side of the respective compartment. Components requiring frequent inspection during operation shall be easily accessible.
- 5.16 Each vertical panel shall be provided with anti condensation heater rated for 240VAC supply, provided with a switch fuse and thermostat having variable setting range of 30-70° C. Adequate space shall be provided for termination of incoming and outgoing cables.
- 5.17 Main bus bars shall be of high conductivity Electrical Grade aluminum having uniform current rating throughout their length. Horizontal and vertical bus bars shall be sized depending upon the maximum expected current and to limit the specified maximum operating temperature at specified design ambient temperature. Bus bar shall be designed to withstand thermal and mechanical stress due to short circuit current.
- 5.18 The maximum operating temperature of bus bars including joints at the maximum design temperature inside the panel shall not exceed 95°C under normal operating conditions.
- 5.19 Minimum clearance between live parts, between live parts/neutral to ground shall be 19 mm.
- 5.20 Adequately sized auxiliary copper bus bars running horizontally in a separate enclosure shall be provided for space heaters, control supply and metering requirements. Necessary tee-off connections shall be used for distributing auxiliary supply to each vertical panel.
- 5.21 All horizontal and vertical bus bars shall be insulated with heat shrink PVC sleeves of 1100 V grade and removable shrouds shall be provided for joints. All bus bars shall be prominently marked with Red; Yellow and Blue colour rings for easy phase identification at regular interval and at every power tap off point and designed to withstand specified short circuit currents for one second.
- 5.22 Copper earth bus of 30x6 mm size for fault level upto 31.5 KA and 50x6 mm<sup>2</sup> size for fault level above 31.5 KA shall be provided throughout the length of the distribution board with provision for interconnection to earthing grid at two ends. All non-current carrying metallic parts of the mounted equipment shall be earthed. Doors and movable parts shall be earthed using flexible copper connections.
- 5.23 Inside the distribution boards, the wiring for power, control, signaling protection and instrument circuits shall be done with PVC insulated copper conductors having 660/1100 V grade insulation.
- 5.24 For modules rated above 100 Amp. Preferably copper strip connection shall be used. Minimum size of control wire shall be 1.5 mm<sup>2</sup> coppers for circuits having fuse rating 10 Amp. or less. For higher fuse rating control circuits, min. 2.5 mm<sup>2</sup> copper conductor shall be used. Each wire shall be identified at both ends by self-sticking wire marker tapes or PVC ferrules. Transparent shrouds shall be used on outgoing power terminals.

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- 5.25 Clamp type terminals shall be acceptable for wires upto 10 mm<sup>2</sup> size, for conductors larger than 10mm<sup>2</sup> bolt type terminals with crimping lugs shall be provided. Each wire shall be terminated at a separate terminal. A minimum of 10% spare terminal shall be provided on each terminal block. Shorting links shall be provided for all CT terminals.
- 5.26 All motor starting shall be DOL type unless otherwise specified. 240 V AC control supply for motor starters shall be derived from a common 415/240 V adequately sized transformer for each bus section.
- 5.27 Components of the similar modules of same sizes shall be identically located and wired. Control supply change over switch shall be provided in case the distribution board is with two bus-sections. Identical modules shall be designed such that these can be interchanged in case of emergency.

## 6.0 EQUIPMENT SPECIFICATION

- 6.1 The number of modules in the panel shall not exceed six for motor starter feeders and eight for switch fuse/MCB/MCCB feeders. The minimum size of module shall be 300 mm and 200 mm for starter and switch fuse feeders. The incomer and bus coupler module sizes for ratings upto 400 A shall be half the panel size. For higher ratings they shall be housed in single panel.  
The module door shall be so interlocked that it shall not be possible to open the door with switch/MCCB in closed position. Defeat interlock facility shall be provided.
- 6.2 All fuses shall be non-deteriorating HRC cartridge, pressure fitting link type.
- 6.3 The contactors shall be air break type having AC-3 duty rating as per package requirement. All contactors shall be provided with 2 NO + 2 NC potential free spare auxiliary contacts wired to the terminal block for owner use.
- 6.4 Thermal overload relays shall be three elements; positive acting ambient temperature compensated type with adjustable setting range and built in protection feature against single phasing. Bimetal relays shall be manually reset type with the reset push button provided on the cubicle door.
- 6.5 Current transformers for metering shall have an accuracy class 1.0 and instrument safety factor less than 5. However accuracy class of 3.0 is acceptable for ammeters only for outgoing feeders. Protective current transformers shall have an accuracy class 5P and an accuracy limit factor greater than 10.
- 6.6 All measuring AC instruments shall be moving iron, flush mounting type and of 96 x 96 mm and 72 mm x 72 mm square pattern instruments for incomer and outgoing feeders respectively. Accuracy class shall be 1.0 for KW/KWH meter and 1.0 for a mmeter and voltmeter. Ammeters for motor feeders shall have a non-linear compressed scale at the end to indicate motor starting current and red mark for the normal current.
- 6.7 All selector switches shall be rotary back-connected types having a cam operated contact mechanism with knob type handle. Ammeter selector switch shall have make before break feature on its contacts.
- 6.8 Indicating lamps shall be suitable for 6.0 V A C, complete with built in 240/6V

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transformers. Lamps shall be provided with translucent covers to diffuse light. Alternately clustered LED type indicating light with minimum 8mm-diameter size shall be considered. The following indicating colours shall be used.

Close/on	:	Red
Open/off	:	Green
Fault trip	:	Amber
Control supply on	:	White

Push button colours shall be as follows:

Stop/ open/emergency	:	Red
Start/close	:	Green
Reset/test	:	Yellow/Black/White

'Stop' push buttons for motor control feeders shall have stay put feature.

All motor starter feeders shall have Stop and Reset push buttons and On and Trip indication lamps.

- 6.9 A centrally located engraved nameplate shall be provided for the switchboard. Each module shall have engraved *nameplate-bearing data* as per approved drawings. Nameplate or *polyester* adhesive stickers shall be provided for each equipment mounted on the switchboard. Identification tags shall be provided inside the panels matching with those shown on circuit diagram. Special warning labels shall be provided on removable covers or doors giving access to cable terminals and bus bars.
- 6.10 At least 20% spare feeders of each rating of outgoing feeders subject to a minimum of one feeder of each rating shall be provided in the switchboard.
- 6.11 Sizing and selection for components of Distribution board shall be submitted to PMC/Owner for review/approval.

## 7.0 INSPECTION, TESTING AND ACCEPTANCE

- 7.1 In addition to the expediting/inspection activities being undertaken by the package vendor, distribution board shall be subject to inspection by LEPL/Owner or by an agency authorised by the owner. All necessary information concerning the supply shall be furnished to LEPL/Owners inspectors. Two weeks notice shall be given to LEPL/owner for witnessing the final testing of the complete assembly to ensure satisfactory operation of all components.
- 7.2 Tests shall be carried out at the manufacturer works under his supervision and at his cost.
- 7.3 All routine tests as specified by the applicable standards and codes shall be conducted. Type tests certificates of a recognized testing organization shall be furnished with the bids. The vendor shall also submit the guaranteed technical particulars with the bids. Type test certificates shall not be older than 5 years.
- 7.4 In addition, specified tests shall be conducted to check mechanical and electrical


operation and the control wiring to specification and schematic drawings.

- 7.5 Acceptance tests shall be as follows:
- 7.5.1 A general visual check shall be carried out. This shall cover measurement of overall dimensions, location, number, and type of devices and their ratings as per bill of materials, terminal blocks, location and connection of terminals.
- 7.5.2 Manual and electrical operation of switches, contactors, relays etc. under various conditions of supply voltage.
- 7.5.3 Insulation resistance of the main and auxiliary circuit shall be checked.
- 7.5.4 Operation check for every control function as per the schematic diagram by manually simulating the actual operating conditions.
- 7.5.5 Primary injection test to check winding of current transformers, ammeter, ammeter selector switch and correctness of wiring connection between them.
- 7.5.6 Relays shall preferably be tested with secondary injection test equipment.
- 7.6 For equipment bought from other sub-suppliers certified test reports of tests carried out at the manufacturer's works shall be submitted. Normally all routine tests as specified in the relevant standards shall be conducted by the sub-supplier at his works. In addition type test if specified shall be additionally carried out and witnessed by the owner at CPRI/approved testing authority.

## 8.0 PACKING AND DESPATCH

All the equipment shall be divided into several shipping sections for protection and ease of handling during transportation. The equipment shall be properly packed for transportation by ship/rail or trailer. The panels shall be wrapped in polyethylene sheets before being placed in wooden crates/cases to prevent damage to the finish. Crates/cases shall have skid bottoms for handling. Special precaution notations such as Fragile, This side up, center of gravity, weight, Owner's particulars, Purchase number etc. shall be clearly marked on the package together with other details as per purchase order. The equipment may be stored outdoors for long periods before installation. The packing should be suitable for outdoor storage in areas with heavy rains and high ambient temperature unless otherwise agreed.

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GAIL INDIA LIMITED

## TECHNICAL SPECIFICATION OF CABLES

(Doc. No. GAIL-STD-EL-DOC-TS-003)

Rev	Date	Purpose	Prepared By	Checked By	Approved By
0	29.01.2019	Issued As Standard	RKS	SB	SB



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**1.0 SCOPE**

This specification along with data sheets covers requirements for design, manufacture, testing at works and supply of Flame Retardant Low Smoke (FRLS) PVC cables and cable terminating accessories for medium voltage systems.

**2.0 STANDARDS**

2.1 The cables and cables j ointing & terminating accessories shall comply with the latest edition of the following standards as applicable:

IS: 1554 [Part-I]	PVC insulated (heavy duty) electric cables.
IS: 7098	Cross-linked polyethylene insulated PVC sheathed.
IS: 8130	Conductors for insulated electric cables and flexible cords.
IS: 5831	PVC insulation and sheath of electric cables.
IS: 3975	Mild steel wires, strips and tapes for armouring of cables.
10810(Part 41)	Methods of test for cables: Mass of zinc coating on steel armour.
IS: 209	Specification for zinc.
IS: 3961(Pt-2)	Recommended current ratings for cables: Part - 2 PVC Insulated and PVC sheathed heavy-duty cables.
IS: 10418	Drums for electric cables.
IS: 10462 (Pt-I)	Fictitious calculation method for determination of Dimensions of protective coverings of cables: Part - I Electrometric and thermoplastic insulated cables
IS: 10810 (Pt-58)	Oxygen Index test.
IS: 10810 (Pt 61)	Flame Retardant test.
IS: 10810 (Pt 62)	Fire resistance test for bunched cables.
IEC: 60332-3	Tests on electric cables under fire conditions.
IEC: 60502	Extruded solid dielectric insulated power cables for rated Voltages from 1 kV.up to 30 kV.
IEC: 60540 & 60540A	Test methods for insulation and sheaths of electric Cables.
ASTM: D2863	Standard method of test for flammability of plastics using oxygen index method.
ICEA S-61-402	Thermoplastic insulated wire and cable for transmission and distribution of electrical energy.
NEMA-WC5	
ICEA S-66-524	Cross-linked thermosetting polyethylene insulated wire and cable for transmission and distribution of electrical energy.
NEMA-WC7	
SP: 30 (BIS)	Special Publication – National Electrical Code.
IS: 10810 (Part 43)	Method of Test for cables; Part 43 Insulation resistance.
IS: 10810 (Part 45)	Method of Test for cables: Part 45 High voltage test.
OISD 147	Inspection and safe practice during electrical installation
OISD 173	Fire prevention and protection system for electrical installation

2.2 In addition to the above it shall be ensured that the installation conforms to the requirements of the following as applicable:


- Indian Electricity Act and Rules.
- Regulations laid down by CEA/Electrical Inspectorate.
- Regulations laid down by CCE/DGMS (as applicable).
- The petroleum rules (Ministry of Industry Government of India).

- e. Any other regulations laid down by central/state/local authorities and Insurance agencies.
- 2.3 The cables and accessories shall also conform to the provisions of Indian Electricity Rules and other statutory regulations, as applicable.
- 2.4 In case of any contradiction between various referred standard/ specification/data sheet and statutory regulations, the following order of priority shall govern:

Statutory Regulations  
Data Sheets  
Job Specifications  
This Specification  
Codes and Standards

### 3.0 GENERAL CONSTRUCTION

- 3.1 The cables shall be suitable for laying in trays, trenches, ducts, and conduits and for underground-buried installation with uncontrolled backfill and possibility of flooding by water and chemicals.
- 3.2 Outer sheath of all PVC cables shall be black in colour and the minimum value of oxygen index shall be 29 at  $27 \pm 2^\circ$  C. In addition suitable chemicals shall be added into the PVC compound of the outer sheath to protect the cable against rodent and termite attack.
- 3.3 All cables covered in this specification shall be Flame Retardant Low Smoke(FRLS) unless specified otherwise in the data sheet. The outer sheath of PVC and XLPE cables shall possess flame propagation properties meeting requirements as per IS-10810 (Part-62) category AF.
- 3.4 Sequential marking of the length of the cable in metres shall be provided on the outer sheath at every one metre. The embossing / engraving shall be legible and indelible.
- 3.5 The overall diameter of the cables shall be strictly as per the values declared by the manufacturer in the technical information subject to a maximum tolerance of  $\pm 2$  mm up to overall diameter of 60mm and  $\pm 3$ mm for beyond 60mm.
- 3.6 PVC / Rubber end caps shall be supplied free of cost for each drum with a minimum of eight per thousand metre length. In addition, ends of the cables shall be properly sealed with caps to avoid ingress of water during transportation and storage.
- 3.7 The cables used in installations under the jurisdiction of Director General of Mines and Safety (DGMS) shall be of copper conductor only, and shall have valid DGMS approvals for the specified locations. The word "Mining Cable" shall be embossed / engraved on the cable outer sheath as per the applicable Indian Standards
- 3.8 PVC cables
- 3.8.1 All power/control cables for use on medium voltage systems shall be heavy-duty type, 650/1100 V grade with aluminium / copper conductor, PVC insulated, inner-sheathed, armoured and overall PVC sheathed unless specified otherwise in data sheet.
- 3.8.2 The conductors shall be solid for conductor of nominal area up to and including  $6\text{mm}^2$  and stranded beyond  $6\text{mm}^2$ . Conductors of nominal area less than  $16\text{mm}^2$  shall be circular only. Conductors of nominal area  $16\text{mm}^2$  and above may be circular or shaped as per IS 8130. Cables with reduced neutral conductor shall have sizes as per Table I of IS 1554 (Part-I).

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- 3.8.3 The core insulation shall be with PVC compound applied over the conductor by extrusion and shall conform to the requirements of type 'A' compound as per IS: 5831. The thickness of insulation and the tolerance on thickness of insulation shall be as per Table 2 of IS: 1554 (Part-I). Control cables having 6 cores and above shall be identified with prominent and indelible Arabic numerals on the outer surface of the insulation. Colour of the numbers shall contrast with the colour of insulation with a spacing of maximum 50 mm between two consecutive numbers. Colour coding for cables up to 5 cores shall be as per Indian standard.
- 3.8.4 The inner sheath shall be applied over the laid-up cores by extrusion and shall be of PVC conforming to the requirements of Type ST-1 PVC compound as per IS: 5831. The minimum thickness of inner sheath shall be as per IS: 1554 (Part-I). Single core cables shall have no inner sheath.
- 3.8.5 If armouring is specified for multicore cables in the data sheet, the same shall be by single round galvanised steel wires where the calculated diameter below armouring does not exceed 13 mm and by galvanised steel strips where this dimension is greater than 13 mm. Requirement and methods of tests for armour material and uniformity of galvanisation shall be as per IS - 3975 and IS -10810 (Part 41). The dimensions of Armour shall be as per method (b) of IS - 1554 (Part -1). If armouring is specified for single core cables in the data sheet, the same shall be with H4 grade hard drawn aluminium round wire of 2.5 mm diameter.
- 3.8.6 The outer sheath for the cables shall be applied by extrusion and shall be of PVC compound conforming to the requirements of type ST-1 compound as per IS: 5831. The minimum and average thickness of outer sheath for unarmoured cables and minimum thickness of outer sheath for armoured cables shall be as per IS: 1554 (Part -1).
- 3.8.7 If heat resisting PVC cables are specified in the data sheet, the following shall be the requirements: It shall be possible to continuously operate the cable at a maximum conductor temperature of 85° C. PVC compounds used for HR PVC cables shall be as follows:
- a. Conductor insulation - Type C
  - b. Inner sheath - Type ST 2
  - c. Outer sheath - Type ST 2

### 3.9 Control Cables:

Control cables shall be 1100 Volt Grade, 2.5 mm<sup>2</sup> copper conductor PVC insulated PVC sheathed FRLS, single wire armored with an overall PVC sheath, as per IS: 1554 pt. I. All cables shall be of armored type only.


### 3.10 XLPE Cables

Power cables for 3.3 kV system shall be with Aluminium conductor, XLPE insulated (unearthed grade), screened, sheathed, armoured and overall PVC sheathed.

The construction of the conductors shall be stranded and compacted circular for all cables.

The cables shall be provided with both conductor screening and insulation screening. The conductors shall be provided with non-metallic extruded semi-conducting shielding.

The core insulation shall be with cross-linked polyethylene unfilled insulating compound. It shall be free from void and shall withstand all mechanical and thermal stresses under steady state and transient operating conditions.

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The insulation shielding shall consist of non-metallic extruded semi-conducting compound in combination with a non-magnetic metallic screening of copper. The insulation screen shall be strippable without application of heat. The copper screen shall be capable of carrying the single line to ground fault current of 1 kA for a duration of one (1) second.

The conductor screen XLPE insulation and insulation screen shall all be extruded in one operation by "Triple Extrusion" process to ensure perfect bonding between the layers. The core identification shall be colored strips or by printed numerals.

The inner sheath shall be applied over the laid up cores by extrusion and shall conform to the requirements of Type ST2 compound of IS:5831. The extruded inner sheath shall be of uniform thickness of size not less than 0.7 mm for all sizes of cables.

For multicore cables, the armouring shall be by galvanized steel strips armouring for single core cables shall be with hard-down aluminium round wire of 2.5 mm diameter.

The outer sheath for the cables shall be supplied by extrusion over the armouring and shall be of PVC compound conforming to the requirements of Type ST2 compound of IS: 5831. To protect cable against rodent and termite attack, suitable chemicals shall be added into the PVC compound of the outer sheath.

### 3.11 Cable Sizing:

Following factors to be considered for cable sizing:

- (i) Continuous current
- (ii) Fault current
- (iii) Voltage drop (Running & Motor starting)

## 4.0 CABLE ACCESSORIES

4.1 The termination and straight through jointing kits for use on the systems shall be suitable for the type of cables offered as per this specification.

4.2 The accessories shall be supplied in kit form. Each component of the kit shall carry the manufacturer's mark of origin.

4.3 The kit shall include all stress grading, insulating and sealing materials apart from conductor fittings and consumable items. An installation instruction sheet shall also be included in each kit.


4.4 The contents of the accessories kit including all consumable shall be suitable for storage without deterioration at a temperature of 45° C, with shelf life extending to more than 5 years ..

### 4.5 Terminating kits

The terminating kits shall be suitable for termination of the cables to an indoor switchgear or to a weatherproof cable box of an outdoor mounted transformer / motor. For outdoor terminations, weather shields / sealing ends and any other accessories required shall also form part of the kit. The terminating kits shall be from one of the makes / types mentioned in the data sheet.

### 4.6 Jointing kits

The straight through jointing kits shall be suitable for installation on overhead trays, concrete lined trenches, and ducts and for underground burial with uncontrolled backfill and possibility of flooding by water and chemicals. These shall have protection against any mechanical damage and suitably designed to be protected against rodent and termite attack. The inner sheath similar to that provided for cables shall be provided as part of straight through joint. The jointing kits shall be from one of the makes / types

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mentioned in the data sheet.

## 5.0 INSPECTION, TESTING AND ACCEPTANCE

The cables shall be tested and inspected at the manufacturer's works. All the materials employed in the manufacture of the cable shall be subjected, both before and after manufacture, to examination, testing and approval by LEPL / owner. Manufacturer shall furnish all necessary information concerning the supply to LEPL / owner's inspectors. The inspector shall have free access to the manufacturer's works for the purpose of inspecting the process of manufacture in all its stages and he will have the power to reject any material, which appears to him to be of unsuitable description or of unsatisfactory quality. The vendor shall give at least 2 weeks advance notice to the purchaser, regarding the date of testing to enable him or his representative to witness the tests.

### 5.1 Cables

- 5.1.1 After completion of manufacture of cables and prior to despatch, the cables shall be subjected to type, routine, acceptance and special tests as detailed below. LEPL/Owner reserves the right to witness all tests with sufficient advance notice from vendor. The test reports for all cables shall be got approved from the Engineer before despatch of the cables.
- 5.1.2 All routine tests, acceptance tests, type tests and additional type tests for improved fire performance shall be carried out as listed in IS: 1554 (Part-I), and IS: 7098 (Part-2) on PVC and XLPE insulated cables respectively.
- 5.1.3 The test requirements for PVC insulation and sheath of cables shall be as per latest revision of IS: 5831
- 5.1.4 Test for Resistance to Ultra Violet Radiation: This test shall be carried out as per DIN 53387 or ASTM-G-53 on outer sheath. The retention value of tensile strength and ultimate elongation after the test shall be minimum 60 % of tensile strength and ultimate elongation before the test. Test certificates with respect to this test (not older than one year) from recognised testing laboratory to be furnished for review by LEPL before despatch clearance of cables. In case test certificates are not available, test is to be conducted by vendor at his own cost in any recognised test laboratory or in house testing laboratory, before despatch clearance of cables. Sampling for this test is to be done randomly once for each order, provided outer sheath remains same.
- 5.1.5 Acceptance tests as per IS-15 54 (Part-I) and IS -7098 (Part-2) and the following special tests to be performed on the cables as per sampling plan. These tests are required to be witnessed by LEPL /owner before despatch of cables.
- a. Accelerated water absorption test for insulation as per NEMA - WC - 5. (For PVC insulated cables) and as per NEMA WC - 7 (for XLPE insulated cables). Test certificates with respect to this test (not older than one year) from recognised testing laboratory to be furnished for review by LEPL before despatch clearance of cables. In case test certificates are not available, test is to be conducted by vendor at his own cost in any recognized test laboratory or in house testing laboratory, before despatch clearance of cables. Sampling for this test is to be done randomly once for each order, provided type of insulation remains same.
  - b. Dielectric Retention Test: The dielectric strength of the cable insulation tested in accordance with NEMA WC - 5 at  $75 \pm 1^{\circ} \text{e}$  shall not be less than 50 % of the original dielectric strength. (For PVC insulated cables). Test certificates with respect to this test (not older than one year) from recognised testing laboratory to be furnished for review by LEPL before despatch clearance of cables. In case test certificates are not available, test is to be conducted by vendor at his own cost in any recognized test laboratory or in house testing laboratory, before despatch clearance of cables. Sampling for this test is to be done randomly and once for each order.
  - c. Oxygen Index Test: The test shall be carried out as per ASTM D2863 or applicable Indian Standard specifications. Sampling to be done for every offered lot/size as per sampling plan.

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- d. Flammability Test: The test shall be carried out on finished cable as per IS - 10810 (part 61 & 62). Sampling for these tests is to be done randomly once for each order, provided outer sheath remains same. The acceptance criteria for tests conducted shall be as under:  
 Part-61- The cable meets the requirement if there is no visible damage on the test specimen within 300 mm from its upper end.  
 Part-62- The maximum extent of the charred portion measured on the test sample should not have reached a height exceeding 2.5 m above the bottom edge of the burner at the front of the ladder.
- e. Test for rodent and termite repulsion property: The vendors shall furnish the test details to analyse the property by chemical method. Sampling to be done for every offered lot / size as per sampling plan.

## 5.2 Cable Accessories

Type tests should have been carried out to prove the general qualities and design of a given type of termination / jointing system as per IS-13573. The type test certificates from independent testing laboratory shall be submitted before despatch.

## 6. MISCELLANEOUS MATERIAL SPECIFICATIONS

All materials and hardwares to be supplied by the contractor shall be new, unused and of best quality and shall conform to the latest specifications of Bureau of Indian Standards.

### 6.1 Cable Trays:

These shall be ladder type trays either prefabricated hot dip galvanized sheet steel trays or site fabricated angle iron painted trays as specifications of Bureau of Indian Standards.

#### 6.1.1 Pre-fabricated hot dipped galvanized trays

The cable trays shall comply to the requirements specified in LEPL installation std.

#### 6.1.2 Site fabricated angle iron trays


Angle iron cable trays shall be fabricated from standard rolled angle iron sections of size 75x75x8 for runners for supporting spans limited to 3000 mm. Cross support shall be 25 x 6 mm MS flat for tray width upto 500 mm and 32 x 6 mm flat for tray of more than 500 mm wide and spacing between two cross supports shall not exceed 250 mm.

- 6.1.3 Vertical supports for both the prefabricated and site fabricated type trays shall be fabricated out of ISMC 100 and horizontal supports shall be with 65 x 65 x 6 mm angle iron sections. Outer most tier of all vertical cable trays shall be covered with GI sheet for protection against physical damage to cables.

Cable racks and trays shall be covered by removable top covers on upper most tier allowing adequate ventilation in following cases where :

- Mechanical damage of cables is likely to occur during maintenance in the plant.
- Oil or spillage of chemicals can be expected.
- Protection from exposure to sun is required.

GI cover sheet shall allow adequate ventilation to the cables and shall be in standard length of 3000 mm, flanged on both sides for fixing on cable tray. Covers shall be complete with required GI hardwares.

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**6.2 Cable Glands:**

Cable glands shall be of nickel plated brass double compression type suitable for outdoor termination. For indoor protected location single compression glands may also be considered selectively, cable glands for the flameproof equipments located in zone-1 and zone-2 areas shall be of flameproof type and suitable for the Hazardous location. They shall be CMRS tested/certified.

**6.3 Connectors:**

Power cable terminations shall be made with crimped type tinned copper solderless lugs which shall be suitable for the cable size mentioned in cable schedule.

**6.4 Ferrules:**

Ferrules shall be of approved type and of size to suit core size mentioned and shall be employed to designate the various cores of control cable by the terminal numbers to which the cores are connected, for ease of identification.

**7. CABLE LAYING****7.1 General**

Cable installation shall include power, control, lighting etc. cables. These shall be laid in trenches/ cable trays as detailed in the cable layout drawings. Cable routing given on the cable layout drawings shall be checked in the field so as to avoid interference with structures, heat sources, drains, piping, airconditioning duct etc. Any change in routing shall be done to suit the field conditions wherever deemed necessary, after obtaining approval of Engineer-in-charge.

- 7.1.1 LT power and control cables shall be separated from each other by adequate spacing or by running through independent pipes, trenches or cables trays, as shown on layout drawings/installation standards. Details of cable routes and cable spacing not shown in detail on these drawing shall be determined by the contractor and approved by the engineer in-charge.


When single core cables are laid in flat formation, the individual cable fixing clamps and spacers shall be of non-magnetic material. As a general practice, the sheath of single core cables shall be earthed at one point to keep sheath at earth potential unless otherwise stated. Single core cables, when laid in trefoil formation shall be braced by suitable clamps at a distance, not exceeding 3 meters along the cable routing.

The Telephone, Communication and Fire alarm cables shall run on instrument trays/ducts/ trenches in the units. Wherever these are not available, cables shall be taken in a separate trench/tray with a min. spacing of 600 mm from power and control cables but in any case such separation shall not be less than 300 mm.

Telephone, fire alarm and plant communication cables shall be directly buried in road berm area, (unless otherwise specified in cable layout drawings) .. These cables shall cross power cables preferably at right angles. Street lighting cables shall be laid on the other side of road berm area

- 7.1.2 The lengths indicated in the cables schedule are only approximate. The contractor shall ascertain the exact length of cable for a particular feeder by measuring at site. All cable routes shall be carefully measured. Before the start of cable laying, the contractor shall prepare cable drum schedule and get that approved by Engineer-in-charge to minimise/avoid straight through joints and then the cables cut to the required lengths, leaving sufficient lengths for the terminations of the cable at both ends. The various cable lengths cut from the cable reels shall be carefully selected to prevent undue wastage of cables. Extra loop length shall be given for feeder cables where required as per the directions of Engineer-in-charge to meet contingencies

Cables shall be laid in directly buried trench or in RCC trench (underground trench) or in cable tray along pipe sleeves as shown on cable layout drawings.

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- 7.1.3 Cables shall be neatly arranged in the trenches / trays in such a manner that criss-crossing is avoided and final take off to the motor / switchgear is facilitated. Arrangement of cables within the trenches / trays shall be in line with cable layout drawings. Cable routing between cable trench and equipment/motors shall be taken through GI pipe sleeves of adequate size. Pipe sleeves shall be laid at an angle of maximum 45° to the trench wall. Bending radii of pipes shall not be less than 8D. It is to be ensured that both the ends of GI pipe sleeves shall be sealed with approved weather proof sealing plastic compound after cabling. In places where it is not possible, cables shall be laid in smaller branch trenches.
- 7.1.4 All cables shall be identified close to their termination point by cable tag numbers as per cable schedule. Cable tag numbers shall be punched on aluminium straps (2mm thick, 20 mm wide and of enough length) securely fastened to the cable and wrapped around it.
- Each underground cable shall be provided with cable tags of lead securely fastened every 30 m of its underground length with at least one tag at each end before the cable enters/leaves the ground. In unpaved areas, cable trenches shall be identified by means of cable markers as per installation drawing. These cable markers shall be placed at location of changes in the direction of cables and at intervals of not more than 30 m and also at cable straight through joint locations.
- 7.1.5 All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of cables shall be taped with an approved PVC end cap or rubber insulating tape.
- 7.1.6 Each row of cables shall be laid in place and before covering with sand. All wall openings/pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water inside building/lined trench. Every cable shall be given an insulation test in presence of Engineer-in-charge/Owner before filling the cable trench with sand. Any cable which is found defective shall be replaced.
- 7.1.7 Where cables pass through foundation walls, the necessary openings shall be provided in advance for the same by another agency. However, should it become necessary to cut holes in existing structures for example floor slab etc., the electrical contractor shall determine their location and obtain approval of the Engineer-in-charge before carrying out the same.
- 7.1.8 Cables for road crossings shall be taken through ERC (Electrical Road Crossing) as shown in the cable layout drawings.
- At road crossing and other places where cables enter pipe sleeves adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends.
- 7.1.9 Wherever cable trench crosses storm water, waste water channel/drain, cables shall be taken through PVC/RCC pipes. Where cables are required to cross drains of depth more than 1200 mm, cables shall be taken over the drain on cable trays supported suitably using ISMC 150/200 sections.
- 7.1.10 Ends of cables leaving trench shall be coiled & capped and provided with protective cover till such time the final termination to the equipment is completed.

## 7.2 Cables laid direct in ground

Cables shall be laid underground in excavated cable trenches where specified in cable layout drawings. Trenches shall be of sufficient depth and width for accommodation of all cables. Cables shall be properly spaced and arranged with a view of heat dissipation and economy of design. Maximum number of cable layers in trench shall be preferably limited to 5 layers.

Minimum depth of cable trench shall be 750 mm for LT Cables. The depth and the width of the trench shall vary depending upon the number of layers of cables as per LEPL installation Standards

Cables shall be laid in buried trenches at depth as shown in the cable layout drawings. It is to be insured by the contractor that the bottom of buried trenches shall be cleared of all rocks, stones and sharp objects before cables are placed. The trench bottom shall be filled with a layer of sand. This sand shall be leveled and cables laid over it. These cables shall be covered with 150 mm of sand on top of the largest diameter

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cable and sand shall be lightly compacted. A flat protective covering of 75 mm thick second class red bricks shall then be laid and the remainder of the trench shall then be back -filled with soil, rammed and leveled.

### 7.3 Cables laid in concrete trench

Cables shall be laid in 3 or 4 tiers in concrete trench as shown on layout drawings. Concrete cables trenches shall be filled with sand in hazardous area to avoid accumulation of hazardous gases and oil. RCC covers of trenches shall be effectively sealed to avoid ingress of chemical and oil in process area. Removal of concrete covers where required for the purpose of cable laying and reinstating them in their proper position after cables are laid shall be done by electrical contractor.

All wall openings/pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water


### 7.4 Above ground cables

- 7.4.1 Cables installed above grade shall be run in cable trays, clamped on walls, ceiling or structures and shall be run parallel or at right angles to beams, walls or columns. Cable routing shall be planned to be away from heat sources such as hot piping, gas, water, oil drainage piping, air-conditioning duct etc. Each cable tray shall contain only one layer of cables as far as possible for power cables. However control cables may be laid in double layer in the cable trays.
- 7.4.2 Individual cable or small group of cables (upto 3 to 4 cables) which run along structures / walls etc. shall be clamped by means of 16 SWG GI saddles on 25 x 6 mm saddle bars. Alternatively small group of cables can be taken through 100/150 mm slotted channel tray / ISMC 100. Cables shall be supported so as to prevent sagging. In general, distance between supports shall be approximately 300 mm for cables upto 25 mm diameter and maximum 450 mm for cables larger than 25 mm dia. to prevent the sagging of cables.
- 7.4.3 Cable laid on supporting angle in cable trenches, structures, columns and vertical run of cable trays shall be suitably clamped by means of G.I. saddles / clamps, whereas cables in horizontal run of cable trays shall be tied by means of nylon cords. Distance between supporting angles shall not exceed 600 mm.
- 7.4.4 All cable trays (other than galvanised trays) and supporting steel structures shall be painted before laying of cables. The under surfaces shall be properly degreased, derusted, descaled and cleaned. The painting shall be done with one coat of redoxide zinc chromate primer. Final painting shall be done with two coats of approved bituminous aluminium paint unless otherwise specified.
- 7.4.5 Where cables rise from trench to motor, lighting panel, control station, junction box etc., they shall be taken in GI pipe for mechanical protection upto a minimum of 300 mm above grade. Cable ends shall be carefully pulled through conduit to prevent damage to cable.
- 7.4.6 All G.I. Pipes shall be laid as per layout drawings and site conditions. Before fabrication of various profiles of pipes by hydraulically operated bending machine (which is to be arranged by the contractor) all the burrs from the pipes shall be removed. GI Pipes having bends shall be buried in soil/concrete in such a way that the bend shall be totally concealed. For G.I. pipes buried in soil, bitumen coating shall be applied on the buried lengths, Installation of G.I. pipes shall be undertaken well before paving is completed and necessary coordination with paving agency shall be the responsibility of Electrical Contractor.

Following guide shall be used for sizing of G.I. pipe.

- |    |                              |   |
|----|------------------------------|---|
| a) | 1 cable in a pipe            | - 53% of pipe cross-sectional area occupied by cables.  |
| b) | 2 cables in a pipe           | - 31% of pipe cross-sectional area occupied by cables.  |
| c) | 3 cables in a pipe           | - 43 % of pipe cross-sectional area occupied by cables. |
| d) | 4 and above cables in a pipe | - 40 % of pipe cross-sectional area occupied by cables. |

- 7.4.7 After the cables are installed and all testing is complete, conduit ends above grade shall be plugged with a suitable weatherproof plastic compound/bitumen/suitable sealing compound. Alternatively rubber bushes

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shall be employed for the purpose of sealing.

## 8. TERMINATIONS

- 8.1 PVC / XLPE cables up to 1100V grade shall be terminated at the equipment by means of compression type cables glands suitable for the cable size. They shall have a screwed nipple with conduit electrical threads and check nut. The cables shall be identified close to their termination points at both the ends of cable (cable numbers shall be punched on aluminium straps 2 mm thick and securely fastened to the cable, wrapped around it) and also along the route at recommended intervals, by cable tag numbers.

All cable entries for outdoor termination shall be preferably through bottom. Outdoor cable termination through top of equipment shall not be permitted.

- 8.2 Power cables cores wherever colour coding is not available shall be identified with red, yellow and blue PVC tapes. Where copper to aluminium connections are made, necessary bimetallic washers shall be used.
- 8.3 In case of control cables, all cores shall be identified at both ends by their terminal numbers by means of PVC ferrules suitable for core size. Wire numbers shall be as per schematic/ wiring/inter-connection diagram. All unused spare cores of control cables shall be neatly bunched and ferruled with cable tag at both ends, for future use.


For trip circuit identification additional red ferrules shall be used only in the particular cores of control cables at the termination points in the Switchgear/ Control panels and Control Switches.

- 8.4 Contractor shall drill holes for fixing glands wherever necessary. Gland plate shall be of non-magnetic material/ aluminium sheet in case of single core cables. All unused cable entries on equipment/panels shall be plugged/sealed.
- 8.5 The cable shall be terminated at electrical equipment/switchboards through glands of proper size. The individual cores shall then be dressed and taken along the cables ways or shall be fixed to the panels with polyethylene straps. The cable glanding shall be done as per manufacturers instructions. Cable armour shall not be exposed after termination is complete. In case of termination of cables at the bottom of a panel over a cable trench having no access from the bottom close fit holes shall be drilled in the gland plate for all the cables in one line, then gland plate shall be split in two parts along the centre line of holes. After fixing bottom plate, uncovered cable holes/gaps shall be sealed with cold setting compound.
- 8.6 Crimping of lugs to cable leads shall be done by hand crimping / hydraulically operated tool as per requirement. Insulation of the leads shall be removed before crimping. Conductor surface shall be cleaned and shall not be left open. Suitable conducting jelly shall be applied on the conductor lead. Lugs shall enclose all strands of cable core. Cutting of strands shall not be allowed.
- 8.7 The contractor shall bring to the notice of Engineer-in-charge any mismatch in cable glands, lugs provided with the equipment vis-a-vis to the cable size indicated in cable schedule for taking corrective action.
- 8.8 The cable joints in power and control cables shall be avoided as far as possible. In case a joint is unavoidable, the following shall be insured:

- The number of joints shall be restricted to minimum as far as possible.
- The location of joints shall be identified with permanent markers.
- No joints shall be allowed in hazardous areas without the approval of Engineer-in-charge.

The jointing and termination of medium voltage power cables shall be carried out by trained personnel only. Jointing and termination of high voltage cables shall be done by skilled and experienced jointer duly approved by Engineer-in-charge. Only type tested termination kits of approved make shall be used.

- 8.9 No unauthorised repairs, modifications shall be carried out on the hazardous area equipment terminal boxes and junction boxes. Damaged enclosures of hazardous area equipment shall be brought to the notice of Engineer-in-charge by contractor. After termination is complete, all the bolts, nuts, hardware of terminal box shall be properly placed in its position and tightened.

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- 8.10 Where required, cable sealing boxes intended to be used with the apparatus shall be filled with solid setting type bituminous compound unless otherwise specified.

## 9. TESTING AND COMMISSIONING

- 9.1 Field testing and commissioning of electrical installation shall be carried out as per LEPL specification.
- 9.2 Before energizing, the insulation resistance of every circuit shall be measured from phase to phase, phase to neutral and from phase/ neutral to earth.
- 9.3 Where terminations are required in circuits rated above 650 volts, insulation resistance of each length of cable shall be measured before terminating. After completion of terminations measurements shall be repeated.
- 9.4 The insulation resistance of directly buried cables shall be measured before cable trenches are backfilled. Measurements shall be repeated after back filling.

For cables upto 1.1 kV grade 1000 V Megger shall be used.

- 9.5 All checks and tests shall be made as per LEPL standard test performa available with site engineer.
- 9.6 Cable schedule, cable layout drawings, Interconnection drawings shall be marked by contractor's 'AS BUILT STATUS' and two sets of copies shall be submitted to LEPL/Owner.

## 10. PACKING AND DESPATCH

- 10.1 Cables shall be despatched in non-returnable wooden or steel drums of suitable barrel diameter, securely battened, with the take-off end fully protected against mechanical damage. The wood used for construction of the drum shall be properly seasoned, sound and free from defects. Wood preservatives shall be applied to the entire drum. Ferrous parts used shall be treated with a suitable rust preventive finish or coating to avoid rusting during transit or storage.
- 10.2 On the flange of the drum, necessary information such as project title, manufacturer's name, type, size, voltage grade of cable, length of cable in metres, drum no., cable code, BIS certification mark, gross weight etc. shall be printed. An arrow shall be printed on the drum with suitable instructions to show the direction of rotation of the drum.
- 10.3 Unless otherwise specified, Cables shall be supplied in drum lengths as follows:

### LT Cables

Multicore Power cables upto 6 mm <sup>2</sup>	1000m
Multicore Power cables from 10mm <sup>2</sup> up to 300 mm <sup>2</sup>	500m
Single Core Power cables upto 630 mm <sup>2</sup>	1000m
Control cables upto 61 cores	1000m

A tolerance of  $\pm 3\%$  shall be permissible for each drum. However, overall tolerance on each size of cable shall be limited to  $\pm 2\%$ . Offers with short / non-standard lengths are liable for rejection. If non-standard drum lengths are specified in the data sheet, the same shall be supplied.



GAIL INDIA LIMITED

## TECHNICAL SPECIFICATION OF LIGHTING SYSTEM


(Doc. No. GAIL-STD-EL-DOC-TS-004)

Rev	Date	Purpose	Prepared By	Checked By	Approved By
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## 1.0 SCOPE

This specification defines the requirements for the supply of equipment, materials, installation, testing and commissioning of the lighting system (lighting fixtures, lighting power distribution etc.).

## 2.0 CODES AND STANDARDS

2.1 The work shall be carried out in the best workmanlike manner, in conformity with this specification LEPL Installation Standards, and the relevant specifications/codes of practice of the Bureau of Indian Standards.

2.2 In addition to the above it shall be ensured that the installation conforms to the requirements of the following as applicable:

- a. The applicable Indian standards are listed below but are not limited to:  
IS : 732 - Code for practice for electrical wiring installations (3 parts).  
IS : 2148 - Specification for flameproof enclosures of electrical apparatus.  
IS : 3043 - Code of Practice for Earthing.  
IS : 5571 - Guide for Selection of Electrical equipments for Hazardous areas.  
IS : 5572 - Classification of Hazardous areas(other than mines) having flammable gases and vapours for electrical installation.  
Listed above Indian standards have priority over than than standards:

### INTERNATIONAL STANDARDS :

IEC 60079 : Electrical apparatus for explosive gas atmosphere.  
IEC 60269 : Low Voltage fuses.  
IEC 60364 : Low Voltage electrical installations.  
IEC 60439 : Low Voltage switchgear and control gear assemblies.  
IEC 60445 : Basic and safety principles of Man Machine interface, marking and identification-identification of equipment terminals and conductor terminals.  
IEC 60529 : Degree of protection provided by enclosures.  
IEC 60664 : Insulation coordination of equipment with in low voltage systems.  
IEC 60947 : Low voltage switchgear and control gear.

The minimum enclosures protection according to IEC 60529 shall be :

For indoor use (External) : IP 52  
For indoor use (Internal) : IP 42  
For Outdoor use (External) : IP 54(with canopy)  
Internal : IP 42


- b. Regulations laid down by CEA/Electrical Inspectorate.
- c. Regulations laid down by CCE/DGMS (as applicable).
- d. The petroleum rules (Ministry of Industry Government of India).
- e. Any other regulations laid down by central/state/local authorities and Insurance agencies.

## 3.0 EQUIPMENT SPECIFICATIONS

All materials, fittings and appliances to be supplied by the contractor shall be new, unused and of the best quality and shall conform to the specifications given hereunder. These shall be manufactured in accordance with the latest revision of the specifications of Bureau of Indian Standards/International standards. In the absence of any specifications for a particular item, contractor shall bring material samples along with proven track record to site and get the same approved by Engineer-in-Charge/Owner before installation.

### 3.1 Lighting and Power panels

- 3.1.1 Lighting and Power panels (general purpose panels for safe area) shall be made of 1.6mm thick sheet steel and shall be dust and vermin proof. All metal surfaces shall be cleaned free of rust, given a coat of red-oxide primer and finished with two coats of epoxy based paint of shade RAL-7032. Panels shall be indoor/outdoor type as specified. Indoor type panels shall have IP42 degree of protection and shall be suitable for surface or flush mounting on wall surface as specified. Lighting and power panels located outdoor shall be IP55 weather protected and shall also preferably have integral canopy for additional weather protection. The canopy shall be made of 2mm thick galvanized sheet steel or FRP where these are separate from the equipment.

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- 3.1.2 Lighting and Power panels shall have TPN incoming feeder and single phase outgoing feeders. Lighting circuit feeders shall be rated for 10 amps and power circuit feeders shall have current rating of 16Amps. in power panels for window Air conditioning units, power circuit feeder shall be rated for 20 amps. Panels shall be equipped with phase and neutral bus bars of required current carrying capacity. The outgoing feeders shall be provided with single pole miniature circuit breakers (MCBs) for safe areas and double pole MCBs for hazardous areas. The incomer shall be with MCB and ELCB unit unless otherwise specified. Miniature circuit breakers shall be mounted in such a way that the operating levers project outside the front bakelite cover plates for ease of operation. A hinged door to cover the operating knobs shall be provided. In addition, a circuit diagram indicating incomer details and outgoing details viz. Circuit number, circuit rating, load connected and details of the load shall be pasted inside the panel. Also a laminated copy of the diagram shall be provided inside the panel in a suitably, designed pocket. Two external earthing studs for connection to the plant earthing grid shall be provided on the panel. Further, the panel shall be provided with an earth bus bar with terminal studs for connection to the third core of each outgoing circuit. Each circuit phase and neutral shall be given ferrule numbers. Complete wiring inside the panel, shall be neatly bunched with PVC tape and button. Sufficient terminals shall be provided in the terminal block so as to ensure that not more than one wire (core) is connected to a terminal. The panel shall have knock out holes or removable gland plate for the entry of incoming and outgoing conduits or cables. The panels shall be complete with requisite number of cable glands as specified.
- 3.1.3 The Main distribution board (MDB) where used, shall be made of 2mm thick sheet steel panel, dust and vermin proof similar in construction to Lighting and Power panels but with TPN MCB incoming and TPN outgoing ( MCB with ELCB units and MCB without ELCB unit as applicable) of required numbers as specified.
- 3.1.4 All MCBs shall be of M9 category as per IS 8828 and sensitivity of ELCBs shall be 100 mA unless otherwise specified.
- 3.1.5 Wherever the size of incoming cable to lighting, power panels/MDB is more than 35 sq. mm a suitable cable adapter box shall be provided and attached to the panel. The incoming cable leads shall be connected to terminal block (bolted type terminals) of required size. This terminal block shall be connected to TPN incomer unit through separate PVC insulated copper conductor wires/bus bars. Sufficient space shall be provided (200 to 250mm) between gland plate and the bottom of terminal block for easy termination.

### 3.2 Lighting fixtures

The types, makes and catalogue numbers of various types of industrial lighting fixtures shall be as given in Fixture schedule job data sheet. HPMV /HPSV lighting fixtures shall be complete with ballast, starters and capacitor, as required. Control gears shall be integral or non-integral as specified in lighting layout drawings. Unless otherwise specified, all fixtures shall be supplied complete with lamps. Ballast for fixture shall be copper wound or electronic type. The fixtures shall be of high power factor type i.e. at least 0.9 or more.


### 3.3 Switches

Switches, manufactured in accordance with IS: 13947 shall be used for non hazardous areas. Switches in areas where concealed wiring has been adopted, shall be flush mounting piano type unless otherwise specified. For surface conduit wiring, piano type switches in surface mounted box shall be provided. Industrial Type switches (Weather protected) shall be used for outdoor areas.

### 3.4 Receptacles

Three pin type 5A/15A receptacles manufactured in accordance with IS: 1293 shall be used for non hazardous areas. The receptacles and the controlling ON/OFF switch shall be mounted in the same enclosure box but these shall be in separate units to facilitate replacement by parts. Flush mounting type receptacles shall be used in areas where concealed wiring has been adopted and surface type shall be used in other areas. For exhaust fans and wall mounted air circulators, socket and switch enclosures shall be separate. In buildings such as sub-station, D.G. shed, Workshop, maintenance shop etc. industrial type metal clad socket outlets and plugs shall be provided. These sockets shall be supplied complete with plugs.

### 3.5 Outlet Boxes

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The outlet boxes used as point outlets shall be prefabricated type 65mm deep junction boxes. Outlet boxes custom fabricated for sockets, switches, fixtures and fan regulators etc. shall be made of M.S. Sheet having minimum thickness of 1.6mm. Outlet boxes shall be galvanized after fabrication. These shall be complete with terminal block suitable for connection of wires up to 4 sq. mm Front cover plate shall be of 3mm thick bakelite / PE sheet. The colour shall suit the shade of the walls or shall be white if the shade of the walls is not finalised. The sheet shall extend at least 2 mm on all sides of outlet box. Cover plate shall be fixed by cadmium plated brass screws and cup washers. Outlet boxes shall be provided with adequate number of knock outs on all the sides for ease of wiring either with conduits or without conduits.

### 3.6 Conduit and Accessories

Conduits for Electrical installations shall conform to IS: 9537. The type of conduit (steel/GI/PVC) shall be as specified on drawing. Black enameled steel or GI conduit shall be of 1.6mm thick and the minimum wall thickness of PVC conduit shall be 2 mm. Generally PVC conduits shall be used in concealed wiring and for surface wiring GI conduit (in plant buildings) and black enamelled steel conduit (in non plant buildings) shall be used.

### 3.7 Lighting Poles

Lighting poles shall be fabricated (as per LEPL installation standards) from ERW steel tubular pipes of specified section, with joints, swaged together when hot and bevelled on outside edges. Poles shall be coated with bituminous preservative solution on the ground portion of the outside surface. Remainder of the outside surface shall be given one coat of red oxide primer and finished with two coats of aluminium paint. The pole shall have, a marshalling box/ junction box near the bottom to contain HRC fuses/ MCB, a neutral link, an earth stud and terminal block.

### 3.8 Lighting Mast


3.8.1 Lighting masts (Lattice tower) where used, shall be fabricated as per LEPL Standard. They shall be complete with 2 nos. MS flats provided at the base plate for connection to the plant earthing grid. A ladder, platform, handrail, a weather protected TPN switch (at 1500mm from ground level) and a weather protected distribution board fabricated out of sheet steel shall be provided at the top of mast. The TPN Switch and the distribution board shall also have a canopy for additional weather protection. The TPN switch shall be suitable for looping one more lighting mast from the same incoming power supply. The distribution board shall have TP&N busbars of 30 Amps. rating and 12 Nos. outgoing circuits each with a 6A single pole MCB. The distribution board shall have cable entries from bottom. Necessary space provision and suitable mounting arrangement shall be made on top of the tower for mounting of ballast (choke) and condensers for all the circuits and the lighting fixtures. The masts shall be given one coat of red oxide primer and two coats of aluminium paint. Distribution board shall be fabricated out of 2mm thick sheet steel and shall be painted with two coats of enamel over a base coat of red oxide.

### 3.9 Wires

Wires shall be FRLS PVC insulated and shall be of 660/1100 Volts grade as per IS:694. Conductor shall be of stranded copper and size shall be minimum 2.5 Sq. mm for lighting, 4.0 Sq. mm for 15A power socket circuits and 6 sq. mm for split A/C power socket circuits. Red/Yellow/blue wires for phases, black wire for neutral and green wire for earth shall be used (size of earth wire shall be same as for phase and neutral size). Wire size for air conditioning circuit feeders shall be as indicated in the panel schedule.

### 3.10 Ceiling fan/ Exhaust fan

Ceiling fans shall be of 1200mm sweep unless otherwise specified with double ball bearing and regulator. The suspension down rod shall be sturdy mild steel rod of adequate diameter and of minimum length of 300mm with shakles suspension arrangement as per IS. For exhaust fans, the sweep dia. and air CFM shall be as specified in job specification. Exhaust fans for battery room shall be FLP type.

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### 3.11 Decorative switches and sockets

Decorative lighting switches and sockets where specified, shall be modular in design. All these items shall fit into the same frame with overall standard dimensions. Frames shall be suitable for surface and flush mounting in brick / concrete wall. The frames shall be suitable for conduit entry from all the sides. Switches and sockets shall match colors of the frame and cover plates to obtain a combination which shall match decor of the interiors of Control Room, Administrative buildings, offices rooms etc.

## 4.0 LIGHTING SYSTEM

### 4.1 General

4.1.1 The lighting fixtures in the plant shall be fed from lighting panel. All outdoor lighting shall be group controlled manually or through synchronous timer or photocell. Lighting wiring between panel and lighting fixtures shall be done with FRLS PVC insulated 3-core (phase, neutral and earth) copper conductor armoured cable for hazardous areas. Wiring in the building shall be done by means of 3-core copper conductor PVC insulated FRLS un-armoured cables, or FRLS PVC insulated copper conductor wires in conduit/Metsec channel as specified. All joints of conductors in Switch boards/JBs Fittings shall be made only by means of approved mechanical connectors (nylon/PVC connectors). Bare twisted joints shall not be permitted anywhere in the wiring system.

4.1.2 The lighting layouts furnished by owner will indicate approximate locations of lighting fixtures. The electrical contractor shall determine, with approval of Engineer-in-Charge, the exact locations of each fixture in order to avoid interference with piping or other mechanical equipment and also with a view to obtain as much uniform illumination as practicable, and to avoid objectionable shadows. Conduits shall be laid out by the contractor to suit field conditions and as per directions of the Engineer-in-Charge.-

4.1.3 On walkways, platforms and other outdoor area, lighting fixtures shall be located nearer to landing of stairs or ladders, gauges, flowmeters, panel boards and other equipment to provide proper illumination.

4.1.4 The minimum height of any lighting fixture shall be preferably not less than 2.5 meters above the floor level.


4.1.5 All outdoor cable terminations to outdoor junction boxes, panels, socket outlets etc. shall be through bottom or from side. Top entries for cables shall be avoided to avoid water entry. All cable glands for outdoor terminations shall be double compression type and the gland shall be covered with PVC or rubber boot shroud. All unused cable entries shall be plugged with suitable blanking plugs.

4.1.6 Mounting height of equipment shall be as under:-

Top of Switch Box	:	1200mm from FFL (Finished floor level)
Top of Lighting/power Panel	:	1800 mm from FFL.
5/15 Amp. Receptacle	:	300 mm FFL unless otherwise specified (1200 mm for process areas and industrial sheds)
Lighting fixture	:	As indicated in layout drawing
Exhaust fan	:	In the cutout provided /as indicated in Layout drawings.

4.1.7 Fixtures shall be firmly supported from the structures. Support clamps etc. may be bolted or welded to the existing steel work or metal inserts. In case of concrete structures, where metal inserts are not available, fixtures shall be suspended from concrete surfaces with the help of anchor fasteners. In such cases special care shall be taken to see that anchoring is firm. In places where ceiling fans are provided, lighting fixtures shall be suspended below the level of fan to avoid shadow effect.

4.1.8 Circuit cables in a group shall be cleated to structure by using galvanised strip clamps or cable run in cable trays wherever trays are available. Spacers and cleats shall be of required size to accommodate the cables. All hardware shall be galvanised or zinc passivated. Underground lighting cables (in paved areas) shall be taken

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in suitable G.I. sleeves buried at a minimum depth of 300mm from FFL. GI pipe sleeves shall be extended to 300mm above FFL. Exact termination/layout of G.I. pipes (for protection of cables) shall be decided at site as per site convenience in consultation with Engineer-in-charge.

- 4.1.9 Wiring for all outlet sockets shall be done with 3 cores of equal sizes for phase, neutral and earth. The terminals of switch sockets shall be suitable to receive the size of wire specified.
- 4.1.10 All lighting fixtures shall be provided with terminal block with required terminals suitable for connection of wire up to 2.5 sq. mm copper conductor.
- 4.1.11 The cable shall be straightened after unwinding it from the drum. All cables be clamped/laid in straight run without any sag and kink.
- 4.1.12 For location where fan points are shown, fan hooks with junction box shall be provided during concreting.

Where fan hooks and J.Bs. are provided separately JB shall be located within a distance of 300mm from hook for mounting of ceiling rose.

- 4.1.13 Industrial type plug sockets with 20A MCB or rating as per job specification shall be provided at a height of 500mm from FFL for window AC units.

Socket outlets and plugs for installation in Sub-station building, DG shed, workshop, maintenance shop etc. shall be of industrial metal clad type.

- 4.1.14 Wiring for exhaust fans shall be terminated in receptacles as specified in layout drawing and the connection from receptacle to the exhaust fan shall be by means of a flexible cord equivalent in size to the main run of wires. Switch for exhaust fan shall be located in a separate switch board along with other switches.

#### 4.2 Conduit System

- 4.2.1 Surface or concealed conduit system of wiring shall be adopted, as specified in the drawings. Required number of pull boxes shall be used at intervals to facilitate easy drawing of wires. Separate conduit shall be run for lighting and power circuits. Further, conduits for Normal lighting/ Emergency lighting /DC critical lighting shall be separate. Conduit layout shall be decided at site as per site conditions. Drop conduits for switch boards shall be decided by contractor as per wall locations shown in Architectural drawings. All exposed run of conduits on surface, shall be vertical or horizontal.

- 4.2.2 Only threaded type conduit fittings shall be used for metallic conduit system. Pin grip type or clamp type fittings are not acceptable. Conduit ends shall be free from sharp edges or burrs. The ends of all conduits shall be reamed and neatly bushed.


Conduit shall be of minimum 25mm dia. Maximum number of wires permissible in a conduit shall be seven/nine for wire size of 2.5 sqmm/1.5 sqmm. respectively.

- 4.2.3 The exposed outer surface of the conduit pipes, including all accessories forming part of the conduit system, shall be adequately protected against rusting. In all cases, bare threaded portion of conduit pipe shall not be exposed unless such bare threaded portion is treated with anti corrosive preservative or covered with approved plastic compound.

- 4.2.4 Conduit connection to outlet boxes shall be by means of screwed hubs or check nuts on either side. Where concealed wiring is done, junction boxes (65mm deep) shall be used so as to rest on shuttering properly. Conduits shall be laid above reinforcement. All conduit connections shall be properly screwed and Junction box covers shall be properly fitted so as to avoid entry of concrete slurry.

- 4.2.5 Conduit pipes shall be fixed by 1.6mm thick G.I. saddles on 3mm thick G.I. saddle bars of required width in an approved manner at intervals of not more than 50cms for straight run. At places near junction boxes, bends, or similar fittings, saddle and bars shall be provided on either side.

- 4.2.6 Where concealed wiring is to be adopted, conduits shall be laid in time before concreting of the slab. Pull wire (GI or steel) shall be provided inside conduit for the ease of wire pulling. The contractor shall coordinate his

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work with other agencies involved in the civil works in such a way, that the work of the other agencies is not hampered or delayed. Vertical conduit runs shall be made in wall before plastering is done so as to avoid chasing. Where chases are made for conduit run contractor shall fill these chases or any other openings made by them after completing the work and patch the surface. During installation, care shall be taken to see that proper covers are provided to prevent rusting of conduits. Locations of all point outlets, junction boxes shall be marked with brick powder or sand so that these are easily identified after shuttering removal. As built conduit layout drawing shall be submitted by contractor after completion of the work.

4.2.7 All bends and other accessories shall be of the same material as that of conduit and shall have the same protective coatings. All junction boxes shall be MS chromium plated.

4.2.8 After erection, the entire surface conduit system shall be tested, for mechanical and electrical continuity and shall be permanently connected to earth by means of approved type of earthing clamps.

**4.3 Hazardous Area**

4.3.1 Wiring in hazardous area shall be done by using minimum 2.5mm<sup>2</sup> copper conductor FRLS, PVC armoured cable. Circuit wiring feeding hazardous areas shall be controlled by two pole switches/MCBs (for phase as well as neutral isolation).

4.3.2 Correct type of lighting equipment (fixtures and JB's) with regard to hazardous protection as specified in the drawing, shall be installed for the areas classified as Zone I, Zone 2 etc.

4.3.3 The terminations in the junction boxes and the lighting fittings shall be done avoiding possibility of loose connections due to vibrations. After the terminations are made the cover of the junction boxes and the lighting fittings shall be closed properly with all bolts and hardware in correct position, retaining its explosion and weather protections. In fixtures having double cable entries, both the entries shall be used for looping in and looping out connection, thus minimising the use of a separate junction box. Wherever separate control gear boxes (C.G. box) are provided looping in and looping out connections shall be through CG box, thus avoiding the use of an additional junction box. All unused cable entries shall be sealed with suitable plugs.


4.3.4 Circuit cables shall be firmly cleated in a group along columns/ beam/ladders/side channels/platform using 1.6mm thick GI saddles on 25x3 mm GI saddle bar at intervals of 400mm to 500mm for straight run and on either side close to bending and at both termination ends as per the directions of Engineer-in-charge. Where required 3 or more of cables may be taken in slotted channel tray after getting the approval of Engineer-in-charge. Cables shall not be routed along hand rails.

Where fire proofing column/structures are encountered, all cabling shall be taken in GI pipes of required size and both ends shall be sealed, well before fire proofing is done. Similarly equipment such as lighting fixture, control gear box, lighting power panels, field call stations, junction boxes etc. shall be installed on a suitable steel mounting frame/distance bracket, thereby avoiding direct contact with the concrete used for fire proofing.

4.3.5 Cable glands for terminating cable on flameproof equipment shall be of double compression FLP type. Any material/equipment specified to be supplied by contractor for installation in hazardous areas, shall be tested by CMRI and duly approved by C.C.E. Nagpur or DGMS Dhanbad or any other applicable statutory authority. All indigenous FLP equipment shall also have valid BIS license as required by statutory authorities.

**OUTDOOR FLAME PROOF SOLAR LIGHT TECHNICAL SPECIFICATION:**

This Flame proof CFL light is powered by a 14.8 volt Li-Poly battery that is recharged by a 12 watt solar panel. This solar panel charged, flame proof light can be configured to turn on and off only when there is motion. This sensor switches the light off when there is no movement detected and light output mode when movement is detected. Light output comes from a 11 watt CFL lamp that produces 900 lumens. The light can be configured to automatically switch on when ambient light levels drop below 30 lux, which is typically at sunset. The light runs for 15 hours when the battery is fully charged. Charging time for the Li-Poly battery is 5 hours when exposed to direct sunlight. Indirect sunlight will extend the charge time.

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As with all solar powered equipment, charging time is affected by the amount of available ambient light. When ambient light levels drop below a certain level, such as on cloudy days, the unit will not recharge as quickly. Mounting options include ceiling, wall and pendant mounting for the lamp fixture and flat surface or round/square pole mounting such as on utility poles or structure supports for the solar panel.

**Technical Specifications:**

- Operation:** Automatic Class 1 Div 1 -Groups C, D
- Solar Panel Dimensions:** W-11 3/8" L-15 3/4" D-1" Class 1 Div 2 -Groups A, B, C, D
- Lamp Dimensions:** 7.44"-Diameter, 11.1" Height Class 2, Division 2, Groups F, G
- Panel Watts:** 12 Watt
- Lamp Watts:** 11 T6 Temperature Rating
- Charging Time:** 5 Hours -55 C to 85 C Operating Temp
- Lumens:** 900 Suitable for Marine Environments
- Runtime:** 15 Hours
- Lamp Mounting:** Wall, ceiling or pendant
- Panel Mounting:** Flat Surface / Round/Square Pole Contact us for special requirements
- Battery:** Li-Poly 14.8 Volt
- Charging Time:** 5 Hours
- Wiring:** 30 feet
- Lamp Wiring Hub:** 3/4" Threaded
- Lamp Temp Rating:** T6 - All Voltage and Temperature Ranges

**4.4 Building Lighting**

- 4.4.1 The type of wiring system shall comprise surface/concealed conduit system or cable wiring as specified on layout drawings.
- 4.4.2 Mounting details of fixtures shall be indicated on the drawings. If specified on the drawings, a group of fluorescent lighting fixtures which are to be mounted end to end, shall be fixed to mild steel cold rolled sections of 50mm x 50mm and of 1.2mm thick (Metsec channel). The entire assembly shall be fixed to the ceiling with necessary number of supports which may be by means of steel conduit or chromium plated chain link as required. The 'Metsec' Channel shall run continuous in suitable sections from one end to other end of wall. The complete channel shall be spray painted, with approved colour as per the directions of Engineer-in-Charge. All wires inside channel shall be neatly bunched by nylon tape & buttons.
- 4.4.3 Wiring in areas above false ceiling shall be done in Surface Conduit (25mm dia GI conduit) suitably clamped to the true ceiling. Vertical drops from true ceiling for panels, switches, receptacles etc. shall be taken in 25mm dia PVC conduit concealed in walls up to switchboards/panels. Lighting fixtures shall be supported from true ceiling. Exact location of fixtures shall be finalized in co-ordination with air-conditioning duct diffuser layout, panels layout and false ceiling grid layout. To facilitate easy maintenance 'Looping back system' of wiring shall be followed throughout. Accordingly supply tapplings and other interconnections including for earthing are made only at fixture connector blocks or at switch boards. Required number of junction boxes shall be used at intervals for wire pulling and inspection.
- 4.4.4 All wires in conduit shall be colour coded as specified. Each circuit shall have independent phase neutral and earth wire. However when group of circuits are run in a single conduit the earth wire can be common.
- 4.4.5 Building conduit lighting system of wiring where measurement is done on point wiring basis generally consists of two parts. The first part is the circuit wiring which includes the work necessary from lighting panel up to switch box and from switch box to another switch box .. The second part is the point wiring which shall include the work necessary from tapping point in the switch box upto various fixtures or fan outlets/ceiling roses.
- 4.4.6 In no case, two different sources or two different phases of supply shall be combined in one switchboard.
- 4.4.7 Switches for light fixtures/exhaust fans in battery room shall be provided outside the Battery room.

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#### 4.5 Street Lighting

- 4.5.1 Street lighting poles to be located on road side shall be installed at a minimum distance of 300mm from the edge of the walkway of the road. Size of wires from marshalling box / Junction box upto fixture shall be min. 2.5mm<sup>2</sup>, copper conductor PVC insulated FRLS.
- 4.5.2 Each pole shall be earthed at two points by connecting to the plant earth grid as shown on Installation standards.
- 4.5.3 Street lighting fixture shall be mounted on steel tubular poles as per standard drawings. The foundation for the street lighting poles will be made by electrical contractor. Street lighting poles shall be supplied with a base plate.
- 4.5.4 The poles shall be numbered as per the drawings/ directions of Engineer in-charge.

#### OUTDOOR SOLAR LIGHT TECHNICAL SPECIFICATION:

PV Module	74 Wp under STC
Battery	Lead acid Tubular Flooded or Tubular GEL / VRLA , 12V- 75 AH @ C/10
Light Source	Compact Fluorescent Lamp of 11 Watt
Light Out put	900±5 % lumens.
Mounting of light	Minimum 4 metre pole mounted
Electronics Efficiency	Minimum 85% total
Inverter	Quasi sine wave or sine wave type
Duty Cycle	Dusk to dawn
Autonomy	3 days or Minimum 42 operating hours per permissible discharge

The Outdoor Solar Lighting System shall be make of TATA BP Solar make MV8 model system.


#### TECHNICAL DETAILS

##### PV MODULE

- (i) Indigenously manufactured PV module should be used.
- (ii) The PV module should have crystalline silicon solar cells and must have a certificate of testing conforming to IEC 61215 Edition II / BIS 14286 from an NA BL or IECQ accredited Laboratory.

#### 4.6 Mast Lighting

- 4.6.1 The lattice structure masts shall be installed on concrete foundations with the base plate bolted on to the anchor bolts. The lattice structure shall be painted with a coat of primer and two coats of aluminium paint, the second coat to be given just before handing over to the owner. The masts shall be numbered as per drawings. The masts shall be connected to the plant earth grid at two points
- 4.6.2 The main feeder upto the distribution board of lighting mast shall be through PVC insulated FRLS armoured cable of size as specified in the respective drawing. Wiring from Distribution Board to each flood-light fixture shall be by means of a 3-core 2.5sqmm, copper conductor PVC insulated FRLS armoured cable. All the cables shall be neatly clamped to the structure at intervals not exceeding 25 cms.
- 4.6.3 Alternatively the flood light high mast shall comply to LEPL specification.
- 4.6.4 Exact orientation of flood lighting fixtures shall be decided at site to achieve optimum utility of these fixtures.

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**5.0 TESTING AND COMMISSIONING**

5.1 Lighting installation shall be tested and commissioned by installation contractor as per LEPL specifications. Pre-commissioning checks and tests, shall include but not be limited to the following:

- a) The insulation resistance of each circuit without the lamps (load) being in place shall be measured and it should not be less than 500,000 ohms. (Between phases, phases to neutral, phase/neutral to Earth).
- b) Current and voltage of all the phases shall be measured at the lighting panel bus bars with all the circuits switched on with lamps. If required load shall be balanced on the three phases.
- c) The earth continuity for all socket outlets shall be checked. A fixed relative position of the phase and neutral connections inside the socket shall be established for all sockets.
- d) After inserting all the lamps and switching on all the circuits, minimum and maximum illumination level shall be measured in the area and recorded.
- e) It shall be ensured that switch provided for ON/OFF control of point (light/fan/socket) is only on LIVE side.
- f) Operation of ELCB's shall be checked.
- g) Contractor shall duty fill in all the above test results and submit the test reports to Engineer-in-Charge in triplicate.

5.2 All lighting layout drawings shall be marked by contractor for 'AS BUILT STATUS' and two sets of copies shall be submitted to LEPL.

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GAIL INDIA LIMITED

## TECHNICAL SPECIFICATION FOR EARTHING (Doc. No. GAIL-STD-EL-DOC-TS-005)

Rev	Date	Purpose	Prepared By	Checked By	Approved By
0	29.01.2019	Issued As Standard	RKS	SB	SB



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- 6.0 CONNECTION
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- 9.0 EQUIPMENT EARTHING SCHEDULE

**1.0 SCOPE**

This specification defines the requirements for the supply of earthing materials and installation of the earthing systems.

**2.0 CODES AND STANDARDS**

2.1.1 The work shall be carried out in the best workman like manner / conformity with this specifications, LEPL installation Standards, layout drawings, the latest edition of relevant specifications, codes of practice of Bureau of Indian Standards and OISD Standards listed below:

SP: 30 (BIS)	Special Publication – National Electrical Code
IS: 2309	Protection of buildings and allied structures against lightning.
IS: 3043	Code of practice for earthing
IS: 7689	Guide for control of undesirable static electricity.
OISD 110	Recommended practices on static electricity
OISD 147	Inspection and safe practice during electrical installation.

2.2 In addition to the above it shall be ensured that the installation conforms to the requirements of the following as applicable:

- a. Indian Electricity Act and Rules.
- b. Regulations laid down by CEA/Electrical Inspectorate.
- c. Regulations laid down by CCE/DGMS (as applicable).
- d. The petroleum rules (Ministry of Industry Government of India).
- e. Any other regulations laid by central/state/local authorities and Insurance agencies.

**3.0 MATERIAL SPECIFICATIONS**

3.1 All materials and hardwares to be supplied by the contractor shall be new, unused and of best quality and shall conform to the specifications given here under and to latest specifications of Bureau of Indian Standards. Contractor shall bring material samples to site and get it approved by Engineer-in-charge before installation.


3.2 The main grid conductor shall be hot dip galvanized G.I. strip or PVC insulated aluminum conductor/copper conductor. Sizes for main conductors shall be marked on the drawings. Thickness of hot dip galvanizing shall not be less than 75 microns. Earth electrodes shall be as per LEPL's standard drawing.

**4.0 EARTHING NETWORK**

4.1 This consists of main earth conductor (grid conductor) forming a closed ring network with required number of earth electrodes connected to it to provide a common earth for electrical devices and metallic structures. From each earth electrode two distinct connections shall be made to the main earth conductor. The earth plates shall be used for taking multiple earth connections to two or more equipment.

4.2 The earth conductor shall be laid along cable trays/cable trench/pipe racks as indicated on the earthing layout drawing. Where lined cable trenches and shall be firmly cleated to the sidewall of concrete trenches using GI clamps at interval of 400 mm to 500 mm and near to the termination end. The earthing conductor shall run along one of the cable trays along a cable route. The earthing conductor shall be suitably cleated and electrically bonded to all the other cable trays on the same cable route at a regular interval of 25 to 30 meter. The earthing for equipment shall be tapped from the main earth conductor and not from cable tray support structure. Earth conductor when laid underground shall be at a depth of 500 mm below finished grade level.

4.3 Joints and tapping in the main earth loop shall be made in such a way that reliable and good electrical connections are permanently ensured. All joints below grade shall be welded and shall be suitably protected by giving two coats of bitumen and covering with Hessian tape. Earth strip laid above ground shall be welded across straight through joints and joints shall be suitably protected by giving

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two coats of bitumen to avoid oxidation and insulation film formation of the strip surface. When two earth strips are to be jointed by means of welding, lap welding with an overlapping of strip equivalent to double the width of the strip and all four sides shall be continuously welded. All joints at tapping above ground shall be by means of connector/lugs. A minimum of two bolts of adequate size shall be used for this purpose. Earthing strip joints at earth plate and equipment shall be through GI bolts, nut etc.

4.4 Neutral point of DG set and Incoming transformer of Local Electricity Board shall be Solidly earthed by two separate dedicated earth pit.

**5.0 INSTALLATION OF EARTH ELECTRODE :**

- 5.1 Earth electrodes shall be installed as shown in the earthing layout drawing and in accordance with the standard drawings and IS:3043. Their location shall be marked to enable accurate location by permanent markers.
- 5.2 All earth electrodes shall preferably be driven to a sufficient depth to reach permanently moist soil. Electrodes shall preferably be situated in a soil which has a fine texture and which is packed by watering and ramming as tightly as possible. Wherever practicable, the soil shall be dug up, all lumps broken and stones removed from the immediate vicinity of the electrodes. Earth pit with all accessories shall be provided as per drawings.
- 5.3 All earth electrodes shall be tested for earth resistance by means of standard earth test meter. The tests shall take place in dry months, preferably after a protracted dry spell.
- 5.4 The electrodes shall have a clean surface, not covered by paint, enamel, grease or other materials of poor conductivity.
- 5.5 Earth electrodes shall be located avoiding interference with road, building foundation, column etc.
- 5.6 The disconnect facility shall be provided for individual earth pits to check their earth resistance periodically.
- 5.6 The distinct No. shall be provided on all earth electrode as per approved drawing. Earth resistance, date shall be marked on a plate above grade level.

**6.0 CONNECTION**

The earth system connections shall generally cover the following:


- Equipment earthing for personnel safety.
- System neutral earthing
- Static and lightning protection

6.1 The following shall be earthed.

- System neutral.
- Current and potential transformer secondary neutral
- Metallic non-current carrying parts of all electrical apparatus such as transformers, switchboards, bus ducts, motors, neutral earthing resistors, capacitors, UPS, battery charger panels, welding receptacles, power sockets, lighting/power panels, control stations, lighting fixtures etc.
- Steel structures/columns, rail loading platforms etc.
- Cable trays and racks, lighting mast and poles
- Storage tanks, spheres, vessels, columns and all other process equipment.
- Fence and Gate for electrical equipment (e.g. transformer, yard etc.)
- Cable shields and Armour
- Flexible earth provision for Wagon, Truck
- Shield wire

Conductor size for branch connection to various equipment shall be as per LEPL Installation Standards unless otherwise stated on earthing layout drawings.

6.2 All process pipelines shall be bonded and earthed at the entry and exist points of battery limit of hazardous area.


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- 6.3 Steel pipe racks in the process units and offsite area shall be earthed at every 24 meters.
- 6.4 Equipment/street light pole etc. located remote from main earth network may be earthed by means of individual earth electrode and earth conductor unless otherwise stated in job specifications.
- 6.5 **LIGHTNING PROTECTION** shall be provided for the equipment, structures and buildings as shown on layout drawing. An independent earthing network shall be provided for lightning protection. Lightning protection system shall generally comprise lightning finials (air terminals), roof conductors, down conductors, test links, and earth electrodes. The number, types, materials and sizes shall be in accordance with the drawings. Air terminals shall be mounted on top of buildings or structure as required. All air terminals shall be inter-connected with roof conductors, pipes, hand rails or any other metallic projection above the roofs shall also be bonded to the roof conductors. Down conductors from air terminals or from roof conductors shall be routed as directly as possible to the test links on earth buses, with minimum bends. All provisions regarding connections of conductors for equipment earthing system shall also apply to lightning protection system. In corrosive atmospheres, plumbing metal for corrosion protection shall cover lightning finials or air terminals.
- 6.6 The main earthing network shall be used for earthing of equipment to protect against static electricity.
- 6.7 All medium and high voltage equipment (above 250V) shall be earthed by two separate from the electrical earthing system.
- 6.8 Plant instrument system clean earthing, UPS system clean/safety earth shall be separate from the electrical earthing system.
- 6.9 All paint, scale and enamel shall be removed from the contact surface before the earthing connections are made.
- 6.10 All earthing connections for equipment earthing shall be preferably from the earth plate mounted above ground wherever provided.
- Equipment foundation bolts shall not be used for earthing connection.
- 6.11 Earth connections shall be made through compression type cable lugs/by welded lugs.
- 6.12 All hardware used for earthing installation shall be hot dip galvanized or zinc passivated. Spring washers shall be used for all earthing connections and all connections adequately locked against loosening.
- 6.13 Lighting fixtures and receptacles shall be earthed through the extra core provided in the lighting circuit/cable for this purpose.
- 6.14 The reinforcements of sub-station building and the sub-station floor shall be connected to main earth grid.

## 7.0 TESTING AND COMMISSIONING

- 7.1 Earthing systems/connections shall be tested as follows:
- 7.2 Resistance of individual earth electrodes shall be measured after disconnection it from the grid by using standard earth test meggar.
- 7.3 Earthing resistance of the grid shall be measured after connecting all the earth electrodes to the grid. The resistance value of an earth grid to the general mass of earth shall be as follows:
- Earthing resistance of the grid shall be measured after connecting all the electrodes to the grid. The resistance between any point on the metallic earth grid and the general mass of earth shall not exceed 1 ohm.

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- For lightning protection, the value of 5 ohms as earth resistance shall be desirable, but in no case it shall be more than 10 ohms.

7.4 The resistance to earth shall be measured typically at the following points:

- a) At each electrical system earth or system neutral earth.
- b) At each earth provided for structure lightning protections.
- c) At one point on earthing system used to earth electrical equipment enclosures.
- d) At one point on earthing system used to earth wiring system, enclosures, such as metal conduits and cable sheaths or Armour.
- e) At one point on fence enclosing electrical equipment.


7.5 All earthing layout drawings shall be marked by contractor for 'AS BUILT STATUS' and two sets of copies shall be submitted to LEPL/Owner.

## 8.0 TEST PROFORMA

The Contractor shall fill up the Test Report after the completion of the tests and shall submit it to the LEPL/Owner duly signed for his approval and acceptance.

### INSTALLATION TESTING REPORT - EARTHING INSTALLATION

- 1.0 Earthing System Data
  - 1.1 Type of Electrodes
  - 1.2 Total number of electrodes
  - 1.3 Main earth grid size
  - 1.4 Material
- 2.0 General Checks (Tick if it is in order  
Otherwise give details)
  - 2.1 Construction of earth pits and  
Installation of ground electrodes as  
per layout drawing
  - 2.2 Size of earth conduct for various  
Equipment as per layout drawing
  - 2.3 Minimum distance kept between  
Two electrodes
  - 2.4 Welding at the joints are properly made:
- 3.0 Tests
  - 3.1 Measured earth resistance of each  
electrode in Ohms
    - No.1
    - No.2
    - No.3
    - No.4
    - No.5
  - 3.2 Measurement of earth grid resistance  
(with all electrode connected to grid) :
    - a) At each electrical system or  
System neutral earth
    - b) At one point on each earthing  
System used to earth electrical  
Equipment enclosure.

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**9. EQUIPMENT EARTHING SCHEDULE**

TYPE OF EQUIPMENT	EARTH CONDUCTOR SIZE (SEE NOTE-1)
MOTOR UPTO 3.7 KW	8 SWG SOLID G.I. WIRE
MOTORS FROM 5.5 KW & WELDING RECEPTACLES	10 MM (3/8") DIA G.I. WIRE ROPE
BUILDING COLUMNS	50x 6 MM G.I. STRIP
STORAGE TANKS (VERTICAL & HORIZONTAL)	50x 6 MM G.I. STRIP
LOADING RACKS	50x 6 MM G.I. STRIP
VESSELS & HEAT EXCHANGERS	50x 6 MM G.I. STRIP
SMALL EQUIPMENT & INSTRUMENTS	8 SWG SOLID G.I. WIRE
LIGHTING, POWER & INSTRUMENT PANELS	10 MM (3/8") DIA G.I. WIRE ROPE
MAIN EARTH BUS/ MV & TRANSFORMER	AS SPECIFIED
TELECOM/ SCADA / INSTRUMENT	SEPARATE Cu STRIP OF 25x5MM OR 25 SQ.MM INSTULATED FLEXIBLE Cu CABLE (GREEN COLOUR)
PUSH BUTTON STATIONS	8 SWG SOLID G.I. WIRE
STREET LIGHT POLES	10 MM (3/8") DIA G.I. WIRE ROPE
LIGHTING TRANSFORMER	16 MM (5/8") DIA G.I. WIRE ROPE
PIPE RACK	50x6 MM G.I. STRIP
BONDING OF PIPE	25 SQ.MM INSTULATED FLEXIBLE CU. CABLE (GREEN COLOUR)
LIGHTNING PROTECTION	20x3 MM G.I. STRIP

**NOTE:-**

- EARTH CONNECTIONS TO INDIVIDUAL EQUIPMENT FROM NEAREST EARTH PLATE/ GRID MAY ALSO BE DONE ALTERNATIVELY USING ALUMINIUM/ COPPER CONDUCTOR PVC INSULATED CORE OF SIZE NOT LESS THAN HALF THE CROSS-SECTION OF RESPECTIVE POWER CABLE TO EQUIPMENT (MOTOR, PANEL ETC.). CONNECTIONS SHALL BE MADE USING CRIMP TYPE OF LUGS.
- GREEN COLOR SLEEVING (ABOUT 50MM LENGTH) SHALL BE PROVIDED AT BOTH ENDS TO DENOTE EARTHING.

\* \* \* \*



**GAIL INDIA LIMITED**

# **TECHNICAL SPECIFICATION FOR INSTALLATION, TESTING, COMMISSIONING OF ELECTRICAL EQUIPMENTS**


**(Doc. No. GAIL-STD-EL-DOC-TS-006)**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
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**1.0 GENERAL****1.1. SCOPE**

This specification covers the technical requirements for equipment, materials and installation methods, testing and commissioning of electrical system which will generally include the following:

- 1) Power Distribution Boards/Power Control Centers
- 2) Lighting Installation, including Lighting Distribution Boards, Lighting Fittings & Socket Outlets
- 3) Wiring for Power, Control, Lighting
- 4) Earthing of Electrical Equipment, & Lightning Protection
- 5) Emergency Power AMF D.G. Set
- 6) Batteries & Associated Equipment

Basic and detailed engineering including sizing and selection of electrical/CP system equipment / switch boards / cables / lighting and other materials required within the battery limit of each stations and terminals shall be performed by the detail engineering contractor. These shall include, but not limited to the following:

- a. Power distribution diagram
- b. Load calculation
- c. Transformer sizing calculation
- d. DG sizing calculation
- e. UPS sizing calculation along with associated back-up Ni-Cd battery bank
- f. Calculation for lighting system, earthing and lightning protection system, voltage drop etc
- g. Sizing of all power & control cables
- h. Preparation of cabling, lighting, earthing, lightning protection, equipment layout including other associated documents such as cable schedule, lighting/power panel schedule, cable interconnection diagrams for terminals and Sv station.
- i. Preparation of area classification drawings as per IS:5572, IEC:60079 and Petroleum rules for Terminals and SV station.

**1.2. CODES, STANDARDS AND STATUTORY REGULATIONS**


All equipment, materials and construction shall be in accordance with the latest issues of ISS, Indian Electricity rules, fire insurance regulations, factory act and regulation.

**1.3. RELATED DOCUMENTS**

This specification is to be read in conjunction with the other Bid document, which will include General Conditions of contract, Special Conditions of Contract, Specific Requirements and Schedule of Quantities and Rates. The scope of work shall be defined in Schedule of Quantities & Rates. In case of conflict between this Specification and Specific Requirement, the latter shall govern.

**GENERAL INFORMATION :**

1. INSPECTION ORGANISATION : The following recommendations will apply to all installations:
  - a) Inspection shall be carried out and witnessed by suitably trained persons.
  - b) All inspections shall be reported to the electrical department/Senior Electrical Engineer.
  - c) Inspection shall as far as practicable, be independent of maintenance, construction and

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operation activities.

- d) Wherever possible, an authorized inspector shall be appointed to be responsible for all inspecting activities, including scheduling, documentation and reporting.

2. GENERAL INSPECTION :

- a) Electrical installations and equipment, which have been completed and are ready for Operation shall be subject to certain take over procedures, which shall have been agreed before the pre-commissioning stage.
- b) Inspection will give evidence of sub standard or in adequate items at an early stage, thus avoiding delays in commissioning progress.
- c) Systematic performance of the take over inspection procedures will facilitate the collection of accurate as-built information, essential for the completion of the equipment record system, refer to section 4 for details of requirements.

3. TESTING ACTIVITIES :

- a) Prior to commissioning, the electrical installations and equipment shall be subject to a comprehensive test procedure as detailed in section 5. all test results shall be reported on the inspection forms(data sheets), section 22.

4. SAFETY ASPECTS :

- a) All inspecting and testing activities shall be carried out in accordance with the procedures in section 3 to 5 and the recommendations included in the vendor specifications for each item of electrical equipment.
- b) For activities in hazardous areas the following additional recommendations shall be adhered to :  
Electrical equipment shall not be opened until it has been isolated/discharge and the voltage shall not be restored until the enclosure has been completely re-closed. Testing in hazardous areas may be carried out, provided that areas where sparking is likely to occur, are proven to be gas free and the appropriate safety / fire permits.

**2.0 DESIGN**

2.1. EQUIPMENT & MATERIALS

Equipments supplied by the Contractor shall conform to the Owner's/Owner's Representatives 'Particular Specifications' for such equipment. These specifications may also be detailed in the documents. Materials not specifically described shall be of the best quality, complying with applicable codes, standards or current Owner's representative practice.

2.2. DOCUMENTS


These shall include but not limited to the following:

Calculations:- Earthing, Lightning Protection, Lighting, CP(TCP/PCP), Cable sizing, Load list, schedule, SLD, UPS Sizing, Servo Stabiliser sizing, DG sizing, Heat loss etc.

These shall include but not limited to the following:

Layouts:- Equipment, Indoor/Outdoor earthing, Indoor/Outdoor lighting, Indoor/Outdoor cable layout, hazardous area classification, CP cable layout etc and other if any.

Bill of materials

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### 2.3. APPROVAL OF DRAWINGS

- 2.3.1. All design calculations & drawings prepared by the Contractor shall be submitted to the Owner/ Owner's representative for comments/approval, before they are finalised. The number of copies to be furnished by the Contractor shall be indicated in the "Drawing & documents".
- 2.3.2. The Contractor shall be responsible for obtaining approvals of drawings and installation from statutory Authorities and Electrical Inspector.

## 3.0 EQUIPMENT & MATERIALS

### 3.1. GENERAL


- 3.1.1 All equipment and materials supplied by the Contractor shall be suitable in all respects for the type of environment in which these are to be used.
- 3.1.2. All equipment shall be of robust construction. The enclosures of equipment installed indoors shall be dust and damp proof. Equipments installed outdoors shall have weather proof enclosures.
- 3.1.3. For equipment installed outdoors, particular attention should be paid to the following:
- Fixing holes shall not be provided through the enclosure of casing of any component. External mounting lugs with fixing holes shall be provided.
  - Removable covers and cable entries at the top of the equipment shall be avoided as far as possible.
  - Gaskets shall be secured to the main parts of the enclosure, in such a way, that they need not be detached during normal installation and maintenance. Gasket material shall be non-deteriorating and shall not deform or set with age. Where hinged doors are provided, the door fasteners shall be designed to ensure uniform pressure at all points on the gasket, when the door is closed.
- 3.1.4. Equipment used in hazardous areas shall be certified by a competent authority as suitable for use in such areas. The enclosures and other requirements shall be in accordance with the ISS.
- 3.1.5. All equipment and materials supplied by the Contractor shall be inspected & approved by Owner/Owner's representative regarding its quality, conformity with specifications and standards and suitability for site conditions.
- 3.1.6. The Contractor shall furnish required number of copies of test certificates from manufacturers for the equipment.

### 3.2. CABLE & CONDUIT ENTRIES

Tapped entries shall be provided on equipments, for conduits and cables as far as possible. If tapped entries cannot be provided on the enclosure, conduit or cable glands terminated at the enclosure shall be effectively bonded to the same by means of an earthing or bonding washer.

### 3.3. EARTHING TERMINALS/EARTH BUS

All metal work of the enclosures and non-current carrying metallic parts of the equipment shall be effectively bonded to one another and connected to two external earth terminals provided on the

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enclosure. In equipments, such as Power Control Centres or Distribution board an earth bus running along the entire length of the board should be provided in place of earth terminals, to which the bonding of internal components shall be carried out, the earth bus in turn shall be connected to the main earthing system by 2 separate and distinct connections.

### 3.4. EQUIPMENT AND MATERIALS SUPPLIED BY THE CONTRACTOR

All equipment and materials required for the complete electrical installation shall be supplied by the Contractor.

### 3.5. CABLE

3.5.1. The types of cables used in the installations shall generally be as given below. If any Other special types of cables are required to be used, details of the types will be given in the Bid documents.

3.5.1.1 XLPE insulated with XLPE/rubber inner sheath armoured unarmoured and with overall XLPE sheath with aluminum or copper conductors.

3.5.1.2 Multicore flexible cables, with stranded copper conductors, rubber / XLPE insulated, with or without pliable armour and with an overall XLPE / Rubber Sheath.

3.5.1.3 Single core XLPE insulated cables with copper/aluminium conductors.

#### 3.5.2 Cable Terminations and Cable Joints

3.5.2.1 Heavy duty XLPE cables, upto 1.1. KV grade (armoured & unarmoured) shall be terminated by means of a compression type cable gland. In hazardous areas or for outdoor installation, cable glands with two seals, one on outer sheath and one on the inner sheath, shall be used. In safe and indoor areas, cable glands, with only one seal on outer sheath may be used. In case of glands for armoured cables, armour earthing cone or washers shall be incorporated in the gland.

3.5.2.2 Cable Glands used in Division 2 hazardous areas shall be flameproof type.


### 3.5. CONDUITS & CONDUIT ACCESSORIES

Heavy gauge, screwed, rigid steel/XLPE conduits shall comply with IS : 9537. Steel conduit may be black enamelled or galvanised as specified in the Bid documents and drawings. XLPE conduit may be black or grey as specified.

All conduit fittings and accessories shall be of cast iron/malleable iron, Provided with screwed entries, and of robust construction. Only large round junction boxes (min. dia. 80 mm) shall be used in the installation. Large round and adaptable rectangular junction boxes, shall have external fixing lugs. Two external and internal earthing terminals complete with hardware shall be provided on the steel junction boxes. Terminal blocks of adequate rating and number shall be provided in the junction boxes for looping.

All conduits and accessories shall be black enamelled or galvanised as specified in the BOQ.

### 3.6. STRUCTURAL STEEL

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All structural steel such as channels, angles, flats, plates, etc. used in the installation shall be new and of best quality, conforming to relevant Indian Standards.

**3.8. CARE OF EQUIPMENT AND MATERIALS**

**3.8.1 Storage and Care prior to Erection**

The contractor shall be entirely responsible for the safe storage and care of equipment and materials during execution of the contract.

**3.8.2. Care of Equipment After Erection**

The Contractor shall be responsible for the care and maintenance of all electrical equipment, after installations is completed and until the Certificate of Acceptance of Electrical installation is signed by the Owner.

The Contractor shall ensure that the proper enclosure of equipment is maintained at all times and that access doors or covers are opened only when necessary to work upon the equipment. All unused cable or conduit entries shall be effectively sealed.

The Contractor shall bring to the attention of the Owner / Owner's representative, in writing, any damage which may occur to electrical equipment after installation and shall also notify the Owner's representative of any abuse of electrical equipment which might cause damage.

**4.0 CIVIL WORK**

**4.1. GENERAL**

All major Civil Work such as foundation for electrical equipment, sub-stations or switch room buildings shall generally be carried by contractor's civil team. However, minor civil works such as grouting of equipment foundation bolts, breaking and remaking of floor walls, etc. is included in the scope of Contractor's electrical team.

Excavation & backfilling of trenches for directly buried cables, earth electrodes, installation of street lighting poles (including concrete foundation for poles) is included in Contractor's scope of work. Provisions of hume pipes for road crossings may also be included in the scope of Contractor's work.

**5.0 INSTALLATION OF POWER CONTROL CENTRE & DISTRIBUTION BOARD**

**5.1. GENERAL**

The Contractor shall carry out a preliminary inspection of the equipment to ensure that the switchgear to be installed is in a satisfactory condition.


**5.2. INSTALLATION**

The Contractor shall place the switchgear correctly on the bases or foundation prepared for the same. If the switchgear consists of a switchboard with number of panels bolted together, he will place all sections of the switchboard correctly, align them and bolt the

sections together to form one continuous switchboard. The switchgear shall then be secured to the foundation by means of nuts and bolts or foundation bolts grouted in the base. The Contractor shall also make inter-section bus/wiring connections.

The Contractor shall clean all parts of the switchgear, plug and socket contacts, auxiliary switches, etc. Conducting petroleum jelly shall be applied to all electrical contact surfaces.

The Contractor shall lubricate all moving parts of the Circuit Breaker mechanism with recommended lubricants, and ensure satisfactory mechanical operation. Alignment of drawout type circuit breakers or switches shall be checked, for horizontal and/or vertical movements and its correctness shall be ensured. Operation of all mechanical inter locks shall also be checked.

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The Contractor shall generally check all internal wiring of the switchgear for its accuracy as per Vendor's wiring diagram. Satisfactory operation of all controls and protection circuits, relays, meters & electrical interlocks shall also be checked. Relay settings and adjustments, if any, shall also be carried out by the Contractor.

The insulation resistance of switchgear and shall be tested with a 500 megger.

The Contractor shall carry out the high voltage tests on the switchgear.

The Contractor shall also carry out Primary and Secondary injection test and check the calibration of relays and meters.

### 5.3 Equipment Clearance

Sl. No.	LOCATION	CLEARANCE
a)	Front clearance between two L.T Panels	2000mm, (minimum 1500mm).
b)	Rear clearance between H.T Panel, L.T Panel and wall	Less than 200mm or more than 750mm(if double front it should be 1500mm).
c)	Front clearance between H.T and L.T Panel.	2500 mm or as per vendor recommendation.
d)	Side clearance between H.T and L.T Panel or Two HT/LT Panels	Less than 200mm or more than 750mm
e)	Front clearance between two H.T Panels.	3000 mm or as per vendor recommendation.
f)	Battery rack to wall clearance for <ul style="list-style-type: none"> <li>- Single row, single/double tier</li> <li>- Double row, single tier</li> <li>- Double row, double tier</li> </ul>	100mm 100mm 750mm
g)	Battery rack to rack clearance	Less than 200mm or more than 750mm.
h)	Front clearance for wall mounted equipment	750mm
i)	Rear clearance for panels from rear(MV)	1000 mm


## 6.0 INSTALLATION OF POWER & LIGHTING DISTRIBUTION BOARD

### 6.1. PRELIMINARY INSPECTION

The Contractor shall carry out a preliminary inspection of the equipment before installation to ensure that the equipment is in a satisfactory condition.

### 6.2. INSTALLATION AND COMMISSIONING

The installation of factory built distribution boards shall be carried out generally in the same manner as for Power Control Centre and Distribution board.

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In case of wall/structure mounted distribution boards, the Contractor shall fabricate and install the structural steel framework suitable for mounting the various distribution boards. The Contractor may have to prepare drawing showing the proposed general arrangement, of the structural frame which shall be to the approval of the Owner's representative. The fabrication and installation of the framework shall be recommended only after the approval of drawing. Various items for the distribution board shall be mounted in accordance with the approved drawings.

After completion of the installation of distribution boards, internal/interconnecting wiring shall be checked for correctness. Insulation resistance of wiring and equipment shall be tested with a 500 Volts megger. Operations of all equipment shall also be checked for correct functioning.

**7.0 MOTORS**

7.1. GENERAL

Motor shall generally be installed by others, along with the driven equipment. The Contractor may, however, be asked to install motors in specific instances.

7.2. COMMISSIONING OF MOTORS

The Contractor, shall however, check all the motors installed, carry out the tests required and commission the motors. The work will include the following:

- a) Check rotor for free movement.
- b) Check end play in bearings.
- c) Check for mechanical defects, if any, by visual inspection.
- d) Inspect bearings to ensure they are greased.
- e) Inspect bearings to ensure they are greased.
- f) Check conduit entries on terminal boxes, block unused entries.
- g) Carry out insulation test with an appropriate megger.

**8.0 WIRING WITH CABLES**

8.1. GENERAL


This specification covers installation, termination and connection of various types of single-core or multicore cables.

8.2. INSTALLATION OF CABLES

Cable routes and mode of installation shall generally be as shown in the Cable Tray layout drawings. When these are not indicated on the drawings, the Contractor shall determine the same and get them approved from the Owner's representative before commencing the work.

For multiple runs of cables, separation between individual cables shall be provided, when so indicated, to meet the following conditions:

- a) Spacing between power cables to suit the rating factors applied in the cable installation design.
- b) Separation between cables for high voltage service and medium or low voltage service.
- c) Separation between certain types of cables for instrument service and other cables.
- d) Separation between duplicate feeders run along the same route, to prevent damage to one feeder when the other feeder becomes faulty.

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Segregation and separation distance for instrument, communication, F&G, control, medium voltage and high voltage cable shall be minimum 300mm.

8.2.1. Identification tags indicating cable designation, shall be affixed to each cable at ends and at an interval not exceeding 15 meters or at the location where cables change direction or elevation. Cable tags shall be made of stainless steel Aluminium suitable for site and installation conditions. Cable designation shall be embossed in the tags.

8.2.2. Mode of Installation

Modes of installation of cables shall generally be as given below:

- a) Directly buried in the ground.
- b) Installed in built-up trenches in ground, floors, etc.
- c) On cable trays run overhead along pipe/cable racks, or supported on structures, masonry etc.
- d) Cables run along structural steelwork or masonry, supported by suitable saddles, cleats, hangers, etc.

8.2.3. Directly Buried Cables

Trenches shall be excavated along the routes indicated in the drawings and/or approved by the Owner / Owner's representative. They shall be straight and excavated uniformly to a depth shown on the drawings or approved by the Owner / Owner's representative.

After excavation, the floor of the trenches shall be firmed and a bedding of sifted soil or clean sand with a well distributed grain sizes shall be prepared. The thickness of the compacted bedding shall not be less than 75 mm.

Proper equipment, such as stands for supporting cable drums and rollers for drawing cables shall be used for laying cables in trenches. Cables shall be laid without kinks and utmost care shall be taken in handling them.

After laying the cables, they shall be covered with sifted soil or clean sand well compacted, upto 150 mm above the top of cables. The cables shall be covered by bricks for cable protection at top and both side.


After placing of bricks tiles, the trenches shall be backfilled completely with riddled soil. Large stones shall not be backfilled. The backfill shall be well rammed and compacted.

At road crossings or at specified locations, cables shall be laid in hume pipes or any other type of pipes specified. After drawing the cables, the ends of pipes shall be sealed adequately with wooden plugs or any other approved means, to prevent ingress of soil or dirt into the pipes and ducts.

When directly buried cables enter the buildings, the openings made in walls shall also be adequately sealed to prevent ingress of soil or sub-soil water into the building. Bituminous or suitable type of XLPE compound shall be used for this purpose.

Approved type of cable markers shall be fixed along the cable routes at a distance not exceeding 15 metres along straight routes, and also where cable loops or cable joints are located. The position of cable markers and cable identification tags shall coincide.

When cables are laid in multiple tiers, space between individual tier shall be filled and compacted with sifted soil or sand. Spacing between tiers shall be as specified in the drawings or as approved by the Owner's representative. Protective cable bricks shall be laid above the topmost tier only.

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8.2.4 Cables in Built-up Trenches

Built-up trenches for cables may be provided in outdoor plant areas, buildings, switchrooms, etc. Cables run in trenches shall unless otherwise specified, be installed in sand, in layers.

Each layer of cables shall be laid on a compacted and consolidated bed of clean sand having well distributed grain sizes (silver sand). Each layer of cables shall be covered by a well compacted clean sand upto 75 mm above the top of cables. Next layer of cables will be laid on this and bed. On completion of laying of cables, the whole trench shall be completely sand filled and well compacted. The trenches shall then be covered by any one of the following methods in accordance with Bid documents.

- a) Fitted with RCC covers (preferably coloured red) and sealed.
- b) Screeded over with red coloured lean concrete to finished payment level.
- c) Fitted with removable steel chequered plate, covers, generally in sub-stations, switch-rooms, control rooms and similar indoor locations.
- d) Fitted with specially designed covers at road crossings or similar locations subjected to heavy traffic.

Cables emerging from trenches for final runs to items of equipment shall be protected by steel pipes upto a height of 200 mm above the finished floor/pavement level. Pipes shall be fixed onto the trench wall and where they pass through the trench cover, shall be sealed with bitumastic compound.

All openings in trenches for ducts, cable entry into buildings, etc. shall be sealed adequately with bitumastic compound or lean concrete.

Where specifically called for in Bid documents, the trenches in non-hazardous indoor areas, such as control rooms, switchrooms, etc., need not be sand filled. Cables may be supported in trenches by means of hangers, cleats, cable trays, etc.

8.2.5 Cables on Walls, Structure or Cable Trays

Cables shall be run on walls, structure or laid on cable trays, as required. Only approved type of cable supports or fixings such as cleats, saddles, hangers or straps shall be used.

8.2.5.1. **Instrument layout drawings**


Cables shall be secured by means of saddle bars and saddles. Minimum clear facing between walls or steelwork and cables shall be 6 mm (1/4"). The type of saddles used shall be as shown in the drawings or subject to the approval of the Owner / Owner's representative.

8.2.5.2. **Cables Supported on Cable Trays**

Cables shall be secured to the cable trays by means of single fixing type of saddles or adjustable cable saddles, made of approved material, when run on horizontal or vertical cable trays.

8.2.5.3. **Spacing of Cable Supports**

Maximum horizontal and vertical spacing of cable supports shall not exceed 750 mm (30") and 500 mm (20") respectively. When cables are run on cable trays, they shall be securely supported on each rung of the cable tray.

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8.2.6. Cable Trays

Cable trays shall be one of the following types or as specified in the Bid document:

- a) Site fabricated ladder type cable trays from M.S. Channels, angles, flats as per cable tray details depending on the weight of cables required to be supported on cable trays and maximum cable tray supporting distance. The construction of these cable trays shall be all welded type.
- b) Shop fabricated, heavy pattern, perforated, steel cable tray galvanised or painted as specified in the Bid documents. The cable trays shall be in standard length sections and such fabricated bends or tees shall be used. Individual sections shall be securely bolted together.
- c) Shop fabricated XLPE/FRP cable trays.

Cable trays supports and tray design shall be based on the loading of cable trays. Generally, the design, shall be such that cable trays supports spacing will be 2 metres or more.

8.3. TERMINATION AND CONNECTION OF CABLES

The earthing drawings shall show the requirements of earth cabling up to the earthing systems.

8.3.1 Heavy Duty L T XLPE/XLPE Cables

Heavy duty L T XLPE/XLPE Cables, armoured or unarmoured shall be terminated with double compression type cable glands .

When armoured cables are used, the armour shall be prepared in a manner suitable for the type of cable glands. Armour shall be securely clamped and bonded to the body of the gland. Armour shall be properly cleaned and petroleum conducting jelly applied to the armour as well as clamping surfaces. When specifically called for and in hazardous areas, cable glands shall be further sealed with cold setting XLPE compound.

When cable glands are fixed onto a sheet metal enclosure, with a slip hole, a bonding/earthing washer and a heavy check-out shall be used to ensure effective bonding of the cable gland with the enclosure.

8.3.2 Prevention of Strain at Terminations


Special attention shall be given to ensure that the cable is adequately supported so that there is no strain on the termination or connection of conductors.

Particularly when cables are terminated at equipments which are subject to vibrations, strain relief clamps shall be provided where the support for the cable is derived from the equipment so as to prevent relative displacement of the support with respect to the termination.

8.3.3 Connection of Cable Cores/Conductors.

8.3.3.1. All cable cores or conductors shall be connected to the equipment terminals by means of approved type of connectors. Conductors of small sizes may be directly connected to equipment terminals, without using special connectors. The sizes of directly connected conductors will depend on the type of terminals provided. Connections of larger cables or cables connected to motors shall be made, generally with crimping type cable lugs, unless best quality, approved type, mechanical connectors are used.

8.3.3.2. Conductors shall be thoroughly cleaned and smeared with conducting petroleum jelly

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before they are connected directly or with mechanical connectors, particularly when bi-metallic connections, such as aluminium and copper or brass are made. Materials used for mechanical connectors shall also be of suitable type when bi-metallic connections are involved.

Mechanical connectors or equipment terminals shall be of pressure clamp type (not pinching type), when aluminium conductors are to be connected.

- 8.3.3.3. Core identification ferrules or coloured XLPE adhesive tapes shall be provided for all multi-core cables at the point of connection. Generally, red, yellow and blue coloured tapes may be used for identification of cores in power circuits, ferrules or numbered tapes shall be used for identification of control cable cores.

## 9.0 CONDUIT WIRING

### 9.1. GENERAL

This section covers installation of exposed and concealed conduit wiring. Concealed conduit wiring may be installed above false ceiling or behind panels, etc. or may be embedded in ceiling, walls, columns, or floor.

### 9.2. CONDUIT INSTALLATION

#### 9.2.1. Surface Conduit Installation

When conduits for exposed or concealed wiring are installed on surface, the complete routing shall be marked on the surfaces. The installation shall be carried out only after approval of the routing by the Owner's representative. Conduit installation shall be carried out accurately and neatly, with conduit runs truly vertical or horizontal. Conduits shall be threaded to close tolerances and burr removed from the ends after threading. All screwed connections shall ensure that at least five threads are engaged and electrical continuity maintained.


Conduits shall be supported with saddles at a spacing of 1200 mm maximum for conduits upto 1" size and 1800 mm maximum for larger sizes. Saddles shall also be provided at both ends of fittings, equipment, devices, junction boxes, bends or offsets, within 200 mm maximum. Minimum clearance between conduits and surface shall be 6 mm. Saddles shall be of cast/malleable iron, cast aluminium or any other approved material, and galvanised painted or cadmium plated.

#### 9.2.2. Embedded Conduit Installation

Conduit installation may be embedded in RCC structures or brick work.

The installation in RCC structures shall be carried out after the form work and reinforcement work is complete, but before concreting. Concreting, will be done only after completion of the conduit installation and its approval by the Owner's representative. Conduits laid in concrete shall have minimum 50 mm cover upto the finished surface and shall preferably be laid behind the reinforcement. Conduits shall be securely fixed to prevent their movement during concreting.

Installation in brickwork will require chases to be made in brickwork, sufficiently deep to provide adequate cover for the conduits. Conduits shall be securely fixed to the brickwork and chases made good.

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In this type of conduit installation, a galvanised fish wire shall be drawn in conduits.

All embedded accessories such as junction boxes, switchboxes, etc. shall be mounted such that they will be flush with the finished surfaces including plaster. All joints in the installation shall be tight and covers properly gasketted and fixed to prevent ingress of concrete slurry, water or dust.

9.3. CONDUIT WIRING

Conduit wiring shall generally be carried out with single core XLPE insulated cables/wires.

The Conduit installation shall be complete in all respects before the cables are drawn in conduits. All conduit runs shall be thoroughly cleaned of dust, moisture, etc. by blowing compressed air or by any other suitable means. An approved lubricating compound (such as soap stone powder, lux flakes or talc) shall be applied to the insulated cables before they are drawn in conduits. The cables shall be neatly bunched together to prevent kinks or twisting.

9.4. SUPPLY AND POINT WIRING

Each point wiring shall comprise the following :

Supply and installation of 1" / 1 1/4" heavy duty M.S. / XLPE conduits with MS/XLPE accessories such as 90° bends, inspection tees etc. as required - supply and pulling of 2 nos. 3/22 XLPE insulated stranded copper single core wires of 440V grade and one number 14 SWG copper wire outside conduit for earthing. It shall also include supply and installation of multi-way large round junction boxes with Dome/Flat covers and four way, 15A terminal block. For suspending of fluorescent lighting fitting dome cover junction box shall be used.

Supply, Fabrication and Fixing of hardware such as Clamp, Saddles, Bolts, Nuts, Framework, etc. as required. 14 gauge bare copper earthing wire shall be run within conduits for earthing of fittings, junction boxes, switch/single phase socket outlet enclosures.

Earthing shall be done at single point.

Wiring from LDB to lighting fittings exhaust fans single phase outlets, shall be carried out with 3/22, YY cables through 1" / 1 1/4" heavy duty M.S. / XLPE conduits.


Junction boxes shall be fixed on brackets, fabricated from 25 x 3 mm MS flat. Such brackets shall be fixed to the ceiling/wall by means of anchor bolts/nylon raw plugs and screws. Each equipment such as lighting fittings, switches, junction boxes, socket outlets, exhaust fans, etc. shall be earthed internally by the third core of the 3 x 2.5 mm YWY cable used.

9.5. MEASUREMENT OF POINT WIRING

Wiring from DB.'s / switchboard to the first lighting fitting through the circuit switch shall be considered as one point. Wiring from the first fitting to the next fitting in the same circuit shall be considered as half point. Wiring to the exhaust fan shall be considered as one point. For measurement of switch socket point wiring, wiring from D.S. / switchboard upto first socket outlet through ckt. Switch shall be considered as one point. Subsequent wiring to next socket outlet shall be considered as half point. Supply and installation of light fitting, fans, exhaust fans, socket outlets shall be covered under separate item rate.

If a separate circuit is tapped from the same lighting circuit, it shall be treated as half point.

If a socket is located very near to a Distribution Board, it will be considered as half point. Otherwise this shall be considered as an independent point.

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Quoted rate of point wiring is applicable for any length of conduit emanating from LOB to first fig subsequent point also.

## 10.0 EARTHING AND LIGHTNING PROTECTION

### 10.1. GENERAL

This section covers installation of earthing system for electrical equipment, static earthing and for lightning protection. Installation of earthing system for an electrical equipment and static earthing shall be carried out in accordance with IS : 3043 - 'CODE OF PRACTICE FOR EARTHING' and IS : 7689 - 'GUIDE FOR CONTROL OF UNDESIRABLE STATIC EARTHING' respectively. Earthing system for lightning protection shall be in accordance with IS : 2309 - 'CODE OF PRACTICE FOR THE PROTECTION OF BUILDINGS AND ALLIED STRUCTURES AGAINST LIGHTNING'.

Generally, a common earthing system shall be provided for equipment earthing and static earthing. The earthing system for lightning protection shall be separate and may be interconnected with the former, unless otherwise specified in the drawings/specific requirement.

### 10.2. EARTH ELECTRODES

Earth electrodes shall generally consist of copper or G.I. plates buried in ground or copper coated steel rods or cast-iron pipes driven in ground. The type of electrodes shall be specified in the Bid documents. The method of installation of earth electrode shall be in accordance with the drawings or in accordance with IS : 3043, when the drawings are not furnished.

### 10.3. MAIN EARTH CONDUCTORS

Main earth conductors shall be copper or G.I. flats or stranded copper / aluminium conductors with or without XLPE sheath as specified in the Bid documents. They shall be connected, at one end, to the earth electrode and to the earth bus or test-link at the other end. All connections below ground shall be made by bolting or riveting and brazing or welding. Sizes of main earth conductors shall be as per drawings or as specified. All connections to the test-link or earth bus shall be securely bolted. Contact surfaces shall be tinned and suitably protected with Petroleum Conducting Jelly to prevent corrosion. All connections below ground shall be protected as per IS : 3043.


### 10.4. EARTH SYSTEMS AND EQUIPMENT EARTHING

Main Earth Loops or Earthing Ring Mains shall originate from the earth bus or test links. Equipments shall be connected to the main earth loops by means of earth conductors.

All electrical equipment viz. Power centres, motors, control stations, switches lighting fittings and other electrical apparatus shall be connected to the main earth loop by means of two separate and distinct, external earth conductors. The material, type and size of the earth conductors will be as shown in the drawings or as specified.

Two earth terminals will, generally, be provided on most of the electrical equipment. However, if these are not provided, the Contractor shall provide the same, by drilling and tapping the equipment suitably and supply necessary hardware. The entire conduit installation, cable sheaths and cable armour shall also be bonded to earth at both ends.

It must be ensured that the conduit installations maintain electrical continuity throughout its entire length. Conduits shall be effectively bonded together at each joint, such as couplings, junction boxes, draw boxes or any other accessories and equipments. Where conduits and screwed cable glands are terminated at equipment enclosures with slipholes,

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earthing/bonding washer shall be used to maintain electrical continuity.

Process equipment and piping requiring static earthing shall also be earthed in a similar manner.

Steel structures for buildings, steel platforms, staircases, ladders, handrails shall also be bonded to the main earth loops by means of two separate and distinct earth conductors at two points which are as remote as possible.

All earth connections with solid or stranded conductors shall be made by means of soldered/crimping cable lugs. Connections with copper or G.I. flats shall be directly bolted type. All hardware used shall be galvanised steel, brass or passivated to prevent corrosion. Spring washer or lock-washers shall be used to make all connections secure and vibration-proof. All contact surfaces shall be thoroughly cleaned and coated with conducting petroleum jelly to prevent corrosion. Copper tapes shall be tinned at contact surfaces.

Main earth conductors from earth bus or test-link to the Earth Electrode shall be coated with bitumastic to reduce straddle potential.

**10.5. LIGHTNING PROTECTION**

Lightning protection system shall generally comprise lightning finials (air terminals), roof conductors, down conductors, test links and earth electrodes: The number, types, materials and sizes shall be in accordance with the drawings.

Air terminals shall be mounted on top of buildings or structure as shown in the drawings. All air terminals shall be inter-connected with roof conductors, pipes, hand rails or any other metallic projection above the roofs shall also be bonded to the roof conductors. Down conductors from air terminals or from roof conductors shall be routed as directly as possible to the test links on earth buses, with minimum bends.

All provisions regarding connections of conductors for equipment earthing system shall also apply to lightning protection system.

In corrosive atmospheres, lightning finials or air terminals shall be covered by plumbing metal for corrosion protection.

**11.0 ELECTRICAL INSTALLATION IN HAZARDOUS AREAS**

**11.1. GENERAL**


Electrical installation in hazardous areas as defined in IS : 5571 shall be carried out with utmost care and special precautions shall be taken to ensure operational safety.

All personnel, especially supervisory staff, working on such installations shall be fully conversant with the applicable National Standards and Codes of Practice and shall have previous experience of such work.

**11.2. EQUIPMENT AND MATERIALS**

Electrical equipment and materials used in the installation shall conform to the relevant Standards and shall be certified ( by a competent authority) suitable for use in Division 1 or Division 2 hazardous areas, as the case may be.

No modifications shall be made in any certified equipment or material used in the installation which will impair its effectiveness and invalidate the certificate.

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All certified equipments shall be inspected before their use for any damaged or deteriorated condition which will render the equipment unsafe. Such equipments shall not be used in the installation.

When any equipment is dismantled for the purpose of installation, care shall be taken to prevent damage to vulnerable parts such as screw threads, conduits threads, machines surfaces, etc. If the equipment is to remain dismantled for a prolonged period, machined surfaces, screw threads, etc. shall be protected against corrosion by means of grease, oil, petroleum jelly or any suitable corrosion inhibitor. These shall, however, be cleaned thoroughly before re-assembly.

All hardware used for mounting shall be hot dip galvanised or plated to prevent corrosion. All bolted connections shall be made secure and vibration proof by means of locknuts, lock washers, etc.

### 11.3. WIRING

All wiring in Division 1 hazardous areas shall be carried out with armoured cables or with solid drawn seamless conduits. In Division 2 areas, ERW conduit may be used.

Termination of cables shall be made with certified or approved cable glands boxes shall be effectively sealed. All conductors connections shall be made with soldered/crimping cable lugs, or approved mechanical connectors. It must be ensured that all connections shall be made secure and vibration-proof, by means of locknuts, lock-washers, etc. Prevention of strain at terminations is of utmost importance.

### 11.4. EARTHING

All provisions for earthing apply with much greater force regarding effective bonding of electrical equipment, cable armour, conduit installation, process equipments and process piping (requiring static earthing) to the earthing system.

Special attention shall be paid to the following :


- a) Adequate support for earth conductors throughout for protection against breakage.
- b) Secure and vibration proof earth connections, protected suitably against corrosion.
- c) Continuity of conduit installation or process piping when static earthing is required, by means of conduit bonds.

### 11.5. MISCELLANEOUS

All openings between hazardous and non-hazardous areas for cable and conduits shall be properly sealed by approved means. In case of conduit wiring, conduit stopper boxes shall be used in conduit runs at the junction of hazardous and non-hazardous areas or at terminations of conduit runs at any equipment such as motors, starters, push buttons, etc. Stopper boxes at the junction of hazardous and non-hazardous areas, shall be located at the boundary between the 2 areas.

### 11.6. STEEL WORK

- 11.6.1. All steel work carried out by the Contractor for equipment and cable supports such as cable trays, brackets, hangers, saddles, etc. shall be of the best workmanship. Only certified

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welders shall be employed for welding. All bolted connections shall be made secure and vibration proof by means of spring washers or lock washers or lock nuts. Fixing or grouting of steel-work in floor, ceilings or walls shall be carried out with approved foundation bolts or fasteners.

11.6.2. Finished steel work shall be thoroughly cleaned by wire-brushing or sand blasting etc. All scales and rust shall be removed. The steel work shall be then painted with 2 coats of approved primer such as red oxide or red lead and shall be finished with 2 further coats of approved paint.

11.6.3. When atmospheric conditions are highly corrosive, chemical works type paints may be specified. In such cases, special primers and paints shall be used for adequate protection from corrosion.

## **12.0 INSPECTION, TESTS AND COMMISSIONING OF ELECTRICAL EQUIPMENT AND INSTALLATION**

### **12.1. GENERAL**

This Section covers the requirements of inspection and tests to be carried out on equipment and installation as well as commissioning of electrical installation. Inspection and tests shall be carried out jointly by the Contractor, Owner & Owner's Representative.

### **12.2. INSPECTION**

Inspection shall be carried out to ensure that the complete installation is carried out in accordance with drawings and complies with the requirements laid down by Indian Electricity Rules, Regulations for the Electrical Equipment of Building by Insurance Association of India (Fire Section), Indian Standard Specifications & Codes of practice, Electrical Inspector, Explosive Inspector and any other statutory regulations. And

competent authorities. The complete installation shall be subject to the approval of any or all of the competent authorities and the Owner / Owner's representative.


### **12.3. TESTS**

The tests specified below shall be carried out on the electrical equipment and installation before commissioning the same. The tests shall be performed by or under the direct supervision of a competent person, qualified to carry out the tests. All tests shall be carried out in the presence of the Authorised Representative of the Owner.

The installation shall not be accepted by the Owner unless it has been approved by the competent authorities, and the authorised representative of the Owner and/or the Owner's representative.

All test results shall be recorded on prescribed ' ELECTRICAL TEST REPORTS ' duly signed by the person conducting the test and by the authorised representative of the Owner and/or the Owner's representative, if tests are witnessed.

In case the installation is found to be not in conformity with the requirements or the test results indicate defective materials or workmanship, the same will have to be rectified to the complete satisfaction of the Owner/Owner's representative and tested again.

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## DETAILS OF TESTS

### • POWER CONTROL CENTRE WITH ACB


- a) Check proper mechanical operation of circuit breakers including alignment of trolleys in case of draw-out type circuit breakers, smooth operation of all mechanical parts, lubrication, mechanical interlocks etc.
- b) Check contact alignment and wipe, proper sequence of closing and opening of main and arcing contacts.
- c) Check electrical relays, instruments and controls for correct wiring.
- d) Insulation test on bus bars - phase to phase and phase to ground. This test will be carried out with circuit breakers in service position, but contacts remaining open.
- e) Insulation test on relays and control wiring including current and potential transformers and wiring of CT & PT secondary.
- f) Insulation test on circuit breakers in withdrawn position - phase to phase and phase to ground with contacts closed.
- g) Adjust correct settings of relays and/or direct acting trips - as specified.
- h) Operation Test - Energise only control circuits and carry out closing and tripping operations (where AC supply derived from main supply is used for operation, the switchgear bus may be energised). Check operations of electrical interlocks. Check tripping of circuit breakers by manual operations of protective relay contacts. Check operations of mechanical closing and tripping devices. Check lockout conditions for closing of circuit breakers by simulating the required conditions. Check control, indications, sequence interlocks and alarms.
- i) Polarity and connections of instrument transformers - Check for correctness of CT & PT connections provided. Check electrical continuity of secondary circuits with ELV tester.
- j) Adjust spacing of arcing horns/rod gaps, if provided.
- k) Check operation of instruments, meters, relays and tripping of circuit breakers by primary/secondary injections as specified.
- l) Check continuity of power circuits and earth continuity of all non current carrying metallic parts with a low voltage (6 volts or less) continuity tester.
- m) Carry out HV test on power and control circuits, if specifically called for.

### • SWITCHGEARS, POWER CONTROL CENTRES (POWER DISTRIBUTION BOARDS), UPS, ETC.

- a) Check equipment, internal wiring, smooth mechanical operation, interlocks, etc.
- b) Check continuity of power circuits and earth continuity of all non current carrying metallic parts with a low voltage continuity tester.
- c) Insulation test for power & control circuits between phases, between phases and neutral and between phase/neutral and ground.
- d) Check operation by energising control circuits (without energising power circuits) for correct functioning. Simulate external controls and interlocks for the same. Note chatter or humming of Contractor and rectify, if necessary.
- e) Check fuse relay and relay.
- f) Carry out HV test on power & control circuits, if specifically called for in Bid documents.
- g) Polarity and connections of instrument transformers - check for correctness of CT & PT connections provided. Check electrical continuity of secondary circuits with ELV tester.

### • MOTORS

- a) Check equipment for free movement of rotor, and play, lubrication, and for any other mechanical defects.
- b) Insulation test of motors.

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- c) Check electrical continuity with ELV tester.
- d) No load running of motor noting down no load current and voltages in all three phases.

• CABLES

- a) Insulation Test - between phases, between each phase and neutral and between each phase/neutral and ground Ref. Appendix - II).
- b) In case of lighting wiring, insulation test shall be carried out on lighting feeders with branch circuits open. Branch circuits shall be tested separately with lampholders, plug receptacles and lighting fittings in position, but without lamps. In case of lighting circuits with lamp ballasts and glow starters insulation resistance may be measured between phase and ground only.
- c) In case of directly buried cables, insulation resistance of cables shall be measured before and after the back-filling.
- d) Test all receptacles for correct phase sequence .

• EARTHING SYSTEM

- a) Measure earth resistance of each electrode separately. If a number of earth electrodes are interconnected with one another, combined earth resistance shall also be measured. The earth resistance of each electrode and/or a group of electrodes shall not exceed the values specified.
- b) Continuity test for earth continuity conductors with ELV tester

• BATTERY

- a) Visual inspection of all components.
- b) Capacity test as per I.S.

**13.0 INSTRUMENTS & TOOLS**

13.1. GENERAL

This section covers the instruments, tools & plant which will normally be required to carry out the electrical installation including testing and commissioning and which shall be made available as and when required by the Contractor. Meters used for tests shall be of proven accuracy and to the satisfaction of the Owner's representative.

13.2. TOOLS AND PLANT

13.2.1. Hand Tools


Screw drivers, pliers, cutters, spanners, hacksaw, hammers, rawl punches, etc.

13.2.2. Power Driven Tools & Equipment

Drilling, grinding, cutting machines, hammers, arc welding set, oxy-acetylene welding and cutting set and welding accessories.

13.3. INSTRUMENTS

- A. Instruments to be always available at Site.
  - a) Insulation resistance tester (Megger) rated 500 volts.
  - b) Multi-meter of a reputed made.
  - c) Clip-on ammeter/voltmeter (tong tester)
  - d) Phase sequence indicator.
  - e) Extra low voltage continuity tester (6 volts or less).

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- B. Instruments to be made available as and when required.
  - a) Insulation resistance tester (Megger) rated 500/100/2500/5000 volts.
  - b) Earth resistance tester with all accessories.
  - c) High voltage testing set.
  - d) Relay testing equipment.

**14.0 LABOUR, SUPERVISION, COORDINATION AND PROGRESS, LICENCE, STATUTORY APPROVAL**

**14.1. SUPERVISORY LICENCE**

The Contractor shall possess a valid contractor's licence for the state in which site is located and shall ensure its validity during the duration of the contract. The Contractor shall furnish authenticated copies of certificates to the Owner for himself and his workmen before commencement of work.

**14.2. LABOUR**

The Contractor shall employ adequate number of supervisors to control the labour force and to carry out the work as per schedule. Supervisory staff shall also possess the minimum qualifications stipulated by statutory and competent authorities.

**14.3. SUPERVISION**

The Contractor shall employ adequate number of supervisors to control the labour force and to carry out the work as per schedule. Supervisory staff shall also possess the minimum qualifications stipulated by statutory and competent authorities.

**14.4. COORDINATION**

The Contractor shall coordinate his work with that of other agencies, so that the work can proceed smoothly and without hindrance to all concerned.

**14.5. PROGRESS**

The Contractor shall submit periodic Progress Reports to the Owner's representative. The period of report shall be determined by the Owner's representative. The Progress Report shall indicate planned progress as per programme and physical progress. The format in which the reports are to be submitted shall be decided by the Owner's representative.

**14.6. STATUTORY APPROVAL**

The Contractor shall be totally responsible for obtaining statutory approval from the electrical inspector or any other statutory authority for the entire installation carried out by him unless otherwise specified and agreed. Necessary test reports shall be submitted by him to electrical inspector. This will be an integral part of the contract and shall not be paid for separately. However, fees payable to statutory authorities shall be borne by Owner.

**14.7. EXTRA ITEMS**

Extra items of work pertaining to the electrical installation may have to be carried out by the Contractor whenever required. The contractor shall submit to the Owner the invoices covering unit rate or lumpsum price for such extra items. Such invoices shall be complete with documents of authorisation and work approval and necessary break up for the cost.


**15.0 RECONCILIATION**

After completion of installation and commissioning work, Contractor has to reconcile all the materials such as steel and cables issued free to him by the Owner. Only 3% will be allowed as wastage for reconciliation and cut piece above 1 M length shall be considered accountable.

**16.0 QUALITY ASSURANCE-- QUALITY CONTROL**

**16.1. QUALITY ASSURANCE (Q.A.)**

Quality Assurance (Q.A.) shall be furnished by contractor for Owner's / Consultant

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- approval.
- 16.2. Q.A. INVOLVEMENT  
Q.A. involvement will commence at the instigation of the project and follow through to final acceptance of each and every system and item of equipment, thus ensuring total conformity to the Owner's requirements.
- 16.3. TEST SHEETS  
The Contractor shall provide the necessary 'Test Sheets' for recording the results of his electrical acceptance tests.
- 16.3.1. The full set of forms shall be submitted to the Owner's representative for his approval prior to the implementation of the acceptance testing programme.
- 16.3.2. The tests which the Contractor must perform, as a minimum requirement, shall be those described in clause 13.0 of this specification in the order indicated and shall be made in accordance with the equipment and/or systems Standards and Regulations quoted by the Owner's representative in the Bid documents and any tests required by the particular equipment/system manufacturer.
- 16.3.3. Test values acceptable to the Owner's representative shall be those laid down in the indicated standards and specifications by the Owner's representative, together with any values quoted in the Bid documents. Any discrepancy in the acceptable test values discovered by the Contractor shall be resolved by the Owner's representative, whose interpretation shall be final. No equipment shall be set to work unless tests on its associated circuits have been found satisfactory.

**17.0 ACCEPTANCE OF INSTALLATION**

On completion of the work the Owner's representative, together with a representative of the Owner and the Contractor, will carry out an Inspection of the Installation. The Owner's representative will issue a completed copy of the Owner's Acceptance of Electrical Installation to the Contractor as confirmation that the work has been accepted, subject to any matters noted on the form being attended to.

## APPENDIX 1 - LIST OF CODES, STANDARDS & STATUTORY REGULATIONS

Spare capacity is depending on the type of equipment and is defined in the following table.

IS: 732	Code of Practice for Electrical Wiring Installations.
IS: 1646	Code of Practice for Fire Safety of Buildings (General) Electrical Installation.
IS: 3043	Code of Practice for Earthing.
IS: 2309	Code of Practice for the Protection of Buildings & Allied Structures against Lightning.
IS: 7689	Guide for control of undesirable static electricity.
IS: 900	Code of Practice for Installation and Maintenance of Induction Motors.
IS: 10118	Code of Practice for Selection, Installation and Maintenance of Switch gear and
Parts I to IV	control gear
IS: 5571	Guide for Selection of Electrical Equipment for Hazardous Areas.
IS: 5572	Classification of Hazardous Areas of Electrical Installation.
IS: 5216	Safety Procedure and Practice in Electrical work.
-	Regulations for the Electrical Equipment of Buildings - The Institution of Electrical Owner's representatives.
-	Indian Electricity Rules.
-	Fire Insurance Regulations
-	Factory Act & Regulations
-	National Building Code (ISI Publication)
-	National Electrical Code (ISI Publication)
-	Tariff Advisory Committee Regulation

## APPENDIX 2 – CABLE

### 1. TESTING AND ELECTRICAL MEASUREMENTS OF CABLE INSTALLATIONS

#### 1.1. INSULATION RESISTANCE TEST ON NEWLY INSTALLED CABLES BEFORE JOINTING.

All new cables should be tested for insulation resistance before jointing. After satisfactory results are obtained cable jointing and termination work should commence. It should be noted here that insulation resistance test gives only approximate insulation resistance and the test is meant to reveal gross insulation fault(s). A fairly low insulation resistance reading compared to the values obtained at factory testing should not be a cause of worry since the insulation resistance varies greatly with parameters such as length and temperature. This is particularly more pronounced in the case of XLPE cables. The voltage rating of the insulation resistance tester for cables of different voltage grades should be chosen from the following table:

Voltage Grade of Cable	Voltage Rating of IR Tester
1.1 Kv	500 V
3.3kV	1000 V
6.6kV	1000 V kV
11	1000V
22	kV 2.5 kV (see Note)
33	kV 2.5 kV (see Note)

NOTE - For long feeders, motorized insulation resistance tester should be used.

1.1.1. More accurate insulation resistance values can be measured only by a portable resistance measuring bridge.

#### 1.2. TEST RESULT OF COMPLETE CABLE -INSTALLATION

The test of completed installation may be measured and entered into record book for comparison purposes during service life of cable installation and during fault location.

##### 1.2.1. Insulation Resistance

Insulation resistance is measured by a suitable bridge. In non-screened cables, the insulation resistance of each core is measured against all the other cores and armour/metal sheath connected to earth. With screened construction the insulation resistance of each core is measured against all the other cores and the metal screen connected to earth.

##### 1.2.2. Conductor Resistance (dc)

1.2.2.1. *The resistance of conductor is measured by a suitable bridge. For this purpose conductors at other end are looped together with connecting bond of at least same effective electrical cross-section as conductor. The contact resistance is kept to a minimum by proper clamped or bolted connections. With properly installed and jointed cables, values thus measured and corrected to 20°C, are in general agreement with values given in test certificates.*

1.2.2.2. *The measured loop resistance is converted to ohms per km per conductor as :*

$$\begin{array}{l} 1) \\ 2) \end{array} \quad R_t = \frac{R}{2L}$$

where


R = measured loop resistance in ohms at temperature, t°C;

R<sub>t</sub> = measured resistance per conductor at t°C in ohms; and

L = length of cable (not the loop) in km.

The ambient temperature at the time of measurement to be recorded and the conductor resistance to be corrected to 20°C by the following formula:

$$3) \quad R_{20} = \frac{R_t}{\dots} \quad \text{ohm/km at } 20^\circ\text{C}$$

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$$4) \quad (1 + a) (t-20)$$

where

R20 = conductor de resistance at 20°C in ohm/km;

t= ambient temperature during measurement in °C ; and

L= temperature coefficient of resistance

(3.93 x 10.3 ohms/°C for aluminium).


## 2. CABLE INSTALLATION PLAN

2.1.1. On completion of laying, terminating and jointing of the cables, a plan should be prepared, which should contain the following details of the installation:

- a) type of cables, cross-section area, rated voltage. Details of construction, cable number and drum number;
- b) Year and month of laying;
- c) Actual length between joint-to-joint or ends
- d) Location of cables and joints in relation to certain fixed reference points, for example, buildings, hydrant, boundary stones, etc.;
- e) Name of the jointer who carried the jointing work;
- f) Date of making joint; and
- g) Results of original electrical measurements and testing on cable installation.

2.1.2. All subsequent changed in the cable plan should also be entered.

\* \* \* \* \*

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GAIL INDIA LIMITED



**DATA SHEET FOR MAIN ELECTRICAL  
DISTRIBUTION BOARD (MEDB)**

TOTAL SHEETS

07

DOCUMENT NO

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REV	DATE	DESCRIPTION	PREP	CHK	APPR
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## TABLE OF CONTENTS

- 1.0 GENERAL**
- 2.0 BUS BAR**
- 3.0 CURRENT TRANSFORMER**
- 4.0 POTENTIAL TRANSFORMER**
- 5.0 SWITCHES**
- 6.0 FUSES**
- 7.0 RELAYS**
- 8.0 INSTRUMENT METERS**
- 9.0 MOULDED CASE CIRCUIT BREAKER**
- 10.0 CIRCUIT BREAKERS**
- 11.0 CONTACTOR**



**DATA SHEET FOR MAIN  
ELECTRICAL DISTRIBUTION  
BOARD (MEDB)**

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## (TECHANICAL DATA SHEET)

TECHINICAL DATA SHEET (To be furnished by Vendor)

### 1.0 GENERAL

- 1.1 Design ambient, Humidity, altitude (Site Conditions) :
- 1.2 Supply system Voltage :
- 1.3 Rated Current :
- 1.4 Symmetrical Short Circuit capacity/ Switchgear Fault Rating :
- 1.5 Power frequency withstand voltage :
- 1.6 Short circuit Making/ Breaking Capacity :
- 1.7 Supply system Earthing :
- 1.8 Cable entry (Incoming & Outgoing) :
- 1.9 Earth Bus bar – Material, Rating, Size etc :
- 1.10 Control supply voltage :
- 1.11 Withdrawable - Draw out type / Fixed :
- 1.12 Lifting arrangement :
  
- 1.13 Make :
- 1.14 IP Class of enclosure :
- 1.15 Type :
- 1.16 Thickness of sheet steel :
- 1.17 Treatment :
- 1.18 Painting :
- 1.19 Overall dimension :
  - L
  - B
  - H
- 1.20 Space heater rating of each panel :
- 1.21 Weight of the MEDB :

### 2.0 BUS BAR

- 2.1 Material :
- 2.2 Size :
  - a) Horizontal bus bar :
  - b) Vertical bus bar :
  - c) Ground :
- 2.3 Minimum Clearance :
  - a) Between phases :



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- b) Between phase and earth :
- 2.4 Minimum creep age distances :
- 2.5 Current rating :
- a) Continuous :
- b) Short time for 1 second :
- 2.6 Temp. rise over ambient :
- a) Supports :
- b) Material :
- c) Make :
- d) BIL :
- 2.7 a) Supports :
- b) Materials :
- c) Make :
- d) Voltage :
- e) BIL :
- 2.8 Bus bar insulation :
- 2.9 Bus bar phase identification mark :

**3. CURRENT TRANSFORMER (CT)**

- 3.1 Make :
- 3.2 Type of primary winding :
- 3.3 Ratio :
- 3.4 Rated Burden :
- 3.5 Accuracy class :

**4.0 POTENTIAL TRANSFORMER (PT)**

- 4.1 Make
- 4.2 Type of primary winding
- 4.3 Ratio
- 4.4 Rated burden
- 4.5 Accuracy class



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**5.0 SWITCHES**

- 5.1 Rated voltage
- 5.2 Rated thermal current
- 5.3 Duty

**6.0 FUSES**

- 6.1 Make
- 6.2 Type of HRC fuse
- 6.3 Rated voltage

**7.0 RELAYS**

- 7.1 Application
- 7.2 Make

**8.0 INSTRUMENT AND METERS**

- 8.1 Application
- 8.2 Make
- 8.3 Maker's type
- 8.4 Ref. Standard
- 8.5 Operating principle
- 8.6 Rated voltage/current
- 8.7 Burden at rated voltage/current
- 8.8 Operating range
- 8.9 Scale range

**9.0 MOULDED CASE CIRCUIT BREAKER (MCCB)**

- 9.1 Make



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- 9.2 Rated Voltage
- 9.3 Rated Thermal current
- 9.4 Short Circuit Capacity

**10.0 CIRCUIT BREAKERS**

- 10.1 Make
- 10.2 Short circuit capacity
- 10.3 Short circuit category
- 10.4 Type of medium
- 10.5 Rated voltage
- 10.6 Maximum operating voltage
- 10.7 Frequency
- 10.8 No. of poles
- 10.9 Rated operating duty
- 10.10 Current rating
  - a) Continuous
  - b) Short circuit Rating
- 10.11 Type of closing mechanism
- 10.12 Type of tripping mechanism
- 10.13 Anti pumping features
- 10.14 Details of spring charged motor
  - a) Motor
  - b) Rating
  - c) Insulation
  - d) Duty
- 10.15 Control Voltage with range
  - a) Closing
  - b) Tripping
  - c) Alarm and Indication



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10.16 Power *I* Current required for

- a) Closing
- b) Tripping

**11.0 CONTACTOR**

11.1 Make

11.2 Rated Voltage

11.3 Rated Thermal current

11.4 Short circuit capacity

\* \* \* \* \*



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GAIL INDIA LIMITED



**DATA SHEET FOR POWER & CONTROL  
CABLES**

TOTAL SHEETS

04

DOCUMENT NO

GAIL-STD-EL-DOC-DS-002

REV	DATE	DESCRIPTION	PREP	CHK	APPR
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## TECHNICAL DATA SHEET

### TECHNICAL DATA SHEET (To be furnished by Vendor)

1. Name of the manufacturer
2. Voltage Grade
3. Type of cable
4. Standard Referred
5. Conductor
  - a. Material grade
  - b. No. of cores
  - c. Max allowable temperature (running & Short circuit)
  - d. Approx. Diameter
  - e. Normal cross sectional area
  - f. Shape of the conductor
  - g. Max. D.C. resistance at 20 Deg. C.
  - h. Number of strands
6. **Insulation**
  - a. Type and material of Insulation
  - b. Thickness of insulation
  - c. Colour Scheme/Core Identification
  - d. Extruded
7. **Inner-Sheath**
  - a. Material
  - b. Minimum Thickness
  - c. Extruded
  - d. Approximate dia over inner sheath



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8. **Armour**
  - a. Type
  - b. Material
  - c. Nominal Thickness
  - d. Diameter
  
9. **Outer Sheath**
  - a. Material
  - b. Minimum Thickness
  - c. Extruded
  
10. **Approximate overall diameter.**
  
11. **Normal drum length**
12. **AC resistance of the conductor at maximum operating Temperature**
  
13. **Approximate Reactance and Capacitance of Cable per phase at 50Hz.**
  
14. **Current Rating**
  - a. In ground
  - b. In air
  - c. Maximum conductor temperature during continuous Operation
  - d. Maximum conductor temperature during short Circuit
  - e. Short circuit rating



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f. Maximum permissible bending radius

**15. Standard Drum Length/Size/Material**

**16. FRLS properties**

**17. Embossing on Outer sheath**

\* \* \* \* \*



**DATA SHEET FOR POWER &  
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**GAIL INDIA LIMITED**  
**QUALITY ASSURANCE PLAN (QAP)**  
**PANELS & DISTRIBUTION BOARDS**



**DOC. No: GAIL-STD-EL-DOC-QAP-001**

date -29.01.2019

**QAP for Panels/Distribution Boards**

SL. No.	Component/Operation	Class	Type of Check	Quantum of Check	Reference Doc	Acceptance Norms	Inspection			
							MANU.	TPI	GAIL	
<b>1</b>	<b>Raw Material Inspection</b>									
1.1	Cubicle	1. Material	B	Visual	100%	IS 513	IS 513	P	R	R
		2. Adhesion	B	Visual	100%	No peeling	No peeling	P	R	R
		3. Coating Thickness	B	Physical	One per lot	60 Microns	60 Microns	P	R	R
		4. Overall Quality & Correctness	B	Visual	100%	As per Drawing	As per Drawing	P	R	R
1.2	Wire	1. Dimension & size	B	Physical	One per lot	IS 694 / IS 732	IS 694 / IS 732	P	R	R
		2. Routine Test	B	Physical		IS 694 / IS 732	IS 694 / IS 732	P	R	R
1.3	Bus bar	1. Dimension	B	Visual	One per lot	IS 5082	IS 5082	P	R	R
		2. Conductivity	B	Electrical		IS 5082	IS 5082	P	R	R
		3. Material grade	A	Test Report		IS 5082	IS 5082	P	R	R
1.4	ACB's, MCCB's, Switches, Fuse connectours, O/L Relays, Timers, MCB's, Terminal Blocks, Control Indicating & Measuring instruments, CT, PT, Control Transformer & Protection Relays etc	1. Physical Check	B	Visual	100%	IS 13947 /IEC 60947	IS 13947 /IEC 60947	P	R	R
		2. Type & Rating	B	Visual				P	R	R
		3. Make	B	Visual				P	R	R
		4. Coil Voltage	B	Electrical				P	R	R
		5. Operation	B	Electrical				P	R	R
		6. Continuity (On/Off)	B	Electrical				P	R	R
		7. Test Certificate	A	Records				P	R	R
1.5	Push Buttons, SFU, Indicating Lamps, Fuses etc	1. Physical Check	B	Visual	100%	IS 13947 /Fuse -IEC 60269	IS 13947 /Fuse -IEC 60269	P	R	R
		2. Type & Rating	B	Visual	100%			P	R	R
		3. Operation	B	Electrical	10%			P	R	R
		4. Continuity (On/Off)	B	Electrical	10%			P	R	R
1.6	Paint	1. Shade	B	Visual	Sample	IS 5	IS 5	P	R	R
		2. Finish	B	Visual	Sample	IS 5	IS 5	P	R	R
	<b>Name Plate</b>	Stainless steel	A	Visual	100%					
		Resistance Screw or rivet	A	Visual	100%					
<b>2</b>	<b>In Process Inspection</b>									
2.1	Cubicle	1. Dimension	B	Physical	100%	IS 513	IS 513	P	R	R
		2. Mounting Facility	B	Visual	100%	As per Drawing	As per Drawing	P	R	R
		3. Cable Glanding Plate	B	Visual	100%	As per Drawing	As per Drawing	P	R	R
		4. Degreasing	C	Visual	100%	IS 6005	IS 6005	P	R	R
		5. Derusting	C	Visual	100%	IS 6005	IS 6005	P	R	R
		6. Deburring	C	Visual	100%	No Burrs	No Burrs	P	R	R
		7. Phosphatising	C	Physical	100%	IS 6005	IS 6005	P	R	R
		8. Passivation	C	Visual	100%	IS 6005	IS 6005	P	R	R



**GAIL INDIA LIMITED**  
**QUALITY ASSURANCE PLAN (QAP)**  
**PANELS & DISTRIBUTION BOARDS**



2.2	Busbaring	1. Material (Al/Cu)	B	Visual	100%	IS 5082	IS 5082	P	R	R
		2. Size (Thickness/Width)	B	Physical		IS 5082	IS 5082	P	R	R
		3. Busbar Tightening	B	Physical		As per specified Torque	As per specified Torque	P	R	R
		4. Phase to Phase Clearance	B	Physical		>25mm	>25mm	P	R	R
		5. Phase to Earth Clearance	B	Physical		>19mm	>19mm	P	R	R
		6. Spacer between parallel busbars	B	Visual		Equal to Busbar size	Equal to Busbar size	P	R	R
		7. Check for Burrs	B	Visual		No Burrs		P	R	R
		8. Finish Uniformity	B	Visual				P	R	R
2.3	Wiring	1. Size of wire	B	Physical	10%	IS 694 / IS 732	IS 694 / IS 732	P	R	R
		2. Colour of wire	B	Visual				P	R	R
		3. Ferruling	B	Visual	100%	As per Drawing	As per Drawing/Requirement	P	R	R
		4. Sleeve size	B	Visual				P	R	R
		5. Terminals	B	Visual				P	R	R
		6. Wiring Layout	B	Visual				P	R	R
		7. Accessibility	B	Visual				P	R	R
		8. Correctness of wiring	C	Electrical				P	R	R
2.4	Circuit checking	MCCB/MCB Closing and tripping mechanism	C	Electrical	100%	As per Drawing	As per Drawing/Requirement	P	R	R
		control circuit and interlock	C	Electrical				P	R	R
		heater, lamp and earth leakage relay	C	Electrical				P	R	R
		Meter and metering cricket	C	Electrical				P	R	R
		Remote close /trip	C	Electrical				P	R	R
		CT/PT Check	C	Electrical				P	R	R
		Indications	C	Electrical				P	R	R
2.5	Gasket	1. Fitment	B	Visual	100%	As per Drawing	As per Drawing/Requirement	P	R	R



**GAIL INDIA LIMITED**  
**QUALITY ASSURANCE PLAN (QAP)**  
**PANELS & DISTRIBUTION BOARDS**



3 Acceptance Test									
	1. Functional check	B	Electrical	100%	IS 9815 & Approved Drawings/Specs /IEC 60439	IS 9815 & Approved Drawings/Specs /Testing certificated /IEC 60439	P	W	W
	2. Bill of material	B	Visual				P	W	W
	3. H.V. Test	C	Electrical				P	W	W
	4. I.R. Test	C	Electrical				P	W	W
	5. Final Test	B	Electrical				P	W	W
	6. CT Ratio / Current	B	Electrical				P	W	W
	7. Dimensional , Layout & Visual Check	B	Visual	Sample	IS 5	IS 5	P	W	W
	8. Paint shade & Thickness	C	Physical				P	W	W
	9. Meggar Test	B	Electrical	100%	IS 9815	IS 9815	P	W	W
	10. Interchangability of similar module	B	Electrical	100%	IS 9816	IS 9815 & Approved Drawings/Specs/Testing certificated	P	W	W
	11.Operation Of Equip.	B	Electrical	100%	IS 9817		P	W	W
	12.Fitting & finishing Of Equipments	B	Visual	100%	IS 9818		P	W	W
4	<b>PACKING FOR DESPATCH</b>								
	1.Standard Weather proof packing	A	Visual	100%		Approved Drawings/Specs	P	R	R
	2. Wooden packing (if required by client)	A	Visual	100%			P	R	R
	3. Each panel	A	Visual	100%			P	R	R
	4. Display of Top & Front	A	Visual	100%			P	R	R
5. Documentation	A	Visual	100%		P		R	R	
5	<b>Inspection Release Note</b>	A	Visual	100%	GAIL Specification		P	R	R
6	<b>Commissioning at site</b>	A		100%	GAIL Specification	GAIL Specification	P	W	W
	R: Review of Docs								
	A: Minor	NOTE: ALL TESTING AND MEASURING EQUIPMENTS/INSTRUMENTS SHALL HAVE VALID CALIBRATION WITH							
	B: Major	CALIBRATION CERTIFICATES & TRACEABILITIES.							
	C: Critical								
	W: Witness								
	TPI	Third Parti	Inspection						



GAIL INDIA LIMITED



DOC. No: GAIL-STD-EL-DOC-QAP-003

QUALITY ASSURANCE PLAN FOR  
LIGHTINGPANEL

SR NO	Component/ Operation	Characteristic	Class	Type of Check	Quantum of check	Reference Document	Acceptance Norm	INSPECTION		Remarks
								Manu.	GAIL/TPI	
<b>1</b>	<b>RAW MATERIAL &amp; COMPONENT</b>									
1.1	MS Steel Paints Electrical Wire	a) Wire/conductor b) Type c) Dimension d) Weight f) Make/Type of Material	Major	Physical	100%	Approved Drgs	Reference Drgs	P	R	
<b>2</b>	<b>In Process</b>									
2.1	Machining & Finishing of enclosure	a) Machining b) Blow holes c) Entry holes/ Threading d) Mounting holes e) Earthing holes	Major	Visual	100%	Approved Drgs	Reference Drgs	P	R	
2.2	Painting	a) Shade b) Colour c) Paint Type	Major	Visual	100%	Approved Drgs	Reference Drgs	P	R	

2.3	Assembly	a)BOM Verification	Major	Visual	100%	Approved Drgs	ReferenceDrgs	P	R/W	
2.4	Wiring	a) Continuity b) Megger	Major	Physical	100%	Approved Drgs	ReferenceDrgs	P	R/W	
<b>3</b>	<b>FinalInspection</b>									
		a)VisualInspection b)Operation/Function c) IRTTest d)Earthing	Critical	Physical and Electrical	Sample	As per approved Drgs	ReferenceDrgs	P	W	
<b>4</b>	<b>DocumentReview</b>									
4.1	Bought Out Component a)Wire b)MS Steel c)Paints		Major		Sample			P	R	
4.2	-	DegreeofProtection	Major		Sample			P	R	
4.3	IRN		Major		100%			P	R	
4.4	Packing and Dispatch		Major		100%			P	R	
<b>5</b>	<b>Other point</b>									
5.1	Dimension	Check & verify with Final G A drawing	Major		100%			P	R	
4.2	BOM	Check & v erify with approved BOM								
4.3	Function test	Checked for all 1.Opeining & closing of isolator, indicating lamps as pe n approved drawing.	Major		100%			P	R	
4.4	Packing and Dispatch	p	Major		100%			P	R	

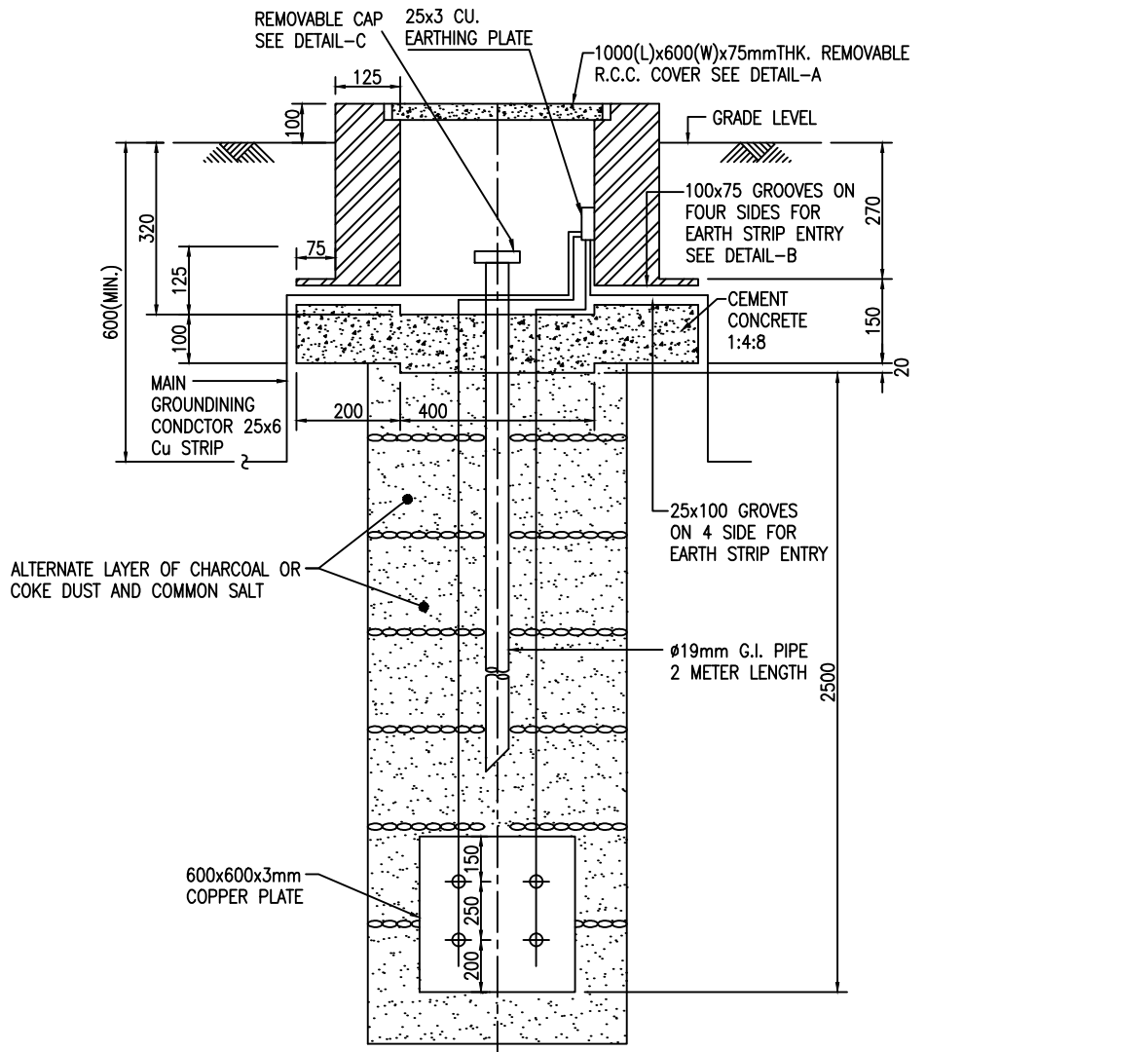
**LEGEND:R: Review,W: WitnessP: Perform**



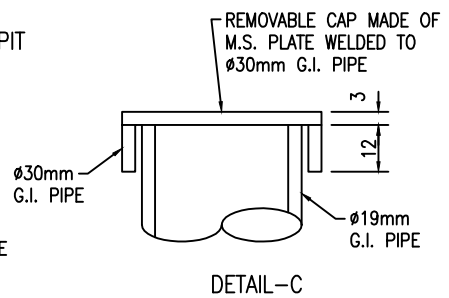
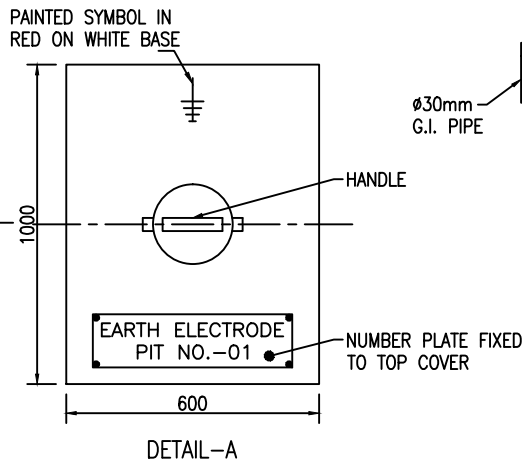
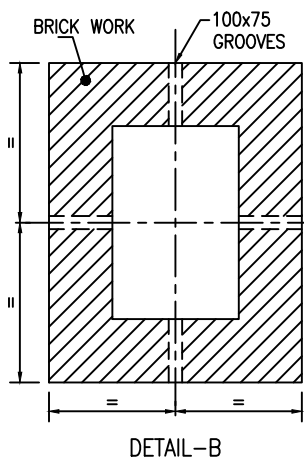
LYONS ENGINEERING PVT. LTD.  
NEW DELHI

STANDARD Cu PLATE  
ELECTRODE IN TEST PIT

DRAWING NO.  
GAIL-STD-EL-DWG-TP-001  
1 OF 1



Cu PLATE ELECTRODE WITH TREATED EARTH PIT



0	04.02.19	ISSUED FOR TENDER	D.V	U.N	S.B
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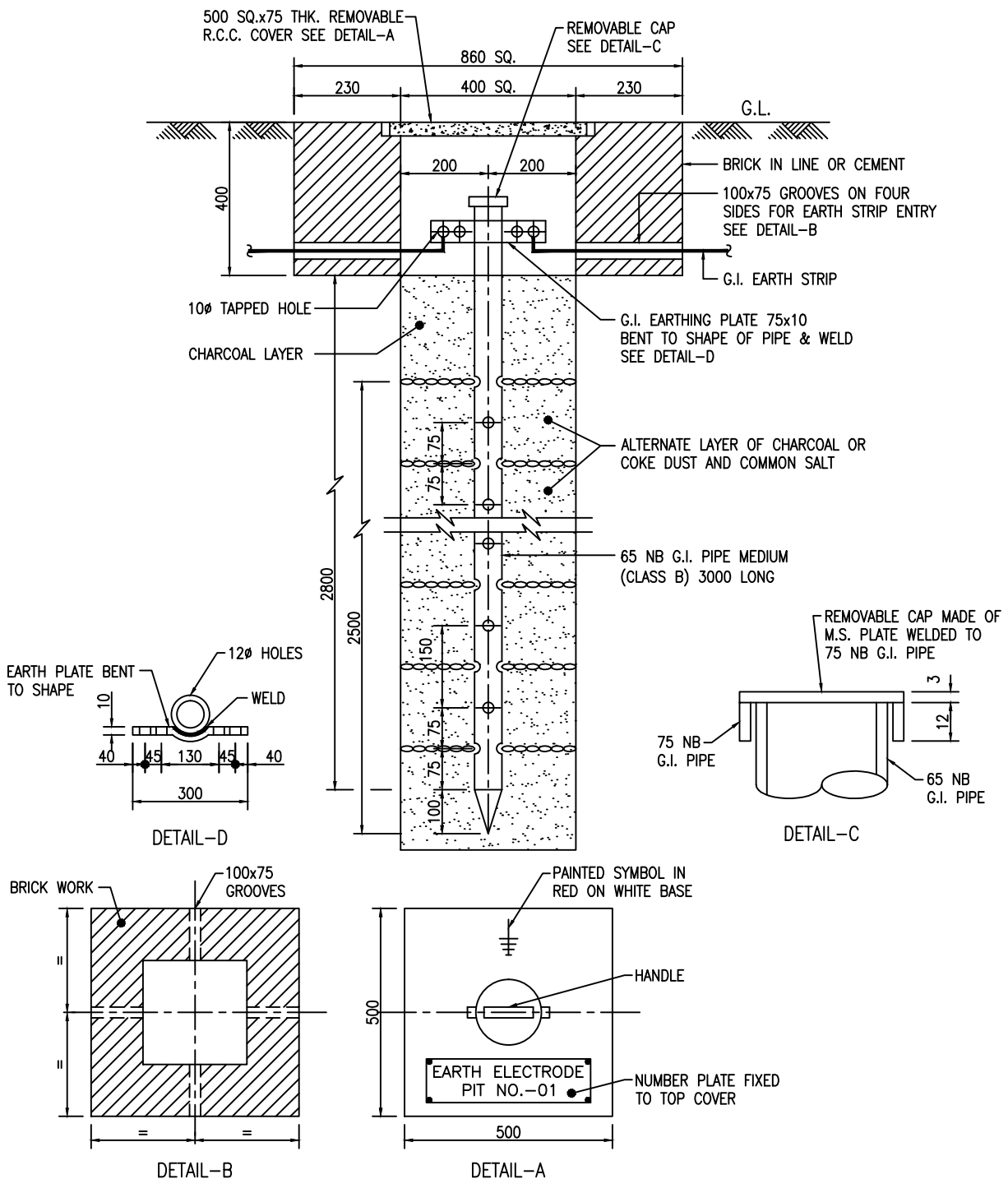
LYONS ENGINEERING PVT. LTD.  
NEW DELHI

STANDARD G.I. PIPE  
ELECTRODE IN TEST PIT

DRAWING NO.

GAIL-STD-EL-DWG-TP-002

1 OF 1



NOTES: -

- 1 THE PIPE ASSEMBLY SHALL BE HOT DIP GALVANISED AFTER FABRICATION.
- 2 BRICK WORK SHALL BE DONE AFTER COMPACTING THE SOIL.

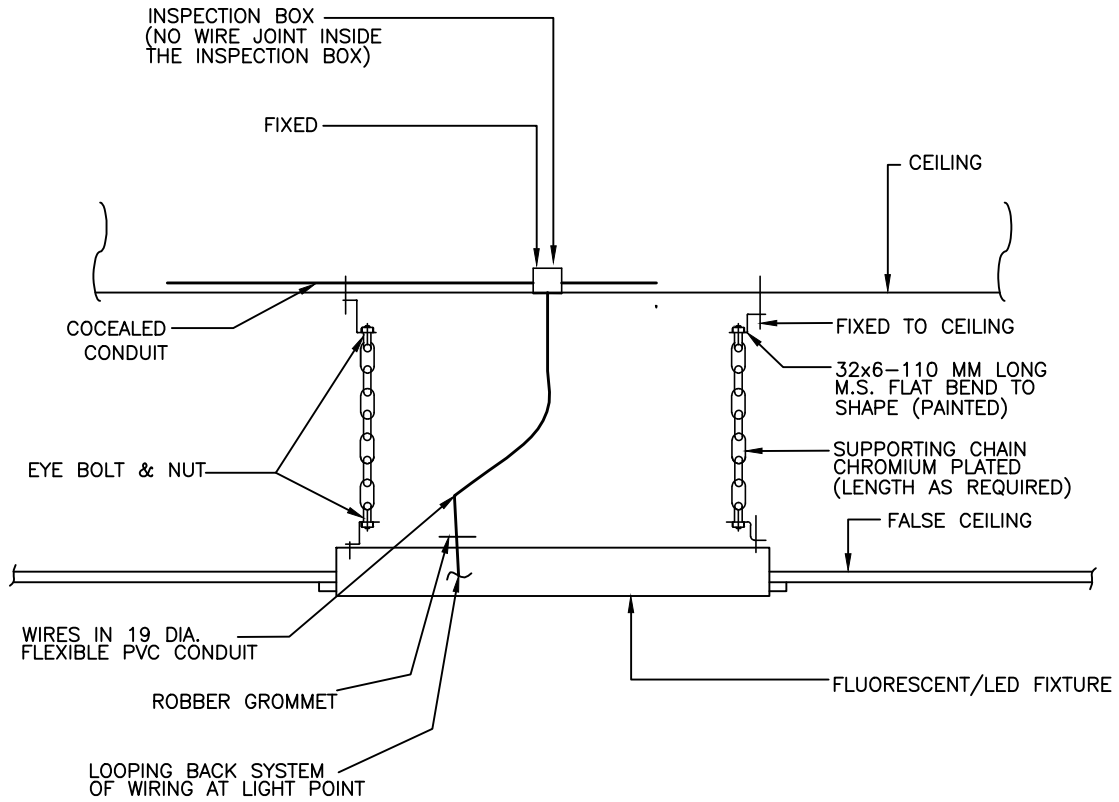
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NEW DELHI

TYP. INSTALLATION OF  
FLUORESCENT/  
FIXTURE ON FALSE CEILING

DRAWING NO.  
GAIL-STD-EL-DWG-TP-004  
1 OF 1



NOTES:-

1. ALL DIMENSIONS ARE IN MM.

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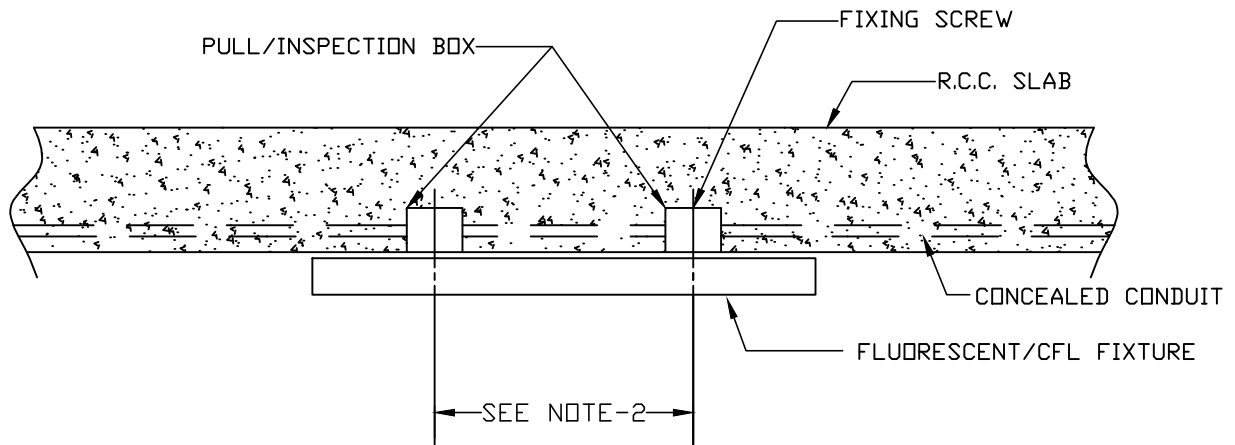
LYONS ENGINEERING PVT. LTD.  
NEW DELHI

TYP. INSTALLATION OF  
CEILING MOUNTING  
FLOURESCENT/ CFL LIGHT FIXTURE

DRAWING NO.

GAIL-STD-EL-DWG-TP-005

1 OF 1



NOTE:-

1. ALL DIMENSIONS ARE IN MM.
2. FIXING CENTERS SHALL BE AS PER FIXTURE MANUFACTURER'S DETAILS.

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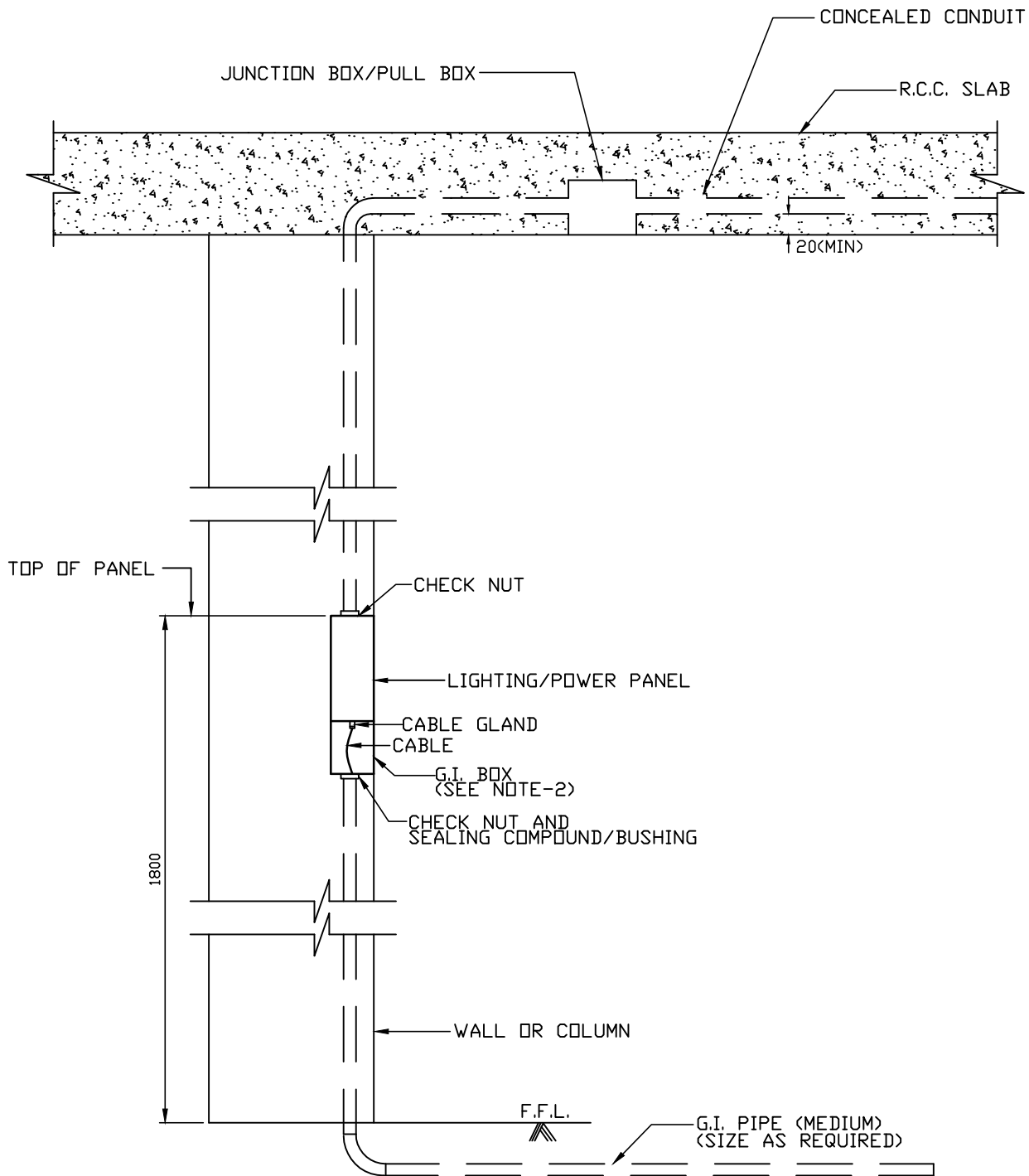
LYONS ENGINEERING PVT. LTD.  
NEW DELHI

TYP. INSTALLATION OF  
POWER/LIGHTING PANEL  
FLUSH MOUNTED

DRAWING NO.

GAIL-STD-EL-DWG-TP-006

1 OF 1



1. ALL DIMENSIONS ARE IN MM.
2. G.I. ADAPTOR BOX OF SUITABLE SIZE WITH REMOVABLE COVER SHALL BE PROVIDED BELOW THE PANEL TO FACILITATE CABLE TERMINATION.

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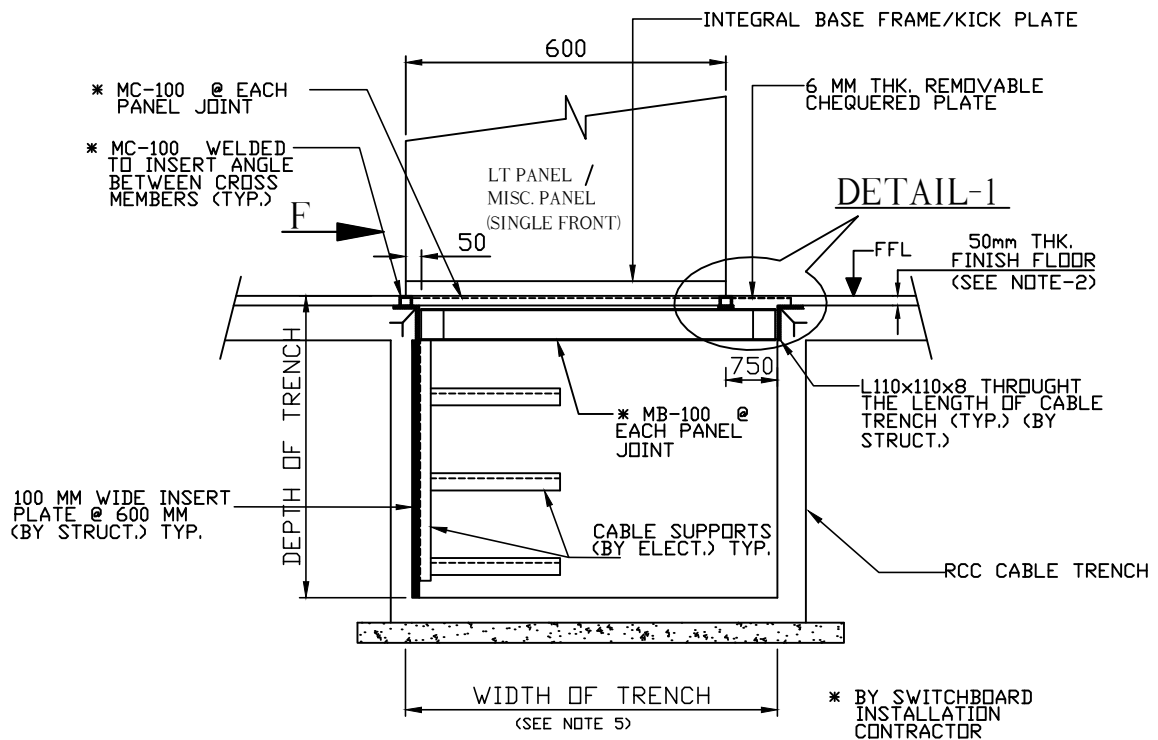
LYONS ENGINEERING PVT. LTD.  
NEW DELHI

TYP. INSTALLATION OF  
ELECTRICAL PANELS ON  
CABLE TRENCH

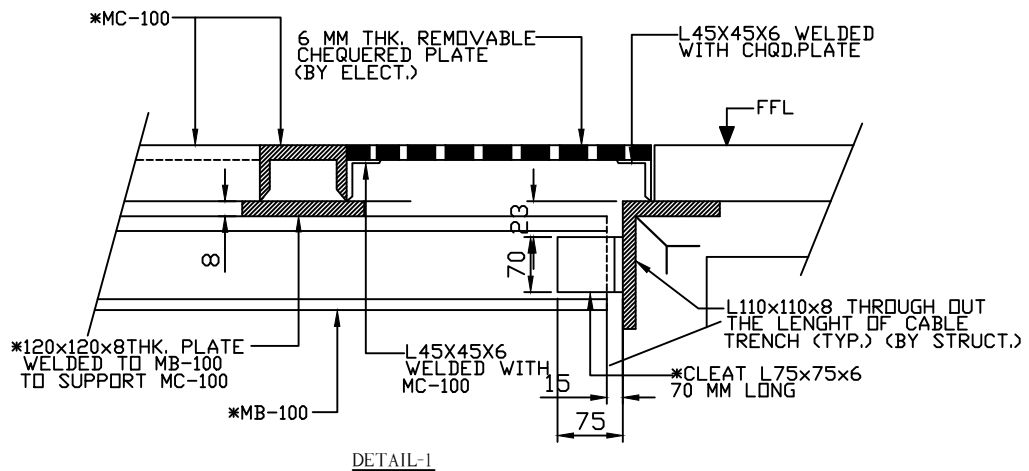
DRAWING NO.

GAIL-STD-EL-DWG-TP-007

1 OF 1



TYPICAL INSTALLATION DETAIL OF LT PANELS



1. FABRICATION, SUPPLY & INSTALLATION OF BASE FRAMES SHALL BE IN ELECT. CONTRACTOR'S SCOPE.
2. 50 THICK FFL SHALL BE DONE AFTER INSTALLATION OF BASE FRAMES BY ELECT. CONTRACTOR.
3. ALL PANELS SHALL BE TACK WELDED WITH BASE FRAME OF SWITCHBOARD.
4. UNUSED PORTION OF CUTOUTS SHALL BE COVERED WITH 6MM THICK CHEQUERED PLATES.
5. SIZE OF TRENCH TO SUIT THE DIMENSION OF PANELS SHALL BE AS PER AFC DRG. OF THE PROJECT.

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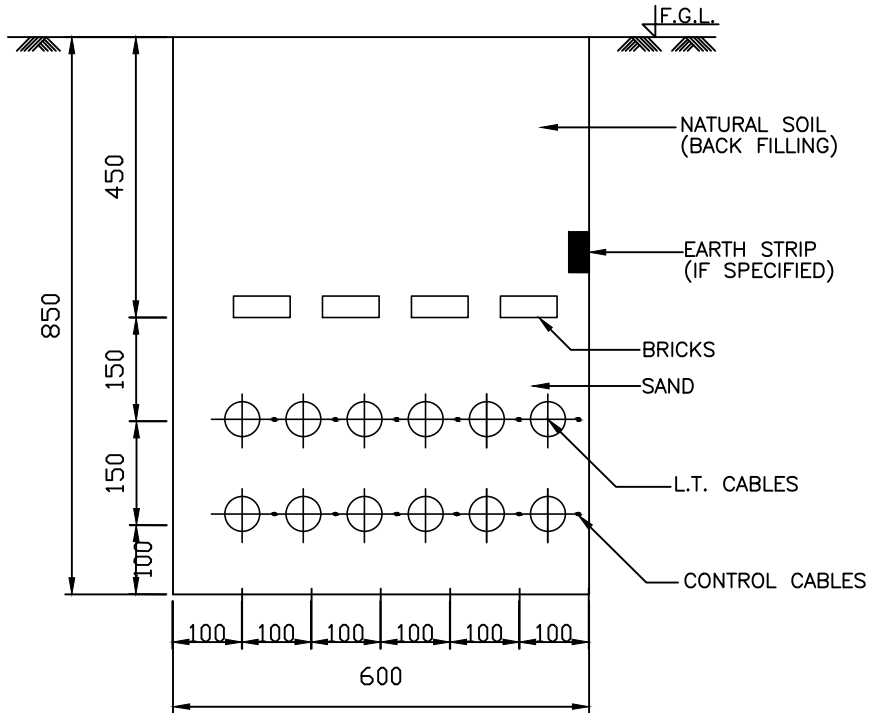
LYONS ENGINEERING PVT. LTD.  
NEW DELHI

TYP. INSTALLATION OF  
DIRECTLY BURRIED  
CABLE

DRAWING NO.

GAIL-STD-EL-DWG-TP-008

1 OF 1



TYP. SECTION OF DIRECTLY BURRIED CABLE TRENCH

NOTES:—

1. ALL DIMENSIONS ARE IN MM.
2. PROVIDE SPACE FOR FUTURE SPARE SPACE OF AT LEAST 2 CABLES OR 15% AVERAGE SPARE SPACE FOR FUTURE EXPANSION.
3. IF FIRE ALARM AND COMMUNICATION CABLES ARE LAID IN THE SAME TRENCH A CLEARANCE OF 300 MM (MIN.) FROM POWER CABLE SHALL BE PROVIDED.

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LYONS ENGINEERING PVT. LTD.  
NEW DELHI

TYP. INSTALLATION OF  
LIGHT FIXTURE AT  
GROUND LEVEL

DRAWING NO.

GAIL-STD-EL-DWG-TP-009

1 OF 1

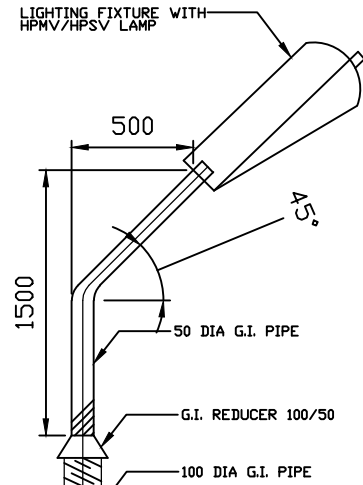
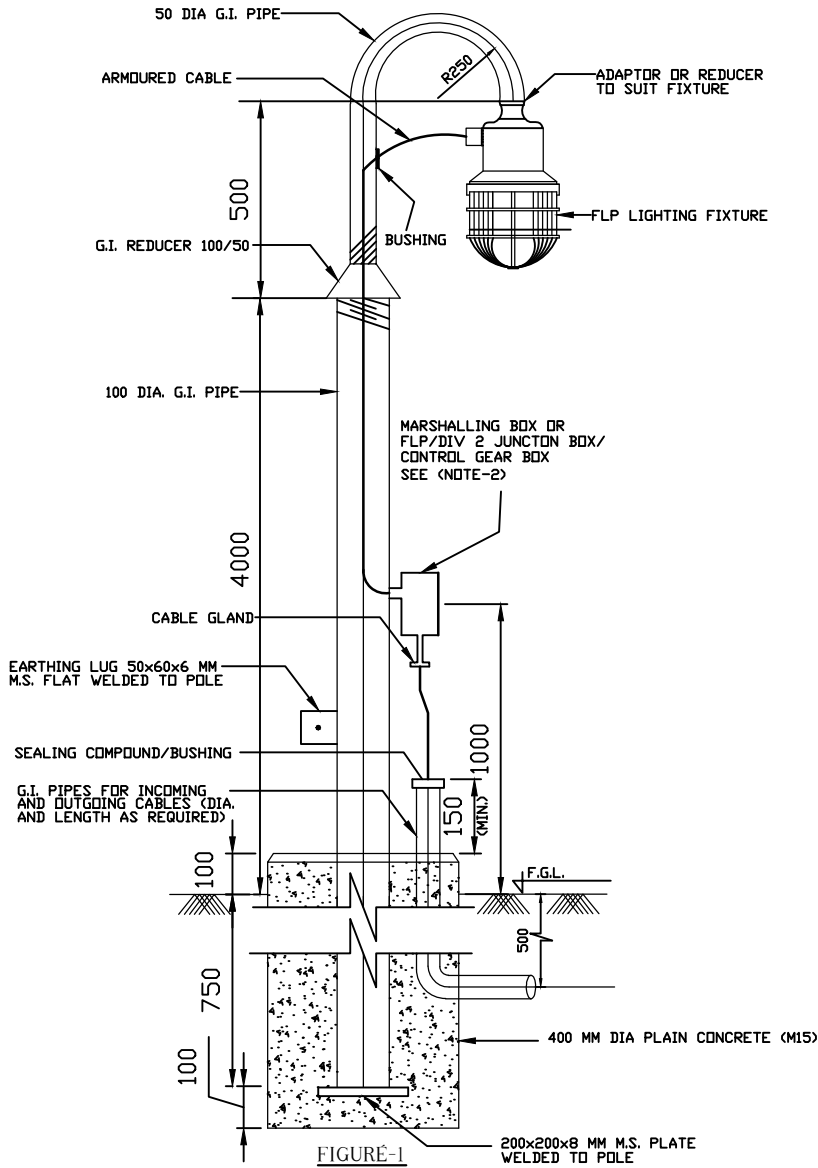


FIGURE-2

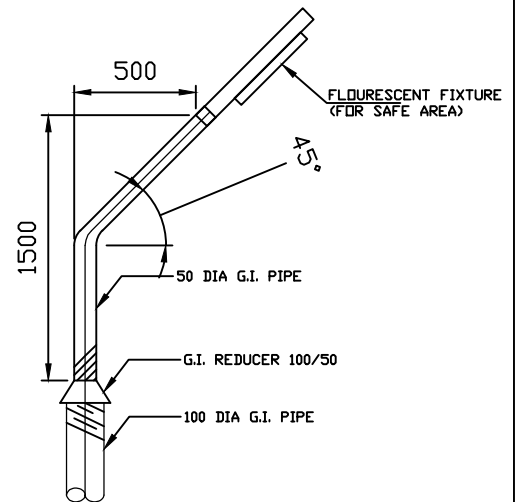


FIGURE-3

NOTES-

1. ALL DIMENSIONS ARE IN MM.
2. MARSHALLING BOX, JUNCTION BOX AND G.I. PIPES FOR CABLES SHALL BE LOCATED FACING CABLE TRENCH SIDE.
3. ALL G.I. PIPES SHALL BE MEDIUM GRADE.

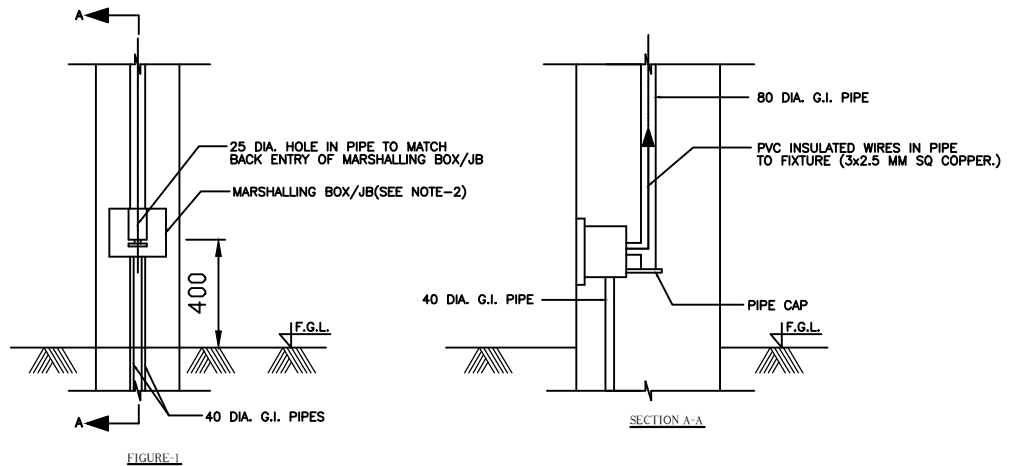
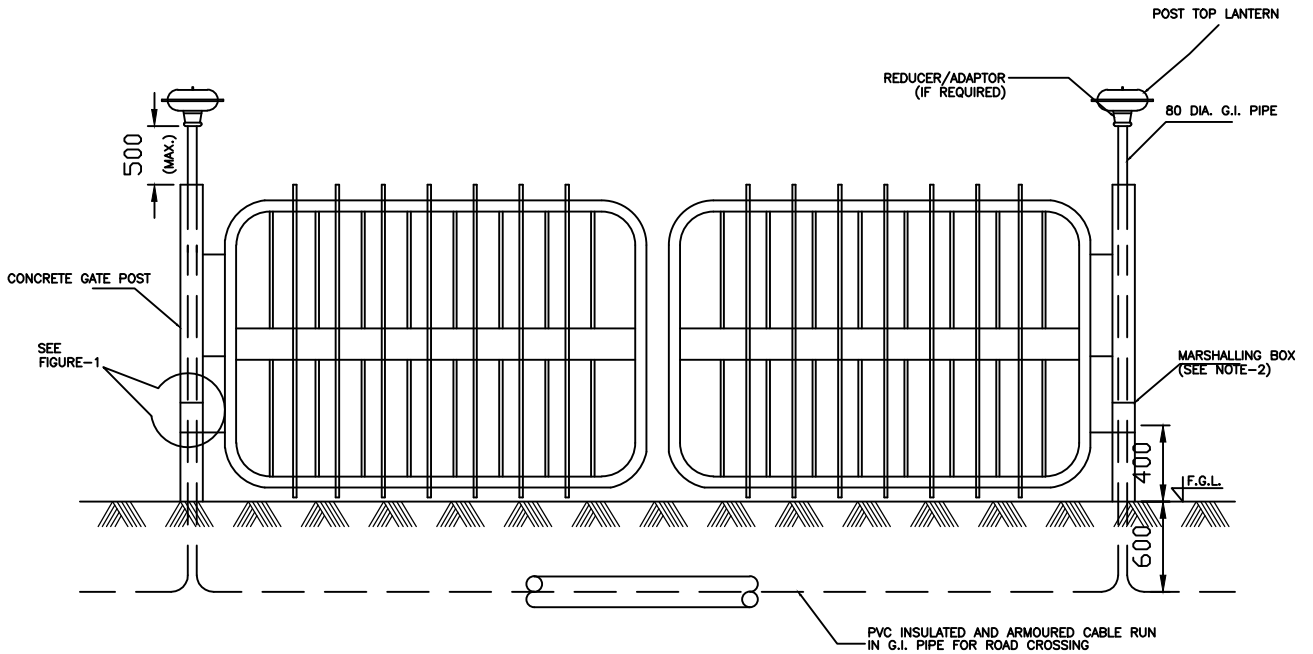
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LYONS ENGINEERING PVT. LTD.  
NEW DELHI

TYP. INSTALLATION OF  
POST TOP LANTERN  
ON GATE

DRAWING NO.  
GAIL-STD-EL-DWG-TP-010  
1 OF 1



NOTES-

1. ALL DIMENSIONS ARE IN MM.
2. USE WEATHER PROOF SINGLE PHASE JUNCTION BOX IN PLACE OF MARSHALLING BOX IF SUPPLY IS SINGLE PHASE.
3. ALL G.I. PIPES SHALL BE MEDIUM GRADE.

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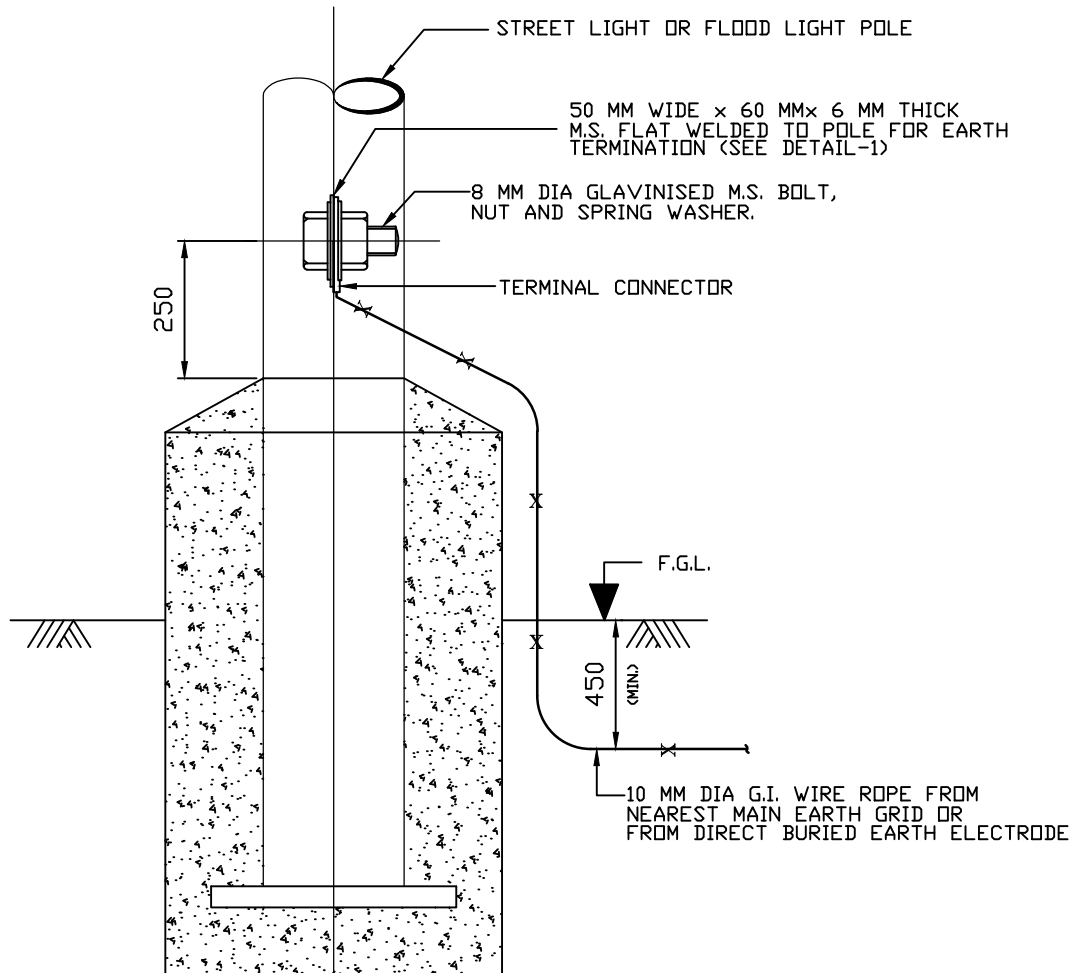
LYONS ENGINEERING PVT. LTD.  
NEW DELHI

TYP. EARTHING  
CONNECTION FOR  
LIGHTING POLE

DRAWING NO.

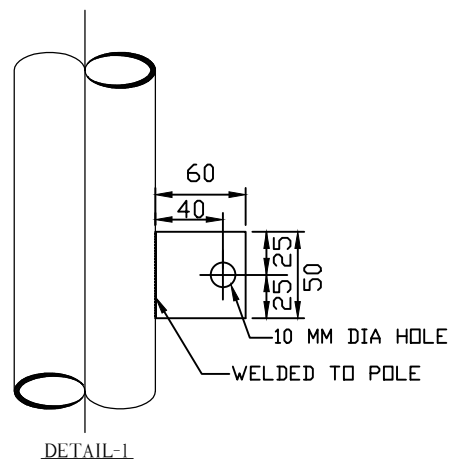
GAIL-STD-EL-DWG-TP-011

1 OF 1



NOTE-

- USE TWO WIRE ROPES IF POLE JUNCTION BOX VOLTAGE IS 415V.



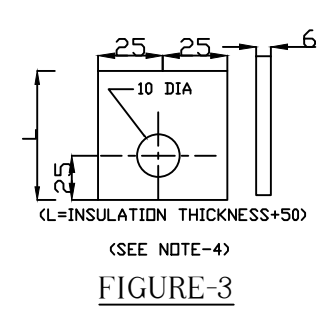
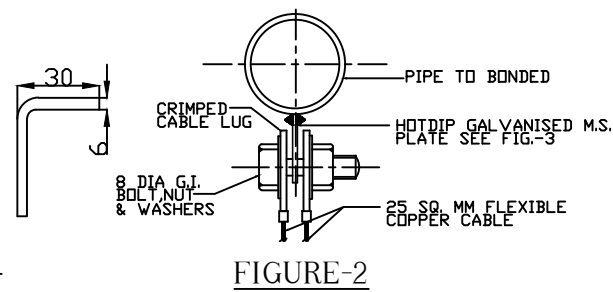
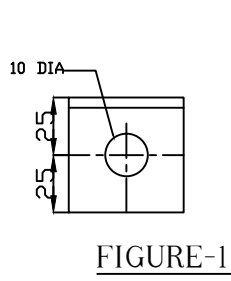
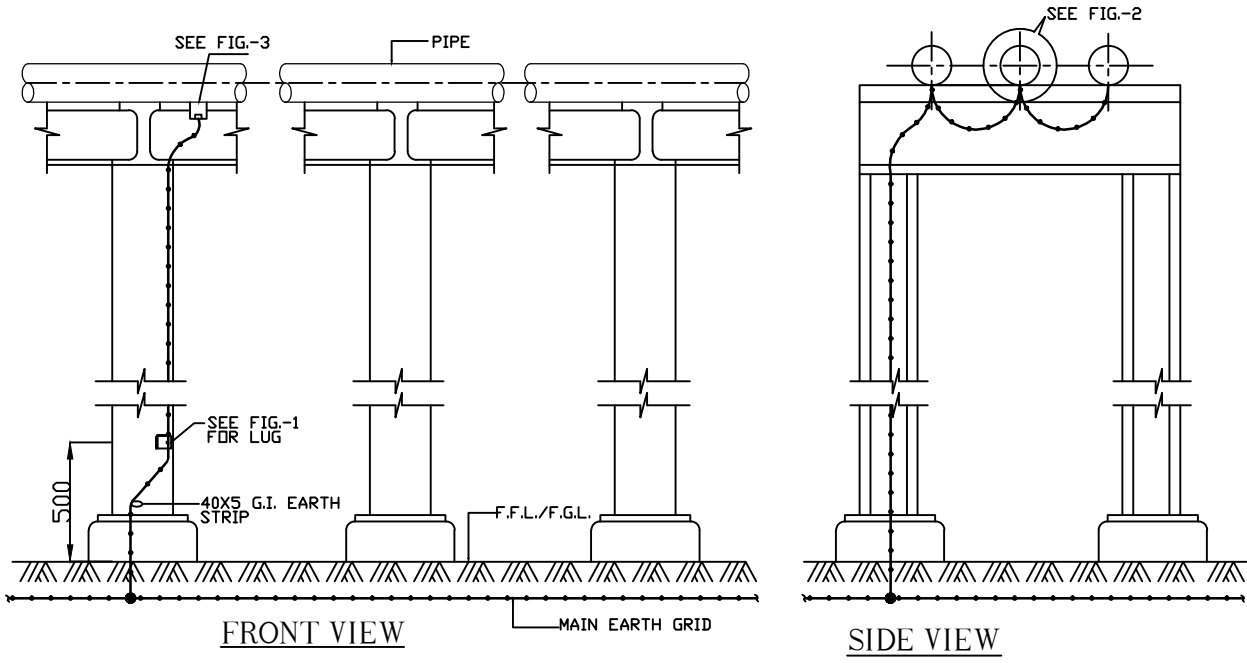
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LYONS ENGINEERING PVT. LTD.  
NEW DELHI

TYP. EARTHING/ BONDING  
OF  
PIPES & PIPE RACKS

DRAWING NO.  
GAIL-STD-EL-DWG-TP-012  
1 OF 2



NOTES:-

1. UNLESS OTHERWISE MENTIONED, THE PIPELINE SHALL BE BONDED & EARTHED ONLY AT THE ENTRY & EXIT POINTS OF BATTERY LIMIT.
2. SUPPLY OF FLEXIBLE Cu CABLE, LUGS, BOLTS, NUTS & WASHERS ETC. & MAKING CONNECTIONS SHALL BE DONE BY ELECTRICAL CONTRACTOR.
3. STEEL PIPE RACKS IN THE PROCESS AREA & OFFSITE AREA SHALL BE EARTHED AT MAX. SPACING OF 24 MTRS.
4. HOT DIP G.I. STRIP AS PER FIG.-3 SHALL BE PROVIDED BY THE PIPING CONTRACTOR BEFORE HYDROTESTING OF LINES.

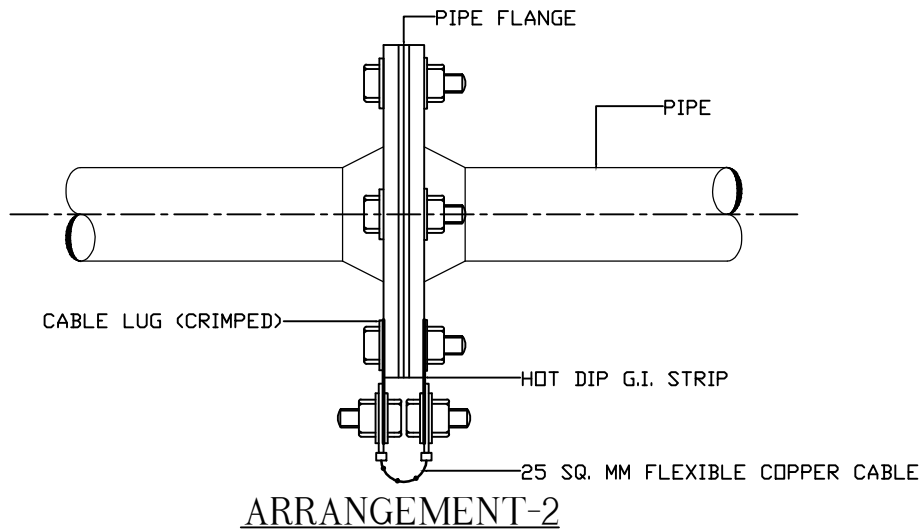
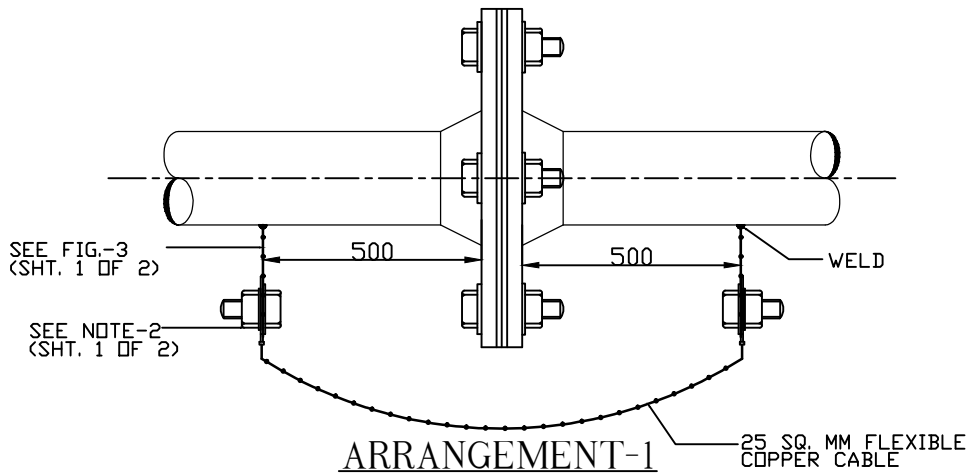
0	04.02.19	ISSUED FOR TENDER	D.V	U.N	S.B
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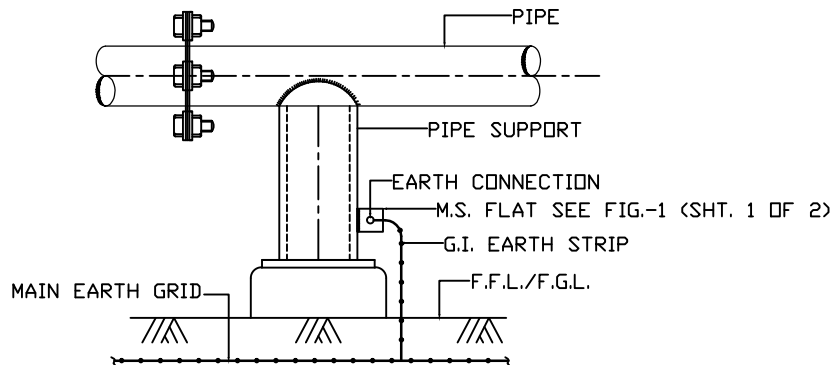
LYONS ENGINEERING PVT. LTD.  
NEW DELHI

TYP. EARTHING/ BONDING  
OF  
PIPES & PIPE RACKS

DRAWING NO.  
GAIL-STD-EL-DWG-TP-012  
2 OF 2



(APPLICABLE WHERE G.I. STRIP ARE NOT  
AVAILABLE AS PER ARRANGEMENT-1)



(APPLICABLE WHEREVER PIPE SUPPORTS ARE  
ON BOTH SIDES OF FLANGES / VALVES ETC.)

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LYONS ENGINEERING PVT. LTD.  
NEW DELHI

TYP. EARTHING OF  
GATE & FENCE

DRAWING NO.

GAIL-STD-EL-DWG-TP-013

1 OF 1

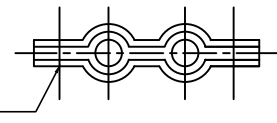
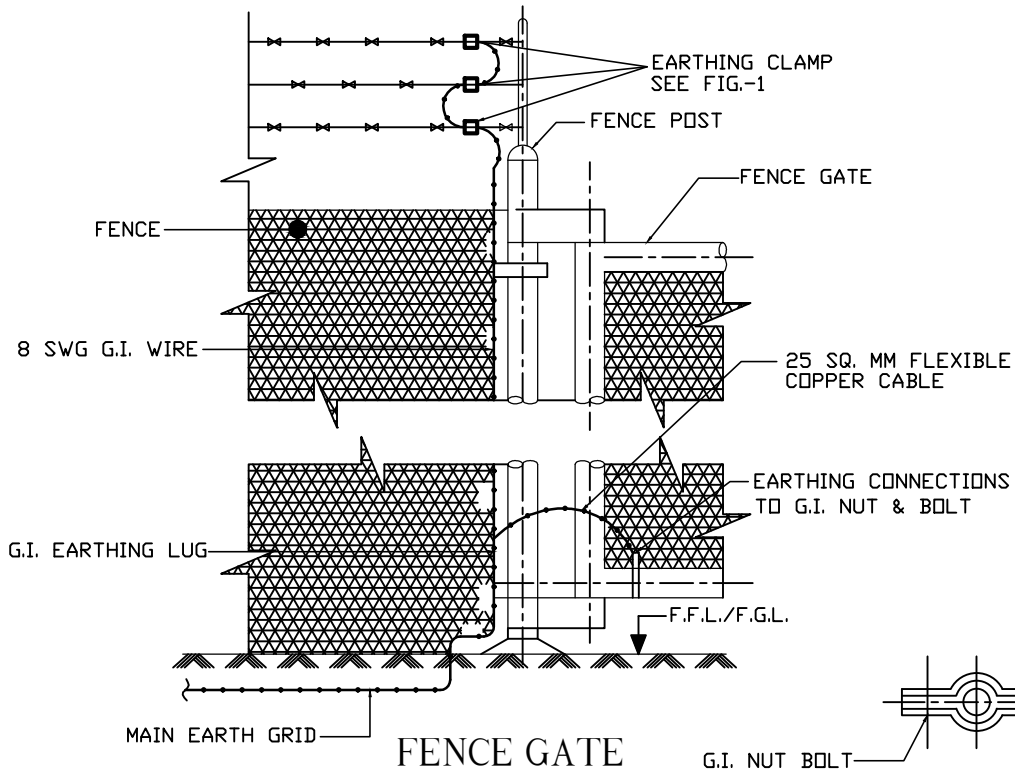


FIGURE-1

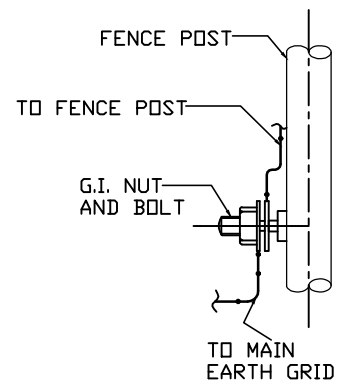
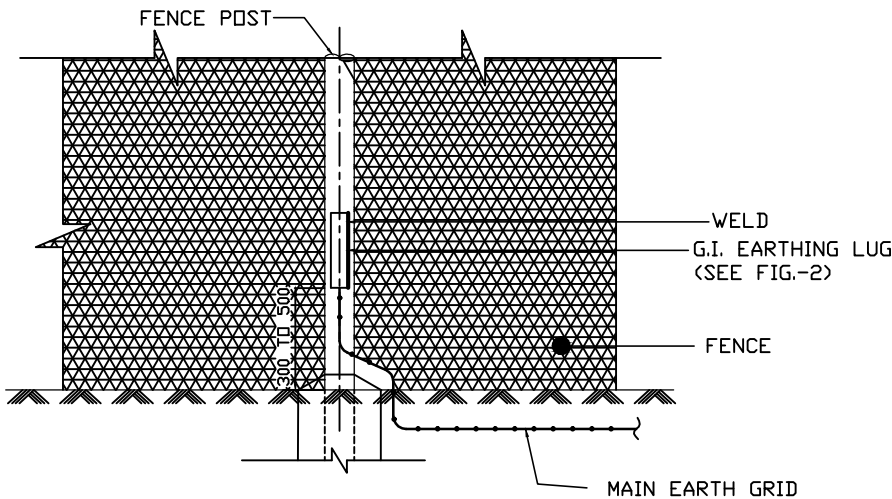


FIGURE-2

0	04.02.19	ISSUED FOR TENDER	D.V	U.N	S.B		
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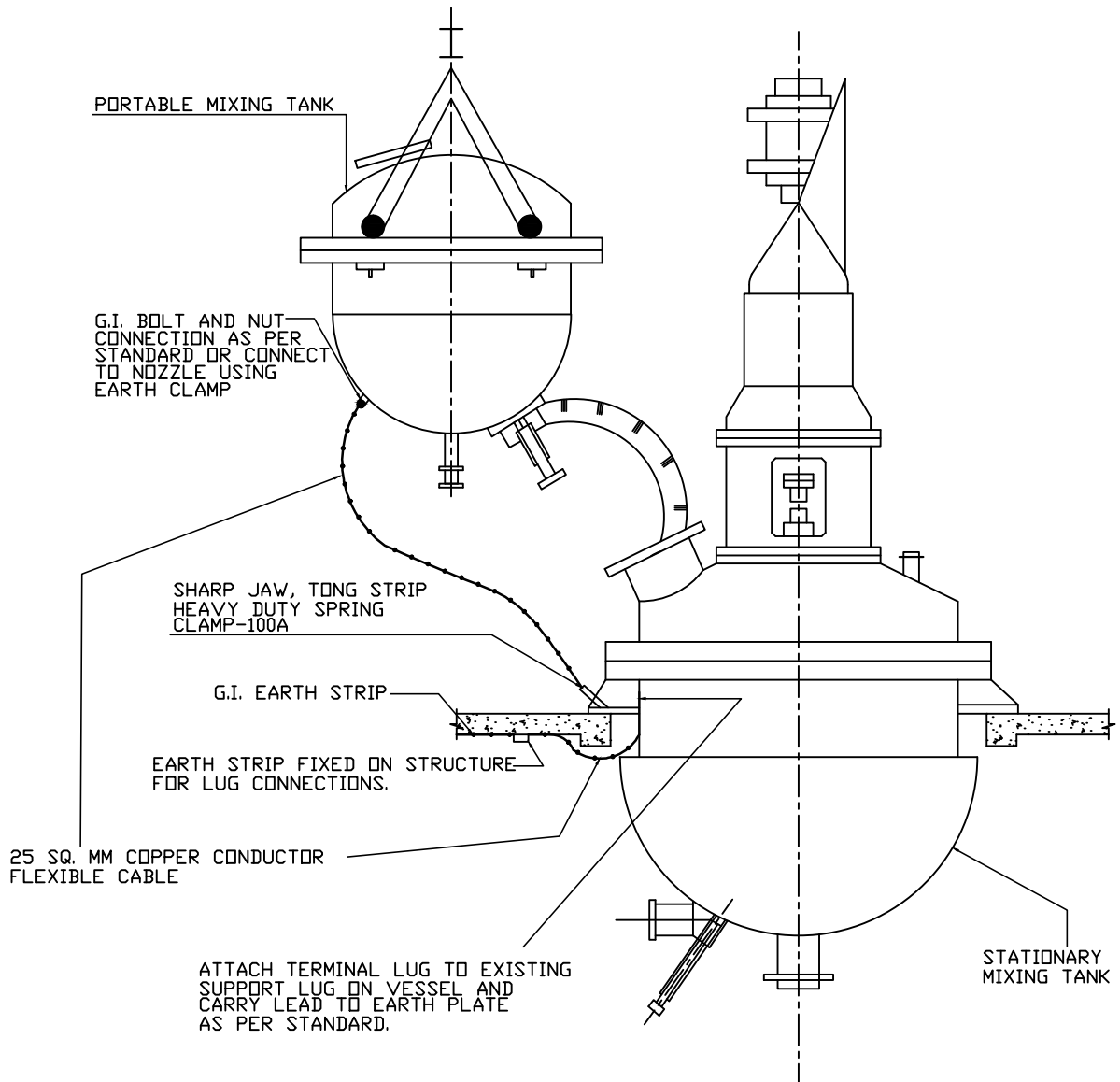
LYONS ENGINEERING PVT. LTD.  
NEW DELHI

TYP. EARTHING FOR  
PROCESSING EQUIPMENT

DRAWING NO.

GAIL-STD-EL-DWG-TP-014

1 OF 1



NOTES:-

1. ALL PROCESSING EQUIPMENT SUCH AS MIXTURES, CHURNS, AUTOCLAVES, COLUMNS, CENTRIFUGES, FILTERS, PRESS PUMPS ETC. SHALL BE EARTHED, IF THESE ARE NOT IN DIRECT CONTACT WITH PROPERLY EARTH STEEL MEMBERS.
2. ALL TEMPORARY EARTH CONNECTIONS SHALL BE MADE BEFORE OPENING THE VESSEL.

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HAR EK KAAM DESH KE NAAM



**GAIL INDIA LIMITED**

**CONSTRUCTION OF STEEL PIPELINE AND ASSOCIATED FACILITIES  
FOR CGD CONNECTIVITIES**

**VOLUME II OF II (TECHNICAL) – H**

**INSTRUMENTATION**



**E-TENDER REF :**

**(BID DOCUMENT NO - 034/LEPL/GAIL/22-R0)**

**LIMITED DOMESTIC COMPETITIVE BIDDING**



**Lyons Engineering Pvt. Ltd.**

	<b>DCI - MASTER DELIVERABLE CONTROL INDEX FOR CGD TO M/s TGPL MORADABAD &amp; CGD TO M/s TGPL GORAKHPUR</b>	<b>Doc No.</b>		
		GAIL-ENG-GN-DOC-DL-001		
		Rev. 0		
<b>Sr. No.</b>	<b>Description</b>	<b>Document / Drawing No.</b>		<b>Rev. No.</b>
<b>TECHNICAL VOLUME - II OF II</b>				
<b>H INSTRUMENTATION</b>				
1	Instrumentation Design Basis	GAIL-STD-IN-DOC-DB-001		0
<b>STANDARD SPECIFICATION FOR INSTRUMENTS</b>				
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
<b>DATASHEET FOR INSTRUMENT</b>				
14	Datasheet for Pressure Transmitter	GAIL-STD-IN-DOC-DS-001		0
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
17	Datasheet for Gas Detector	GAIL-STD-IN-DOC-DS-004		0
18	Datasheet for Pressure Gauges	GAIL-STD-IN-DOC-DS-005		0
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
22	Datasheet for GOOV	GAIL-STD-IN-DOC-DS-009		0
<b>QAP FOR INSTRUMENT</b>				
23	QAP for Temperature Transmitters	GAIL-STD-IN-DOC-QAP-001		0

PMC:		Doc No.		CLIENT: 
	DCI - MASTER DELIVERABLE CONTROL INDEX FOR CGD TO M/s TGPL MORADABAD & CGD TO M/s TGPL GORAKHPUR	GAIL-ENG-GN-DOC-DL-001		
		Rev. 0		
		Sr. No.	Description	Document / Drawing No.
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	
27	QAP for Temperature Gauges	GAIL-STD-IN-DOC-QAP-005	0	
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	
<b>STANDARD TYPICAL DRAWING</b>				
33	Instrument Connection on Vessels, Standpipes and Tanks	STD-ENG-IN-DWG-TP-001	0	
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	
38	Instrument Connection on Vessel, Standpipes and Tanks	STD-ENG-IN-DWG-TP-006	0	
39	Meter Runs – Piping Connections D – D/2 Taps	STD-ENG-IN-DWG-TP-007	0	
40	Meter Runs – Piping Connections Pipe (2 ½ D – 8d) Taps	STD-ENG-IN-DWG-TP-008	0	
41	Thermowell	STD-ENG-IN-DWG-TP-009	0	
42	Thermocouple / RTD Assembly With Thermowell	STD-ENG-IN-DWG-TP-010	0	
43	Symbol for Instrument Location Drawings	STD-ENG-IN-DWG-TP-011	0	
44	Instrument Support Single Instrument	STD-ENG-IN-DWG-TP-012	0	
45	Instrument Support Two Instruments	STD-ENG-IN-DWG-TP-013	0	
46	Support Details for Junction Boxes	STD-ENG-IN-DWG-TP-014	0	
47	Fabricated Canopy for Instruments	STD-ENG-IN-DWG-TP-015	0	
48	Perforated Tray Supports and Cables Clamping Details	STD-ENG-IN-DWG-TP-016	0	
49	Pressure Gauge Liquid / Gas Service	STD-ENG-IN-DWG-TP-017	0	
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	





**GAIL INDIA LIMITED**

**INSTRUMENTATION DESIGN BASIS**

**GAIL-STD-IN-DOC-DB-001**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
0	08.07.2020	Issued for Bid	RKS	SR	TR



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## 1.0 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 CGD to M/s TGPL Moradabad & CGD to M/s TGPL Gorakhpur, GAIL is laying 4" NB Pipeline to connect TGPL Moradabad Receiving Terminal & TGPL Gorakhpur receiving terminal(as per indicative plot plan / P&ID and Schematic attached elsewhere). Work shall include all the interconnecting piping, civil, electrical, instrumentation works at Customer End and Hook-up.

### ▪ SITE PARAMETERS FOR DESIGN:

The system shall be designed to conform following design conditions:

- Ambient Temperature - Maximum 60°C & Minimum -20°C
- Relative Humidity - 100%
- Altitude Above Sea Level - Less ≤ 1,000M
- Atmospheric Pollution - Tropicalized to withstand the site Conditions, dust, vapour etc.
- Hazardous Area Classification - Zone1 & 2, Gas Gr.IIA & IIB; Temperature Class T3
- Battery, TRU room - Safe Area

For Proposed pipeline system, please refer Pipeline Schematic Diagram.

## 2.0 APPLICABLE CODES , STANDARDS, ABBREVIATIONS AND DEFINITIONS

### 2.1 Precedence of Codes, Standards and Specifications

It is the main responsibility of EPC CONTRACTOR to inform the COMPANY of any deviations from or exceptions to the listed specifications, codes, and standards. COMPANY will take non-listing or non-specification of exception or deviation by EPC CONTRACTOR in the bid proposal document, as being in full compliance with the specifications, codes, and standards listed. If there is a conflict between the various codes, standards, specifications and the attached drawings, the most stringent requirement shall be govern. EPC CONTRACTOR shall seek COMPANY'S final interpretation of any conflicts prior to the execution of work. Rework of engineering and relevant scope arising out of underestimation shall be done at no additional cost to the COMPANY.

As a minimum, all equipment shall be designed, manufactured, and delivered in accordance with the relevant section of the national/international Codes, Standards, and Regulations as listed

	INSTRUMENTATION DESIGN BASIS	Document No.	Rev.
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below. The latest editions of Codes, Standards including all addenda, supplements, or revisions current at time of order placement, as issued by the following authorities shall apply:

- British Standard Institution (BS)
- International Electro technical Commission (IEC)
- The Institute of Petroleum (IP)
- Institute of Electrical Engineers (IEE)
- IP Codes of Practice
- American Petroleum Institute (API)
- Instrument Society of America (ISA)
- Oil Industry Safety Directorate (OISD)
- National Fire Protection Association (NFPA)
- Petroleum & Natural Gas Regulation Board (PNGRB)

## 2.2 International Codes and Standards

The design shall in general comply with the applicable sections of the latest editions of the applicable engineering codes and standards listed below:

Document Number	Document Title
AGA 3	Orifice Metering of Natural Gas
AGA 7	Measuring of Gas by Turbine Meter
AGA 8	Compressibility and Super-compressibility for Natural Gas
AGA 9	Measuring of Gas by Multipath Ultrasonic Meter
AGA ANSI B109.3	Rotary Type Gas Displacement Meter
ANSI / ASME PTC 19.3	ASME Performance Test Codes Supplement on Instruments and Apparatus Part 3 – Temperature Measurement
ANSI MC 96.1	Temperature Measurement Thermocouple
ANSI/ISA-75.05.01-2000 (R2005)	Control Valve Terminology
ANSI / FCI 70.2	Control Valve Seat Leakage
ANSI / ISA 75.01	Flow Equations for Sizing Control Valves
ANSI / ISA 5.1	Instrumentation Symbols and Identification
ANSI B 16.5	Pipe Flanges and Flanged Fittings
ANSI B16.10	Face to face dimensions and End to End Dimensions of

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API 14 C	valves Analysis, Design, Installation, and Testing of Basic Surface Safety Systems for Offshore Production Platforms
API 607	Fire Test for Soft Seat Quarter Turn Valves
API 6D	Pipeline Valves
API 6FA	Specification for Fire Test for valves
API MPMS	Sizing, Selection and Installation of Pressure-Relieving Devices
API RP 500	Recommended Practices for Classification of location for electrical installations at petroleum facilities as class 1, DIV 1&2
API RP 520, Part I	Sizing, Selection of Pressure Relieving Devices in Refineries, Installation
API RP 520, Part II	Installation of Pressure Relieving Devices In Refineries, Installation
API RP 521	Pressure-Relieving and De-Pressuring Systems
API RP 526	Flanged Steel Safety-Relief Valves
API RP 527	Commercial Seat Tightness of Safety Relief Valves with Metal to Metal Seats
API RP 551	Process Measurement Instrumentation
API RP 552	Transmission System
API RP 553	Refinery Control Valves
API RP 554	Process Instrument and Control
API RP 555	Recommended Practices for Process Analyzer
ASME B 16.31	Non-Ferrous Pipe Flanges
ASME PTC 19.3	Temperature Measurement Instruments and Apparatus
ASME A213	Seamless Ferritic and Austenitic Alloy Steel Tubes
ASME B 2.1	NPT Pipe Threads
ASTM A269	Seamless or welded austenitic Stainless Steel Tubing for General Service.
ATEX 94/9/EC	Equipment Intended for use in Potentially Explosive

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	Atmospheres
BS 6739	Code of Practice for Instrumentation in Process Control Systems: Installation Design and Practice
BS 1904	Industrial Platinum Resistance Thermometer Sensors
BS 5555	SI Units
BS 6174	Differential Pressure Transmitters with Electrical Output
BS EN 50020	Electrical apparatus for potentially Explosive atmosphere intrinsic safety 'I'
BS-5308-Part 1	Instrumentation cables. Specification for polyethylene insulated cables
BS-5308-Part 2	Instrumentation cables. Specification for PVC insulated cables
BS-EN-60751	Industrial Platinum Resistance Thermometer Sensors
BS-EN-837-1	Bourdon Tube Pressure and Vacuum Gauges
EN 50288	Instrumentation Cables – Specification for PVC Insulated Cables
IEC 61000	Electromagnetic Compatibility
IEC 61158	Digital data communications for measurement and control, field bus for use in industrial control system
IEC 61131	Programmable Logic Controllers – Part 2 and 3
IEC 61831	On line analyzer systems Guide to design and installation
IEC 60079	Electrical Apparatus for Explosive Gas Atmospheres.
IEC 60529	Classification of Degrees of Protection Provided by Enclosures (IP code)
IEC 60331	Fire Resisting Characteristics of Electrical Cables
IEC 60332	Test on Electrical Cables under Fire Conditions
IEC 60529	Degrees of Protection Provided by Enclosures (IP Code)
IEC 60540	Test Method for Insulation and Sheaths of Electrical Cables and Cords

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IEC 60605-1	Equipment Reliability Testing
IEC- 60793-1	Optic Fibers, Part 1 Generic Specification
IEC-61804-3 – 2010	Function Blocks (FB) for Process Control: Electronic device description Language
IEC 61508	Functional Safety: Safety Related Systems
IEC 61511-1	Functional Safety: Safety Instrumented Systems for the Process
IEC 62453	Field Device Tool (FDT) Interface Specification
IEC-1024-1	Protection against Lighting
IEC-60227-1	PVC cables of rated voltage up to and including 450/750 V – General requirements
IEEE-C37.90.1	Surge Withstanding Capability Standard
ISA RP 12.06.01	Instrument Wiring Methods for Hazardous (Classified) Locations Instrumentation – Part 1: Intrinsic safety
ISA S 5.4	Instrument Loop Diagram
ISA-5.5	Graphic symbols for process displays
ISA-7.0.01	Quality standard for instrument air
ISA S5.1	Instrument Symbols and Identification
ISA S5.4	Instrument Loop Diagrams
ISA RP42.00.01-2001	Nomenclature for Instrument Tube Fittings
IS 1239	Mild Steel Tubes, Tubular and other Wrought Steel Fittings
IS 2148	Flame Proof Enclosures for Electrical Apparatus
IS 5571	Guide for Selection and Installation of Electrical Equipment for Hazardous Areas (Other than Mines)
IS 5831	PVC Insulation and Sheath of Electric Cables
T4S	Technical Standards and Specifications including Safety Standards for Natural Gas Pipeline PNGRB

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	Notification G.S.R. 808 €
ISO 5167 Part 1 – 4	Measurement of Fluid Flow by means of Pressure Differential 2003 Devices
ISO 5168	Measurement of Fluid Flow: Estimation of Uncertainty of Flow- Rate Measurement.
NEMA VE1	Metal Cable Tray Systems
NEMA ICS4	Terminal Block for Industrial Use
NEMA ICS6	Enclosure for industrial Control and system
NFPA 2001	Clean Agent Fire Extinguishing System
NFPA 72	National Fire Alarm Code
NFPA 12	Standard for Carbon Dioxide Extinguishing System

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

### 2.3 Abbreviations:

ANSI	:	American National Standards Institute
API	:	American Petroleum Institute
AGA	:	American Gas Association
ASME	:	American Society Of Mechanical Engineers
DG	:	Diesel Generator
DIN	:	Deutsches Institute For Normung
ER	:	Electrical Resistance
HOV	:	Hydraulic actuated Manually Operated Valves
HDD	:	Horizontal Directional Drilling
HDPE	:	High Density Poly Ethylene
LF2	:	Lead Free #2
LCP	:	Local Control Panel
LMC	:	Last Mile Connectivity
MCR	:	Master Control Room
MMI	:	Man Machine Interface
MMSCMD	:	Million Metric Standard Cubic Meter per Day
OFC	:	Optical Fiber Cable
OISD	:	Oil Industry Safety Directorate
PCP	:	Permanent Cathodic Protection

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PESO	:	Petroleum and Explosives Safety Organization
PSP	:	Pipe to Soil Potential
PSV	:	Pressure Safety Valve
PNGRB	:	Petroleum and Natural Gas Regulatory Board
RLNG	:	Re-gasified Liquefied Natural Gas
RTU	:	Remote Telemetric Unit
SCADA	:	Supervisory Control and Data Acquisition
SMART	:	Self-Monitoring and Reporting Technology
STM	:	Synchronous Transmission Module
IP	:	Intermediate Pigging Station
TOP	:	Tap Off Point
TR	:	Transformer Rectifier
UPS	:	Uninterrupted Power Supply

## 2.4 Definitions:

<b>COMPANY</b>	:	The party that initiates the projects and ultimately pays for it design and construction, GAIL India Limited
<b>CONSULTANT</b>	:	The party which carries out FEED, detailed engineering and owner's Engineer
<b>SUPPLIER/VENDOR</b>	:	The party which manufactures or supplies the equipments and services to perform the duties specified by the Contractor EPC
<b>CONTRACTOR</b>	:	Refer Instrumentation Scope of work (doc. No. GAIL-ENG-IN-DOC-SW-001)

## 3.0 DESIGN CRITERIA

### 3.1 GENERAL

All Instrumentation and Control and Monitoring systems shall be in accordance with this specification and as defined in the P&I Diagrams.

All Instrumentation and Control Systems shall be designed for continuous operation in the given site conditions with the following design criteria:

- Ease of operation and maintenance;
- Suitability for applicable environmental condition;
- Suitability for operation in the designated classification of hazardous areas;
- State of art proven technology and instrumentation;
- Safety to operating and maintenance personnel;
- Safety to connected equipment;
- Safe starting and shutdown of the plant under all conditions;

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- High Redundancy with high reliability (high MTBF and low MTTR) and no single point of failure;
- Minimum cost of ownership.

### 3.2 Quality Assurance

Procurement & Construction CONTRACTOR, CONSULTANT, SUPPLIER and VENDOR of equipment shall operate a Quality Assurance system. This system shall be based on the principles of ISO 9001 or equivalent. The quality system may be subject to auditing and monitoring by the COMPANY or his representative.

### 3.3 Reliability and Maintenance

High reliability of instrumentation is of paramount importance and therefore only existing field proven instrumentation, which is readily available and used widely in similar applications, shall be considered. Selection of instrumentation systems and equipment shall take account of the projects overall requirements for high availability. Importance shall be given to reducing the maintenance frequency and duration.

### 3.4 Operation and Design Life

The instrumentation and control equipment shall be designed to operate in the site environmental conditions continuously. The life time of the plant is envisaged to be 25 years. However, optimum design life expectancy of an instrument shall be 10 years and spare parts availability shall be for 10 years after cease of production. The life time expectancy of control equipment such as controllers, modules is expected to be 20 years with the availability of spares for 10 years after discontinuation of product.

The maintenance/replacement schedule shall be planned accordingly in order to maintain the instruments/control equipment for the duration of the plant life time.

### 3.5 Hazardous Area Classification

Field equipment and instruments shall be certified for use in designated areas when installed in hazardous area classified zones as per IEC 60079 and IS 5571.

Hazardous area classification shall be Zone 1, Gr. IIA/B, temperature Class T3. All field instruments shall be EEx „ia“ type, Whereas F&G equipment such as detectors, beacons and hooters shall be EEx „d“ type. All junction boxes shall be EEx „d“ type and all cable glands shall be EEx „d“ certified.

Instruments shall be certified by an internationally recognized organization (statutory body in the country of origin) such as BASEEFA, PTB, FM, CSA, UL etc. for operation in hazardous area classification. Instruments shall also meet the relevant requirements of ATEX directive 94/9/EC and shall carry the ATEX marking as a minimum. Calibration /carrier gas cylinders for gas chromatographs shall be PESO approved

### 3.6 Ingress Protection

All field mounted equipment, junction boxes, etc. including entries and blanking plugs shall have

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an environmental protection rating of min. IP65 to BS EN 60529. Indoor located equipment shall be to min. IP42.

### 3.7 Electromagnetic Compatibility

Individually supplied instruments should conform to the intent of IEC 61000 and carry a CE/UL/CSA conformity mark.

In view of the highly corrosive (Saline) ambient conditions, all instrument internal and external parts which are not inherently corrosion resistant by choice of instrument and construction material shall be prepared and finished by suitable protective coating and paint finish.

All equipment shall also be able to withstand these conditions during shipment, storage and installation prior to commissioning.

### 3.8 Special Tools

The SUPPLIER/VENDOR of the main equipment shall provide tools, and any other specialist items, required to operate and maintain any instrument or system.

### 3.9 Instrument Air Supply

Instrument air headers with suitable tap-offs shall be provided by piping near the instrument air consumers such as control valves, emergency shutdown valves. Instrument tubing shall be used for further connection to the valves. Air filter regulator shall be provided at each consumer. Instrument air supply shall be provided from existing IA supply network at site.

### 3.10 Nameplates

All instruments, junction boxes, cabinets, panels and ancillary equipment should be provided with a manufacturer's engraved corrosion resistant nameplate, permanently attached with stainless steel screws or rivets. In addition, instruments shall be provided with SS304 tag number plates and junction boxes shall be provided with traffolyte service labels.

### 3.11 Instrument Selection:

Instruments and instrumentation systems of proven reliability and latest technology shall be used. Selection of instrumentation shall be made from the approved Instrument Supplier Lists. Any exception has to be justified and is subject to approval by the CONSULTANT & CLIENT.

### 3.12 Tagging:

All instruments and instrumentation equipment shall be permanently identified by tags, labels and/or nameplates. Use of adhesive tapes shall not be allowed.

### 3.13 RF Immunity:

All instruments and control systems shall be immune from the effects of any R.F. interference that may occur at the plant location in accordance with IEC 801 "Electromagnetic compatibility for industrial-process measurement and control equipment". Equipment to be installed inside the control room shall be in compliance with the European Community directive requirements, denoted by the "CE mark". This compliance shall extend to each relevant item.

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#### 4.0 TYPE OF INSTRUMENT PROTECTION (AS APPLICABLE)

Instrument	Explosion proof	Intrinsically safe	Increased Safety	Others
Field Switches		√		
2-wire Transmitters		√		
Solenoid Valves		√		
Proximity Switches		√		
Junction Box	√ (For Non-IS signals)		√ (For IS signals)	
Cable Gland	√ (For Non-IS signals)		√ (For IS signals)	
F&G Devices	√	√	√	

Generally, Weather Protection Type for Field Instruments and junction boxes shall be minimum IP-65.

All intrinsically safe instruments shall be provided with isolator barriers in control panel.

#### 5.0 CERTIFICATION REQUIREMENT

All instrumentation items used in hazardous areas shall be certified as indicated above, by international agencies like UL, FM or BSEIFA. As a minimum all the field instruments shall be suitable for the use in **Zone 1, Gr. IIA/B, Temperature Class T3**.

Instruments shall be certified EEx'ia', EEx'ib' (Intrinsic Safety), EEx'e' (Increased Safety) or EExd (Explosion Proof) to suit the area classification. Area classification drawings shall be prepared by Consultant. All electrical and instrumentations Items shall be Certified for use in Hazardous areas wherever applicable including PESO (CCOE) approval.

#### 6.0 UNITS OF MEASUREMENT:

The units of measure used will be those of the SI system in particular

Parameter description	Unit of Measure
Differential Pressure	bar
Flow Rate	MMSCMD
Density	kg/m <sup>3</sup>
Duty	kJ/hr, GJ/ hr
Energy	kJ

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Gas Flow @ STP	Sm <sup>3</sup> /h, MSm <sup>3</sup> /h
Length	mm, m, km
Power	kW
Pressure	bar (g)
Specific Heat	kJ/kg °C
Temperature	°C
Thermal Conductivity	W/m °k
Transfer Rate	kW/m <sup>2</sup> °C
Velocity	m/sec.
HC & Toxic Gas Concentration	ppM / Mol%
Viscosity	cP (centipoises)

Standard Temperature and Pressure conditions (STP) are defined at 15 °C and 1.01325 atm.

- **CANOPY:** FRP of minimum, thickness of canopy should be 4mm (min.). FRP shall be UV Protected.

## 7.0 UTILITY REQUIREMENT (As Applicable):

### 7.1 ELECTRONIC INSTRUMENTS

#### 7.1.1 Power Supply requirement

Transmitters	:	24 V, DC
Solenoid valves	:	24 V, DC
RTU Panel	:	24 V DC, 50 Hz, - UPS,
F&G Panel	:	24 V DC, 50 Hz, - UPS,

7.1.2 Signal transmission : 4-20 mA DC, 2 wire

7.1.3 Switching : DPDT / SPDT dry contacts

Normal	:	Close
Alarm/ Shutdown	:	Open

7.1.4 All valves requiring Power supplies shall be directly powered from the Instrumentation Panel & controlled locally from field and remotely from SCADA. There shall be no interface with electrical except for the main power supplies.

7.1.5 One UPS power feeder and one NON-UPS power feeder (for non –critical loads such as panel light, fan etc.) shall be provided for RTU panel by contractor. Distribution to panel instruments and field instruments shall be provided within the control panel. Power to field instrumentation shall be from RTU panel.

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### 7.1.6 Instrument Earthing System Philosophy

Three separate earthing systems shall be provided:

- Electrical Safety Earth – Bonded to the Electrical Earth pit and utilized for electrical safety of metal enclosures and chassis on all instruments and electrical components.
- Instrument Clean Earth – Insulated from the Electrical Earth pit and other metal work, utilized for instrument cable screens and bonded to the main Instrumentation earthing system at a single point.
- Intrinsically Safe Earth – Insulated from the Electrical Earth pit and other metal work, utilized for termination of IS zener barrier earth connections and bonded to the main Instrumentation earthing system at a single point.

## 8.0 PROCESS AND ELECTRICAL CONNECTION:

### 8.1 PROCESS CONNECTIONS

Instrument	Process Connection Size			Instrument Connection
	Vessel	Piping	Tank	
Pressure Gauge	2" RF flg	3/4" NPT	2" RF flg	½" threaded
Pressure Transmitter	2" RF flg	3/4" NPT	2" RF flg	½" threaded
DP Transmitter	2" RF flg	1" NPT	2" RF flg	½" threaded
Radar	4" RF flg	--	4" RF flg	4" RF flg
Level Transmitter (Radar Type/Displacer)	2" RF flg	2" RF flg	2" RF flg	4" RF flg
Level Gauge (Magnetic)	2" RF flg	--	2" RF flg	--
Thermowell	1 1/2" RF flg	1 1/2" RF flg	1 1/2" RF flg	1 1/2" RF flg

## 9.0 MATERIAL SELECTION PHILOSOPHY

### 9.1 MATERIAL OF CONSTRUCTION

The material of construction of the wetted parts and the body of all the individual instruments / equipment shall be suitable to the process fluid / conditions and the site ambient conditions.

All materials and equipment furnished shall be new and unused, of current manufacture and the highest grade and quality available for the required service, and free of defects.

Process wetted parts shall be suitable for process fluid and conditions. Body / trim materials

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shall be selected based on the applicable pipe class as per Piping Material Specification. Wetted parts material shall be SS316 as a minimum. Tubing and tube / pipe fittings used to hook up instruments to piping / vessel shall be SS316. Material of construction of enclosures and junction boxes shall be cast aluminum (LM6/LM25).

Galvanic compatibility between dissimilar materials is to be ensured to prevent corrosion due to galvanic action.

## 10.0 INSTRUMENTATION

### GENERAL

All electronic transmitters shall be, "Smart" type with "HART" protocol. Transmitter output shall be 4~20mA, two wire loop powered at 24VDC from the system it is connected to. Smart sensors connected to safety systems shall be write-protected to prevent unintentional modification from a remote location.

All transmitters shall be supplied with integral LCD digital indicators scaled in engineering units; however, scale for level transmitters shall be 0 to 100% of instrument span.

Separate dedicated instruments shall be used for shutdown and process control & monitoring. Shutdown initiating devices shall only be used for shutdown functions.

Low power signals (i.e. RTD / thermocouple) shall be converted in field to 4-20 mA by means of remote mounted transmitters.

Gas chromatograph shall preferably have retractable type of probes inserted into pipelines for ease of maintenance.

Field instrument design and selection shall suit process and environmental conditions as well as hazardous area classification requirements.

All electronic / electric instruments shall have 2 Nos. ½" NPT cable entries. Suitable nickel plated brass adapters shall be provided if the cable entry on the instrument is other than NPT threads. Spare cable entries shall be plugged with certified nickel plated brass plugs.

## 10.1 PRESSURE INSTRUMENTS

### GENERAL

- a) Process connections for pressure instruments shall normally be ½" NPT and process interface shall consist of 2" ball valves with double isolation
- b) Static pressure sensing connections on horizontal lines are normally made at the top
- c) Impulse connection between primary process taps and pressure instruments shall generally be ½" OD SS316L seamless tubing. The tubing wall thickness shall be determined by pressure and temperature design limits of the process for that particular installation. As a minimum wall thickness for impulse tubing shall be 0.065". All tube fittings shall be of compression type with double ferrule, Swagelok or Parker only.
- d) Two valve manifolds shall be provided for pressure instruments installations. Valve Manifolds shall have MOC SS316 as Valve and seat material shall be determined by the process requirement.

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- e) All pressure instruments shall be suitably mounted so as to minimize the length of impulse lines.
- f) Local Gauges shall be provided for field monitoring & control purpose. All instrument ranges shall be selected such that the normal operating point is between 35% and 75% of the instruments total range.

**1. PRESSURE GAUGES**

- a) Gauges shall be bourdon tube type.
- b) Pressure gauge; accuracy shall be  $\pm 1.0\%$  of full range and over range protection shall be 130%.
- c) Dial size shall be 150 mm and cases shall be stainless steel screw on or bayonet bezel type. Blow out disc and solid front protection shall be provided and gauges shall be orientated such that they vent safely.
- d) All pressure gauges shall be liquid filled type. It is widely known that vibration, pulsation and pressure spikes are the most common causes of poor performance and failure in pressure gauges.
- e) Gauge windows shall be constructed from safety pattern/toughened glass.
- f) Bourdon tube material shall be type 316 Stainless steel,
- g) Over-range protection shall be 1.3 times the maximum scale range. Where a gauge is subject to greater pressure, a gauge protector shall be used.
- h) On pulsating service, a snubber shall be fitted in the input connection. Syphon shall be fitted to pressure gauges on steam or hot condensable gas services.
- i) To facilitate pressure gauge removal and alignment, gauges shall be connected to the piping by means of gauge adapter and not directly into valves.

**2. PRESSURE TRANSMITTER**

- a) Pressure transmitter shall be electronic SMART type, two wire, loop powered at 24VDC with 4-20 mA output and integral digital indicator meter in engineering units. Transmitters shall have HART protocol for digital communication.
- b) Material of construction for wetted parts shall be SS 316 as a minimum.
- c) Pressure transmitters shall have minimum accuracy  $\pm 0.075\%$  of the calibrated span.
- d) Transmitters shall have independent external screws for zero and span adjustment.

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- e) Pressure transmitters shall be installed as close as practical to the primary taps shall not require seal or condensate chambers unless the fluid contains sediment or is corrosive. Transmitters shall be installed in accessible places.

**10.2 TEMPERATURE INSTRUMENTS**

**1 THERMOWELLS**

- a) Temperature measuring instruments shall be provided with thermowell. The process connection size of thermowell shall be 2" Butt Welded. Minimum line size for thermowell connection shall be 4". For lower size line, same shall be expanded to 4".
- b) The thermowell shall be constructed from drilled bar stock SS 316 material. Thermowell shall have a sufficient internal bore to properly accommodate the devices placed in the bore.
- c) Thermowell to be fabricated as per standard drawing for thermowell (Annexure-2)
- d) All thermowells shall be stress analysed for velocity conditions. Calculation shall be done as per ASME PTC 19.3 TW-2016 code. 100% radiography shall be conducted for all fabricated thermowells.
- e) Test wells shall be furnished with a permanently attached plug and chain. The bore shall be 10 mm to allow for the insertion of a glass stem mercury or ethyl alcohol test thermometer.
- f) All thermowells shall be of welded type only.

**2 Resistance Temperature Detectors (RTDs)**

- Sensor - Pt 100 RTD
- Type - 4 Wire, Duplex

**3 TEMPERATURE TRANSMITTERS**

- a) The sensor shall be RTD PT-100, 4-wire, Duplex type system. The transmitter shall be remote yoke mounted "SMART" type, two wire loop powered at 24V DC with 4-20 mA output with digital output indicator meter. Transmitters shall have HART protocol for digital communication. The 4-20 mA output signal must be directly proportional and linear to temperature. The RTD shall be class A type.
- b) The range shall be selected so that the normal operating temperature shall fall in the middle third of the span.
- c) Temperature transmitters shall have a built-in linearization function to produce an output linear to temperature range.
- d) Transmitters shall have independent external screws for zero and span adjustment.
- e) The accuracy of the transmitter shall be minimum  $\pm 0.15$  % of range.

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## 11.0 GAS OVER OIL ACTUATORS (GOOV)

Actuator shall be double acting piston design to enable quarter turn operation of the valve. The design pressure of the actuator shall be suitable to the pipe design to ensure trouble free operation of the actuator.

Actuator torque shall be 1.25 times the valve torque required at full rated differential pressure of valve. The actuator shall be suitable for operation using gas supply from upstream and downstream of the valve. Tapping for gas supply shall be provided on upstream and downstream piping of the valve.

Pneumatic cylinder storing gas with non-return valve shall be provided for emergency operation of valve. The gas tank (storage) shall cater at least 2 open / close cycles of valve operation. Both storage and accumulator cylinders shall be provided with relief valve and gauges and shall be designed as per ASME Sec VII.

Each actuator shall be provided with open / close limit switches, remote / local switch and differential pressure switch. A local actuator panel shall be provided to enable opening and closing of valve under local mode. Solenoid valves shall be 3 way with manual reset facility. Independent solenoids shall be provided for open and close conditions.

Tubing and tube fittings shall be minimum SS316. Local panel shall be die-cast aluminum and Ex"d" certified. All signals from GOOV to control system shall be potential free.

### Accessories:

- Valve Position Switch

All block valves shall be supplied with limit switches for valve position indications. Two separate limit switches are required, one for "closed" position and one for "open" position. Each limit switch shall be proximity type with NAMUR design. The switch enclosure shall be copper free cast aluminium/AISI 316, weather proof IP-65 minimum and it shall be intrinsic safe suitable to hazardous area classification.

- Solenoid Valve

The solenoid valve shall be double acting type. The body and internals shall be of SS316. Valve shall be made leak proof with 'O' ring seals. The Solenoid valve shall be weatherproof to minimum IP-65 and intrinsic safe type, suitable to hazardous area classification. The power supply shall be 24 VDC.

- Differential Pressure Switch

The differential pressure switch shall be of electric type. The switch enclosure shall be copper free cast aluminium, weather proof to minimum IP 65 & it shall be intrinsic safe suitable to hazardous area classification.

- Local /Remote Selector switch the L/R switch shall be provided on the valve actuator for local operation from the valve or remote operation from the local control panel or SCADA.

- Actuator Sizing

The actuators shall be sized for maximum differential pressure across the valve body at the minimum medium supply pressure. The breakaway, run and end torque values of

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each actuator shall be carefully designed to ensure no damage to the valve stem will occur.

## 12.0 CONTROL VALVE

The control valve shall be self – contained totally enclosed unit, complete with actuator, electro-pneumatic positioner, filter regulator and accessories, which are required for automatic and manual operation of the valve. The control valve shall be designed for throttling operation of the valve to meet the process requirements.

Vendor shall select control valve as per the process conditions. The possible effects of erosion, cavitation and noise shall be considered in the valve selection procedure. Maximum permissible limit for noise generated by control valves shall be 85 dBA or less, as measured at a distance of 1 meter from the valve for any flow condition.

Control valve selection shall be done in accordance the necessary valve of the characteristics and to ISA S75.01, standard with regard to Flow equations for sizing of control valves. Equal percentage and linear trim are two of the main characteristic which is generally applicable to the process requirement.

Globe valves (linear motion, rotary / eccentric plug or rotary / segmented ball) shall be preferred for general service where precise flow control is required apart from low allowable pressure drop conditions and shall be cage guided expect in dirty or abrasive services.

The calculated Cv value shall be in accordance with ISA S75.01, Flow Equations for Sizing Control valves or the Vendor’s proprietary sizing program.

Control valves shall be sized for a minimum wide open capacity of 110 percent of maximum flow. The selected valve should normally be 80 to 90 percent open at maximum flow. The selected valve shall be no less than 10 percent open at minimum flow, or shall be within the Vendor’s minimum throttling Cv recommendation.

Control valve actuators shall be pneumatic, spring return type, diaphragm or piston type. Spring shall be corrosion resistant, cadmium plated or equal.

The pneumatic actuator shall be suitable for instrument air and shall function properly under the minimum, normal and maximum instrument air supply pressures. The minimum instrument air pressure required for the actuator shall be 4 barg.

Actuators shall be sized for operation under maximum shutoff pressure drop across the valve with minimum instrument air pressure to the actuator.

The Vendor shall be responsible for the mechanical compatibility and provision of mechanical coupling between the valve and actuator. Valve to actuator mating and alignment shall be in accordance with ISO 5210 and ISO 5211.

Actuators shall be fully compatible with the valve with regard to torque/thrust figures, inertial stresses on the valve stem and mechanical stresses on the valve top.

Control valve shall be supplied duly fitted with electro-pneumatic positioner for all services except on / off control. Valve positioner supplied shall be “smart” type, 4 – 20 mA output, two wire loop powered unit with HART capability and integral LCD display. The device shall provide self-diagnostics as well as control valve diagnostics.

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Positioner output action shall be direct. The valve positioner shall have sufficient capacity in both directions for pressuring and venting the actuator to prevent response time limitations. The positioner shall have a weatherproof enclosure with a minimum degree of protection of IP 65 in accordance with IEC 60529.

### 13.0 PRESSURE SAFETY VALVES (PSV)

Pressure safety valves (PSV) shall be direct acting, spring loaded; full nozzle / full lift, adjustable blow down high capacity type.

PSV shall have flanged end connections, enclosed spring, bolted bonnet, screwed cap, and full one-piece nozzle. Flanges shall be in accordance with ANSI B16.5 requirements.

Flanges shall be integral part of the body. Weld-on flanges shall not be allowed. Bodies and flanges shall be of the same material. Inlet flange shall be of sufficient rating to withstand the reaction force of the PSV.

PSV sizing shall be carried out based on API RP 520 Part 1. Orifice letter designation shall be in accordance with API STD 526. For blocked discharge case, overpressure shall be 10% above the set pressure. For fire relieving case overpressure shall be 21% above the set pressure.

All wetted parts of PSV shall be SS316. Safety valves shall be provided with test gags and manual test lever. Springs of safety valves shall be selected as per process conditions.

### 14.0 CONTROL PANEL

- Control panel shall be constructed from 2 mm thick CRCA sheet metal. However, thickness of panel front shall be 3 mm and thickness of cable gland plate shall be 3 mm.
- Panel shall be with a minimum protection of IP 42.
- Control panel shall have bottom cable entries.
- Power distribution shall be provided with in the panel for all field instruments, panel mounted instruments, annunciator, lamps, Relays, Active Barriers,etc.
- All the ferruling in the panels for the internal and field wiring shall be strictly cross Ferruled.
- The colour of the control panel shall be as per RAL 7032 / latest addition of RAL, same as that of existing control panels in order to have consistency or else as instructed by OWNER.
- Control panel shall be fabricated as per standard specification for Control Panel, except that semi-graphic panels are not required.
- One spare trim of each type of valve, 20% spare with minimum of one (01) number of each type of instruments, relays, active barriers, all hardwares inside the panel etc. shall be provided on each panel.

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## 15.0 GAS DETECTION SYSTEM (GDS)

Hydrocarbon Gas Detectors which are to be installed at field shall be Open Path and Point detector. Gas Detectors shall be 3-wire type and triad cable shall be used for connecting to control room. Gas Detector shall operate through 24VDC power supply and shall be explosion proof. Gas detector body shall be of die cast aluminium with epoxy coating and shall be weather proof to IP-65. Gas Detector shall have 4-20 mA HART output.

Point gas detection system will be Infrared Type.

The low and high gas concentrations and a failure/default state will be detected and signaled by the control unit. The three signals will be sent to the SCADA System located in the Control Room.

Hydrocarbon Gas detector portable IR type shall be provided where specified.

Also, Hydrocarbon Gas detector Open Path and Point IR Type detector shall be provided at stations shown in respective P&IDs to monitor leakage due to failure of prone equipment part, accessories, valves and pipes depending upon wind direction gas density. However, exact quantity will be decided at the time of detail engineering.

Gas detector shall flash alarm light in local and panel at 20% LEL and flash alarm light and sound alarm hooter in local & panel at 40% LEL.

### OPEN PATH GAS DETECTION SYSTEM:

Standard Specification: AC (FP) Part – II, FA 1948 & GSR 1963, OISD

The system comprise TWO sets of Open path IR Gas detectors located in the process area. The entire Open Path Detectors are connected to a Control Panel. The control Panel for open path detection system is located in the main control room which will receive and transmit the required signals to the Detectors located in the field. All the Transmitters & Receivers of the open path detectors are connected to the Control Panel by the means of 6 P Armoured FLP Cable. From Transmitter and Receiver the continuous monitoring will be there and if the gas leaks in the field respective loop will be indicated in the front panel.

### ENVIROMENTAL CONDITIONS & GENERAL REQUIREMENTS:

- All the field equipments shall be suitable for IP 65 and should be for outdoor application.
- Flame proof equipment should be installed in the process area.
- Area classification for Hazardous area shall be Zone – 2, Group –IIA, II B, & Temperature class shall be T3.
- All Electronic circuits used in the system shall be resistant from the effects of any RF interference.
- Contacts used in intrinsically safe circuit must be gold plated.

### CONTROL PANEL FOR OPEN PATH DETECTORS:

The control Panel for the open path detectors Gas module is an electronic control unit designed to operate Gas detector head. Control Card and Controller for Gas Detection system shall be of OEM make only. Its Function is to:

- Supply the detector Head with a stabilized voltage and current.

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- To receive the signal from the Detector Head and process it.
- To visually display the concentration of gas present at the Detector Head.
- To initiate alarms at pre-set levels of gas concentration.

The module contains comprehensive fault monitoring facilities and circuits that allows remote display and control of its state. The unit is powered by 24 V DC supply and a switch mode regulator for the detector Head supply such that the voltage at the Head can be maintained accurately at the value required by the sensor (typically 2.0 volts) with up to 40 ohms loop conductor resistance between Detector Head and module.

The three wire interconnection between the module and the Detector Head is monitored by the fault detection circuits for any combination of short circuit or open circuit. Under normal conditions a fault relay is energized and when fault is detected this relay then de-energises. Fault conditions exist whenever the front panel function switch is in any position other than NORM. The input signal from the Detector is amplified accordingly the % LEL will be displayed in the front panel. Also the same amplified signal is compared in two separate comparator circuits against pre-set level to provide the ALARM 1 & ALARM 2 control signals.

Detected Gases: Simultaneous detection of C 1 –C 8 flammable gases. Other Features –

- Long – range gas detection up to 140 m
- High sensitivity and fast response to hydrocarbon gases.
- Compatible with extreme and harsh environments.
- Solar blind and immune to industrial environments.
- Withstands extreme vibration conditions.
- Interfaces with most commonly used control panels.
- Standards 4 – 20mA and Dry Contacts Relays.
- RS –485 Output for PC communications.
- Network for a maximum of 64.
- Simple installation , alignment, and calibration
- Explosion – proof enclosure.
- Cenelec and UL approved

**Power Supply:**

- 230VAC as a main Supply.
- 24V DC as a standby Supply.

**Input Signals:**

- Open path detectors
- Point Gas Detectors

**Output Signals:**

- Signals to PLC / SCADA system located in the Control Room.

Critical alarms from the GDS such as confirmed gas detection alarm, panel fault alarm shall be hardwired to the RTU / GAIL SCADA as a minimum.

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## 16.0 FIRE ALARM CONTROL PANEL (FACP)

Terminal buildings shall be equipped with Fire Alarm Control Panels (FACP) along with smoke detectors and manual call points (MCP) to initiate alarm on fire detection for safety of personnel and equipment in building. FACP shall be interfaced to RTU / GAIL SCADA in the terminal building.

FACP system shall be analog system compliant to NFPA 72 requirements. All buildings shall have conventional type smoke & heat detectors, hooters and beacons etc. interfaced to the FACP as required per HSE requirements.

Upon fire detection, the system shall initiate audible and visual alarms at the facility via hooters and beacons to alert personnel and initiate HSE procedures.

Critical alarms from the building FACP such as confirmed fire alarm, panel fault alarm shall be hardwired to the RTU / GAIL SCADA as a minimum.

## 17.0 INSTRUMENT CABLING AND WIRING

17.1 Only 1Pair / 2 pair / 1 Quad / 6 pair / 8 pair / 12 pair with PVC type primary insulation shall be used for instrumentation cables.

17.2 All cables shall be FRLS type to IEC - 60332 (Type-III, Category 'A').

17.3 Cables for analog signals shall have both individual pair screen and overall screen, and the pairs (or triples) shall be uniformly twisted together. Conductor size shall be 1.5mm<sup>2</sup> stranded. Cables for discrete signals shall have an overall screen, and the pairs shall be uniformly twisted together. Conductor size shall be 1.5 mm<sup>2</sup> stranded for both single pair and multipair cables.

17.4 Power supply cables (24V DC to solenoid valves, etc.) shall have stranded 2.5 mm<sup>2</sup> conductor size. Contractor to check the correct size depending upon length of cable and voltage drop.

17.5 In general, cable shall be armored type.

17.6 Wiring inside the control room local panels shall be 1.0 mm<sup>2</sup> copper stranded conductors with PVC insulation. Wiring shall be flame retardant & termination shall be via MCT. Panel wiring raceways and terminal blocks shall be flame retardant type (FRLS). All terminal blocks shall be with screw clamp type and shall be UL listed, 25% spare to be provided for future expansion.

17.7 All terminals shall be suitable for minimum 2.5mm<sup>2</sup> conductor size excepting those on main power supply distribution arrangements. The cable shields shall be grounded at one location only. Required number of junction box shall be allowed in the way of any interconnecting cable between the field instruments and the final termination point both for skid and non-skid equipment. Special signal cables shall be wired without Junction Boxes.

## 18.0 JUNCTION BOX

18.1 Junction boxes shall be weatherproof to NEMA 4X. Junction boxes located in explosion proof circuits shall be certified explosion proof to NEMA 7 suitable for the specified area classification.

18.2 Material of construction of junction box shall be LM-6 cast aluminum.

18.3 Terminals shall be vibration proof, clip on type mounted on nickel-plated steel rails complete with end cover and clamps for each row.

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- 18.4 All terminals shall be suitable for accepting minimum 2.5 sq.mm copper conductor in general. Sizing shall be done with due consideration for accessibility and maintenance.
- 18.5 Plugs shall be of Nickel plated brass.
- 18.6 Cable glands shall be double compression type for use with armored cables. They shall be of Nickel plated brass.
- 18.7 All cable glands shall be weatherproof to NEMA 4X. They shall be supplied to suit the cable dimensions. Various components like rubber ring, metallic ring, metallic cone and the outer/inner nuts etc. shall be capable of adjusting to the cable tolerances.
- 18.8 Colour shade for Junction box shall be:
  - For IS JB - High build Epoxy Deep Sky Blue Shade
  - For non IS JB - Light Gray Shade Equivalent to RAL7035
- 18.9 Cable gland for hazardous area shall be Explosion proof to Exd. IIA/IIB, T3 & WP to IP 65.

**19.0 OTHERS**

- 19.1 All cable & tube entries to control room shall be through MCT blocks. MCT blocks shall confirm to 'SOLAS'. MCT shall have 25% spares
- 19.2 Cable trays shall be ladder type in trenches and otherwise trays shall be perforated type. Material of construction for all trays shall be GI with min. 2 mm thickness.
- 19.3 A minimum of 20% spare capacity shall be provided in terminals in junction boxes, Control panels, and multicore cables, cable entries in junction boxes, cable trays etc.
- 19.4 In general, instrument Installation shall be as per specification for instrument installation works and typical installation hook-up drawings attached elsewhere in the bid document.

**20.0 GENERAL**

- 20.1 In general, instrument Installation shall be as per specification for instrument installation works and typical installation hook-up drawings.
- 20.2 20% or minimum one (01) number (whichever is greater), of each type of Instruments shall be provided as mandatory spare.

**21.0 TECHNICAL DESIGN DOCUMENTS:**

**21.1 Piping and Instrumentation Diagram (P&ID)**

The instrumentation symbology and presentation on the P&ID's shall be in accordance with ISA S5.1, including tag numbering.

The numbering system shall follow the project standard. A strategy of numbering, however, shall be developed during the detailed design, and approved by the COMPANY.

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Instruments supplied by mechanical package equipment SUPPLIER/VENDOR shall bear tag numbers provided by the CONTRACTOR and will be part of the Instrument Index prepared by the CONTRACTOR.

**21.2 Instrument Data Sheets**

Instrument data sheets shall be provided for all instrument types. Data sheets shall be subdivided for each process parameter, i.e. Flow, Level, Pressure, Temperature, Control Valves, Relief Valves, Analyzers, and Miscellaneous etc.

Instrument Data Sheets shall completely identify the instrument by type and model number and shall indicate operating data such as range, capacity, action, and set-point.

**21.3 Instrument Drawings**

The design shall include all detailed drawings to enable purchased equipment to be installed correctly. The following design drawings are typical requirements as minimum:

- System Architecture Drawing
- Instrument Index
- IO List
- Instrument location Drawings
- Typical Installation details
- Hook up Drawings
- Instrument Cable schedule
- Instrument interconnection diagrams
- Loop drawings
- Instrument cable tray & trench layout
- Instrument earthing layout
- Thermowell wake frequency calculation
- PSV capacity, surface temperature and sizing calculation
- Any other document drawing required for the project.

Following software shall be used for this project for all instrumentation documentation / datasheets.

- Instrument Index / IO List – MS Excel
- Drawings – AutoCad
- Cable / Tubing Schedule – AutoCad / MS Excel
- Instrument JB termination – AutoCad

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**ANNEXURE-1**

**MATERIAL SELECTION CHART FOR INSTRUMENTS**

Sr No.	Piping Class	Pressure Gauge / Pressure Switch	Thermo well
		Element / Socket / Gauge Saver / Snubber	
1	6A4	SS316	SS316
2	X65	SS316	SS316

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Sr No.	Piping Class	Miniature Inst. Valve	Impulse Tube & Tube Fitting
1	6A4	SS316	SS316
2	X65	SS316	SS316

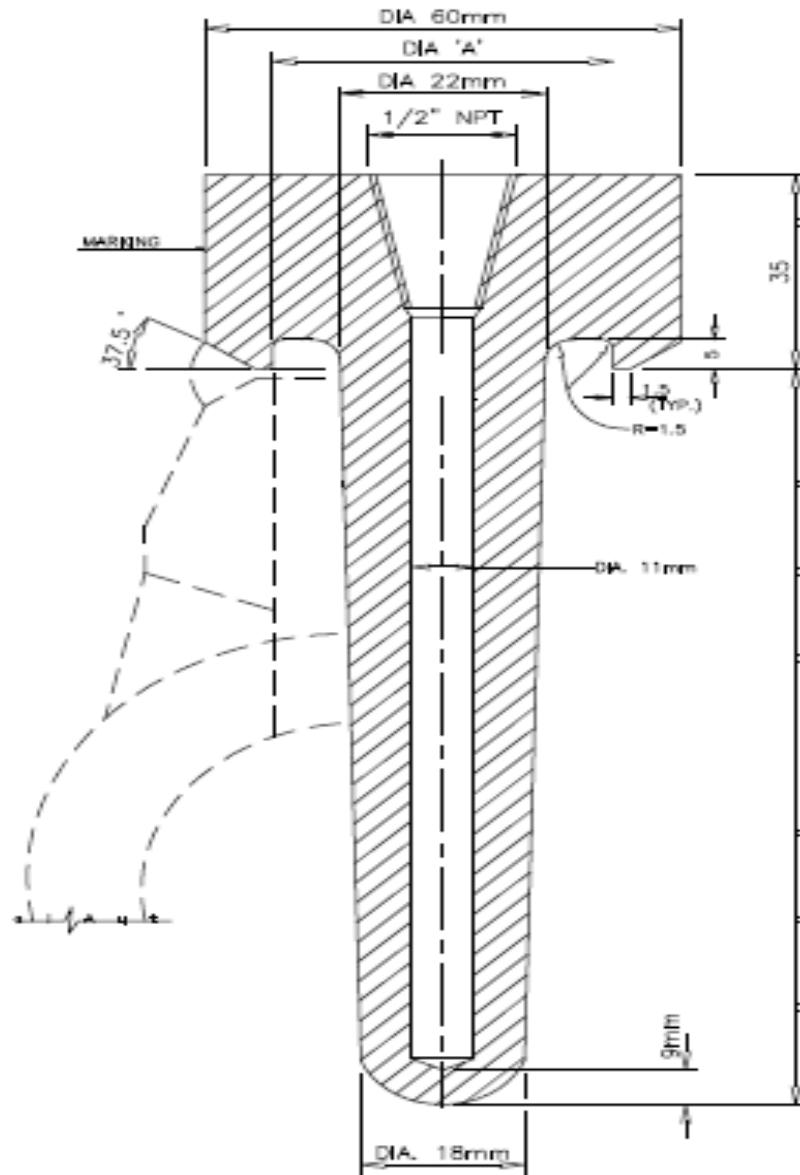
**General Notes:**

1. All Casting and welding of wetted parts shall be 100% radiographed.
2. In case of any conflict between the following documents, order of priority shall be as following:
  - a. Instrument Data Sheets
  - b. Instrument Material Selection Chart
  - c. Design Basis for Instrumentation
3. Abbreviations LTCS: Low Temperature Carbon Steel; SS: Stainless Steel
4. Contractor shall complete all these data sheets based on final selection. These shall be duly approved by the company as part of respective purchase specification.

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**ANNEXURE-2**

**THERMOWELL  
(WELDED TYPE - ABOVE GROUND)**





**GAIL INDIA LIMITED**

**STANDARD SPECIFICATION  
FOR  
PRESSURE GAUGES**

**GAIL-STD-IN-DOC-TS-001**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
0	15.01.2019	Issued As Standard	RKS	UNU	UNU



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ANNEXURE-1: MATERIAL OF CONSTRUCTION

**1.0 GENERAL**

**1.1 Scope**

1.1.1 This specification, together with the data sheets attached herewith covers the requirements for the design, materials, nameplate marking, and inspection, testing and shipping of pressure gauges.

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

ANSI/ASME	American National Standards Institution/American Society of Mechanical Engineers.
B 1.20.1	Pipe Threads General Purpose (Inch)
B 16.5	Pipe Flanges and Flanged Fittings NPS1/2 through NPS24
B 16.20	Metallic Gaskets for Pipe Flanges, Ring Joint, Spiral wound and Jacketed.
EN10204	Inspection Documents for Metallic Products
IEC-60529	Degree of Protection Provided by Enclosures (IP Code)
IS-3624	Specification for Pressure and Vacuum Gauges.


1.1.3 In the event of any conflict between this standard specification, data sheets, statutory regulations, related standards, codes etc., the following order of priority shall govern:

- a) Statutory Regulations'
- b) Datasheets
- c) Standard Specification
- d) Codes and Standards

In addition to compliance to purchaser's specifications in totality, vendor's extent of responsibility shall include the following:

- a) Purchaser's data sheets specify the type of pressure element. Unless specifically indicated otherwise, alternate type of pressure elements shall also be acceptable provided all the functional and performance requirements specified in the respective data sheets are guaranteed by the vendor.
- b) Purchaser's data sheets indicate the minimum acceptable material of construction for pressure element, movement etc. Alternate superior material of construction shall also be acceptable provided vendor assumes complete responsibility for the selected materials for their compatibility with the specified fluid and its operating conditions.

**1.2 Drawing and Data**


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- 1.2.1** Detailed drawings, data, catalogues and manuals required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of reproducible, prints and soft copies shall be dispatched to the address mentioned, adhering to the time limits indicated.
- 1.2.2** Final documentation consisting of design data, installation manual, operation and maintenance manual etc., submitted by the vendor after placement of purchase, order shall include the following, as a minimum:
- a) Specification sheet for each gauges, and its accessories.
  - b) Certified drawings sheets for each gauges and its accessories, which shall provide dimensional details, internal constructional details, end connection details and materials of construction.
  - c) Copy of type test certificates.
  - d) Copy of the test certificates for all tests indicated in clause 4.0 of this specification.
  - e) Installation procedure for each gauge and its accessories.
  - f) Calibration and maintenance procedures including replacement of internal parts wherever applicable

## **2.0 DESIGN AND CONSTRUCTION**

### **2.1 Pressure Elements, Gauge Movement and Socket**

- 2.1.1 The pressure element shall be an elastic element like bourdon tube, bellow, diaphragm etc with material as specified in the data sheet.
- 2.1.2 In case of bourdon type of gauges, the size of the bourdon tube shall not be less than 75% of the nominal diameter of the dial size.
- 2.1.3 Gauge construction shall ensure no leakage of process fluid from the sensor elements to atmosphere and between the high pressure and low-pressure side (in case of differential pressure gauges) under normal condition.
- 2.1.4 The gauge socket shall be in one piece and shall also serve as element anchorage in case of bourdon tube type element, which shall be directly connected to the socket, without any capillary or tube in between. For other types of elements, the anchorage may be integral with the socket or connected with the socket using capillary tube with minimum bore of 3 millimetres.
- 2.1.5 Any joint in the process wetted system including joint between the element and the anchorage/socket shall be welded type only.
- 2.1.6 Unless specified otherwise, the pressure gauges shall have an over-range protection of at least 130% of maximum working pressure, as a minimum.
- 2.1.7 Data sheet indicates the minimum requirement of material of construction. Alternate materials as specified in Annexure 1 to this specification shall also be acceptable subject to meeting process conditions.

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- 2.1.8 The gauge movement material shall be of stainless steel unless specified otherwise in the data sheet. It shall be adjustable for calibration without dismantling the sensor unit. The use of link for calibration of span is not permitted. Gauges shall be provided with external zero adjustment.
- 2.1.9 Vendor shall ensure that the operating pressure falls in the middle 30% of the full working range i.e. operating pressure shall fall between 35% and 65% of the range offered.
- 2.1.10 Pressure gauges with range as 0 to 100kg/cm<sup>2</sup>g and above shall have safety type solid front case. All gauges in oxygen and chlorine service shall be thoroughly degreased using reagents like trichloro-ethylene or carbon tetrachloride. All connections shall be plugged after degreasing process in order to avoid entrance of grease or oil particles.

## 2.2 Cases and Dials

- 2.2.1 Unless specified otherwise, the gauges shall be weather proof to IP 65 as per IEC 60529, as a minimum.
- 2.2.2 In general, dial markings and dial colour shall be as per IS 3624. Dials of gauges in oxygen service shall additionally have the word 'OXYGEN' or 'CHLORINE' written in black and 'USE NO OIL' written in red.
- 2.2.3 The gauge dial shall be made of a suitable metallic materials so that the finished dial shall be capable of withstanding a dry heat of 85°C for 10 hours and immersion in water-at 85°C for 1 hour without cracking, blistering, warping or discolouration of the dial or paint on the dial.
- 2.2.4 The pointer stops shall be provided at both ends of the scale to restrict the pointer motion beyond 5% above the maximum of scale and less than 5% below the minimum of the scale.
- 2.2.5 The dial cover shall be made out of shatter proof glass sheet of thickness 1.5 to 3mm for gauges with dial size less than 100mm while minimum 3.0mm for gauges with dial size 100mm or greater.
- 2.2.6 All gauges shall be provided with a blow out device i.e. blow out disc of aperture not less than 25mm for gauges with dial size 100mm and above, while 20mm for gauges with dial size less than 100mm.
- 2.2.7 When safety type solid front type of gauges are specified, they shall consist of a solid partition isolating the pressure element from the dial. In such gauges the total solid partition disc area shall not be less than 75% of the cross sectional area of the inside of the case surrounding the pressure element.

## 2.3 Diaphragm Seals

- 2.3.1 Unless otherwise indicated in purchaser's data sheets, gauges specified with diaphragm seals shall have their diaphragms integral with the gauges.
- 2.3.2 Whenever diaphragm seal gauges are specified with capillary, the size of the capillary shall be selected to ensure response time of the gauge better than 5 seconds.

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- 2.3.3 The sealing liquid for diaphragm seal gauges shall be an inert liquid, compatible with the process fluid and its temperature. For gauges in oxygen and chlorine service, the sealing liquid shall be fluoro lube or equivalent compatible with the specified service.
- 2.3.4 For diaphragm seal pressure gauges with flanged ends, the diaphragm shall be rated for the maximum allowable pressure of the associated flange.

## 2.4 End Connection

- 2.4.1 Unless specified otherwise, the following shall govern;
- Threaded end connections shall be NPT as per ANSI / ASME B. 1.20.1.
  - Flanged end connection shall be as per ANSI / ASME B. 16.5
  - Ring joint flanges shall have octagonal grooves as per ANSI / ASME B16.20.
  - Flange face shall be as per clauses 6.4.4.1, 6.4.4.2 and 6.4.4.3 of ANSI / ASME B16.5.
- The face finish as specified in the data sheet shall be as follows;
- |         |                   |
|---------|-------------------|
| 125AARH | : 125 to 250 AARH |
| 63 AARH | : 32 to 63 AARH   |

## 2.5 Performance Requirements


- 2.5.1 Unless otherwise specified, the accuracy which is inclusive of repeatability and hysteresis of pressure gauges shall meet the following performance requirements:
- Direct pressure gauge :  $\pm 1\%$  of full scale
  - Chemical seal type pressure gauge :  $\pm 2\%$  of full scale
  - Differential pressure gauges :  $\pm 2\%$  of full scale

## 2.6 Accessories

- 2.6.1 Gauges shall be supplied with all accessories as specified in the data sheets pre-installed.
- 2.6.2 For flanged diaphragm seal gauges, spacer ring, isolation valve and plugs shall be provided whenever specified.
- 2.6.3 Over Range Protector (OPV)
- Whenever the maximum pressure specified in the data sheet exceeds the over range protection pressure, over range protector shall be supplied.
  - In case of pressure gauges with diaphragm seal, the over-range protector shall be installed between the seal and the gauge.
  - The material of construction of over range protector shall be same as socket material, as a material.

## Snubber

- Whenever the service specified is pulsating type, snubber shall be supplied.
- The material of construction of snubber shall be same as socket material, as a minimum.

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**3.0 NAME PLATE**

3.1.1 Each gauge shall have a stainless steel nameplate attached firmly to it at a visible place either by riveting or screwed to the case, furnishing the following information:

- a) Tag number as per purchaser's data sheets.
- b) Vendor's name
- c) Model number and manufacturer's serial number.
- d) Range of the instrument.
- e) MAWP and maximum vacuum rating of element

**4.0 INSPECTION AND TESTING**

4.1 Unless otherwise specified, purchaser reserves the right to test and inspect all the items at the vendor's works inline with the inspection test plan for pressure gauges.


4.2 Vendor shall submit following test certificates and test reports for purchaser's review:

- a) Material test report as per EN10204 clause 2.2 for wetted parts like gauge socket and sensing element
- b) Type test report for enclosure.
- c) Dimensional test report for all gauges.
- d) Performance test reports for all gauges including accuracy, repeatability, over pressure and vacuum test (as applicable)
- e) Type test reports for shock test and endurance test as per IS-3624 for each type / model.
- f) Type test report for influence of temperature for each type/model.

**4.3 Witness Inspection**

4.3.1 All pressure gauges shall be offered for pre dispatch inspection for following as a minimum:

- a) Physical dimensions verification and workmanship.
- b) Performance test including accuracy and repeatability, on representative samples of each type/model number before and after over-pressure and vacuum test.
- c) Over-pressure and vacuum test (as applicable) shall be carried out on representative samples of each type / model number without loss of their elastic characteristics.
- d) Review of all certificates and test reports as indicated in clause 4.2 of this specification.

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- 4.3.2 In the event when the witness inspection is not carried out by purchaser, vendor shall anyway complete the tests and the test documents for the same shall be submitted to purchaser for scrutiny.

**ANNEXURE-I**

**Material of Construction**

S.No.	Item	Specified Material of Construction	Alternate Material of Construction
1.	Sensing Element	SS316	SS316L, SS316Ti
2.	Socket	SS316	SS316L, SS316Ti
		SS304	SS304L, SS316
3.	Case	SS 316	SS316Ti, SS316L,SS
4.	Capillary	SS	SS304, SS316, SS304L, SS316L, SS316Ti
. 5.	Diaphragm	SS316	SS316L, SS316Ti
		SS	SS 302, SS 304, SS 304L, SS316, SS316L, SS316Ti

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**GAIL INDIA LIMITED**

**STANDARD SPECIFICATION  
FOR  
PRESSURE SAFETY VALVES**

**GAIL-STD-IN-DOC-TS-002**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
0	15.01.2019	Issued As Standard	RKS	UNU	UNU



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**1.0 GENERAL****1.1 Scope**

- 1.1.1 This specification, together with the data sheets attached herewith covers the requirements for the design, materials, fabrication, nameplate marking, inspection, testing and shipment of pressure Safety valves.
- 1.1.2 The related standards referred to herein and mentioned below shall be of the latest editions prior to the date of the purchaser's enquiry: -

**ANSI/ASME**                    **American National Standards Institute/American Society for Mechanical Engineers.**

B 1.20.1	Pipe Threads General Purpose (Inch).
B 16.5	Pipe Flanges and Flanged Fittings NPS 1/2" through JSr PS 24
B 16.20	Metalic Gasket for Pipe Flange
B 16.34	Valves- Flanged, Threaded and Welding End


**ASME**                            **American Society of Mechanical Engineers.**

Sec-VIII	Boiler and Pressure Vessels Code Section VIII 'Pressure Vessels'
Sec-I	Boiler and Pressure Vessels Code. Section-I 'Power Boilers'

**API**                                **American Petroleum Institute**

API 520	Sizing, Selection and Installation of Pressure Relieving Devices in Refineries.
Part I	Sizing & Selection
Part II	Installation
API 521	Guide for Pressure Relieving and Depressurizing Systems.
API 526	Flanged Steel Pressure Relief Valves
API 527	Seat Tightness of Pressure Relief Valves.
EN 10204	Inspection Documents For Metallic Products.
IBR	Indian Boiler Regulations

- 1.1.3 In the event of any conflict between this specification, data sheets, related standards, codes etc., the following order of priority shall govern:
- Statutory Regulations
  - Data Sheets
  - Standard Specification
  - Codes and Standards
- 1.1.4 In addition to compliance to purchaser's specifications in totality, vendor's extent of responsibility shall include the following;

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- a) Technical data sheets indicate the type, size, relieving area etc. of the selected the valve. However, vendor shall be responsible to size and select the proper valve with orifice relieving area meeting the indicated operating conditions.
- b) Technical data sheets specify the minimum acceptable materials for body, bonnet, disc, nozzle, spring, bellows etc.

**1.2 Drawing and Data**

- 1.2.1 Detailed drawings, data, catalogues and manuals required from the vendor are indicated by the purchaser in vendor data requirement sheets.
- 1.2.2 Final documentation consisting of design data, installation manual, operation and maintenance manual etc. submitted by the vendor after placement of purchase order shall include the following as a minimum:
  - a) Specification sheet for each pressure Safety valve and its accessories
  - b) Certified drawing sheets for each pressure Safety valve and accessories, which shall provide dimensional details, internal construction details, end connection details, weight and material of construction.
  - c) Copy of type test certificates.
  - d) Copy of test certificates for all the tests indicated in clause 4.0 of this specification.
  - e) Installation procedure for Pressure Safety valve and its accessories
  - f) Calibration and maintenance procedure including replacement of internals wherever applicable.

**2.0 DESIGN AND CONSTRUCTION**

**2.1 Valve Design**

- 2.1.1 The definitions of various terminologies used in purchaser's data sheets are as per clause 1.2 of API RP 520 part 1.
- 2.1.2 Unless specified otherwise, all pressure Safety valves shall be full nozzle full lift type and all Safety valves in thermal safety application shall be modified nozzle type.
- 2.1.3 For flanged pressure Safety valves, the valve inlet and outlet size, the orifice designation and corresponding relieving area shall be as per API 526.

**2.2 Valve Sizing**

- 2.2.1 Sizing shall be carried out using the formulae mentioned in the following standards whenever the sizing code mentioned in the purchaser's data sheets refers to these

<u>Sizing Code</u>	<u>Standard</u>
API	API RP 520 Part I API 520 Part-II API RP 521 API 526 API 527.

- 2.2.2 Discharge Co-efficient

For all valves in gas, vapour or steam service with design code as ASME Sec VIII or ASME Section I discharge co-efficient of 0.975 as per API 520 shall be used.

- 2.2.3 For the selected orifice letter designation and inlet and outlet size of the pressure Safety valve, relieving area of the valve offered by vendor shall meet those in API-526.



## 2.3 Valve Construction

### 2.3.1 Body

2.3.1.1 Unless otherwise mentioned, end connection details shall be as below: -

- a) Threaded end connections shall not be used.
- b) Flanged end connections shall be as per ANSI/ASME B 16.5.
- c) Flanged face finish shall be as per ANSI/ASME B 16.5. The face finish as specified in the data sheets, shall be as follows;

125AARH	125 to 200AARH
63 AARH	32 to 63 AARH

2.3.1.2 For flanged valves, inlet and outlet sizes and ratings and centre to flange face dimensions shall be in accordance with API-526. Dimensional tolerance shall be as mentioned therein.

2.3.1.3 Body drain with a plug shall be provided as a standard feature on every pressure Safety valve.

2.3.1.4 For the pilot operated pressure safety valves, where vendor's standard model provides only semi nozzle design (i.e. the body is part of the inlet flow path), body material shall be of the same material as that of nozzle specified in purchaser's data sheets, as a minimum.

### 2.3.2 Trim

2.3.2.1 The term 'trim' covers all the parts of the valves exposed to and in contact with the process fluid except for the body and bonnet assembly i.e. nozzle, disc, disc holder, stem etc.

2.3.2.2 Valves shall be of the full nozzle type of design with the exception as per clause 2.3.1.4 and valves in thermal Safety application.

2.3.2.3 Wherever stelling of disc and nozzle has been specified, it stands for stelling of the seat joint and the entire disc contour, unless otherwise mentioned.

2.3.2.4 For high temperature application, the materials for the internals shall be selected to avoid galling.

2.3.2.5 Resilient seat, seals or o-rings wherever used shall be suitable for pressure and temperature conditions specified.

2.3.2.6 Gaskets wherever used shall be metallic type. Gaskets with asbestos filler or with asbestos bearing material shall not be used.

### 2.3.3 Bonnet and Spring

2.3.3.1 All valves shall be provided with a cap over the adjusting bolt. Cap shall be of either bolted type or screwed type as specified in the purchaser's data sheets.


2.3.3.2 Lifting lever shall be provided whenever the fluid to be relieved is steam and air or water above 65°C.

2.3.3.3 Valve spring shall be selected such that it can permit an adjustment of  $\pm 5\%$  of the set pressure, as a minimum.

2.3.3.4 Carbon steel springs shall be made corrosion resistant through plating/coating as per manufacturer's standard design or as specified in the purchaser's data sheets.

2.3.3.5 The allowable tolerance in set pressures are as below:

- a)  $\pm 0.14 \text{ kg/cm}^2 \text{ g}$  for set pressure upto and including  $5 \text{ kg/cm}^2 \text{ g}$ .

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- b)  $\pm 3\%$  for set pressure above 5kg/cm<sup>2</sup> g.

2.3.3.6 Bonnet shall be of the closed type for all process applications in general. Open type bonnet shall be used only for steam and non-hazardous/non-toxic fluids. For all steam applications under design code IBR or ASME Section-I with open bonnet design, weather protection cover shall be provided.

#### 2.3.4 Pilot Design

2.3.4.1 For pilot operated valves, the pilot design shall be of inherently fail safe.

2.3.4.2 Unless specified otherwise, pilot shall be non-flowing type.

2.3.4.3 All accessories like back flow preventer, pilot filter etc. required for proper operation of pilot operated valves as per indicated service conditions shall be included.

2.3.4.4 Material of construction of pilot shall be same as that of main valve nozzle as a minimum.

2.3.4.5 The o-ring and diaphragm material of pilot shall be suitable for the pressure and temperature conditions specified in the data sheet.

### NAMEPLATE

2.4 Each pressure Safety valve shall have a stainless steel nameplate attached firmly to it at a visible place furnishing the following information: -


- a) Tag number as per purchaser's data sheet.
- b) Manufacturer's serial number and/or model number.
- c) Manufacturer's name/trade mark.
- d) Nominal flange size in inches and rating in pounds for both inlet and outlet.
- e) Orifice letter designation.
- f) Valve set pressure.
- g) Cold bench test set pressure.

2.4.1 For the above, pressures shall be marked in the same units as those followed in purchaser's data sheets.

### 3.0 INSPECTION AND TESTING

3.1 Vendor shall submit the following test certificates and test reports for purchaser's review:-

- a) Material test certificate as per clause 3.1B of EN10204 for each valve body and bonnet castings/forging, nozzle and as per clause 2.2 for stem, disc etc.
- b) Certificate of radiography/X-ray for valve castings as per following requirements;
  - i) 100% radiography shall be carried out for all valve castings with body rating of 600# and above or wherever specifically indicated for in the material requisition.
  - ii) Radiography procedure shall be as per ANSI B 16.34 and acceptance criteria shall be as per ANSI B 16.34 Annexure-B. Following area of pressure Safety valve shall be radiographed unless specified otherwise.
    - Inlet flange neck
    - Outlet flange neck
    - Nozzle (in case of cast construction)
    - Body/bonnet joint neck.
- c) Dimensional, hydrostatic and functional test reports for all valves as per clause 3.2 and 3.3 of this specification.

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d) Type test certificate for blow-off and closing down pressure.

### 3.2 Hydrostatic Test

3.2.1 Each Pressure Safety valve body shall undergo hydrostatic test as per outlet flange ANSI rating. However all the safety valves castings covered under IBR shall be tested as per IBR regulations. There shall not be any visible leakage during this test.

3.2.2 For full nozzle type of pressure Safety valve, nozzle shall undergo hydrostatic test as per inlet flange ANSI rating. For Semi nozzle design, valve Inlet shall be tested after assembly as per Inlet flange ANSI rating.

### 3.3 Functional Test

3.3.1 Cold bench set pressure test:

Pressure Safety valve shall be tested for opening at specified set pressure. Testing of pressure Safety valves shall be with air or nitrogen, testing of thermal Safety valves shall be with water.

3.3.2 Seat Leakage test

a) Whenever the specified set pressure is less than or equal to 420 kg/cm<sup>2</sup>g, the valve shall meet the seat tightness requirements specified in API RP-527. The maximum permissible leakage rates against various sizes shall be as specified therein. Whenever the specified set pressure exceeds 420 kg/cm<sup>2</sup>g, the vendor shall submit the leakage rates of valves for approval by the purchaser. Where bubble tightness has been specified, there shall be no leakage or bubbles of air at the specified percentage of set pressure.


b) Seat leakage test pressure shall be as per API RP 527 (determining the seat tightness of metal- and soft-seated pressure relief valves, including those of conventional, bellows, and pilot operated designs) except for valves under IBR or ASME Section-I design code. Safety valves. For these valves seat leakage shall be carried out at the following pressure;

i) Valves under IBR or ASME Section-I : 95% of Set Pressure

ii) Pilot operated Pressure Safety valves

- Upto 3.5 Kg/cm<sup>2</sup>G : 90% of set Pressure
- Above 3.5 Kg/cm<sup>2</sup>G : 95% of Set Pressure

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**STANDARD SPECIFICATION  
FOR  
ELECTRONIC TRANSMITTERS**

**GAIL-STD-IN-DOC-TS-003**

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**1.0 General****1.1 Scope**

- 1.1.1 This specification, together with the data sheets attached herewith forms the requirements for the design, materials, nameplate marking, inspection, testing and shipping of electronic / pneumatic instruments.
- 1.1.2 The related standards referred to herein and mentioned below shall be of the latest editions prior to the date of the purchaser's enquiry:-

ANSI/ASME	American National Standards Institute / American Society of Mechanical Engineers
B 1.20.1	Pipe Threads General Purpose (Inch)
B 16.5	Pipe Flanges and Flanged Fittings NPS½ through NPS24
B 16.20	Metallic Gaskets for Pipe Flanges, Ring Joint, Spiral wound and Jacketed.
BS-5760	Reliability of System, Equipments and Components
EN 10204	Inspection Documents For Metallic Products
IEC-60068	Environmental Testing
IEC-60079	Electrical Apparatus for Explosive Gas Atmosphere.
IEC-60529	Classification of Degree of Protection Provided by Enclosures.
IEC-61000-4	Electromagnetic Compatibility for Industrial Process Measurement and Control Equipment.
IEC-61158	Fieldbus Standard for use in Industrial Control System
IEC-61158-2	Physical layer specification and Service definition for Field bus
IEC 61508	Functional Safety of Electrical/Electronic/Programmable Electronic Safety- related Systems.
IS-2148	Flame Proof Enclosures of Electrical Apparatus.
ISA	International Society of America
S 7.3	Quality Standard for Instrument Air
S 50.1	Compatibility of Analog Signals for Electronic Industrial Process Instruments.
ITK-x.x	Interoperability Test Kit (latest version)

- 1.1.3 In the event of any conflict between this standard specification, job specification/data sheets, Statutory regulations, related standards, codes etc. the following order of priority shall govern:
- Statutory Regulations
  - Data Sheets
  - Standard Specification
  - Codes and standards

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- 1.1.4 In addition to compliance to purchaser's specifications in totality, vendor's extent of responsibility shall include the following:
- a) Purchaser's data sheets specify the minimum acceptable material of construction of body, measuring element and accessories. Alternate superior material of construction shall also be acceptable provided vendor assumes complete responsibility for the selected materials for their compatibility with the process fluid and its operating conditions.
  - b) Selection of suitable sealant liquid for diaphragm seal instruments compatible with the process fluid and its operating temperature.


## 1.2 Drawing and Data

- 1.2.1 Detailed drawings, data, catalogues and manuals required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of reproducible, prints and soft copies should be dispatched to the address mentioned, adhering to the time limits indicated.
- 1.2.2 Final documentation consisting of design data, installation manual, operation and maintenance manual, etc submitted by the vendor after placement of purchase order shall include the following, as a minimum;
- a) Specification sheet for each electronic/pneumatic instrument and their accessories.
  - b) Certified drawing for each instrument, which shall provide dimensional detail, internal construction and part list, material of construction etc.
  - c) Calculations for integral orifice
  - d) Copy of type test certificates.
  - e) Copy of the test certificates of all the tests indicated in clause 4.0 of this specification.
  - f) Installation procedure for electronic/pneumatic instrument and its accessories.
  - g) Calibration and maintenance procedures including replacement of its internal parts.

## 2.0 DESIGN AND CONSTRUCTION

### 2.1 General Requirements


- 2.1.1 The type and material of construction of electronic/pneumatic instruments shall be as specified in the purchaser's data sheet.
- 2.1.2 The range of instruments shall be selected by vendor base on the set range indicated in the purchaser's data sheet. Where no set range is indicated, vendor may select the same as per the following guidelines;
- a) The set range shall be 1.1 times the maximum process value or 1.4 times the operating process value whichever is higher rounded to the nearest ten.
  - b) The set range shall preferably be in the middle third of the selected instrument range.

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- 2.1.3 Except for instruments covered under clause 2.2.3.10 of this specification or specified otherwise in purchaser’s data sheets, each instrument shall have an over-range protection of at least 130% of specified range.
- 2.1.4 Measuring element in vacuum service shall have under range protection down to full vacuum, without undergoing a change in calibration or permanent set.
- 2.1.5 Unless otherwise specified, diaphragm seal instrument shall meet the following requirements;
  - a) Instruments shall have its diaphragm seal integral with the instrument and shall be supplied with adaptor flange.
  - b) When purchaser data sheets specify wafer seal type of instrument, vendor shall include supply of studs, nuts and gasket as per the materials specified in the purchaser’s data sheet.
  - c) The sealant shall be an inert liquid, compatible with the process fluid and process temperature indicated in the purchaser’s data sheets. In general, sealant shall be;
    - i) DC 704 or equivalent for all diaphragm seal instruments except for oxygen and chlorine.
    - ii) Flouro-lube or equivalent for all diaphragm seal instruments in oxygen and chlorine.

The requirement of spacer ring shall be as specified in purchaser’s data sheet. The material of construction of spacer ring shall be 316 Stainless Steel, as a minimum unless otherwise specified in the purchaser’s data sheets.

- 2.1.6 Wherever purchaser data sheet specified integral flow transmitter, vendor shall supply complete assembly consisting of integral orifice, upstream and downstream meter runs with end flanges.
  - a) Three nos. of integral orifice plates shall be supplied i.e one is installed and two are spares.
  - b) Unless otherwise specified, material of construction shall be 316 Stainless Steel for integral orifice and meter run with flanges.
- 2.1.7 The instrument enclosure shall be suitable for the area classification indicated in the purchaser's data sheets. Unless otherwise specified, the enclosure shall meet the following standards;
  - Weatherproof housing IP-65 to IEC-60529.
  - Flameproof housing Flameproof/ Ex (d) as per IEC-60079/IS-2148.
  - Flameproof housing shall also be made weatherproof.
- 2.1.8 Unless otherwise mentioned, end connection details shall be as below:-
  - a) Threaded end connections shall be to NPT as per ANSI/ASME B 1.20.1.
  - b) Flanged end connections shall be as per ANSI/ASME B 16.5.
  - c) Grooves of ring-type joint flanges shall be octagonal as per ANSI B16.20.

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- d) Flanged face finish shall be as per clauses 6.4.5.1, 6.4.5.2, and 6.4.5.3 of ANSI B 16.5. The face finish as specified in the data sheets shall be as follows: -

125 AARH	:	125 to 250 AARH
63 AARH	:	32 to 63 AARH

- 2.1.9 All electronic / pneumatic instruments in oxygen and chlorine service shall be thoroughly degreased using reagents like trichloro-ethylene or carbon tetrachloride. End connection shall be blinded / plugged after the degreasing process in order to avoid entrance of grease or oil particles.


#### 2.1.10 Electronic Instruments

- All instruments shall be of state-of-the-art technology and shall be in compliance with the electromagnetic compatibility requirements specified in IEC-61000-4 standard.
- Plug-in circuit boards shall be designed and manufactured such that reverse insertion or insertion of the wrong card is prevented.
- Electronic instruments shall generally operate on nominal voltage of 24 V DC and shall be protected against short circuit and reverse voltage. Transmission and output signal shall generally be 4 to 20 mA DC for analog and smart transmitters. The display of integral output meter shall be in engineering units for pressure, differential pressure and flow and 100% linear for level.
- Electronic transmitters with two-wire system shall be suitable for delivering rated current to an external loop resistance of at least 600ohm when powered with 24 V DC.
- Terminals for electrical connections shall be clearly identified, and polarity shall be permanently marked.
- Peak to peak ripple and total noise level in the analog output signal shall not exceed 0.25% of the maximum signal.
- Power supply, signal isolation, ripple and noise requirements shall generally be as per ISA-S 50.1.
- Electrical conduit entries shall have internal NPT ½” threads.

#### 2.1.11 Pneumatic Instruments.

- All pneumatic connections shall be 1/4" NPT, unless otherwise specified.
- All threaded connections shall be internal, unless otherwise specified.
- The process input connections and pneumatic output and air supply connections etc. shall be permanently stamped on the body at a suitable place.
- Unless otherwise specified, pneumatic instruments shall operate on air supply of 1.4 kg/cm<sup>2</sup>g and shall have transmission and output signal of 0.2 to 1.0 kg/cm<sup>2</sup>g.
- Instrument air quality shall be as per ISA-S7.3 and shall be free from all corrosive, hazardous, flammable and toxic contaminants.

## 2.2 Transmitters

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**2.2.1 Pneumatic Transmitters**


- a. Pneumatic blind transmitters shall be of the force-balance type and pneumatic indicating transmitters of the motion balance type.
- b. Transmitters shall have an accuracy of 0.5 % of span.
- c. Transmitters shall be supplied with external zero and span adjustments.

**2.2.2 Electronic Analog Transmitters**

- a. Electronic transmitters shall be of the two-wire dc current regulating type. They shall be provided with integral output indicator. When specified, field mounted external output meters shall be provided.
- b. Electronic analog transmitters shall have an accuracy of  $\pm 0.075$  % of span.
- c. Transmitters shall be supplied with external zero and span adjustments, Flameproof transmitters shall also have their calibration adjustment from outside, without any need to remove the cover.
- d. Unless otherwise specified, the electronic transmitters shall be certified intrinsically safe.

**2.2.3 Smart and Field bus based Transmitters**

- 2.2.3.1 Smart and field bus based transmitters shall be two wire microprocessor based type. These shall have a non-volatile memory, storing, complete sensor characterisation and configuration data of the transmitter. All necessary signal conversions and output generation with the required protocol shall be carried out in the transmitter electronics. Integral output meter with LCD display shall be provided for all transmitters.
- 2.2.3.2 Transmitter shall also run complete diagnostic subroutines and shall provide diagnostic alarm messages for sensor as well as transmitter healthiness. Field bus based transmitter in addition shall have facility to detect plugged impulse lines, whenever specifically indicated in purchaser's data sheets. In the event of detection failure, the output shall be driven to a predefined value, which shall be field configurable.
- 2.2.3.3 The transmitters with field bus connectivity shall have built in control algorithm like proportional, proportional-integral and proportional-integral-differential.
- 2.2.3.4 Whenever specifically indicated in purchaser's data sheets, the meter electronics shall be provided with in-built lightning and power supply surges. The transient protection shall meet the requirements specified in IEC-60587.
- 2.2.3.5 The configurational data of the instruments shall be stored in a non-volatile memory such that this remains unchanged because of power fluctuations or power off condition. In case vendor standard instrument has battery backed RAM, vendor to ensure that battery drain alarm is provided as diagnostic maintenance message.
- 2.2.3.6 Accuracy of transmitters, smart as well as field bus based, shall be as follows:

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- a) For transmitter ranges of 760 mm WC and above, the accuracy shall be equal to or better than  $\pm 0.075\%$  within a turndown of 1:10 of the offered span.
- b) For transmitters with ranges less than 760 mm WC the accuracy shall be equal to or better than  $\pm 0.15\%$  within a turndown of 1:10 of the offered span.
- c) For all diaphragm seal transmitter with ranges 500 mm WC and above, the accuracy shall be equal to or better than  $\pm 0.25\%$  within a turndown of 1:10 of the offered span.
- d) For all diaphragm seal transmitter with ranges less than 500 mm WC, the accuracy shall be equal to or better than  $\pm 0.5\%$  within a turndown of 1:10 of the offered span.

The accuracy is defined as the combined effect of repeatability, linearity and hysteresis.

2.2.3.7 The stability of the transmitters shall be equal to or better than  $\pm 0.1\%$  of span for a period of minimum 6 months, as a minimum.

2.2.3.8 Transmitter shall update the output at least 8 times a second unless otherwise specified.

2.2.3.9 Unless specified otherwise in purchaser's specification, transmitter response time shall be as follows:

- a) For transmitter range of 760 mm WC and above, the response time shall be equal to or 1 second. The response time of the transmitter shall be considered as the sum of dead time and 63.2% step response time of the transmitter.


2.2.3.10 Unless specified otherwise, the over-range/static pressure protection of the transmitter shall be as follows;

- a) For transmitter range between 1 kg/cm<sup>2</sup>g and 100kg, the over range/static pressure shall be 130 kg cm<sup>2</sup>g.
- b) For transmitter with ranges of 100 kg/ cm<sup>2</sup>g and above, the over-range/static pressure shall be 210 kg/cm<sup>2</sup>g or 130% of maximum range whichever is higher.
- c) For transmitter range between 0.5 kg/cm<sup>2</sup>g to 1.0 kg/ cm<sup>2</sup>g, the over pressure/static pressure shall be 70kg/cm<sup>2</sup>g.
- d) For transmitters with ranges between 1000mm WC to 5000mm WC, the over-range/static pressure shall be 35kg/cm<sup>2</sup>g.
- e) For transmitter with ranges less than 1000mm WC, over-range/static pressure shall be 1.0kg/cm<sup>2</sup>g.

2.2.3.11 In the transmitter, the 'WRITE' option shall be protected through password.

2.2.3.12 Temperature transmitters shall meet the following requirements as a minimum:

- a) Temperature transmitter shall be universal type and shall be able to accept input from resistance temperature detector (RTD) or thermocouple (T/C) of any type and range.
- b) Temperature transmitters shall be freely programmable i.e. element type and range shall be programmable without any change in hardware / software.
- c) Temperature transmitter shall be remote mounted type, in general. Head mounted transmitters shall be supplied when specifically indicated in purchaser's data sheets.

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- d) The accuracy of the temperature transmitter with RTD element shall be as follows:
- For temperature range above 350°C, the accuracy shall be equal to or better than  $\pm 0.075\%$  of full scale.
  - For temperature range with ranges between 350°C to 150°C, the accuracy shall be equal to or better than  $\pm 0.15\%$  of full scale.
  - For temperature range below 150°C, the accuracy shall be equal to or better than  $\pm 0.2\%$  of full scale.
- e) The accuracy of temperature transmitter with cold junction compensation for Thermocouple element shall be as follows;
- For temperature above 350°C, accuracy shall be  $\pm 0.25\%$  of range.
  - For temperature between 150°C to 350°C. accuracy shall be  $\pm 0.5\%$  of range.

2.2.3.13 When HART protocol is specified, the following features must be ensured;


- a) It shall allow multi masters (two for example, primary and secondary) for configuration, calibration, diagnostics and maintenance. The primary could be the control system or host computer and the secondary could be the hand-held communicator.
- b) It shall be capable of implementing universal commands from either of these locations.

2.2.3.14 In addition to the requirements specified above, field bus based transmitter shall meet the following requirements;

- a) All instruments must satisfy the requirements of the field bus registration laboratory with applicable checkmark like foundation field bus, profibus PA, or as specified in the purchaser's data sheets.
- b) All instruments shall have two analog input blocks, as a minimum. In addition, when specified the transmitter shall also have PID controller block.
- c) All instruments must be interoperable and shall have valid interoperability test clearance like ITK latest version for foundation field bus or equivalent for profibus PA, as applicable.
- d) The field bus instruments shall support peer to peer communication.
- e) Field bus instruments as offered shall not be polarity sensitive.
- f) The field bus instruments in hazardous area shall be certified as per entity concept or shall be FISCO approved as per the requirements specified in the purchaser's specification.

## 2.3 Receivers

- a) Pneumatic/electrical cables shall be such that they permit the instrument internals to be drawn from its normal mounting position without affecting operation. Pneumatic connection points shall seal automatically upon disconnection.

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- b.. Electronic receivers shall be suitable for standard voltage inputs of 0.25 to 1.25 V, 1 to 5 V, 0 to 10 V dc. Any voltage receiver shall not alter the voltage drop across the conditioning resistor by more than  $\pm 0.1\%$  of input range of maximum input voltage.
- c. Recorder pens shall be easily replaceable. Each recorder shall be supplied with chart-rolls and ink for six months continuous operation


## 2.4 Controllers

- i. Automatic control stations including dedicated cascade control stations shall have switches to transfer control from automatic to manual mode and vice-versa. The transfer shall be procedureless and shall not produce any bump in the process under control during such a transfer, the output signal shall not change by more than 1% of span.
- ii. Cascade control stations shall have a switch to select local or remote set point.
- iii. The control settings of the controller shall be readily adjustable from the front.
- iv. Controller action shall be easily reversible.
- v. Pneumatic automatic controller shall be easily removable, without disturbing the manual control mechanism.
- vi. Electronic controller shall be easily removable, with the aid of a service station.
- vii. Local mounted pneumatic controllers shall be supplied with gauges for air supply pressure and control signal. The gauges shall be integral with the instrument.

## 2.5 Accessories

### 2.5.1 Field HART Communicator:

- 2.5.1.1 It shall be possible to perform routine configuration, calibration, display process variable, diagnostics etc. from a hand held portable communicator, which can be connected at any location in the transmitter loop. It shall be possible to perform all the above functions online. The loop function shall remain unaffected while communication is going on between transmitter and the field communicator.
- 2.5.1.2 There should be no interruption on the output while communicating with the transmitter.
- 2.5.1.3 Field communicator shall meet the following requirements:
- a) Hand Held communicator shall be universal type and shall be compatible with all make and models of HART transmitters, Smart positioners, instruments with all engineering capability like calibration, diagnostics, configuration, inhibition of HART signal, etc.
  - b) It shall be possible to connect the communicator at any of the following locations for purpose of digital communication;
    - i) Marshalling cabinet serving the transmitter, in safe area.
    - ii) Junction box serving the transmitter, in hazardous area.

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- iii) Directly at the transmitter, in hazardous area. Plug-in type connections shall be provided with field communicator. Necessary interconnection shall be supplied by the vendor.
- c) Offered communicator shall be dust-proof, certified intrinsically safe and suitable for outdoor location. Carrying case shall be supplied with each communicator.
- d) When specified in data sheets, the software shall also be capable of configuring other makes of transmitters.
- e) They shall be battery powered with replaceable and rechargeable batteries.

**2.5.2 Field Bus Tester**

- I. The field bus testers shall be able to determine the ability of the field bus wiring to carry field bus signals. The field bus tester shall be capable of testing both signal and resistance of
- II. There shall not be any interruption on the output while communicating with the field bus devices.
- III. The field bus tester shall meet all the requirements as specified in clause 2.6.3 (b), (c), (d) and (e)

**2.5.3 Field Bus Configurator**

The field bus configurator shall be centralised device like personal computer with hardware and software for configuration and maintenance of field bus instrument.


**2.5.4 Remote Output Meter**

- a. Remote output meter shall be electronic with LCD display. The display shall be in actual engineering units.
- b. The indicator electronic shall be able to perform square root extraction for flow measurement.
- c. Offered indicators shall be certified Intrinsically safe, when used in hazardous area.
- d. Power supply shall be loop powered with smart transmitter, unless otherwise specified.
- e. Fieldbus based field indicator shall be able to indicate all signals available in the fieldbus segment, selectively.

**2.5.5 Remote mounted** instruments shall be supplied with mounting bracket, U-bolt and nuts suitable for mounting the instruments on a 50 mm (nominal bore) pipe stanchion (horizontal or vertical).

**2.5.6 Air set**

Air set, where provided, shall be a combination air filter regulator set with 5-micron filter cartridge. It shall have a 50 mm diameter pressure gauge to indicate the regulated pressure. Each air set shall be supplied with mounting bracket and bolts with nuts for surface mounting.

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**2.5.7 Battery charger**

Battery charger shall be supplied with all necessary accessories and shall operate at 230V  $\pm 10\%$ , 50Hz $\pm 3$ Hz, unless otherwise specified.

**3.0 NAMEPLATE**

3.1 Each flush panel mounted instrument shall have the following information identified in the front:-

- a) Tag number as per purchaser's data sheet.
- b) Reading coefficient, if any
- c) Pen colour, tag number-wise in the case of recorders.
- d) Each flush panel mounted instrument shall have a back nameplate permanently fixed to it at a visible place reporting the following information:
  - e) Manufacturer's serial number or model number.
  - f) Manufacturer's name/trade mark.

3.2 Surface mounted instruments need be provided with only one nameplate.

Local mounted instruments shall have a stainless steel nameplate attached firmly to it at a visible place, furnishing the following information:


- a) Tag number as per purchaser's data sheets.
- b) Manufacturer's serial number and /or model number
- c) Manufacturer's name/trade mark.
- d) Body material.
- e) Measuring element material.
- f) Range of measurement.
- g) Area classification in which the equipment can be used, this shall be to the same code as per purchaser's data sheets.

**4.0 INSPECTION AND TESTING**

4.1 Unless otherwise specified, purchaser reserves the right to test and inspect all the items at the vendor's works in line with the inspection test plan for electronic/pneumatic instruments.

4.2 Vendor shall submit the following test certificates and test reports for purchaser's review: -

- a) Material test report as per clause 3.1B of EN 10204 for body, flanges and spacer rings for all transmitters and diaphragm seal transmitters
- b) Material test report as per clause 2.2 of EN 10204 for sensing element
- c) Hydrostatic test report as per clause 4.3.

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- d) Functional and calibration report for each instrument including accuracy, linearity, hysteresis and repeatability.
- e) Performance test report as per clause 4.4.
- f) Response time of smart and fieldbus transmitters
- g) Capability of smart and field bus based transmitters to accept multimasters for configuration, calibration, diagnostics and maintenance.
- h) Configuration, calibration and diagnostics check through hand held configurator / field bus tester for smart and field bus based instruments.
- i) Configuration, calibration and diagnostics check through field bus configurator for field bus based instruments.
- j) Interoperability test certificate as per clause 2.2.3.14c) for fieldbus transmitters
- k) Certificate from statutory body for intrinsic safety/flameproof enclosures.
- l) Functional test report for fieldbus tester

#### 4.3 Hydrostatic Test


- 4.3.1 All transmitters shall be hydrostatically tested at static pressure as per clause 2.2.3.10 for a period of minimum 1 minute. After this test the transmitter shall not undergo a permanent set from the original calibration.

#### 4.4 Performance Test

- 4.4.1 All instruments shall meet the Accuracy performance characteristics stated in clause 2.2.3.6 after the instruments have been subjected to the following over-range conditions: -
- a) An air supply pressure of 2kg/cm<sup>2</sup>g for all pneumatic instruments.
  - b) Differential pressure transmitters subjected to a differential pressure in either direction equal to the manufacturer's pressure rating of the body.

#### 4.5 Witness Inspection


- 4.5.1 Vendor shall offer all items for pre-dispatch inspection. Following tests/checks shall be carried out, as a minimum: -
- a) Physical dimensional checks and workmanship.
  - b) Hydrostatic testing as per clause 4.3 of this specification on representative sample.
  - c) Performance testing as per clause 4.4 of this specification on representative sample.
  - d) Functional and calibration check on representative samples.
  - e) Effect of power supply/air supply variation and load driving capability check on representative samples.
  - f) Response time check on representative samples for smart and fieldbus transmitters

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- g) Capability of smart and field bus based transmitters to accept multimasters for configuration, calibration, diagnostics and maintenance.
- h) Configuration, calibration and diagnostics check through hand held configurator /field bus tester for smart and field bus based instruments.
- i) Configuration, calibration and diagnostics check through field bus configurator for field bus based instruments.
- j) Review of all certificates and test reports as indicated in clause 4.2 of this specification.
  - a. Functional checks on fieldbus tester.

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**GAIL INDIA LIMITED**

**STANDARD SPECIFICATION  
FOR  
RTD AND THERMOWELLS  
GAIL-STD-IN-DOC-TS-004**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
0	15.01.2019	Issued As Standard	RKS	UNU	UNU



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**1.0 INTRODUCTION**

## 1.1 Scope

1.1.1 This specification, together with the data sheets attached herewith covers the requirements for the design, materials, nameplate marking, inspection, testing and shipping of thermo-couples, RTDs and thermowell.

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


ANSI/ASME	B 16.5	Pipe Flanges & Flanged Fittings
ANSI/ASME	B 16.20	Metallic Gaskets for Pipe Flanges
	B 1.20.1	Pipe Threads General Purpose (Inch)
	B16.34	Valves Flanged, Threaded and Welding End
	Sec-VIII	Boiler & Pressure vessel code rules for construction of Pressure vessels
API		American Petroleum Institute
RP 551		Recommended Practice 551 -Process Measurement Instrumentation.
PTC 19.3 TW 2016		Performance Test Code-Temperature measurement Inspection Documents For Metallic Products.
IEC -60079		Electrical Apparatus for Explosive Gas Atmosphere
IEC 60529		Degree of protection provided by enclosures (IP)
IEC 60751		Industrial platinum resistance thermometers and platinum temperature
IEC 60854-2		Thermocouple Tolerances.
IS-2148		ELECTRICAL APPARATUS FOR EXPLOSIVE GAS ATMOSPHERES-FLAMEPROOF ENCLOSURES "d"
IS-7358		Specifications for Thermocouples
ISA		International Society of Automation
MC 96.1		Minerals Insulated Thermocouple

1.1.3 In the event of any conflict between this standard specification, job specification, datasheets, statutory regulations, related standards, codes etc. the following order of priority shall govern:

- a) Statutory Regulations
- b) Data Sheets
- c) Standard Specification
- d) Codes and Standards

1.1.4 In addition to compliance to purchaser's specifications, vendor's extent of responsibility shall include the following:

- a) Data sheets indicate the minimum acceptable material of construction for sensing element, thermowell etc. Alternate superior material of construction shall also be acceptable provided vendor assumes complete responsibility for the selected materials for their compatibility with the specified fluid and its operating conditions.
- b) Vendor shall carry out the vibration analysis of thermowell as per ASME PTC 19.3 standard

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and shall provide suitable design for the thermowells wherever necessary.


## 2.0 DESIGN AND CONSTRUCTION

### 2.1 Resistance Temperature Detectors

- 2.1.1 The type of RTD shall be as specified in purchaser's data sheet. In general RTD shall be 4 wire, Class A type with platinum element having 100 ohms resistance at 0°C, selected for temperature range of (-) 200 to 650°C.
- 2.1.2 The element shall be of highly refined material of reference grade and shall have been stress relieved. RTD calibration shall be as per IEC-60751.
- 2.1.3 The wire shall be wound on a ceramic core and immobilised against strain or damage. The winding shall be of bifilar type. The leads shall be copper up to terminal block.
- 2.1.4 The element shall be within a metal sheath, in a manner which provides good thermal transfer and protection against moisture. The sheath material shall be 316 Stainless Steel, unless otherwise specified.
- 2.1.5 The RTD assemblies shall be furnished with threaded heads. The heads shall consist of a case, screwed on cover and terminal block. The RTD shall be screwed to the terminal block. Separate screw shall be provided on the terminal block for terminating the incoming cable. There shall be an extra terminal in the terminal block connected to the head for grounding the shield.
- 2.1.6 The case shall be suitable for mounting terminal blocks for single or duplex type RTD element assemblies. The connecting terminals shall be properly numbered and shall be permanently and legibly identified.
- 2.1.7 The RTD assemblies shall be spring loaded.
- 2.1.8 A heat resistant and moisture proof gasket shall be fitted between the case and cover. The head support chain (between case and cover) shall be of stainless steel.
- 2.1.9 Unless otherwise specified, the assembly shall conform to the following standards:
- a) The heads shall be weather proof to IP-65 as per IEC-60529.
  - b) In case of flame proof construction, heads shall be flame proof as per IS-60079/IS-2148 & weather proof to IP-65 as per IEC-60529/IS-13947.

### 2.2 Thermowells

- 2.2.1 Unless otherwise specified, the thermowell material shall be 316 Stainless Steel, as a minimum.
- 2.2.2 Thermowells with immersion length up to 500 mm shall be machined out of forged bar-stock. Built-up thermowell with welded wall construction shall be acceptable for immersion length of greater than 500 mm, unless specified otherwise in purchaser's datasheet.
- 2.2.3 Thermowell flange material and rating shall be as specified in the data sheet.
- 2.2.4 All thermowell weld joints shall be full penetration weld type only.
- 2.2.5 Thermowell immersion length shall be as specified in purchaser's data sheet. Where immersion length is not specified in purchaser's data sheet, following shall govern:

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<u>Line Size</u>	<u>Immersion length</u>
Up to 6"	280 mm
8" and above	320 mm
Equipments	400 mm

The immersion length of built-up thermowells shall be as per actual requirements.

2.2.6 Tip thickness of Thermowell shall be minimum 9 MM.

2.2.7 Unless otherwise specified, the following shall govern:

- a) Threaded end connections shall be NPT as per ANSI/ASME B 1.20.1
- b) Flanged end connections shall be to ANSI/ASME B 16.5
- c) Where ring type joint flanges shall have been specified, groove shall be suitable for octagonal rings as per ANSI/ASME B 16.20.
- d) Flange face finish shall be as per clauses 6.4.5.1, 6.4.5.2 and 6.4.5.3 to ANSI/ASME B 16.5. The face finish as specified in the datasheets, shall be as follows:

125AARH	:	125 to 250AARH
63 ARH	:	32 to 63 AARH

2.2.8 All the thermowells in oxygen and chlorine service shall be thoroughly degreased using reagents like trichloro-ethylene or carbon tetrachloride.

### 3.0 NAME PLATE

3.1 Thermowell

3.1.1 The following information shall be punched on the extension of the thermowell:

- a) Tag number as per purchaser's data sheets.
- b) Thermowell material as per purchaser's data sheets.
- c) Thermowell immersion length TJ'.


3.1.2 The following information shall be punched on the thermowell flange at a visible place:

- a) Nominal flange size in inches and rating in pounds.
- b) Flange material as per purchaser's data sheets.

### 4.0 INSPECTION AND TESTING

4.1 Vendor shall submit following test certificates and test reports for purchasers review.

- a) Material test certificate as per clause 3.2 of EN 10204 for thermowells and flanges and as per clause 2.2 for RTDs.
- b) Dimensional test report.
- c) For instruments with rating of 600# and above, certificate of radiography / X-ray for welded joints. Dye penetration test certificate shall be provided for joints where Radiograph / X-ray is not possible.
- d) Certificate for concentricity of bore.

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- e) Hydrostatic test report as per clause 4.2 of this specification.
- f) Calibration report for RTD's.
- g) Certificate from any statutory authority for explosion proof and weatherproof
- h) Construction of RTD's head as applicable.

#### 4.2 Hydrostatic Test

4.2.1 Each thermowell made of bar stock or built-up type shall be subjected to hydrostatic test for a time period of 20 minutes at the following pressures:

- a) Inside of the well at 100 kg/cm<sup>2</sup> upto 600# flange rating and at 200 kg/cm<sup>2</sup> above 600# or up to flange rating whichever is higher
- b) Outside of the well as per ANSI flange rating.

During and after the hydrostatic test, the thermowell shall not show any leaks or rupture.

#### 5.0 MATERIAL OF CONSTRUCTION

SNo	Item	Specified Material of Construction
	Thermowell	SS316

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**GAIL INDIA LIMITED**

**STANDARD SPECIFICATION  
FOR  
INSTRUMENT CABLES**

**GAIL-STD-IN-DOC-TS-005**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
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**1.0 GENERAL****1.1 Scope**

- 1.1.1 This specification, together with the data sheets attached herewith covers the requirements for design, materials, manufacturing, inspection, testing and shipping of signal cables.
- 1.1.2 Cables shall comply with latest edition of the following standards prior to the date of the purchaser's enquiry.
- |                 |  |
|-----------------|--|
| ASTM D 2843     | Standard Test Method for Density of Smoke from the Burning or Decomposition of Plastics.                                 |
| ASTM D 2863     | Test method for measuring the minimum oxygen concentration to support candle like combustion of plastics (oxygen index). |
| BS-5308 Part 1  | Specification for Polyethylene insulated cables.   |
| BS-5308 Part 2  | Specification for PVC insulated cables.  |
| IEC: 540 & 540A | Test methods for insulation and sheaths of electric Cables   |
| IEC60584-3      | Extension and compensating cables - Tolerances and identification system.  |
| IEC-60331       | Testing of Fire Resistant cables.  |
| IEC-60332       | Tests on bunched wires and cables  |
| .IEC-60092      | Electrical Installations of Cables.  |
| IEC – 60574     | Test on Gases Evolved during Combustion of materials from Cables - Part 1,2.   |
| IS-1554         | PVC insulated (heavy duty) electric cables-working voltage up to and including 1100 V.                                   |
| IS-3975         | Mild steel wires, formed wires and tapes for armouring of cables.  |
| IS-5831         | PVC insulation and sheath of electric cables.  |
| IS-6380         | Elastomeric insulation and sheath of electric cables   |
| IS-6474         | Polyethelene Insulation and sheath of electric cables  |
| IS-10810        | Method of test for cables.   |
| Part 40         | Method for testing uniformity of coating on zinc coated articles.  |
| Part 41         | Mass of zinc coating on steel armour   |
| Part 58         | Oxygen Index test  |
| Part 59         | Determination of halogen acid gas evolved during combustion of polymeric material taken from cables                      |
| Part 61         | Flame Retardant test   |
| Part 62         | Flame Retardance test for bunched cables   |
| Part 63         | Smoke density of electric cables under fire conditions   |
- 1.1.3 In the event of any conflict between this standard specification, data sheets, statutory regulations, related standards, codes etc., the following order of priority shall govern:

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- a) Statutory Regulations
- b) Data Sheets
- c) Standard Specification
- d) Codes and Standards


### 1.3 Drawings and Data

- 1.3.1 Detailed drawings, data and catalogues required from the vendor are indicated by the purchaser in the vendor data requirement sheets. The required number of reproducible, prints and soft copies should be dispatched to the address mentioned, adhering to time limits indicated.
- 1.3.2 Final documentation consisting of design and constructional data submitted by the vendor after placement of order shall include the following, as a minimum.
- a) Specification sheet for each type of cable.
  - b) Cable details giving electrical characteristics, overall diameter, diameter under armour and diameter over armour

## 2.0 DESIGN AND CONSTRUCTION

### 2.1 Constructional requirements:

- 2.1.1 Cable shall be Flame Retardant Low Smoke Type.
- 2.1.2 Voltage Class of cables shall be 1100 V.
- 2.1.3 Primary insulation for PVC insulated cables, shall be 85°C polyvinyl chloride Type C as per IS 5831. Thickness of primary insulation shall be 0.5 mm as a minimum. For PE insulated cables, primary insulation shall be of 70° C Polyethylene.
- 2.1.4 Inner sheath colour of signal cables shall be black. Outer sheath colour shall also be black except for cables used in intrinsically safe systems. The outer sheath colour for all such cables used in intrinsically safe application shall be light blue. The thickness of the sheath shall be as per IS 1554. part 1.
- 2.1.5 Inner and outer sheath of cable shall be Flame Retardant Low Smoke made of extruded PVC Type ST2 (90°C) as per IS 5831 and shall meet the following requirements:
- a) Minimum Oxygen index of PVC shall be 30 at 27 °C ±2°C.
  - b) Temperature index shall be over 250 °C.
  - c) Inner and Outer sheath shall meet flame retardant requirements for bunched cables as per IS 10810 (Part 62) category AF or IEC 60332 category A.
  - d) A rip cord shall be provided for inner sheath.
  - e) Outer sheath shall be suitable for protecting the cable against rodent and termite attack.

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- 2.1.6 Armour over inner sheath shall be of galvanised steel wire/flat. The dimensions of armour shall be as per IS 1554 (Part 1). Requirement and methods of tests for armour material and uniformity of galvanisation shall be as per IS 3975 and IS 10810 (Part 40) respectively.
- 2.1.7 Each pair/triad shall be shielded. Shield shall be of aluminium backed by mylar / polyester tape bonded together helically applied with metallic side down having 25% overlap on either side and 100% coverage. Minimum shield thickness shall be 0.05 mm. Drain wire shall be 0.5 mm<sup>2</sup> multi-strand bare tinned annealed copper conductor. The drain wire shall be in continuous contact with aluminium side of the shield.
- 2.1.8 Overall shield shall be of aluminium backed up by mylar/polyester tape helically applied with the metallic side down with either side having 25% overlap and 100% coverage. Minimum shield thickness shall be 0.075 mm. Drain wire shall be similar to individual pair/triad drain wire and shall be over the overall shield.
- 2.1.9 The cores of a pair triad shall be twisted with a minimum of 10 twists per metre of cable.
- 2.1.10 Sequential marking of the length of the cable in meters shall be provided on the outer sheath at every one meter. The embossing /engraving shall be legible and indelible.
- 2.1.11 Tolerance in overall diameter of cable shall be within  $\pm 2$  mm over offered value.
- 2.1.12 The cables used in installations under the jurisdiction of Director General of Mines and Safety (DGMS) shall meet all requirements of DGMS. The word "Mining Cable" shall be embossed on the cable outer sheath as per IS 1554 (Part 1).
- 2.1.13 Tinning process shall be performed over cable conductor.

#### 2.1.14 Drum length and length tolerance

- 2.1.14.1 The length of the cables in each drum (drum length) shall be as specified in the purchaser data sheets .Where no drum length is indicated in the data sheet /material requisition, the following shall be apply:
- Drum length for single pair/ single triad cable : 500 metres
- Drum length for multi-pair/ multi- triad cable : 1000 metres
- 2.1.14.2 Actual produced drum length shall not vary by more than  $\pm 5\%$  from the length indicated in purchaser's datasheet or clause 2.1.14.1 of the specification

Tolerance over the total ordered length for a type of cable shall be as follows;

- a)  $\pm 5\%$  for total length less than 5 km.
- b)  $\pm 2\%$  for total length more than 5 km.


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### 2.1.15 Specific Requirements for fire resistant cable.

- a. The cables shall have circuit integrity as per IEC 60331.
- b. Primary insulation shall be heat resisting elastomeric which can withstand temperature up to 90°C such as silicon rubber/mica glass tape/EPR (medium grade) as per IS 6380. Insulation thickness shall be 1.0mm minimum and shall confirm to IEC 60092.
- c. A wrapping of tape made of PETP (polyethylene terephthalate) /woven glass shall be provided over core insulation.
- d. Individual pair triad shall be shielded. The shield shall be aluminium backed by glass mica / PETP tape with the metallic side down helically applied with 25% overlap on either side and 100% coverage. Minimum shield thickness shall be as per IEC 60092. Drain wire shall be 0.5mm<sup>2</sup> (7/0.3mm dia). Multi-stranded bare tinned annealed copper conductor. Drain wire shall be in continuous contact with aluminium side of the shield.
- e. Inner and outer sheath shall be made of low smoke, heat resistant, oil resistant and flame retardant material with oxygen index over 30, temperature index shall be over 250°C. Acid generation shall be maximum 20% by weight as per IEC 60754. Smoke density rating not to exceed 60% as per ASTM D 2843.
- f. The thickness of the sheath shall be as per IEC 60092. Inner and outer sheath colour shall be orange. A rip cord shall be provided for inner sheath.
- g. Armour bedding over inner sheath shall be of special high oxygen index, low smoke halogen free fire resisting compound.

## 2.2 Electrical Characteristics

- a. Maximum DC resistance of the conductor of the finished cable shall not exceed 12.3  $\Omega$  / km at 20°C for cables with 1.5 mm<sup>2</sup> conductors and 39.7  $\Omega$  / km at 20°C for cables with 0.5 mm<sup>2</sup> conductors.
- b. Mutual Capacitance for PVC Insulated cables. The mutual capacitance of between pairs/triads or adjacent cores shall not exceed of 250 pF / metre at a frequency of 1 KHz.
- c. Mutual Capacitance for PE Insulated cables. The mutual capacitance between the pairs/triads shall not exceed of 100 pF / metre at a frequency of 1 KHz.
- d. Capacitance between any core or screen. The capacitance between any core and screen shall not exceed a maximum of 400 pF / meter at a frequency of 1 KHz.
- e. L/R ratio of adjacent core shall not exceed 40 uH /  $\Omega$ .for cables with 1.5 mm<sup>2</sup> conductors and 25 micro H /  $\Omega$  for cables with 0.5 mm<sup>2</sup> conductors.
- f. The drain wire resistance including shield shall not exceed 30  $\Omega$  / km.
- g. Electrostatic noise rejection ratio of the finished cable shall be over 76 dB.

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**2.3 Type I (Single pair / Triad shielded).**

- a. Each core shall be 1.5 mm<sup>2</sup> made of 7 stranded annealed tinned electrolytic copper conductor. Each strand shall be 0.53 mm dia.
- b. Colour of core insulation shall be black and blue in pair and black, blue and brown in a triad.
- c. All other specifications shall be as per clauses 2.1. and 2.2 of this specification.

**2.4 Type-II (Multi-pair / Multi-triad cable with individual pair / triad shield and overall shield)**

- a. Conductor sizes shall be 0.5mm<sup>2</sup> made up of 7 strands of annealed tinned electrolytic copper conductor. Each strand shall be of 0.3 mm diameter. Tinned conductor copper wire.
- b. Overall twist of all pair / triads shall be as per vendor's standard.
- c. A pair of communication wire shall be provided for multipair / multitriad cables. Each wire shall be 0.5 mm<sup>2</sup> of plain annealed single or multistrand copper conductor with 0.4 mm thick 85°C PVC insulation. Insulation shall be green and red colour coded.
- d. A pair identification shall be with numbers at interval of not more than 250 mm.
- e. All other specifications shall be as per clauses 2.1. and 2.2 of this specification.

**2.5 Type-III (Multi-pair / Multi-triad cable with only overall shield)**

The cable shall be same as type-II cable, except that the individual pair/triad shall not have shielding.

**2.6 Type-IV (Multi-pair / Multi-triad cable with individual pair shield and overall shield)**

The cable shall be same as Type II, except conductor size shall be 1.5 mm<sup>2</sup> made of 7 stranded annealed tinned electrolytic copper conductor. Each strand shall be of 0.53 mm dia.

**2.7 Type-V (Multi-pair / Multi-triad cable with overall shield only)**

The cable shall be same as type IV except that the individual pair/triad shall not have the shielding.

**2.8 Wiring Coding**

The wiring shall be marked by colour code to differentiate the signal level/type according to the following table:

Function	Wire Colour	Outer Jacket Colour
FF signals	Orange (+) / Blue (-)	Orange
Signals for DCS	Black (+) / White (-)	Grey
Signals for ESD/FGS	Black (+) / White (-)	Red
Intrinsically safe signals	Black (+) / White (-)	Blue
Thermocouple signals	Green (+) / White (-)	Green
AC power	Brown (Ph) / Blue (Ne)	Black
DC power	Red (+) / Black (-)	Black
Safety earth	-	Green/Yellow

Instrument earth	-	Black outer, Green/Yellow sheath
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### 3.0 NAMEPLATE

3.1 Each cable drum shall be marked with the following information at a visible place;

- a) Manufacturer's name
- b) Type and size of the cable with cable indicated in material requisition.
- c) Length of the cable in meters contained in the drum.
- d) Gross weight
- e) Drum number
- f) Direction of rotation of drum for unwinding by means of an arrow.
- g) Purchase order number.

### 4.0 INSPECTION AND TESTING

4.1 Unless otherwise specified purchaser reserves the right to test and inspect all the items at the vendors work in line with the inspection test plan for signal cables..

4.2 Vendor shall furnish raw material test certificates for conductor, PVC / PE etc to prove the quality and composition of the materials used for manufacturing the cable to the satisfaction of purchaser or their authorised representative during various stages of expediting and inspection.

4.3 Type test, routine test and acceptance tests shall be carried out as per relevant Indian Standard (IS), unless specified otherwise.


#### 4.4 Type Test

4.4.1 Certificates from third party or purchaser's authorised representative for the following shall be furnished by vendor for cables similar to those being offered ;

- a) Flame retardant test on bunched cables.
- b) Electrostatic noise rejection test
- c) Fire resistance test

4.4.2 Vendor shall submit the following test certificates and test reports as per IS 10810 for each batch for purchaser's review:

- a) Physical tests for insulation and outer sheath as given below as minimum:
  - i) Tensile strength and elongation at break
  - ii) Ageing in air oven.
  - iii) Shrinkage test
  - iv) Hot deformation
  - v) Loss of mass in air oven

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- vi) Heat shock test
- vii) Thermal stability
- b) Test for armouring wires / strips.
- c) H.V. Water Immersion Tests.

#### 4.5 Routine Tests


4.5.1 Each of the following tests shall be carried out by vendor during various stages of manufacture on each finished cable drum.

- a) Spark test as per BS 5308 Part 2.
- b) Conductor resistance
- c) High voltage test as per BS 5308 Part 2
- d) Armour resistance test (for mining cables).
- e) Mutual capacitance and capacitance between any core or screen.
- f) Inductance and L/R ratio.
- d) Annealing test (for copper)

#### 4.6 Acceptance Tests

4.6.1 Following acceptance tests shall be carried out by vendor on representative samples taken from manufactured lot:

- a) Finished cable dimensions
- b) Conductor resistance
- c) Thickness of insulation and sheath.
- d) Tensile strength and elongation at break of insulation and sheath.
- e) Pair twisting, laying and identification.
- f) Shield overlap, drain wire resistance and continuity check.
- g) Armour resistance test (for mining cables).
- h) Uniformity of zinc coating on armour.
- i) Insulation resistance (volume resistivity) as per BS 5308 Part 2.
- j) High voltage.
- k) Test for rodent and termite repulsion.
- l) Mutual capacitance and capacitance between any core or screen
- m) Inductance and L/R ratio
- n) Oxygen and Temperature index as per ASTM D 2863.
- o) Flame retardant Test on sample cable as per IS 10810 Part 61.
- p) Acid Generation test IEC 60754 / IS 10810 Part 59 (for fire resistant cables)
- q) Smoke density test ASTM D 2843 / IS 10810 Part 63 (for fire resistant cables)

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- r) Overall finish and drum length check.
- s) Swedish Chimney test

**4.7 Witness Inspection**

4.7.1 Vendor shall offer all cables for pre-dispatch inspection to purchaser or their authorized representative and following test/checks shall be carried out as minimum:

- a) Acceptance tests as per clause 4.6 on representative samples.
- b) Review of all certificates and test reports as indicated in clause 4.0.

4.8 Immediately after completion of electrical tests, the ends of the cable shall be sealed to prevent ingress of moisture with suitable PVC / rubber caps.

4.9 In the event no witness inspection is carried out by purchaser, the tests shall anyway be completed by the vendor and documents for the same shall be submitted to purchaser for scrutiny.

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**GAIL INDIA LIMITED**

**STANDARD SPECIFICATION  
FOR  
JUNCTION BOXES & CABLE GLANDS**

**GAIL-STD-IN-DOC-TS-006**

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## 1.0 GENERAL

### 1.1 Scope

1.1.1 This standard specification, together with the data sheets attached herewith, covers the requirements for design, materials, nameplate marking, testing and shipping of junction boxes and cable glands which include the following types:

- a) Electrical junction boxes
- b) Pneumatic junction boxes
- c) Cable glands (whenever specified)

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

ANSI/ASME American National Standards Institute / American Society of Mechanical Engineers.

B 1.20.1 Pipe Threads, General Purpose (Inch).

EN 10204 Inspection Documents For Metallic Products.

IEC-60079 Electrical Apparatus for Explosive Gas Atmosphere.

IEC-60529 Degrees of Protection Provided by Enclosures. (IP Code)

IS-5 Colours for ready mixed paints and enamels.

IS-13947 Specification for Low Voltage Switchgear and Control gear.

IS-2148 Electrical Apparatus for Explosive Gas Atmospheres - Flame proof Enclosures 'd'.

1.1.3 In the event of any conflict between this specification, data sheets, related standards, codes etc., the following order of priority shall govern:


- a) Statutory Regulations
- b) Data Sheets
- c) Standard Specification
- d) Codes and Standards

### 1.2 Drawings and Data

1.2.1 Detailed drawings, data, catalogues and manuals required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of reproducible, prints and soft copies, shall be sent to the address mentioned, adhering to the time limits indicated.

1.2.2 Final documentation consisting of design data and installation manual submitted by the vendor after placement of purchase order shall include the following, as a minimum;

- a) Specification sheet for each junction box and its accessories like cable glands etc.

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- b) Certified drawing sheets for each junction box and its accessories, which shall provide dimensional details, internal constructional details (general arrangement details), and material of construction.
- c) Copy of type test certificates.
- d) Copy of test certificates for all the tests indicated in clause 4.0 of this specification.
- e) Installation procedure for junction boxes and its accessories.

## 2.0 DESIGN AND CONSTRUCTION

### 2.1 Junction Boxes

2.1.1 Junction boxes shall be either of the following type as specified in data sheets.

- a) Weather proof junction boxes.
- b) Weather proof and flameproof junction boxes.

No other type of junction boxes shall be offered / supplied unless specifically indicated otherwise.

2.1.2 Unless otherwise specified, the enclosure shall conform to the following standards:

Weatherproof housing : IP 65 to IEC-60529

Flameproof housing : Flameproof/Ex (d) as per IEC-60079.

2.1.3 Number of entries and their location shall be as per data sheets. Junction boxes with top entries shall not be offered. The size of cable entries shall be as per the cable sizes indicated in the data sheet.

2.1.4 Multi-pair junction boxes shall be provided with telephone sockets and plugs for connection of hand-powered telephone set.

#### 2.1.5 Electrical Junction Boxes


- a) The material of construction of electrical junction boxes shall be die-cast aluminium of minimum 5 mm thick (LM-6 alloy).
- b) Weather proof junction box shall have hinged type door with neoprene gasket, which shall be fixed to the box by plated countersunk screws.
- c) Flameproof junction box shall have detachable cover, which shall be fixed to the box by means of cadmium plated triangular head/hexagonal head screws.
- d) Flameproof junction boxes for signal, alarm and control shall have the following warning engraved/integrally cast on the cover;

"Isolate power supply elsewhere before opening"

- e) Power junction boxes (junction boxes for power supply cable / distribution) shall have either the warning cast or shall have warning plate with following marking;

"Isolate power supply elsewhere before opening".

Unless otherwise indicated in the job specification, power junction boxes shall be suitable for incoming armoured power cable up to 150 sq.mm conductor size.

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- f) Terminals shall be spring loaded, vibration proof, clip-on type, mounted on nickel plated steel rails complete with end cover and clamps for each row.
- g) All terminals used in signal, alarm and control junction boxes shall be suitable for accepting minimum 2.5sq.mm copper conductor, in general.
- h) Terminal used in power junction boxes / power supply distribution box shall be suitable for accepting conductor size of 4 Sq. mm to upto 120 sq. mm. Exact requirement shall be specified in data sheet/job specification. Higher size of terminals provided when indicated. Bus bar terminals shall be provided for conductor size 50 sq.mm and above. Suitable size of lugs shall be provided to suit conductor size specified.
- i) Each junction shall have minimum of 30% spare terminal of those actually required to be utilised. Unless higher number of terminal are specified in the purchaser's data sheet, the number of terminals for various types of junction boxes shall be as follows;
- 24 Nos. for 6 pair junction box.
- 48 Nos. for 12 pair junction box
- 36 Nos. for 6 triad junction box.
- 48 Nos. for 8 triad junction box.
- j) Terminals shall be identified as per the type of input signal indicated in data sheets e.g all terminal for intrinsically safe inputs shall be blue while others shall be grey in colour.
- k) Junction boxes shall be provided with external earthing lugs.
- l) Sizing shall be done with due consideration for accessibility and maintenance in accordance with the following guidelines;
- i) 50 to 60 mm gap between terminals and sides of box parallel to terminal strip for upto 50 terminals and additional 25 mm for each additional 25 terminals.
- j) 100 to 120 mm between two terminal strips for upto 50 terminals and additional 25 mm for each additional 25 terminals.
- iii) Bottom/top of terminal shall not be less than 100 mm from bottom / top of the junction box.

#### 2.1.6 Pneumatic Junction Boxes

- a) Pneumatic junction boxes shall be made of 3 mm thick hot rolled steel. They shall have necessary neoprene gasket between door and body. Door shall be flush with the box and shall be hinged type and provided with wing nuts.
- b) Single tube entries shall be suitable for 6 mm O.D copper tube with bulk head fittings. Multi tube bundle entry shall be suitable for the data furnished in data sheets.

#### 2.1.7 Painting

- a) Surface shall be prepared for painting. It shall be smooth and devoid of rust and scale.

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- b) Two coats of lead-free base primer and two final coats of lead free epoxy based paint shall be applied both for interior and exterior surfaces.
- c) The colour shall be as specified in data sheets. However, following philosophy shall be followed, in general:
  - (i) Light blue for all intrinsically safe junction boxes.
  - (ii) Light grey for all others

## 2.2 Cable glands, Plugs and Reducers/Adaptors

- 2.2.1 Cable glands shall be supplied by vendor whenever specified.
- 2.2.2 Cable glands shall be double compression type for use with armoured cables.
- 2.2.3 The cable glands shall be of nickel plated brass, as a minimum and shall be provided with PVC shrouds.
- 2.2.4 The cable glands shall be weatherproof. Whenever specified they shall also be flameproof and certificate for the specified electrical area classification specified in the data sheets.
- 2.2.5 Cable glands shall be supplied to suit the cable dimensions indicated along with tolerances in data sheets. Various components like rubber ring, metallic ring, metallic cone and the outer / inner nuts etc. shall be capable of adjusting to the indicated tolerances of cable dimensions.
- 2.2.6 Reducers / adapters shall be supplied as per details indicated in data sheets. They shall be nickel-plated brass, as a minimum. These shall also be weatherproof and / or flame proof wherever specified and certified for the electrical area classification specified in the data sheets.
- 2.2.7 Plugs shall be provided wherever specified. They shall be of nickel-plated brass.
- 2.2.8 Plugs shall be certified flameproof when used with flameproof junction boxes.


## 3.0 NAME PLATE

Each junction box shall have an anodised aluminium nameplate permanently fixed to it at a visible place furnishing the following information;

- a) Tag number as per purchaser's data sheet.
- b) Manufacturer's serial number and model number.
- c) Manufacturer's name/trade mark.
- d) Stamp of certifying agency with certificate number.
- e) Electrical area classification.

## 4.0 INSPECTION AND TESTING

- 4.1 Unless otherwise specified, purchaser reserves the right to test and inspect all the items at the vendor's works in line with inspection test plan for junction boxes and cable glands.


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- 4.2 Vendor shall submit following test certificates and test reports for purchaser's review:
- a) Material test certificates as per clause 2.2 of EN 10204
  - b) Pressure test on castings for flameproof junction boxes.
  - c) Dimensional test report.
  - d) High voltage and insulation resistance test report.
  - e) Air leak test report on pneumatic junction boxes.
  - f) Certificate from statutory body for suitability to install in specified hazardous area.

### 4.3 Witness Inspection

- 4.3.1 All junction boxes, cable glands and other accessories shall be offered for pre-dispatch inspection for the following, as a minimum;
- a) Physical dimensional verification and workmanship on representative samples.
  - b) High voltage and Insulation resistance test on representative samples.
  - c) Air leak test report on representative samples of pneumatic junction boxes.
  - d) Review of all certificates and test reports as indicated in clause 4.2 of this specification.
- 4.3.2 In the event when witness inspection is not carried out by purchaser, the tests shall anyway be completed by the vendor and documents for the same shall be submitted for scrutiny of purchaser.

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**GAIL INDIA LIMITED**

**STANDARD SPECIFICATION  
FOR  
INSTRUMENT TUBE FITTINGS  
(STAINLESS STEEL TUBE FITTINGS)**

**GAIL-STD-IN-DOC-TS-007**

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ANNEXURES:

ANNEXURE - 1: HYDROSTATIC TEST PRESSURES FOR INSTRUMENT TUBE FITTINGS

**1.0 GENERAL****1.1 Scope**

1.1.1 This standard specification, together with the data sheets attached herewith, covers the requirements for the design, materials, inspection, testing of instrument tube fittings which includes the following types:

- a) Stainless steel compression fittings (for stainless steel tube)
- b) Brass compression fittings (for copper tube)

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

ANSI/ASME American National Standards Institute/American Society of Mechanical Engineers

B 1.20.1 Pipe Threads General Purpose (Inch).

B 16.11 Forged Steel Fittings - Socket Welding and Threaded.

BS-4368 Metallic tube connectors for fluid power and general use. Specification for type test requirements

ASTM F 1387 Standard Specification for Performance of Piping and Tubing Mechanically Attached Fittings

EN 10204 Inspection Documents For Metallic Products.

IS-319 Specification for free cutting Brass Bars, Rods and Sections.

ISA International Society of Automation

RP 42.1 Nomenclature for Instrument Tube Fittings.


1.1.3 In the event of any conflict between this standard specification, data sheets, statutory regulations, related standards, codes etc., the following order of priority shall govern:

- a) Statutory Regulations
- b) Data Sheets
- c) Standard Specification
- d) Codes and Standards

**2.0 DESIGN AND CONSTRUCTION****2.1 Stainless Steel Tube Fittings**

2.1.1 Nomenclature of all tube fittings shall be as per ISA RP 42.1.

2.1.2 Fittings shall be of flare less compression type having four-piece (for double compression type) construction consisting of two ferrules, nut and body or three piece (compression type) construction consisting of single ferrule, nut and body suitable for use on tubes of specified material for example stainless steel tubes conforming to ASTM A269 TP 316L with hardness in the range of HRB 70 to 79.

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- 2.1.3 All parts of the tube fittings shall be of 316 Stainless Steel unless specified otherwise.
- 2.1.4 Hardness of the ferrules shall be in the range of HRB 85-90 so as to ensure a hardness difference of the order of 5 to 10 between tube and fittings for better sealing.
- 2.1.5 Nuts and ferrules of a particular size shall be interchangeable for each type.
- 2.1.6 Spanner hold shall be metric.
- 2.1.7 Threaded ends of fittings shall be NPT as per ANSI B 1.20.1.
- 2.1.8 Specific techniques like silver plating shall be used over threading in order to avoid jamming and galling.
- 2.1.9 Ferrule finish and fitting finish shall be such that there is no abrasion/galling when the nut is tightened.
- 2.1.10 All instrument tube fittings in oxygen and chlorine service shall be thoroughly degreased using reagents like trichloro-ethylene or carbon tetrachloride. End connection shall be plugged after degreasing process in order to avoid entrance of grease or oil particles.

**2.2 Copper Tube Fittings**


- 2.2.1 Nomenclature of all tube fittings shall be as per ISA RP 42.1.
- 2.2.2 Fittings shall be of flare less compression type and of three-piece construction consisting of ferrule, nut
- 2.2.3 and body suitable for use on copper tubes conforming to ASTM B68 /B68M, hardness not exceeding HRB 50.
- 2.2.4 All parts shall be manufactured from brass as per IS 319 bar stock and nickel plated.
- 2.2.5 For better grip, vendor shall maintain hardness difference between tube and ferrule and indicate the same along with the offer.  
Threaded ends of fittings shall be NPT as per ASME B 1.20.1  
Spanner hold shall be metric.

**3.0 NAMEPLATE**

- 3.1 No separate nameplates are required on the fittings. However, manufacturer's name/trademark should be punched on a visible place on the body of each fitting for easy identification.

**4.0 INSPECTION AND TESTING**

- 4.1 Unless otherwise specified, purchaser reserves the right to test and inspect all items at vendor's works, inline with the inspection test plan for instrument tube fittings.
- 4.2 Vendor shall submit following test certificates and test reports for purchaser's review:
  - 4.2.1 Type test reports for following tests in accordance with BS-4368 Part IV:
    - a) Hydrostatic proof pressure test.

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- b) Minimum hydrostatic burst pressure test.
- c) Disassembly and reassembly test.
- d) Minimum static gas pressure (vacuum) test.
- e) Maximum static gas pressure test.
- f) Hydraulic impulse and vibration test.

4.2.2 Material test certificates as per clause 3.1 B of EN 10204.

4.2.3 Routine test reports for following tests:

a) Hydrostatic Test

Instrument tube fittings shall be hydrostatically tested at ambient temperature at test pressures given in Annexure 1 of this specification. During and after the hydrostatic test, the tube fittings shall not show any leakage or rupture.

b) Pneumatic pressure test

The fittings shall be tested at 7 kg/cm<sup>2</sup>g of dry air. There shall not be any visible leakage when immersed in water or coated with a leak detection solution.

c) Disassembly and reassembly test.

d) Hardness verification:

Hardness test shall be carried out on each rod used for machining ferrules. Vendor shall ensure that after machining, the finished ferrules shall meet the required hardness given in the specification.


e) Dimensional test report

### 4.3 Witness Inspection

4.3.1 All fittings shall be offered for pre-dispatch inspection for the following as a minimum:

- a) Physical dimensional verification and workmanship on representative samples.
- b) Hydrostatic and pneumatic tests as per clause 4.2.3 of this specification on representative samples.
- c) Hardness verification as per clause 4.2.3 of this specification.
- d) Disassembly and reassembly test on representative samples.
- e) Review of all certificates and test reports as indicated in clause 4.2 of this specification.


4.3.2 In the event when no witness inspection is carried out by purchaser, vendor shall anyway complete the tests and test reports for the same shall be submitted to purchaser for scrutiny.

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## ANNEXURE – 1

HYDROSTATIC TEST PRESSURES  
FOR INSTRUMENT TUBE FITTINGS

Sr. No.	Size of Tube Fittings	Material	Line Pressure Class	Max Working Pressure	Hydrostatic Test Pressure
1	6mm and 1/2"	Stainless Steel	< or = 600#	102 Kg/cm <sup>2</sup> g	153 Kg/cm <sup>2</sup> g
2	6mm and 1/2"	Stainless Steel	> or = 900# to < or = 1500#	253 Kg/cm <sup>2</sup> g	383 Kg/cm <sup>2</sup> g
3	1/4" and 3/8"	Brass	> or = 900# to < or = 1500#	53 Kg/cm <sup>2</sup> g	80 Kg/cm <sup>2</sup> g

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**GAIL INDIA LIMITED**

**STANDARD SPECIFICATION  
FOR  
INSTRUMENT TUBING (STAINLESS STEEL TUBES)**

**GAIL-STD-IN-DOC-TS-008**

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ANNEXURE - 1: MAXIMUM WORKING PRESSURE AND HYDROSTATIC TEST  
PRESSURES FOR INSTRUMENT TUBING



**1.0 GENERAL****1.1 Scope**

1.1.1 This standard specification, together with the data sheets attached herewith, covers the requirements for the design, materials, inspection, testing and shipping of Instrument Tubing which includes the following types: -

- a) Stainless steel tubes
- b) Copper tubes

1.1.2 The related standards referred to herein and mentioned below shall be of the latest edition prior to the date of purchaser's enquiry;


ASTM	American Society for Testing and Materials.
A269 /A269- 15A	Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Services.
A632	Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing (Small Diameter) for General Services.
B 251	Specification for general requirements for wrought seamless copper and copper alloy tube.
B 251M	Specification for general requirements for wrought seamless copper and copper alloy tube (Metric)
B 68/B68M	Specification for seamless copper tube, bright annealed.
E 243	Standard Practice for Electromagnetic (Eddy - Current) Examination of Copper and Copper - Alloy Tubes
EN 10204	Inspection Documents for Metallic Products

1.1.3 In the event of any conflict between this standard specification, job specification/data sheets, statutory regulations, related standards, codes etc. the following order of priority shall govern:

- a) Statutory regulations
- b) Job specification
- c) Standard specification
- d) Codes and standards

**1.2 Drawings and Data**

1.2.1 Detailed drawings, data, catalogues and manuals required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of reproducible, prints and soft copies shall be dispatched to the address mentioned adhering to the time limits indicated.

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1.2.2 Final documentation consisting of design data by the contractor after placement of purchase order shall include the following as a minimum;

- a) Specification sheet for each type of tube.
- b) Copy of test certificates of all tests indicated in clause 4.0 of this specification.

**2.0 DESIGN AND CONSTRUCTION**

**2.1 Stainless Steel Tubes**

- 2.1.1 The tubes shall be 316L Stainless Steel fully annealed, seamless and cold drawn as per ASTM A 269/A269-15A.
- 2.1.2 The hardness of the tubes shall be limited to HRB 70-79. Equivalent hardness as Rockwell superficial scale (30T/15T) or Vicker's hardness scale shall also be acceptable.
- 2.1.3 Tubes shall have good surface finish and shall be free from scratches burrs etc. and suitable for bending.
- 2.1.4 Maximum working pressure shall be as per Annexure - 1 attached with this specification.
- 2.1.5 Tubes shall preferably be supplied in length of 5 to 6 metres without welding in between. Tube length less than 5 meters shall be rejected.
- 2.1.6 All tubes in oxygen and chlorine service shall be thoroughly degreased using reagents like trichloro-ethylene or carbon tetrachloride and tube ends shall be plugged after degreasing process in order to avoid entrance of grease or oil particles.


**2.2 Copper Tubes**

2.2.1 Copper Tubes (PVC Jacketed)

- a) The tube shall be soft annealed copper with 6mm OD and a wall thickness of 1.0mm as per ASTM B 68/B68 M copper No. C 12200.
- b) The tube shall be jacketed with black PVC. The jacket thickness shall be 1.6mm. The PVC jacket shall confirm to ASTM D-1047.
- c) The tube ends shall be plugged prior to transportation.
- d) The tube shall be continuous length without any brazing in between.
- e) The length of single tube shall preferably be 100 metres. However any tube length less than 70 meters shall be rejected unless specifically required otherwise in job specification.
- f) The dimensional tolerances shall be as per ASTM B 251/B251 M.

2.2.2 Bare Copper Tubes (For Steam Tracing)

- a) The tube shall be soft annealed copper with 3/8" (10mm) OD with wall thickness of 0.049" or 6mm OD with wall thickness of 1.0mm as per ASTM B68/B68 M, copper No. C12200.

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- b) The tube ends shall be plugged prior to transportation.
- c) The tube shall be continuous length without any brazing in between.
- d) The length of single tube shall preferably be 100 metres. However any tube length less than 70 meters shall be rejected unless specifically required otherwise in job specification.
- e) The dimensional tolerances shall be as per ASTM B 251/B 251M.
- f) Maximum working pressure shall be 53.0kg/cm<sup>2</sup>g at 38°C unless specified otherwise.

### 3.0 NAME PLATE

The following information shall be marked on the stainless steel tubes:

- a) Name of manufacturer
- b) Type and material grade of tube
- c) Tube outer diameter and wall thickness.

### 4.0 INSPECTION AND TESTING

4.1 Unless otherwise specified, purchaser reserves the right to test and inspect all the items at vendor's works, inline with the inspection test plan for instrument tubing.

4.2 Vendor shall submit following test certificates and test reports for purchasers review:


- a) Material test certificates as per clause 3. IB of EN 10204.
- b) Hydrostatic test for stainless steel tube and bare copper tubes as per clause 4.3 of this specification.
- c) Pneumatic test for PVC jacketed copper tubes as per clause 4.4 of this specification.
- d) Hardness / tension test for stainless steel tubes as per clause 4.5 of this specification.
- e) Ball test for copper tubes as per clause 4.6 of this specification.
- f) Eddy current examination of copper tubes as per ASTM E-243
- g) Dimensional test report.

#### 4.3 Hydrostatic test

4.3.1 Stainless steel and bare copper tube shall be hydrostatically tested at ambient temperature at test pressures given in Annexure - 1 attached with this specification. During and after the hydraulic test, the tubes shall not show any leaks or rupture.

#### 4.4 Pneumatic test

4.4.1 PVC jacketed copper tubes shall be tested at 7.0 kg/cm<sup>2</sup>g of dry air. During and after the test, tubes shall not show any leak or rupture.

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**4.5 Hardness/Tension Test**

4.5.1 All mother tubes shall be hardness tested for each heat prior to drawing for proper quality control. The hardness of the drawn tubes shall be checked by Rockwell Hardness Test. Following shall apply;

- a) For tubing less than 0.65in (1.65mm) in wall thickness, Rockwell superficial hardness test on 30T / 15T scale or Vicker's scale shall be equivalent to HRB 70 - 79.
- b) Hardness test is not required for tubes smaller than 1/4in (6.4mm) inside diameter or tubes having a wall thickness thinner than 0.020in (0.51mm). These tubes shall be tension tested in accordance with ASTM A632.

**4.6 Ball Test**


4.6.1 Ball test shall be carried on all copper tubes to ensure clear opening of the tube. The OD of the ball shall be minimum 1.0mm for 6.0mm OD tube and 2.0mm for 3/8" (10mm) OD tube.

**4.7 Witness Inspection**

4.7.1 All tubes shall be offered for pre-dispatch inspection for the following, as a minimum;

- a) Physical dimensional verification and workmanship.
- b) Hardness / tension test for stainless steel tubes.
- c) Hydrostatic and pneumatic tests on representative samples.
- d) Ball test on copper tubes on representative samples.
- e) Eddy current examination of copper tubes on representative samples.
- f) Review of all certificates and test reports as indicated in clause 4.2 of this specification.

4.7.2 In the event that the witness inspection is not carried out by purchaser, contractor shall anyway complete the tests and test reports for the same shall be submitted to purchaser for scrutiny.

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**ANNEXURE - 1**  
**MAXIMUM WORKING PRESSURE AND**  
**HYDROSTATIC TEST PRESSURES**  
**FOR INSTRUMENT TUBING**

Sr. No.	Size of Tube (OD)	Material	Line Pressure Class	Thickness	Maximum Working Pressure	Hydrostatic Test Pressure
1	1/2" (12mm)	Stainless Steel	< or = 600#	0.049" (1.2mm)	102 Kg/ cm <sup>2</sup> g	153 Kg/ cm <sup>2</sup> g
2	1/2" (12mm)	Stainless Steel	> or = 900# to < or =1500#	0.065" (1.65mm)	253 Kg/ cm <sup>2</sup> g	383 Kg/ cm <sup>2</sup> g
3	(6mm)	Stainless Steel	< or = 600#	1.00mm	102Kg/cm <sup>2</sup> g	153 Kg/cm <sup>2</sup> g
4	1/4" (6mm)	Stainless Steel	> or = 900# to < or =1500#	0.065" (1.65mm)	253 Kg/ cm <sup>2</sup> g	383 Kg/cm <sup>2</sup> g
5	3/8" (10mm)	Copper	< or = 300#	0.049"	53 Kg/ cm <sup>2</sup> g	80 Kg/ cm <sup>2</sup> g
6	1/4" (6mm)	Copper	< or = 300#	1.00mm	53 Kg/ cm <sup>2</sup> g	80 Kg/ cm <sup>2</sup> g




**GAIL INDIA LIMITED**

**STANDARD SPECIFICATION  
FOR  
INSTRUMENT VALVE AND MANIFOLDS**

**GAIL-STD-IN-DOC-TS-009**

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**1.0 GENERAL****1.1 Scope**

1.1.1 This standard specifications, together with the data sheets attached herewith, covers the requirements for the design, materials, inspection, testing and shipping of instrument valves and manifolds which includes the following types:

- a) Miniature instrument valves
- b) Instrument valve manifolds
- c) Instrument air valves

1.1.2 The related standards referred to herein and mentioned below shall be of the latest edition prior to the date of purchaser's enquiry;

ASME/ANSI American Society of Mechanical Engineers/ American National Standards Institute

B 1.20.1 Pipe threads General Purpose (Inch)

B 16.11 Forged steel fittings-socket welding and threaded.

B 16.9 Factory made Wrought Steel Butt welding fittings.

B 16.34 Valves-Flanged. Threaded and welding end.

API-598 Valve Inspection and Testing

EN 10204 Inspection Documents for Metallic Products.

MSS Manufacturers Standardization Society of the Valve and Fittings Industry.

SP99 Instrument Valves


1.1.3. In the event of any conflict between this standard specification, job specification/data sheets, statutory regulations, related standards, codes etc. the following order of priority shall govern:

- a) Statutory Regulations
- b) Data Sheets
- c) Standard Specification
- d) Codes and Standards

**1.3 Drawings and Data**

1.3.1 Detailed drawings, data, catalogue and manuals etc. required from the vendor is indicated by the purchaser in vendor data requirement sheets attached with material requisition. The required number of reproducible, prints and soft copies shall be dispatched to the address mentioned in the material requisition, adhering to the time limits indicated.

1.3.2 Final documentation consisting of design data, installation and maintenance manual etc. submitted by the vendor after the placement of purchase order shall include the following, as a minimum:

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- a) Specification sheet for type of instrument valve and manifold.
- b) Certified dimensional details showing internal constructional details and material of construction.
- c) Copy of type test certificates.
- d) Copy of test certificates for all the tests indicated in clause 4.0 of this specification.
- e) Installation and maintenance procedures.

## 2.0 DESIGN AND CONSTRUCTION

- 2.1 The instrument valves shall be of manufacturer proprietary design. However, the minimum requirements specified herein must be complied.
- 2.2 Qualification tests (hydrostatic proof and burst tests) as per MSS SP-99 shall be conducted by vendor for each design and size of valve to establish the cold working pressure (CW.P) rating.
- 2.3 For all valves and manifolds with body material of carbon steel/stainless steel, the valve trim material shall be 316 Stainless Steel, as a minimum. Whenever body material is other than that specified above, trim material should be same as body material as a minimum.
- 2.4 Unless otherwise specified, the valve packing material for all valves and manifolds shall be PTFE only. The o-ring materials wherever used shall also be of PTFE.
- 2.5 The finishing and tolerances of parts like stem, piston, stem threading etc. of the offered valves and manifolds shall be properly machined to avoid problems like galling.
- 2.6 The hand wheel material for all valves and manifolds shall be zinc/nickel plated carbon steel. Any other material, if provided as per standard vendor design, shall also be acceptable.

## 2.7 Instrument Valves (Miniature)

- 2.7.1 The instrument valves shall be of globe pattern needle valves forged/ bar stock with inside screwed bonnet, with back-seated blow out proof system.
- 2.7.2 Body material shall be 316 Stainless Steel unless otherwise specified.
- 2.7.3 The minimum cold working pressure (CWP) rating of the valve shall be as per Annexure 1 of this specification, unless otherwise specified.
- 2.7.4 The end connection shall be 1/2"NPTF to ANSI B 1.20.1, unless otherwise specified.
- 2.7.5 Flow direction shall be marked on the body.
- 2.7.6 The valve dimensions shall be as follows:
- a) End to end dimensions 76mm (approximately).
  - b) Height in fully open condition - 135mm maximum. These dimensions are indicative only.

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**2.8 Valve Manifolds**

## 2.8.1 3-Valve and 5-Valve manifolds:

## 2.8.1.1 3-Valve manifold

- a) 3-Valve manifold shall be designed for direct coupling to differential pressure transmitters having 2 bolt flanges with 54mm (2-1/8") centre-to-centre connections and 41.3mm (1 - 5/8") bolt-to-bolt distance.
- b) 3-Valve manifold shall contain two main line block valves and an equalising bypass valve. The valves shall be needle type. They shall use self-aligning 316 Stainless Steel ball seats, unless otherwise specified.

## 2.8.1.2 5-Valve manifold

- a) 5-Valve manifold shall be designed for direct coupling to differential pressure transmitters having 2 bolt flanges with 54mm (2-1/8") centre-to-centre connections and 41.3mm (1- 5/8") bolt-to-bolt distance.
- b) 5-Valve manifold shall contain two main line block valves and a combination double block and bleed for the bypass line. The valve shall of needle type or special ball with bleed hole.

2.8.1.3 The flanges shall be integral part of manifold block.

2.8.1.4 The material of construction shall be 316 Stainless Steel, unless otherwise specified.

2.8.1.5 The minimum cold working pressure (CWP) rating of manifolds shall be as per Annexure 1 of this specification, unless otherwise specified.

2.8.1.6 The process connection shall be 1/2"NPTF to ANSI B 1.20.1.

2.8.1.7 Wherever the manifolds are specified for stanchion mounting, these shall be supplied along with mounting accessories. The bolts and nuts shall be alloy steel as per ASTM A 193 Gr B7 and ASTM A194 Gr. 2H (Hot dip galvanised or zinc plated) respectively. Other accessories shall be zinc plated.


## 2.8.2 3 way 2 valve manifold for pressure gauges

2.8.2.1 The manifold shall be designed for use with pressure gauges with block and bleed valves. The manifold body shall be either straight or angle type as specified in the data sheet.

2.8.2.2 The valve shall be a needle type.

2.8.2.3 The body material shall be 316 Stainless Steel, unless otherwise specified.

2.8.2.4 The minimum cold working pressure rating of the manifold shall be as per Annexure 1 of this specification, unless otherwise specified.

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2.8.2.5 The manifold shall have the following connections:

- a) The inlet connection shall be 3/4" plain ends with a minimum of 100mm nipple extension suitable for socket weld or butt weld as per B 16.11/ BI 6.9 as specified in the job specifications
- b) The gauge connection shall be with union nut and tail piece threaded to 1/2"NPTF.
- c) The drain connection shall be W'NPTF.

**2.9 Instrument Air Valves**

**2.9.1 Instrument Air Isolation Valves (Miniature)**

- 2.9.1.1 The valves shall be full-bore ball type with forged body.
- 2.9.1.2 Body material shall be 316 Stainless Steel.
- 2.9.1.3 The minimum cold working pressure rating of instrument air isolation valves shall be as per Annexure 1 of this specification, unless specified otherwise.
- 2.9.1.4 The end connection shall be 1/2"NPTF to ANSI B 1.20.1, unless otherwise specified.
- 2.9.1.5 End to end dimensions shall be 70mm (approximately).

**2.9.2 Instrument Air Needle Valves (Miniature)**


- 2.9.2.1 The instrument valves shall be globe pattern-needle valves forged/bar stock with inside screwed bonnet.
- 2.9.2.2 Body material shall be 316 Stainless Steel.
- 2.9.2.3 The minimum cold working pressure of Instrument Air Needle valves shall be as per Annexure 1 of this specification, unless otherwise specified.
- 2.9.2.4 The end connection shall be 1/2" NPTF to ANSI B1.20.1, unless otherwise specified.
- 2.9.2.5 Flow direction shall be marked on the body.
- 2.9.2.6 The valve dimensions shall be as follows:
  - a) End to end dimensions - 54 mm (approximately).
  - b) Height in fully open condition - 49 mm maximum. These dimensions are tentative only.

2.10 All instrument valves in oxygen and chloride service shall be thoroughly degreased using reagents like trichloroethylene or carbon tetrachloride. End connection shall be plugged after degreasing process in order to avoid entrance of grease or oil particles.

**3.0 NAME PLATE**

3.1 Following information shall be punched on the body of each of these items;

- a) Material of construction to the same standards as in purchaser's data sheets.
- b) Cold working pressure of each item to the same standards as in purchaser's data sheets.

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- c) Manufacturer's identification and model number.
- d) Flow direction (if applicable)
- e) Material of construction.

#### 4.0 INSPECTION AND TESTING

4.1 Unless otherwise specified, purchaser reserves the right to test and inspect all the items at vendor's works, inline with the inspection test plan for instrument valve and manifolds.

4.2 Vendor shall submit following test certificates and test reports for purchaser's review:

- a) Material test certificates as per clause 3. IB of EN 10204 for body and bonnet and as per clause 2.2 for other parts.
- b) Dimensional test report.
- c) Pressure test report as per clause 4.3 of this specification.
- d) Hydrostatic proof and burst tests as per MSS-SP-99 for each design and size of valve.

#### 4.3 Pressure Test Requirements

4.3.1 Each valve and manifold shall be subjected to hydrostatic pressure test at ambient temperature for both seat and shell leakage at test pressures given in Annexure-1 of this specification. During and after the hydrostatic test there shall not be any visible leakage.

#### 4.3.2 Pneumatic Test


Each valve and manifold shall be subjected to pneumatic test for both shell and seat leakage at 7.0 kg/cm<sup>2</sup>g with testing medium as air at ambient temperature. There shall not be any visible leakage when immersed in water or coated with a leak detection solution.

#### 4.4 Witness Inspection

4.4.1 All valves and manifolds shall be offered for pre-dispatch inspection for following, as a minimum:

- a) Physical dimensional verification and workmanship.
- b) Pressure test as per clause 4.3 of this specification on representative samples.
- c) Review of all certificates and test reports as indicated in clause 4.2 of this specification.

4.4.2 In the event, when witness inspection is not carried out by purchaser, the tests shall anyway be completed by the vendor and documents for the same shall be submitted to purchaser for scrutiny.

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## ANNEXURE-1

## HYDROSTATIC TEST PRESSURES FOR INSTRUMENT VALVES AND MANIFOLDS

SL.NO.	ITEM	LINE PRESSURE	MIN. COLD WORKING PRESSURE	HYDROSTATIC TEST PRESSURE FOR SEAT LEAKAGE	SHELL LEAKAGE TEST
1.	Instrument Valves (Miniature)				
A)		< or = 600#	102kg/cm <sup>2</sup> g	112kg/cm <sup>2</sup> g	153kg/cm <sup>2</sup> g
B)		> or = 900# to < or = 1500#	253kg/cm <sup>2</sup> g	278kg/cm <sup>2</sup> g	383kg/cm <sup>2</sup> g
2.	Instrument Valve Manifold				
A)		< or = 600#	102kg/cm <sup>2</sup> g	112kg/cm <sup>2</sup> g	153kg/cm <sup>2</sup> g
B)		> or = 900# to < or = 1500#	253kg/cm <sup>2</sup> g	278kg/cm <sup>2</sup> g	383kg/cm <sup>2</sup> g
3.	Instrument Air Isolation Valves	< or = 300#	27kg/cm <sup>2</sup> g	30kg/cm <sup>2</sup> g	41kg/cm <sup>2</sup> g
4.	Instrument Air Needle Valves	< or = 300#	27kg/cm <sup>2</sup> g	30kg/cm <sup>2</sup> g	41kg/cm <sup>2</sup> g



**GAIL INDIA LIMITED**

**STANDARD SPECIFICATION  
FOR  
FIRE & GAS DETECTION SYSTEM**

**GAIL-STD-IN-DOC-TS-011**

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## 1. GENERAL

1.1.1 This document defines the technical requirements for Design, engineering, Fabrication / manufacturing, assembly, testing at works, packing and supply of:

- A. Fire Detection systems
- B. Gas Detection systems

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

API RP-55	Recommended Practice for Oil and Gas Producing & Gas Processing Plant Operations Involving Hydrogen sulphide.
API RP-552	Transmission Systems
EN-10204	Inspection Documents for Metallic Products
EN-50054	Electrical Apparatus for the Detection and Measurement of Combustible Gases - General Requirements and Test Methods.
EN-50057	Performance Requirements for Group II Apparatus Indicating upto 100% LEL.
IEC-1000-6-3	Electromagnetic Compatibility (EMC)-Generic Standard - Emission Standard for Residential, Commercial and Light Industrial Environments
IEC-60079	Electrical Apparatus for Explosive Gas Atmosphere.
IEC 60331	Testing of Fire Resisting Cables
IEC-60332	Tests on hunched wires and cables.
IEC-60529	Degree of protection provided by Enclosures (IP code).
IEC-60617 (Part12)	Graphical Symbols for Diagrams – Binary Logic Elements
IEC-61000-4	Electromagnetic compatibility for Industrial Process Measurement and Control Equipment.
IEC-61131	Programmable Logic controllers
IEC 61508	Functional Safety of electrical/electronic/programmable electronic safety related systems
IEC 61511	Functional Safety – Safety Instrumented Systems for the Process Industry Sector.
IS-13947	Specification for low Voltage Switchgear and Control gear.
IS-2148	Flameproof Enclosures for Electrical Apparatus for Explosive Gas Atmospheres – Flameproof Enclosures 'd'.

1.1.3 In the event of any conflict between this standard specification, job specification/datasheets, statutory regulations, related standards, codes etc the following order of priority shall govern:

- a. Statutory Regulations

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- b. Data Sheets
- c. Standard Specifications
- d. Codes and standards

## 2. FIRE DETECTION SYSTEMS

### 2.1 SMOKE DETECTION

Smoke detectors shall be provided in control building. The detectors shall be installed in control room inside cable trenches, inside building in various rooms, electrical equipment room.

High sensitivity photo cell type (optical type) smoke detectors shall be provided.

All smoke detectors shall have self checking facility.

Each detector shall have a LED indicating the status of the detector. For smoke Detectors installed above false ceiling and in cable trenches remote indicator shall be provided in fire and gas panel.

Circuit type: 2 wire.

Open and short circuit shall be monitored by end of line resistor.

All smoke detectors shall have facility for remote reset.

Mounting type: on ceiling with base.

Alarm indication shall be LED.

### 2.2 HEAT DETECTORS

Heat detectors shall be provided in battery room. Rate of temp. rise type detectors shall be provided as these provide rapid response while the ambient temp. is subject to fluctuations. Quantity and installation requirements are given in data provided in this specification.

Temp set point: 85 Deg C.

Mounting: on ceiling with base.

Circuit type: 2 wire.

Alarm indication: LED.

Open and short circuit shall be monitored by end of line resistor.

All heat detectors shall be auto reset type.

### 2.3 Manual Call Points:

Manual Call Points (MCP) shall be positioned in such a way that they stand out against the Background i.e. they shall be clearly recognizable from a distance either by day or Night.

Manual call points shall be located;

- a) Two nos at each end outside control building
- b) Outside guard room (one no.)
- c) One no. as decided in field by Project Manager.

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Type: Break glass type.

Operation: By hammer. Hammer and chain shall be provided.

Housing material: UV resistant GRP for break glass installed outside control building IP 65.

MCPs installed outdoors in field shall be in addition be suitable for hazardous area classified

Housing colour:- Red paint two coat epoxy type.

Each manual call point shall have SS tag / label with wording "Manual alarm call station", & "Break glass to activate"

## 2.4 LINEAR HEAT SENSOR CABLE

- a. LHS cable shall be capable of detecting heat from a fire over entire length of cable trench and false ceiling area of control room. Cable shall be located where it will not be subject to physical damage. Normal operating state of LHS cable shall be open circuit type.
- b. The operation of system must be based on two conductors to short circuit together, and then creating an alarm condition on the Fire Alarm Panel. "switching " cable where a change in state of internal insulation - caused by temperature rise to a pre-defined level - allows a short circuit or "hot junction" to occur between two twisted tin plated copper conductors.
- c. The system shall follow principles of fire protection engineering, as well as comply applicable standard NFPA-72 / NEC 760.
- d. Alarm Temperature of the system shall be set at temperature of minimum 68 °C and response time of fire detection less than 5 second.
- e. Twisted pair copper coated steel conductors shall be covered by temperature sensitive thermoplastic or fluoropolymer insulation and protected by a jacket of thermoplastic strip braid, PVC, nylon or fluoropolymer material.
- f. LHS cable connects to Fire Alarm Panel (FCP) as a dry-contact initiative device. The maximum length of cable shall be determined by the electrical characteristic (resistance and capacitance) of the FCP initiating circuit board. FCP initiating circuit shall be installed at the end of cable.
- g. LHS cable shall be mounted at the ceiling above false ceiling of the control room. The thermal path of the LHS cable must be obstructed and maintain 1" distance from ceiling fast detection. The cable shall be adequately supported to prevent sagging; it is not necessary to tension the cable , however on straight runs it is recommended that the cable is supported every 3 feet (1m).
- h. Standard accessories like Weather tight connector, master clamp, flange clip and nylon cable tie shall be used for installation of LHS cable.
- i. In any case soldering, heat shrink tubing cannot allow during installation as well as any maintenance. Use of junction box for connecting two lengths of sensor cable will be preferable. Junction box must be weather proof.

## 3.0 Gas Detection system.

### 3.1 Open Path Gas Detectors:-

IR absorption type gas detectors shall be provided as follows:

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2 nos detectors near each pig launcher / pig receiver  
 2 nos around isolation valve in SV station.  
 4 nos detectors around metering skid.

Power supply: 24 VDC.

Area classification:-Zone1,Gr IIA,IIB,T3.

Weather proof protection: IP65.

Out put :-4-20 ma DC.

Accuracy:-+/-3% full scale.

Response time:-T 95<5 secs.

Range :8 LEL meters /100 meters minimum.

Housing Material:- SS 316.

Mounting: Swivel mounting.

Lens cleaning fluid shall be supplied by contractor.

Beam blockage more than 10 secs. Shall give "BEAM BLOCKED" warning after 60 secs  
 Shall give fault alarm.

Calibration Accessories. Hand held calibrator suitable for area classified with battery and charging unit, TEST FILM etc;

Tag plate :-SS 316.

### 3.2 Fixed Point Gas Detectors.:

IR absorption type detectors shall be provided as follows:

2 nos detectors near each pig launcher/pig receiver.  
 2 nos around isolation valve in SV station  
 4 nos detectors in metering skid.

Power supply: 24 V DC.

Area classification :- Zone 1,Gr. II A.IIB.T3.

Weather proof protection:-IP65.

Detection Range:-100% LEL.

Out put: 4-20 mA DC

Accuracy : +/- 3% full scale.

Response time : T90< 15 Secs.

Housing material: SS 316.

Tag plate: SS required with tag details.

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Each detector shall be equipped with facilities for site calibration and testing. The detection Range shall be adjustable between 0 and 100% LEL.

3.3 Control Card and Controller for Gas Detection System shall be of OEM make only.

**4.0 Field Annunciation Devices.**

**Alarm Beacons / Flash Lights.**

Alarm beacons shall be rotating type with a coloured lens and dual high intensity halogen Bulbs. One no. red (for fire alarm) and one no. blue (for gas alarms) shall be supplied and installed at highly visible location outside control building.

**5.0 Fire Alarm / Monitoring Panel and Gas Alarm / Monitoring Panel.**

Fire Alarm monitoring Panel and **separate** Gas Alarm monitoring Panel shall be supplied and installed in each control room.

This panel shall have following minimum facilities / equipment.

- a) **Gas Alarm / Monitoring Panel:** For gas detectors Single channel gas monitors shall be provided with 0-100% LEL indication (LCD) ,alarms adjustable over 100% LEL range ) for low and high LEL.,AND fault alarm.(LEDs). Shall have test/acknowledge alarm, reset push buttons.

Control Card and Controller for Gas Detection System shall be of OEM make only

- b) **Fire Alarm / Monitoring Panel:** Alarm annunciator showing zone wise fire alarms, and remote indication for smoke Detectors installed above false ceiling and inside cable trenches.
- c) A horn installed above fire /gas alarm panel, and high sound level (120 DbA) installed Guard room.
- d) The panel shall be wall mounting type suitable for safe area installation.
- e) Siren with range of 1 KM shall be provided at the top of the building with acknowledge, Test and Reset provision in panel.

**6.0 Portable Calibrator:**

- a. Portable calibrator for fixed point detectors consisting of all accessories like volume bottles, containing known gas / mixture, a pressure regulator, a flexible hose adapter cap shall be supplied to enable field calibration of the sensors/detectors without dismantling them from the field.
- b. Calibration range shall be suitable for the sensors supplied, 0-100% LEL.
- c. Sufficient quantity of calibration gas shall be supplied to enable calibration of all the Sensors / detectors at least twice.

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## 7.0. Area Classification

The Hazardous area classification is Zone 1, gas Group IIA/IIB, Temp. Class T3. For Certification requirement for instruments items are as below:

For all flame proof equipment / instrument / systems, which is manufactured abroad (outside India) certification by any approving authority like BASEEFA, FM, UL, PTB, LCIE. ATEX etc shall be required. For units manufactured in India certificate from CMRI will be required.

## 8.0 Power Supply

Power supply available is 24V DC, Contractor to convert from this level to other levels.

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## 9.0 FIRE DETECTOR ALLOCATION PLAN

Sl. no	Area Description	OSD	MHSD	Multicriteria Heat Detectors	MCP (Break Glass Unit)	LHS CABLE	Hooter	Flashlight	ZONE
1	Control room / UPS room a) above false ceiling		2		-	1			Zone-1
	b) Below false ceiling	2		—					Zone-2
2	Inside cable trench in a) Control room			—		1			Zone-3
	b) Electrical room.					1			
3	Battery room	—		2	-				Zone-4
4	Electrical Room	1	1	—	-				Zone-5
5	Manual Call points (Break Glass Unit)	—		—					Zone-6
	a) Control room				1				
	b) Electrical room				1				
	c) Store Room				-				
	d) Battery Room				1				
6.	Store Room	1							Zone-7
7	Guard Room				1				Zone-8
8	Hooter + Flash Light								Zone-9
	a) Control Room						2	1	
	b) Guard Room						-	1	

OSD -- Optical Smoke Detector  
 MHSD – Multicriteria Heat & Smoke Detectors  
 MCP – Manual Call Point

### NOTES:

- Above mentioned numbers are tentative, However same shall be finalized during detail Engineering.
- Hooter / Flash lights / Beacons – Shall be different from Fire suppression system.


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**GAIL INDIA LIMITED**

**STANDARD SPECIFICATION  
FOR  
CONTROL PANEL**

**GAIL-STD-IN-DOC-TS-012**

						
0	14.01.2019	Issued As Standard	RKS	UNU	UNU	
Rev	Date	Purpose	Prepared By	Checked By	Approved By	

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- 2.0 CONTROL PANEL CONSTRUCTION
- 3.0 DIMENSIONS AND MATERIAL OF CONSTRUCTION
- 4.0 WIRING
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- 6.0 BULK POWER SUPPLY UNIT
- 7.0 SPECIFICATIONS FOR ACCESSORIES
- 8.0 INDICATORS
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- 10.0 ZENER BARRIERS/ ISOLATORS
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**1.0 GENERAL**

- 1.1** Pipeline and location of panels (Local control panel, fire alarm panel, gas alarm/monitoring panel, telecom interface panel).
- 1.2** Location of control panel and accessories: Indoor
- 1.3** Floor : Concrete Floor with Trench
- 1.4** Air conditioning :- YES
- 1.5** Control Panels Size :- Local control panel (Size 2100mmX1000mmX800mm)  
Wall mounted Fire and gas monitoring panels, Telecom interface panel.  
(Approx size 600mmX600mmX300mm)
- 1.6** Contractor shall provide an alarm annunciator for fire and gas alarms, in fire and gas monitoring panels.

**2.0 CONTROL PANEL CONSTRUCTION**

- 2.1** Type: Self supported, Free standing, enclosed cubicle.
- 2.2** Lighting: Required inside Panel with door switch
- 2.3** Ventilation: Required with louvers backed by wire fly screen & fan. Fan failure alarm required.
- 2.4** Doors: Rear double removable hinged doors with flush pull type handles & with locking arrangement.
- 2.5** Cable Entry: Bottom, Cable glands shall be single compression type. All unused entries are plugged.
- 2.6** Receptacles: Required for 230VAC UPS.
- 2.7** Painting: The finish should include sand blasting, grinding, chemical cleaning's finishing by suitable filler and two coats of paint. Panel colour shall be Non-glossy high strain finish. Panel colour shall be RAL 7032.
- 2.8** Channel Base : 100\*50\*6 MM, MS material
- 2.9** Name Plates: Front of panel instrument name plates shall be black laminated plastic white core. Name plate shall be provided on rear of panel also.

**3.0 DIMENSION & MATERIAL OF CONSTRUCTION**

- 3.1** Panel Dimension: 800(w) mm X 2100(H)mm X 800(D)mm including channel base

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- 3.2 Control Panels : 3.0 CRCA / 5.0 mm thick HRCA steel welded to frame
- 3.3 Side & Top plates : 2mm thick CRCA steel welded to frame.
- 3.4 Door of Panel: 1.6 mm thick CRCA steel. Rear side door shall be double door type. Concealed Hinges and Flush pull chrome plated handles.
- 3.5 Cable Gland Plate: 3mm thick CRCA steel
- 3.6 Anchor Bolt Size: By contractor
- 3.7 Frame: 50 mm \* 50 mm \* 3mm Formed section
- 3.8 Lifting Eye Bolt : Required

**4.0 WIRING**

- 4.1 Type : General Purpose
- 4.2 Wiring details (Power)
  - 230 V AC UPS Wiring (Outside cabinet) : Min, 3\* 2.5 mm<sup>2</sup> copper conductor PVC insulated armoured
  - Low Voltage Inside the Cabinet: (24V DC) : Min 19 strands, 16 AWG copper conductor PVC insulated.
  - 230V AC Non UPS (outside cabinet) : Min, 3\* 2.5 mm<sup>2</sup> copper conductor PVC insulated armoured
- 4.3 Signal Wiring :
  - External to cabinet : 1.0 mm<sup>2</sup> twin twisted, individual shielded/overall Shielded with overall drain PVC insulated, armoured.
  - Inside the cabinet : Multi strand min 1.0mm<sup>2</sup> copper conductor PVC Insulated.
  - Terminal Type : Screw clamp with pressure plate
  - Terminal Size for signal : Suitable for min. 2.5mm<sup>2</sup> size conductor.
  - Terminal size for power dist : Suitable for min 4.0 mm<sup>2</sup> size conductor and higher as per actual cable sizes.
  - Terminal Block : Clip on type.
  - Wiring colour code
    - Power supply : Hot-Red
    - Neutral-Black
    - Earth-green
  - DC Wiring : Positive-Red Negative Black
  - Alarm System : White

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Control and shutdown	:	Yellow
Analog Signals( IS )	:	Light Blue

## 5.0 Deleted

## 6.0 BULK POWER SUPPLY UNIT

6.1	Input	:	As per Scope of Work
6.2	Output	:	24V DC _+ 5 % or as required for instruments.
6.3	Rating	:	By Contractor
6.4	Mounting	:	DIN Rail mounted
6.5	Qty	:	2 nos. for each Panel (Dual Redundant)

## 7.0 SPECIFICATIONS FOR ACCESSORIES

### 7.1 ALARM ANNUNCIATOR

No. of Window	12 (4X3)
Type	Solid State
Mounting	Flush Panel
Enclosure	General Purpose IP 41
Window Size	50 mm X 60 mm
Make / Model No.	By Contractor

Annunciator alarm sequence shall be as per F3A of ISA.

The design of the alarm annunciator system shall be such that transient alarms of less than 330 milliseconds duration shall be automatically rejected.

### 7.2 LAMPS

Type	Miniature filament
Rating	By Contractor
Voltage	24V DC
Make/Model No.	By Contractor

Lamps shall be provided with series resistor to increase life of lamp.

### 7.3 Push Buttons

Type	Spring return
Contacts	2NO + 2NC
Contact Rating	2A 24V DC
Make	By Contractor
Color	As per standard

### 7.4 Selector Switch

Type	As per functional switching and logic requirement
------	---

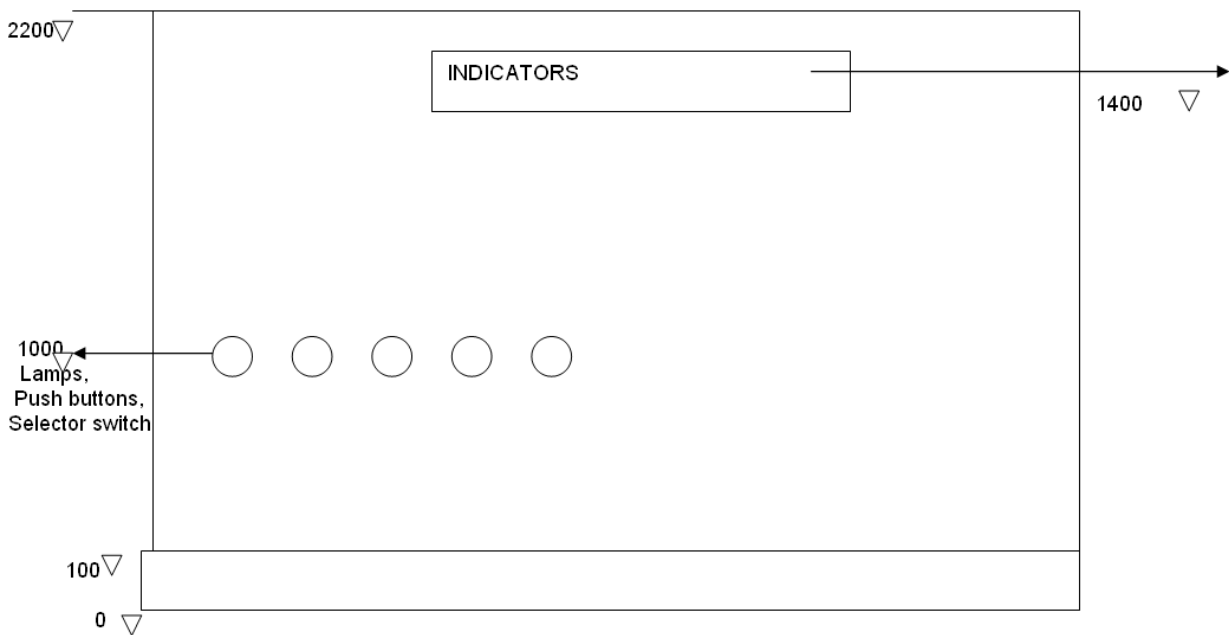
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Specification	Silver alloy gold plated contacts with SS shaft dust covers with water proof covering and contact shall be made before break type.
Rating	2A, 24V DC
Make	KAYCEE/Eqv.

**7.5 Relays**

Type	Plug in relays
Contact Type	Potential free contact
Contact nos.	3NO + 3NC
Rating	24V DC , 5.0 AMP
Make	OEN/Eqv.

**7.6 SUGGESTIVE PANEL ARRANGEMENT**



1. All dimensions are in mm
2. Panel front arrangement is tentative only

Panel layout shall be designed considering ease of operation. No push button or hand switch shall be located below 600 mm. Instrument Mounting heights, in general, shall be as follows:-

- a) Annunciators - 1950 mm
- b) Indicators - 1400 mm
- c) Electric push buttons / Switches, lamps etc. - 1000 mm

**8.0 INDICATORS**

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8.1	Type	: Single Channel Microprocessor Based Fluorescent Display with Engineering units
8.2	Mounting	: Flush Panel
8.3	Enclosure	: General Purpose
8.4	To be used in intrinsically safe System	: With exit. Zener barrier / Isolator cum Repeater
8.5	Inputs	: 4-20 mA DC (2 wires)
8.6	Outputs	: 4-20 mA DC
8.7	Facia	: Bar graph display of PV (with digital display)
8.8	Scan time	: 500 msec. Max
8.9	A/D Convertor resolution	: 1500 steps min
8.10	D/A Convertor resolution	: 1500 steps min
8.11	Load driving capacity	: 750 ohms
8.12	Online diagnostics	: Required
8.13	Power Supply	: 24V DC
8.14	QTY	: AS Required

**Note: One number spare indicator (dual channel) shall be provided.**

#### 9.0 SIGNAL DISTRIBUTION CARDS

9.1	Type	Dual output current isolator
9.2	Input	4-20 mA DC
9.3	Output	Two nos 4-20m A isolated outputs as minimum
9.4	Isolation	Between input & output, Between power supply and between output and input
9.5	Accuracy	$\pm 0.1\%$
9.6	Power Supply	24V DC
9.7	Transmitter Power Supply	24V DC
9.8	Output load driving capacity	550ohms min for each output
9.9	Qty	As Required

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**10.0 ZENER BARRIERS / ISOLATORS CUM REPEATER****10.1** Type Active**10.2** Application Instrument Type

- a) 4-20 mA Analog I/P from 2 wire transmitter .
- b) RTD (4wire) Input output 4-20 mA analog O/P
- c) Limit switch ( SPDT snap acting micro type ) Output Pot. free contact
- d) Proximity switch (inductive type) output Pot. Free contacts
- e) solenoid valves 24V DC.

**10.3** Hazardous Area Classification Zone 1 Gr IIA,IIB,T3**10.4** Approval FM/Basseefa/CSA/ATEX/CCOE/BIS/CMRI**10.5** Supply Volt 20-35V DC**10.6** Qty. As Required

ZENER BARRIERS/ISOLATORS CUM REPEATER AND SIGNAL DISTRIBUTION CARDS MAY BE COMBINED INTO ONE CARD.

**10.7** MAKE MTL/P&F.**11.0 Drawings and Data**

- 11.1** Detailed drawings, data, catalogues and manuals required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of prints, soft copies and reproducible shall be provided by contractor.
- 11.2** Basic engineering drawings required for preparation of detail panel drawings are provided in the tender.
- 11.3** Final documentation consisting of design data, installation manual, maintenance manual etc. submitted by the contractor after placement of purchase order shall include the following, as a minimum;
- a) Specification sheet for control panels, instruments and accessories.
  - b) Certified drawings for each control panel, which shall provide following details:
    - i) Control panel front arrangement drawing showing all dimensions including bezel/cut out dimensions.
    - ii) Loop wiring drawings showing the terminal numbers of each instrument/ accessory used in the wiring.
    - iii) Ladder drawings and relay wiring drawings showing terminal numbers for interlock/shutdown.
    - iv) Power supply distribution drawings with terminal numbers, incoming/ outgoing feeder size, fuse and isolator rating etc.

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- c) Contractor shall provide test certificates for all the tests as per approved QAP.
  
- d) Calibration and maintenance procedure including replacement of instruments and accessories in contractor's scope, whenever it is applicable

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**GAIL INDIA LIMITED**

**STANDARD SPECIFICATION FOR  
PIG SIGNALLERS**

**GAIL-STD-IN-DOC-TS-013**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
0	14.01.19	Issued for Standard	RKS	UNU	UNU





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## 1. SCOPE

This specification covers the basic requirements for the design and manufacture testing & supply of pig signallers, used for the detection of passage of scraper and instrumented gauging pigs, to be installed in pipeline systems handling RLNG.

## 2. MATERIALS

2.1 All materials used in the manufacture of the main components of the pig signalers shall be as indicated in the data sheets. Other components shall be as per manufacturer's standard suitable for the service conditions indicated in data sheets which will be subject to approval by Purchaser.

## 3. DESIGN AND CONSTRUCTION REQUIREMENTS

3.1 Pig signallers shall be Bi-directional, Non-Intrusive, Magnetic type.

3.2 Pig signallers shall be designed to meet the requirements of pipeline diameter indicated in the data sheet.

3.3 Pig signallers shall be provided with a visual indicator to indicate the passage of pigs.

3.4 Pig signallers shall be fitted with sealed, weather-proof and explosion proof micro switch for remote signal indication. The area classification and rating of micro switch shall be as indicated in data sheet. Suitable for installation in IEC- Zone II, Gas Group-IIA & IIB, T3 hazardous area, Micro switch shall have the following rating;

2 Amp, 240 Volts, 50 Hz,  
Type: SPDT,

## 4. INSPECTION AND TESTS

4.1 Manufacturer shall perform all inspection and tests required to supply the signallers as per the requirements of this specification.

4.2 All pig signallers shall be visually inspected.

4.3 Chemical composition & mechanical properties including hardness shall be checked for each heat of steel used.

4.4 All welds shall be non destructively examined.


4.5 Manufacturers shall perform functional tests to establish satisfactory performance of both manual and electrical indications.

## 5. TEST CERTIFICATES

5.1 Manufacturer shall supply the test certificates for material compliance as per the relevant Material Standards.

5.2 Certificate for hydrostatic test and functional test

5.3 Test reports on heat treatment carried out, if any.

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## 6. PAINTING, MARKING AND SHIPMENT

6.1 Exterior surface of the pig signallers shall be thoroughly cleaned, freed from rust and grease and applied with sufficient coats of corrosion resistant paint. Manufacturer shall indicate the type and corrosion resistant paint used in the drawings submitted for approval. The minimum dry film thickness shall be 300 microns.

6.2 A corrosion resistant metal tag shall be permanently attached with each unit, with the following marking:-

- i) Manufacturer's name
- ii) Serial No.
- iii) Tag No.

6.3 Each unit shall be suitably protected to avoid any damage during transit. Care shall be exercised during packing to prevent any damage to the welding ends. All machined surfaces subject to corrosion shall be well protected by a coat of grease or other suitable materials.


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**GAIL INDIA LIMITED**

**DATASHEET FOR PRESSURE TRANSMITTER (PT)**

**GAIL-STD-IN-DOC-DS-001**

						
0	14.01.2019	Issued for Bid	RKS	UNU	UNU	
<b>REV</b>	<b>Date</b>	<b>Purpose of Issue</b>	<b>Prepared By</b>	<b>Checked By</b>	<b>Approved By</b>	


<b>CLIENT:</b>													
<b>QUANTITY:</b>		<b>AS PER P&amp;ID</b>											
1	Function	Transmission & Indication			Other Material		(*)						
2	Type	2 Wire, Electronic smart transmitter with HART Protocol.			Process Connection		(*)						
3	Case	Mfr. Std.			Size & Rating		(*)						
4	Mounting	Yoke			Facing & finish		(*)						
5	Elec. Area Class.	IEC Zone 1, Gr. II A/IB, Temp. class T3			Capillary Material		(*)						
6	Enclosure	WP to IP 65 as per IEC 60529			Armour Flexible		(*)						
7	Ex-Proof	NOTE - 3			Armour flexible material		(*)						
8	Power Supply	(*)			Capillary Length		(*)						
9	Cable Entry	1/2 " NPT(F) with SS plug			20	Fill Fluid	Silicone Oil						
10	Accuracy	"+/-" 0.075% or better of span (Note 1)			21	Zero Suppression & Elevation	100% of span						
11	Repeatability	40:1 or better			22	Zero & span adjustment	Continuously adjustable externally, non interactive type						
12	Transmitter Output	4-20mA DC			23	Adapter "O" ring	PTFE						
13	Load Driving Capability	(*)			24	Body Rating	(*)						
MEASURING UNIT					MISCELLANEOUS								
14	Service	Natural Gas			25	Over Range Protection	Yes						
15	Element	Diaphragm			26	Options	(*)						
16	Body Materials	SS 316			a)	Output meter :- Yes (LCD in Engg. Unit)							
17	Element Materials	SS 316 L			b)	Air Filler Regulator							
18	Process Connection	1/2" NPT (F) thru flange adapter with plug.			c)	Mounting Accessories suitable for 2" NB pipe :- Yes							
	Process Connection Location	Bottom			d)	2 Way manifold:- Yes							
19	Diaphragm Seat	(*)			27	Model	(*)						
	Wetted Parts Material	(*)											
Bill of Material (BOM)													
S.NO.	TAG NO.	Range (Barg)		Operating Pressure (Barg)	Maximum Operating		Fluid	Service	Options				
		Span	Set		Pressure (Barg)	Temperature (°C)							
1	ITC-7006-PT-01001	Note 6	0 ~ 150	60 ~ 95	98	(-)20 ~ 65	Gas	Natural Gas	a, c & d				
2	ITC-7006-PT-04001	Note 6	0 ~ 150	10 ~ 19	98	(-)20 ~ 65	Gas	Natural Gas	a, c & d				
3	ITC-7006-PT-01002A	Note 6	0 ~ 150	10 ~ 19	98	(-)20 ~ 65	Gas	Natural Gas	a, c & d				
4	ITC-7006-PT-01002B	Note 6	0 ~ 150	10 ~ 19	98	(-)20 ~ 65	Gas	Natural Gas	a, c & d				
5	ITC-7006-PT-06001A	Note 6	0 ~ 150	10 ~ 19	98	(-)20 ~ 65	Gas	Natural Gas	a, c & d				
6	ITC-7006-PT-06001B	Note 6	0 ~ 150	10 ~ 19	98	(-)20 ~ 65	Gas	Natural Gas	a, c & d				
7	ABU-4002-PT-01001	Note 6	0 ~ 150	60 ~ 95	98	(-)20 ~ 65	Gas	Natural Gas	a, c & d				
8	ABU-4002-PT-04001	Note 6	0 ~ 150	04 ~ 19	98	(-)20 ~ 65	Gas	Natural Gas	a, c & d				
9	SHI-1276-PT-01001	Note 6	0 ~ 150	75 ~ 95	98	(-)20 ~ 65	Gas	Natural Gas	a, c & d				
10	SHI-1276-PT-04001	Note 6	0 ~ 150	10 ~ 19	98	(-)20 ~ 65	Gas	Natural Gas	a, c & d				
11	PIN-4004-PT-01001	Note 6	0 ~ 150	60 ~ 95	98	(-)20 ~ 65	Gas	Natural Gas	a, c & d				
12	PIN-4004-PT-04001	Note 6	0 ~ 150	10 ~ 19	98	(-)20 ~ 65	Gas	Natural Gas	a, c & d				
<b>NOTES:-</b> (*) Vendor to furnish													
	1	Accuracy includes the combined effect of repeatability, linearity, hysteresis etc.											
	2	Operating principle of transmitters shall be capacitance / peizo resistance											
	3	Transmitter shall be Intrinsically safe.											
	4	Transmitters shall have Lightning Protection.											
	5	Transmitter Load Resistance shall be Max 600Ω @ 24 V DC											
	6	Contractor shall develop detailed datasheets with all the required information like span, make/model etc. during detailed engineering.											
	7	Manifold Shall be of Swgelok or Parker Only.											
	8	PESO/CCOE certificate for specified hazardous area classification is required with transmitters.											
	9	2 Nos cable entries shall be provided with one cable entry plugged with weather proof plug.											
					PRESSURE TRANSMITTERS					DOCUMENT NO.		Rev.	
										GAIL-STD-IN-DOC-DS-001		0	
										SHEET 1 of 1			



**GAIL INDIA LIMITED**

**DATASHEET FOR TEMPERATURE TRANSMITTER (TT)**

**GAIL-STD-IN-DOC-DS-002**

						
0	14.01.2019	Issued for Bid	RKS	UNU	UNU	
<b>REV</b>	<b>Date</b>	<b>Purpose of Issue</b>	<b>Prepared By</b>	<b>Checked By</b>	<b>Approved By</b>	

<b>CLIENT:</b>		
<b>QUANTITY: AS PER P&amp;ID</b>		
1	Function	Transmission & Indication
2	Type	2 Wire, Electronic smart transmitter with HART Protocol.
3	Case	Mfr. Std.
4	Mounting	Yoke & Remote
5	Elec. Area Class.	IEC Zone 1, Gr. II A/II B, Temp. class T3
6	Enclosure	WP to IP 65 as per IEC 60529 / IS 2147
7	Intrinsically Safe	Yes
8	Power Supply	24 VDC, 2 Wire
9	Cable Entry	1 Nos 1/2" NPTF for output signal + 1 Nos. 1/2" or 3/4" NPTF for RTD signal wire
10	Accuracy	±0.18% or better of span
11	Self Diagnostic Facility	Yes
12	Cold Junction Compensation	(*)
13	Transmitter Output	4-20 mA DC
14	Load Capability	(*)
15	Sensor Element	(*)
16	Calibration	As per DIN 43760
17	Options	(*)
	a)	Mount. Accessories for 2" NB Pipe
	b)	Integral output meter
18	Model	(*)
19	Quantity	(*)

**Bill of Material (BOM)**

S.NO.	TAG NO.	Range (°C)		Temperature (°C)		SERVICE	OPTIONS
		Adjustable	Set	Operating (Nor)	Design (Max)		
1	ITC-7006-TT-01001	Note 5	(-) 20 ~ 100	20	(-) 20 ~ 65	Natural Gas	a,b
2	ITC-7006-TT-04001	Note 5	(-) 20 ~ 100	20	(-) 20 ~ 65	Natural Gas	a,b
3	ITC-7006-TT-01002A	Note 5	(-) 20 ~ 100	20	(-) 20 ~ 65	Natural Gas	a,b
4	ITC-7006-TT-01002B	Note 5	(-) 20 ~ 100	20	(-) 20 ~ 65	Natural Gas	a,b
5	ITC-7006-TT-06001A	Note 5	(-) 20 ~ 100	20	(-) 20 ~ 65	Natural Gas	a,b
6	ITC-7006-TT-06001B	Note 5	(-) 20 ~ 100	20	(-) 20 ~ 65	Natural Gas	a,b
7	ABU-4002-TT-01001	Note 5	(-) 20 ~ 100	20	(-) 20 ~ 65	Natural Gas	a,b
8	ABU-4002-TT-04001	Note 5	(-) 20 ~ 100	20	(-) 20 ~ 65	Natural Gas	a,b
9	SHI-1276-TT-01001	Note 5	(-) 20 ~ 100	20	(-) 20 ~ 65	Natural Gas	a,b
10	SHI-1276-TT-04001	Note 5	(-) 20 ~ 100	20	(-) 20 ~ 65	Natural Gas	a,b
11	PIN-4004-TT-01001	Note 5	(-) 20 ~ 100	20	(-) 20 ~ 65	Natural Gas	a,b
12	PIN-4004-TT-04001	Note 5	(-) 20 ~ 100	20	(-) 20 ~ 65	Natural Gas	a,b

**NOTES:-**

(\*) Vendor to furnish

- 1) PESO/CCOE certificate for specified hazardous area classification is required with transmitters.
- 2) Transmitters shall have Lightning Protection.
- 3) Transmitter Load Resistance shall be Max 600Ω @ 24 V DC
- 4) Temperature transmitter shall be dual compartment type.
- 5) Contractor shall develop detailed datasheets with all the required information like span, make/model etc. during detailed engineering.



**TEMPERATURE TRANSMITTERS**

**DOCUMENT NO.**

**GAIL-STD-IN-DOC-DS-002**

**SHEET 1 of 1**

**Rev.**


**0**



**GAIL INDIA LIMITED**

**DATASHEET FOR TEMPERATURE ELEMENT (RTD) WITH THERMOWELL**

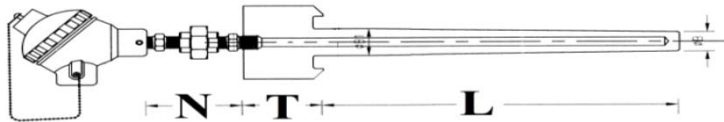
**GAIL-STD-IN-DOC-DS-003**

							
0	14.01.2019	Issued for Bid	RKS	UNU	UNU		
<b>REV</b>	<b>Date</b>	<b>Purpose of Issue</b>	<b>Prepared By</b>	<b>Checked By</b>	<b>Approved By</b>		<b>Lyons Engineering Pvt. Ltd</b>



CLIENT:	
QUANTITY: AS PER P&ID	

1	Assembly	As per drawing	12	Cable Entry	1/2" NPT	
2	Element	4 Wire RTD Class A type	13	No. of Entries	Two	
3	No. of Elements	Duplex	14	Enclosure Type	WP to IP 65 as per IEC 60529 / IS 2147 and Ex-Proof (IS 2148)	
4	Calibration	As per DIN 43760 / IEC 60751	THERMOWELL			
5	Element Material	Pt-100, Class A	15	Material	SS 316	
6	Resistance at 0 deg. Celsius	100 Ω	16	Construction	Drilled bar stock upto immersion length 500 mm, otherwise fabricated	
7	Leads	Hermetically Sealed	17	Process Connection	2" But-Weld	
8	Sheath	(*)	18	Inst. Connection	1/2" NPT	
	a)	O.D.	8 mm	20	Thermowell Dwg	
	b)	Material	SS 316	21	Options	(*)
9	Nipple & Union Material	SS 316	a)	Extra nipple extents	150 mm	
10	No. of Wires	Four Wires	b)			
			c)			
HEAD						
MEASURING UNIT						
11	Head Cover Type	Screw Cap of Die Cast Aluminium with SS chain				



Bill of Material (BOM)

S.NO.	TAG NO.	Element Length	Temperature (°C)		Thermowell			Service	Options	
			Operating (Nor)	Design (Max)	Material	Dimension				
						N	T			L
1	ITC-7006-TE-01001	Note 1	20	(-) 20 ~ 65	SS 316L	(*)	(*)	(*)	Natural Gas	
2	ITC-7006-TE-04001	Note 1	20	(-) 20 ~ 65	SS 316L	(*)	(*)	(*)	Natural Gas	
3	ITC-7006-TE-01002A	Note 1	20	(-) 20 ~ 65	SS 316L	(*)	(*)	(*)	Natural Gas	
4	ITC-7006-TE-01002B	Note 1	20	(-) 20 ~ 65	SS 316L	(*)	(*)	(*)	Natural Gas	
5	ITC-7006-TE-06001A	Note 1	20	(-) 20 ~ 65	SS 316L	(*)	(*)	(*)	Natural Gas	
6	ITC-7006-TE-06001B	Note 1	20	(-) 20 ~ 65	SS 316L	(*)	(*)	(*)	Natural Gas	
7	ABU-4002-TE-01001	Note 1	20	(-) 20 ~ 65	SS 316L	(*)	(*)	(*)	Natural Gas	
8	ABU-4002-TE-04001	Note 1	20	(-) 20 ~ 65	SS 316L	(*)	(*)	(*)	Natural Gas	
9	SHI-1276-TE-01001	Note 1	20	(-) 20 ~ 65	SS 316L	(*)	(*)	(*)	Natural Gas	
10	SHI-1276-TE-04001	Note 1	20	(-) 20 ~ 65	SS 316L	(*)	(*)	(*)	Natural Gas	
11	PIN-4004-TE-01001	Note 1	20	(-) 20 ~ 65	SS 316L	(*)	(*)	(*)	Natural Gas	
12	PIN-4004-TE-04001	Note 1	20	(-) 20 ~ 65	SS 316L	(*)	(*)	(*)	Natural Gas	

NOTES:- (\*) Vendor to furnish

- 1) Element length shall be suitable for thermowell.
- 2) Thermowell immersion length shall be selected in such a way that tip of thermowell shall preferably be at the centre of pipe to sense temperature properly.
- 3) RTD element shall be 4-wire, duplex type, Class A tolerance, Pt-100
- 4) Vendor to furnish GAD of complete assembly (TG with T/W), WFC Calculation as per the latest PTC 19.3.



RESISTANCE TEMPERATURE DETECTORS (RTD) WITH THERMOWELL

DOCUMENT NO.

GAIL-STD-IN-DOC-DS-003

Rev.


0



**GAIL INDIA LIMITED**

**DATASHEET FOR GAS DETECTOR**

**GAIL-STD-IN-DOC-DS-004**

							
0	14.01.2019	Issued for Bid	RKS	UNU	UNU		
<b>REV</b>	<b>Date</b>	<b>Purpose of Issue</b>	<b>Prepared By</b>	<b>Checked By</b>	<b>Approved By</b>	<b>Lyons Engineering Pvt. Ltd</b>	

<b>CLIENT:</b>		
<b>QUANTITY: AS PER P&amp;ID</b>		
1	Tag Number	Refer below BOM
2	Qty.	12 Nos.
3	Hazardous area Classification	Zone-1, Div. 1, Group IIA & IIB, T3
4	P&ID Number	GAIL -ENG-7006-PR-DWG-PID-002/003/007/011/013
5	Technology	IR based
6	Ambient Tempertaure	25 ~ 30°C
7	Electrical Certification	Intrinsically Safe(Ex 'ia') or Ex 'd'
8	Protection	IP 65 as per IEC 60529
9	Housing material	Stainless steel 316, Flameproof
10	Low Explosive Limit (LEL)	1 (% v/v in Air)
11	Range	0 ~ 100% LEL and Detection Range upt 15 feet.
12	Accuracy	± 2% LEL
13	Immunity to catalytic poisoning	Required
14	Temperature compensation	Required
15	Output	4~20 mA DC HART
16	Power supply	24V DC
17	Type of wiring	3-Wire
18	Cable Entry	3/4" NPTF
19	Response time	Less than T90 < 12 sec
20	Sensor life	5 Years
21	Self diagnostic facility	Required
22	Fail safety	Required
23	Mounting Accessories	Refer Note 2
24	Dustguard & Splashguard	Required
25	Integral meter	Digital LED type
26	High concentration alarm	Required
27	High concentration switch	Not Required
28	Model No.	(*)
29	Make	(*)

**Bill of Material (BOM)**

S.NO.	TAG NO.	Type of Gas Detector	Remarks
1	ITC-7006-GDPA-01001	Point Gas Detector	
2	ITC-7006-GDPA-01002	Point Gas Detector	
3	ITC-7006-GDPA-01003	Point Gas Detector	
4	ITC-7006-GDPA-01004	Point Gas Detector	
5	14.01.2019	Point Gas Detector	
6	ITC-7006-GDPA-06002	Point Gas Detector	
7	ABU-4002-GDPA-01001	Point Gas Detector	
8	ABU-4002-GDPA-01002	Point Gas Detector	
9	SHI-1276-GDPA-01001	Point Gas Detector	
10	SHI-1276-GDPA-01002	Point Gas Detector	
11	PINSHI-4004-GDPA-01001	Point Gas Detector	
12	PINSHI-4004-GDPA-01002	Point Gas Detector	

**NOTES:-** (\*) Vendor to furnish

1)	Instrument shall be tested by any recognised authority like BASEEFA, FM, PTB, CMRI etc. and certified by Petroleum and Explosives Safety Organisation (PESO) / Chief Controller of Explosives (CCOE) in India.
2)	Mounting Brackets shall be suitable to 2" pipe mounting. The bolts and nuts shall be alloy steel as per ASTM A193 Gr. B7 and ASTM A194 Gr. 2H (Hot dipped Galvanized or zinc Plated) respectively. Other accessories shall be zinc Plated.



**POINT GAS DETECTOR**

**DOCUMENT NO.**

**Rev.**

**GAIL-STD-IN-DOC-DS-004**

**0**

**SHEET 1 of 3**

<b>CLIENT:</b>			
<b>QUANTITY: AS PER P&amp;ID</b>			
1	Tag Number	Refer below BOM	
2	Qty.	12 Nos.	
3	Hazardous area Classification	Zone-1, Div. 1, Group IIA & IIB, T3	
4	P&ID Number	GAIL -ENG-7006-PR-DWG-PID-002/003/007/011/013	
5	Ambient Tempertaure	25 ~ 30°C	
6	Technology	IR based (Transmitter & Receiver type)	
7	Electrical Certification	Intrinsically Safe(Ex 'ia') or Ex 'd'	
8	Protection	IP 65 as per IEC 60529	
9	Housing material	Stainless steel 316, Flameproof	
10	Low Explosive Limit (LEL)	1 (% v/v in Air)	
11	Range	0 ~ 100% LEL and Detection Range 5 to 100 mtrs.	
12	Accuracy	± 2% LEL	
13	Immunity to catalytic poisoning	Required	
14	Temperature compensation	Required	
15	Output	4~20 mA DC HART	
16	Power supply	24V DC	
17	Type of wiring	3-Wire	
18	Cable Entry	3/4" NPTF	
19	Response time	Less than T90 < 5 sec	
20	Sensor life	5 Years	
21	Self diagnostic facility	Required	
22	Fail safety	Required	
23	Mounting Accessories	Refer Note 2	
24	Dustguard & Splashguard	Required	
25	Integral meter	Digital LED type	
26	High concentration alarm	Required	
27	High concentration switch	Not Required	
28	Model No.	(*)	
29	Make	(*)	
Bill of Material (BOM)			
S.NO.	TAG NO.	Type of Gas Detector	Remarks
1	ITC-7006-AE(T/R)-01001	Open Path Gas Detector	
2	ITC-7006-AE(T/R)-01002	Open Path Gas Detector	
3	ITC-7006-AE(T/R)-01003	Open Path Gas Detector	
4	ITC-7006-AE(T/R)-01004	Open Path Gas Detector	
5	14.01.2019	Open Path Gas Detector	
6	ITC-7006-AE(T/R)-06002	Open Path Gas Detector	
7	ABU-4002-AE(T/R)-01001	Open Path Gas Detector	
8	ABU-4002-AE(T/R)-01002	Open Path Gas Detector	
9	SHI-1276-AE(T/R)-01001	Open Path Gas Detector	
10	SHI-1276-AE(T/R)-01002	Open Path Gas Detector	
11	PINSHI-4004-AE(T/R)-01001	Open Path Gas Detector	
12	PINSHI-4004-AE(T/R)-01002	Open Path Gas Detector	
<b>NOTES:-</b>			
(*) Vendor to furnish			
1)	Instrument shall be tested by any recognised authority like BASEEFA, FM, PTB, CMRI etc. and certified by Petroleum and Explosives Safety Organisation (PESO) / Chief Controller of Explosives (CCOE) in India.		
2)	Mounting Brackets shall be suitable to 2" pipe mounting. The bolts and nuts shall be alloy steel as per ASTM A193 Gr. B7 and ASTM A194 Gr. 2H (Hot dipped Galvanized or zinc Plated) respectively. Other accessories shall be zinc Plated.		
3)	Detector able to operate even when obscured by fog, rain, dust, snow or blowing sand.		
4)	Detector shall be based on Transmitter module & Receiver Module.		
		<b>OPEN PATH GAS DETECTOR</b>	<b>DOCUMENT NO.</b>
			<b>Rev.</b>
			<b>0</b>
			<b>GAIL-STD-IN-DOC-DS-004</b>
			<b>SHEET 2 of 3</b>


CLIENT:		<b>TECHNICAL DATA SHEET - IR TYPE PORTABLE GAS DETECTOR</b>	
QUANTITY - AS PER REQUIREMENT			
Sr No.	Parameter	Typical requirements	
<b>GENERAL CHARACTERISTICS</b>			
1	Manufacture	(*)	
2	Model	(*)	
3	Part No.	(*)	
4	Quantity	5 Nos.	
<b>DETECTOR CHARACTERISTICS</b>			
5	Sensor Type	Non-Dispersive Type IR Absorption	
6	Detection Method	Diffusion Type	
7	Detector Range	0 to 100% Vol. CH4, 0-30% vol. O2	
8	Warm Up Time	Less than 5 Mins.	
9	Response Time	≤ 15 Secs.	
10	Battery	Rechargeable Li-ion Type, Battery back up time is 18 hours and recharge time is < 6 hours.	
11	Display	Monochrome graphical LCD display (128 X 160) with backlighting (activated automatically in dim ambient lighting conditions when monitor is in alarm or with a button press), Automatic screen flipping.	
12	Display Readout	Real-time reading of gas concentrations; battery status; datalogging on/off; STEL, TWA, Peak, and minimum values, Various instrument status related information.	
13	Alarms	Multi-tone audible (95 db @30 cm), Vibration, Visible (flashing bright red LEDs), on-screen indication of alarm conditions and Man Down Alarm with pre-alarm.	
14	Datalogging	Continuous datalogging (six months for 5 sensors at 1-minute intervals, 24/7) or User configurable datalogging interval (from 1 to 3600 seconds).	
15	Monitoring Object	Natural Gas Leak, O2	
16	Calibration Gas	Methane	
17	Calibration	Pre-Calibrated with Methane (Valid Calibration Certificate shall be provided). O2 (with valid calibration certificates).	
18	Self Test & Diagnostics	Fitted	
<b>ENVIRONMENTAL PROTECTION</b>			
17	Hazardous Area Classification	II 2G Ex ia d IIC T4 Gb	
18	Ingress Protection	IP 65	
19	Operating Humidity	0 to 95% RH (Non-Condensing)	
20	Operating/Ambient Temp. Range	- 20 to 50 deg C	
21	Storage Temp. Range	- 20 to 50 deg C	
<b>MECHANICAL CHARACTERISTICS</b>			
22	Total Weight		
23	Dimensions		
24	Mounting		
25	Accessories	Travel Charger, AC Adapter, Calibration Adapter	
<b>Note: (*) Vendor to furnish</b>			
1. Required certificates has to be submitted by Contractor.			
	<b>DATA SHEET - IR TYPE PORTABLE GAS DETECTOR</b>	<b>DOCUMENT NO.</b>	<b>Rev.</b>
		GAIL-STD-IN-DOC-DS-004	0
		SHEET 3 of 3	



**GAIL INDIA LIMITED**

**DATASHEET FOR PRESSURE GAUGES (PG)**

**GAIL-STD-IN-DOC-DS-005**

						
0	14.01.2019	Issued for Bid	RKS	UNU	UNU	
<b>REV</b>	<b>Date</b>	<b>Purpose of Issue</b>	<b>Prepared By</b>	<b>Checked By</b>	<b>Approved By</b>	

CLIENT:					
QUANTITY: AS PER P&ID					
1	Type	Direct	Wetted Parts Material	(*)	
2	Mounting	Local	Other Material	(*)	
3	Dial Size	150 mm	Process Connection	1/2"	
4	Colour	White with black inscription	Size & rating	(*)	
5	Case Material	SS 316	Facing & finish	(*)	
6	Bezel Ring	Beyonnet type SS 316	Capillary Material	(*)	
7	Window Material	Shatterproof glass	Armour Flexible Material	(*)	
8	Enclosure	WP to IP 65 as per IEC 60529/IS 2147	Capillary Length	(*)	
9	Pressure Element	Bourdon	Flushing/filling connection with	(*)	
10	Element Material	SS 316	17 Over range protection	130 % of FSD	
11	Socket Material	SS 316	18 Blow out protection	Yes	
12	Accuracy	"±" 1% of FSD	19 Options		
13	Zero Adjustment	Micropointer - External Type	a) Scrubber	b) Syphon	
14	Connection	1/2" NPT(M)	c) Gauge Saver	d) Liquid filled casing	
	Connection location	Bottom	e) Vacuum protection	f) Solid front	
15	Movement	SS 316	g) Three valve manifold	Yes (*)	
16	Diaphragm Seat	Rigid			
	Type	(*)			

Bill of Material (BOM)

Sl. No.	Tag No.	Range (Barg)	Operating Pressure (Barg)	Maximum Service		Fluid	Service	Options
				Pressure (Barg)	Temperature (°C)			
1	ITC-7006-PG-01003A	0 ~ 160	10 ~ 19	98	(-) 20 ~ 65°C	Gas	Natural Gas	c, d, f, g
2	ITC-7006-PG-01003B	0 ~ 160	0 ~ 01	98	(-) 20 ~ 65°C	Gas	Natural Gas	c, d, f, g
3	ITC-7006-PG-01002A	0 ~ 160	10 ~ 19	98	(-) 20 ~ 65°C	Gas	Natural Gas	c, d, f, g
4	ITC-7006-PG-06001	0 ~ 160	10 ~ 19	98	(-) 20 ~ 65°C	Gas	Natural Gas	c, d, f, g
5	ITC-7006-PG-06002	0 ~ 160	10 ~ 19	98	(-) 20 ~ 65°C	Gas	Natural Gas	c, d, f, g
6	ITC-7006-PG-06002A	0 ~ 160	10 ~ 19	98	(-) 20 ~ 65°C	Gas	Natural Gas	c, d, f, g
7	ITC-7006-PG-06002B	0 ~ 160	0 ~ 01	98	(-) 20 ~ 65°C	Gas	Natural Gas	c, d, f, g
8	ITC-7006-PG-09001	0 ~ 160	0 ~ 01	98	(-) 20 ~ 65°C	Gas	Natural Gas	c, d, f, g
9	ITC-7006-PG-09002	0 ~ 160	0 ~ 01	98	(-) 20 ~ 65°C	Gas	Natural Gas	c, d, f, g
10	MDR-4003-PG-01001	0 ~ 160	60 ~ 95	98	(-) 20 ~ 65°C	Gas	Natural Gas	c, d, f, g
11	MDR-4003-PG-06001	0 ~ 160	60 ~ 95	98	(-) 20 ~ 65°C	Gas	Natural Gas	c, d, f, g
12	MDR-4003-PG-06002	0 ~ 160	12 ~ 19	98	(-) 20 ~ 65°C	Gas	Natural Gas	c, d, f, g
13	ABU-4002-PG-06001	0 ~ 100	04 ~ 19	49	(-) 20 ~ 65°C	Gas	Natural Gas	c, d, f, g
14	ABU-4002-PG-07001	0 ~ 100	04 ~ 19	49	(-) 20 ~ 65°C	Gas	Natural Gas	c, d, f, g
15	ABU-4002-PG-07002	0 ~ 100	04 ~ 19	49	(-) 20 ~ 65°C	Gas	Natural Gas	c, d, f, g
16	ABU-4002-PG-13002	0 ~ 100	04 ~ 19	49	(-) 20 ~ 65°C	Gas	Natural Gas	c, d, f, g
17	ABU-4002-PG-15001	0 ~ 100	04 ~ 19	49	(-) 20 ~ 65°C	Gas	Natural Gas	c, d, f, g
18	ABU-4002-PG-15002	0 ~ 100	04 ~ 19	49	(-) 20 ~ 65°C	Gas	Natural Gas	c, d, f, g
19	ABU-4002-PG-18001	0 ~ 100	04 ~ 19	49	(-) 20 ~ 65°C	Gas	Natural Gas	c, d, f, g

20	ABU-4002-PG-18002	0 ~ 100	04 ~ 19	49	(-) 20 ~ 65°C	Gas	Natural Gas	c, d, f, g
21	ABU-4002-PG-08001	0 ~ 100	04 ~ 19	49	(-) 20 ~ 65°C	Gas	Natural Gas	c, d, f, g
22	ABU-4002-PG-08002	0 ~ 100	04 ~ 19	49	(-) 20 ~ 65°C	Gas	Natural Gas	c, d, f, g
23	SHI-1276-PG-06001	0 ~ 160	10 ~ 19	98	(-) 20 ~ 65°C	Gas	Natural Gas	c, d, f, g
24	SHI-1276-PG-06002	0 ~ 160	10 ~ 19	98	(-) 20 ~ 65°C	Gas	Natural Gas	c, d, f, g
25	PIN-4004-PG-06001	0 ~ 160	10 ~ 19	98	(-) 20 ~ 65°C	Gas	Natural Gas	c, d, f, g
26	PIN-4004-PG-06002	0 ~ 160	10 ~ 19	98	(-) 20 ~ 65°C	Gas	Natural Gas	c, d, f, g

<b>NOTES:-</b>		* Vendor to furnish	
	1)	Gauge Saver shall be provide with Low Pressure Gauges on Pig Launcher & Receiver.	
	2)	Manifold shall be of Swgelok or Parker Only.	
	3)	Contractor shall develop detailed datasheets with allthe required information like make/model etc during detailed engineering.	


	<b>PRESSURE GAUGE</b>	DOCUMENT NO.	Rev.
		GAIL-STD-IN-DOC-DS-005	0
		SHEET 2 of 2	





**GAIL INDIA LIMITED**

**DATASHEET FOR TEMPERATURE GAUGES (TG)**  
**GAIL-STD-IN-DOC-DS-006**

							
0	14.01.2019	Issued for Bid	RKS	UNU	UNU		
<b>REV</b>	<b>Date</b>	<b>Purpose of Issue</b>	<b>Prepared By</b>	<b>Checked By</b>	<b>Approved By</b>	<b>Lyons Engineering Pvt. Ltd</b>	


<b>CLIENT:</b>										
<b>QUANTITY: AS PER P&amp;ID</b>										
1	Type	Bimetalic	17	Extension Type	Rigid					
2	Well	Required	18	Bulb diameter	To suit thermowell					
3	Mounting	Local	19	Capillary Material	WP to IP 65 as per IEC 60529 /IS 2147					
4	Dial Size	150 mm		Armour flexible	(*)					
5	Colour	White with black inscription		Armour Material	(*)					
6	Case Material	Cast Aluminium		Capillary Length	(*)					
7	Window Material	Shatter proof glass	20	Over Range protection						
8	Conn. Location	Bottom		THERMOWELL						
9	Accuracy	"±" 1% of FSD	21	Material	SS 316					
10	Enclosure	WP to IP 65 as per IEC 60529 / IS 13947	21	Options	(*)					
11	Zero adj. screw	Required External Type	22	Construction	Drilled bar stock upto immersion length 500mm, otherwise fabricated					
	BIMETAL		23	Process Connection	Welded					
12	Stem		24	Gauge Connection	1/2" NPT(F)					
	Type	(*)	25	Thermowell Dwg.	(*)					
	Material	(*)	26	Over Range protection	(*)					
	Size	(*)	27	Options	(*)					
13	Stem Diameter	(*)	a)	Liquid Filled	Yes					
	Filled System	(*)	b)							
14	SAMA class	V	c)							
	Compensation	Case								
15	Bulb Type	Adjustable Union								
	Bulb Material	SS 316								
16	Bulb Union Threaded to	1/2" NPT(M)								
Bill of Material (BOM)										
Sl. No.	Tag No.	Range	Temperature (°C)		Thermowell			Service	Options	
			Operating (Nor)	Design (Max)	Material	Dimension				
						N	T			L
1	ITC-7006-TG-09001	(-) 20°C ~ 100°C	20°C	(-) 20°C ~ 65°C	(*)	(*)	(*)	Natural Gas		
2	MDR-4003-TG-06001	(-) 20°C ~ 100°C	20°C	(-) 20°C ~ 65°C	(*)	(*)	(*)	Natural Gas		
3	ABU-4002-TG-06002	(-) 20°C ~ 100°C	20°C	(-) 20°C ~ 65°C	(*)	(*)	(*)	Natural Gas		
4	ABU-4002-TG-07001	(-) 20°C ~ 100°C	20°C	(-) 20°C ~ 65°C	(*)	(*)	(*)	Natural Gas		
5	ABU-4002-TG-15001	(-) 20°C ~ 100°C	20°C	(-) 20°C ~ 65°C	(*)	(*)	(*)	Natural Gas		
6	ABU-4002-TG-18001	(-) 20°C ~ 100°C	20°C	(-) 20°C ~ 65°C	(*)	(*)	(*)	Natural Gas		
7	ABU-4002-TG-08001	(-) 20°C ~ 100°C	20°C	(-) 20°C ~ 65°C	(*)	(*)	(*)	Natural Gas		
8	SHI-1276-TG-06002	(-) 20°C ~ 100°C	20°C	(-) 20°C ~ 65°C	(*)	(*)	(*)	Natural Gas		
9	PIN-4004-TG-06002	(-) 20°C ~ 100°C	20°C	(-) 20°C ~ 65°C	(*)	(*)	(*)	Natural Gas		
<b>NOTES:-</b>		(*) Vendor to furnish								
	U	Immersion length								
	T	Lagging Extension								
	1)	Element length shall be suitable for thermowell.								
	2)	U-length shall be selected in such a way that the thermowell tip shall be preferably at the centre of pipe to sense the temperature accurately.								
		<b>TEMPERATURE GAUGE</b>					<b>DOCUMENT NO.</b>	<b>Rev.</b>		
							GAIL-STD-IN-DOC-DS-006	0		
							SHEET 1 of 1			



**GAIL INDIA LIMITED**

**DATASHEET FOR PRESSURE SAFETY VALVE (PSV)**

**GAIL-STD-IN-DOC-DS-007**

						
0	14.01.2019	Issued for Bid	RKS	UNU	UNU	
<b>REV</b>	<b>Date</b>	<b>Purpose of Issue</b>	<b>Prepared By</b>	<b>Checked By</b>	<b>Approved By</b>	

<b>CLIENT:</b>	
<b>QUANTITY:</b>	As Per P&ID

**PSV**

UNITS: Flow-> Liquid- m<sup>3</sup>/hr Gas- Sm<sup>3</sup>/hr Steam- kg/hr Pressure->Barg Temperature-> Deg C Level/Length-> mm

General	1	Tag No.	Quantity	ITC-7006-PSV-01001 / 06001	2 nos.
	2	Line No.	Schedule	X"-NG-01013-6D1-P / X"-NG-06010-6D1-P	600# / 150#
	3	Vessel No.		ITC-7006-PL-01001 / ITC-7006-PR-06001	
Valve	4	Safety / Relief		Pressure Safety Valve	
	5	Full Nozzle Full Lift/Mod. Nozzle		Full nozzle full lift	
	6	Bonnet type		Closed	
	7	Conv./Bellows/Pilot Operated		Conventional	
	8	Inlet Conn.	Size & Rating	As per P&ID	
	9		Facing & Finish	*	
	10	Outlet Conn.	Size & Rating	As per P&ID	
	11		Facing & Finish	*	
	12	Cap Over Adj. Bolt		Yes	
	13		Screwed / Bolted	Bolted	
Material	14	Lifting Gear - Type			
	15	Test Gag		Yes	
	16	Lever(Plain/Packed)		*	
	17				
	18	Body and Bonnet		A352 Gr LCC / A 350 LF2 / A 351 CF8M	
	19	Nozzle and Disc		SS316	
Options	20	Spring		As per API 526	
	21	Bellows		--	
	22				
	23				
	24	Resilient Seat Seal		--	
	25				
	26				
	27	Code		ASME / API	
Basis	28				
	29				
Service conditions	30	Fluid	State	Natural Gas	Gas
	31	Corrosive Constituent			
	32	Required Flow Capacity		0.578 MMSCMD	
	33	Mol.Wt.	S.G. at Rel. Temp	17.95	
	34	Oper. Pressure	Normal	10 ~ 19	
	35	Oper. Temp.	Rel. Temp.	(-) 20 ~ 65°C	
	36	Valve Discharges to		Atmosphere	
	37	Back Press.	Const. Or Variable	Constant	
	38	Set Pressure (Barg)		98	
	39	Cold Bend Test Pressure			
	40	% Over Pressure	% Blow Down	21%	As per API / ASME
	41	Cp/Cv (k)	Compressibility Factor	1.29%	0.97
	42	Viscosity @ Rel. Temp.	mPas(cP)		
	43	Vess. Wall Temp.	Surf.Area-m2		
	44	Max & Min Pressure (Barg)		10 ~ 19	
	Orifice	45	Calculated Area cm2		*
46		Sel. Area cm2	Orifice Design	*	*
47		No. of Valves Req'd. for capacity		*	
48		Tota Area - cm2		*	
49		Actual Flow Capacity		*	
50					
	51	Model No.		*	
	52	CCOE		Yes	
	53	Radiography		100%	
	54	ASME UV/NB		Yes	

**NOTES:**

- \*1: Vendor to furnish
- 1 At the time of approval, vendor shall furnish sizing calculation and catalogues of PSV.
- 2 Test GAG Required for safety valve & Pressure Safety valve shall be fire case type.
- 3 Vendor to submit Sizing sheet, Model Decodification sheet, Catalogue, Drawings and QAP for approval.



**Data Sheet of Pressure Safety Valve**

**DOCUMENT NO.**

GAIL-STD-IN-DOC-DS-007

**Rev.**


**0**



**GAIL INDIA LIMITED**

**DATASHEET FOR SCRAPPER/PIG SIGNALLER/DETECTOR - INTRUSIVE  
TYPE**

**GAIL-STD-IN-DOC-DS-008**

							
0	14.01.2019	Issued for Bid	RKS	UNU	UNU		
<b>REV</b>	<b>Date</b>	<b>Purpose of Issue</b>	<b>Prepared By</b>	<b>Checked By</b>	<b>Approved By</b>	<b>Lyons Engineering Pvt. Ltd</b>	

<b>CLIENT:</b>	
<b>QUANTITY: AS PER P&amp;ID</b>	


1	General	Tag No. & Quantity	As per BOM below
2		Make	(*)
3		Model	(*)
4		Service	Outdoor,unprotected
5		Ambient temp.	0°C ~55°C
6		Relative Humidity	0.98
7		Area Classification	Zone-2, IIA/IIB T3
8	Process Condition	Process Fluid	Natural Gas
9		Gas Temperature (Design)	(-)20~60 (Under Ground); (-)20~65 (Above Ground)
10		Line gas Pressure (Design)	(*)
11		Multiphase Product	No
12	Pig Details	Pig Material	Carbon Steel (*)
13		Pig Length	(*)
14		Pig Diameter (O. D.)	95% ~ 100 % of Pipeline ID
15		Pig Velocity (Max.)	8 m/Sec
16	Sensing Element	Type	Intrusive (Bi-directional)
17		Mounting	On Above Ground Pipe
18		Detection Speed	By Vendor
19		Connection	Welded on Scrapper Barrel
20		Body Material	ASTM A 350 LF 2
21		Corrosion Allowance	1.6 mm
22		Internals	SS 316 or better
23		Type of neck	Short neck
24	Body enclosure	Anti-corrosive epoxy painted	
25	Switch	Enclosure type	EEx 'd', IP 65
26		Electrical Entry	1/2" NPTF(Note-3)
27		Signal Output	Potential free contact SPDT (2 NOS.)/ DPDT (1 NO.)
28		Setting	Adjustable (Factory set for Scrapper passage/detection signal)
29		Type	Limit switch / Proximity Switch Hermetically sealed; auto reset (restores to normal Position after actuation). Make – As per vendor list
30		Contact Rating	24 VDC, 2A
31	Response Time	(*)	
32	Barrel Specification	Pipeline Diameter (NB)	6"
33		Pipeline wall Material API 5L Gr. (PSL-2)	X-52
34		Wall Thickness (mm)	6.4 mm (Main Pipeline)
35		Min. Pipeline Coating Thickness (External-3 Layer Polyethylene)	Minimum 2.7 mm
36	Others	Local Indicator	Mechanical visual (flag) with manual reset
37		Local Reset Buton	Black Colour, Eexd, IP65
38		Ball valves for removing scraper detector for servicing	Required
39		Jacking bracket for removal of scraper detector	Required

**Bill of Material(BOM)**

Sr. No.	Station No.	Tag No.	Line Size	Operating temp (°C)		Line Gas pressure (barg)		Remarks
				Normal	Max.	Normal	Max.	
1	Existing SV - 7006 of BJPL (New Despatch Terminal	ITC-7006-XXS-01001	ITC-7006-PL-01001					
2	Existing SV - 7006 of BJPL (New Despatch Terminal	ITC-7006-XXS-01002	6"-NG-01019-XS2-P					
3	ITC Food Park - Kapurthala (New Receiving Terminal	ITC-7006-XXS-06002	ITC-7006-PR-06001					
4	ITC Food Park - Kapurthala (New Receiving Terminal	ITC-7006-XXS-06001	6"-NG-06005-XS2-P					

**NOTES:-**

1	(*) To be provided by Vendor.
2	Pig Signallers shall be with isolation valve (Full Bore) for On-line repair. Valve material shall be LTCS.
3	Visual Indicator with manual reset shall be provided.
4	Material Compliance as per EN 10204 3.2 Certificate.
5	Painting shall be suitable for Corrosive Industrial environment.


	<b>DATASHEET FOR SCRAPPER/PIG SIGNALLER/DETECTOR - INTRUSIVE TYPE</b>	<b>DOCUMENT NO.</b>	<b>Rev.</b>
		<b>GAIL-STD-IN-DOC-DS-008</b>	<b>0</b>
		<b>SHEET 1 of 1</b>	



**GAIL INDIA LIMITED**

**DATASHEET FOR GAS OVER OIL ACTUATOR VALVES (GOOV)**

**GAIL-STD-IN-DOC-DS-009**

							
0	14.01.2019	Issued for Bid	RKS	UNU	UNU		
<b>REV</b>	<b>Date</b>	<b>Purpose of Issue</b>	<b>Prepared By</b>	<b>Checked By</b>	<b>Approved By</b>	<b>Lyons Engineering Pvt. Ltd</b>	



**DATASHEET FOR GOOV**



Doc. No. GAIL-STD-IN-DOC-DS-009

Rev. 0

Page 1 of 4

Tag No. ITC-7006-GOV-6"-0101 / 0601

General	1	Location Class	Confirm later	ACTUATOR	51	Type	Gas Over Oil Actuator ,Quarter Turn Operation
	2	Press. / Temp. Rating	ANSI Class 600#		52	Min. Pressure For Actuator Sizing	15 barg Or Specified in PTS
	3	Pipe Class	6D1 (ASTM A333 Gr. 6)		53	Supply Pressure Min. / Nor / Max. bar(g)	As per Process Parameters given in Tender
	4	Design Standard	API 6D		54	Power Gas supply Connection	Vendor to Provide
	5	Location	After Pig Launcher (ITC-7006-PL-01001)		55	Tubing Material	SS316L
	6	Valve Type & Size	ON/OFF-Ball & 6"		56	Tubing Size	Vendor to Provide
	7	Area Classification	Zone-1, Gr. A / B, T3-4 or Better		57	Filter Regulator	Required
	8	P&ID No.			58	Filter regulator Material \ Filter Element	SS316 / 2-5 Micron
VALVE	9	Make	VTA	59	Valve Position Indicator	Required	
	10	Model	VTA	60	Manual Override	Required on The Actuator local Control Panel	
	11	Weight / Dimension	VTA	61	Failure Position	Stay Put	
	12	Body	Top entry	62	Painting	As per Painting Specification	
	13	Stem	Quarter Turn Design/Anti Blow Out	63	Control Panel Material	SS316	
	14	Ball	Solid Ball	64	Logic / Tubing Components	SS316L (SWAGELOK/PARKER )	
	16	Body Stud	Fully Threaded	65	Panel Enclosure Class	WP- IS 2147 to IP-66 - IEC 60529 & Flame Proof as per IS 2148	
	17	Body Nuts	Two Hexagonal Nuts	66	Gas Storage and Hydraulic Cylinder Capacity	Min Two Open & close operations in case of loss of line pressure	
	18	Body Seat Ring	Renewable	67	Stroke Time/Response Time	Vendor to Provide for Opening & Closing @ specified Pressure	
	19	Type of Bore	Full Bore	68	Safety Factor	Actuator torque shall be minimum 1.25 times the maximum valve break torque required at full rated differential pressure of valve	
	20	Type of Support	Trunion Mounted	69	Position Switches	Required for both open and close positions	
	MATERIAL	21	Body	ASTM A 350 Gr. LF2 / Equivalent	70	Solenoid Valves	Required Asper Attached Data sheet
22		Stem (No Casting - Single Piece)	ASTM A276 Type 410 (SS 410) / A 564 Type 630 (17-4 PH) / ASTM A 479 Gr. 316	71	Relief Valve	Required - Material: SS316	
23		Ball	ASTM A 182 Gr. F 316 / A 351 Gr. CF8M / A 350 Gr. LF2 + 75 Micron ENP) / ASTM A 479 SS 316	72	Pressure Gauge	Required - Material: SS316	
24		Stud Bolts	ASTM A 320 Gr. L7	73	Differential Pressuer Switches	Required As per Attached Data sheet integral with system	
25		Nuts	ASTM A 194 Gr. 4 / Gr. 7	74	Adjustable Stoppers for Actuator	Required for both opening and closing	
26		Body Seat Ring	ASTM A 182 Gr. F 316 / A 350 Gr. LF2 + 75 Micron ENP	75	Stem Extension	As per Approved P&ID's	
27		Spring	Inconel X-750	76	Certification	As mentoned below	
END CONNECTIONS	28	Line Size	6"	77	Gas Consumption \ Displacement	Vendor to Provide	
	29	Pipe Material	ASTM A 333 Gr. 6	78	Oil Displacement	Vendor to Provide	
	30	End connection	Butt Weld	79	Tank Capacity	Vendor to Provide	
	31	Schedule of Pup piece	ASTM A 333 Gr. 6, Sch. 80	80	Oil Content	Vendor to Provide	
	32	End to End Dimensions	As per API 6D	81	Hydraulic Fluid Cleanliness	As per NAS 1638 / ISO 4406 - Latest Editions	
ADDITIONS	<b>FLUID PROPERTIES</b>			POSITION SWITCH	82	Hand Pump	Required
	33	Fluid Type / Phase	Natural Gas / Gas		83	Area Classification	Zone-1, Gr.II A/B, T3-T4 or Better
	34	Corrosive / Erosive constituent	CO2 (0.24%)		84	Switch Type	Proximity Type(Namur Certified)
	35	Flow Rate: Min./Max.	1.5 MMSCMD		85	Form	DPDT / SPDT
	36	Pressure Drop @ Normal flow, bar (g)	2.93		86	Contact Rating	Vendor to Provide
	37	Operating Pressure: Min./Max.	19 bar (g) /		87	Cable Entry	1/2" NPTF (2 Nos.)
38	Operating Temperature: Min./Max.	20°C	88	Switch Quantity	Two		



PROCESS COI	39	Design Pressure	98 bar (g)	VALVES PC	89	Enclosure Material	SS 304 or Equivalent (Mfr Std Subject to Approval)		
	40	Design Temperature: Min./Max.	-20°C / 65°C		90	Enclosure Class	WP to IP-65		
	41	Density, Kg/M3: Min./Max.			91	Certification	Required		
	42	Molecular Weight	19 Kg/Kmol		92	Certifying Agency	CCOE/UL / FM / BASEEFA/ATEX or Equal		
	43	Viscosity, Cp: Min./Max.			JUNCTION BOX	93	Junction Box (JB)	As per PTS\GTS\Data Sheet of Junction Box	
	44	Specific Heat Ratio, Cp/Cv: Min./Max.				CABLE GLAND	94	Cable Gland	1) As per PTS\GTS\Data Sheet of Junction Box 2) Double Compression Type
	45	Compressibility Factor: Min/Max.					<b>Certification required :</b> 1) Flame Proof / Ex. Proof Certificates, 2) Weather Proof Certificates, 3) Functional Test Reports, 4) Test Certificates for Actuator, 5) Calibration Report of Relief Valve with Serial No marked on Valve, 6) Calibration Report of Pressure Gauge with Serial No marked, 7) Blasting , Surface Preparation & Painting Report, 8) Operational , Maintenance & Installation Manual, 9) Catalogues for all the accessories.		
PERFORMANCE TABLE / TORQUE DETAILS	46	Break to Open (BTO)	Vendor to Provide						
	47	End to Open	Vendor to Provide						
	48	Running	Vendor to Provide						
	49	Break to Close	Vendor to Provide						
	50	End to Close	Vendor to Provide						
<b>Documents Required:</b> 1) Electrical Wiring Diagram 2) Interconnection Loop Diagram 3) Pnuematic Operating Diagram 4) Overall Dimension Drawing 5) Actuator GA Drawing 6) Technical Summary Table of OEM 7) Tank Sizing Calculation of OEM 8) Junction Box Details with GA Drawing									
Above mentioned details are bare minimum ther than as specified in Instrument Design Basis are also applicable									
The control logic shall enable the following: a) Local and remote selection in field. b) Maintenance / panel / SCADA selection in local panel. c) Logic function shall include open / close facilities. Logic may be implemented using relay logic in control panel. Panel / SCADA contacts shall be momentary, hold on contacts shall be used in logic. d) Remote function shall facilitate remote closure and opening of valve (without any manual intervention if all process interlocks are met). In case electrical signal to solenoid valves fail, e) Manual local hydraulic operation of valve , with hand pumps, in case of non availability of pneumatic (gas) operation. f) High differential pressure inhibit switch shall inhibit the remote operation of the valve, when differential becomes high (more than 3 bars). However it shall be possible to operate the valve locally. g) Close command (or open command) shall be inhibited during valve opening (or valve closing) and be made effective only after 100% opening (or closing ) is achieved. h) Opposite movement inhibitor shall be provided.									



DATASHEET FOR SOLENOID VALVES (SOV)



Doc. No. GAIL-STD-IN-DOC-DS-009

Tag No. ITC-7006-GOV-6"-XXXX/ XXXX

Rev. 0

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General	1	Tag Numbers	XX-XSV-XXXX	
	2	Make \ Model	Vendor to provide	
	3	Quantity	Vendor to provide	
	4	Location	Mounted on Actuator Cabinet	
	5	Service	Natural Gas	
	6	Area Classification	Zone-0,1, Gr.II A/B,T3-T4 or Better,Exia	
	7	Enclosure Calss	WP to IP-66	
	8	Certification	Required (Note-1)	
VALVE	9	Configuration (See Figure)	Vendor to provide	
	10	Body Size/ Rating	Vendor to provide	
	11	Body Material	SS316L	
	12	Process Connection	Vendor to provide	
	13	Trim Material	SS316L	
	14	Operation :Direct/Pilot	Vendor to provide	
	15	Operating Mode NC/NO/UNIVERSAL	Vendor to provide	
ACTUATOR	16	Style of Coil	Vendor to provide	
	17	Coil Voltage	24 VDC	
	18	Coil Insulation Class	Vendor to provide	
	19	Electrical Connection	Required	
	20	Cable Entry	1/2" NPTF	
	21	Volts	Vendor to provide	
	22	On De-Energised Condition, Port	Vendor to provide	
	23	On Energised Condition,Ports	Vendor to provide	
END CONNECTION	24	Manual Reset	Not Required	
	25	Process Fluid	State	Natural Gas Gas
	26	Flow	Vendor to provide	
	27	Temperature	Vendor to provide	
	28	Upstream Pressure	Vendor to provide	
	29	Down stream Pressure	Vendor to provide	
	30	Density	Vendor to provide	
CONFIGURATION				

Notes:

- 1) The Solenoid valves shall be intrinsically safe to specified area classification. The Certificate from a statutory body like UL /FE / BASEEFA\ATEX or equal shall be submitted along with the bid.
- 2) Flying Leads are not acceptable and shall be terminated in a termination box.
- 3) Solenoid valves shall be Operated by open/close command from SCADA system or Local Panel.
- 4) This is a Part of main line Valve/Emergency Isolation Valve Actuators and shall be supplied by main line valve Actuator Vendor.



**DATASHEET FOR DIFFERENTIAL PRESSURE SWITCH (DPSH)**



Doc. No. GAIL-STD-IN-DOC-DS-009

Tag No. ITC-7006-GOV-6"-XXXX/ XXXX

Rev. 0

Page 4 of 4

General	1	Tag No.	XX-PDSH-XXXX
	2	Quantity	As per latest P&ID's
	3	Service	Natural gas
	4	Type	Electric ,Differential Pressure
	5	Mounting	Surface mounted
	6	Area Classification	Zone 0, 1, GR.II A/B,T3-T4 or Better, Exia
	7	Enclosure Class	WP to IP-66
	8	Housing Material	LM-6 Cast Aluminum
SWITCH	9	Electrical output	Contact
	10	Form	DPDT
	11	Type	Micro Switch, Hermetically Sealed
	12	Current	Vendor to provide
	13	Load Type	Inductive
	14	Conduit conn.	1/2"NPTF
	15	No. of Entries	Two
	16	Terminal Block	Required
	17	Set Point adjustment	Internal
	18	Differential Range	Fixed
	19	Accuracy	±1% of Span
	20	Repeatability	±1% of Span
MEASURING UNIT	21	Hysteresis / Dead Band Details	Vendor to provide
	22	Pressure Element	Diaphragm
	23	Element Material	SS316L
	24	Process Connection	1/2" NPTF, Bottom
	25	Over Range Protection	150% of FSD
	26	Manifold Type	5 Valve Manifold
	27	Manifold Material	SS316
	28	Manifold Connection	1/2" NPTF
OTHERS	29	Make	Vendor to provide
	30	Model no.	Vendor to provide
	31		

**Notes:**


- 1) The Switch Enclosure Shall be Weather Proof To NEMA 4X and it shall be intrinsic Safe for Zone-0,1 group II A/B and temperature class T3- T4.
- 2) Vendor shall select the suitable model for each Tag no. such that the switch differential shall be with in the following limits. The sum of the differential & repeatability (in Engg.Units) Shall be less than the difference between the set point and the normal operating pressure .In other words, it shall be ensured that at no point of time the switch shall remain in Alarm status while the process is within the normal operating range.
- 3) 5 -way valve Manifold in 316SS shall be provided for all Tags.
- 4) Differential Pressure Switches Shall withstand maximum Static/Design Pressure Without affecting calibration, 150% Full Scale Deflection or design pr. Whichever is higher.
- 5) Differential pressure Switch shall be mounted on Valve Actuator and electrical/pneumatic connections shall be shown in respective drawings.
- 6) Calibration Report.



**GAIL INDIA LIMITED**

**QAP FOR TEMPERATURE TRANSMITTERS**

**GAIL-STD-IN-DOC-QAP-001**

							
0	15.01.2019	Issued for Bid	RKS	UNU	UNU		
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VENDOR LOGO



STANDARD QUALITY ASSURANCE PLAN FOR TEMPERATURE TRANSMITTER

CUSTOMER:- END USER:- QAP NO.:- REV.:-  
 SO NO.:- DATE:-  
 PO NO.:-  
 PROJECT:-  
 REF DOCUMENT:-

Sr No.	Component Operation	Characteristics	Class	Type of Check	Quantum of Check	Reference document	Acceptance norm	Format of Record	Agency			Remarks
									Vendor	TPI	Client	
1	Internal test/Inspection	Physical Verification of -General Finishing -Model no. & Serial no. -Tag no. -Certification -Accessories -Range -Accuracy -Calibration -Communication with HART	Major	Visual	100%	Approved Datasheet / Job Specification	Approved Datasheet / Job Specification	Test and Calibration Report	P	R	R	
			Critical	Electrical	100%				P	R	R	
2	Final Test/ Inspection	Physical Verification of -Model No.,Serial no -Tag No -Electrical / Conduit Entry -connection check -Accessories Check - Dimensional Check -Visual Inspection  -Calibration Test -Indicator Operation Check(If Meter Display) -Configuration of Range -Communication with HART configurator -Accuracy -Repeatability -Power supply variation test -Reverse Polarity Test -Load Variation Test	Major	Visual	100%	Approved Datasheet / Job Specification	Approved Datasheet / Job Specification	COC	P	W	W / R	
			Critical	Electrical	100%				P	W	W / R	
			Critical	Electrical	100%			P	W	W / R		
3	Review Documents	-Review of internal test report & MTC -Hazardous Area Classification Report - Test & Calibration Report - Certification for Compliance - CCOE certificate -Degree of protection certificate	Major	Visual	100%	Approved Datasheet / Job Specification	Approved Datasheet / Job Specification	T&C and COC	H	R	R	
4		TPI Inspection Report & Inspection Release Note							H	P	R	

P - Performance, R - Review, W - Witness, COC - Certificate of Conformance, T&C - Test & Calibration Report, H - Hold

Notes:


- 1). Material and Type shall be as per tender specification / datasheet.
- 2). Acceptance Norms/ Acceptance Criteria for all the activities shall be as per specification/ data sheets/ applicable codes & standards etc.
- 3). GAIL and/or his representative reserve right for inspection at any stage of manufacturing of materials as per approved QAP.
- 4). All Testing & Measuring Instruments shall have valid Calibration with Calibration Certificates & Traceabilities.



**GAIL INDIA LIMITED**

**QAP FOR RTDs AND THERMOWELLS**

**GAIL-STD-IN-DOC-QAP-002**

							
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VENDOR LOGO



STANDARD QUALITY ASSURANCE PLAN FOR RTD AND THERMOWELLS

<b>CUSTOMER:-</b>	<b>END USER:-</b>	<b>QAP NO.:-</b>	<b>REV.:-</b>
<b>SO NO.:-</b>	<b>DATE:-</b>		
<b>PO NO.:-</b>			
<b>PROJECT:-</b>			
<b>REF DOCUMENT:-</b>			

Sr. No.	Component Operation	Characteristics	Class	Type of Check	Quantum of Check	Reference Document	Acceptance Norm	Format of Record	Agency			Remarks
									Vendor	TPI	Client	

RTD ASSEMBLIES												
1	RTD Assemblies	a) Accuracy Test	Major	Testing	100%	IEC751/DIN43760	IEC751/DIN43760	Test & Calibration Certificate	P	W	W/R	
		b) IR at AMB & at 500VDC	Major	Testing		As per STD	As per STD	Test Report				
		c) Hot IR at 320 Deg c & 500 VDC	Major	Testing		As per STD	As per STD	Test Report				
		d) N2 Test	Major	Testing		As per STD	As per STD	Test Report				
		e) Response Time test	Major	Testing		As per STD	As per STD	Test Reports				
		f) Dimensions/Connection	Major	Measurement		Approved Specification/Drawings	Approved Specification/Drawings	Test Report				
		g) Weather proof test / Ex-proof Test	Major & Critical	Testing		IS 2147 / IS2148	IS 2147 / IS2148	Statutory Test Certificate				

THERMOWELL												
1	Raw material of Thermowell	Chemical Composition	Major	Analysis	One Sample	Approved Datasheet / Technical Specification	Approved Datasheet / Technical Specification	Material Test Certificate	P	R	R	
2	Thermowell	a) Dimensions	Major	Measurement	100%	Approved Datasheet / Drawings Applicable STD	Approved Datasheet / Drawings Applicable STD	Test Reports & Certificates	P	W	W/R	
		b) Hydro test	Major	Testing								
		c) Bore Concentricity test	Critical	Testing								
		d) Visual	Major	Observation								
		e) Workmanship/Finish	Major	Observation								
		f) Spec/Tagging	Major	Visual								
		g) Threading	Critical	Testing								
		h) Surface Finish	Major	Visual								
3		TPI Inspection Reports & Inspection Release Note							H	P	R	

P - Performance, R - Review, W - Witness, COC - Certificate of Conformance, T&C - Test & Calibration Report, H - Hold

**Notes:**


- 1). Material and Type shall be as per tender specification / datasheet.
- 2). Acceptance Norms/ Acceptance Criteria for all the activities shall be as per specification/ data sheets/ applicable codes & standards etc.
- 3). GAIL and/or his representative reserve right for inspection at any stage of manufacturing of materials as per approved QAP.





**GAIL INDIA LIMITED**

**QAP FOR PRESSURE TRANSMITTERS**

**GAIL-STD-IN-DOC-QAP-003**

						
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		<b>VENDOR LOGO</b>											
<b>STANDARD QUALITY ASSURANCE PLAN FOR PRESSURE TRANSMITTER</b>													
CUSTOMER:-		END USER:-			QAP NO.:-			REV.:-					
SO NO.:-		DATE:-											
PO NO.:-													
PROJECT:-													
REF DOCUMENT:-													
Sr No.	Component Operation	Characteristics	Class	Type of Check	Quantum of Check	Reference document	Acceptance norm	Format of Record	Agency			Remarks	
									Vendor	TPI	Client		
1	Internal test/Inspection	Physical Verification -General Finish -Model no. & Serial no. -Tag no. -Certification -Accessories -Calibration -Range -Accuracy -Leak Check Process -Connection -Communication with HART	Major	Visual	100%					P	R	R	
			Critical	Electrical	100%		Approved Datasheet / Job Specification	Approved Datasheet / Job Specification	Test and Calibration Report				
2	Final Test/ Inspection	Physical Verification of -Model no., Serial no., Tag no., -Process connection check -Electrical/Conduit Entry Connection check -Accessories check	Major	Visual	100%	Approved Datasheet / Job Specification	Approved Datasheet / Job Specification	COC	P	W	W / R		
		Calibration	Critical	Electrical	100%	Approved Datasheet / Job Specification	Approved Datasheet / Job Specification	T&C	P	W	W / R		
		-Accuracy -Repeatability -Indicator Operation Check(if Meter display) -Communication with Field Communicator -Power supply variation test -Reverse Polarity Test -Load Variation Test	Critical	Electrical	100%	Approved Datasheet / Job Specification	Approved Datasheet / Job Specification	COC	P	W	W / R		
3	Review of Documents	-Review of internal test report & MTC -Hazardous Area Classification Report - Test & Calibration Report - Certification for Compliance -CCOE certificate -Degree of protection certificate	Major	Visual	100%	Approved Datasheet / Job Specification	Approved Datasheet / Job Specification	Test Certificate & COC	P	R	R		
4		TPI Inspection Report & Inspection Release Note							H	P	R		

P - Performance, R - Review, W - Witness, COC - Certificate of Conformance, T&C - Test & Calibration Report, H - Hold

**Notes:**


- 1). Material and Type shall be as per tender specification / datasheet.
- 2). Acceptance Norms/ Acceptance Criteria for all the activities shall be as per specification/ data sheets/ applicable codes & standards etc.
- 3).GAIL and/or his representative reserve right for inspection at any stage of manufacturing of materials as per approved QAP.





**GAIL INDIA LIMITED**

**QAP FOR PRESSURE GAUGES**

**GAIL-STD-IN-DOC-QAP-004**


							
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						<b>VENDOR LOGO</b>						
<b>STANDARD QUALITY ASSURANCE PLAN FOR PRESSURE GAUGE</b>												
<b>CUSTOMER:-</b>		<b>QAP NO.:-</b>			<b>REV.:-</b>							
<b>SO NO.:-</b>		<b>DATE:-</b>										
<b>PO NO.:-</b>												
<b>PROJECT:-</b>												
<b>REF DOCUMENT:-</b>												
Sr. No.	Component Operation	Characteristics	Category	Type of Check	Quantum of Check	Reference Document	Acceptance Norm	Format of Plan	Agency			Remarks
									Vendor	TPI	Client	
1	Raw Material	a) Dimensions	MA	Mechanical	100%	PO approved Spec./Drig. Approved Spec./PO	PO approved Spec./Drig. Approved Spec./PO	Test Certificate	P	R	R	
		b) Chemical Analysis	MA	Chemical	Sample				P	R	R	
		c) Dial Marking, Unique, Srl. No.	MA	Visual	100%				P	R	R	
2	Internal Test/Inspection	Accuracy Hystresis Repeatability	CR	Measurement	100%	EN 837-1	EN 837-1	Calibration Report	P	R	R	
		Over range protection	CR	Visual	100%	EN 837-1	EN 837-1	Test Report	P	R	R	
3	Final Test/Inspection	Accuracy Hystresis Repeatability Dimension Visual	CR	Measurement	100%	EN 837-1	EN 837-1	Calibration Report	P	W	W/R	
		Over range protection	CR	Visual	100%	EN 837-1	EN 837-1	Test Report	P	W	W/R	
4	Accessories	1) Chemical Analysis	MA	Chemical	Sample	Approved Datasheet/ Drawing/Job Specification	Approved Datasheet/ Drawing/Job Specification	Material Test Certificate	P	R	R	
	Gauge Saver in SS 316	2) Dimensions	MA	Measurement	100%	Approved Datasheet/ Drawing/Job Specification	Approved Datasheet/ Drawing/Job Specification	Test Reports/ Certificates	P	W	W / R	
	2-Way Valve Manifold	3) Leak Tightness	CR	Hydrotest	100%	Approved Datasheet/ Drawing/Job Specification	Approved Datasheet/ Drawing/Job Specification	Test Reports/ Certificates	P	W	W/ R	
3	IRN	TPI Inspection Reports & Inspection Release Note							P	R		
<b>Legends:</b> P - Performance, R - Review, W - Witness, COC - Certificate of Conformance, T&C - Test & Calibration Report, H - Hold <b>Category:</b> CR - Characteristics affecting safety of equipment and personnel <b>Notes:</b> 1). Material and Type shall be as per tender specification / datasheet. 2). All Testing & Measuring Instruments shall have valid Calibration with Calibration Certificates & Traceabilities. 3). Acceptance Norms/ Acceptance Criteria for all the activities shall be as per specification/ data sheets/ applicable codes & standards etc. 4). GAIL and/or his representative reserve right for inspection at any stage of manufacturing of materials as per approved QAP.												



**GAIL INDIA LIMITED**

**QAP FOR TEMPERATURE GAUGES  
GAIL-STD-IN-DOC-QAP-005**

							
0	15.01.2019	Issued for Bid	RKS	UNU	UNU		
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VENDOR LOGO



QUALITY ASSURANCE PLAN FOR TEMPERATURE GAUGE WITH THERMOWELL

Sr No.	Components & Operation	Characteristics	Class	Type of Check	Quantum of Check	Reference document	Acceptance norm	Agency		
								Vendor	TPI	Client
<b>1</b>	<b>Raw Materials</b>									
1.1	Ring	Chemical composition	Major	Chemical Analysis	100%	As per Specification/data sheet	Approved Documents	P	R	R
1.2	Case	Chemical composition	Major	Chemical Analysis	100%	As per Specification/data sheet	Approved Documents	P	R	R
1.3	Movement	Chemical composition	Major	Chemical Analysis	100%	As per Specification/data sheet	Approved Documents	P	R	R
1.4	S.S. Socket	Chemical composition	Major	Chemical Analysis	100%	As per Specification/data sheet	Approved Documents	P	R	R
1.5	Dial	Chemical composition	Major	Visual	100%	As per Specification/data sheet	Approved Documents	P	R	R
1.6	Rubber Parts	Oil Test	Major	Oil Test	Sample	As per Relevant Std	Approved Documents	P	R	R
<b>2</b>	<b>Routine &amp; Acceptance Testa</b>									
2.1	Thermometers	Dimensions, Connections & Mounting		Measurement, Visual	100%	EN 13190 Std	Approved Documents	P	R	R
2.2	Calibration Test (5 points)	Accuracy and Repeatability		Calibration Check	100%	Approved test procedure	Approved Documents	P	R	R
2.3	Response Time Test	Response			10%		Approved Documents	P	R	R
<b>3</b>	<b>In Process Inspection</b>									
3.1	Dimensional check	Physical Measurement	Major	Measurement	100%	As per Relevant Std	Approved Drawings	P	R	R
3.2	Leakage test	Leak Test	Critical	Hydro test	100%	As per Relevant Std	As per Relevant Std	P	R	R
<b>4</b>	<b>Final Test Inspection</b>									
4.1	Finish Product check for completeness	Performance check & Calibration	Major	Measurement	100%	As per Relevant Std	Approved Documents / Relevant Std	P	W	W/R
		a) Accuracy +/- 1% of FSD						P	W	W/R
		b) Repeatability						P	W	W/R
		c) Leakage						P	W	W/R
4.2	Finished Gauge Protection	Over Range Protection	Major	130% of FSD	100%			P	W	W/R
4.3	Casing	Dimension, Enclosure Type	Major	Measurement	100%			P	W	W/R
4.4	Finished Gauge	Identification, Name plate detail, appearance & Cleanliness	Minor	Visual	100%			P	W	W/R
5	Review of Documents	Weather Proof Test	Major	Environmental	Type test report	IS 2147 / IEC 60529	As per Relevant Std	P	R	R
<b>THERMOWELL</b>										
1	Raw material of Thermowell	Chemical Composition	Major	Analysis	One Sample	Approved Datasheet / Technical Specification	Approved Datasheet / Technical Specification	P	R	R

2	Thermowell	a) Dimensions	Major	Measurement	100%	Approved Datasheet / Drawings Applicable STD	Approved Datasheet / Drawings Applicable STD	P	W	W/R
		b) Hydro test	Major	Testing						
		c) Bore Concentricity test	Critical	Testing						
		d) Visual	Major	Observation						
		e) Workmanship/Finish	Major	Observation						
		f) Spec/Tagging	Major	Visual						
		g) Threading	Critical	Testing						
		h) Surface Finish	Major	Visual						
3		TPI Inspection Reports & Inspection Release Note					H	P	R	

**LEGEND:** R: Review, W: Witness, P: Perform, H: Hold

**Notes:**


- 1). Material and Type shall be as per tender specification / datasheet.
- 2). All Testing & Measuring Instruments shall have valid Calibration with Calibration Certificates & Traceabilities.
- 3). Acceptance Norms/ Acceptance Criteria for all the activities shall be as per specification/ data sheets/ applicable codes & standards etc.
- 4). GAIL and/or his representative reserve right for inspection at any stage of manufacturing of materials as per approved QAP.



**GAIL INDIA LIMITED**

**QAP FOR INSTRUMENT CABLES**

**GAIL-STD-IN-DOC-QAP-006**

							
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VENDOR LOGO



**QAP for Instrument Cables**

CUSTOMER:-

QAP NO.:-

REV.:-

SO NO.:-

DATE:-

PO NO.:-

PROJECT:-

REF DOCUMENT:-

1.2	Insulation & Sheathing compound	1. Tensile & Elongation before & after ageing	A	Visual	One sample per batch	IS 5831/ BS 5308(P-2) Relevant Standard as per Specification	IS 5831/ BS 5308(P-2) Relevant Standard as per Specification	P	R	R
		2. Type of compound	C	Visual				P	R	R
		3. Thermal Stability	C	Physical				P	R	R
	FR Test for FR PVC only	1. Oxygen Index	C	Enviro	ASTM-D2863	Min. 30%	Min 250deg C	P	R	R
		2. Temperature Index	C	Enviro				P	R	R
1.3	Armour	1. Surface Condition	A	Visual	One sample per batch	IS 3975/ BS 5308(P-2) Relevant Standard as per Specification	IS 3975/ BS 5308(P-2) Relevant Standard as per Specification	P	R	R
		2. Uniformity of Zinc Coating	C	Chemical				P	R	R
		3. Mass of zinc coating	B	Chemical				P	R	R
		4. Tensile strength & elongation	B	Physical				P	R	R
		5. Wrapping	B	Physical				P	R	R
		6. Torsion/ Winding	B	Physical				P	R	R
<b>2</b>	<b>Process Inspection</b>									
2.0	Insulated core	1. Type of Material	B	Visual	Each setting &	BS 5308(P-2) & Relevant	BS 5308(P-2) &	P	R	R
		2. Thickness of Insulation (Avg. Min.)	C	Physical				P	R	R



		3. Core Identification	C	Visual	during run of M/c	Standard as per Specification	Relevant Standard as per Specification	P	R	R
		4. Surface Finish	B	Visual				P	R	R
		5. Volume Resistivity	C	Electrical				P	R	R
2.1	Pair/Triad	1. Sequence of laying	C	Visual	Setting & During Process	BS 5308(P-2) & Relevant Standard as per Specification	BS 5308(P-2) & Relevant Standard as per Specification	P	R	R
		2. Continuity of conductor	C	Electrical				P	R	R
		3. Lay Length	B	Physical				P	R	R
2.2	Pair/Triad screening	1. Tape thickness	B	Physical	Setting & During Process	BS 5308(P-2) & Relevant Standard as per Specification	BS 5308(P-2) & Relevant Standard as per Specification	P	R	R
		2. Tape overlap	B	Visual				P	R	R
		3. Drain wire size	B	Physical				P	R	R
2.3	Pair/Triad Laying	1. Sequence of laying	B	Visual	Setting & During Process	BS 5308(P-2) & Relevant Standard as per Specification	BS 5308(P-2) & Relevant Standard as per Specification	P	R	R
		2. Lay Length	B	Physical				P	R	R
		3. Dimension	B	Physical				P	R	R
		4. Continuity of conductor	C	Electrical	100% Drum	BS 5308(P-2) & Relevant Standard as per Specification	BS 5308(P-2) & Relevant Standard as per Specification	P	R	R
		5. HV	C	Electrical				P	R	R
		6. Continuity of common pair	C	Electrical				P	R	R
2.4	Overall screening	1. Tape thickness	B	Physical	Setting & During Process	BS 5308(P-2) & Relevant Standard as per Specification	BS 5308(P-2) & Relevant Standard as per Specification	P	R	R
		2. Tape overlap	B	Visual				P	R	R
		3. Drain wire size	B	Physical				P	R	R
2.5	Inner sheath	1. Type of PVC	B	Visual	Each setting & at the running of M/c	BS 5308(P-2) & Relevant Standard as per Specification	BS 5308(P-2) & Relevant Standard as per Specification	P	R	R
		2. Dimension	B	Physical				P	R	R
		3. Thickness of Inner Sheath	C	Physical				P	R	R
		4. Surface finish & Colour	B	Visual			BS 5308(P-2)/Should be smooth & free from porosity & Relevant Standard as per Specification	P	R	R



		1. HV Test a) Core to core b) Core to shield/Armour	C	Electrical	10% Sample	BS 5308(P-2) & Relevant Standard as per Specification	BS 5308(P-2) & Relevant Standard as per Specification	P	W	W/R
		2. Conductor Resistance	B	Electrical	10% Sample	IS 8130/ BS 5308(P-2) & Relevant Standard as per Specification	IS 8130/ BS 5308(P-2) & Relevant Standard as per Specification	P	W	W/R
		3. Continuity test	B	Electrical	10% Sample	BS 5308(P-2) & Relevant Standard as per Specification	BS 5308(P-2) & Relevant Standard as per Specification	P	W	W/R
		4. Insulation Resistance (Before & After HV) a. Individual Conductor b. Individual Screens	C	Electrical	One sample per lot			P	W	W/R
		5. Tensile Strength & Elongation for Insulation & sheath before ageing	B	Physical	10% Sample			P	W	W/R
		6. Dimension	B	Visual	10% Sample			P	W	W/R
		7. Electrostatic noise reduction ratio	B	Electrical	One sample per lot			P	W	W/R
		8. Cable capacitance & L/R ratio test	B	Electrical	10% Sample			P	W	W/R
		9. Spark Test a. Core b. Sheath				BS 5308(P-2) / BS 5099 & Relevant Standard as per Specification	Relevant Standard as per Specification	P	W	W/R
	<b>Flammability Test for FRLS PVC only</b>	1. Oxygen Index	C	Enviro	One sample per lot	ASTM-D2863	Min. 30%	P	W	W/R
		2. Temperature Index	C	Enviro			Min 250deg C	P	W	W/R
		3. Flammability test	C	Fire		IEC 332-1	Shall Pass	P	W	W/R
		4. Smoke Density	As Applicable	As Applicable		ASTM 2843		P	W	W/R
		5. Acid Gas Generation	As Applicable	As Applicable		IEC-754-1		P	W	W/R
		6. Swedish Chimmney Test	As Applicable	As Applicable		As per Relevant Staandard		P	W	W/R

5	Type Test									
5.0	Tests For Conductor	1. Conductor Resistance	B	Electrical	One sample per lot	IS 8130/ BS 5308(P-2) & Relevant Standard as per Specification	IS 8130/ BS 5308(P-2) & Relevant Standard as per Specification	P	R	R
		2. Annealing Test on Cu		Physical		BS 6360 & Relevant Standard as per Specification	BS 6360 & Relevant Standard as per Specification	P	R	R
5.1	Test on Armour wire/strip	1. Tensile strength	B	Physical	One sample per lot	BS 5308(P-2) & Relevant Standard as per Specification	BS 5308(P-2) & Relevant Standard as per Specification	P	R	R
		2. % Elongation	B	Physical				P	R	R
		3. Torsion/Winding	B	Physical				P	R	R
		4. Wt. of zinc coating	B	Chemical				P	R	R
		5. Dimensions	B	Physical				P	R	R
		6. Uniformity of coating	C	Chemical				P	R	R
5.2	Thickness of Insulation & Sheath	Thickness of Insulation & Sheath	B	Physical	One sample per lot	BS 5308(P-2) & Relevant Standard as per Specification	BS 5308(P-2) & Relevant Standard as per Specification	P	R	R
5.3	Physical tests on Insulation & Outer Sheath	1. Elongation & T. S. Before & After Ageing	B	Physical	One sample per lot	BS 5308(P-2) & Relevant Standard as per Specification	BS 5308(P-2) & Relevant Standard as per Specification	P	R	R
		2. Ageing in Air oven	B	Physical				P	R	R
		3. Shrinkage test	B	Physical				P	R	R
		4. Hot Deformation	B	Physical				P	R	R
		5. Heat Shock	B	Physical				P	R	R
		6. Thermal stability	B	Physical				P	R	R
		7. Flammability Test	B	Physical				P	R	R
		8. Loss of Mass	B	Physical				P	R	R
5.4	Insulation Resistance test at room & rated temperature	Volume resistivity	C	Electrical	One sample per lot	BS 5308(P-2) & Relevant Standard as per Specification	BS 5308(P-2) & Relevant Standard as per Specification	P	R	R
5.5	H.V. test at room temperature	H.V. test at room temperature	B	Electrical	One sample per lot	BS 5308(P-2) & Relevant Standard as per Specification	BS 5308(P-2) & Relevant Standard as per Specification	P	R	R

5.7	Flammability test	FRLS Tests (FR PVC Only)	C	Enviro	One sample per lot	Relevant Standard as per Specification	Relevant Standard as per Specification	P	R	R
		1. Oxygen Index				ASTM 2863	Min. 30%	P	R	R
		2. Temperature Index				ASTM 2863	Min 250deg C	P	R	R
		4. Smoke Density				ASTM 2843	ASTM 2843	P	R	R
		5. Acid Gas Generation				IEC-754-1	IEC-754-1	P	R	R
		6. Swedish Chimmney Test				As per Relevant Staandard	As per Relevant Staandard	P	R	R

**LEGENDS:** R: Review of Docs., A: Minor, B: Major, C: Critical, W: Witness


**Notes:**

- 1). All Testing and Measuring Equipments / Instruments shall have valid Calibration with Calibration Certificate & their Traceabilities.
- 2). Acceptance Norms/ Acceptance Criteria for all the activities shall be as per specification/ data sheets/ applicable codes & standards etc.
- 3). GAIL and/or his representative reserve right for inspection at any stage of manufacturing of materails as per approved QAP.
- 4). All Testing & Measuring Instruments shall have valid Calibration with Calibration Certificates & Traceabilities.



**GAIL INDIA LIMITED**

**QAP FOR PRESSURE SAFETY VALVES  
GAIL-STD-IN-DOC-QAP-007**

						
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VEDOR LOGO



QUALITY ASSURANCE PLAN FOR PRESSURE SAFETY VALVE

Sr No.	Components & Operation	Characteristics	Class	Type of Check	Quantum of Check	Reference document	Acceptance norm	Agency		
								Vendor	TPI	Client
<b>1 Raw Materials</b>										
1.1	Incoming materials like Forgings and castings for body, Bonnet & Nozzle, Springs, Bellows etc.	i. Material Properties (Mechanical & Chemical ) ii. Size iii. Rating iv. Make v. Type	Major	Visual	100%	As per clause 3.1 of EN 10204 for each valve body & Bonnet/forging, nozzle and clause 2.2 for stem, disc etc.	Manufacturers certificate of conformity	P	R	R
1.2	Machining of components & their assembly.	Dimensions, Finish	Major	Visual/Physical	100%	Data sheet/Standard specification/Relevant code	Data sheet/Standard specification/Relevant code	P	R	R
1.3	Internal test/Inspection	i. Radiography of valve castings	Major	Visual/Physical	100%	ANSI B16.34	ANSI B16.34 annex.B	P	R	R
		ii. Bend test & Magnetic Particle Inspection of Body & Bonnet casting	Major	Visual/Physical	100%			P	R	R
		iii. Charpy V -notch impact testing (If specified)	Major	Visual/Physical	100%			P	R	R
		iv. Visual check, Verification of tag plate/Marking, Accessories.	Major	visual	100%			P	R	R
		v. Helium Leak test	Major	Physical	100%	Data sheet/Standard specification/Relevant code	Data sheet/Standard specification/Relevant code	P	R	R
		vi. Dye Penetrant test of Welds.	Major	Physical	100%			P	R	R
		vii. Hydrostatic test.	Major	Physical	100%			P	R	R
		viii. Cold bench set pressure	Major	Physical	100%			P	R	R
		ix. Seat Leakage test	Major	Physical	100%			P	R	R
		x. Valve lift test.	Major	Visual/Physical	100%	API RP 527	API RP 527	P	R	R
		xi. Blow down/ Reclosing pressure test	Major	Physical	100%			P	R	R
		xii. Capacity test	Major	Physical	100%			P	R	R
		xiii. Post weld Heat treatment of weld joints	Major	Physical	100%	Data sheet/Standard specification/Relevant code	Data sheet/Standard specification/Relevant code	P	R	R
3	Final Inspection Test	i. Dimensional, Finish, Visual check, Verification of tag plate/Marking, Accessories.	Major	Visual/Physical	100%	Data sheet/Standard specification/Relevant code	Data sheet/Standard specification/Relevant code	P	W	W/R
		ii. Helium Leak test	Critical					Physical	P	W
		iii. Dye Penetrant test of Welds.	Major	Physical				P	W	W/R
		iv. Hydrostatic test.	Major	Physical				P	W	W/R
		v. Cold bench set pressure	Major	Physical				P	W	W/R
		vi. Seat Leakage test	Major	Physical		P	W	W/R		
		vii. Valve lift test.	Major	Visual/Physical		P	W	W/R		
4	Review of Documents	i. Review of IBR certificate & Type test report for valves under IBR regulation (If Applicable)	Critical	Visual	100%	Data sheet/Standard specification/Relevant code	Data sheet/Standard specification/Relevant code	P	R	R
		ii. PWHT report/ Radiography reports/MPI reports	Critical	Visual	100%	Data sheet/Standard specification/Relevant code	Data sheet/Standard specification/Relevant code	P	R	R


	iii. Capacity test as per ASME (Type test report)	Critical	Visual	100%	Data sheet/Standard specification/Relevant code	Data sheet/Standard specification/Relevant code	P	R	R
	iv. Material test certificate	Major	Visual	100%	As per clause 3.1 of EN 10204 for each valve body & Bonnet/forging, nozzle and clause 2.2 for stem, disc etc.	Data sheet/Standard specification/Relevant code	P	R	R
<p><b>LEGENDS:</b> R: Review of Docs      W: Witness      P: Perform</p> <p>Notes:</p> <p>1). Acceptance Norms/ Acceptance Criteria for all the activities shall be as per specification/ data sheets/ applicable codes &amp; standards etc.</p> <p>2). GAIL and/or his representative reserve right for inspection at any stage of manufacturing of materials as per approved QAP.</p> <p>3). All Testing &amp; Measuring Instruments shall have valid Calibration with Calibration Certificates &amp; Traceabilities.</p>									





**GAIL INDIA LIMITED**

**QAP FOR PIG SIGNALLER  
GAIL-STD-IN-DOC-QAP-008**

						
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VENDOR LOGO



QUALITY ASSURANCE PLAN FOR PIG SIGNALLER

CUSTOMER:- END USER:- QAP NO.:- REV.:-

SO NO:- DATE:-

PO NO.:-

PROJECT:-

REF DOCUMENT:-

Sr. No.	Stage / Activity	Characteristics	Quantum of Check	Reference documents	Acceptance norm	Format of Record	Agency			Remarks
							Vendor	TPI	Client	
<b>A</b>	<b>Procedures</b>									
a	Hydrostatic test, NDT, PWHT, Functional test and Visibility test	Documented Procedures	100%	Approved Datasheet / Job Specification	Approved Datasheet / Job Specification	Procedure Documents	P	R	R	
b	Welding Procedure Specification (WPQ), Procedure Qualification Record (PQR), Welders Performance Qualification (WPQ)	Qualification requirements as per ASME Sec.IX and Purchase specification	100%	Approved Datasheet / Job Specification	Approved Datasheet / Job Specification	WPS,POR & WPQ Records	P	W / R (Refer Note-3)	R	
<b>B</b>	<b>Material Inspection</b>									
a	Forgings for Trigger,Weldolet, Mounting Nozzle,etc at suppliers works	i) Chemical Properties ii)Tensile/Impact/Hardness/HIC (Hydrogen Induced Cracking) & other applicable tests iii) NDT (Non Destructive Testing) - As Applicable	Approved Datasheet / Job Specification	Approved Datasheet / Job Specification	Approved Datasheet / Job Specification	Material Test Certificates / Lab Test Reports	P	Mech- W, Rest-R	R	
b	Forgings ,Gaskets, Fasteners, Visual Indicator, Limit switch, and other material after receipt at suppliers works	i) Chemical Properties ii)Tensile/Impact/Hardness/HIC (Hydrogen Induced Cracking) & other applicable tests iii) NDT (Non Destructive Testing) - As Applicable	100%	Approved Datasheet / Job Specification	Approved Datasheet / Job Specification	Material test certificates	-	R	R	
<b>C</b>	<b>In process Inspection</b>									
a	Machining of Components	Visual & Dimensional	100%	Approved Datasheet / Job Specification	Approved Datasheet / Job Specification	Suppliers Records	P	R	-	


b	Inspection of Welds	i) Visual ii) Applicable NDT	100%	Approved Datasheet / Job Specification	Approved Datasheet / Job Specification	Test Reports	P	W/R (Refer Note-1)	R	
c	Heat Treatment	Heat treatment as applicable	100%	Approved Datasheet / Job Specification	Approved Datasheet / Job Specification	HT Chart/Record	P	R		
<b>D</b>	<b>Final Inspection</b>									
a	Functional Test	Satisfactory Performance	100%	Approved Datasheet / Job Specification	Approved Datasheet / Job Specification	Test Reports	P	W	W/R	
b	Hydrostatic Test	Leak Check	100%	Approved Datasheet / Job Specification	Approved Datasheet / Job Specification	Test Reports	P	W	W/R	
c	Visual and Dimensional Inspection	Dimensions & Completeness of Assembly	100%	Approved Datasheet / Job Specification	Approved Datasheet / Job Specification	Inspection Record	P	W	W/R	
<b>E</b>	<b>Painting</b>									
a	Corrosion Resistant Painting & / or Antifouling Coating (As Applicable)	i) Painting Scheme ii) Visual Check iii) Final DFT Check	100%	Approved Datasheet / Job Specification	Approved Datasheet / Job Specification	Inspection Record	P	R	R	
<b>F</b>	<b>Documentation and IC</b>									
a	Final Documentation & Inspection Certificate(IC)	Issue of IC & Final document completeness certificate	As per PR	Approved Datasheet / Job Specification	Approved Datasheet / Job Specification	IC & Document completeness certificate	H	P	R	
<b>Legend:</b>										
H- Hold (Do not proceed without approval), Random -10% (min. 1 no.) of each size and type of Bulk item, R-Review, W-Witness (Give due notice, work may proceed after scheduled date).										
<b>Notes:</b>										
1). Inspection Engineer shall decide the option to be exercised for the particular stage and Suppliers 2). Forgings for Trigger, Weldolet, Mounting Nozzle, etc Shall be procured duly inspected by TPIA appointed by Supplier. 3). Witness-If New PQR / Applicable PQR is not qualified under reputed TPIA. Review-If Applicable PQR is qualified under reputed TPIA. 4). Supplier's in house procedures may be accepted in case TPIA is satisfied with adequacy of procedures to comply with Purchase Order/Specifications requirements; in case of non availability of suitable procedure s fresh procedures may be qualified under EIL witness. 5). In case of conflict between purchase specification, contract documents and QAP more stringent conditions shall be applicable. 6). This document describes generally the requirements pertaining to all types of the item. Requirements specific to PO and the item are only applicable. 7). Acceptance Norms/ Acceptance Criteria for all the activities shall be as per relevant/ job specification / Standard specifica tion/ data sheets/applicable codes & Standards etc. referred there in /Job Specification /Approved Documents.										



**GAIL INDIA LIMITED**

**QAP FOR GAS DETECTOR**

**GAIL-STD-IN-DOC-QAP-009**

						
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VENDOR LOGO



QUALITY ASSURANCE PLAN FOR GAS DETECTOR

CUSTOMER:- END USER:- QAP NO.:- REV.:-  
 SO NO.:- DATE:-  
 PO NO.:-  
 PROJECT:-  
 REF DOCUMENT:-

Sr No.	Components & Operation	Characteristics	Class	Type of Check	Quantum of Check	Reference document	Acceptance norm	Agency		
								Vendor	TPI	GSPL
1	Raw Materials									
1.1	Gas detectors, Portable gas detectors & Power supply units,	i. Material Properties ii. Size iii. Rating iv. Make v. Type/Model No.	Major	Visual	100%	Clause 2.2 of DIN 50049/BS EN-50054 & 50057	Manufacturers certificate of conformity	P	R	R
2	In Process Inspection									
2.2	Internal test/Inspection	i. Calibration check of gas detectors including alarm. ii. General Finish & Physical Verification of Model no. - Range - Serial no. - Tag no. - Certification label - Accessories iii. Bill of material check iv. Interface with RTU v. Checking of all power wiring for continuity. vi. Checking of all control wiring for continuity & Polarity	Critical Major Major	Electrical/Physical Visual Visual Physical / Electrical Electrical/Physical Physical Physical	100%	BS EN-50054/BS EN-50057/Relevant Drawing	BS EN-50054/BS EN-50057	P	R	R
3	Witness Test Inspection	i. Calibration check of gas detectors including alarm. ii. Interface with SCADA/RTU	Critical Critical	Electrical/Physical Physical				P	W	W/R
4	Review of Documents	i. Statuary approval certificates (BIS or equivalent) for gas detectors, portable detectors etc. for use in specified Hazardous area. ii. Certificates from testing agencies like BASEEFA, CENELEC, CMRI, FM, PTB, CCOE/PESO or equivalent for gas detectors, portable detectors, Junction boxes etc. for use in specified Hazardous area. iii. Degree of Protection iv. Material test certificate with detailed chemical analysis (MIL certificate)	Critical Critical Critical Critical	Visual Visual Visual Visual	100% 100% 100% 100%	IS-2148/IEC-79 IS-2148/IEC-79 IS-2147/IEC-529 Clause 2.2 of DIN 50049/BS EN-50054 & 50057	IS-2148/IEC-79 IS-2148/IEC-79 IS-2147/IEC-530 Clause 2.2 of DIN 50049/BS EN-50054 & 50057	P P P P	R R R R	R R R R

LEGENDS: R: Review of Docs, W: Witness, P: Perform

Notes:


1). 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.



**GAIL INDIA LIMITED**

**GAS OVER OIL ACTUATOR**

**GAIL-STD-IN-DOC-QAP-010**

							
0	15.01.2019	Issued for Bid	RKS	UNU	UNU		
<b>REV</b>	<b>Date</b>	<b>Purpose of Issue</b>	<b>Prepared By</b>	<b>Checked By</b>	<b>Approved By</b>	<b>Lyons Engineering Pvt. Ltd</b>	



## QUALITY ASSURANCE PLAN GAS OVER OIL ACTUATOR

DOC.No.  
GAIL-STD-IN-DOC-QAP-010



Sr. No.	Stage /Activity	Characterstics	Quantum of Check	Reference Document	Acceptance Norms	Format Of Records	Inspection By		Remarks
							Sub Suppliar	suppliar	
1	<b>Procedures</b>	--	--			--	--	--	
2	<b>Material Description</b>								
2.1	Incoming material like Control Valves, Solenoid Valves,Gaskets,Junction Boxes, Flow regulators, Hydraulic filters, Gas Filters, Limit Switches, Instrument tubing,Cables,Hydraulic Pumps,Limit Valves, Pressure Gauges, etc.	1. Matreial Identification & Chemical Composition 2. Mechanical & Physical prosperties 3. Operational Checks 4. Caliberation Checks (As applicable)	100% by Supplier	Refer note -6	Refer note -5	Material test Certificate	p	H	
2.2	Oil Tanks	Hydrostatic Pressure test	100% by Sub Supplier	Refer note -6	Refer note -5	Material test Certificate	p	H	
2.3	Gas Buffer Tanks	Hydrostatic Pressure test	100% by Sub Supplier			Material test Certificate	p	H	
2.4	Hydraulic Fluid	1.Chemical Composition 2. Cleanliness Levels	100% by Sub Supplier	Refer note -6	Refer note -5	Material test Certificate	p	H	
3	<b>In Process Inspection</b>								
3.1	Castings of pressure Contating Parts	Radiographt test	100% by Supplier	Refer note -6	Refer note -5	Supplier's test record	-	H	
3.2	Forgings	Ultrasonic testing	100% by Supplier	Refer note -6	Refer note -5	Supplier's test record	-	H	
3.3	Machined Surface	Liquid Penetrent test	100% by Supplier	Refer note -6	Refer note -5	Supplier's test record	-	H	
	Sealing areas within the actuator body	Magnetic particle Testing	100% by Supplier	Refer note -6	Refer note -5	Supplier's test record	-	H	
	Actuator body	Pressure test for Flame proff Enclosuere	100% by Supplier	Refer note -6	Refer note -5	Supplier's test record	-	H	
	Complete Assembly	1. Visual, Dimensional & BOM 2.Operation Checks	100% by Supplier	Refer note -6	Refer note -5	Supplier's test record	-	H	
4	<b>Final Inspection</b>								



## QUALITY ASSURANCE PLAN GAS OVER OIL ACTUATOR

DOC.No.  
GAIL-STD-IN-DOC-QAP-010



Sr. No.	Stage /Activity	Characterstics	Quantum of Check	Reference Document	Acceptance Norms	Format Of Records	Inspection By		Remarks
							Sub Suppliar	suppliar	
4.1	Final Inspection ( At Actuator Manufacturer's Works)	1. Visual, Dimensional Checks 2. Bill of Material 2.Verification of Tag no. and Plate no. 4.Hydrostatics test at 1.5 times the actuator Design pressure for min. 2 hrs. 5.Check for Actuator torque or Thrust 6. Seal test of Hydraulic Circuits 7. Verification of opening and closing time and contriol of operating time 8. Actutaor functional test including open close operations ( at Least 5 times) Remote operation of actuatorand checking of all remote feedbacks and signals, Local operation of actuator, operation of linit switches and position indicators (mechanical & Electrical) 9. Check for Emergency manual override.	100% by Supplier and on random basis by EIL/TPIA	Refer note -6	Refer note -5	Supplier's test record	-	P	
4.2	Integral Testing	Valve/Actuator assembly test at valve manufacturer's work. The following as a minmum shall be Carried out - Open/Close Operations. ( at min. & Max. Pressure. -Stroke time ( if applicable) -No Load test or Load operations with the min. Required feeding pressure. - Electrical and Mechanical Operation test.	100% of each type and rating	Refer note -6	Refer note -5	Supplier's test record	-	P	
5	<b>Painting</b>								





## QUALITY ASSURANCE PLAN GAS OVER OIL ACTUATOR

DOC.No.  
GAIL-STD-IN-DOC-QAP-010



Sr. No.	Stage /Activity	Characteristics	Quantum of Check	Reference Document	Acceptance Norms	Format Of Records	Inspection By		Remarks
							Sub Suppliar	suppliar	
5.1	Painting & Packing	1. Visual 2. Suitable protection to prevent entry of foreign material 3. Protection against damage during transportation 4. Suitable packing for outdoor storage areas with heavy rains/high ambient temprature ubnless otherwise agreed	100%	Refer note -6	Refer note -5	Supplier's test record	-	W	
6	<b>Documentation and IC</b>								
6.1	Documentation and IC	1. Certificate for testing agency like ATEX,CIMFR,BASEEFA,FM/UL, PTB etc. for suitability in specified hazardeous area. 2. Statutory approval certificates from CCE/PESO for use in specifised hazardeous area. 3. Degree of protection certificate for actutaor enclosure, JB, Solenoid Enclosure, Limit switches etc. 4. Flameproof Certification for cable glands, Relays, Valves etc from independent testing agency. 4. A valid BIS license for inmdegenious supply. 5. Operation and maintenace manual	100%	Refer note -6	Refer note -5	Supplier's test record	-	R	
- Supplier to submit internal test reports, type test reports before offereing items for ispection to TPIA.									
*Radiography Films shall be reviewed									
Legend :									
M : Manufacturer		C : Client (GAIL)				A : Approval		H : Hold	
NA : Not Applicable		W / R : Witness of Test & Review of Certificates & Documents as per QAP			W : Witness		RW : Random Witness		
Notes: -									
1	wherever W/R or H/W is indicated, inspection Engineer shall decide the option to be exercised for the particular stage and supplier.								
2	In case of conflict between purchase specification, cotract documents and ITP, more stringent conditions shall be applicable.								
3	This documnets describes genreally the requirements pertaining to all types of the items. Requirements specific to PO and the item are only applicable								
4	Acceptance norms/ acceptance criteria for all the activities shall be as per relevent/job specification/standard specification/data sheets/applicable codes & standard etc. referred there in /job specification/approved documents.								
5	Reference documents are relevent Job specifications /standard specifications/data sheets/applicable codes & standards								



LYONS ENGINEERING PVT. LTD.  
NEW DELHI

INSTRUMENT CONNECTION ON VESSEL,  
STANDPIPES AND TANKS

DRAWING NO.

GAIL-ENG-IN-DWG-TP-001

1 OF 4

# INSTRUMENT CONNECTION ON VESSEL, STANDPIPES AND TANKS

REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED
0	15.01.19	ISSUED FOR TENDER	D.V	U.N	S.B



LYONS ENGINEERING PVT. LTD.  
NEW DELHI

INSTRUMENT CONNECTION ON VESSEL,  
STANDPIPES AND TANKS

DRAWING NO.

GAIL-ENG-IN-DWG-TP-001

2 OF 4

S.NO.	TYPE OF INSTRUMENTS	UNCLADDED EQUIPMENTS		CLADDED EQUIPMENTS		INSTRUMENT CONNECTION
		EQUIPMENT/STANDPIPE CONNECTION	FIRST BLOCK VALVE	EQUIPMENT/STANDPIPE CONNECTION	FIRST BLOCK VALVE	
1.	EXTERNAL DISPLACER LEVEL INSTRUMENT ON EQUIPMENT	2" FLGD.	2" FLGD.	3" FLGD.	3" FLGD.	2" FLGD.
2.	EXTERNAL DISPLACER LEVEL INSTRUMENT ON STANDPIPE	2" FLGD.	2" FLGD.	2" FLGD.	2" FLGD.	2" FLGD.
3.	EXTERNAL GUIDED WAVE LEVEL INSTRUMENT ON EQUIPMENT	2" FLGD.	2" FLGD.	3" FLGD.	3" FLGD.	2" FLGD.
4.	EXTERNAL GUIDED WAVE LEVEL INSTRUMENT ON STANDPIPE	2" FLGD.	2" FLGD.	2" FLGD.	2" FLGD.	2" FLGD.
5.	EXTERNAL MAGNETIC LEVEL INSTRUMENT/ GAUGE ON EQUIPMENT	2" FLGD.	2" FLGD.	3" FLGD.	3" FLGD.	2" FLGD.
6.	EXTERNAL MAGNETIC LEVEL INSTRUMENT/ GAUGE ON STANDPIPE	2" FLGD.	2" FLGD.	2" FLGD.	2" FLGD.	2" FLGD.
7.	EXTERNAL BALL FLOAT LEVEL INSTRUMENT ON VESSEL	2" FLGD.	2" FLGD.	3" FLGD.	3" FLGD.	1" SW.
8.	EXTERNAL BALL FLOAT LEVEL INSTRUMENT ON STANDPIPE	1" SW/BW #	1" SW/BW #	1" SW/BW #	1" SW/BW #	1" SW
9.	INTERNAL DISPLACER / FLOAT LEVEL INSTRUMENTS	4" FLGD.	-	-	4" FLGD.	4" FLGD.
10.	INTERNAL GUIDED WAVE LEVEL INSTRUMENT ON EQUIPMENT	4" FLGD.	-	-	4" FLGD.	4" FLGD.
11.	MAGNETIC LEVEL INSTRUMENT/ GAUGE (INTERNAL - TOP MOUNTED)	4" FLGD.	-	-	4" FLGD.	4" FLGD.
12.	LEVEL GAUGE ON VESSEL	2" FLGD.	2" FLGD.	3" FLGD.	3" FLGD.	3/4" SCRD.
13.	LEVEL GAUGE ON STANDPIPE	3/4" SW/BW #	3/4" SW/BW #	3/4" SW/BW #	3/4" SW/BW #	3/4" SCRD.
14.	SPECIAL LEVEL INSTRUMENT ON EQUIPMENT (CAPACITANCE PROBE/ULTRASONIC PROBE/R.F.PROBE)	2" FLGD.	-	3" FLGD.	-	2" FLGD.
15.	D.P. INSTRUMENT/ GAUGES ON VESSEL	2" FLGD.	2" BW/FLGD #	3" FLGD.	3" FLGD.	3/4" SCRD.
16.	D.P. INSTRUMENT/ GAUGES ON STANDPIPE	3/4" SW/BW #	3/4" SW/BW #	3/4" SW/BW #	3/4" SW/BW #	1/2" SCRD.
17.	DIAPHRAGM SEAL D.P.IN STRUMENT/ GAUGES ON VESSEL		3" FLGD.	3" FLGD.	3" FLGD.	3" FLGD.
18.	EXTENDED DIAPHRAGM SEAL D.P. INSTR/ GAUGE ON VESSEL	4" FLGD.(NOTE-1)	4" FLGD.(NOTE-1)	-	3" FLGD.	4" FLGD.

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LYONS ENGINEERING PVT. LTD.  
NEW DELHI

INSTRUMENT CONNECTION ON VESSEL,  
STANDPIPES AND TANKS

DRAWING NO.

GAIL-ENG-IN-DWG-TP-001

3 OF 4

S.NO.	TYPE OF INSTRUMENTS	UNCLADDED EQUIPMENTS		CLADDED EQUIPMENTS		INSTRUMENT CONNECTION
		EQUIPMENT/STANDPIPE CONNECTION	FIRST BLOCK VALVE	EQUIPMENT/STANDPIPE CONNECTION	FIRST BLOCK VALVE	
19.	DIP TUBE LEVEL INSTRUMENT	6" FLGD.	1/2" SW (BY INST)	6" FLGD.	1/2" SW (BY INST)	1/2" SCRD.
20.	TANK LEVEL INSTRUMENT (MECHANICAL)	1/2" FLGD.	1/2" FLGD. (BY INST)	-	-	1/2" SCRD.
21.	TANK LEVEL INSTRUMENT (SERVO) ON ATMOSPHERIC TANKS	6" FLGD.	-	-	-	6" FLGD.
22.	TANK LEVEL INSTRUMENT (SERVO) FOR PRESSURISED EQUIPMENT	6" FLGD.	6" FLGD.(BY INST)	6" FLGD.	6" FLGD.(BY INST)	6" FLGD.
23.	TANK LEVEL INSTRUMENT (RADAR) ON ATMOSPHERIC TANK (CLEAN SERVICE)	8" FLGD.	-	-	-	8" FLGD.
24.	TANK LEVEL INSTRUMENT (RADAR) ON ATMOSPHERIC TANK (VISCIOUS SERVICE)	24" FLGD.	-	-	-	24" FLGD.
25.	TANK LEVEL INSTRUMENT (RADAR) FOR PRESSURISED EQUIPMENTS	8" FLGD.	-	8" FLGD.	-	8" FLGD.
26.	TANK LEVEL INSTRUMENT - CAPACITANCE / ULTRASONIC/ RF TYPE ON ATMOSPHERIC TANKS/PRESSURSED EQUIPMENTS	2" FLGD.	-	3" FLGD.	-	2" FLGD.
27.	TANK LEVEL INSTRUMENT - TUNING FORK	3" FLGD.	-	-	-	3" FLGD.
28.	PRESSURE INSTRUMENT/ GAUGE ON VESSEL	2" FLGD.	2" BW/FLGD. #	3" FLGD.	3" BW/FLGD. #	1/2" SCRD.
29.	PRESSURE INSTRUMENT/ GAUGE ON STANDPIPE	3/4" SW/BW #	3/4" SW/BW #	3/4" SW/BW #	3/4" SW/BW #	1/2" SCRD.
30.	CHEMICAL SEAL PRESSURE INSTRUMENT/ GAUGE ON VESSEL	2" FLGD.	2" FLGD.	3" FLGD.	3" FLGD.	1/2" SCRD.
31.	DIAPHRAGM SEAL PRESSURE INSTRUMENT /GAUGE ON VESSEL	2" FLGD.	2" FLGD.	3" FLGD.	3" FLGD.	2" FLGD.
32.	THERMOWELL ON EQUIPMENT	2" FLGD.	-	3" FLGD.	-	2" FLGD./ 3" FLGD.
33.	MULTI-POINT TEMPERATURE ELEMENTS FOR TANKS	3" FLGD.	-	3" FLGD.	-	3" FLGD.
34.	STANDPIPE (RATING UP TO 600#)	2" FLGD.	-	3" FLGD.	-	-
35.	STANDPIPE (RATING > 600#)	3" FLGD.	-	3" FLGD.	-	-

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REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED



LYONS ENGINEERING PVT. LTD.  
NEW DELHI

INSTRUMENT CONNECTION ON VESSEL,  
STANDPIPES AND TANKS

DRAWING NO.

GAIL-ENG-IN-DWG-TP-001

4 OF 4

**NOTES:**

1. O.D OF EXTENDED DIAPHRAGM OF INSTRUMENT SHALL BE SELECTED TO SUIT NOZZLE I.D OF EQUIPMENT.
2. ALL FLANGES/SW RATING SHALL BE AS PER PIPING SPECIFICATION UNLESS PROJECT SPECIFICATION REQUIRES MIN. 300#.
3. IN CASE OF DIRECT MOUNTED FLANGED INSTRUMENTS AND WHERE FLANGED TYPE FIRST ISOLATION VALVE ARE PROVIDED, BOLTING AND GASKETS SHALL BE IN PIPING SCOPE.
4. INSTALLATION OF STILL WELL OF TANK LEVEL INSTRUMENTS (SERVO, MECHANICAL AND MULTIPOINT TEMPERATURE ELEMENT) ON TANKS ARE IN TANK VENDOR SCOPE
5. FOR ANY OTHER INSTRUMENTS NOT REFERED ABOVE THE CONNECTION DETAILS SHALL BE AS PER PROJECT REQUIREMENT.
6. AS PER PIPING SPECIFICATION/PROJECT PHILOSOPHY.

REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED
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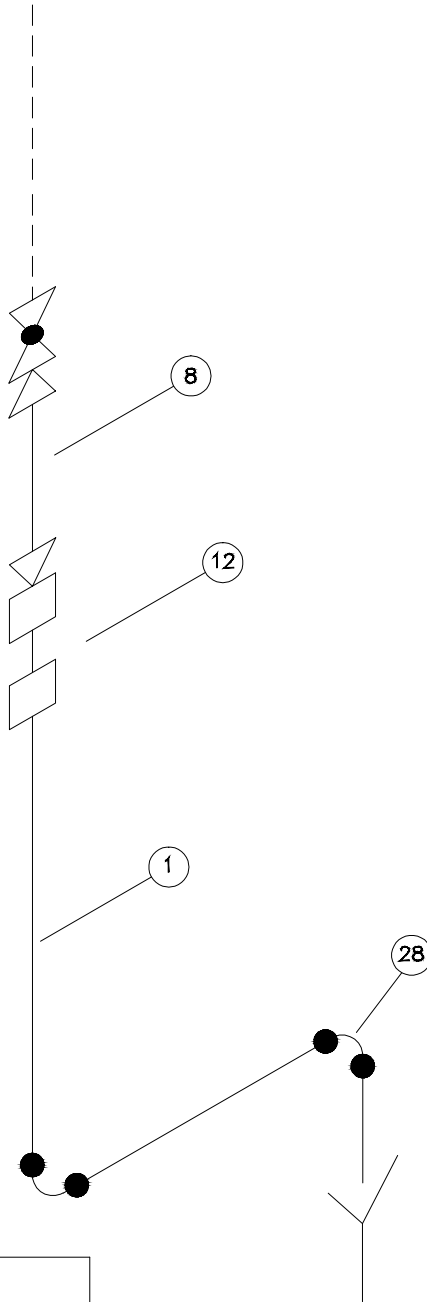
LYONS ENGINEERING PVT. LTD.  
NEW DELHI

DARIN FOR SINGLE LINE

DRAWING NO.

GAIL-ENG-IN-DWG-TP-002

1 OF 1



LIST OF ITEMS

CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT
1	PIPE	1/2"	PL	A/R	m
8	NIPPLE	1/2"	TH X TH	1	No
12	COUPLING	1/2"	TH	1	No
28	ELBOW	1/2"	SW	2	No

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REV.NO.	DATE	SUBJECT OF REVISION			BY	CHECKED	APPROVED		



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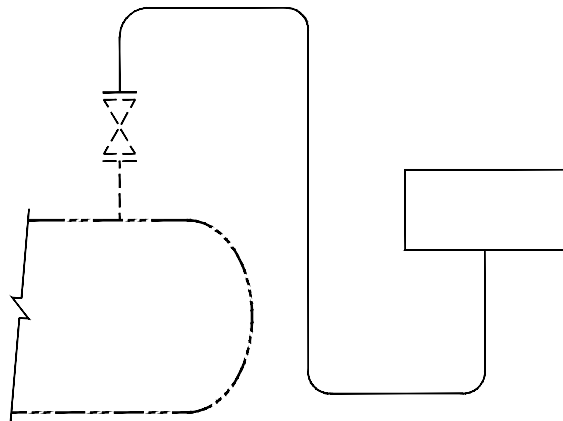
**PRESSURE INSTRUMENT  
INSTALLATION  
SCOPE OF WORK**

DRAWING NO.

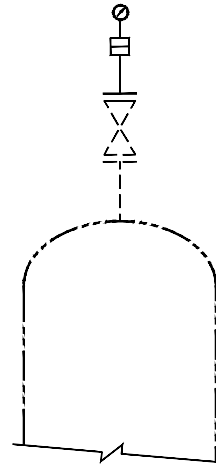
GAIL-ENG-IN-DWG-TP-003

1 OF 3

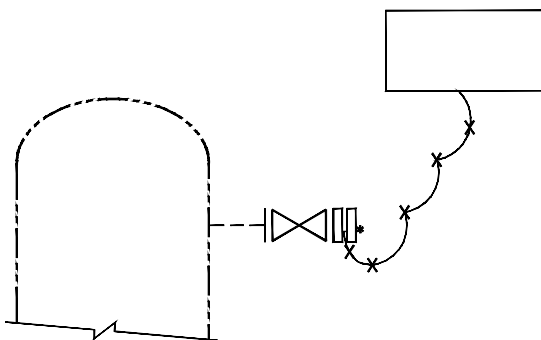
**(P-1) PRESSURE INSTRUMENT  
ON VESSEL**



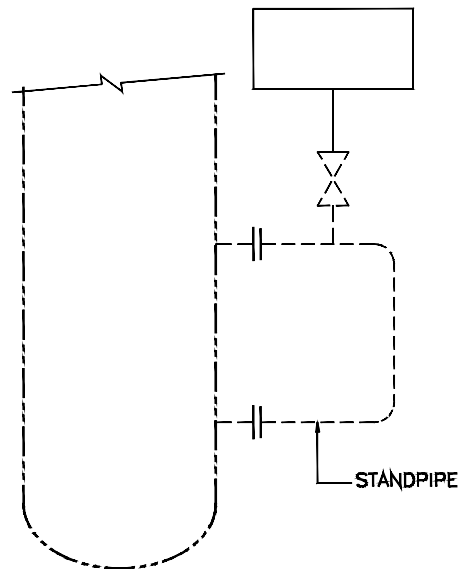
**(P-2) CHEMICAL SEAL PRESSURE  
GAUGE  
(SCRD.) ON VESSEL**



**(P-3) DIAPHRAGM SEAL PRESS.  
INST./GAUGE  
(FLGD.) ON VESSEL WITH CAPILLARY**



**(P-4) PRESSURE INSTRUMENT  
ON STAND PIPE**



**NOTES:**

- \* STUD LENGTH = STANDARD LENGTH + 3" STUD & NUTS BY INSTRUMENT GROUP
- 1. REFER STANDARD NO. SD-IC-001 FOR SIZE AND CONNECTION TYPE OF ISOLATION VALVE.

————— INSTRUMENT GROUP  
 - - - - - PIPING GROUP  
 - - - - - VESSEL GROUP

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REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED			



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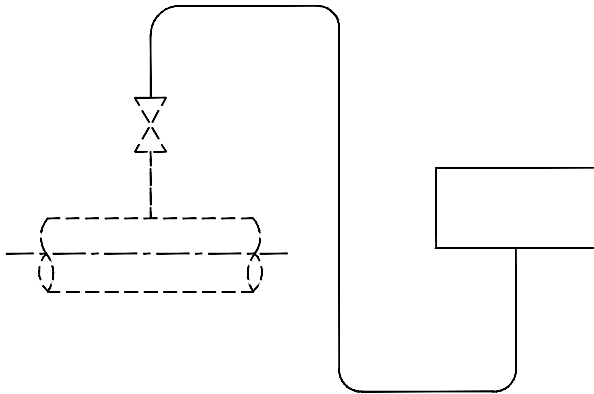
**PRESSURE INSTRUMENT  
INSTALLATION  
SCOPE OF WORK**

DRAWING NO.

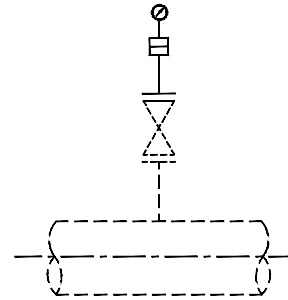
GAIL-ENG-IN-DWG-TP-003

2 OF 3

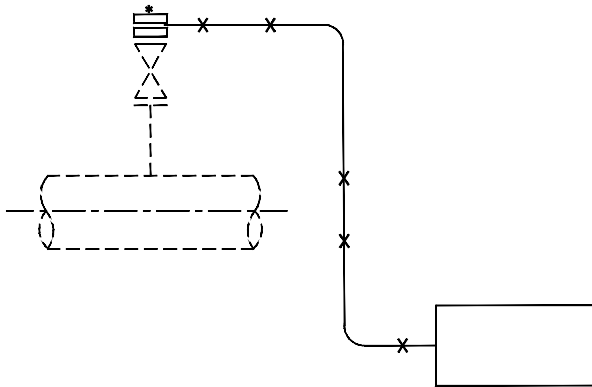
**(P-5) PRESSURE INSTRUMENT  
ON PIPE**



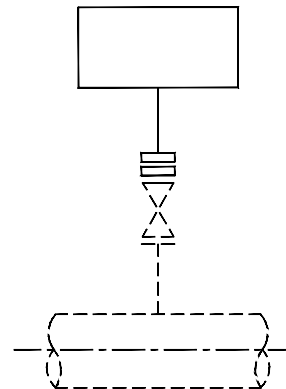
**(P-6) CHEMICAL SEAL  
PRESSURE GAUGE (SCRD.) ON PIPE**



**(P-7) DIAPHRAGM SEAL PRESSURE  
INST./  
GAUGE ON PIPE WITH CAPILLARY**



**(P8) DIAPHRAGM SEAL PRESSURE  
INST./  
GAUGE (FLGD) ON PIPE**



**NOTES:**

\* STUD LENGTH = STANDARD LENGTH + 3" STUD & NUTS BY INSTRUMENT GROUP.

1. REFER STANDARD NO. SD-IC-001.

FOR SIZE AND CONNECTION TYPE OF ISOLATION VALVE.

————— INSTRUMENT GROUP  
- - - - - PIPING GROUP  
- - - - -

0	15.01.19	ISSUED FOR TENDER	D.V		U.N		S.B	
REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED			





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NEW DELHI

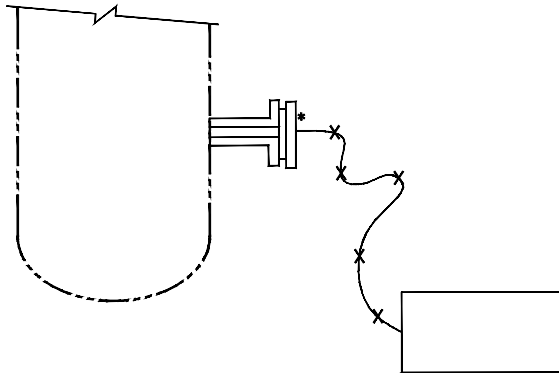
**PRESSURE INSTRUMENT  
INSTALLATION  
SCOPE OF WORK**

DRAWING NO.

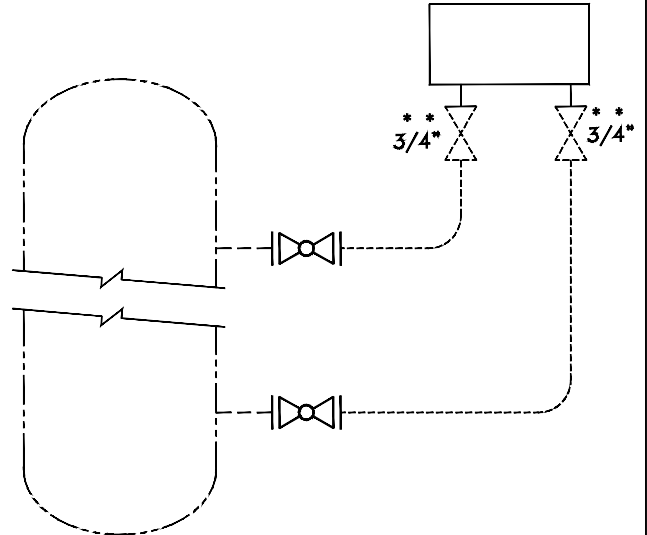
GAIL-ENG-IN-DWG-TP-003

3 OF 3

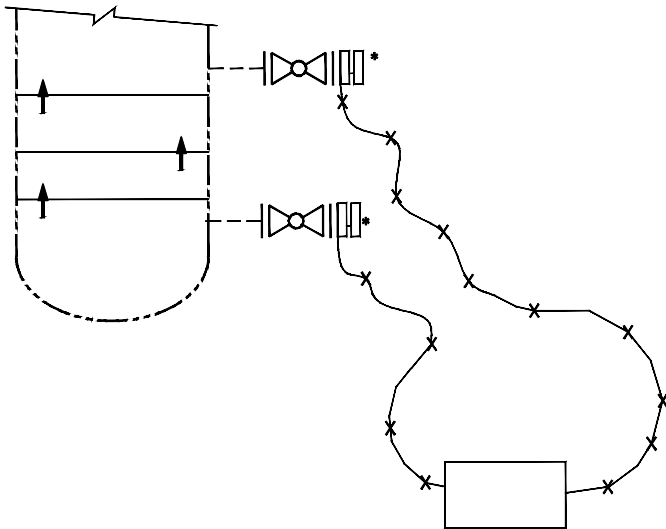
**(P-9) PRESSURE INSTRUMENT  
EXTENDED DIAPHRAGM SEAL ON  
VESSEL**



**(P-10) DIFFERENTIAL PRESSURE  
INSTRUMENT  
ACROSS COLUMN**



**(P-11) DIAPHRAGM SEAL  
DP INSTRUMENT ON EQUIPMENT**



**NOTES:**

\*STUD LENGTH = STANDARD LENGTH + 3" STUD & NUTS BY INSTRUMENT GROUP

\*\* PROVIDE AT THE PLATFORM ABOVE THE UPPER TAP-OFF POINT.

1. REFER STANDARD NO. SD-IC-001.

FOR SIZE AND CONNECTION TYPE OF ISOLATION VALVE.

————— INSTRUMENT GROUP  
 - - - - - PIPING GROUP  
 - - - - - VESSEL GROUP

0	15.01.19	ISSUED FOR TENDER	D.V		U.N		S.B	
REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED			



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NEW DELHI

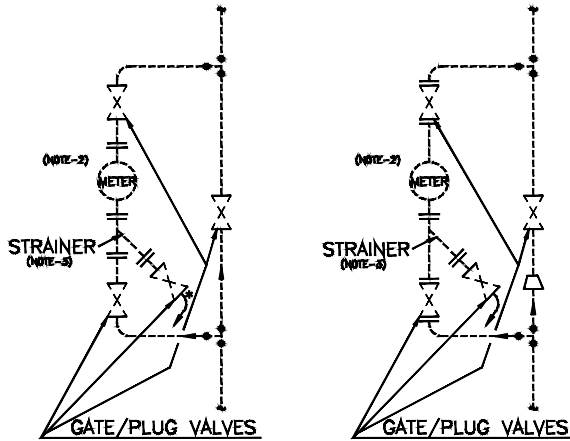
FLOW METER  
INSTALLATION  
SCOPE OF WORK

DRAWING NO.

GAIL-ENG-IN-DWG-TP-004

1 OF 8

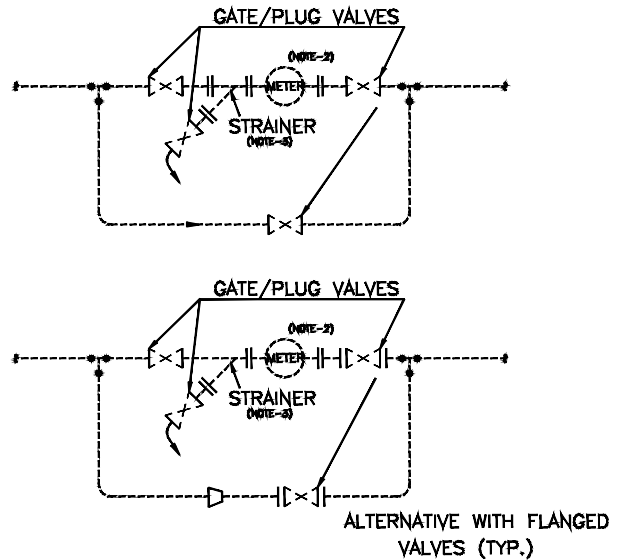
POSITIVE DISPLACEMENT METER IN  
VERTICAL LINE



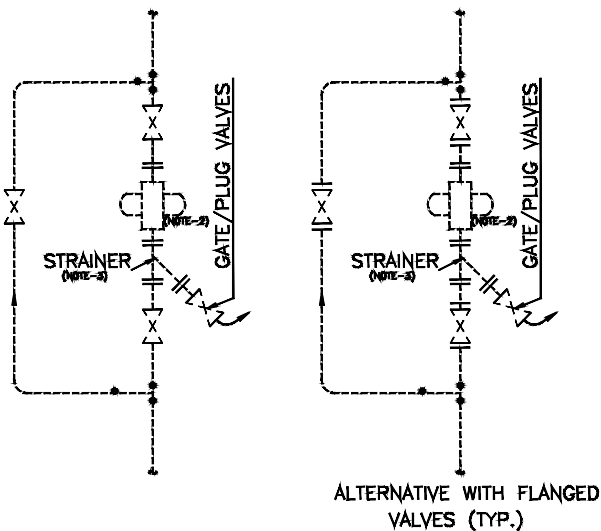
\* DRAIN (TYP.)

ALTERNATIVE WITH FLANGED  
VALVES (TYP.)

POSITIVE DISPLACEMENT METER IN  
HORIZONTAL LINE

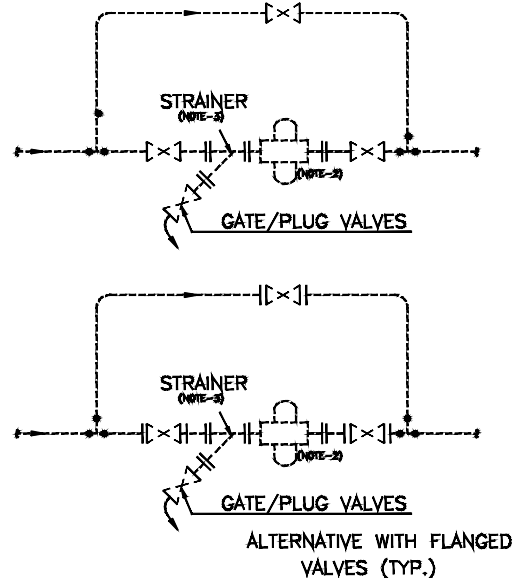


MASS FLOW METER IN VERTICAL LINE



ALTERNATIVE WITH FLANGED  
VALVES (TYP.)

MASS FLOW METER IN HORIZONTAL LINE



ALTERNATIVE WITH FLANGED  
VALVES (TYP.)

**NOTES:**

1. ENTIRE INSTALLATION SHOWN IS BY PIPING / MECHANICAL CONTRACTOR, P & ID SHALL BE REFERRED FOR FINAL SCHEME.
2. PROCUREMENT BY INSTRUMENT GROUP.
3. PROCUREMENT BY PIPING / INSTRUMENT GROUP AS PER P&ID.
4. PROCUREMENT OF OTHER ITEMS NOT COVERED IN NOTE-2 & NOTE-3 BY PIPING.

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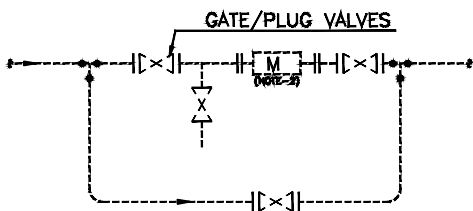
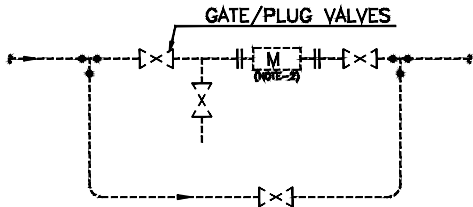
FLOW METER  
INSTALLATION  
SCOPE OF WORK

DRAWING NO.

GAIL-ENG-IN-DWG-TP-004

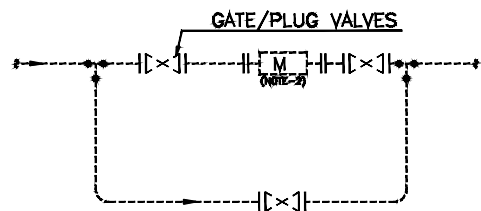
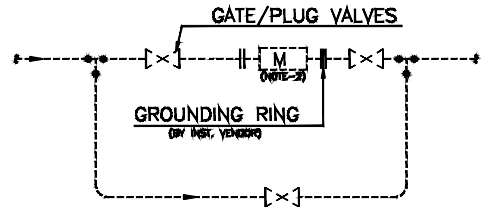
2 OF 8

MAGNETIC FLOW METER  
(UNLINED PIPE)



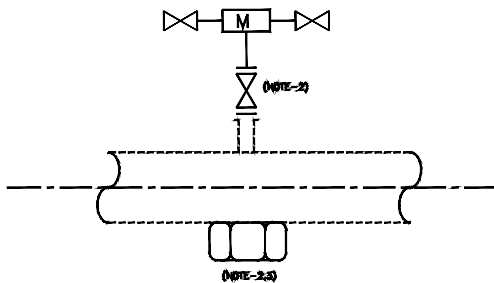
ALTERNATIVE WITH FLANGED  
VALVES (TYP.)

MAGNETIC FLOW METER (LINED PIPE)

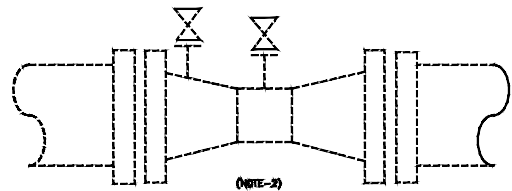


ALTERNATIVE WITH FLANGED  
VALVES (TYP.)

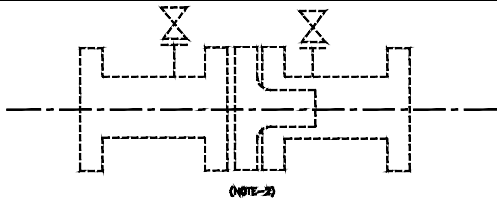
AVERAGING PITOT TUBE



VENTURI TUBE



FLOW NOZZLE



**NOTES:**

1. ENTIRE INSTALLATION SHOWN IS BY PIPING / MECHANICAL CONTRACTOR, P & ID SHALL BE REFERRED FOR FINAL SCHEME.
2. PROCUREMENT BY INSTRUMENT GROUP.
3. PROCUREMENT BY PIPING / INSTRUMENT GROUP AS PER P&ID.
4. PROCUREMENT OF OTHER ITEMS NOT COVERED IN NOTE-2 & NOTE-3 BY PIPING.

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FLOW METER  
INSTALLATION  
SCOPE OF WORK

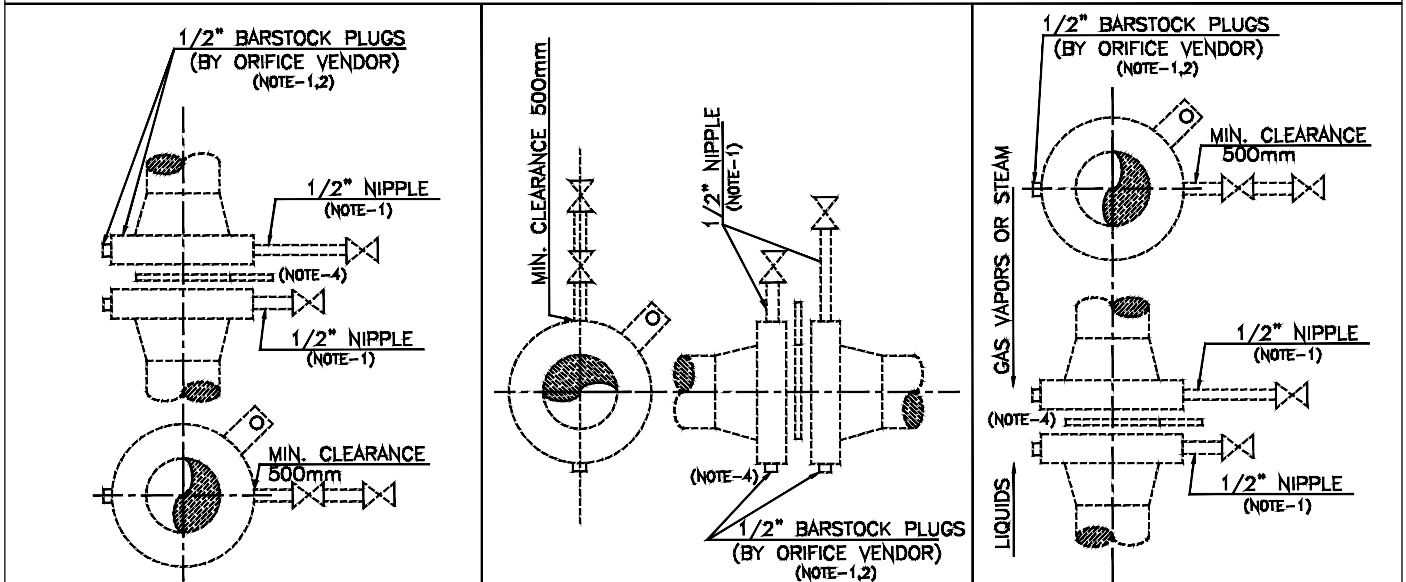
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GAIL-ENG-IN-DWG-TP-004

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ORIFICE FLANGE ASSEMBLIES – SINGLE TAPPING

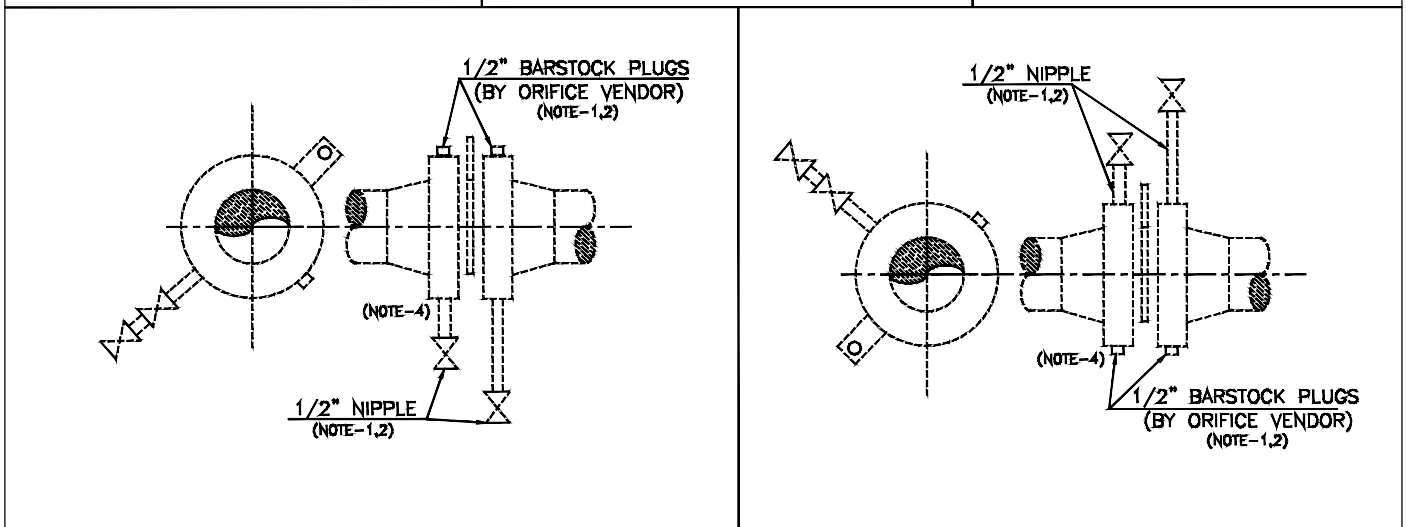
( FOR RATING UPTO ASME CLASS 600 )



HORIZONTAL METER RUN  
WHEREVER REQUIRED

GAS, HORIZONTAL METER RUN

ANY FLUID, VERTICAL METER RUN



LIQUID LINES ON PIPE RACK

STEAM / GAS LINES ON PIPE RACK

**NOTES:**

1. SEAL WELDING BY PIPING GROUP.
2. ORIFICE VENDOR SHALL PROVIDE 1/2" BAR STOCK PLUG FOR SPARE TAPPING.
3. ENTIRE INSTALLATION SHOWN IS BY PIPING / MECHANICAL CONTRACTOR.
4. PROCUREMENT BY INSTRUMENT GROUP
5. PROCUREMENT OF OTHER ITEMS NOT COVERED IN NOTE-2 & NOTE-4 BY PIPING.
6. IN CASE OF PRE-FABRICATED HOOKUP, NIPPLE & ISOLATION VALVE SHALL BE SUPPLIED BY PREFAB VENDOR.

0	15.01.19	ISSUED FOR TENDER	D.V	U.N	S.B
REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED

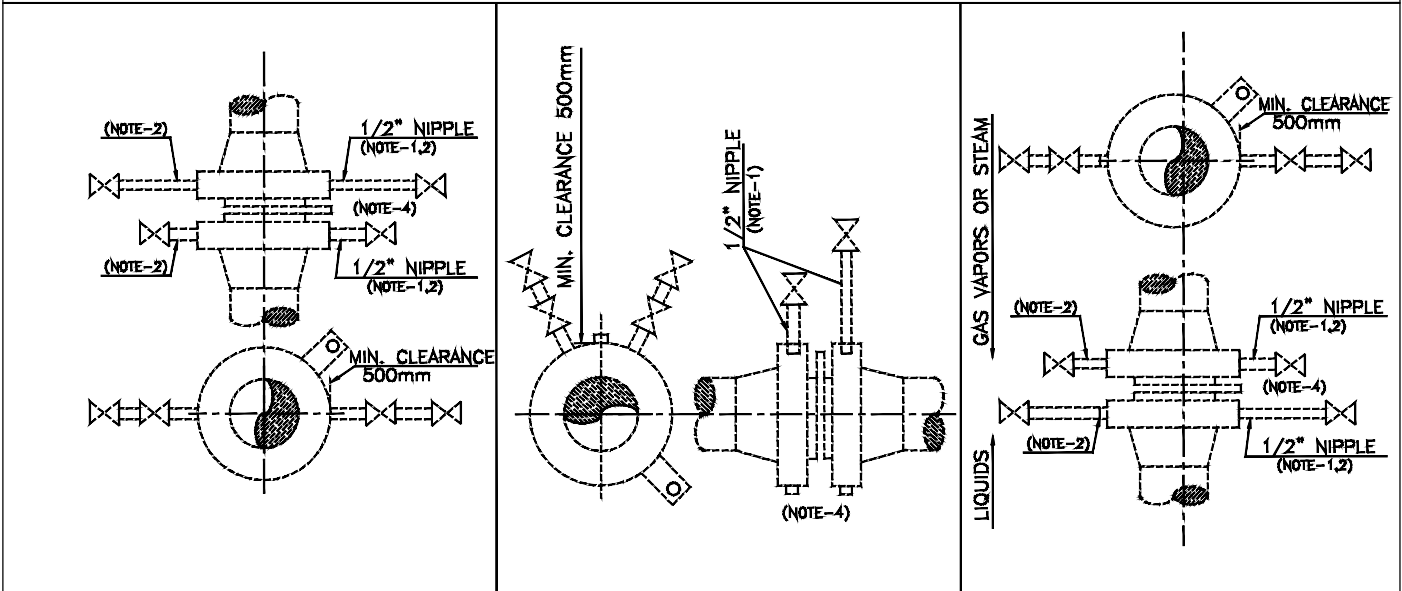


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FLOW METER  
INSTALLATION  
SCOPE OF WORK

DRAWING NO.  
GAIL-ENG-IN-DWG-TP-004  
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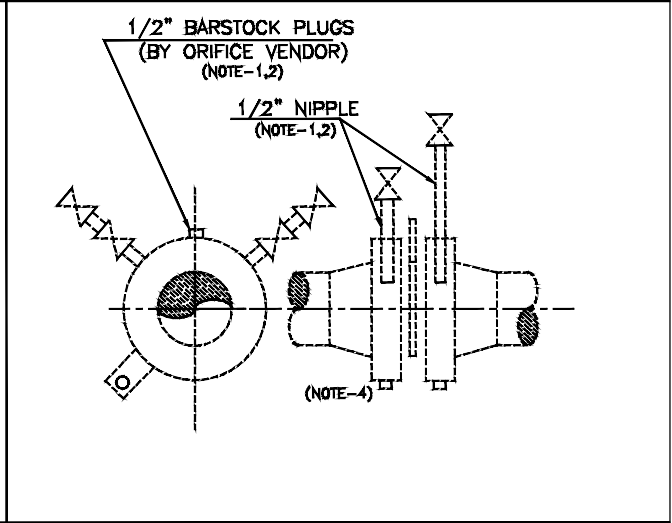
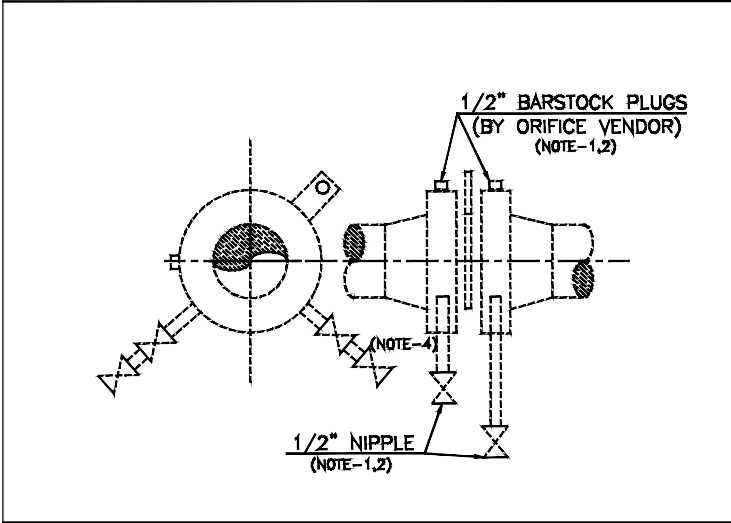
ORIFICE FLANGE ASSEMBLIES – TWO TAPPINGS  
( FOR RATING UPTO ASME CLASS 600 )



HORIZONTAL METER RUN  
WHEREVER REQUIRED

GAS, HORIZONTAL METER RUN

ANY FLUID, VERTICAL METER RUN



LIQUID LINES ON PIPE RACK

STEAM / GAS LINES ON PIPE RACK

**NOTES:**

1. SEAL WELDING BY PIPING GROUP.
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REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED

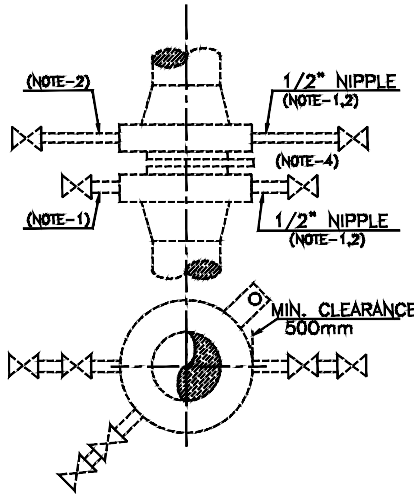


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NEW DELHI

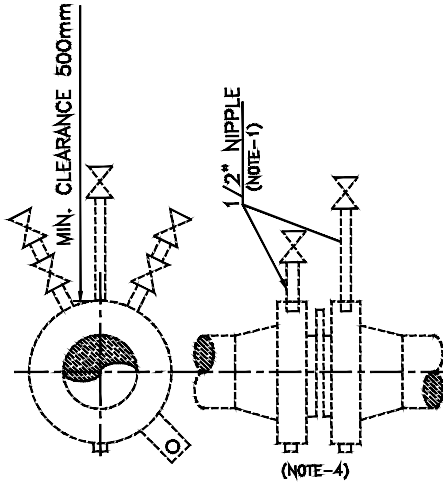
FLOW METER  
INSTALLATION  
SCOPE OF WORK

DRAWING NO.  
GAIL-ENG-IN-DWG-TP-004  
5 OF 8

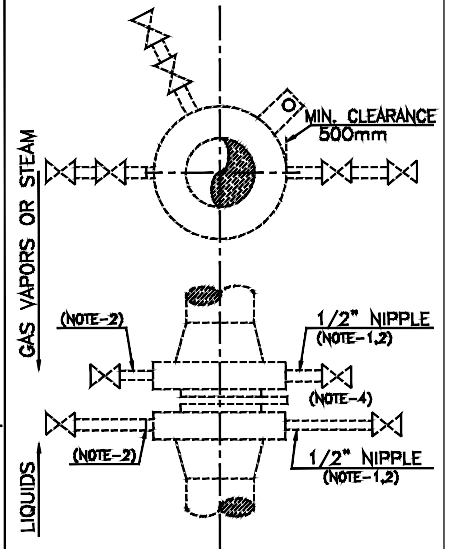
ORIFICE FLANGE ASSEMBLIES – THREE TAPPINGS  
( FOR RATING UPTO ASME CLASS 600 )



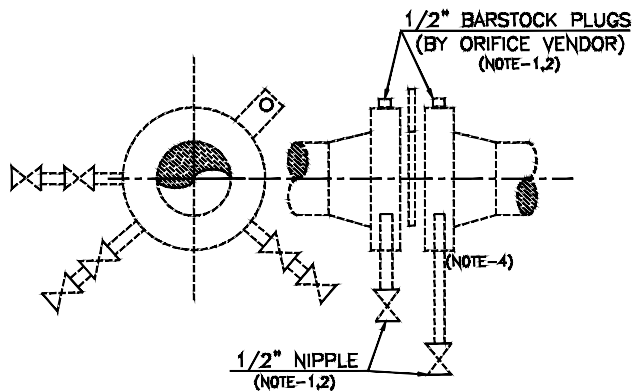
HORIZONTAL METER RUN  
WHEREVER REQUIRED



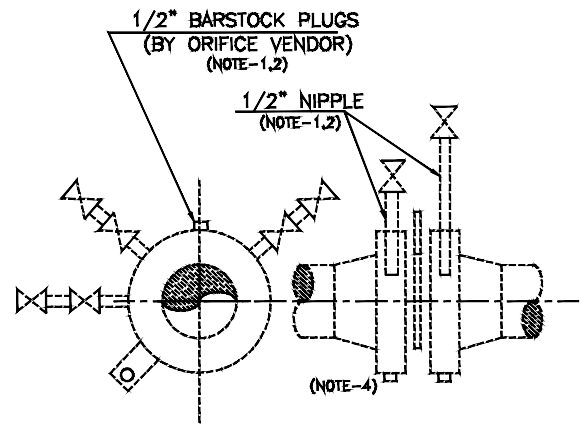
GAS, HORIZONTAL METER RUN



ANY FLUID, VERTICAL METER RUN



LIQUID LINES ON PIPE RACK



STEAM / GAS LINES ON PIPE RACK

**NOTES:**

1. SEAL WELDING BY PIPING GROUP.
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REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED



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NEW DELHI

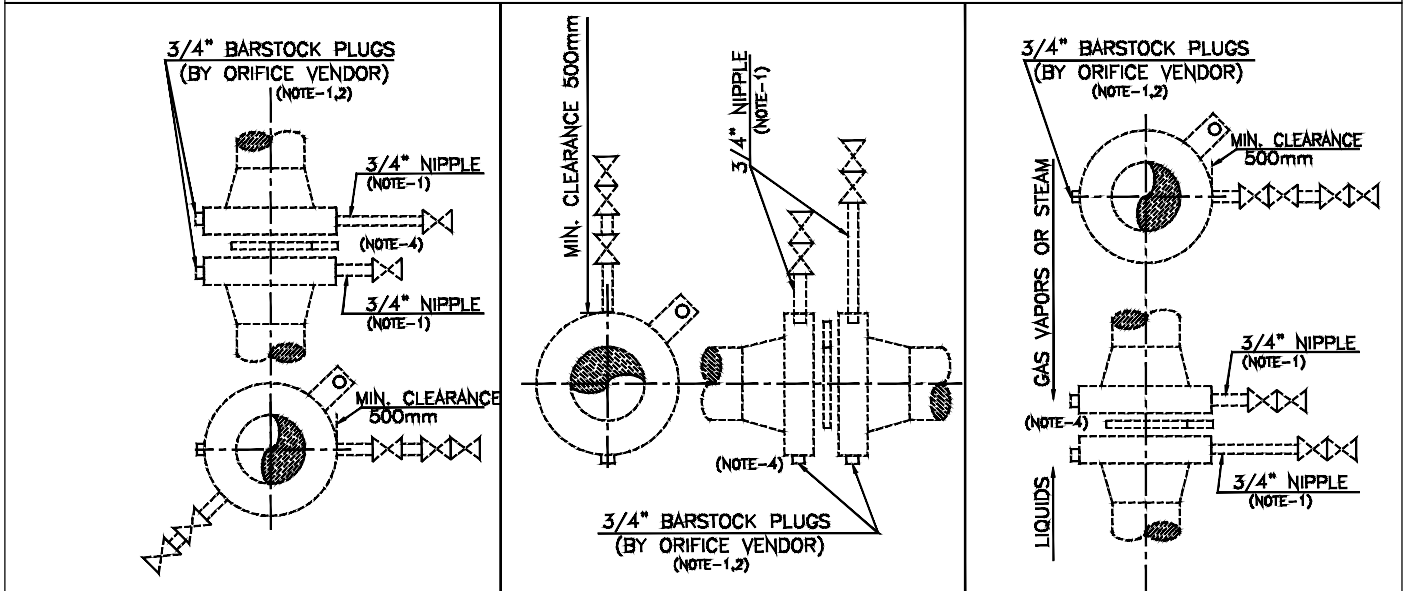
FLOW METER  
INSTALLATION  
SCOPE OF WORK

DRAWING NO.

GAIL-ENG-IN-DWG-TP-004

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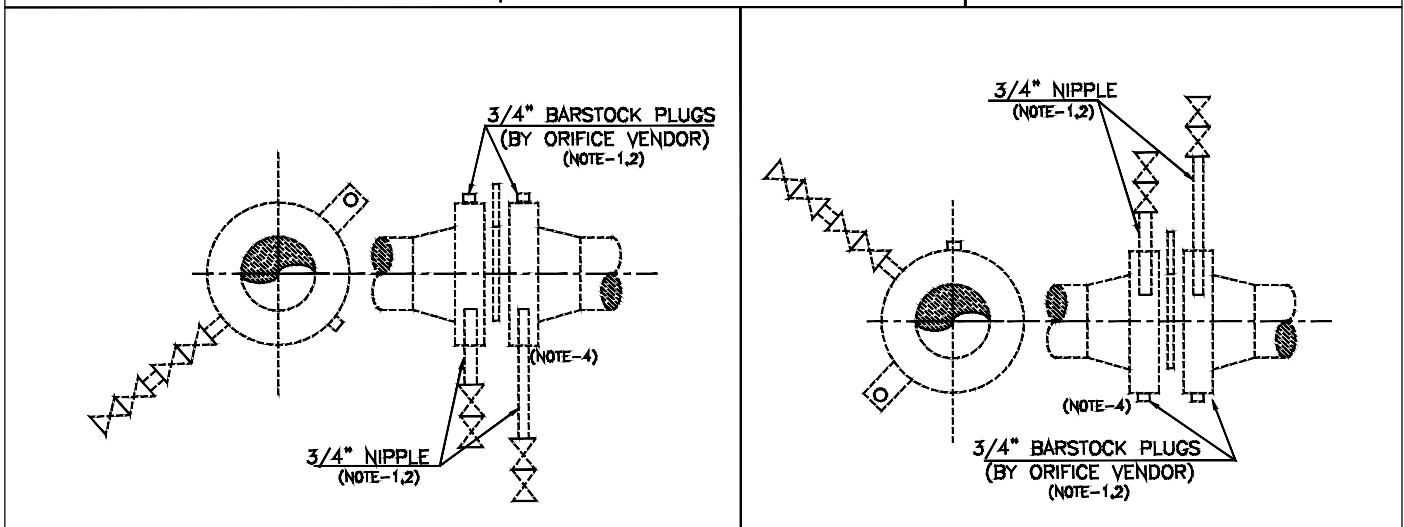
ORIFICE FLANGE ASSEMBLIES – SINGLE TAPPING  
(FOR RATING ABOVE ASME CLASS 600)



HORIZONTAL METER RUN  
WHEREVER REQUIRED

GAS, HORIZONTAL METER RUN

ANY FLUID, VERTICAL METER RUN



LIQUID LINES ON PIPE RACK

STEAM / GAS LINES ON PIPE RACK

**NOTES:**

1. SEAL WELDING BY PIPING GROUP.
2. ORIFICE VENDOR SHALL PROVIDE 1/2" BAR STOCK PLUG FOR SPARE TAPPING.
3. ENTIRE INSTALLATION SHOWN IS BY PIPING / MECHANICAL CONTRACTOR.
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5. PROCUREMENT OF OTHER ITEMS NOT COVERED IN NOTE-2 & NOTE-4 BY PIPING.
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0	15.01.19	ISSUED FOR TENDER	D.V	U.N	S.B
REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED

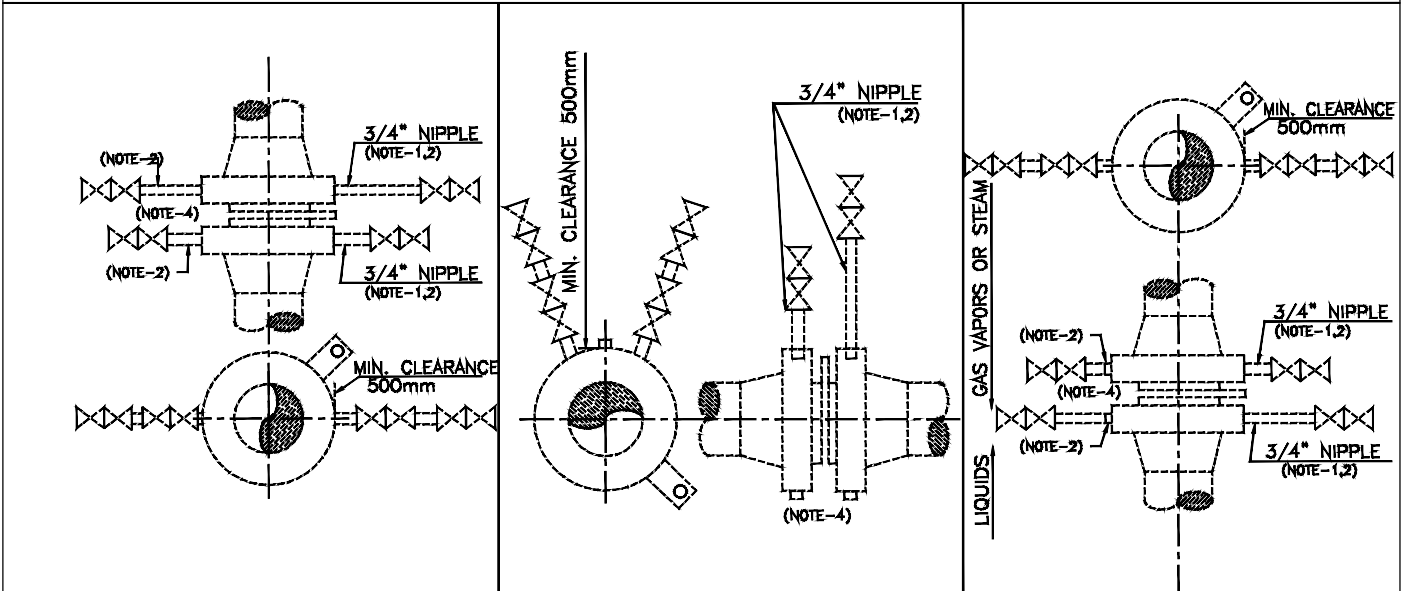


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FLOW METER  
INSTALLATION  
SCOPE OF WORK

DRAWING NO.  
GAIL-ENG-IN-DWG-TP-004  
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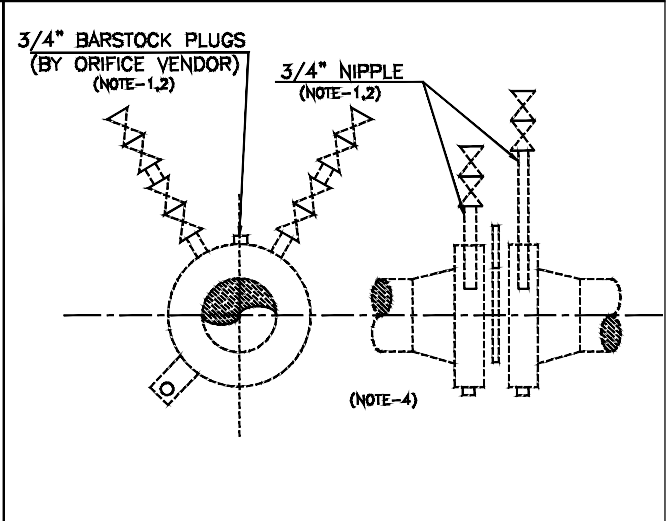
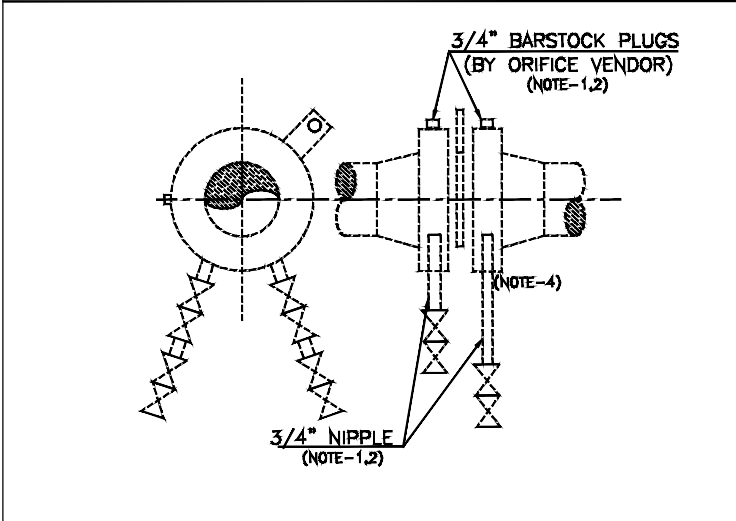
ORIFICE FLANGE ASSEMBLIES – TWO TAPPINGS  
(FOR RATING ABOVE ASME CLASS 600)



HORIZONTAL METER RUN  
WHEREVER REQUIRED

GAS, HORIZONTAL METER RUN

ANY FLUID, VERTICAL METER RUN



LIQUID LINES ON PIPE RACK

ANY FLUID, VERTICAL METER RUN

**NOTES:**

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0	15.01.19	ISSUED FOR TENDER	D.V	U.N	S.B
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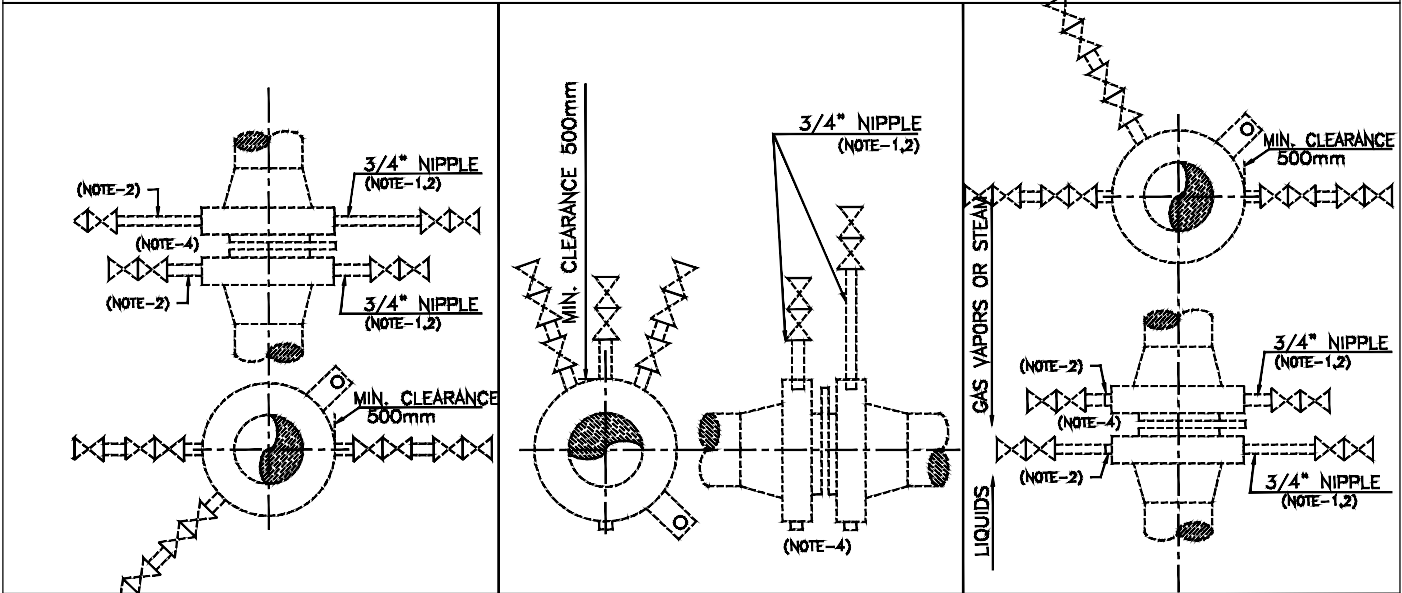


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FLOW METER  
INSTALLATION  
SCOPE OF WORK

DRAWING NO.  
GAIL-ENG-IN-DWG-TP-004  
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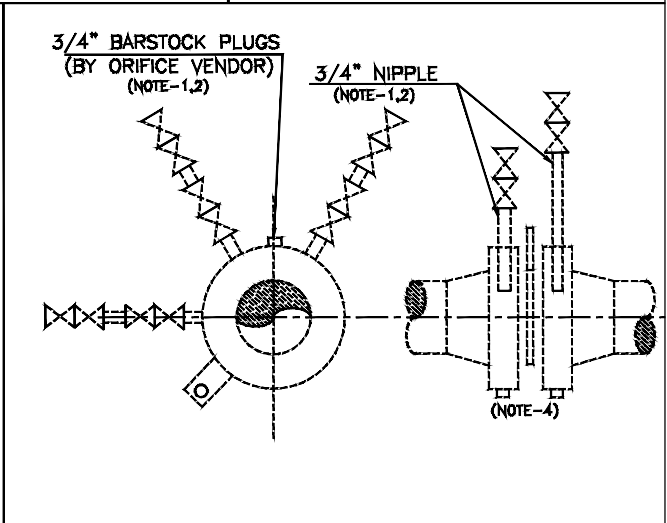
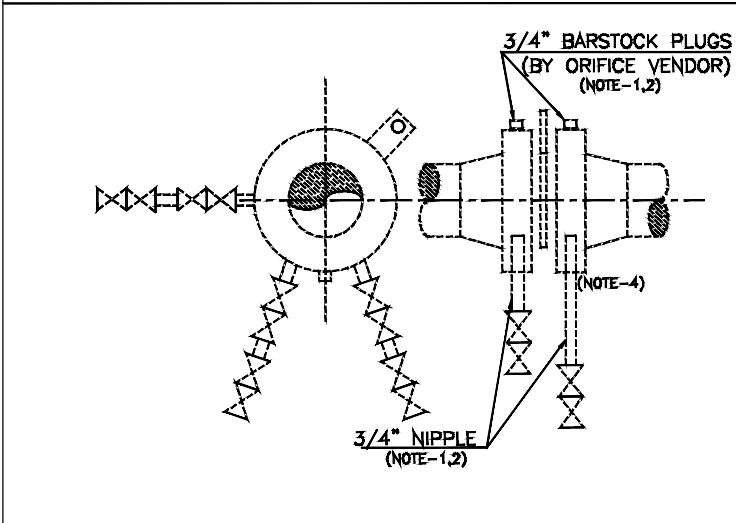
ORIFICE FLANGE ASSEMBLIES – THREE TAPPINGS  
(FOR RATING ABOVE ASME CLASS 600)



HORIZONTAL METER RUN  
WHEREVER REQUIRED

GAS, HORIZONTAL METER RUN

ANY FLUID, VERTICAL METER RUN



LIQUID LINES ON PIPE RACK

ANY FLUID, VERTICAL METER RUN

**NOTES:**

1. SEAL WELDING BY PIPING GROUP.
2. ORIFICE VENDOR SHALL PROVIDE 1/2" BAR STOCK PLUG FOR SPARE TAPPING.
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0	15.01.19	ISSUED FOR TENDER	D.V	U.N	S.B
REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED



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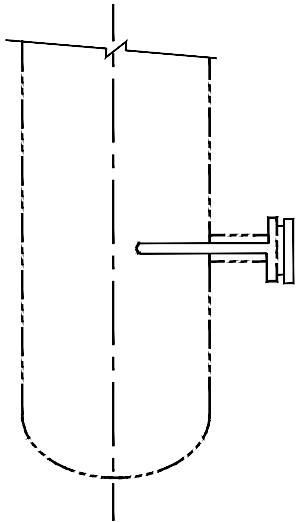
**THERMOWELL  
INSTALLATION  
SCOPE OF WORK**

DRAWING NO.

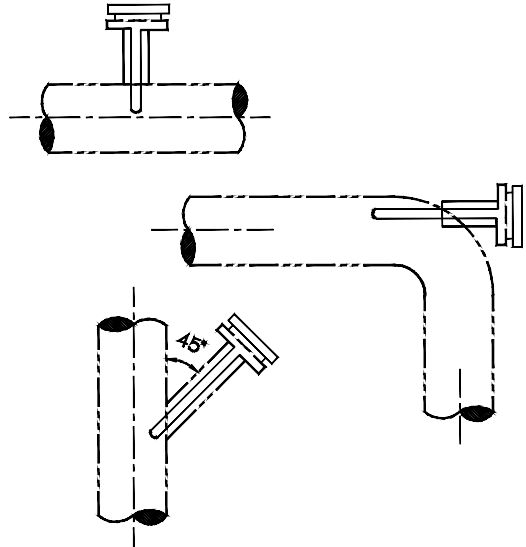
GAIL-ENG-IN-DWG-TP-005

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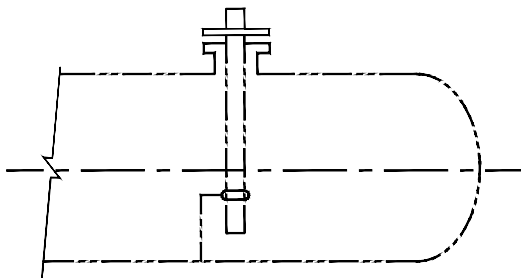
**(T-1) THERMOWELL ON VESSEL**



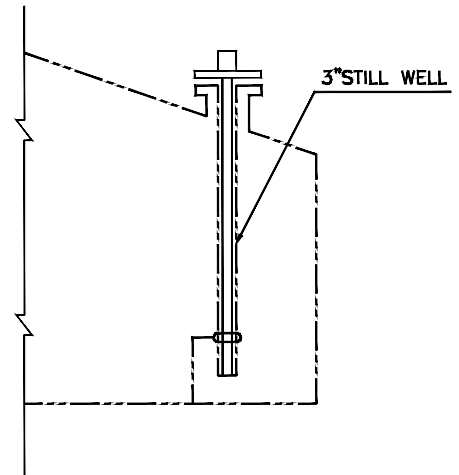
**(T-2) THERMOWELL ON PIPE**



**(T-3) THERMOWELL ON BURRIED VESSEL**



**(T-4) THERMOWELL ON STORAGE TANK**



**NOTES:**

1. REFER STANDARD NO. 7-52-0001 & 7-52-0002 FOR CONNECTION SIZE.

\_\_\_\_\_ INSTRUMENT GROUP  
 - - - - - PIPING GROUP  
 - - - - - VESSEL GROUP

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**INSTRUMENT CONNECTION ON VESSEL,  
STANDPIPES AND TANKS**

DRAWING NO.

GAIL-ENG-IN-DWG-TP-006

1 OF 1

S.NO.	TYPE OF INSTRUMENTS	HEATER/DUCT/LINE CONNECTION	FIRST BLOCK VALVE	INSTRUMENT CONNECTION
1.	FLOW ELEMENT - AVG. PITOT TUBE (F1)	3" FLANGED	-	3" FLANGED (NOTE-4)
2.	FLOW ELEMENT - VENTURI TUBE (F2)	1/2" FLANGED	1/2" FLANGED	1/2" NPT (F)
3.	FLOW ELEMENT - THERMAL MASS (F3)	1 1/2" FLANGED	-	1 1/2" FLANGED
4.	PRESSURE INSTRUMENT (P1)	1 1/2" FLANGED	1 1/2" FLANGED	1/2" NPT (F)
5.	PRESSURE INSTRUMENT (COIL) (P2/P4)	1 1/2" FLANGED	1 1/2" FLANGED	1/2" NPT (F)
6.	DRAFT GAUGE (P3)	1 1/2" FLANGED	-	1/2" NPT (F)
7.	TEMPERATURE INSTRUMENT (T1)	1 1/2" FLANGED	-	1 1/2" FLANGED
8.	TEMPERATURE INSTRUMENT (COIL) (T2)	1 1/2" FLANGED	-	1 1/2" FLANGED
9.	SKIN THERMOCOUPLE (T3)	1" PIPE	-	-
10.	FLUE GAS ANALYSER (SO <sub>x</sub> , NO <sub>x</sub> , O <sub>2</sub> , HC,CO) (A1/A2/A4)	4" FLANGED	-	4" FLANGED
11.	FLUE GAS ANALYSER (SPM) (A3)	6" FLANGED	-	6" FLANGED

**NOTES:**

1. PRESSURE RATING OF FLANGE CONNECTION SHALL BE 150# FOR INSTRUMENTS MOUNTED DIRECTLY ON HEATER EXCEPT TEMPERATURE INSTRUMENTS FOR WHICH FLANGE RATING SHALL BE 300#.
2. PRESSURE RATING OF FLANGE CONNECTION ON TUBE SIDE SHALL BE AS PER PIPING CLASS.
3. FOR IDENTIFICATION (F1), (P1) ETC. REFER TO STANDARDS SD-IC-001, SD-IC-002, SD-IC-013, SD-IC-014.
3. TRANSMITTER CONNECTION SHALL BE 1/2" NPT(F).

0	15.01.19	ISSUED FOR TENDER	D.V	U.N	S.B
REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED



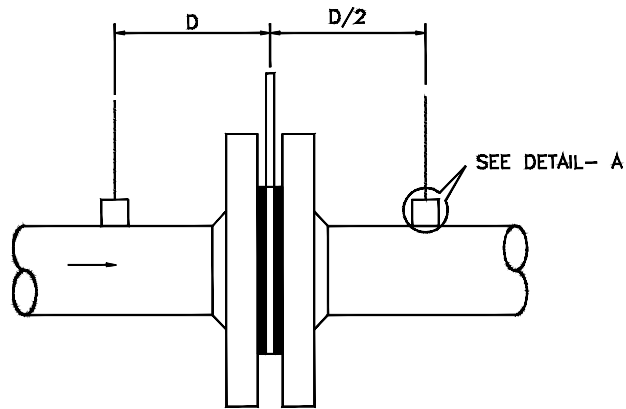
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NEW DELHI

METER RUNS-PIPING  
CONNECTIONS  
D - D/2 TAPS

DRAWING NO.

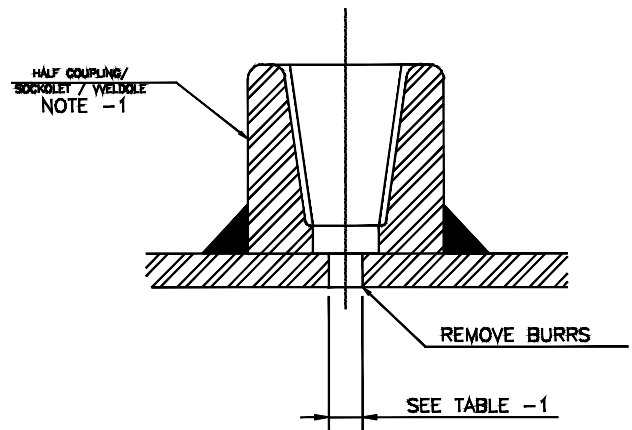
GAIL-ENG-IN-DWG-TP-007

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D-D/2 TAPS

TABLE -1	
NOMINAL PIPE DIAMETER & RATING	MAX. DIAMETER PRESSURE TAPS
400mm (16") & ABOVE 150# / 300#	13mm DRILL
500mm (20") & ABOVE 600#	13mm DRILL
350mm (14") & ABOVE 900#	13mm DRILL
600mm (24") & ABOVE 1500# & ABOVE	13mm DRILL



**LEGEND :-**

D = PIPE I. D (INTERNAL DIAMETER)

**NOTES:**

- WELD 15mm (1/2") HALF COUPLING / SOCKOLET / WELDOLET TO LINE, IN ACCORDANCE WITH THE APPLICABLE PIPING SPECIFICATION, FOR RATING UPTO 600# AND 20mm (3/4") SOCKOLET / WELDOLET TO LINE, IN ACCORDANCE WITH THE APPLICABLE PIPING SPECIFICATIONS, FOR RATING ABOVE ASME CLASS 600.
- DIMENSIONS, ARE FROM FACE OF PLATE TO CENTER LINE OF TAP DRILLED HOLE, AND SHALL INCLUDE THE THICKNESS OF THE GASKET.

0	15.01.19	ISSUED FOR TENDER	D.V	U.N	S.B
REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED



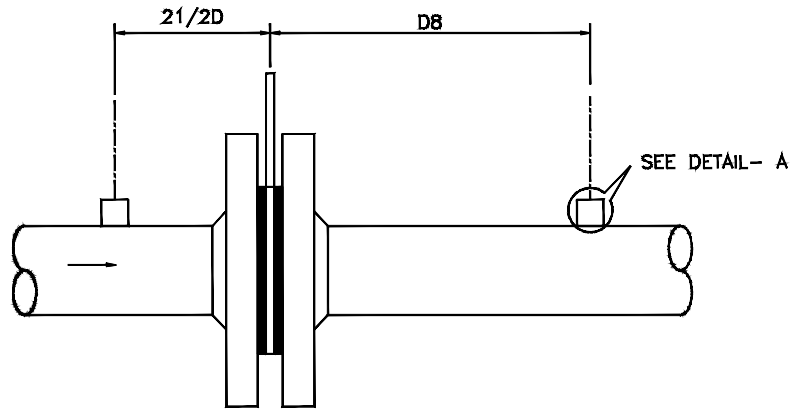
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METER RUNS-PIPING  
CONNECTIONS  
PIPE (2 1/2 D - 8 D) TAPS

DRAWING NO.

GAIL-ENG-IN-DWG-TP-008

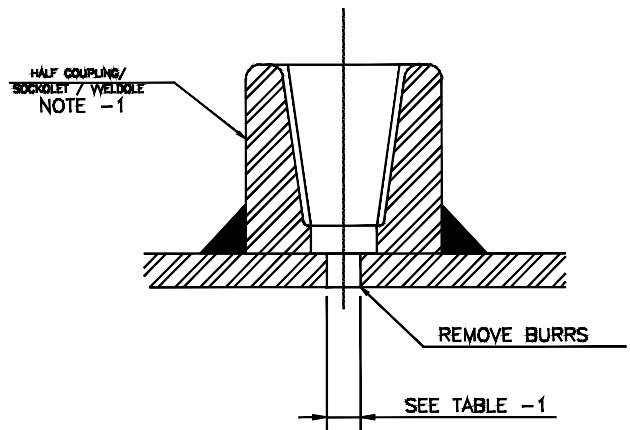
1 OF 1



PIPE TAPS

TABLE -1

NOMINAL PIPE DIAMETER	MAX. DIAMETER PRESSURE TAPS
50mm (2")	6mm DRILL
80mm (3")	10mm DRILL
100mm (4") AND ABOVE	13mm DRILL



LEGEND :-

D = PIPE I. D (INTERNAL DIAMETER)

NOTES:

- WELD 15mm (1/2") HALF COUPLING / SOCKOLET / WELDOLET TO LINE, IN ACCORDANCE WITH THE APPLICABLE PIPING SPECIFICATION, FOR RATING UPTO 600# AND 20mm (3/4") SOCKOLET / WELDOLET TO LINE, IN ACCORDANCE WITH THE APPLICABLE PIPING SPECIFICATIONS, FOR RATING ABOVE ASME CLASS 600.
- DIMENSIONS, ARE FROM FACE OF PLATE TO CENTER LINE OF TAP DRILLED HOLE, AND SHALL INCLUDE THE THICKNESS OF THE GASKET.

0	15.01.19	ISSUED FOR TENDER	D.V	U.N	S.B
REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED



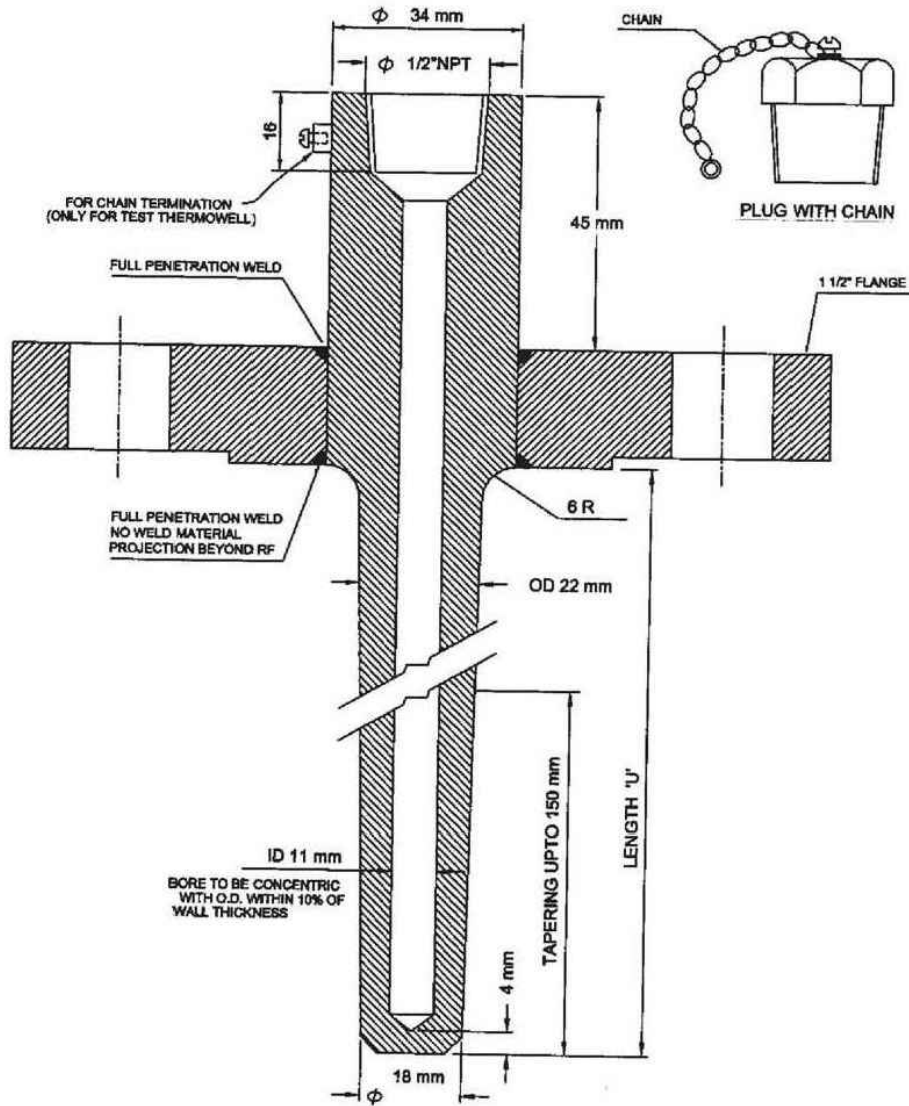
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### THERMOWELL

DRAWING NO.

GAIL-ENG-IN-DWG-TP-009

1 OF 3



**NOTES:**

1. THIS STANDARD IS APPLICABLE FOR ;
  - a).TEMPERATURE GAUGES, BEADED TEMPERATURE ELEMENTS AND DUPLEX TEMPERATURE ELEMENTS.
  - b).THERMOWELL UPTO 1500 CLASS AS PER ASME OR EQUIVALENT.
2. TYPE OF FLANGE SHALL BE RTJ FOR RATING (AS PER ASME CLASS) > 600.
3. DP TEST SHALL BE CARRIED OUT FOR ALL WELD JOINTS.
4. CHAIN AND PLUG SHALL BE APPLICABLE ONLY FOR TEST THERMOWELLS.

0	15.01.19	ISSUED FOR TENDER	D.V	U.N	S.B		
REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED		



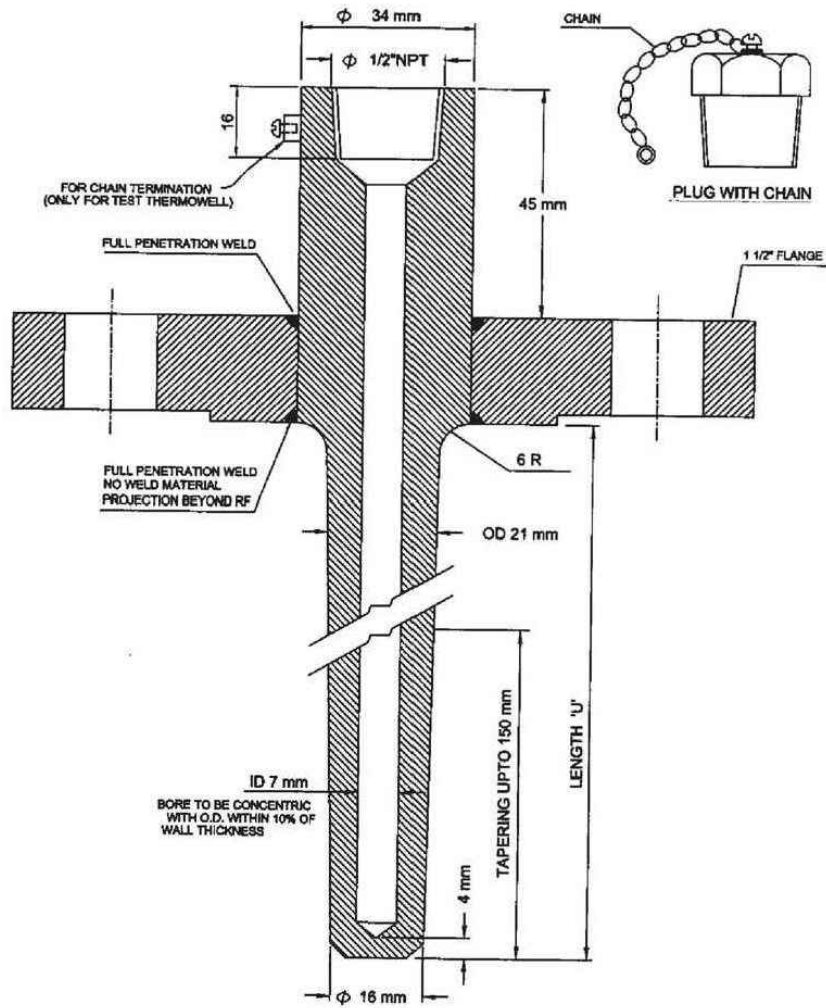
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# THERMOWELL

DRAWING NO.

GAIL-ENG-IN-DWG-TP-009

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**NOTES:**

1. THIS STANDARD IS APPLICABLE FOR ;
  - a).TEMPERATURE GAUGES, BEADED TEMPERATURE ELEMENTS AND DUPLEX TEMPERATURE ELEMENTS.
  - b).THERMOWELL UPTO 1500 CLASS AS PER ASME OR EQUIVALENT.
2. TYPE OF FLANGE SHALL BE RTJ FOR RATING (AS PER ASME CLASS) > 600.
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REV.NO.	DATE	SUBJECT OF REVISION	BY	CHECKED	APPROVED		



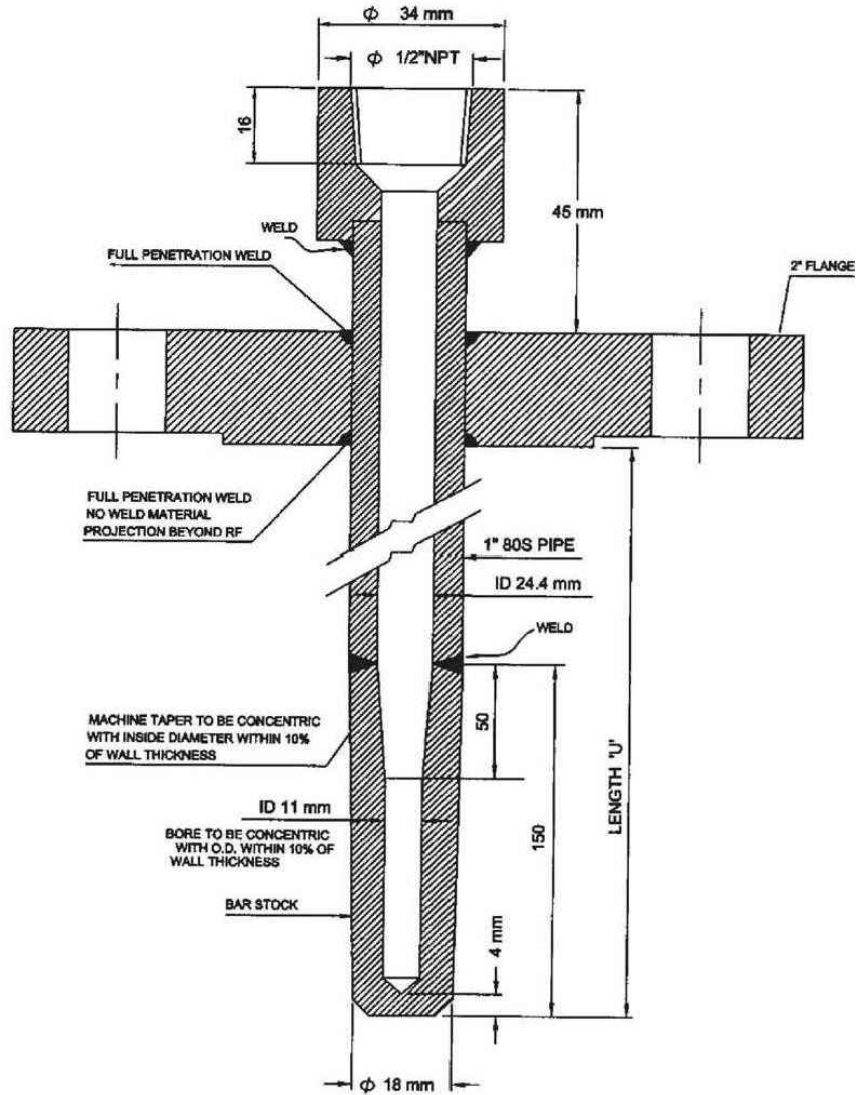
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BUILT-UP THERMOWELL

DRAWING NO.

GAIL-ENG-IN-DWG-TP-009

3 OF 3



**NOTES:**

1. CHAIN AND PLUG SHALL BE APPLICABLE ONLY FOR TEST THERMOWELLS.
2. TYPE OF FLANGE SHALL BE RTJ FOR RATING (AS PER ASME CLASS) > 600.

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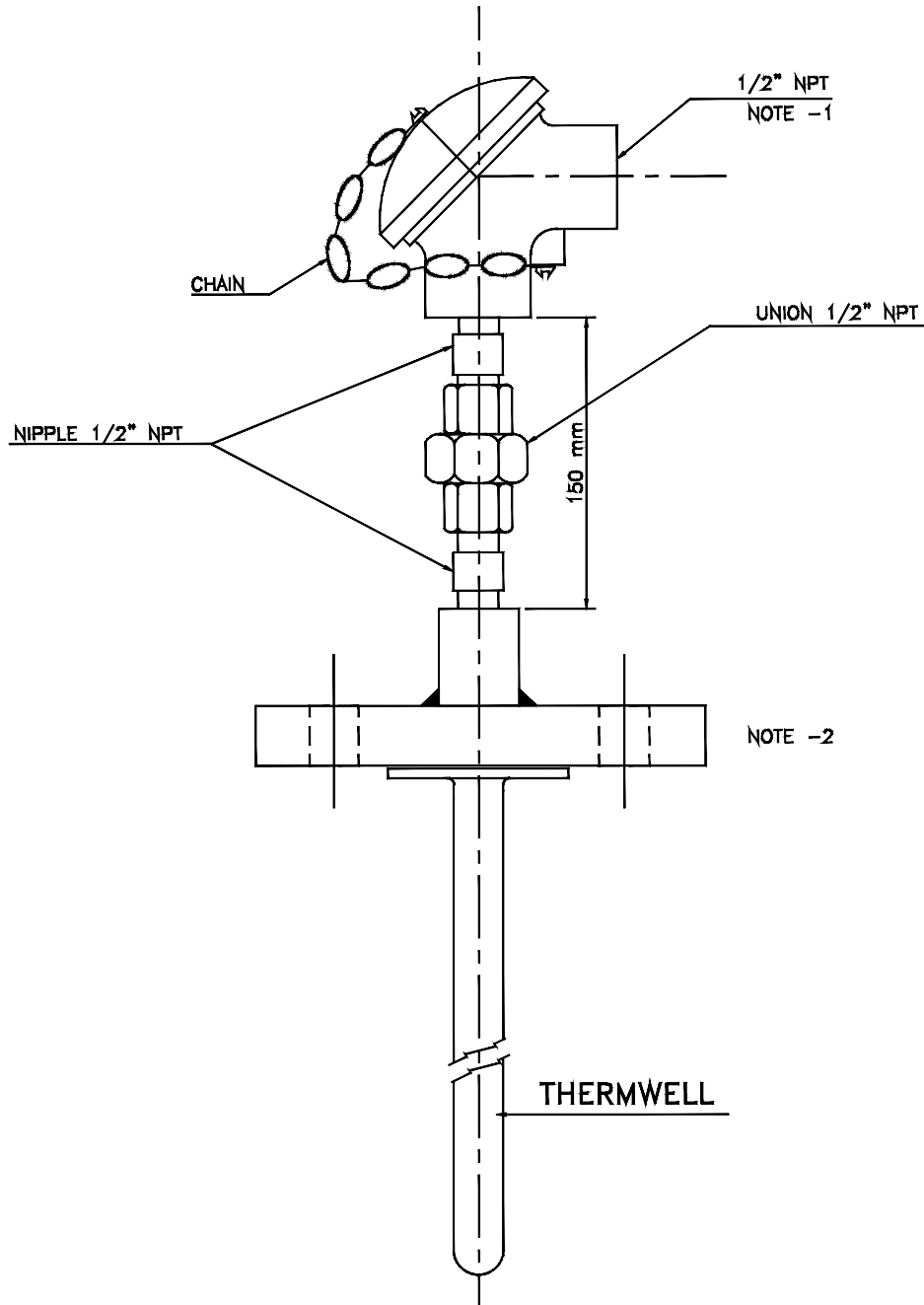
LYONS ENGINEERING PVT. LTD.  
NEW DELHI

**THERMOCOUPLE / RTD  
ASSEMBLY  
WITH THERMOWELL**

DRAWING NO.

GAIL-ENG-IN-DWG-TP-010

1 OF 1



**NOTES:**

1. IN THE CASE OF DUPLEX THERMOCOUPLE/RTD, TWO INDEPENDENT CABLE ENTRIES SHALL BE PROVIDED.
2. FLANGE TYPE, SIZE AND RATING SHALL BE AS PER DATA SHEET.

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## SYMBOL FOR INSTRUMENT LOCATION DRAWINGS

DRAWING NO.

GAIL-ENG-IN-DWG-TP-011

1 OF 4

SYMBOL	DESCRIPTION	REMARKS
	TRANSMITTER (FLOW, PRESSURE, LEVEL AND TEMPERATURE)	
	LEVEL TRANSMITTER (DISPLACER / GUIDED WAVE RADAR)	
	ANALYSER TRANSMITTER (IN CABINET)	
	TRANSMITTER ( FILLED SYSTEM )	
	LOCAL INDICATOR (FI, LI, DPI)	
	LOCAL CONTROLLER	
	THERMOCOUPLE (SINGLE ELEMENT)	
	THERMOCOUPLE (DUPLEX ELEMENT)	
	THERMOCOUPLE (TRIPLEX ELEMENT)	
	RESISTANCE TEMPERATURE DETECTOR (SINGLE ELEMENT)	
	RESISTANCE TEMPERATURE DETECTOR (DUPLEX ELEMENT)	
	SWITCH	
	SWITCH (FILLED SYSTEM)	
	PUSH BUTTON (HAND SWITCH)	
	LEVEL GAUGE (TRANSPARENT TYPE)	

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## SYMBOL FOR INSTRUMENT LOCATION DRAWINGS

DRAWING NO.

GAIL-ENG-IN-DWG-TP-011

2 OF 4

SYMBOL	DESCRIPTION	REMARKS
	HYDROCARBON GAS DETECTOR	
	HYDROGEN SULPHIDE DETECTOR	
	HYDROGEN DETECTOR	
	BEACON (* APPLICATION LIKE LEL / H2S / H2 )	
	HOOTER	
	CCTV CAMERA	
	CONTROL VALVE (WITHOUT POSITIONER)	
	CONTROL VALVE (WITH SMART / FF POSITIONER)	
	CONTROL VALVE (WITH I/P CONVERTER)	
	SOLENOID VALVE (TWO WAY)	
	SOLENOID VALVE (THREE WAY)	
	SOLENOID VALVE (FOUR WAY)	
	CONTROL VALVE (WITH POS. / WITHOUT POS.)	[ WITH LIMIT SWITCH LOW AND HIGH ]

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## SYMBOL FOR INSTRUMENT LOCATION DRAWINGS

DRAWING NO.

GAIL-ENG-IN-DWG-TP-011

3 OF 4

SYMBOL	DESCRIPTION	REMARKS
	ORIFICE (ON HORIZONTAL LINE)	
	ORIFICE (ON VERTICAL LINE)	
	TRANSMITTER ( ROTAMETER )	
	TRANSMITTER (MAGNETIC FLOW METER)	
	VENTURI	
	AVERAGING PITOT TUBE	
	MASS FLOW METER	
	ULTRASONIC FLOW METER	
	FLOW NOZZLE	
	VORTEX FLOW METER	

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## SYMBOL FOR INSTRUMENT LOCATION DRAWINGS

DRAWING NO.

GAIL-ENG-IN-DWG-TP-011

4 OF 4

SYMBOL	DESCRIPTION	REMARKS
	POSITIVE DISPLACEMENT METER	
	TURBINE METER	
	ANALYSER TAPPING WITH ANALYSER IN SHELTER	
	NUMBERING OF AN INSTRUMENT ALONG WITH JB NO.	
	INSTRUMENT WITH DIRECT RUN OF CABLE TO CONTROL ROOM. (WITHOUT INTERMEDIATE JUNCTION BOX)	
	JUNCTION BOX	
	INSTRUMENT DUCT	
	INSTRUMENT PERFORATED TRAY	
	INSTRUMENT LADDER TRAY	
	INSTRUMENT AIR HEADER WITH AIR SUPPLY TAP-OFF NO.	
	INSTRUMENT AIR SUPPLY DISTRIBUTION WITH MANIFOLD	

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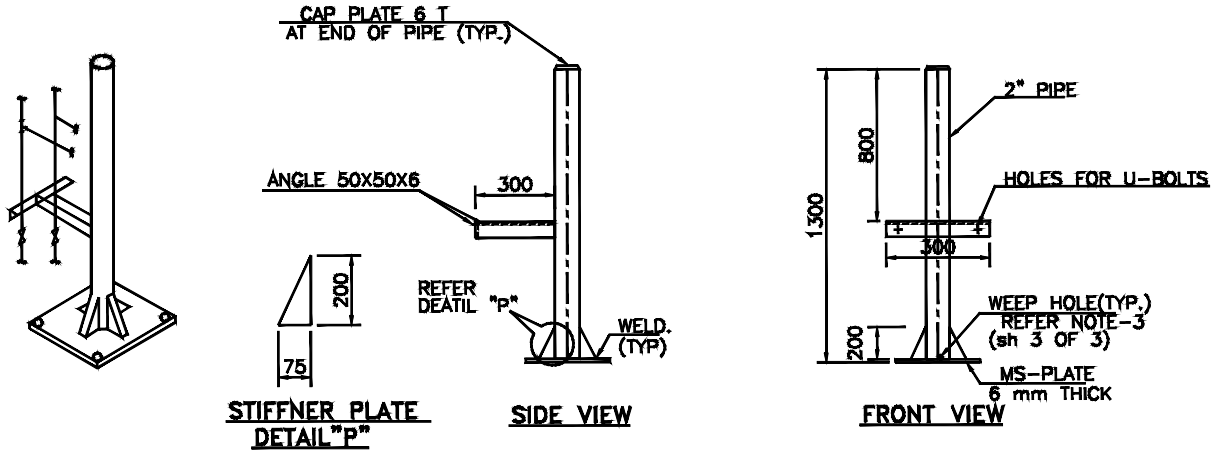
**INSTRUMENT SUPPORT  
SINGLE INSTRUMENT**

DRAWING NO.

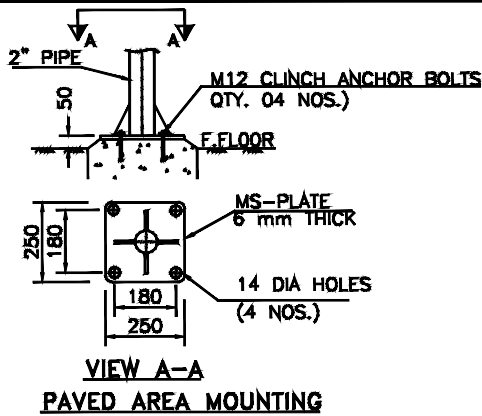
GAIL-ENG-IN-DWG-TP-012

1 OF 3

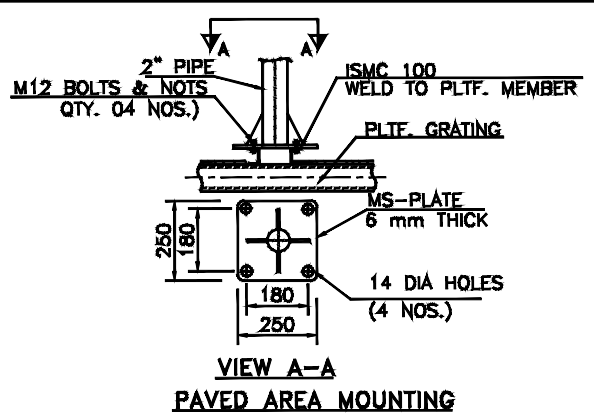
**TYPE 11 SINGLE INSTRUMENT SUPPORT - GENERAL ARRANGEMENT**



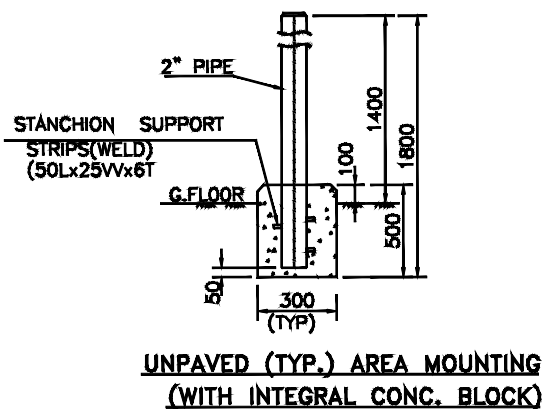
**TYPE 11-1**



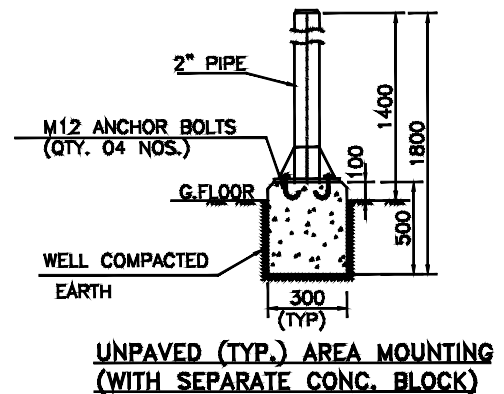
**TYPE 11-2**



**TYPE 11-3**



**TYPE 11-4**



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**INSTRUMENT SUPPORT  
SINGLE INSTRUMENT**

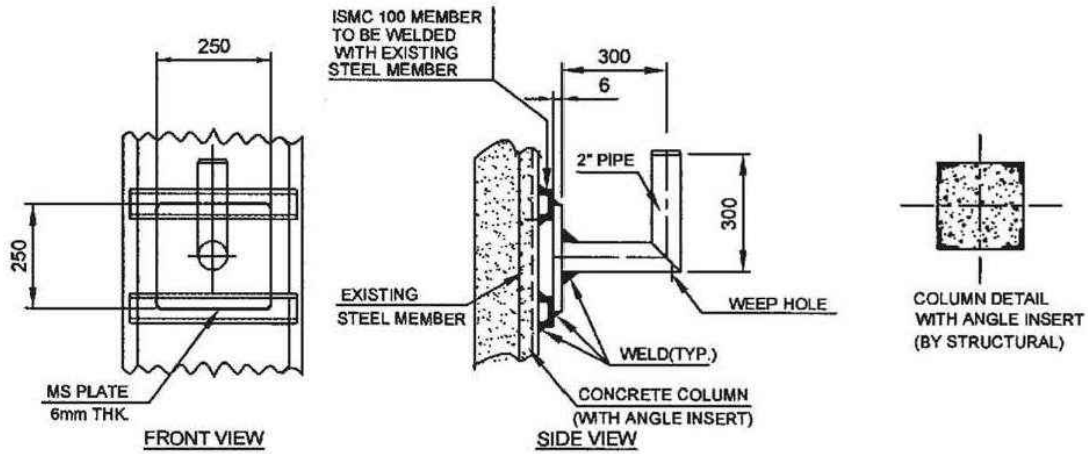
DRAWING NO.

GAIL-ENG-IN-DWG-TP-012

2 OF 3

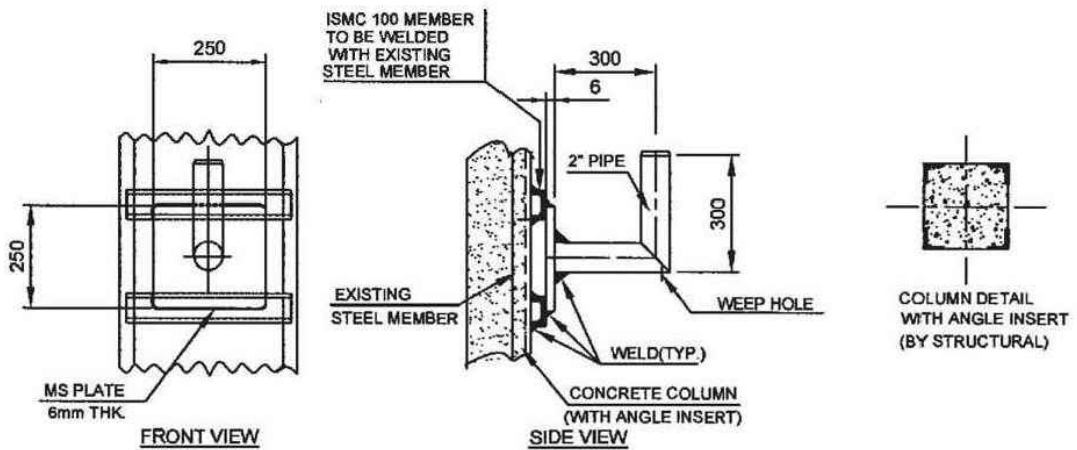
**TYPE 12**

**CONCRETE COLUMN MOUNTING**



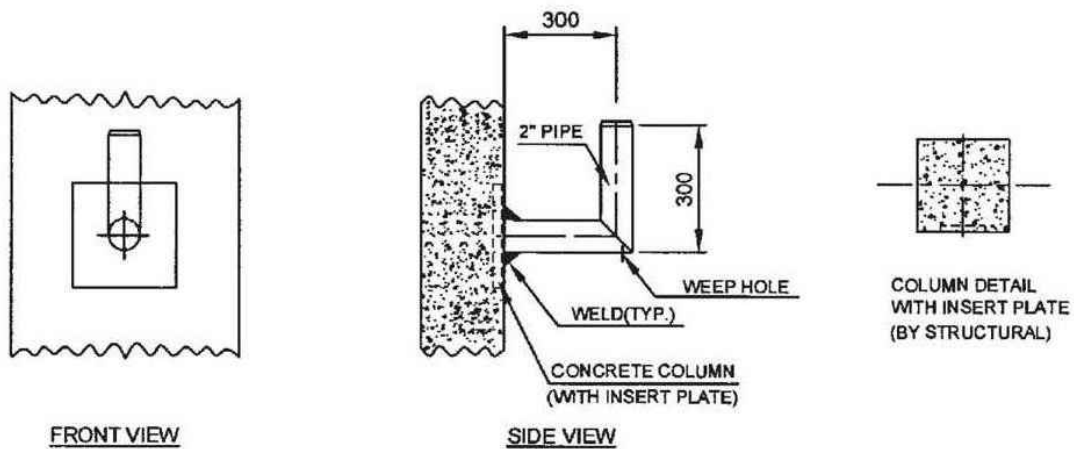
**TYPE 13**

**CONCRETE COLUMN (WITH ANGLE INSERT) MOUNTING**



**TYPE-14**

**CONCRETE COLUMN (WITH INSERT PLATE) MOUNTING**



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**INSTRUMENT SUPPORT  
SINGLE INSTRUMENT**

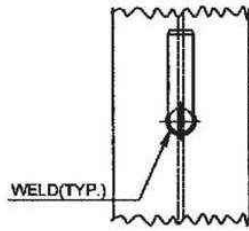
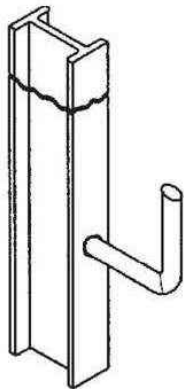
DRAWING NO.

GAIL-ENG-IN-DWG-TP-012

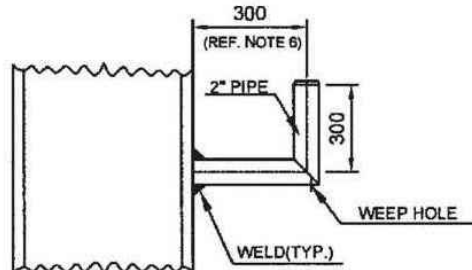
3 OF 3

**TYPE 15**

**STEEL COLUMN MOUNTING (FLANGE FACE)**



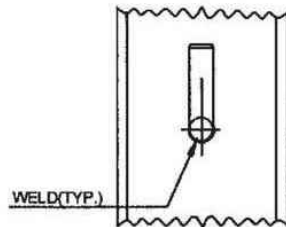
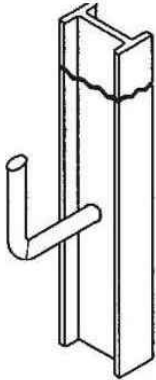
SIDE VIEW



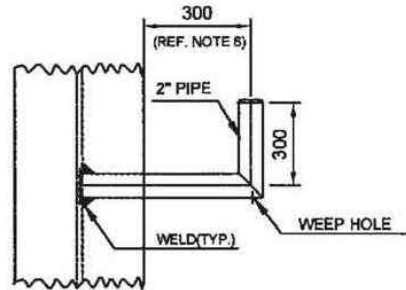
FRONT VIEW

**TYPE 16**

**STEEL COLUMN MOUNTING (WEB FACE)**



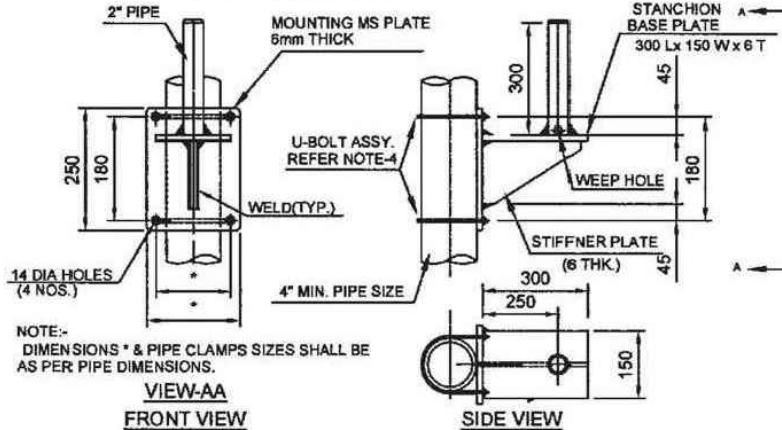
SIDE VIEW



FRONT VIEW

**TYPE 17 PIPE BRACKET MOUNTING**

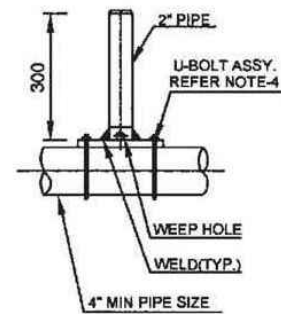
**TYPE 17.1 (VERTICAL PIPE)**



VIEW-AA  
FRONT VIEW

SIDE VIEW

**TYPE 17.2 (HORIZONTAL PIPE)**



(HORIZONTAL PIPE)

**NOTES:**

1. ALL DIMENSIONS ARE IN M.M. UNLESS OTHERWISE SPECIFIED.
2. PIPE MATERIAL SHALL BE IS:1239 HEAVY GRADE AS A MINIMUM.
3. 6 mm DIA WEEP HOLE SHALL BE PROVIDED AT LOW POINT.
4. U-BOLT ASSEMBLY SHALL BE OF MINIMUM M12 SIZE WITH NUTS AND SPRING WASHERS.
5. ALL WELD SHALL BE 3mm FILLET WELD FULL STRENGTH
6. ADD 50mm WHERE-EVER FIRE INSULATION IS PROVIDED.
7. BOLT SHALL BE TURNED FROM M.S. ROUNDS CONFIRMING TO IS : 432 GRADE 1.
8. NUTS AND WASHERS SHALL CONFIRM TO IS : 1363 AND IS : 3138.

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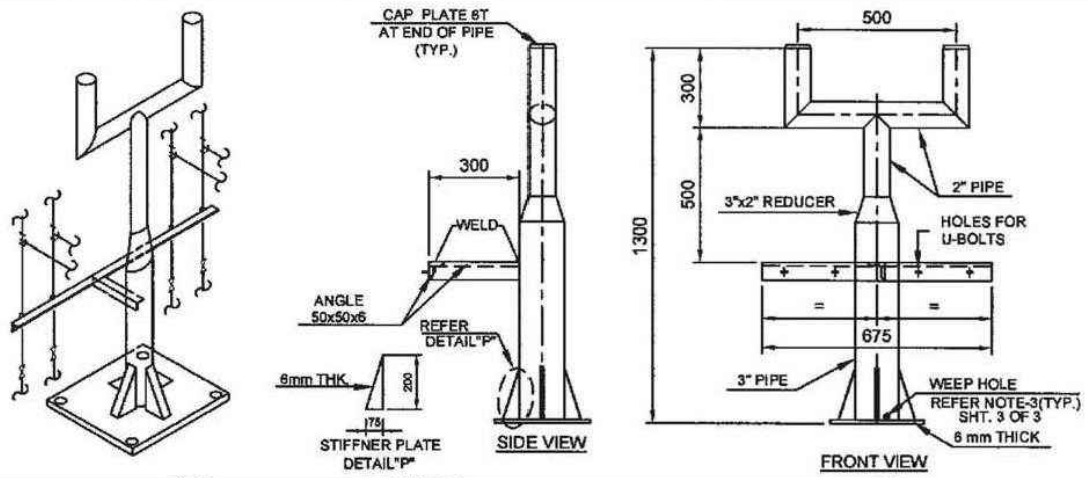
**INSTRUMENT SUPPORT  
TWO INSTRUMENTS**

DRAWING NO.

GAIL-ENG-IN-DWG-TP-013

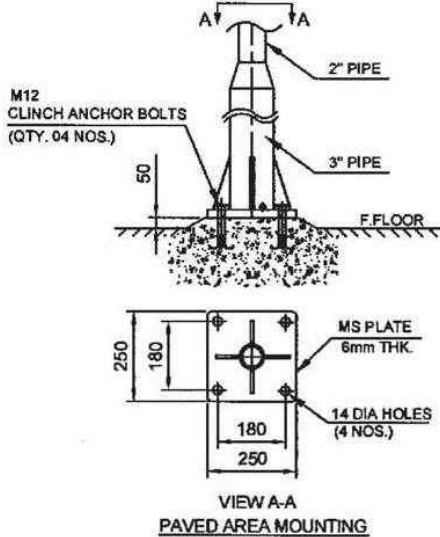
1 OF 3

**TYPE 21 TWO INSTRUMENTS SUPPORT – GENERAL ARRANGEMENT**

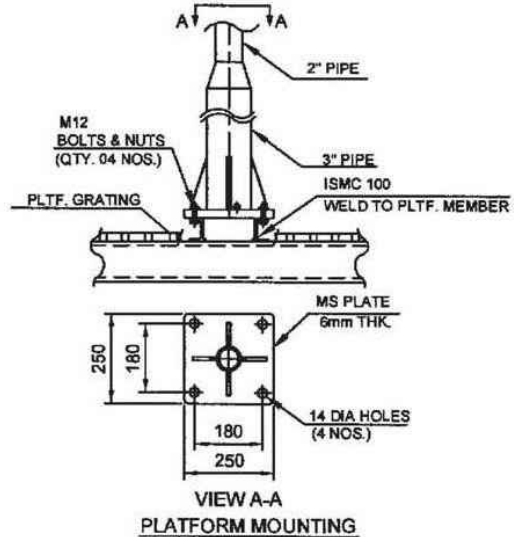


TYPE 21-1

TYPE 21-2



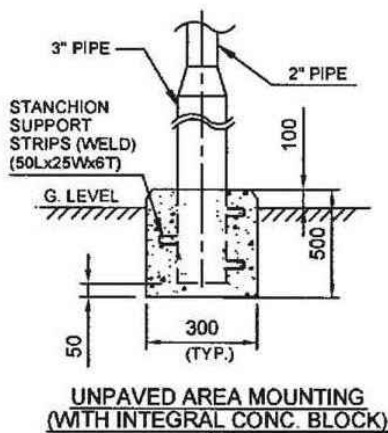
VIEW A-A  
PAVED AREA MOUNTING



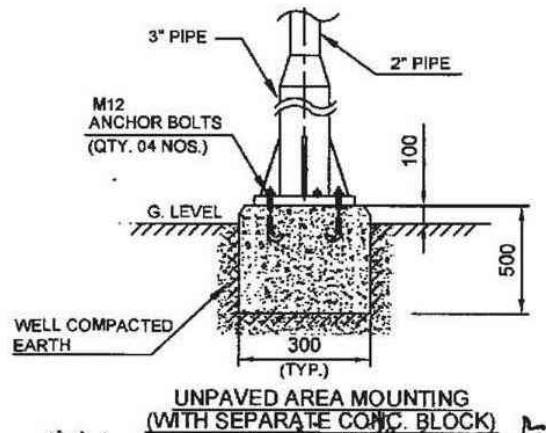
VIEW A-A  
PLATFORM MOUNTING

TYPE 21-3

TYPE 21-4



UNPAVED AREA MOUNTING  
(WITH INTEGRAL CONC. BLOCK)



UNPAVED AREA MOUNTING  
(WITH SEPARATE CONC. BLOCK)

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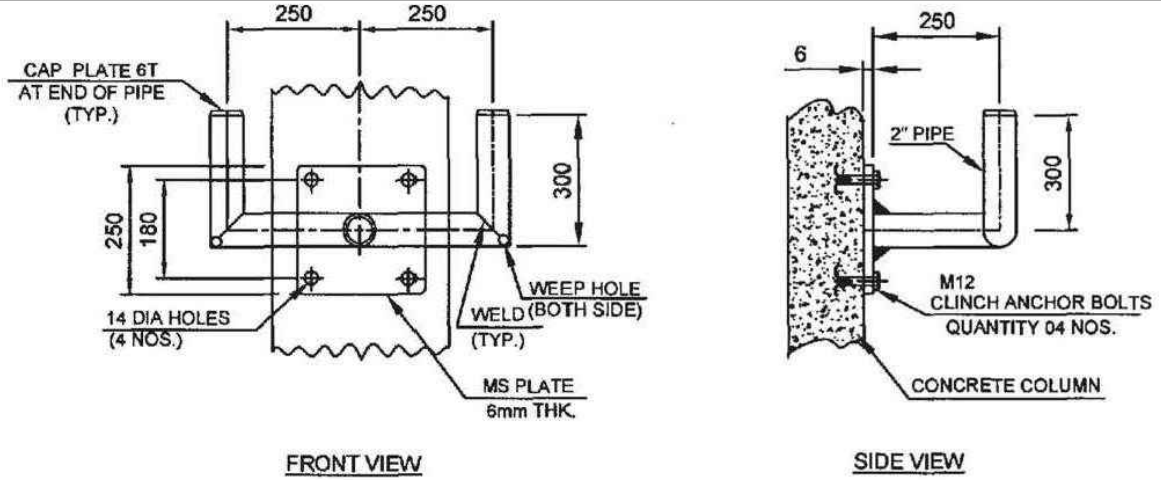
**INSTRUMENT SUPPORT  
TWO INSTRUMENTS**

DRAWING NO.

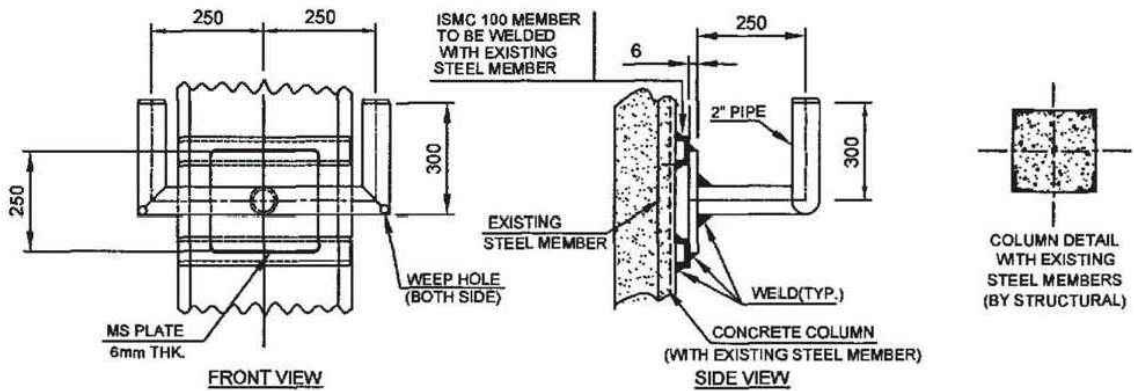
GAIL-ENG-IN-DWG-TP-013

2 OF 3

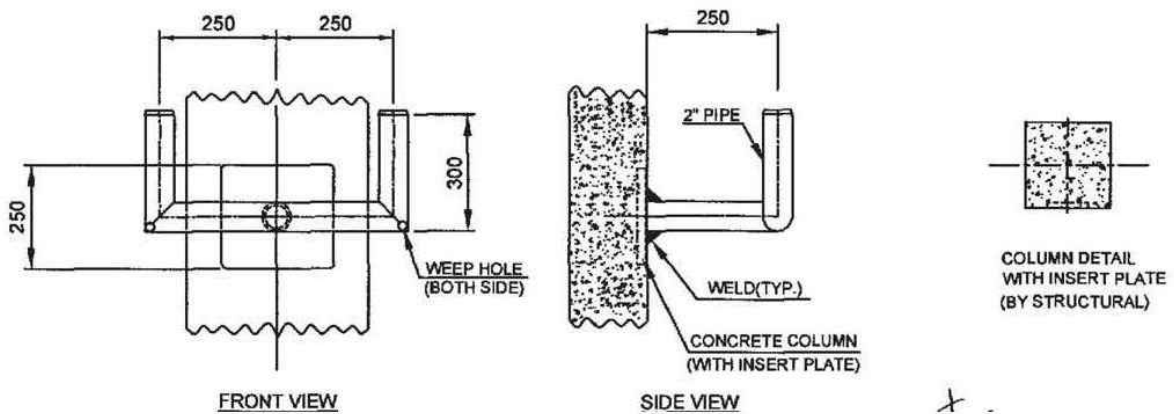
**TYPE 22 CONCRETE COLUMN MOUNTING**



**TYPE 23 CONCRETE COLUMN ( WITH ANGLE INSERT ) MOUNTING**



**TYPE 24 CONCRETE COLUMN ( WITH INSERT PLATE ) MOUNTING**



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**INSTRUMENT SUPPORT  
TWO INSTRUMENTS**

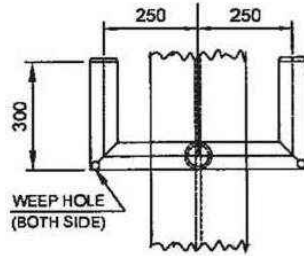
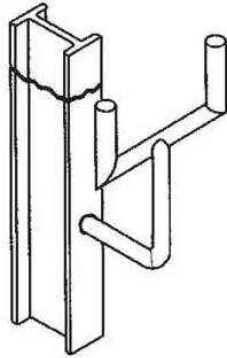
DRAWING NO.

GAIL-ENG-IN-DWG-TP-013

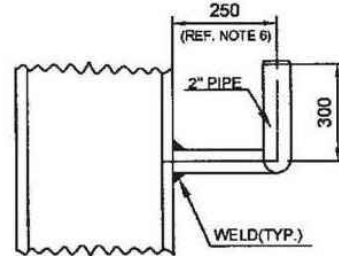
3 OF 3

**TYPE 25**

**STEEL COLUMN MOUNTING (FLANGE FACE)**



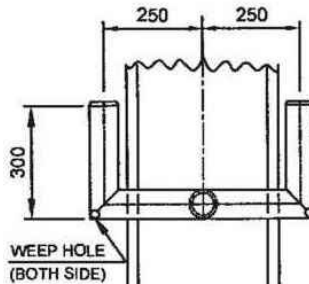
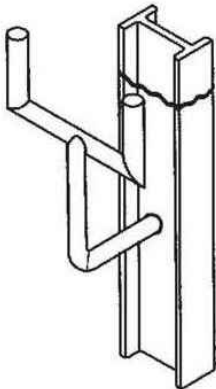
FRONT VIEW



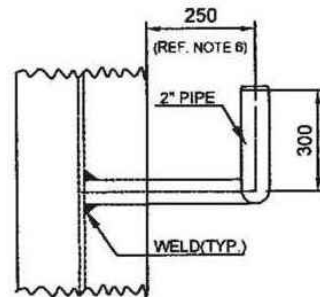
SIDE VIEW

**TYPE 26**

**STEEL COLUMN MOUNTING (WEB FACE)**



FRONT VIEW



SIDE VIEW

**NOTES:**

1. ALL DIMENSIONS ARE IN M.M. UNLESS OTHERWISE SPECIFIED.
2. PIPE MATERIAL SHALL BE IS:1239 HEAVY GRADE AS A MINIMUM.
3. 6 mm DIA WEEP HOLE SHALL BE PROVIDED AT LOW POINT.
4. U-BOLT ASSEMBLY SHALL BE OF MINIMUM M12 SIZE WITH NUTS AND SPRING WASHERS.
5. ALL WELD SHALL BE 3mm FILLET WELD FULL STRENGTH
6. ADD 50mm WHERE-EVER FIRE INSULATION IS PROVIDED.
7. BOLT SHALL BE TURNED FROM M.S. ROUNDS CONFIRMING TO IS : 432 GRADE 1.
8. NUTS AND WASHERS SHALL CONFIRM TO IS : 1363 AND IS : 3138.

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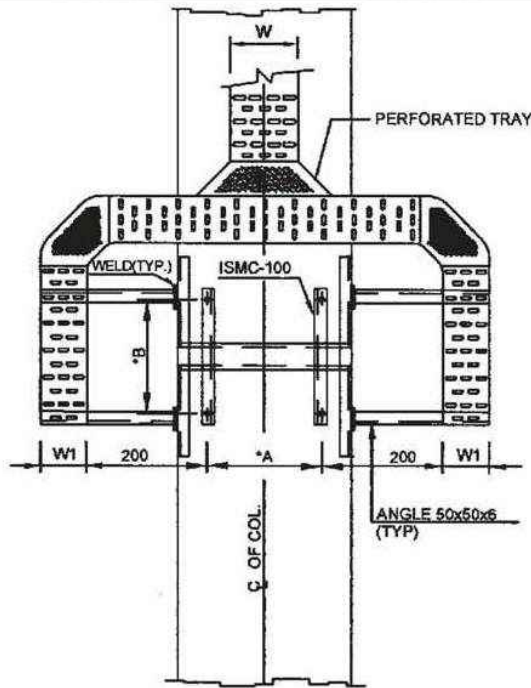


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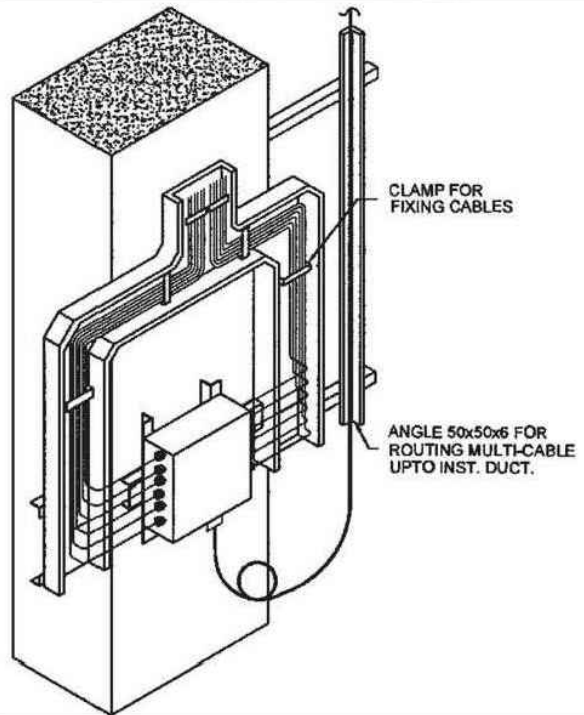
**SUPPORT DETAILS FOR  
JUNCTION BOXES**

DRAWING NO.  
GAIL-ENG-IN-DWG-TP-014  
1 OF 1

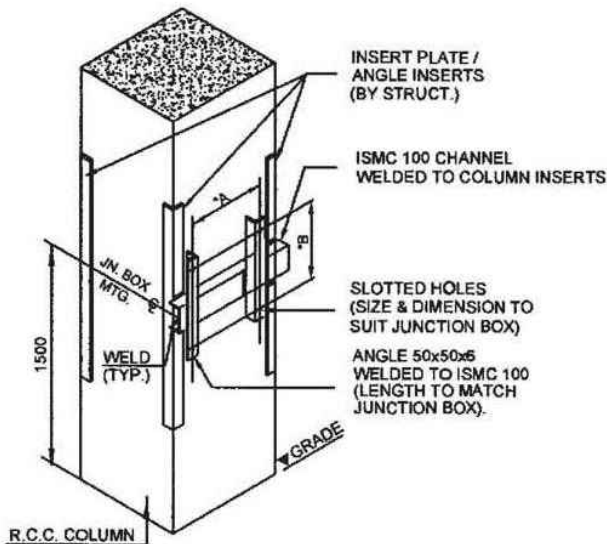
**TRAY ARRANGEMENT FOR JUNCTION BOXES**



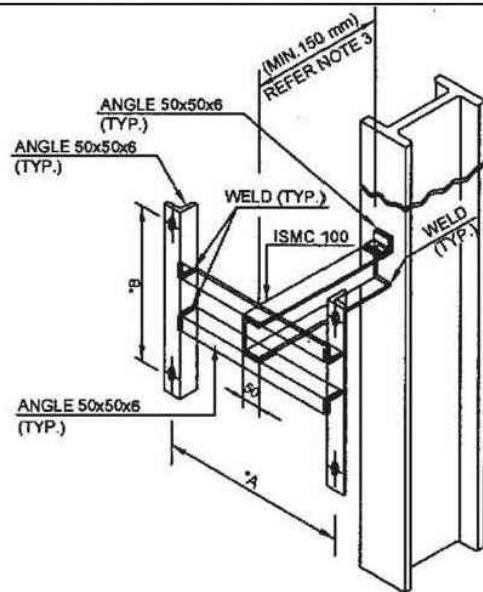
**CABLE ROUTING FOR JUNCTION BOXES.**



**JN. BOX MOUNTING FRAME (R.C.C. COLUMN)**



**JN. BOX MOUNTING FRAME (STEEL COLUMN)**



\*DIMENSION 'A and B' TO SUIT JUNCTION BOX.

**NOTES:**

1. ALL DIMENSIONS ARE IN mm.
2. CLAMP MULTICABLE ON ANGLE WITH 25mm LAME PVC COVERED ALLUMINIUM STRIP.
3. ADD 50 mm WHERE-EVER FIRE INSULATION IS PROVIDED.

**TREY WIDTH**

JN. BOX	W	W1
12 PAIR	300	150
8 TRIAD	300	150
6 PAIR	150	100
6 TRIAD	150	100

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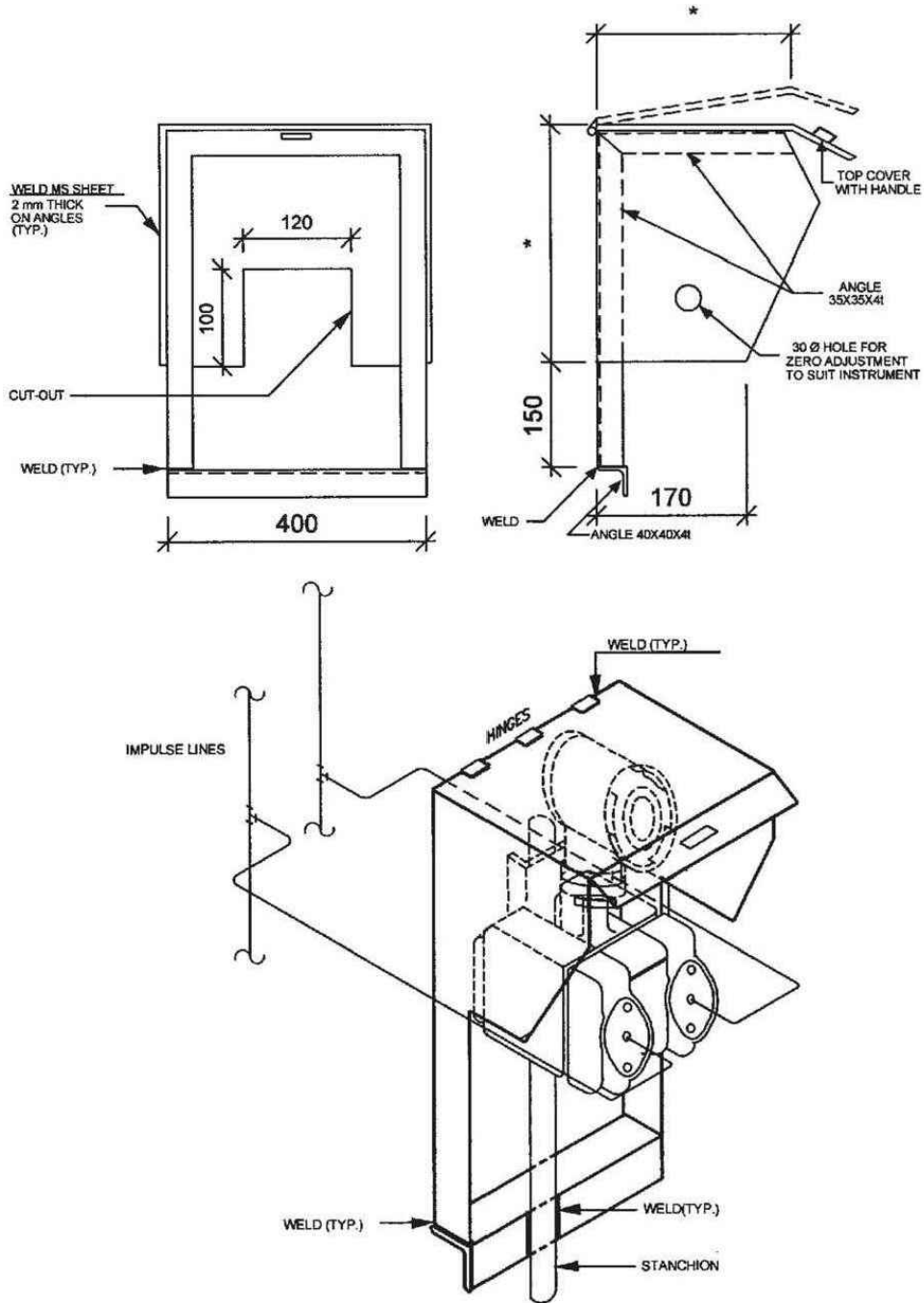
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NEW DELHI

FABRICATED CANOPY  
FOR  
INSTRUMENTS

DRAWING NO.

GAIL-ENG-IN-DWG-TP-015

1 OF 1



**NOTES:**

1. ALL DIMENSIONS ARE IN mm.
2. \* - TO SUIT INSTRUMENT DIMENSIONS
3. HINGES SHALL BE OF STAINLESS STEEL
4. A MINIMUM OF TWO COATS PAINTING SHALL BE CARRIED OUT AFTER A MINIMUM OF ONE COAT OF RED OXIDE ZINC CHROMATE PRIMER. THE COLOUR OF THE PAINT SHALL BE AS PER IS-5,

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NEW DELHI

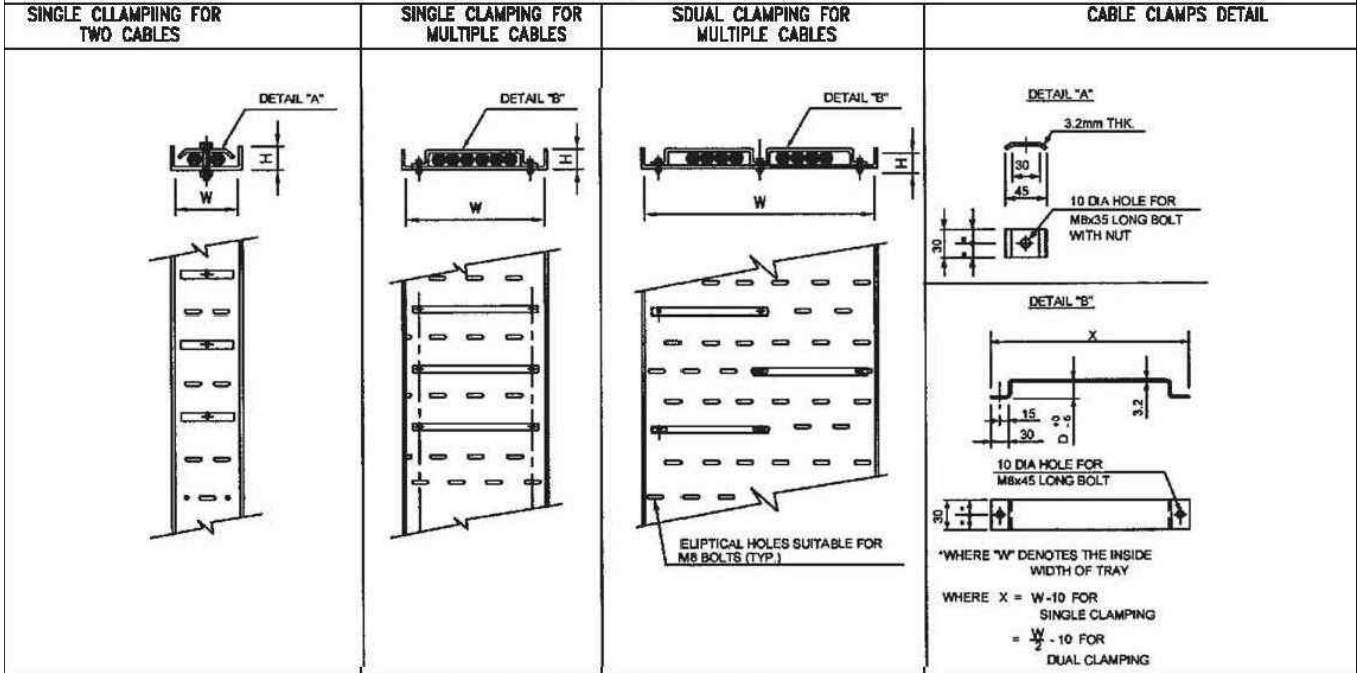
**PERFORATED TRAY SUPPORTS  
AND  
CABLES CLAMPING DETAILS**

DRAWING NO.

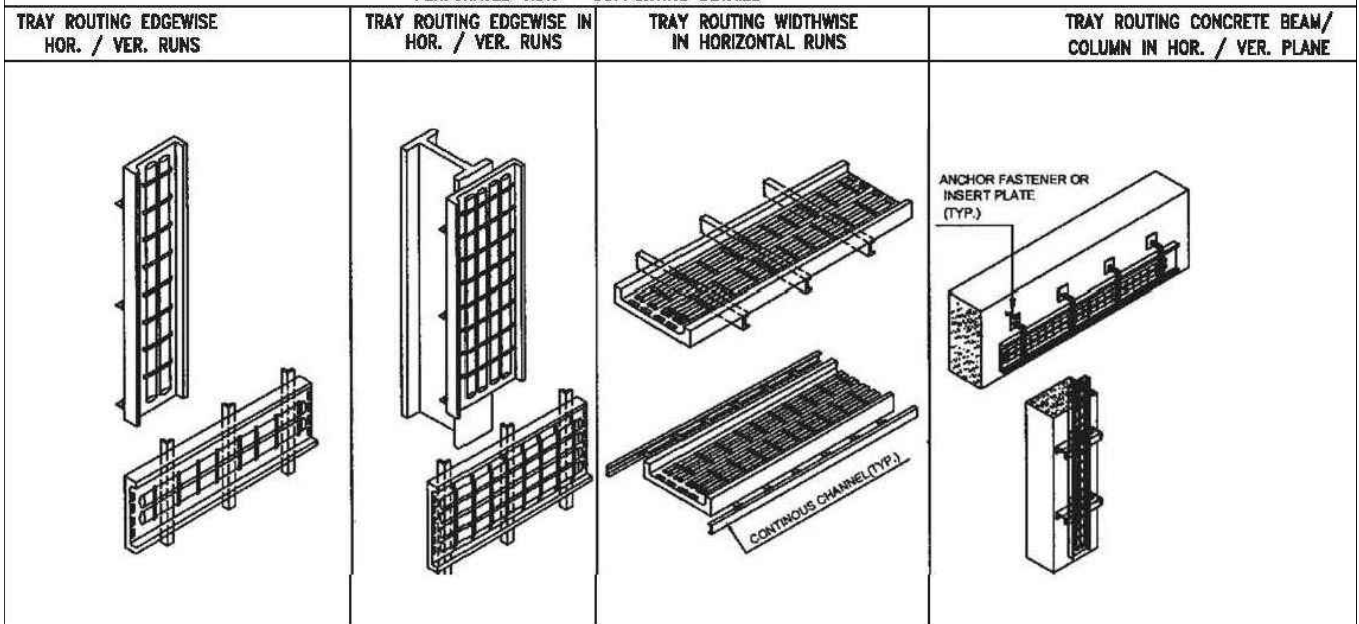
GAIL-ENG-IN-DWG-TP-016

1 OF 1

**CABLE CLAMPING ON PERFORATED TRAYS**



**PERFORATED TRAY - SUPPORTING DETAILS**



**NOTES:**

1. ALL DIMENSIONS ARE IN mm.
2. PERFORATED TRAYS SHALL BE SUPPORTED AT EVERY 1000 mm (TYP.) INTERVAL FOR HORIZONTAL AS WELL AS VERTICAL RUNS USING MINIMUM ANGLE SIZE AS
3. CLAMPING OF CABLES ON PERFORATED TRAYS SHALL BE AT EVERY 500 mm ON VERTICAL RUNS AND EVERY 1000 mm ON HORIZONTAL RUNS.
4. PERFORATED TRAYS SHALL BE SUPPLIED WITH CLAMPS, BOLTS / NUTS AND WASHERS OF GALVANISED MILD STEEL.
5. GALVANISING SHALL BE AS PER IS 4759 (66 gm/ 460 g / m<sup>2</sup>)
6. THE PERFORATED TRAY THICKNESS SHALL BE 2 mm.

**CAPACITY OF PERFORATED TRAYS**

TRAY WIDTH (W)	FLANGE HEIGHT (H)	NO. OF CABLES		
		1 PAIR / 1 TRIAD	6 PAIR / 6 TRIAD	12 PAIR / 6 TRIAD
60	20	2	1	1
100	30	4	2	1
150	30	6	4	3
200	30	10	6	4
300	30	15	8	6

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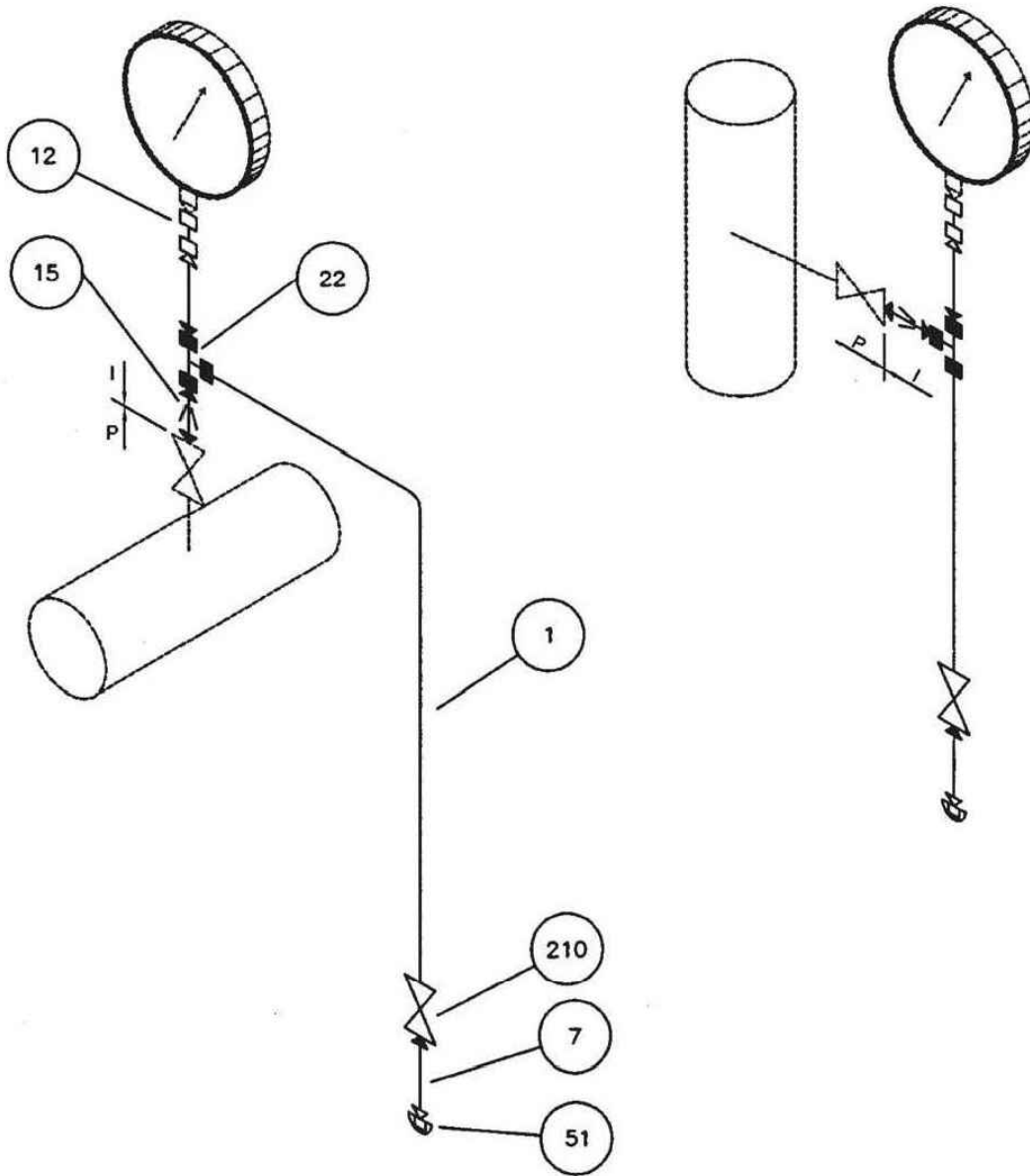
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**PRESSURE GAUGE  
LIQUID/GAS SERVICE**

DRAWING NO.

GAIL-ENG-IN-DWG-TP-017

1 OF 1



P - BY PIPING  
I - BY INSTRUMENTATION

**LIST OF ITEMS**

CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT	CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT
1	PIPE	1/2"	PL	A/R	m						
7	NIPPLE	1/2"	TH X PL	2	No						
12	COUPLING	1/2"	TH	1	No						
15	SWAGE NIPPLE	3/4" X 1/2"	PL X PL	1	No						
22	EQUAL TEE	1/2"	SW	1	No						
51	CAP	1/2"	TH	1	No						
210	GATE VALVE	1/2"	SW	1	No						

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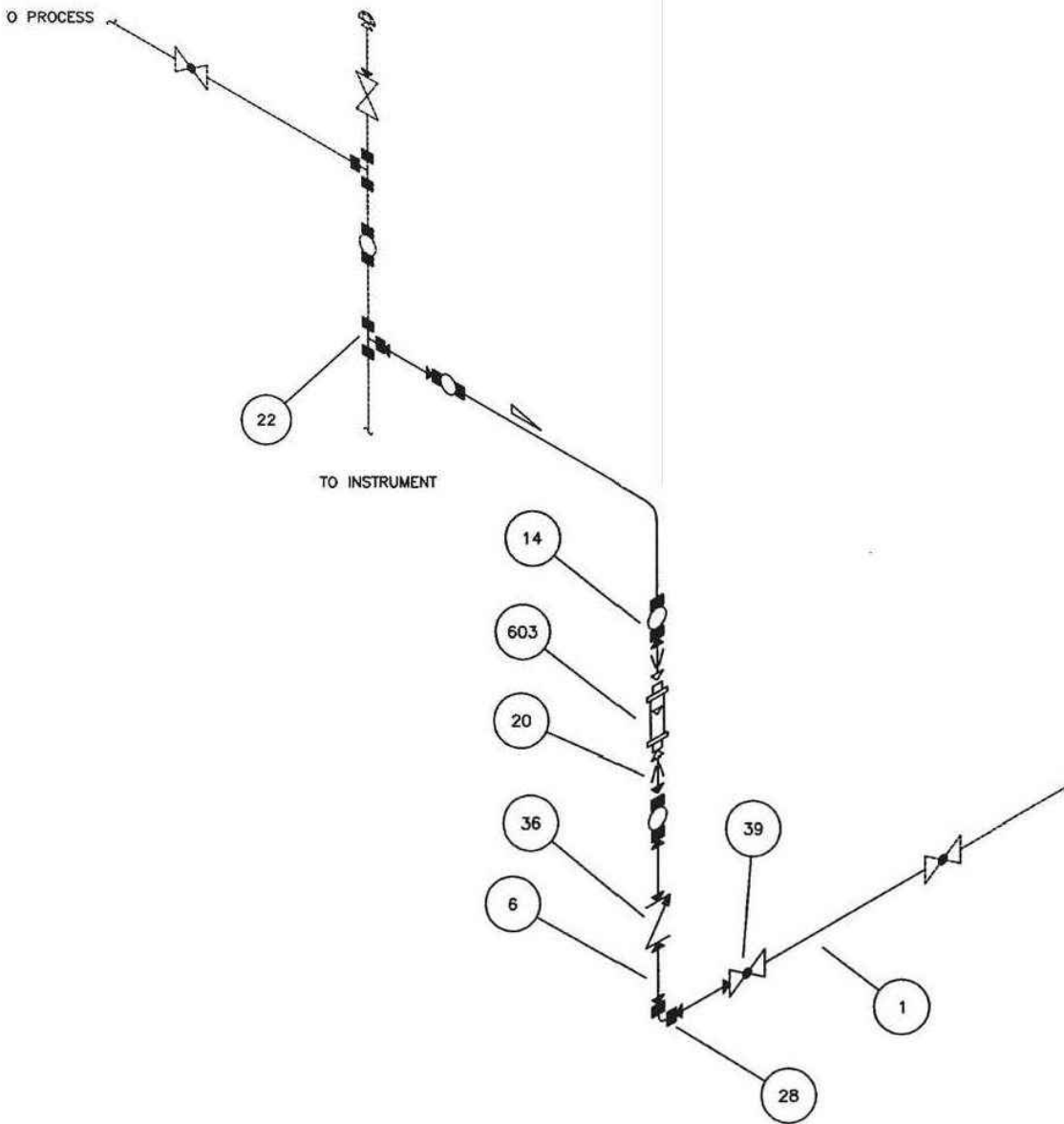
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PURGE FOR INSTRUMENT  
SINGLE LINE

DRAWING NO.

GAIL-ENG-IN-DWG-TP-018

1 OF 1



\* PL x PL NIPPLE SHALL BE FABRICATED FROM PIPE

LIST OF ITEMS

CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT	CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT
1	PIPE	1/2"	PL	A/R	m	603	PURGE ROTAMETER	1/4"	TH (Int)	1	Ns
6	NIPPLE *	1/2"	PL X PL	4	Ns						
14	UNION	1/2"	SW	3	Ns						
20	SWAGE NIPPLE	1/2" X 1/4"	PL X TH	2	Ns						
22	EQUAL TEE	1/2"	SW	1	Ns						
28	ELBOW	1/2"	SW	1	Ns						
39	GLOBE VALVE	1/2"	SW	1	Ns						
36	CHECK VALVE	1/2"	SW	1	Ns						

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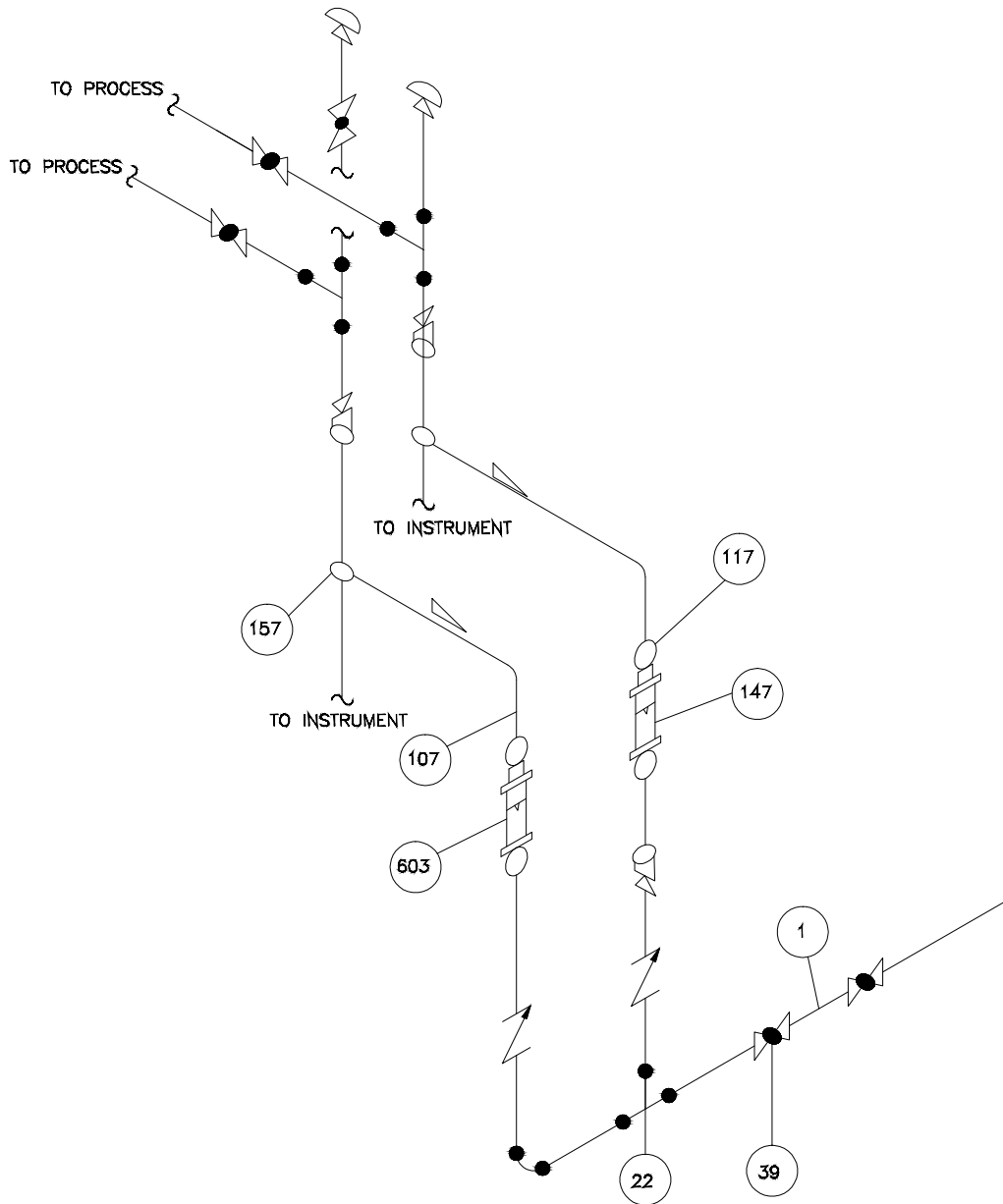
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NEW DELHI

PURGE FOR INSTRUMENT  
DOUBLE LINE

DRAWING NO.

GAIL-ENG-IN-DWG-TP-019

1 OF 1



\* PL x PL NIPPLE SHALL BE FABRICATED FROM PIPE

LIST OF ITEMS

CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT	CODE	DESCRIPTION	SIZE	ENDS	QTY.	UNIT
1	PIPE	1/2"	PL	A/R	m	107	TUBE	1/2"	OD	A/R	N#
6	NIPPLE *	1/2"	PL X PL	3	N#	117	MALE CONNECTOR	1/4" X 1/2"	TH X OD	4	N#
7	NIPPLE	1/2"	TH X PL	2	N#	147	FEMALE CONNECTOR	1/2" X 1/2"	TH X OD	2	N#
22	EQUAL TEE	1/2"	SW	1	N#	157	UNION TEE	1/2"	OD	2	N#
28	ELBOW	1/2"	SW	1	N#	603	PURGE ROTAMETER	1/4"	TH (Int)	2	N#
39	GLOBE VALVE	1/2"	SW	1	N#						
36	CHECK VALVE	1/2"	SW	2	N#						

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**GAIL INDIA LIMITED**

**CONSTRUCTION OF STEEL PIPELINE AND ASSOCIATED FACILITIES  
FOR CGD CONNECTIVITIES**

**VOLUME II OF II (TECHNICAL) – I**

**TELECOM**



**E-TENDER REF :**

**(BID DOCUMENT NO - 034/LEPL/GAIL/22-R0)**

**LIMITED DOMESTIC COMPETITIVE BIDDING**



**Lyons Engineering Pvt. Ltd.**

<b>PMC:</b> 	<b>DCI - MASTER DELIVERABLE CONTROL INDEX FOR CGD TO M/s TGPL MORADABAD &amp; CGD TO M/s TGPL GORAKHPUR</b>	<b>Doc No.</b>		<b>CLIENT:</b> 
		GAIL-ENG-GN-DOC-DL-001		
		Rev. 0		
<b>Sr. No.</b>	<b>Description</b>	<b>Document / Drawing No.</b>		<b>Rev. No.</b>
<b>TECHNICAL VOLUME - II OF II</b>				
<b>I</b>	<b>TELECOM</b>			
<b>STANDARD SPECIFICATION FOR TELECOM</b>				
1	Standard Specifications for OFC & HDPE	GAIL-STD-TL-DOC-TS-001		0
2	Standard Procedure for Fiber Optical Cable Testing	GAIL-STD-TL-DOC-TS-002		0
<b>DATASHEET FOR TELECOM</b>				
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
<b>QAP FOR TELECOM</b>				
5	QAP for Optical Fibre Cable	GAIL-STD-TL-DOC-QAP-001		0
6	QAP for HDPE Duct & Accessories	GAIL-STD-TL-DOC-QAP-002		0
<b>STANDARD TYPICAL DRAWING</b>				
7	Telecom Typical (Cross section Installation & Joint Identification Marker) drawing	GAIL-STD-TL-DWG-TP-001		0
<b>J LIST OF APPROVED VENDORS</b>				
i)	List of Approved Parties for Bought Out Items	GAIL-ENG-GN-DOC-VL-001		0




**GAIL INDIA LIMITED**

**STANDARD SPECIFICATION FOR  
OPTICAL FIBRE CABLE AND HDPE DUCT**

**GAIL-STD-TL-DOC-DS-001**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
0	14.01.19	First Issue	RKS	UNU	UNU



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## 1.0 GENERAL

This document describes the specifications of 24 fiber metal free Optical Fiber Cable for underground installation in ducts, which shall conform to TEC Draft GR No. TEC/GR/TX/OFC-23/01/XXX-2011 (under finalization in TEC). The optical fiber cable shall have low weight, small volume and high flexibility. The optical fiber cable shall have double HDPE jacketing with anti-rodent & anti-termite properties with glass yarn in between as reinforcement. The cable shall be suitably protected from the ingress of moisture by flooding jelly. The raw material used in the cable shall meet the requirements of the specifications for the raw materials (GR No.TEC/GR/TX/ORM-01/04 SEP-09).

The contractor shall be totally responsible for the desired performance of the offered OFC including design, engineering, manufacture, testing and supply of direct underground burial type OFC and for underground installation in ducts.

The design and construction of metal free optical cable shall be inherently robust and rigid under all conditions of operations, installation, adjustment, replacement, storage and transport and shall be of capable of laying in permanently lubricated HDPE conduits using blowing technology & shall be capable of direct burial and for crossing various roads, railways, canals, small rivers, marshy areas, etc. through appropriate casings & directly as per site conditions.


OFC shall be blow through self-lubricating type HDPE conduit of required diameter and shall be minimum of 50 mm (OD) by compressed air blowing method. Across each said crossing, the contractor shall install two HDPE duct sub-ducted in CS Pipe and blow optical fibre cable through the one of these HDPE ducts. Spare HDPE duct shall be plugged & kept for future use.HDPE conduits along with accessories such as end cap, cable sealing plug and all the machinery, tools, tackles etc. to complete the job in all respects to lay the HDPE & OFC shall be provided by the bidder.

It is mandatory that the supplied optical fiber cable shall be manufactured from a single source of optical fibers.

The intent of the following specifications is to establish the minimum requirements and guidelines for the OFC to be supplied for the project.

### 1.1 Abbreviations

ASTM	- American Society for Testing and Materials
EIA	- Electronic Industry Association
FRP	- Fiber Reinforced Plastic
HDPE	- High Density Polyethylene
IEC	- International Electra -Technical Commission
ISO	- International Standard Organizations
ITU-T	- International Telecommunication Union- Transmission
MFD	- Mode Field Diameter
OF	- Optical Fiber
OTDR	- Optical Time Domain Reflect meter
QA	- Quality Assurance
QM	- Quality Manual
RMS	- Route Mean Square
SMOF	- Single Mode Optical Fibre
TEC	- Telecommunication Engineering Centre
UV	- Ultra Violet

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## 1.2 Conflicting Requirement

In the event of any conflict between this standard specification, job specification, datasheets, statutory regulations, related standards, codes etc. the following order of priority shall govern:

- i) Statutory Rules & Regulations
- ii) Technical Specification for OFC & HDPE
- iii) Data Sheets
- iv) Codes and Standards Instrumentation Drawings

## 1.3 Drawing and Data

- 1.3.1 Detailed drawings, data, catalogues and manuals required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of reproducible, prints and soft copies shall be dispatched to the address mentioned, adhering to the time limits indicated.
- 1.3.2 Final documentation consisting of design data, installation manual, operation and maintenance manual etc., submitted by the vendor after placement of purchase, order shall include complete technical literature in English with detailed cable construction diagram of various sub-components with dimensions & test data. All aspects of installation, operation, and maintenance shall also be covered in the document.
- 1.3.3 The Vendor / Contractor shall be completely responsible for the successful completion of the job. However, to ensure good quality of workmanship. As also of the uttered system, vendor shall prepare and submit the documents to be approved by the Owner/Owner's representatives. Vendor shall proceed with the manufacture / procurement / installation of the respective materials and/or equipment only after obtaining the necessary approval from the Owner/Owner's representatives.

## 1.4 Safety Requirement


The material used in the manufacturing of the armoured optical fibre cables shall be non-toxic and dermatologically safe in its lifetime.

## 2.0 OPERATING REQUIREMENT

- a) The design and construction of metal free optical cable shall be inherently robust and rigid under all conditions of operations, adjustment, replacement, storage and transport.
- b) The optical fibre cable shall be able to work in a saline atmosphere in coastal areas and should be protected against corrosion.
- c) Life of cable shall be better than 40 years. The bidder shall submit necessary statistical calculations.
- d) It shall be possible to operate and handle the metal free optical fibre cable with tools as per TEC specs No. G / OFT—01 / 02 Mar.'99 (or Latest) and subsequent amendment, if any. In case any Special tool requirement for operating and handling the optical fibre cable. The same shall be provided along with the cable.

## 3.0 TECHNICAL PARTICULARS- OPTICAL FIBRE CABLES

### 3.1 Specification of Optical Fibres

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Out of 24 fiber, eighteen fiber shall be as per ITU – T Rec. G 652 D and remaining six fiber shall be as per ITU-T Rec. G655. The specifications of optical fibers are as follows:

SR. NO.	SPECIFICATION	G.652D	G.655
3.1.1	Type of fiber	Single mode (Section – I of the TEC/GR/TX/ORM 01/04/ SEP-09 and subsequent amendments, if any)	NZDS Single mode Optical Fibre optimized for use in 1550 nm window conforming to ITU-T Rec.G.655
3.1.2	<b>Geometrical Characteristics</b>		
3.1.2.1	Nominal Mode Field Diameter (MFD) For matched clad	8.8 – 9.8 $\mu\text{m}$	9.6 $\pm$ 0.4 $\mu\text{m}$
3.1.2.2	Nominal Cladding Diameter	125 $\mu\text{m} \pm 1.0 \mu\text{m}$	125 $\mu\text{m} \pm 1.0 \mu\text{m}$
3.1.2.3	Cladding Non-circularity	$\leq 1\%$	$\leq 1\%$
3.1.2.4	Core clad concentricity error	$\leq 0.6 \mu\text{m}$	$\leq 0.6 \mu\text{m}$
3.1.2.5	Diameter over primary coated with double UV cured acrylate (shall be measured on uncoloured fiber)	245 $\mu\text{m} \pm 10 \mu\text{m}$	245 $\mu\text{m} \pm 10 \mu\text{m}$
3.1.2.6	Coating / Cladding Concentricity	$\leq 12 \mu\text{m}$	$\leq 12 \mu\text{m}$

3.1.3	<b>Transmission Characteristics of G.652D fibers</b>	
3.1.3.1	<b>Attenuation</b>	
	a) Fiber attenuation before cabling	
	i) At 1310 nm	$\leq 0.34 \text{ dB/Km}$
	ii) Between 1285 to 1360 nm	$\leq 0.37 \text{ dB/Km}$
	iii) Between 1480 to 1525 nm	$\leq 0.34 \text{ dB/Km}$
	iv) At 1550 nm	$\leq 0.21 \text{ dB/Km}$
	v) Between 1525 to 1625 nm	$\leq 0.24 \text{ dB/Km}$
	b) Water Peak Attenuation before cabling Between	$\leq 0.34 \text{ dB/Km}$

3.1.3	<b>Transmission Characteristics of G.652D fibers</b>	
	<p style="text-align: center;">1360 – 1480 nm</p> <p>Note :</p> <ol style="list-style-type: none"> <li>1. Sudden irregularity in attenuation shall be less than 0.1 dB</li> <li>2. The spectral attenuation shall be measured on un-cabled fiber.</li> <li>3. The spectral attenuation in the 1250 nm – 1625 nm band shall be measured at an interval of 10 nm and the test results shall be submitted.</li> </ol>	
	<p>c) Fiber attenuation after cabling</p> <ol style="list-style-type: none"> <li>i) At 1310 nm</li> <li>ii) At 1550 nm</li> <li>iii) At 1625 nm</li> </ol>	$\leq 0.36$ dB/Km $\leq 0.23$ dB/Km $\leq 0.26$ dB/Km
	<p>d) Water Peak Attenuation after cabling</p> <ol style="list-style-type: none"> <li>i) At 1383 nm</li> <li>ii) Between 1360 – 1480 nm</li> </ol> <p><b>Note:</b> Water Peak Attenuation after cabling shall be measured either at 1383 nm or between 1360 – 1480 nm.</p>	$\leq 0.34$ dB/Km $\leq 0.34$ dB/Km
3.1.3.2	<p><b>Dispersion</b></p> <p>a) Total Dispersion</p> <p>In 1285 – 1330 nm band  In 1270 – 1340 nm band  At 1550 nm  At 1625 nm</p> <p><b>Note-</b>The dispersion in 1250 nm – 1625 nm band shall be measured on un-cabled fiber at an interval of 10 nm and the test results shall be submitted.</p> <p>b) Polarization mode dispersion at 1310 &amp; 1550 nm</p> <ol style="list-style-type: none"> <li>i) Fiber</li> <li>ii) Cabled Fiber</li> </ol> <p><b>Note-</b> Measurement on un-cabled</p>	

3.1.3	<b>Transmission Characteristics of G.652D fibers</b>	
	fiber may be used to generate cabled fiber statistics and correlation established c) Zero Dispersion Slope  d) Zero Dispersion wave length range	$\leq 0.092\text{ps}/(\text{nm}^2\cdot\text{km})$ 1300 – 1324 nm
3.1.4	a) Cut off wavelength for fibers used in cable  <b>Note</b> – The above cut off wave length is w.r.t. 2 M sample length of fiber  b) Cable Cut off wavelength	1320 nm Max    1260 nm Max

3.1.5	<b>Transmission Characteristics of G655 fibres</b>	
3.1.5.1	<b>Attenuation</b>	
	a) Fiber attenuation before cabling	
	i) Between 1525 to 1565 nm	$\leq 0.23 \text{ dB/Km}$
	ii) Between 1565 to 1625 nm	$\leq 0.26 \text{ dB/Km}$
	b) Fiber attenuation after cabling i) At 1550 nm ii) At 1625 nm <b>Note :</b> 1. Sudden irregularity in attenuation at 1550 nm shall be $\leq 0.05 \text{ dB}$ . 2. The spectral attenuation shall be measured on uncabled fibre. 3. The spectral attenuation in the 1525 nm – 1625 nm band shall be measured at an interval of 10 nm and the test results shall be submitted.	$\leq 0.25 \text{ dB/Km}$ $\leq 0.28 \text{ dB/Km}$
3.1.5.2	<ul style="list-style-type: none"> <li>• <b>Chromatic Dispersion</b></li> <li>a) Chromatic Dispersion Coefficient in 1530-1565 nm band <ul style="list-style-type: none"> <li>i) <math>\lambda_{\text{min}}</math> &amp; <math>\lambda_{\text{max}}</math></li> <li>ii) Minimum value of <math>D_{\text{min}}</math></li> </ul> </li> </ul>	1530 nm to 1565 nm 1.0 ps/nm.Km

3.1.5	<b>Transmission Characteristics of G655 fibres</b>	
	iii) Maximum value of Dmax iv) Dmax - Dmin v) Sign  b) Chromatic Dispersion Coefficient in 1565-1625 nm band i) $\lambda_{min}$ & $\lambda_{max}$ ii) Minimum value of Dmin iii) Maximum value of Dmax iv) Sign  • <b>Polarization mode dispersion at 1550 nm</b> Individual (un-cabled) Fibre Cabled Fibre Link design value of PMD  Note : Measurement on uncabled fibre may be used to generate cabled fibre statistics and correlation established  <b>Dispersion Slope at 1550 nm</b>	10.0 ps/nm.Km  $\leq 5.0$ ps/nm.Km Positive  1565 nm & 1625 nm 4.0 ps/nm.Km  14.0 ps/nm.Km  Positive  $\leq 0.15$ ps/ $\sqrt{\text{Km}}$ $\leq 0.3$ ps/ $\sqrt{\text{Km}}$ $\leq 0.1$ ps/ $\sqrt{\text{Km}}$
3.1.6	c) Cut off wavelength for fibers used in cable	1480 nm Max
3.1.7	<b>Mechanical Characteristics of G.652D &amp; G.655 Fibers</b>	
3.1.7.1	a) Proof test for minimum strain level (Test method IEC-60793-1-30)  b) Peak Strippability force to remove primary coating of the fiber (Test method IEC-60793-1-32)  <b>Note:</b> The force required to remove 30 mm $\pm$ 3mm of the fiber coating shall not exceed 8.9 N and shall not be less than 1.3 N.  c) Dynamic Tensile Strength (Test method IEC-60793-1-31) i) Un-aged ii) Aged  d) Dynamic Fatigue (Test method IEC-60793-1-33)  e) Static Fatigue	1%  $1.3 \leq F \leq 8.9$ N  $\geq 550$ KPSI (3.80 Gpa) $\geq 440$ KPSI (3.00 Gpa)  $\geq 20$  $\geq 20$

3.1.5	<b>Transmission Characteristics of G655 fibres</b>	
	(Test method IEC-60793-1-33)	
3.1.7.2	Fiber macro bend Change in attenuation when fiber is coiled with 100 turns on 30 ±1.0 mm radius mandrel(Test method FOTP– 62/ IEC- 60793-1-47)	$\leq 0.05$ dB at 1550 nm for G.652D& G.655 fiber $\leq 0.5$ dB at 1625 nm for G.655fiber
3.1.7.3	Fiber macro bend Change in attenuation when fiber is coiled with 1 turn around 32 ± 0.5 mm diameter mandrel(Test method FOTP– 62/ IEC- 60793-1-47)	$\leq 0.5$ dB at 1550 nm for G.652D & G.655 fibers $\leq 1.0$ dB at 1625 nm for G.655 fiber
3.1.7.4	Fiber Curl (Test method as per IEC-60793-1-34)	$\geq 4$ meters radius of curvature
3.1.8	<b>Material properties of G.652D &amp; G.655fibers</b>	
3.1.8.1	Fiber Materials a) The substances of which the fibers are made. b) Protective materials requirement <ul style="list-style-type: none"> <li>• The physical and chemical properties of the material used for the fiber primary coating and for single jacket fiber.</li> <li>• The best way of removing protective coating material.</li> </ul>	contractor to specify  To be indicated by the bidder/vendor/contractor.

## 3.2 OPTICAL FIBRE CABLE CONSTRUCTION SPECIFICATIONS


### 3.2.1 Secondary Protection

The primary coated fibers shall be protected by loose packaging within a tube, which shall be filled with thixotropic jelly.

Number of fibers	: 24
Number of loose tubes	: 6
Number of Filler/ Dummy	: 0
Number of fibers per loose tube	: 4
Material for loose tube	: Polybutylene terephthalate.
The OD of loose tube	: 1.9 mm + 0.1 mm
The ID of loose tube	: minimum 1.2mm

### 3.2.2 Cable Core Assembly

Four fibers shall be placed loosely in each loose tube.

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**3.2.3 Core Wrapping**

The core wrapping shall not adhere to the secondary fiber coating and shall not leave any kink marks over the loose tube.

**3.2.4 Filling Compound**

The filling and the flooding jelly compound shall be as per the TEC Specs No. TEC/GR/TX/ORM 01/04/SEP-09 and subsequent amendment issued, if any.

**3.2.5 Inner Sheath**

A non-metallic moisture barrier sheath shall be applied over and above the cable core. The core shall be covered with tough weather resistant High Density Polyethylene (HDPE) sheath black in colour (UV stabilised) and colour shall conform to Munsell Colour Standards. Thickness of the sheath shall be uniform & shall not be less than 1.2 mm. The sheath shall be circular, smooth, free from pin holes, joints, mended pieces and other defects. Reference test method to measures thickness shall be as per IEC 189 Para 2.2.1 and Para 2.2.2.

**Note :** HDPE material, black in colour, from the finished cable shall be subjected to following tests (on sample basis) and shall conform to the requirement of the material as per GR No.TEC/GR/TX/ORM-01/04 SEP.09.


- i. Density
- ii. Melt Flow Index
- iii. Oxidative Induction time
- iv. Carbon Black Content
- v. Carbon Black Dispersion
- vi. ESCR
- vii. Moisture Content
- viii. Tensile Strength and Elongation at break
- ix. Absorption Coefficient
- x. Brittleness Temperature

**3.2.6 Glass Reinforcement**

Impregnated Glass Fiber Reinforcement shall be used to achieve the required tensile strength of the optic fiber cable over the cable inner sheath to provide peripheral reinforcement along with solid rigid FRP Rod in the centre at cable core. These flexible strength members shall be Non-water blocking type. Impregnated Glass Fiber Reinforcement used shall be equally distributed over the periphery of the cable inner sheath. It shall be applied helically and shall provide full coverage to inner sheath to provide rodent protection. The quantity of the Impregnated Glass fiber Reinforcement used per km length of the cable shall be minimum 20kg per KM cable. The specification of the glass roving shall be as per Section XII of GR No. TEC/GR/TX/ORM-01/04 SEP.09.

**3.2.7 Outer Sheath**

A non-metallic moisture barrier sheath (black in colour) shall be applied over the inner sheath and glass roving layer, which shall consist of tough weather resistant made High Density Polyethylene compound (HDPE) with anti-termite and anti-rodent properties. The outer sheath shall be UV stabilized and the

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colour shall confirm to Munsell colour standards. The thickness of the outer sheath shall not be less than 1.6mm. The outer sheath shall be uniform, circular, smooth; free from pin holes, joints mended pieces and other defects. The reference test method to measure thickness shall be as per IEC 811-5-1.

**Note:** HDPE material from finished product shall be subjected to following tests (on sample basis) and shall confirm to the requirement of the material as per the GR no. TEC/GR/TX/ORM-01/04/SEP-09 (Section-III):


- a) Density
- b) Melt flow index
- c) Oxidative Induction time
- d) Carbon black content
- e) Carbon black dispersion
- f) ESCR
- g) Moisture content
- h) Tensile strength and elongation at break
- i) Absorption Coefficient
- j) Brittleness Temperature
- k) Anti termite and Anti-rodent dopants shall be added in the outer sheath to resist termite attack and rodent attack on the cable. Bidder/vendor/contractor shall provide the details of doping material used and same shall be verified during testing.
- l) Protection against rodents- For protection against rodents, HDPE sheath shall have rodent repellent properties with the use of an eco-friendly, non-toxic rodent repellent additive. 2%-3% master-batch of rodent repellent material consisting of 5% additive & 95% HDPE/ LDPE shall be mixed in the HDPE sheath material/ granules (If otherwise, bidder/vendor/contractor to submit details of additive with OEM recommendation for mixing).
- m) Protection against termites- For protection against termites, HDPE sheath shall have termite repellent properties with the use of an eco-friendly, non-toxic termite repellent additive. The termite protection shall be as per DIN EN117.
- n) A copy of Invoice from OEM of rodent repellent material & termite repellent material shall be submitted with the pre-FAT internal inspection reports and bidder/vendor/contractor to evidence Original Invoice from OEM of rodent repellent master-batch & termite repellent material during Factory Acceptance Test of finished cable.
- o) Termite & Rodent Test - Termite & Rodent test shall be carried out at any recognized lab on finished cable samples. The reports shall be submitted by the bidder/vendor/contractor. Termite resistance shall be provided with an additive in outer sheath and rodent protection shall be provided with an additive in outer sheath and by use of Glass roving yarns around the periphery of inner sheath. These yarns should spread uniformly around the periphery of inner sheath. Bidder/vendor/contractor to note that apart from the above test report, it shall be Owner's prerogative to get sample of finished cable tested at OEM/ Other recognized test labs to establish presence of rodent & termite repellent additives in specified proportion.

### 3.2.8 Cable Diameter

- a) Bidder/vendor/contractor to specify the cable diameter.
- b) Bidder/vendor/contractor to note that the overall cable diameter shall be between 13-14mm.

### 3.2.9 Rip Cord

- a) Three suitable ripcords shall be provided in the cable, which shall be used to open the HDPE sheaths of the cable. Two ripcords shall be placed diametrically opposite to the each other at below the outer sheath & one ripcord shall be placed below the inner sheath. It shall be capable of consistently slitting the sheath without breaking for a length of 1 meter at the installation temperature. The ripcords (3ply & twisted) shall be properly waxed to avoid wicking action and shall not work as water carrier.

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- b) The ripcords used in the cable shall be readily distinguishable from any other components utilized in the cable construction.

#### 4. INSPECTION & TESTING OF OPTICAL FIBER CABLES

##### 4.1 Cable Aging Test (Type Test)

**Objective:** To check the cable material change dimensionally as the cable ages.

**Method:** At the completion of temperature cycle test, the test cable shall be exposed to  $85 \pm 2$  degree C for 168 hours. The attenuation measurement at 1310 & 1550 nm wave length to be made after stabilization of the test cable at ambient temperature for 24 hours.

**Requirement:** The increase in attenuation allowed:  $\leq 0.05$  dB at 1310 and 1550 nm.

**Note:** The attenuation changes are to be calculated with respect to the base line attenuation values measured at room temperature before temperature cycling.

##### 4.2 Cable Jacket Yield Strength and Ultimate Elongation

**Objective:** To determine the yield strength and elongation of the polyethylene (HDPE) cable sheath (jacket).

**Test Method:** FOTP-89 or ASTM 1248 Type III class

**Test Condition:**

1. Sample shall be taken from a completed cable. The aged sample shall be conditioned at  $100 \pm 2^\circ\text{C}$  for 120 hours before testing.
2. The cross-head speed shall be 50 mm per minute.

**Requirement:**

Jacket Material	Minimum Yield Strength		Minimum Elongation (%)
	(MPa)	(psi)	
HDPE un-aged	16.5	2400	400
HDPE aged	12.4	1800	375


##### 4.3 To Check of the quality of the loose tube (containing optical fiber) (Type Test)

###### a. Drip test on the cable

**Objective:** The purpose of this test is to determine the ability of jelly in the O.F. cable to withstand a temperature of 70 degree C.

**Method:** Take a sample of 30 cm. length of the cable with one end sealed by end cap. Remove outer black sheath, binder tapes for 5 cm from open end of the sample. Clean the jelly. Then the sample is kept vertically with open end downwards in the oven for 24 hours at  $70^\circ\text{C}$  with a paper under the sample.

**Test Specs:** Examine the paper placed below the cable inside the oven for dripping of the jelly after 24 hours. There should be no jelly drip or oily impression on the paper.

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#### 4.4 Termite & Rodent Test (Type Test)

Termite & Rodent test shall be carried out at any recognized lab on finished cable samples. The reports shall be submitted by the manufacturers. Termite resistant shall be provided with an additive in outer sheath.

#### 4.5 Tensile Strength Test

**Objective:** This measuring method applies to optical fibre cables, which are tested at a particular tensile strength in order to examine the behavior of the attenuation as a function of the load on a cable, which may occur during installation.

**Method:** IEC 794 -1 -2 - E 1

**Test Specs:** The cable shall have sufficient strength to withstand a load of value  $T(N) = 9.81 \times 2.5 W$  Newton or 2670 N whichever is higher. (Where W=mass of 1 km of cable in Kg) The load shall be sustained for two minutes and the strain of the fibre monitored.

**Requirement:** The load shall not produce a strain exceeding 0.25% in the fibre and shall not cause any permanent physical and optical damage to any component of the cable. The attenuation shall be noted before strain and after the release of strain. The change in attenuation of each fibre after the Test shall be  $< 0.05$  dB both for 1310 nm and 1550 nm wavelength.

#### 4.6 Abrasion Test

**Objective:** To test the abrasion resistance of the sheath and the marking printed on the surface of the cable.

**Method:** IEC - 794-1-2-E2 or by any other international test method.

**Requirement:** There shall be no perforation & loss of legibility of the marking on the sheath.

**Test Specs:** a) The conditions for testing shall be in accordance with standard atmospheric conditions.

b) Securely attach the cable sample, measuring approximately 750 mm in length, to the supporting plate by means of cable clamps. The abrading edge shall be loaded with the mass necessary to provide the force stated in the detail specification while avoiding shock on the cable.


Four tests shall be made on each sample, with the sample moved forwards 100 mm between tests and rotated through an angle of  $90^\circ$ , always in the same direction.

#### 4.7 Crush Test (Compressive Test)

**Objective:** The purpose of this test is to determine the ability of an optical fibre cable to withstand crushing

**Method:** IEC 794-1-2-E3.

**Test Spec.:** The fibres and component parts of the cable shall not suffer permanent damage when subjected to a compressive load of 2000 Newton applied between the plates of dimension 100 x 100mm. The load shall be applied for 60 secs. The attenuation shall be noted before and after the completion of the test.

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**Requirement:** The change in attenuation of the fibre after the test shall be  $< 0.05$  dB/Km both for 1300 nm and 1550 nm wavelength.

#### 4.8 Impact Test

**Object:** The purpose of this test is to determine the ability of an optical fibre cable to withstand impact

**Method:** IEC 794-1-2-E4

**Test Spec.:** The cable shall have. Sufficient strength to withstand art impact caused) by a mass weight of 50 Newton, when falls freely from a height of 0.5 meters. The radius R of the surface causing impact shall be 300 mm. ten such impacts shall be applied at the same place with a gap between one impact to another of approximately at 60 seconds. The attenuation shall be noted before and after the completion of the test.

**Requirement:** The. Change in attenuation of the fibre after the test shall be  $< 0.05$  dB/Km both for 1300 nm and 1550 nm wavelength.

#### 4.9 Repeated Bending

**Objective:** The purpose of this test is to determine the ability of an optical fibre cable to withstand repeated bending.

**Method:** EIA-455-104

**Test Specs.:** The cable sample shall be of sufficient length (5 m minimum) to permit radium power measurements as required by this test. Longer lengths may be used if required.

Parameters	5 Kg
Minimum distance from Pulley center to holding device	216 mm
Minimum device from Wt. To Pulley center	457 mm
Pulley Diameter(U-cable diameter)	20 D
Angle of Turning	90°
No. of cycles	30
Time requirement for 30 cycles	2 minutes.

**Requirement:** During this test, no fibre shall break and the attenuation shall be noted before and after the completion of the test. The change in attenuation of the fibre after the test shall Be  $< 0.05$  dB both for 1300 nm and 1550 nm wavelength.

#### 4.10 Torsion Test

**Object:** The purpose of this test is to determine the ability of an optical fibre cable to withstand torsion.

**Method:** IEC 794- 1-2-E7

**Test Spec.:** The length of the specimen under test shall be 2 meters and the load shall be 100 N. The sample shall be mounted in the test apparatus with cable clamped in the fixed clamp sufficiently tight

to prevent the movement of cable sheath during the test. One end of the cable shall be fixed to the rotating clamp, which shall be rotated in a clockwise direction for one turn. The sample shall then be returned to the starting position and then rotated in an anti-clock wise direction for one turn and returned to the starting position. This complete movement constitutes one cycle, the cable shall withstand ten such complete cycles. The attenuation shall be noted before and after the completion of the test.

**Requirement:** The cable shall be examined physically for any cracks. Tearing on the outer sheath and for the damage to other component parts of the cable, the twist mark shall not be taken as damage. The change in attenuation of the fibre after the test shall be  $< 0.05$  dB/Km. both for 1300 nm and 1550 nm wavelength.

#### 4.11 Kink Test

**Object:** The purpose of this test is to verify whether kinking of an optical fibre cable results in breakage of any fibre, when a loop is formed of dimension small enough to induce a kink on the sheath.

**Method:** IEC 794-1-2-E10.

**Test Spec.:** The sample length shall be 10 times the minimum bending radius of the cable. The sample is held in both hands. A loop is made of a bigger diameter and by stretching both the ends of the cable in opposite direction. The loop is made to the minimum bend radius, and no kink shall form, the cable is then normalized and attenuation reading is taken.

**Requirement:** The kink should disappear after normalizing the cable. The change in attenuation of the fibre after test shall be  $< 0.05$  dB both for 1300 nm 1550 nm wavelength.

#### 4.12 Cable Bend Test

**Objective:** The purpose of this test is to determine the ability of an optical fibre cable to withstand repeated flexing. The procedure is designed to measure optical transmittance changes and requires an assessment of any damage occurring to other cable components.

**Method:** IEC 794-1-2-E11 (Procedure-1)


**Test Spec.:** The fibre and the component parts of the cable shall not suffer permanent damage when the cable is repeatedly wrapped and unwrapped 4 complete turns of 10 complete cycles around a mandrel of  $20 D$ , where  $D$  is the diameter of the cable. The attenuation shall be noted before and after the completion of the test.

**Requirement:** The change in attenuation of the fibre after the test shall be  $< 0.05$  dB both for 1300 nm and 1550 nm wavelength. Sheath shall not show any cracks visible to the naked eye when examined whilst still wrapped to the mandrel.

#### 4.13 Temperature Cycling

**Objective:** To determine the stability behavior of the attenuation of a cable subjected to temperature changes, which may occur during storage, transportation and usage.

**Method:** IEC 794-1-2-F1 (To be tested on cable length of 200 m).

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**Test Specs.:** The permissible temperature range for storage and operation will be from  $-20^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$ . The rate of change of temperature during the test shall be  $1^{\circ}$  per minute approx. The cable shall be subjected to temperature cycling for 12 Hrs. at each temperature as given below:

- |   |           |
|---|-----------|
| i) at room temperature                  | : 1 hr.   |
| ii) at zero degrees                     | : 12 hrs. |
| iii) at 65 degrees                      | : 12 hrs. |
| iv) from 65 degrees to room temperature | : 1 hr.   |

The test shall be conducted for 2 cycles at the above temperatures.

**Requirement:** The change in attenuation of the fibre under test shall be  $< 0.05$  dB/Km for 1300 nm and 1550 nm wavelengths for the entire range of temperature.

#### 4.14 Water Penetration Test

**Objective:** The aim of this test is to ensure that installed jelly filled Metal free Optical fibre cable will not allow water passage along its length.

**Method:** IEC 794-1-2-F5 (Fig. B) 1992.

**Test Specs:** A circumferential portion of the cable end (with HDPE sheath after removing the nylon jacket) shall face the water head. The watertight sleeve shall be applied over the cable. The cable shall be supported horizontally and two meter head of water. Containing a sufficient quantity of water soluble fluorescent dye for the detection of seepage; shall be applied on the HDPE sheath for a period of 7 days at ambient temperature. No other colored dye is permitted.

**Requirement:** No dye shall be detected when the end of the 3 m length is examined with ultraviolet light detector. The cable sample under test shall be ripped open after the test and it shall be examined for seepage of water into the cable and the distance to be noted. It shall not be more than 20cm. For Semi Dry core cable, it shall not be more than 1 meter.

#### 4.15 Water Immersion Test

**Method:** IEC 60793 -53

#### 4.16 Flexural Rigidity Test on the Optical Fibre Cable

**Objective:** To check the Flexural Rigidity of the metal free optical fibre cable.


**Method:** To be tested as per ASTM D-790

**Test Specs.:** The fibre and the component parts of the cable shall not suffer permanent damage in the cable subjected to Flexural Rigidity Test as per the above method. The attenuation shall be noted alter and before the completion of the test.

**Requirement:** The change in attenuation of the fibre after the test shall be  $< 0.05$  dB both for 1300 nm and 1550 nm wavelength. The sheath shall not show any cracks visible to the naked eye.

#### 4.17 Test of Figure of 8 (Figure on the Cable)

**Objective:** Check of easiness in formation of figure of 8 of the cable during installation in the field.

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**Test method:** 1000 meter of the cable shall be uncoiled from the cable reel and shall be arranged in figure of 8(eight) shape. The dimensions of each loop of the figure of 8 shall be maximum 2 meters.

**Requirement:** It shall be possible to make figure of 8 of minimum 1000 meters of the cable uncoiled from the cable reel without any difficulty. No visible damage shall occur.

#### 4.18 Static Bend Test

**Objective:** To check the cable under Static bends

**Method:** As per clause no. 4.8 of the GR. alternatively as per ASTM D790

**Test Specs.:** The cable shall be subjected to static bend test. The optical fibre cable shall be bent on a mandrel having a radius of 10 D (D- is diameter of the cable).

**Requirement:** The change is attenuation of the fibre after the test shall be < 0.05 dB both for 1300 nm and 1550 nm not wavelength. Sheath shall not show any cracks visible with the naked eye when examined whilst wrapped on the mandrel.

#### 4.19 Sheath Integrity (Spark Test)

The sheath shall withstand a spark test voltage of at least 8 KV nms or 12 KV DC.

#### 4.20 Jointing Closures

Jointing closures shall be suitable for the cables, jointing closures shall be dust tight (No dust ingress) and protected against –immersion in water (Suitable for continuous immersion in saline water 0 and should be complete with all accessories including splice cassettes, splice protection and all accessories for electrical continuity of metallic layer of optical fibre cable. The jointing enclosures shall be provide with suitable jointing pit support hardware to secure the jointing closures to a 1200 mm dia circular jointing pit.

##### Jointing Closure Tests

Bidder shall provide detailed test procedures for testing Jointing Closures, and may improve upon the same. The following shall be conducted as a minimum:

##### a) Water ingress test


The cable jointing box shall be assembled along with a continuous piece of cable passing through. The jointing box shall then be secured at the bottom of a immersion tank containing water upto a height of 2.0m at normal room temp. for a period of 24 hrs. The joint box will then be opened as per the specified procedure and visually examined for any ingress of water. It shall be declared to have passed the test in case there is no water present inside the box.

##### b) Impact test

The cable joint box shall be kept on a metal platform. A weight of 5 kgs spherical type having radius of R 50 mm at striking end will be made to stike the box at the middle after having been released from a height of 500mm for 10 times. The joint box will be declared to have passed the test in case there are no cracks or fracture inside or outside of the box.

##### c) Drop and topple test

A drop test platform consisting of a steel plate not less than 6.5 mm thick is to be used. The steel plate is bolted to a fully set concrete block at least 460mm thick. The joint box shall then be

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allowed to topple and fall freely from a height of 200mm. The joint box will be declared to have passed the test in case there is no visible damage to the enclosure.

**d) Pulling test**

The joint box should be assembled with a long length of cable so that it can be pulled to the required tension of 100 KGS to check the strength of fixing arrangement inside the joint box.

**e) Static load test**

The assembled cable joint closure shall be kept on a platform with dimension more than that of cable joint closure. A curved hollow profiled mandrel shall be used for application of load and the mandrel shall be at the middle straight part of the joint closure. Weights shall be gradually placed on the mandrel till the weight becomes 250 kgs. The joint box shall be kept under the weight for a period of 24 hrs. The joint closure shall be declared to have passed the test in case there is no visible damage.

#### 4.21 Test for Loose Tube

**a) Embitterment Test of Loose Tube**

The test method is based on bending by compression and reflects embitterment much better than the other used tensile test. The test is independent of wall thickness of the loose tube.

Sample: The minimum length of the test sample depends on the outside diameter of the loose tube and should be 85 mm for tubes upto 2.5 mm outside dia. The length of the bigger tubes should be, calculated by using the following\* equation:

$$L_0 > 100 \times \sqrt{(D^2 + d^2)} / 4$$

Where

$L_0$  = Length of tube under test

$D$  = Outside dia of loose tube

$d$  = Inside dia of loose tube

**Procedure:** Both the ends of a butler tube test sample may be mounted in a tool which is clamped in jaws of a tensile machine which exert a constant rate of movement. The movable jaw may move at a rate of 50 mm per minute toward the fixed jaw. Under load the tube will be bent, so that the tube is subjected to tensile and compressive stresses. The fixture for holding the tube should be designed in a manner that the tube might bend in all directions without further loading.


**Requirement:** The tube should not get embitter. No kink should appear off the tube upto the safe bend dia of tube (20 D) where D is the outside diameter of the loose tube. There should not be any physical damage or mark on the tube surface.

**b) Kink Resistance Test-on the loose tube**

**Objective:** To safeguard the delicate optical fibres, the quality of the loose tube material should be such that no kink or damage to the tube occurs while it is being handled during installation and in splicing operations.

**Procedure:** To check the kink resistance of the loose tube. A longer length of the loose tube is taken (with fibre and gel). A loop is made and loop is reduced to the minimum bend radius of loose tube i.e. 20 D. (where D is the outside dia of the loose tube). This test is to be repeated 4 times on the same sample length of the loose tube.

**Requirement:** No damage or kink should appear on the surface of the tube.

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**c) Drainage Test For Loose Tube**

**Sample Size:** 30 cm tube length.

**Test Procedure**

- i. Cut the tube length to 40 cm
- ii. Fill the tube with the tube filling gel ensuring there are no air bubbles and the tube is completely full.
- iii. Place the filled tube in a horizontal position on a clean worktop and cut 5 cm from each end so that the finished length of the sample is 30 cm.
- iv. Leave the filled tube in a horizontal position at an ambient temperature for 24 hrs. (This is necessary because the gel has been sheared and the viscosity has been reduced during the filling process).
- v. The sample tube is then suspended vertically in an environment heat oven, over a weighted beaker. It is left in the oven at a temperature of 70°C for a period of 24 Hrs.
- vi. At the end of the 24 Hrs periods the beaker is checked and weighted to see if there is any gel in the beaker.

**Requirement:**

- i. If there is no gel or oil in the beaker the tube has PASSED the drainage test.
- ii. If there is gel or oil in the beaker the tube has FAILED the drainage test.

**d) Check Of Easy Removal Of Sheath:**

Check of the easy removal of sheath of the optical fibre cable by using normal sheath removal tool.

To check easy removal: The sheath shall be cut in circular way and about 300 mm lengths of the sheath should be removed in one operation. It should be observed during sheath removal process that no undue extra force is applied and no component part of the cable is damaged. One should be able to remove the sheath easily.

**Note:** - Easy removal of both the outer jacket and the inner sheath shall be checked separately.

**e) Acidic And Alkaline Behavior Test**

To check the effect of the aggressive media, solution of PH4 and PH10 shall be made. The two test samples of the finished cable each of 600 mm in length are taken and die ends of the Samples are sealed. These test samples are put in the PH4 and PH10 solutions separately. After 30 days these samples are taken out from the solutions and examined for any corrosion etc. on the sheath and other markings of the cables. (Test method no. ISO 175).

**Requirement:** The sample should not show any effect of these solutions on the sheath and other marking of the cable.

## 5. GENERAL REQUIREMENTS

### 5.1 Cable Marking

A long lasting suitable marking shall be applied in order to identify this cable from other cables. The cable marking shall be imprinted (indented). The marking on the cable shall be indelible of durable quality and at regular intervals of one meter length. The accuracy of the sequential marking must be within -0.25% to +0.5% of the actual measured length. The sequential length markings must not rub off during normal installation and in life time of optical fiber cable. The total length of the cable supplied shall not be in negative tolerance.

The marking shall be in contrast colour over the black HDPE Sheath (jacket) and shall be one by hot foil indentation method. The colour used must withstand the environmental influences experienced in the field.

The type of legend marking on O.F. cable shall be as follows:

- a) Company Legend
- b) Legend containing telephone mark & international acceptable Laser symbol
- c) Type of Fiber– G.652 D
- d) Number of Fibers
- e) Type of cable
- f) Year of manufacture
- g) Sequential length marking
- h) User's Identification
- i) Cable ID

### 5.2 Cable Ends


Both cable ends (the beginning end and end of the cable reel) shall be sealed and readily accessible. Minimum 5 meter of the cable of the beginning end of the reel shall accessible for testing. Both ends of the cable shall be kept inside the drums and shall be located so as to be easily accessible for the test. The drum (confirming to GR No. G/CBD-O1/02 Nov. 94 and subsequent amendment) should be marked to identify the direction of rotation of the drum. Both ends of cable shall be provided with cable pulling (grip) stocking and the anti twist device (free head hook). The wooden drums shall be properly treated against termites and other insects during transportation and storage. The manufacturer shall submit the methodology used for the same.

An anti twist device (Free head hook) shall be provided, attached to the both the ends of the cable pulling arrangement. The arrangement of the pulling eye and its coupling system along with the anti twist system shall withstand the prescribed tensile load applicable to the cable.

### 5.3 The Nominal Drum Length

Length of Optical Fiber Cable (OFC) in each drum shall be 4Km with tolerance of  $1\pm\%$ . The fibers in cable length shall not have any joint. The drum shall be marked with arrows to indicate the direction of rotation. Packing list supplied with each drum shall have at least the following information:

- a) Drum No.
- b) Type of cables
- c) Physical Cable length
- d) No. of fibers
- e) Length of each fiber as measured by OTDR
- f) The Cable factor - ratio of fiber/cable length
- g) Attenuation per Km. of each fiber at 1310 & 1550 nm

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- h) Owner's Name
- i) Manufacturers Name, Month, Year and Batch No.
- j) Group refractive index of fiber
- k) Purchase Order No.
- l) Cable ID

#### 5.4 Colour coding in O.F. Cables

The colorant applied to individual fibers shall be readily identifiable throughout the lifetime of the cable and shall match and conform to the Munsell Colour Standards (EIA-359-A) and also IEC Publication 304 (4).

#### 5.5 Colour Coding Scheme

Color code to be adapted for individual fibers in each loose tube shall be:

1. Blue
2. Orange
3. Green
4. Natural

Colour code to be adapted for individual loose tube shall be:

When the loose tubes are placed in circular format, the marking to indicate the loose tube no. "1" shall be in blue colour followed by loose tube no.2 of orange and so on for other tubes as per below:

1. Loose tube number 1 shall be Blue
2. Loose tube number 2 shall be Orange
3. Loose tube number 3 shall be Green
4. Loose tube number 4 shall be Brown
5. Loose tube number 5 shall be Slate
6. Loose tube number 6 shall be White

## 6. QUALITY REQUIREMENTS


The cable shall be manufactured in accordance with the international quality standards ISO 9001-2008 (latest issue) for which the manufacturer should be duly accredited. The Quality Manual shall be submitted by the manufacturer.

## 7. RAW MATERIAL

The cable shall use the raw materials approved against the GR No. TEC/GR/TX/ORM-01/04 SEP.09 and the subsequent amendment issued, if any.

## 8. DOCUMENTATION

Complete technical literature in English with detailed cable construction diagram of various sub-components with dimensions, weight & test data and other details of the cable shall be provided. All aspects of installation, operation, maintenance and fiber splicing shall also be covered in the handbook. The pictorial diagrams of the accessories (with model no. and manufacturer name) supplied along with the cable as package shall be also be submitted. A hard as well as soft copy of the manuals shall be provided.

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**9. SAFETY**

It shall not be hazardous to health. The contractor shall submit MSDS (Material Safety Data Sheet) for all the material used in manufacturing of cable to substantiate the statement.

**10. REFERENCE DOCUMENTS**

Drawings and Standard as per table below:

Sr. No.	Document/Drawing Name	Drawing No
1.	Raw Material	TEC Specs No. TEC/GR/TX/ORM 01/04/SEP-09 and latest amendments if any.
2.	Colour Standards	EIA 359-A and IEC Publication 304(4) with latest amendments, if any
3.	ITU-IT Recommendation	G.652 D & G655
4.	Operation & handling	TEC Specs No. G/OFT-01/03 APR 2006
5.	Specification for Optical Joint Closure	TEC Specs No. GR/OJC-02/02 SEPT 03 with latest amendments, if any
6.	OFC with Respect of Pipeline	
7.	OFC Installation inside Terminal	
8.	OFC Installation Cased Crossing	
9.	OFC Diagram	

**11. PERMANENTLY LUBRICATED HDPE DUCT**


The bidder shall be totally responsible for the desired performance of the offered permanently lubricated HDPE duct including design, engineering, manufacture, testing and supply.

The intent of the following specifications is to establish the minimum requirements and guidelines for the permanently lubricated HDPE duct and associated items offered for this project.

Design, Engineering, Manufacture, Testing and supply of solid lubricated HDPE duct, HDPE duct couplers. End plugs, cable staling plugs and end caps for sealing conduits.

The length of Permanent lubricated HDPE Duct shall be as per actual requirement

**11.1 Technical Specifications of HDPE Duct**

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50mm OD / 42 mm ID permanently lubricated two layered HDPE duct of 1 km +/- 100 Mt. Length complying the DOT's GR-G/CDS-08/01 Dec 99 (with all amendments issued by TEC up to Dec 2005).

HDPE duct shall also conform to the following specifications:

IS: 7328.

IS: 4984

ASTM: D-1693

The HDPE duct shall be permanently Lubricated with an inner layer of solid permanent lubricant continuous throughout its length co-extruded during the manufacturing process to minimize internal coefficient of friction.

HDPE duct shall be supplied in orange colour and one colour shall be maintained throughout its drum length.

Two layered permanently lubricated HDPE ducts as per above specifications should be converted in continuous coil length of 1 Km +/- 100 Mt. 3.2. The converter should have requisite expertise of converting permanently lubricated two layered HDPE duct.

The HDPE duct shall have smooth surfaces and shall be free from defects. Break, Shrink holes, flaking, and chips. Scratches, Roughness &. Blisters

Typical requirements are indicated below. However the same shall conform to latest revision and amendments of GR No. G/CDS-08/01

Sr No.	Parameters	Reference Standard	Typical Requirements
1	Dimensions and tolerance	GR	
A	Length of each duct		1000 ± 100 Mtrs
B	Nominal Outside Diameter		50 ± 0.4 mm
C	Wall Thickness		4 ± 0.3 mm
D	Thickness of inner lubricant layer		≥0.35 mm
E	Bending Radius		1.25 Mtrs minimum
F	Color		Light Blue / Parrot Green
2	Ovality	IS :4984	1.0 mm
3	Heat Reversion	IS:4984	Max 3%
4	Hydraulic Test Type Test Duration : 165 Hrs at 80°C Induced stress :3.5 Mpa Acceptance test Duration : 48 Hrs at 80°C Stress induced : 3.8 Mpa	IS:4984	No failure or leakage seen
5	Tensile Strength Elongation	IS: 14151 Part 1	Min 20 N/mm <sup>2</sup> Min 600%
6	Environmental stress crack resistance	ASTM D 1693	No Failure

Sr No.	Parameters	Reference Standard	Typical Requirements
7	Impact Strength (Striker weight 10 kg)	IS: 12235 part 9	No crack or split
8	Crush Resistance 50 kg load	GR	Deflection with load < 10% Deflection after recovery < 2%
9	Oxidation induction test ( > 30 minutes)	GR	Satisfactory
10	Internal coefficient of friction	GR	< 0.06
11	Density of finished product	IS:7328	0.940 to 0.958 g/cc at 27°C
12	Melt flow rate MFR	IS:2530	0.2 to 1.10 10 minute at gm/and 5 kg 190°C load
13	Maximum pulling force		300 Kg

### 11.2 Identification

The outer surface of the conduit shall be permanently & legibly marked with colour in contrast to the outer sheath of the cable at regular intervals not exceeding one meter with name of client name of manufacturer part number. Following details shall be added over the HDPE duct:

- a) Owner's Name
- b) OWNER LOGO
- c) Manufacturer's name
- d) Duct size
- e) Sequential length marking at every meter.
- f) Sr no. of the HDPE duct

### 11.3 Plastic Couplers

HDPE duct couplers, end plugs. Cable sealing plugs, end caps for sealing conduits shall be suitable for 50 mm OD HDPE conduit.

Joint of HDPE duct shall be by fusion type HDPE duct coupler.

The couplers used for joining two ducts shall be push fit type having push lock mechanism which enables them to be installed on duct without pre-dismantling.

Design shall be simple, easy to install and shall provide air tight and water tight leak proof joints. It shall withstand air pressure test of 15 kg/cm<sup>2</sup> for a minimum.

### 11.4 Testing

Following sample tests shall be conducted on three randomly selected permanent lubricated HDPE conduits drums. These shall be tested as per the latest edition of TEC standard for Permanently lubricated HDPE ducts for use as underground optical fiber cable conduits.

- a) Visual Inspection
- b) Impact strength
- c) Crush resistance
- d) Quality test
- e) Coil test
- f) Hydraulic characteristics Internal co-efficient of friction

In case permanent lubricated HDPE duct. Tested and inspected in accordance with this specification. Fail to pass the test or comply with the specification requirement, the tests shall be repeated on a further representative sea of conduit pieces. And if it again fails, the whole lot shall be rejected subject to the discretion of the Owner/Owner's representatives.

Bidder shall provide detailed test procedures for each of the above mentioned tests after award of contract for approval and the tests shall be conducted as per approved procedures.

### 11.5 Packing

All drums shall be individually packed to avoid damage during transit and storage in accordance with best commercial practice and with the requirements of applicable. The materials used for packing, wrapping, sealing etc. shall be of recognized brands and shall conform to best standards in the areas in which the articles are packaged. This packing shall protect the HDPE duct from impact of vibration, rough handling, rodents, etc.

The minimum diameter of the coiled duct shall be 25 times the outer diameter of the duct.

Each drum shall have a copy of factory acceptance test report enclosed in it.

## 12. FIBER TERMINATION CLOSURE

### 12.1 General

The FTC shall be wall-mounted type as suitable for the Optical Fiber cable used for this project (24 fibers). The FTC shall have grounding arrangement for all the metallic layers of the cable. The cable shall be spliced to pigtails on trays provided in the FTC. The connector side for the pigtails shall be secured with suitable coupler/through adapter provided as integral part of the FTC itself.

The FTC shall be of 24-fibre termination type. The FTC shall have trays suitable for splicing maximum of 6 fibers per tray. The arrangement inside the FTC should be simple and in straight line.

FTC should have entry points for a minimum of 2 no. of Optical Fiber Cable (armoured /un-armoured) of diameter up to 20 mm with cable clamps to avoid entry of rodents/ dust in general. It should have a minimum of 2 nos. of outlets for taking out 24 nos. of pigtail. The outlets should have cable clamps.

Grounding arrangement should be provided with the FTC. It should include as a minimum 2 nos. Grounding shield bonds with nut and bolts for fixing to the armour of the OFC and 2 nos. of grounding cable of suitable length “& of green colour eight lugs clamped to its end for connecting the armour of OFC with the grounding terminal of the FTC.

The FTC shall be of reputed make like: 3M, Corning, Siemens, Raychem & Tyco.

Insertion loss of Coupler / Adaptor shall be maximum 0.25 dB per connector.


The FTCs shall be provided with Pigtails for all terminations

### 12.2 Pigtail & Connectors:

12.2.1 This specification provides requirements for single mode fibre pigtails and connectors. They should meet the ITU- T recommendations G-652 & G 655 as required.

12.2.2 Both connectors and cables should be robust and should withstand wear and tear due to frequent use, connection and disconnection. Normal expected life should be 15 years or more.

12.2.3 Pigtail & connectors shall essentially be of same make as FTC.

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## 12.2.4 Optical Parameters of Connectors With Pigtails shall be as below:


Insertion loss	:	Maximum 0.3 dB Per connector plus fiber loss
Return loss	:	Better than 40 dB
Temperature Dependency	:	< 0.3 dB From – 20 to + 60
Change in connection loss With passage of time at 60 °C for 100 hrs	:	It should be < 0.3 dB
Change in connection loss Due to vibration	:	< 0.05 dB
Reproducibility of Connection loss by repeated Connections and Disconnection for 500 times.	:	< 0.3 dB
Change in Connection loss In relation to Tensile strength	:	(1) Loaded : – 50 dB (2) Unloaded : – 30 dB

12.3 **Optical Patch Cords**

The patch chords provided shall be 20 Mtrs. in length  
Make: Birla-3M / Cancam / Advanced Fiber System / Corning

**13. INSTALLATION****13.1 General Requirement**

- 13.1.1 OFC laying and HDPE duct laying shall be in Terminal area, SV station, Dispatch Terminal and Receiving Terminal area, as applicable other than for pipeline route.
- 13.1.2 The permanently lubricated HDPE duct used for leading in of the OFC into room housing the telecom equipment shall be below ground level without getting exposed outside ( the entry point shall be properly sealed after OFC installation to avoid entry of rodents, insects etc.).
- 13.1.3 At all Tie-in locations, the trench shall be excavated further wherever possible, and permanently lubricated HDPE duct shall be laid away ( approx 1 meter ) from the pipeline to avoid damage to the HDPE conduit and to the pipeline.
- 13.1.4 At crossings one spare duct to be laid in addition with OFC with HDPE duct.
- 13.1.5 Route survey to collect cable routing information such as crossing of railways, roads, nala, rivers etc, and requirements of any local detours etc., and also to determine the exact length of cable required. Vendor shall obtain the cable as per the requirement (based on survey conducted by the vendor).
- 13.1.6 The Contractor shall determine a suitable cable installation method to ensure that all cable installation requirements shall be met in all conduit sections. All work shall be carried out in accordance and consistent with the highest standards of quality and craftsmanship in the communication industry with regard to the electrical and mechanical integrity of the connections, the finished appearance of the

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installation as well as the accuracy and completeness of the documentation.

13.1.7 The scope of installation of OFC shall include all that is necessary to lay the optical Fibre cable in the same trench as the pipeline and it shall be generally as described below:-

13.1.8 Laying of optical fibre cable along the pipeline in the same trench as that of the pipeline including crossing of railways, roads, Nala, rivers etc and splicing jointing, earthing (as required) along with all associated cabling work. The cable laying shall be by Compressed air blowing method. Necessary tools and tackles for cable laying shall be arranged by the Contractor.

13.1.9 The cable shall be laid at level approx. depth of 1.6 m from ground level.

13.1.10 Laying of optical fibre cable within the terminals / Repeater station areas where telecom cable leaves the pipeline trench and is required to be laid in a separate trench up to the control building cabinets (Telecom room).

13.1.11 Sealing of the cable ends as required to prevent moisture ingress shall be contractor scope

### 13.2 Scope of Work for Installation

The contractor scope for installation of FO cable shall include but not limited to

13.2.1 Survey the cable route and prepare cable route sheers on the basis of the pipeline route alignment sheets. Where service crossing exists, in addition to the general guidelines stated in this specification, the Contractor shall follow all the particular requirements of the purchaser.

13.2.2 Trench excavation in pipeline trench, as needed.

13.2.3 Laying bed preparation.

13.2.4 Laying the HDPE pipe.

13.2.5 Installation of cable in 50mm outer dia mm, Permanent lubricated HDPE Duct. The HDPE ducts shall be suitable to withstand a load of 10 kg/cm<sup>2</sup>. All HDPE duct couplers shall be of Fusion type only.

13.2.6 Warranty & guarantee for performance of the laid cable.

13.2.7 Transit & storage insurance of all materials (cable & accessories) till the System is fully handed over.

13.2.8 Provision of necessary power supply at site for the splicing etc.


13.2.9 Procurement and supply & installation of any other materials required for laying jointing & end sealing of cable including jointing-pit. splice-closures. cable-markers, sand, bricks, HDPE duct etc.

### 13.3 OFC Pit

An RC pit will be provided at the places of jointing of OFC and as required for blowing/inspection. Water retaining structure of minimum size L 1.5m x W 1.5m (with Depth of the pit as required to carry out jointing, inspection & testing of OFC).

Blowing and inspection pit at every 2 Km.

Joining pit at every 4 Km.

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The pit shall be provided with a concrete cover slab with a man-hole. The top of this slab shall be minimum 300mm above the finished ground level or depth of water logging during monsoon whichever is higher.


A cat ladder shall be provided, if depth of pit is more than 1 m, on the side where OFC is not to be routed.

#### 13.4 Protective Measures During Installation

- 13.4.1 The Contractor shall comply with the cable manufacturer's recommended installation procedures at all times.
- 13.4.2 To reduce the possibility of damage to the outer jacket of the fiber optic cable protective measures shall be used when the cable is installed. The requirements herein shall be renewed, but does not limit the installation to only those identified. The purpose of the installation specifications is to ensure protection of the fibre optic cable when it is installed. Other protective measures not specified herein may be taken during installation if it will ensure protection of the cable.
- 13.4.3 The cable shall be protected against damages from termite, rodent, fire chemicals (such as oil & natural gas, LPG and other petroleum products), moisture and water over the lifetime of the cable.
- 13.4.4 A cable feeder guide shall be used between the cable reel and the face of the duct and conduit to protect the cable and guide it of the reel and into the duct.
- 13.4.5 Precautions shall be taken during installation to prevent the cable from being kinked, crushed or twisted. A pulling eye shall be attached to the cable end and be used to pull the cable through the duct and conduit system. As the cable is pulled off the reel and into the cable feeder guide, it shall be lubricated with a lubricant that shall be of the water based type and approved by the cable manufacturer.
- 13.4.6 Dynamometers or breakaway pulling swings shall be used to ensure the pulling line tension does not exceed the installation tension values specified by the cable manufacturer. The mechanical stress placed upon the cable during installation shall not be such that the cable is twisted and stretched. Maximum allowable cable strain during: installation shall be less than 0.75%.

#### 13.5 Cable Laying Procedure

- 13.5.1 The trench shall be enlarged at the splicing points as needed to carry out the splicing works. The enlargement shall be carried out on the same side of the cable for the entire route.
- 13.5.2 A laying bed shall be prepared by the contractor, in case, separate trench is planned in any area. The laying bed of 10cm depth shall be made of sand or riddled earth obtained by passing through a sieve having meshes not exceeding 15 mm<sup>2</sup>, or of a natural soft around not requiring riddling.
- 13.5.3 Contractor shall plan the cable-laying operation such that the complete drum-length of cable can be laid without cutting in between. The cable can be laid using a mobile reel system or a fixed reel system in relation to the characteristics of each section (excavation partially open, crossings, etc.)
- 13.5.4 The cable shall be carefully inspected for jacket defects as it is removed from the reel. If defects are noticed, the pulling operation shall be terminated immediately and the CONSTRUCTION MANAGER (SITE-INCHARGE) notified.
- 13.5.5 The contractor shall establish section by section the ways and means for the cable laying taking into account the characteristics of the layout.
- 13.5.6 In all jointing locations, including the normal joint at the end of the drum length and also at points of cable-cuts due to laying necessities, at least one meter of cable shall be left in a coiled form in the pit to allow for splicing and jointing of the cable.
- 13.5.7 At all telecom building locations (including terminals and intermediate stations) an extra length of about

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20 meter of each cable shall be kept in a coiled form.

- 13.5.8 Vendor shall provide the necessary cable leading pipes for cable(s) entry inside the telecom room. All these leading-in-pipes shall be properly scaled to prevent entry of rodents, snakes, insects and foreign materials. At locations where the telecom room shall not be available. The extra length of the cable shall be kept buried in ground near the proposed telecom room location.
- 13.5.9 If the splicing or termination operation does not follow immediately after the cable laying, all cable ends must be sealed carefully with heat-shrinkable end-caps.
- 13.5.10 To accommodate long continuous installation lengths, bi-directional "center pull" techniques for pulling of the fiber optic cable is acceptable and shall be implemented as follows:
- 13.5.11 From the midpoint pull the fibre optic cable into the conduit from the shipping reel in accordance with the manufacturer's specifications.

When this portion of the pull is complete, the remainder of the cable must be removed from the reel to make the inside end available for pulling in the opposite direction.

This is accomplished by hand pulling the cable from the reel and laying into large "figure eight".

This loop shall be laid carefully one upon the other (to prevent subsequent tangling) and shall be in a protected area.

The inside reel end of the cable is then available for installation.

In some cases, it may be necessary to set up a winch at an intermediate cable vault.

The required length of cable shall be pulled to that point, and brought out of the cable vault and coiled into a figure eight.

The figure eight is then turned over to gain access to the free cable end. This can then be reinserted into the duct system for installation into the next section.

When power equipment is used to install fiber optic cables, the pulling speed shall not exceed 30 meters per minute. The pulling tension, bending radius and twist limitation for fiber optic cable shall not be exceeded under any circumstances.

Large diameter wheels, pulling sheaves and cable guides shall be used to maintain the appropriate bending radius. Tension monitoring shall be accomplished using commercial dynamometers or load-cell instruments.


The pulling eye/sheath termination hardware on the fiber optic cables shall not be pulled over any sheave blocks

Under no condition shall OFC be left exposed or unattended.

Repairs: Repair of cable jacket shall not be permitted. Jacket damage shall require removal and re-installation of a new cable run at the Contractor's expense.

#### 13.5.12 Lubrication

As the cable is pulled into the conduit system, it shall be sufficiently lubricated with a lubricant that shall be the water-based type and approved by the cable manufacturer, Lubricant shall be applied at a rate to provide a continuous 10-mil coating, as recommended by the manufacturer.

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### 13.6 Crossing

13.6.1 Cable laying for rail, road, Canal & river crossings shall be through a min. 50 mm outer with HDPE pipe, provided as part of the pipeline laying. An additional pulling rope shall be kept inside to meet future requirements. One spare duct shall be laid in addition with OFC with HDPE duct.

13.6.2 After installation the casing pipe shall be cleaned inside of any kind of dirt stones, etc. Bituminized jute shall be used to close the ends of the conduit to prevent any dirt deposit. Similarly, Bituminized jute shall be used to close the conduits ends after introduction of the cable.

#### 13.6.3 Crossing of Underground Services

Where crossing of existing underground pipelines and cables, pipes on sleepers, etc. occur, the same requirements for normal laying shall apply, the cable maintaining the normal position with respect to the pipeline.

### 13.7 Jointing / Installation At Pull Boxes

13.7.1 The pulling of the cable shall be hand assisted at each pull box.

13.7.2 The extra length of fiber optic cable shall be coiled and secured with cable ties in the pull box. The Contractor shall ensure minimum bending radius of the fibre optic cable.

13.7.3 Imprinted plastic coated identification tags shall be securely attached to the cables in at least two locations in each pull box.

13.7.4 When all cables at each pull box are securely racked, unused conduits and void area around conduit containing cables shall be sealed.

13.7.5 The joint enclosure shall support an optical fibre organizer and allow sealing-off the outer sheaths of the cable.

13.7.6 Vendor shall provide detailed procedure for jointing of the cable along with the details of the jointing pits to be used for housing the joint enclosure and the excess cable after jointing.

13.7.7 Splicing loss shall not be more than 0.7db/Splice.

13.7.8 Vendor shall provide “ELECTRONIC MARKER & ELECTRONIC INDICATOR” of approved make at each Jointing location


### 13.8 Backfilling

Above the laid cable, a cover of 75 mm minimum depth of sand or riddled earth or of natural earth not requiring riddling (as stated elsewhere) shall be provided. Such an operation shall be under the responsibility of the contractor.

Above this cover a single layer of second-class brick shall be laid in a transverse manner over the cable laid in the trench. The bricks shall be fully soaked in water before being laid in the trench.

There shall be minimum seven bricks per meter laid with uniform spacing over the length of the laid cable.

A warning mat made of PVC sheet of orange colour and 150 mm, 0.1 mm size shall be laid over the cable as shown in annexure-6. At regular interval of 1.5 Mts. There shall be clear permanent print “OWNER’S NAME.”

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At the splicing points, the contractor shall also take care to backfill the trench and to restore the relevant area and to repair any damaged works.

After entering the telecom room the cable shall be secured on steel mesh or wire mesh by the help ties (-15 m cable being kept in turns in oval form). This mesh shall have suitable chemical coating/ painted to prevent corrosion. In case of painting, the color shall match the wall color. The dimensions of the wire mesh at all the locations shall be 3 feet X 4 feet / 3.5 feet X 3.5 feet.

### 13.9 Earthing System:

- i. Relevant Indian Standard (IS 3043) or equivalent BIS & IEC standard shall be followed.
- ii. The earthing material to be used shall be Electrolytic Copper having the material specifications confirming to the IS standards.
- iii. The dimension of the Earthing strip, which shall be connected between Earth pit & the equipment or the earthing distributor, shall not be less than 25 mm x 5 mm.
- iv. The earthing pit should have water pouring facility.
- v. Earthing resistance should be less than 2 ohms or should be suitable for the equipment to which the earthing is extended.

### 13.10 Testing

Once OFC is laid and commissioned, joint testing of OFC shall be carried out for all 24 fibers with pipeline laying contractor and telecom equipment contractor for fiber length measurement, insertion loss measurement. A format shall be enclosed for joint testing of all 24 fibers.

## 14. QUALITY ASSURANCE PROGRAMME & TESTING

### 14.1 OFC Cable


Vendor shall submit Quality Assurance Plan (QAP) immediately after receipt of order for Owner's approval. The test and inspection shall be carried out as per the QAP in accordance with the codes and standards outlined in this specification. As per requirements, stage wise inspection shall be carried out by Owner / Owner's representative during the various stages of manufacturing and vendor shall provide free access to them in his facility.

### 14.2 HDPE Duct

The bidder shall submit QA/QC procedures and inspection plan for Owner/Owner's representative review and approval before manufacturing the solid lubricated HDPE duct. Manufacturing by the vendor and inspection by owner/owner's representative shall be in accordance with the approved QA/QC procedures and inspection test plan.

### 14.3 Tests

Following test shall be conducted as a minimum as per the codes and standards indicated in this document. Test results must comply to specifications of latest revision and amendments of TEC GR No GR/CDS-08/02 Nov'04 along with other requirements.

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Visual inspection

Dimensions

Tensile Strength and elongation

Reversion Test

Environmental Stress Crack Resistance

Impact Strength Test

Crush Resistance Test

Ovality Test

Oxidation Induction Test

Hydraulic Characteristic Test

Internal Coefficient of friction Test

Density of finished product

Melt Flow Rate (MFR) of finished product

#### 14.4 **Factory Acceptance Tests**

FAT of OFC and HDPE duct shall be conducted at manufacturing premises of OFC and HDPE duct.

No material shall be dispatched unless vendor has complied to all the specification requirements to the satisfaction of inspection authority of Owner and a dispatch note issued by Owner / Owner's representative. Converter has to arrange for all test facilities for inspection at factory.

#### 14.5 **Site Acceptance Tests**

Once OFC is laid and commissioned, joint testing of OFC shall be carried out for all 24 fibers with pipeline laying contractor and telecom equipment contractor for fiber length measurement, insertion loss measurement. A format shall be enclosed for joint testing of all 24 fibers.


#### 14.6 **HDPE Duct Tests**

Owner / Consultant may carry out Site Acceptance Tests on randomly selected samples from the finished HDPE duct supplied at project site in field.

Random checks somewhere in the middle of the coil, by cutting the duct, will be made at site to ensure that ducts supplied are of correct dimension and thickness and there is no compromise on thickness in intermediate length, for saving in materials cost.

100% Duct coils being supplied would be weighed to cross check the quantity of plastic used.

To keep a check on the use of filler material, ash contents would be determined on randomly selected samples as per ASTM D 1603 method and the value of ash content, thus determined, shall not exceed 0.4% or 0.2% more than the ash content of Raw Granules.

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UV Stabilize content: Identification of UV additive shall be done by FTIR Spectra, NMR Spectra and UV Spectra. UV Stabilizer content of finished duct shall not be less than 0.05%.

#### 14.7 REFERENCE DOCUMENTS

Drawings and Standard as per table below:

Sr. No.	Document/Drawing Name	Drawing Number
10.	OFC WITH RESPECT OF PIPELINE	
11.	OFC INSTALLATION INSIDE TERMINAL	
12.	OFC INSTALLATION CASSED CROSSING	
13.	OFC DIAGRAM	
14.	IS: 2530	Methods for test for Polyethylene Moulding Materials and Polyethylene Compounds.
15.	IS: 4984	High density polyethylene pipes for water supply
16.	IS: 5175	Polypropylene ropes
17.	IS:7328	High density polyethylene materials for moulding and extrusion
18.	IS:9938	Recommended colours for PVC insulation for LF wires and cables
19.	IS:12235 (Part-9)	Methods of test for unplasticized PVC pipes for potable water supplies – Impact strength at 0 Deg C.
20.	IS:14151 (Part-1)	Polyethylene pipes for sprinkler irrigation systems (Part-1 Pipes)
21.	ASTM D 638	Standard Test Method for Tensile Properties of Plastics
22.	ASTM D 648	Test method Deflection Temperature of plastics under flexural load.
23.	ASTM D 790	Test Method for Flexural Properties of Un-reinforced and Reinforced Plastics and Electrical Insulating Materials.

24.	ASTM D 1693	Test Method for environmental stress cracking of ethylene plastics
25.	ASTM D 1712	Standard Practice for Resistance of Plastics of to Sulfide Staining.
26.	ASTM D 2240	Standard Test Method for Rubber Property
27.	ASTM 114565	Standard Methods of Testing Physical and Environmental Performance Properties of Insulations and Jackets for Telecommunications wire and cable.
28.	ASTM F 2160	Standard Specifications for solid Wall, HDPE Conduit Based on Controlled OD.
29.	ASTM G 154	Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Non-metallic materials.



**GAIL INDIA LIMITED**

**STANDARD PROCEDURE  
FOR  
FIBER OPTICAL CABLE TESTING**

**GAIL-STD-TL-DOC-TS-002**

Rev	Date	Purpose	Prepared By	Checked By	Approved By
0	15.01.2019	Issued As Standard	RKS	UNU	UNU



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## 1 HOP TESTING

After back filling of the trench, fiber optic cable shall be tested for continuity and attenuation over the laid length.

The test shall be conducted both before and after the splicing. It shall be ensured that the cable attenuation does not exceed as recommended for G 655 or G 652 cables (excluding the splice loss) and the splice loss on each fiber shall be 0.1 dB per splice (max.). Test procedures mentioned herein are minimum requirements to be followed. However, Contractor shall provide the detailed procedure for cable testing.

Fiber optic cable test-results shall clearly provide the attenuation for each fiber in following aspects:

- Different Wavelengths (1310 nm and 1550 nm)
- Each cable section
- Individual splice.

Total Attenuation = (wavelength ( $\lambda$ ) loss dB/km x fiber length) + (connector loss x number of connectors) + (splice loss x number of splices).

Where,

L = Length of the cable between two nodes;

N = No. of joints between two nodes.

Results shall be within permissible limits. After hop testing results with average losses shall be recorded for each fiber and hop wise report shall be submitted as per approved procedure. Testing shall be witnessed jointly by GAIL and PMC. Contractor shall furnish as built documents and hop loss report hop wise.

## 2 FIBER LENGTH MEASUREMENT

### 2.1 Test Description

This test will check the continuity of the fibre from station to station and record the length of fibre. Average loss per kilometre of fibre length shown in dB/km shall be recorded for information only. Testing will be done from both ends and average loss will be calculated (for 310nm/1550nm/1625nm, as applicable).

### 2.2 Test Equipment


Following test equipment shall be used:

- Optical Time Domain Reflectometer (OTDR);
- Patch cords;
- Pigtails


### 2.3 Procedure

Test procedure shall be as detailed below. Test formats (1A & 1B) shall be as depicted in Section 2.4 and 2.5.

- Power ON the OTDR and make the settings as required for the hop under test.
- Connect the OTDR with patch cord to the connector in FTC.

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- Make the Laser ON and observe the trace till it gets settled up to the end of the trace.
- Store the results in the hard disk/floppy disk with proper identification of the fibre under test.
- Record the results in format provided
- Repeat the procedure for the opposite direction.
- Repeat above steps for each fiber.

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**2.4 Format 1A**

**Fiber Length Measurement (G.652)**

Date:

Location A:

Location B:

Wavelength: 1310 nm & 1550 nm

Equipment Used:

Tube No. / Color	Fiber No. / Color	Fiber Length (m)	Optical Loss dB/km		Average Cable Loss (dB/km)
			From A	From B	

**2.5 Format 1B**

**Fiber Length Measurement (G.655)**

Date:

Location A:

Location B:

Wavelength: 1550 nm & 1625 nm

Equipment Used:

Tube No. / Color	Fiber No. / Color	Fiber Length (m)	Optical Loss dB/km		Average Cable Loss (dB/km)
			From A	From B	

### 3 INSERTION LOSS MEASUREMENT

#### 3.1 Test Description

During insertion loss measurement, light is launched (LASER) in the fibre by using a LASER source from one end at the other end by using an Optical Power meter the received power is measured. Fiber loss is calculated by subtracting the receive power from the transmit power. This test also determines the fiber termination continuity on end-to-end basis as the measurement is done on both the ends of a link.

#### 3.2 Test Equipment


Following test equipment shall be used:

- Power meter working on 1310 nm / 1550 nm / 1625 nm;
- Laser source working on 1310 nm / 1550 nm / 1625 nm;
- Patch cords;
- Pigtails


#### 3.3 Procedure

Test procedure shall be as detailed below. Test formats (2A & 2B) shall be as depicted in Section 3.4 and 3.5.

- One power meter, one laser source and one unit of optical talk set is required at each station between which the link is to be tested.
- At location A, switch ON the laser source, set it to operating wavelength of 1310nm and connect it to the power meter (set at 1310nm for G.652 fibres) by two FC/PC patch cords (these FC/PC patch cords will be connected to each other with FC/PC coupler) and record the laser power transmitted. Subtract 0.5 Db (Coupler Loss) from this reading and record it in the test sheet (Appendix-2A & 2B) as 'Power transmitted'.
- Disconnect the power source and power meter by disconnecting FC/PC patchcords from the FC/PC connector. Do not disconnect patch cords from the power meter and power source.
- Connect the power source to the one of the fibres terminated in FTC at location A and the power meter to the same fibre under test in FTC at location B.
- Record the power received in test sheet.
- To establish communication between two stations A & B, optionally connect optical talk set to one of the fiber (e.g. No 12) at both the stations. When that particular fiber is due for testing connect the talk set to one on which testing is complete (e.g. No 1).
- Confirm on the talk set that the power received is recorded.
- Repeat the test for 1550nm.
- Connect the source to next fibre terminated in FTC at location A and power meter at location B.
- Repeat the same procedure with source at location B and power meter at location A.
- Continue the above process till all fibers are tested.

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- Average loss of each fiber should be less than the average loss estimated.  
Above test procedure shall be repeated for G.655 fibers for 1550 nm / 1625 nm as required.  
Test formats (3A & 3B) shall be as depicted in Section 3.6 and 3.7.

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**3.4 Format 2A**

**Insertion Loss Measurement (G.652)**

Date:

Location A:

Location B:

Wavelength: 1310 nm

Equipment Used:

Cable Length (km) (L):

Number of Splices including Pigtails (N):

Number of Connectors (C):

Average Insertion Loss Estimated (dB/km)  $(0.37L+0.07N+0.5C)$ :

Tube No. / Color	Fiber No. / Color	A-B		B-A		Average Insertion Loss (IL) (dB/km)
		Power Transmitted at A		Power Transmitted at B		
		Power Received at B	Insertion Loss (A-B) (dB/km)	Power Received at A	Insertion Loss (B-A) (dB/km)	

**3.5 Format 2B****Insertion Loss Measurement (G.652)**

Date:

Location A:

Location B:

Wavelength: 1550 nm

Equipment Used:

Cable Length (km) (L):

Number of Splices including Pigtails (N):

Number of Connectors (C):

Average Insertion Loss Estimated (dB/km) ( $0.22L+0.07N+0.5C$ ):

Tube No. / Color	Fiber No. / Color	A-B		B-A		Average Insertion Loss (IL) (dB/km)
		Power Transmitted at A		Power Transmitted at B		
		Power Received at B	Insertion Loss (A-B) (dB/km)	Power Received at A	Insertion Loss (B-A) (dB/km)	



**3.6 Format 3A****Insertion Loss Measurement (G.655)**

Date:

Location A:

Location B:

Wavelength: 1550 nm

Equipment Used:

Cable Length (km) (L):

Number of Splices including Pigtails (N):

Number of Connectors (C):

Average Insertion Loss Estimated (dB/km) ( $0.24L+0.07N+0.5C$ ):

Tube No. / Color	Fiber No. / Color	A-B		B-A		Average Insertion Loss (IL) (dB/km)
		Power Transmitted at A		Power Transmitted at B		
		Power Received at B	Insertion Loss (A-B) (dB/km)	Power Received at A	Insertion Loss (B-A) (dB/km)	

**3.7 Format 3B****Insertion Loss Measurement (G.655)**

Date:

Location A:

Location B:

Wavelength: 1625 nm

Equipment Used:

Cable Length (km) (L):

Number of Splices including Pigtails (N):

Number of Connectors (C):

Average Insertion Loss Estimated (dB/km) ( $0.26L+0.07N+0.5C$ ):

Tube No. / Color	Fiber No. / Color	A-B		B-A		Average Insertion Loss (IL) (dB/km)
		Power Transmitted at A		Power Transmitted at B		
		Power Received at B	Insertion Loss (A-B) (dB/km)	Power Received at A	Insertion Loss (B-A) (dB/km)	



**GAIL INDIA LIMITED**

**DATASHEET  
FOR  
FIBER OPTIC CABLE**

**GAIL-STD-TL-DOC-DS-001**


Rev	Date	Purpose	Prepared By	Checked By	Approved By
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DATASHEET FOR FIBER OPTIC CABLE				
GENERAL	1	Cable No.	**	
	2	Application	FOC for Pipeline SCADA / Telecommunication	
	3	Quantity (Mts)	Refer Note 2	
CONSTRUCTION	4	Standard	IEC 60793-1-1, 60794-3	
	5	Fiber Type	Single Mode	
	6	No of Core	24	
	7	Color Code	EIA/TI598B	
	8	No of Buffer and Fiber per Loose Tube	4 buffer tubes and 6 fibers / loose tube	
	9	Buffer Inner/Outer Diameter(mm)	1.7/2.7 +/- 0.1mm	
	10	Index Profile	Step Index	
	11	Cladding Diameter(μm)	125 +/- 0.7 microns	
	12	Mode Field Diameter(μm)	9 (1310nm) / 10 (1550nm) +/- 10% of nominal value	
	13	Mode Field Concentricity Error	<=0.5μm	
	14	Cladding Non-Circularity	<=0.7%	
	15	Coating Diameter(μm)	245+/-5μm	
	16	Construction	Loose fiber in buffer tube	
	17	Loose Tube	PBT 2.1 +/- 0.1mm filled with Thixotropic Jelly	
	18	Core Wrapping	Polyster Tape and water swellable tape with binders	
	19	Water Blocking Compound	Flooding Jelly and water swellable tape	
	20	Expected Fiber Life Span	>25 years	
	21	Rodent Protection	Glass Yarn	
	22	Inner Sheath	HDPE minimum 1.5mm thick	
	23	Lead Sheath	N/A	
	24	Armoring	Corrugated ECCS tape of thickness >=0.15mm	
	25	Armoring Overlap	*	
	26	Outer Sheath	Polyamide / Nylon jacket over HDPE sheath	
	27	Cable Length Marking	Every one meter	
	28	Cable / Core Diameter (mm)	16 mm*	
	29	Central Strength Member (mm)	Non metallic - FRP rod(diameter min 2.5 mm*)	
	30	Primary Coating	Primary UV cured acrylate coating with dia of 245μm +/- 5μm coated	
OPTICAL PROPERTIES	31	Wave Length and Band Optimized (nm)	1310 / 1550	
	32	Numerical Aperture	*	
	33	Cut-Off Wavelength(nm)	1200 - 1320nm (maximum for coated fiber, <=1260nm)	
	34	Attenuation@Wavelength:1550NM(dB/km)	<=0.19 ~0.20 dB/km	
	35	Attenuation@Wavelength:1310NM(dB/km)	<=0.33 ~ 0.35 dB/km	
	36	Attenuation Uniformity(dB)	<=0.1	
	37	Variation of Attenuation between 0 degC and 70 degC(dB)	0.01	
	38	Dispersion Wavelength(1300 to 1324 nm) / 1550 nm	better than 3.5 ps/nm.km@1310 / 18ps/nm.km@1550	
	39	Refractive Index	1.47	
	40	Optical path Discrete Reflectance and Return Loss in Accordance with Requirements of Table	ITU G.957	
	41	Zero Dispersion Wavelength(nm)	1300 to 1324 nm	
	42	Chromatic Dispersion(ps/km)	<=3.5	
	43	Individual Splice Loss(dB/splice)	<=0.1 (bi-directional measurement)	
	44	Mean Splice Loss(dB)	<=0.05	
	45	Polarization Mode Dispersion	@1300nm and 1550nm wavelength <0.2ps/sqrt.km for fiber, <0.3ps/sqrt.km for cabled fiber	
MISC.	46	Ambient Temperature		
	47	Electrical Area Class	Zone 1 Group IIA /IIB as per IEC, T3	
	48	Make	Model No.	* *
	49			
	50			

Notes: \*\* TBD

1. Vendor to specify. \*
2. Refer SOR for Quantities required and Scope of Work.
3. Refer Specification for FOC Cable and HDPE duct for more information.

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**GAIL INDIA LIMITED**

**DATASHEET  
FOR  
HDPE DUCT**

**GAIL-STD-TL-DOC-DS-002**


Rev	Date	Purpose	Prepared By	Checked By	Approved By
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DATASHEET FOR HDPE DUCT					
GENERAL	1	Duct Identification No.	*		
	2	Application	Duct to include Pipeline FOC		
	3	Quantity (Mts)	Refer Note 2		
CONSTRUCTION	4	Description	HDPE duct suitable for direct burial application		
	5	Standard	TEC GR No GR/CDS-008/03 March'11		
	6	Duct Drum Length (Mts)	1000 Mts		
	7	Outer Diameter (mm)	40 mm ± 0.4mm		
	8	Wall Thickness(mm)	3.0mm ± 0.4mm		
	9	Pressure Rating (kg/cm2)	10 kg/cm2		
	10	Lubrication	Solid permanent lubricant across drum length		
	11	HDPE Density (kg/m3 at 27 degC)	940 to 958 kg/m3 at 27° C		
	12	HDPE Melt Flow Index	0.2 to 1.1 grams per 10 min. at 190 °C		
	13	Color	Orange - uniform across drum length		
	14	Identification	Black, Length mark at every meter		
	15	Preinstalled Tape	Factory installed Bull-line Pull tape		
	16	Ribbed	Internal straight ribs		
	17	Number of Ribs	80 / 32		
18	Rib Height	0.2 - 0.5 mm/0.3 to 0.9mm			
19	Tensile strength	Min. 20 N/mm2 (Testing as per IS-14151 (Part-I))			
20	Elongation	Min. 350% (Testing as per IS-14151 (Part-I))			
21	Internal Coefficient of friction	≤ 0.08			
ACCESSORIES	22	Plastic Coupler	Push-fit type having Push-Lock mechanism		
	23	Air Pressure Testing of Coupler	15 Kg/cm2 min period of 2 hours without any leakage		
	24	End plugs, Cable Sealing Plug & End Cap	Required		
	25	End Cap material	Hard rubber/plastics fitted to HDPE Ducts		
TESTS	26	Duct Integrity Test	Required		
	27	Pressure Test	Required		
	28	Crush and Deformity Test	Required		
	29	End Plug Test	Required		
MISC.	30	Make	Model No.	**	**
	31				
	32				
	33				
	34				

Notes: \*\* TBD

1. Vendor to specify. \*
2. Refer SOR for Quantities required and Scope of Work.
3. Refer Specification for FOC Cable and HDPE duct for more information regarding complete list of tests required.
4. HDPE duct specification shall confirm to IS 7328, IS 4984 and ASTM D-1963 standards.


DATASHEET FOR HDPE DUCT	Doc No.	Rev	
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**GAIL INDIA LIMITED**

**QAP FOR OPTICAL FIBRE CABLES**

**GAIL-STD-TL-DOC-QAP-001**

						
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## STANDARD QUALITY ASSURANCE PLAN FOR OPTICAL FIBRE CABLE

CUSTOMER:-	END USER:-	QAP NO.:-	REV.:-
SO NO.:-	DATE:-		
PO NO.:-			
PROJECT:-			
REF DOCUMENT:-			

Sr No.	Activity Description	Description of Test	Test Frequency	Ref. Std. & Cl. No.	Procedure No.	Approved Specification in acceptance Criteria	Document/Report	Agency		
								Vendor	TPI	Client

A. FOR FIBRES (AT FIBRE STAGE)										
1	Core (Mode Field Diameter) - @1310nm - @1550nm - @1625nm	Geometry Test	100%	ITU-T-G652/G655		As per approved Specification & datasheet	Fibre Supplier Test Report	P/R	R	R
3	Attenuation Co-efficient - @1310nm - @1550nm - @1625nm	Attenuation co-efficient Test(OTDR test)	100%	ITU-T-G652/G655		As per approved Specification & datasheet	Fibre Supplier Test Report	P/R	R	R
4	Chromatic Dispersion - 1285 - 1330nm - 1270 - 1340nm - 1550nm - 1625nm -Zero Dispersion Wavelength -Zero Dispersion Slope	Chromatic Dispersion	100%	ITU-T-G652/G655		As per approved Specification & datasheet	Fibre Supplier Test Report	P/R	R	R
5	Geometrical Parameters - Primary Coating Diameter - Cladding Diameter - Clad Non-circularity - Mode Field Concentricity	Geometrical Test	100%	ITU-T-G652/G655	IEC 60793-1-20/21	As per approved Specification & datasheet	Fibre Supplier Test Report	P/R	R	R
6	Spectral Attenuation	Spectral Test	Sample test (5%, in case of fraction the next higher rounded figure to be taken)	ITU-T-G652/G655		As per approved Specification & datasheet	Report	P/R	R	R
7	Polarization Mode Dispersion		Sample test (5%, in case of fraction the next higher rounded figure to be taken)	ITU-T-G652/G655		As per approved Specification & datasheet	Report	P/R	R	R
8	Sheath integrity (spark test)	Spark Test	Sample test (5%, in case of fraction the next higher rounded figure to be taken)		IEC-794-1-2-F3	As per approved Specification & datasheet		P/R	R	R
9	Repeated Bending	Repeated Bending	Sample test (5%, in case of fraction the next higher rounded figure to be taken)		EIA-455-104	As per approved Specification & datasheet	Report	P/R	R	R



10	Flexural Rigidity Test on the optical fibre cable	Type Test	5%		To be tested as per ASTM D-790	As per approved Specification & datasheet	Report	P/R	R	R
11	Cable Aging Test	Type Test	5%	As per Job specification/ ITU-T-G652/G655		As per approved Specification & datasheet	Report	P/R	R	R
12	Check of easy removal of sheath	-		As per Job specification/ ITU-T-G652/G655		As per approved Specification & datasheet	Report	P/R	R	R
13	Effect of aggressive media on the cable surface (Acidic and Alkaline behaviour)	-		As per Job specification/ ITU-T-G652/G655		As per approved Specification & datasheet	Report	P/R	R	R
14	Check of the Quality of the Loose Tube (Containing Optical Fibre)	-		As per Job specification/ ITU-T-G652/G655		As per approved Specification & datasheet	Report	P/R	R	R
15	Drainage Test for Loose Tube and Drip Test on the Cable	-		As per Job specification/ ITU-T-G652/G655		As per approved Specification & datasheet	Report	P/R	R	R
16	Fibre PMD Maximum Individual Fibre	PMD Test	100%	ITU-T-G652/G655	IEC 60793-1-49	As per approved Specification & datasheet	Fibre Supplier Test Report	P/R	R	R
17	Fibre Proof Test	Fibre Proof Test	100%	ITU-T-G652/G655	IEC 60793-1-30	As per approved Specification & datasheet	Fibre Supplier Test Report	P/R	R	R
18	Fibre Curl	Fibre Curl Test	100%	ITU-T-G652/G655	IEC 60793-1-34	As per approved Specification & datasheet	Fibre Supplier Test Report	P/R	R	R
19	Attenuation Vs Wavelength - 1285 - 1330nm - 1525 - 1575nm	Spectral Attenuation Test	100%	ITU-T-G652/G655	IEC 60793-1-40A	As per approved Specification & datasheet	Report	P/R	R	R
20	Attenuation with Bending - 100 turns on a mandral of 60 mm diameter - 1 turn on mandrel of 32mm diameter	Attenuation Test	100%		IEC 60793-1-47	As per approved Specification & datasheet	Report	P/R	R	R
21	Fibre Micro Band Test (1 around 32+0.5 diameter mandrel) <0.5 dB at 1550 nm.	Fibre Micro Band Test	100%			As per approved Specification & datasheet	Report	P/R	R	R
<b>B. FOR FINISHED CABLES</b>										
1	Visual Inspection - Cable lay up and fibre identification - Identification and length marking on outer jacket - Overall diameter of the cable - Colour contact of the marking with the outer sheath or the cable	Visual Tests	5% or Minimun One Drum (Whichever in higher)	ITU-T-G652/G655	As per approved cross sectional drawing/Datasheet of OFC	As per approved Specification & datasheet	Report	P	W	R
2	Test on Moisture barrier - Thickness of layers - Extent of overlapping - Electrical continuity - Water swellable tape or power - Water immersion	Moisture Barrier Test	- 5% !- 5% !- Not applicable	ITU-T-G652/G655	As per approved cross sectional drawing/Datasheet of OFC	As per approved Specification & datasheet	Report	P	W	R

3	Tensile performance (Tensile load of 9.81 W Newton or 2700 N whichever is higher where W=Weight of 1km cable in kg)	Tensile Test	1 drum per order	ITU-T-G652/G655	IEC-794-1-2-E1	As per approved Specification & datasheet	Report	P	W	R
4	Attenuation Co-efficient/Length - @ 1310 nm - @ 1550 nm - @1625nm	Attenuation Co-efficient Test (OTDR Test)	5% or Minimum One Drum (Whichever in higher)	ITU-T-G652/G655	IEC 60793-1-40C	As per approved Specification & datasheet	Report	P	W	R
5	Crush (200kg of load to be slowly placed and held for 60 sec)	Crush Test	1 drum per order		IEC-794-1-2-E3	As per approved Specification & datasheet	Report	P	W	R
6	Impact (Mass of 5 kg to fall freely from 500mm height on the cable sample 10 times repeatedly with a gap between 1 impact to another approx. at 60 sec)	Impact Test	1 drum per order		IEC-794-1-2-E4	As per approved Specification & datasheet	Report	P	W	W/R
7	Torsion (Weight of 7.5 kg attached to the stationary chuck and shall be subjected to 10 cycles)	Torsion Test	1 drum per order		IEC-794-1-2-E7	As per approved Specification & datasheet	Report	P	W	W/R
8	Bend (To be performed preferably with procedure 1 (of IEC) with mandrel diameter of 20D, where D is the diameter of the cable and testing shall be done with 4 turns of cable wrapped and then unwrapped for 10 complete cycles)	Bend Test	1 drum per order		IEC-794-1-2-E11 Procedure 1	As per approved Specification & datasheet	Report	P	W	W/R
9	Snatch Test (with a load of 100N)	Snatch Test	1 drum per order		IEC-794-1-2-E9	As per approved Specification & datasheet	Report	P	W	W/R
10	Kink (Radius : 10 X Cable Diameter)	Kink Test	1 drum per order		IEC-794-1-2-E10	As per approved Specification & datasheet	Report	P	W	W/R
11	Temperature Cycling	Tested on a > 200m cable with temperature cycle as follows: - At room temperature : 1 hr - At 0°C : 12 hrs - At 65°C : 12 hrs - From 65°C to room temperature - 1 hr	1 drum per order		IEC-794-1-2-F1	As per approved Specification & datasheet	Report	P	W	W/R

12	Test of Figure of 8 (Eight) on the cable	-	5%	As per Job specification/ ITU-T-G652/G655		As per approved Specification & datasheet	Report	P	W	W/R
13	Static Bend Test	Band test	5%	As per the clause no. 13.8 of the GR alternatively as per ASTM D 790		As per approved Specification & datasheet	Report	P	W	W/R
14	Water Penetration	Water Penetration Test	5%		IEC-794-1-2-F5	As per approved Specification & datasheet	Report	P	W	W/R
15	Water Immersion	Water Immersion Test			IEC 60793-53	As per approved Specification & datasheet	Report	P	W	W/R
16	Length of Cable	-	-	-	-	Std Length 4.0 km±5%		P	W	W/R
17	Abrasion Test	Abrasion Test			IEC-794-1-2-E2	Test the abrasion resistant of sheath and printing		P	W	W/R
18	IRN							H	P	R
19	DOCUMENTATION							H	P	R

**LEGEND:** R: Review, W:Witness, P:Perform, TPIA:Third Party Inspection Agency, NA:Not Applicable

**NOTE:**


- 1). Material and Type shall be as per tender specification / datasheet.
- 2). Acceptance Norms/ Acceptance Criteria for all the activities shall be as per specification/ data sheets/ applicable codes & standards etc.
- 3). GAIL and/or his representative reserve right for inspection at any stage of manufacturing of materials as per approved QAP.
- 4). All Testing & Measuring Instruments shall have valid Calibration with Calibration Certificates & Traceabilities.



**GAIL INDIA LIMITED**

**QAP FOR OPTICAL HDPE DUCT & ACCESSORIES**

**GAIL-STD-TL-DOC-QAP-002**

							
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REV	Date	Purpose of Issue	Prepared By	Checked By	Approved By		Lyons Engineering Pvt. Ltd



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QUALITY ASSURANCE PLAN FOR HDPE DUCT

S.No	Activity Description	Description of Test	Test Frequency	Ref. std & Cl. No.	Procedure No.	Acceptance Criteria	Document / Report	Manufacturer	TPI Agency	Client
<b>TEST ON RAW MATERIALS</b>										
1	Melt flow Index of HDPE resin	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	As Per IS 2530	As per IS 2530	Vendor to specify	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	P	R	R
2	Density of HDPE Resin	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	As Per IS 7328	As per IS 7328	Vendor to specify	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	P	R	R
3	UV Stabilizer Content	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	TEC GR NO. TEC/GR/TX/CDS-08/03/MAR-11 with latest amendment.	TEC GR NO. TEC/GR/TX/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	P	R	R
4	Ash Content of Color Master Batch	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	TEC GR NO. TEC/GR/TX/CDS-08/03/MAR-11 with latest amendment.	TEC GR NO. TEC/GR/TX/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	P	R	R
<b>TESTS ON FINISHED PLB HDPE DUCT</b>										
1	Visual Appearance			IS: 4984-95	Smooth Inside and outside surface, free of blisters, shrink hole, flaking, chips, scratches, roughness etc. Thickness of inside Lubricant layer shall be uniform throughout the length and shall be white in color for clear visibility.			P	W	W/R
	Dimensions:	Dimensional outside diameter wall thickness	As Per Table 1 of GR/CDS-08/03/MAR-11 with latest amendment.	TEC GR NO. TEC/GR/TX/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	P	W	W/R
	a) Wall Thickness			IS: 4984-95	3.50 + 0.20 mm or better			P	W	W/R
	b) Outside Diameter			IS: 4984-95	50.0 +0.4 – 0.0 mm			P	W	W/R
	c) Thickness of inner Lubricant Layer	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	TEC GR NO. TEC/GR/TX/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	P	W	W/R

2	d) Bending Radius	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	TEC GR NO. TEC/GR/TX/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	P	W	W/R
	e) Color			-	As per job specification			P	W	W/R
	f) Identification Markings			TEC GR NO. TEC/GR/TX/CDS-08/03/MAR-11 with latest amendment.	As per job specification	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.		P	W	W/R
	g) Fading of colors of duct	GR/ASTM D-1712	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	TEC GR NO. TEC/GR/TX/CDS-08/03/MAR-11 with latest amendment.	As per job specification	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	P	W	W/R
3	Reversion Test	Shrinkage	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	TEC GR NO. TEC/GR/TX/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	P	W	W/R
4	Environmental Stress Crack Resistance	Chemical Property of Product	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	TEC GR NO. TEC/GR/TX/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	P	W	W/R
5	Impact Strength	Impact Strength Test	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	TEC GR NO. TEC/GR/TX/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	P	W	W/R
6	Crush Resistance Test	Deflection of Duct	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	TEC GR NO. TEC/GR/TX/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	P	W	W/R
7	Oxidation Induction Test	Oxidation of HDPE material	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	TEC GR NO. TEC/GR/TX/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	P	W	W/R
8	Hydraulic Characteric Test	Leakage,Swelling,Weeping and Burst and Crack in test duration	As Per Table 1 of GR/CDS-08/03/MAR-11 with latest amendment.	TEC GR NO. TEC/GR/TX/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	P	W	W/R
9	Tensile Strength	Tensile Elongation Property	As Per Table 1 of GR/CDS-08/03/MAR-11 with latest amendment.	TEC GR NO. TEC/GR/TX/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	P	W	W/R
10	Internal Co-efficient of friction	Co-efficient of friction HDPE material	As Per Table 1 of GR/CDS-08/03/MAR-11 with latest amendment.	TEC GR NO. TEC/GR/TX/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	P	W	W/R
11	UV Stabiliser of content of Resin	Identification of UV additive	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	TEC GR NO. TEC/GR/TX/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	P	W	W/R
12	Ovality	Dimensional outside diameter	As Per Table 1 of GR/CDS-08/03/MAR-11 with latest amendment.	TEC GR NO. TEC/GR/TX/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	P	W	W/R
12	Mandrel Test	Internal Dia of Duct	As Per Table 1 of GR/CDS-08/03/MAR-11 with latest amendment.	TEC GR NO. TEC/GR/TX/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	P	W	W/R

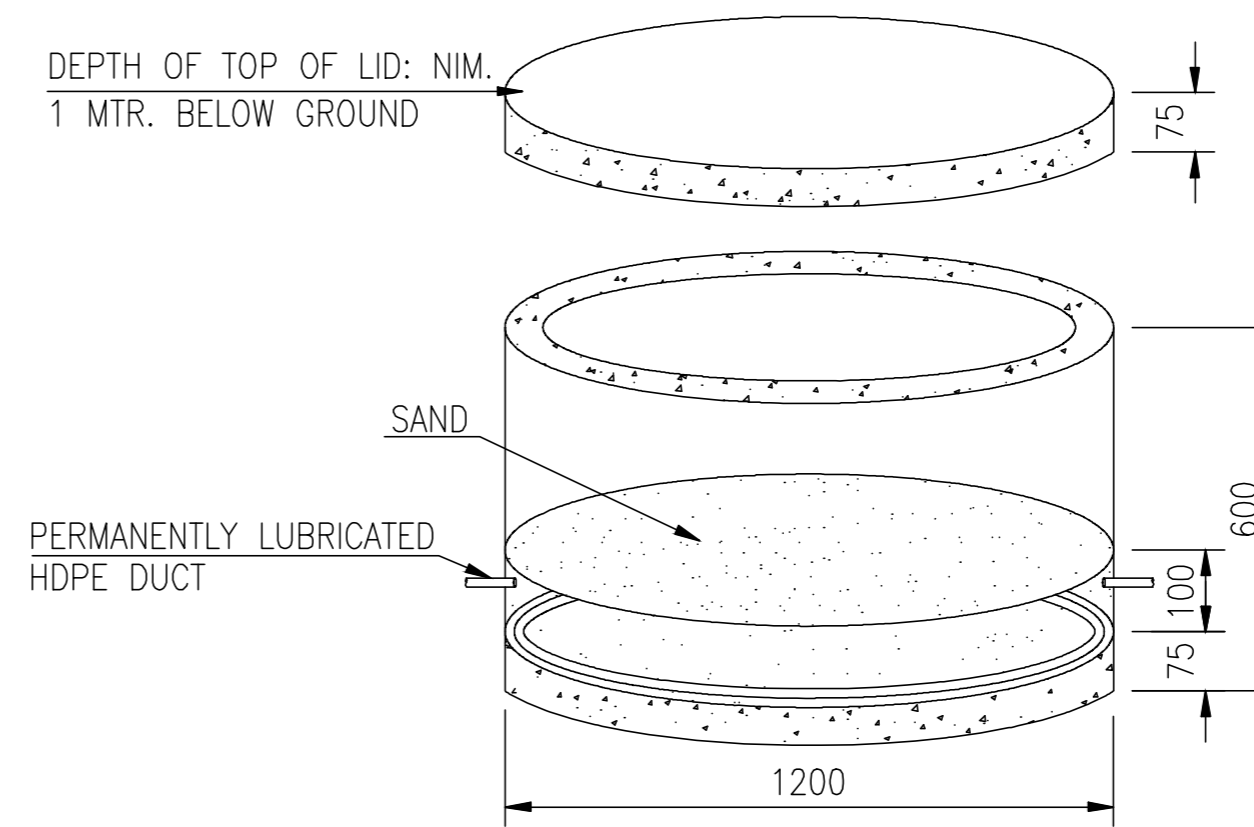
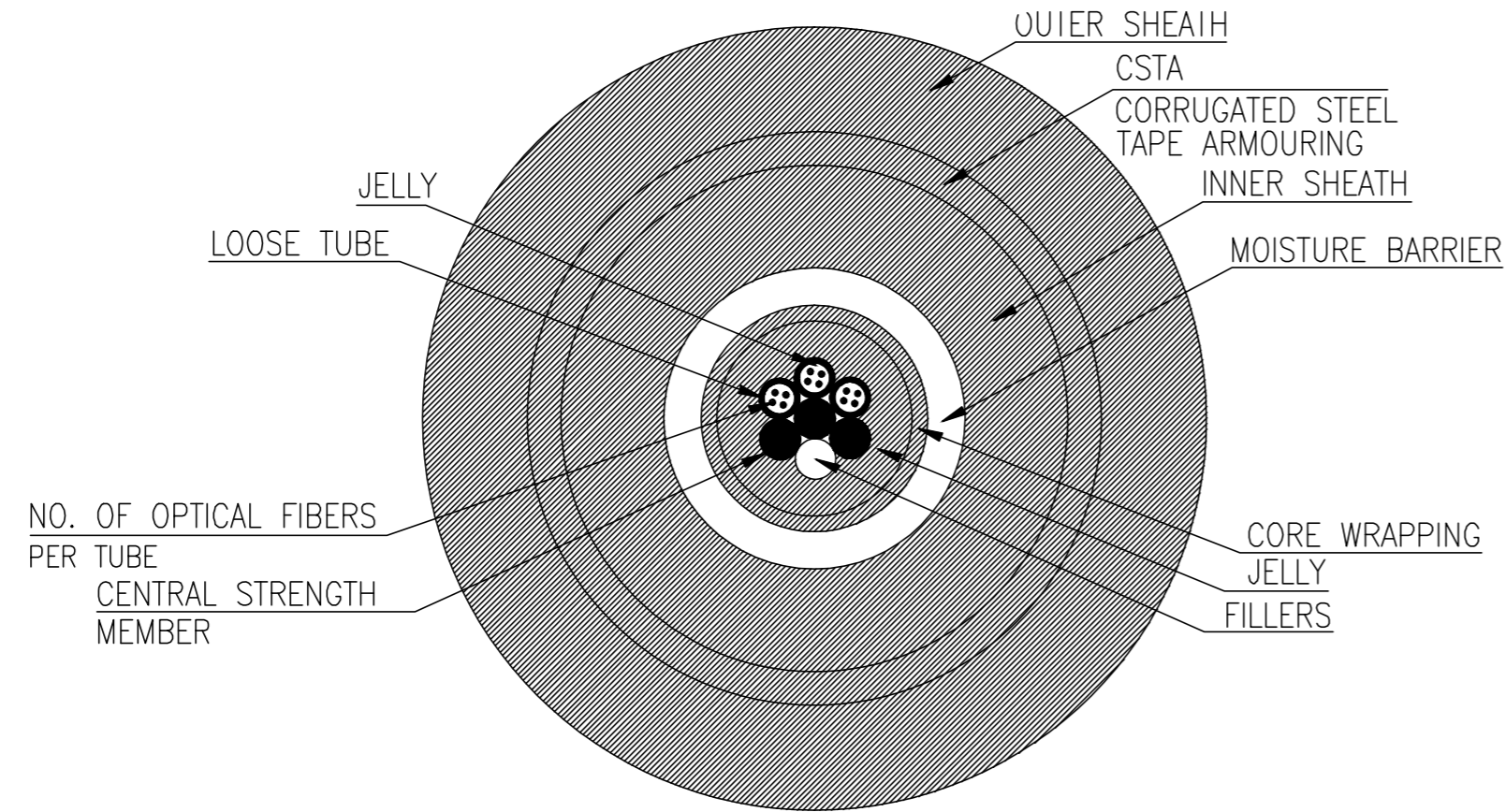
13	Maximum Pulling Strength	Pulling force on coupler	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	TEC GR NO. TEC/GR/TX/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	P	W	W/R
14	Change in MFR	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	TEC GR NO. TEC/GR/TX/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	Vendor to specify	P	W	W/R

**Tests on HDPE Conduit Accessories:**

1	Push-fit Coupler, End Plug & Cable Sealing Plug			As per data sheet/specification and GR/CDS-08/03/MAR-11 with latest amendment.	<ul style="list-style-type: none"> <li>• Shall pass ageing test as per TEC GR.</li> <li>• End plug and cable sealing plug shall be tested for air tightness with pressure of 1 bar for 30minutes.</li> <li>• Pulling force test shall be conducted by loading coupler joined by two pieces of duct for 15 minutes using</li> </ul>			P	W	W/R
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**LEGEND: R: Rewiew, W:Witness,P: Perform,TPIA:Third party inspection agency**

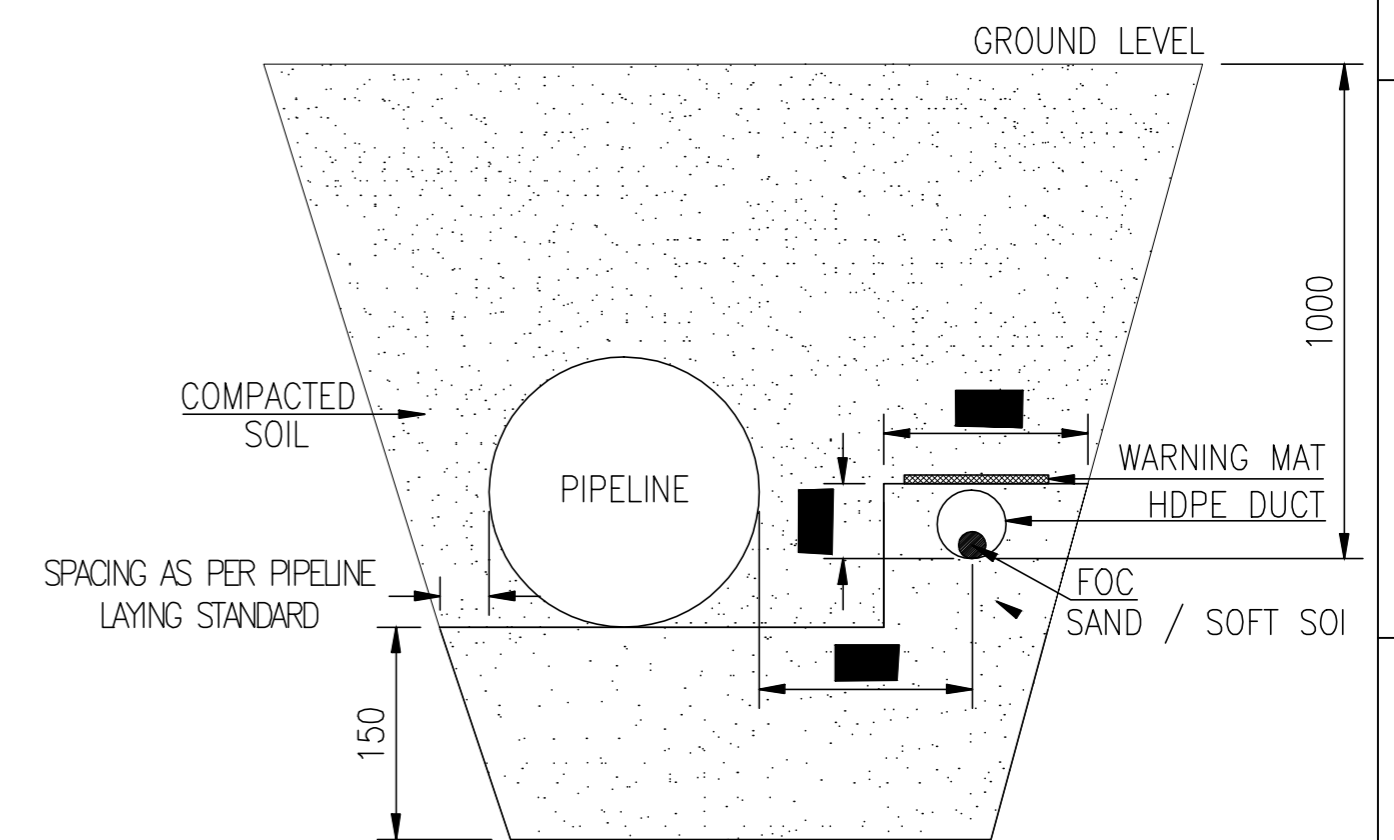
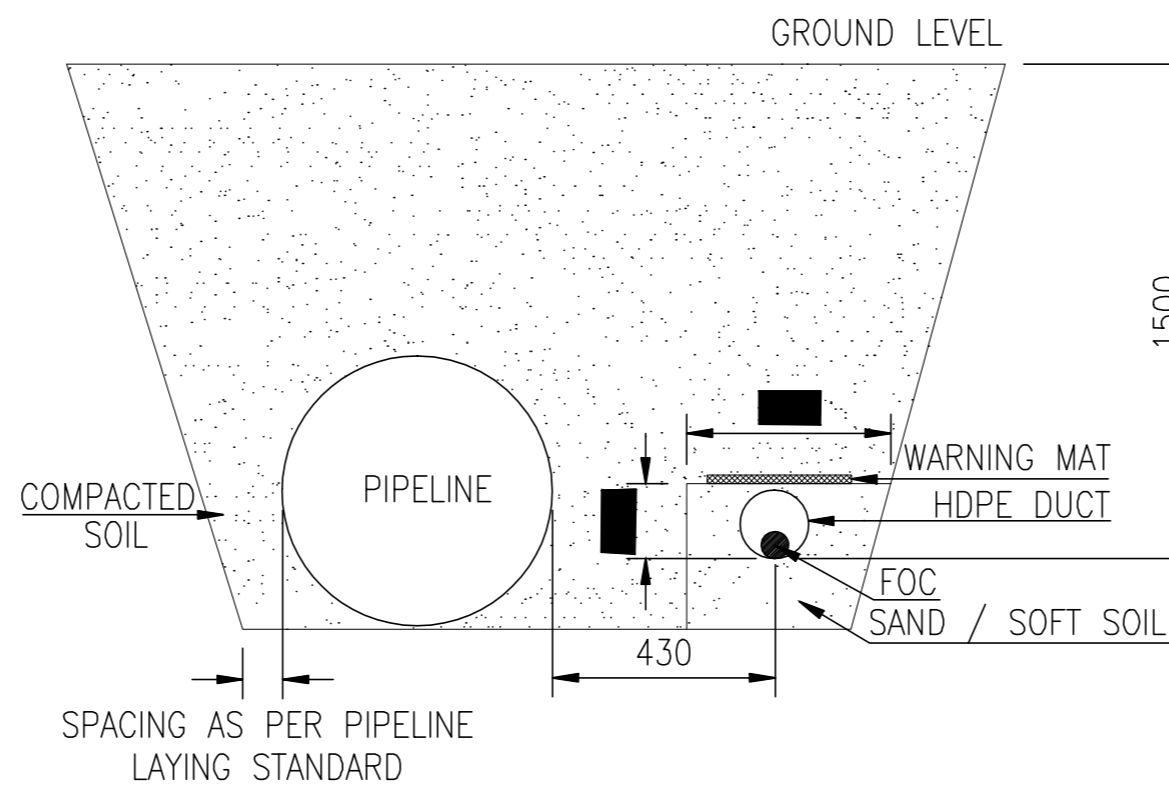
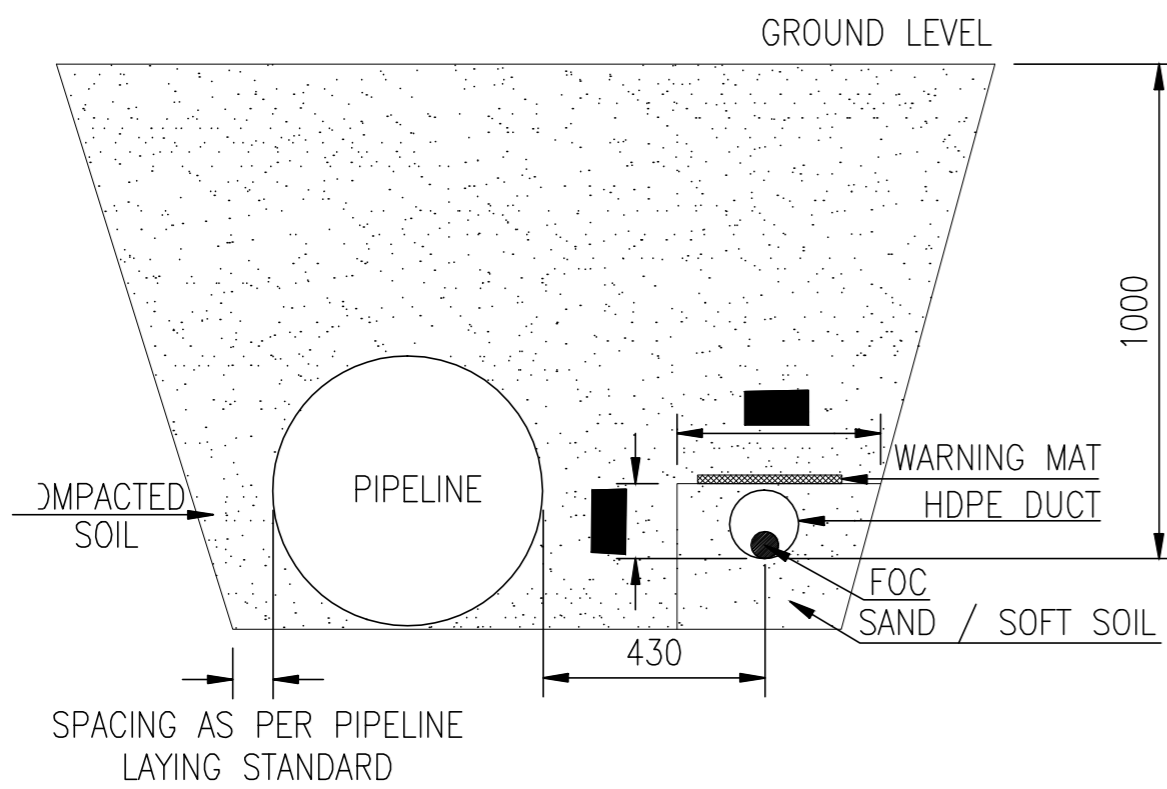
- 1) Material and Type shall be as per tender specification / datasheet.
- 2) The supplier shall submit their own detailed QAP prepared on the basis of the above approval of owner/owner's representative and TPIA
- 3) TPIA shall have right to inspect 100% of all manufacturing activities on each day or as specified above.
- 4) TPIA along with owner/owner's representative shall review /approve all the documents related to QAP /Quality manuals Drawings etc. submitted by supplier
- 5) TPIA shall also review the test certificates submitted by the manufacturer.
- 6) Supplier shall in cordination with sub vendor shall issue detailed production and inspection schedule indicating the dates and the locations to facilitate owner/owner's representative to organise inspection
- 7) Supplier shall submit their own detailed QAP duly sighned and stamped.
- 8). Acceptance Norms/ Acceptance Criteria for all the activities shall be as per specification/ data sheets/ applicable codes & standards etc.
- 9). GAIL and/or his representative reserve right for inspection at any stage of manufacturing of materails as per approved QAP.



FOC IN PIPELINE TRENCH-NORMAL SOIL

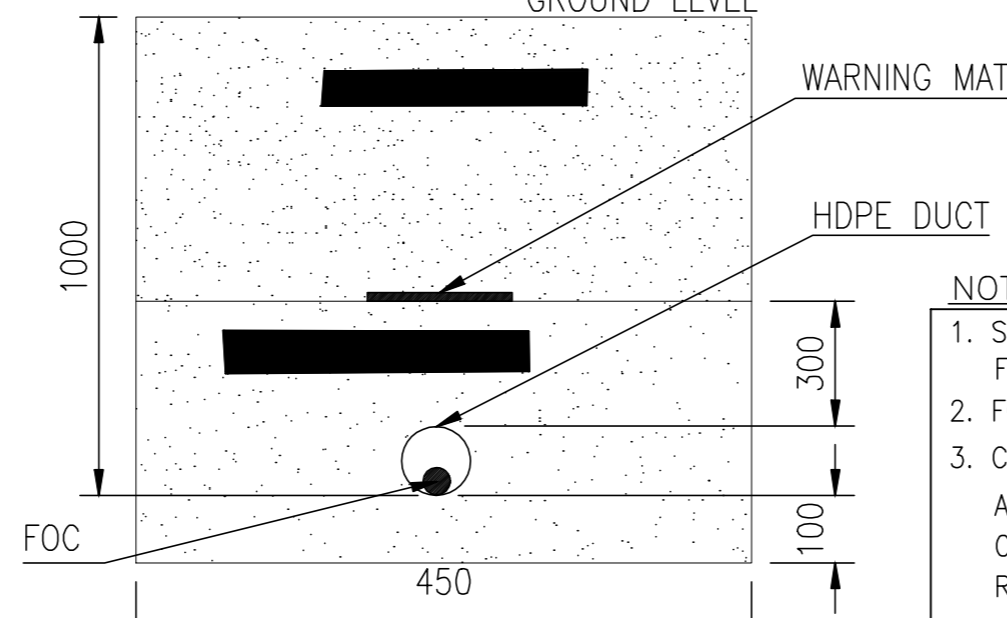
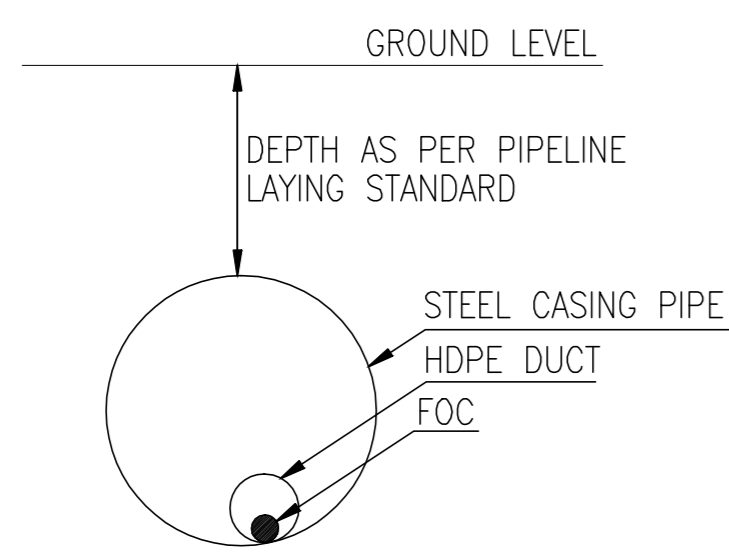
FOC IN PIPELINE TRENCH-CROSSINGS

FOC IN PIPELINE TRENCH-ROCKY AREA



FOC LAYING IN CASED CROSSING

FOC LAYING IN SEPARATE TRENCH



- NOTES**
1. SINGLE MODE FOC SHALL BE LAID IN THE SAME PIPELINE TRENCH FROM SCRAPER LAUNCHER FACILITY TO SCRAPER RECEIVER FACILITY
  2. FOC SHALL BE LAID INSIDE PERMANENT LUBRICATED HDPE DUCT.
  3. CONTRACTOR SHALL SUPPLY ALL FOC INSTALLATION MATERIAL SUCH AS WARNING / PROTECTIVE TAPE, MARKERS, SPLICE ENCLOSURES, CASING PIPE AT CROSSING (AS APPLICABLE), MANHOLES ETC. REQUIRED FOR COMPLETE INSTALLATION.
  4. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE STATED.

0	10.01.19	ISSUED FOR TENDER	DV	UN	UN
REV.	DATE	DESCRIPTION	PREP.	CHKD.	APPD.
CLIENT:		<b>GAIL (INDIA) LIMITED</b>			
PMC:		<b>LYONS ENGINEERING PVT. LTD.</b>			
SCALE	TITLE: FOR CROSS SECTION AND INSTALLATION DETAILS				
NTS					
SIZE	DRAWING NUMBER	SHEET	REV.		
A2	GAIL-STD-TL-DWG-TP-001	1 OF 2	0		



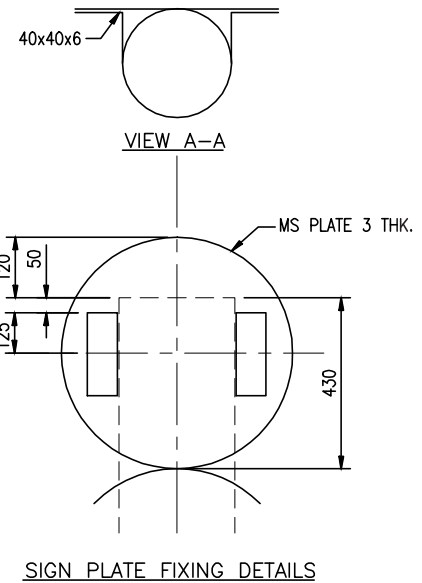
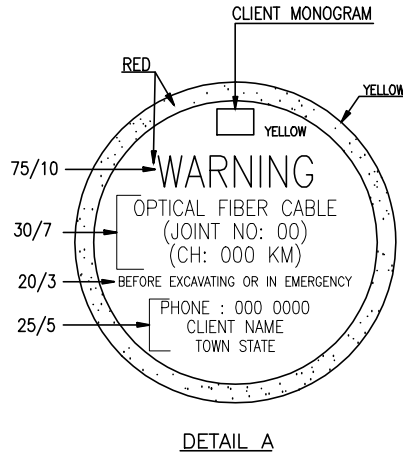
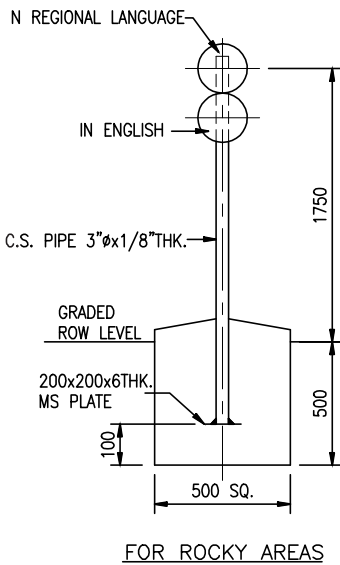
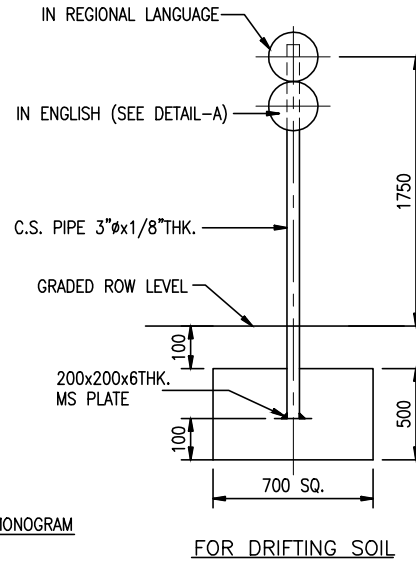
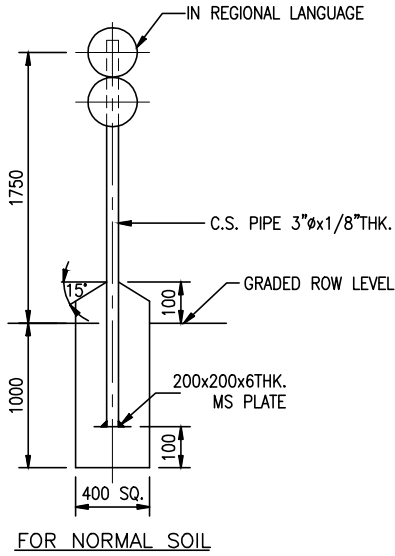


LYONS ENGINEERING PVT. LTD.  
NEW DELHI

OPTICAL FIBER CABLE  
JOINT IDENTIFICATION MARKER

DRAWING NO.  
GAIL-STD-TL-DWG-TP-001

SHEET NO. 2 OF 2



NOTES

- SCHEME FOR PAINTING AND COLOURING
  - UNDERGROUND STEEL : COAL TAR EPOXY (MIN 300 MICRON THK). (EXCEPT THAT EMBEDDED IN CONCRETE).
  - OVER GROUND STEEL : ONE COAT OF PRIMER AND TWO COATS OF SPECIFIED COLOUR PAINT.
  - ALL LETTERS EXCEPT 'WARNING' TO BE PAINTED BLACK.
  - POST SHALL BE PAINTED WITH 250 WIDE ALTERNATE BANDS OF BLACK AND WHITE PAINT.
  - ALL OTHER ABOVE-GROUND STEEL SHALL BE PAINTED YELLOW.
- ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE STATED.
- FOUNDATION SHALL BE MADE OF CONCRETE.
- SIGN PLATE IN REGIONAL LANGUAGE SHALL BE PREPARED BY THE CONTRACTOR IN SIMILAR LINES.

0	10-01-2019	ISSUED FOR TENDER	DV	UN	UN
REV. NO.	DATE	SUBJECT OF REVISION	DRAWN	CHECKED	APPROVED



**GAIL INDIA LIMITED**

**LIST OF APPROVED PARTIES  
FOR  
BOUGHT OUT ITEMS**

0	29.01.2019	Issued for Bid	RKS	UN	SB
<b>Rev</b>	<b>Date</b>	<b>Purpose</b>	<b>Prepared By</b>	<b>Checked By</b>	<b>Approved By</b>




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**LIST OF SUPPLIERS OF MAJOR BOUGHT-OUT ITEMS****1. (MECHANICAL & FIRE FIGHTING EQUIPMENT)****A). MAINLINE & MECHANICAL****i) Pipe Carbon Steel To Indian Standards**


1. A.S.T. Pipes Pvt. Ltd. (AST Group)
2. Advance Steel Tube Ltd.
3. Apl Apollo Tubes Ltd. (Er. Bihar Tubes Ltd.)
4. Asian Mills Pvt. Ltd.
5. Asrani Tubes Limited
6. Dadu Pipes (P) Ltd.
7. Essar Steel Limited(Er Hazira Pipes Mill)
8. Gaurang Products Pvt Ltd. (Ast Group)
9. Goodluck Steel Tubes Ltd.
10. HiCTech Pipes Limited
11. Indus Tube Limited
12. Jindal Industries Ltd
13. Jindal Pipes Ltd.
14. Jindal Saw Ltd (Kosi Works)
15. Jotindra Steel & Tube Ltd
16. Lalit Pipes And Pipes Ltd.
17. Maharashtra Seamless Ltd.
18. Man Industries (India) Ltd. – Pithampur
19. Man Industries (India) Ltd. Anjar
20. Mukat Tanks & Vessels Ltd.
21. Nezone Tubes Limited
22. North Eastern Tubes Limited
23. Pratibha Industries Limited
24. Pratibha Pipes & Structural Ltd.
25. Psl Ltd (Chennai)
26. Psl Ltd (V1, V2 & Nc)
27. Rama Steel Tubes Ltd.
28. Ratnamani Metals And Tubes Ltd.
29. Ravindra Tubes Limited
30. Samshi Pipe Industries Limited

<b>LIST OF APPROVED PARTIES FOR BOUGHT OUT ITEMS</b>	<b>Doc No.</b>	<b>Rev</b>	
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31. Surya Roshni Ltd.
32. Swastik Pipes Ltd.
33. Utkarsh Tubes & Pipes Ltd. (Formly Bmw)
34. Welspun Corp. Limited (Dahej)
35. Zenith Birla (India) Limited

**ii) Pipe & Tubulars To A.P.I. Standards**

1. Arcelormittal Tubular Products Roman Sa, Romania
2. Bhel (Trichy), India
3. Dalmine Spa (Enquiry To Tenaris), Uae
4. Eewkorea Co. Ltd (Germany), Korea
5. Eew Korea Co. Ltd. (Korea), Korea
6. Eisenbau Kramer Gmbh, Germany
7. Hyundai Rb Co. Ltd. South Korea
8. Ilva Lamiere E Tubi Srl (Enq To Ilva Spa, Italy)
9. Inox Tech. Spa, Italy
10. Ismt Ltd. Ahmedngr, India
11. Ismt Ltd. Baramati, India
12. Jindal Pipes Ltd., India
13. Jindal Saw Ltd. (Kosi Works), India
14. Jindal Saw Ltd. (Nashik Works), India
15. Lalit Pipes And Pipes Ltd. India
16. Maharashtra Seamless Ltd., India
17. Man Industries (I) Ltd. (Pithampur), India
18. Mukat Tanks & Vessels Ltd., India
19. Pratibha Industries Limited, India
20. Ratnamani Metals And Tubes Ltd., India
21. Siderca S.A.I.C (Enquiry Totenaris), Uae
22. Sumitomo Metal Ind. Ltd., India
23. Surya Roshni Ltd., India
24. Swastik Pipes Ltd, India
25. Tata Steel Uk Limited (Formerly C702)
26. Tubos De Acero De Mexico Sa (Enq. Tenaris), Uae
27. Tubos Reunidos Sa Spain
28. Umrans Steel Pipe Inc (Turkey), Turkey
29. Valcovny Trub Chomutov, Czech Republic
30. Vallourec And Mannesmann Tubes, France

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31. Welspun Corp Limited (Dahej), India

**iii) Pipe/Tube CS (Seamless) To ASTM STDs**

1. Arcelormittal Tubular Products Roman Sa, Romania
2. Bhel (Trichy), India
3. Changshu Seamless Steel Tube Co. Ltd., China
4. Dalmine Spa (Enquiry To Tenaris, Uae
5. Heavy Metals & Tubes Limited (Mehsana), India
6. Ismt Ltd. Ahmednagr, India
7. Ismt Ltd. Baramati India
8. Jfe Steel Corporation, Uae
9. Jindal Sdaw Ltd (Nashik Works) India
10. Kit Automotive And Tubular Products Ltd., India
11. Mahalaxmi Seamless Limited, India
12. Maharashtra Seamless Ltd, India
13. Products Tubulares S.A.U, Spain
14. Ratnadeep Metal Tubes Ltd., India
15. Staineest Tubes Pvt Ltd., India
16. Sumitomo Metal Ind. Ltd., India
17. Tubos Reunidos Sa Spain
18. Valcovny Trub Chomutov, Czech Republic
19. Vallourec Andmannesmann Tubes France
20. Yangzhou Chengde Steel Pipe Co. Ltd Dubai (UAE)

**iv) Pipe Carbon Steel (Welded) To ASTM STDs**

1. Eew Korea Co. Ltd. (Germany), Korea
2. Eew Korea Co. Ltd. (Korea), Korea
3. Eisenbau Kramer Gmbh, Germany
4. Hyundai Rb Co. Ltd., South Korea
5. Inox Tech. Spa, Italy
6. Jindal Saw Ltd (Kosi Works), India
7. Lalit Pipes And Pipes Ltd., India
8. Man Industries (I) Ltd.(Pithampur), India
9. Man Industries (India) Ltd. Anjar, India
10. Mukat Tanks & Vessels Ltd., India
11. Ratnamani Metals And Tubes Ltd., India
12. Sumitomo Metal India Ltd., India

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13. Tata Steel Uk Limited


v) **Valve**

**a) Globe Valves**

- 1) M/S BDK (New Delhi)
- 2) M/S Datre Corpn (Calcutta)
- 3) M/S KSB Pumps (New Delhi)
- 4) M/S L&T (New Delhi)
- 5) M/S Neco Schuber & Salzer Ltd. (New Delhi)
- 6) M/S Niton Valve (Mumbai)
- 7) M/S Ornate Valves (Mumbai)
- 8) M/S Panchavati Valves (Mumbai)
- 9) AV Valves Ltd.
- 10) BHEL (Trichy), India
- 11) Econo Valves Pvt Ltd, India
- 12) Fouress Engg (I) Ltd (Aurangabad)
- 13) Guru Industrial Valves Pvt Ltd
- 14) Leader Valves Ltd, India
- 15) NSSL Ltd. (Neco Schubert & SalzerLtd)
- 16) Oswal Industries Ltd, India
- 17) Petrochemical Engineering Enterprises, India
- 18) Sakhi Engineers Pvt Ltd
- 19) Shalimar Valves Pvt Ltd
- 20) Steel Strong Valves India Pvt Ltd, India
- 21) Petro Valves Pvt. Limited, Ahmedabad

**b) Check Valves**

1. M/s Advance Valves Pvt. Ltd., Noida
2. M/s Aksons & Mechanical Enterprises, Mumbai
3. M/s Larsen & Toubro Limited (M/s Audco India Limited, Chennai)
4. M/s AV valves Ltd., Agra
5. M/s BDK engineering India Ltd., Hubli
6. M/s BHEL, OFE&OE Group, New Delhi
7. M/s Datre Coroportion Limited, Calcutta
8. M/s Leader Valves Ltd., Jalandhar
9. M/s Neco schubert & Salzer Ltd., New Delhi
10. M/s Niton Valves Industries (P) Ltd., Mumbai

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11. M/s Precision Engg.Co., Mumbai
12. Econo Valves Pvt Ltd, India
13. Fouress Engg (I) Ltd (Aurangabad)
14. KSB Pumps Ltd (Coimbatore), India
15. NSSL Ltd. (Neco Schubert & SalzerLtd)
16. Oswal Industries Ltd, India
17. Panchvati Valves & Flanges Pvt Ltd, India
18. Petrochemical Engineering Enterprises, India
19. Sakhi Engineers Pvt Ltd
20. Shalimar Valves Pvt Ltd
21. Steel Strong Valves India Pvt Ltd, India

### c) Plug Valves

1. M/s Breda Energia Sesto Industria Spa, Italy
2. M/s Fisher Sanmar Ltd., Chennai
3. M/s Larsen & Toubro Ltd., New Delhi
4. M/s Nordstrom Valves, USA
5. M/s Serck Audco Valves, UK
6. M/s Sumitomo Corporation India Pvt. Ltd., New Delhi
7. M/s Z Corporation, Korea
8. M/s Hawa Valves (India) Pvt. Ltd., Mumbai
9. M/s Steel Strong Valves India Pvt. Ltd., Navi Mumbai
10. M/s Econo Valves
11. M/s Flow-Serve PTE (Mfr. SERCK), India

### d) Ball Valves

1. M/s Hawa Valves (India) Pvt. Ltd, Navi Mumbai
2. M/s Larsen & Toubro, Delhi
3. M/s Microfinish Valves Pvt. Ltd., Noida
4. M/s Oswal Industries Ltd., Gandhi nagar
5. M/s Virgo Engineers Ltd., Delhi
6. M/s Boteli Valve Group Co. Ltd., China
7. M/s Cameron (Malaysia) SDN BHD, Malaysia
8. M/s Dafram S.P.A., Italy
9. M/s Fangyuan Valve Group Co. Ltd., China
- 10.M/s Franz Schuck GmbH, Germany

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- 11.O.M.S. Saleri (Italy)
- 12.Pibi Viesse S.P.A (Italy)
- 13.Nuovo Pignone (Italy)
- 14.Perar S.P.A (Italy)
- 15.Pietro Fiorentini (Italy)
- 16.Cooper Cameron Valv Italy SRL-FRM, Itly
- 17.Petrol Valves SRL
- 18.Tormene Gas Technology S.P.A (VALVITALIA)

**vi) Flow Tee**


- 1) M/s Coprosider SPA, Italy
- 2) M/s GEA Energy System India Limited, Chennai
- 3) M/s Multitex Filtration
- 4) M/s Pipeline Engineering, UK
- 5) M/s Scomark Engg. Limited (U.K.)
- 6) M/s Skeltonhall Limited, Engaland(U.K.)
- 7) M/s Technospecial SPA, Italy
- 8) M/s Tectubi SPA, Italy
- 9) M/s RMA Germany
- 10) M/s Pipefit Engineers Pvt. Ltd.

**vii) Split Tee**

- 1) M/s Ipsco, Canda
- 2) M/s TD Willamsons, USA

**viii) Flanges**


1. M/s Aditya Forge Ltd., Vadodara
2. M/s Amforge Industries Ltd., Mumbai
3. M/s CD Engineering Co., Ghaziabad
4. M/s Echjay Forgings Pvt. Ltd. (Bombay), Mumbai
5. M/s Echjay Industries Ltd., Rajkot
6. M/s Forge & Forge Pvt. Ltd., Rajkot
7. M/s Golden Iron & Steel Works, New Delhi

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8. M/s JK Forgings, New Delhi
9. M/s Metal Forgings Pvt. Ltd., Mumbai
10. M/s Perfect Marketings Pvt. Ltd., New Delhi
11. M/s Sky Forge, Faridabad
12. M/s S&G, Faridabad
13. Chaudhry Hammer Works Ltd, India
14. JAV Forgings (P) Ltd, India
15. Kunj Forgings Pvt Ltd, India
16. MS Fittings
17. R.N. Gupta & Co. Ltd, India
18. R.P. Engineering Pvt Ltd, India
19. Sanghvi Forgings & Engineering Ltd
20. Shri Ganesh Forgings Ltd., India
21. Uma Shankar Khandelwal & Co., India
22. Sawan Engineers, Baroda
23. Stewarts & Lloyds of India Ltd., Kolkata
24. Engineering Services Enterprises
25. Pipefit Engineers Pvt. Ltd.

**ix) Fittings**

1. M/s Commercial Supplying Agency, Mumbai
2. M/s Dee Development Engineers Ltd.
3. M/s Eby Industries, Mumbai
4. M/s Flash Forge Pvt. Ltd., Vishakhapatnam
5. M/s Gujarat Infra Pipes Pvt. Ltd., Vadodara
6. M/s M.S. Fittings Mfg. Co. Pvt. Ltd., Kolkata
7. M/s Stewarts & Lloyds of India Ltd., Kolkata
8. M/s Teekay Tubes Pvt. Ltd., Mumbai
9. M/s Pipe Fit, Baroda
10. M/s Sky Forge, Faridabad
11. M/s S&G, Faridabad
12. M/s Sawan Engineers, Baroda
13. Eby Fasteners, India
14. Leader Valves Ltd, India
15. R.N. Gupta & Co. Ltd, India

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16. Exten Engg Pvt Ltd
17. Sivananda Pipe & Fittings Ltd

**x) Gaskets**

1. IGP Engineers (P) Ltd., Madras
2. Madras Industrial Products, Madras
3. Dikson & Company, Bombay
4. Banco Products (P) Ltd., Vadodara
5. Goodrich Gaskets Pvt Ltd
6. Starflex Sealing India Pvt Ltd, India
7. Teekay Meta Flex Pvt Ltd
8. UNIKLINGER Ltd
9. HEM Engg. Corp.
10. Unique Industrial Packing Pvt. Ltd.

**xi) Fasteners**

1. Nireka Engg. Co. (P) Ltd., Calcutta
2. Precision Taps & Dies, Bombay
3. AEP Company, Vithal Udyoug Nagar
4. Fix Fit Fasteners, Calcutta
5. Precision Engg. Industries, Baroda
6. Echjay Forgings Pvt. Ltd., Bombay
7. Capital Industries, Bombay
8. Boltmaster India Pvt Ltd, India
9. Deepak Fasteners Limited, India
10. Fasteners & Allied Products Pvt Ltd, India
11. Hardwin Fasteners Pvt Ltd, India
12. J.J. Industries, India
13. Multi Fasteners Pvt Ltd, India
14. Nexo Industries, India
15. Pacific Forging & Fasteners Pvt Ltd, India
16. Pioneer Nuts & Bolts Pvt Ltd, India
17. Precision Auto Engineers, India
18. President Engineering Works, India
19. Sandeep Engineering Works, India
20. Syndicate Engineering Industries, India

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**xii) Welding Electrodes**


1. For Mainline – Lincon make
  2. For Terminal – For root pass - Lincon Make
- For other passes – Lincon, D&H or equivalent make

**xiii) Fire Fighting****Equipments****a) Fire****Extinguishers**

1. Avon Services (Production & Agencies) Pvt. Ltd., Bombay
2. Kooverji Devshi & Co., Bombay
3. Zenith Fire Services, Bombay
4. Safex Fire Services, Bombay
5. Reliable (Fire Protection) India Ltd., Bombay
6. Brij Basi Hi
7. tech Udyog
8. Bharat Engg Works, India
9. Gunnebo India Ltd
10. Nitin Fire Protection Industries Ltd, India
11. Supremex Equipments, India
12. Vimal Fire Controls Pvt Ltd., India

**b) Fire Hydrants, Monitors, Deluge Valve, Nozzles**

1. Zenith
2. Minimax
3. Newage
4. HD Fire
5. Vijay Fire
6. Asco Strumech Pvt Ltd, India
7. Brij Basi Hi
8. tech Udyog
9. Gunnebo India Ltd
10. Nitin Fire Protection Pvt Ltd
11. Shah Bhogilal Jethamal & Brothers
12. Venus Pumps & Engineering Works

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**c) RRL Hose**

1. Jayshree
2. Newage

**d) Hoses**

1. Ashit Sales Corporation, Bombay
2. Royal India Corporation, Bombay
3. Gayatri Industrial Corporation
4. Simplex Rubber Products Ltd., Ahmedabad
5. Zaverchand Marketing Pvt. Ltd., Baroda
6. Presidency Rubber Mill, Calcutta
7. The Cosmopolite, Calcutta
8. Simplex Rubber Products, Thane

**e) Hose Delivery**

1. Chhatarya Rubber & Chemical Industries,
2. Nitin Fire Protection Industries Ltd, India

**f) Fire Hose Accessories**

1. Asco Strumech Pvt Ltd
2. Brij Basi Hi-tech Udyog
3. Gunnebo India Ltd
4. Shah Bhogilal Jethamal & Brothers
5. Vimal Fire Controls Pvt Ltd., India

**g) Heat Shrinkable Sleeves**


1. Covalence Raychem (Berry Plastics Corporation)
2. Canussa – CPS
3. Rigil Techno India Pvt. Ltd.

**h) Cold Applied Tapes**

1. Denso GmbH
2. Polyken (Berry Plastics Corporation)

**i) PUR Coating**

1. Powercrete (Berry Plastics Corporation)

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**j) Casing End Closure**

1. Raci, Italy
2. Raychem RPG Limited

**k) Casing Insulators**

1. Raci, Italy
2. Raychem RPG Limited

**l) Rockshield**

1. Raychem RPG Limited

**m) Warning Tape /Mesh**

1. Sparco Multiplast Pvt. Ltd., Ahmedabad
2. M/s Raychem RPG Limited
3. Singhal Industries Private Limited

**n) High Build Epoxy Coating**


1. Berry Plastics – Powercrete
2. Specialty Polymer Canada
3. Denso Protal, Canada

**o) Casing Insulators**

1. Raci, Italy
2. Raychem RPG Limited
3. Veekay Vikram

**xiv) DRY GAS FILTER & FILTER SEPERATOR**

1. Grand Prix Fab (Pvt.) Ltd.(New Delhi)
2. Perry Equipment, USA
3. Faudi Filter, Germany
4. Forain S.r.l., Italy
5. ABB, Faridabad
6. Burgess Manning, USA
7. Multitex Filtration Engineers India
8. Triveni Plenty Engg. Ltd. (New Delhi)

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9. Siirtec International Contractor S.P.A (Italy)
10. Flashpoint, Pune india
11. Filtration Engineers (I) Pvt Ltd, India
12. Gujarat Otofilt, India
13. Tormene Gas Technology
14. Ultrafilter (India) Pvt Ltd, India
15. Ravi Techno Systems Pvt Ltd, India
16. Siirtec Nigi S.P.A
17. Filtan Filter Anlagenbau GmbH
18. Fairley Arlon BV
19. PECO Facet
20. EPE Epenstenner GMBH
21. Filtrex srl
22. Petromar Engineered Soln
23. Plenty Filter
24. Eurofiltec
25. PTI Technologies Inc

**xv) QUICK OPENING END CLOSURE (QOEC)**

1. Forain S.R.L.
2. GD Engineering
3. Pipeline Engineering, UK
4. Siirtec Nigi S.P.A
5. TD Williamson
6. Peerless
7. Grinelli
8. Huber Yale
9. Tube Turn (U.S.A.)
10. Pipeline Technologies, France

**xvi) FILTER ELEMENT**

1. Peco – Facet

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2. Velcon
3. Pall – Filterite
4. Burgress Manning

**xvii) NDT Agency**


1. NDT Services, Ahmedabad
2. GEECY Industrial Services Pvt. Ltd., Mumbai
3. Corrosion Control Services, Mumbai
4. Perfect Metal Testing & Inspection Agency, Calcutta
5. Inter Ocean Shipping Co., New Delhi
6. RTD, Mumbai
7. Sievert, Mumbai
8. X-Tech, Vizag

**xviii) Long Radius Bends**

1. M/s BHEL, Trichy, Tamilnadu
2. M/s Jindal SAW Limited, (Koshi Works), U.P.
3. M/s PSL Limited, Gandhidham, Gujarat
4. M/s Welspun, Gujarat
5. M/s Fabricon, Belgium
6. M/s Sawan
7. M/s Gujarat Infra
8. M/s P K Tubes
9. M/s DEE Development
10. Pipefit Engineers Pvt. Ltd.


**xix) PIG LAUNCHERS/ RECEIVERS/ PIG SIGNALERS**

1. Bassi Luigi Fittings B.V., Holland
2. BRAUN STAHL PIPE TEC, GERMANY
3. FORAIN, ITALY
4. Fluidel SRL, ITALY

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5. RMA Maschinen- und, GERMANY
6. Siirtec Nigi, Itlay
7. SCHUCK ARMATUREN, GERMANY
8. T.D. Williamson Inc., USA
9. Tectubi SPA, Italy
10. Taylor Forge Engineering System INC, USA
11. Tormene Americana S.A. (Argentina)
12. Tormene Gas Technology S.p.A., Italy
13. PIPELINE ENGINEERING, UNITED KINGDOM
14. Krohne, Oil & Gas BV, Drive Houston,
15. Multitex Filtration Engrs. Ltd, New Delhi
16. BGR ENERGY SYSTEMS LIMITED New Delhi
17. Glapwell Contracting Services Ltd. UK
18. FULGOSI GIOVANNI S.n.c di Corrado & C , ITALY
19. VEEKAY VIKRAM & CO, GUJRAT
20. GBM S.R.L, ITALY
21. Multitex Filtration Engineers Ltd., India
22. Cardew Ltd., Alexeander
23. Forain S.R.L.
24. GD Engineering, India
25. Pipeline Engineering, UK
26. Siirtec Nigi SPA

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## 2. LIST OF MATERIALS OF APPROVED BRAND AND/ OR MANUFACTURE

### B. (CIVIL & STRUCTURE)


Unless otherwise specifically mentioned in the Schedule of Items, Contractor has to use materials as listed below, of only these brand names/Company's names, which are mentioned in the approved list for civil, water supply and sanitary items thereon.

### CIVIL


Sr. No.	Items/ Name of Products	Make/ Brands/ Manufactures
1.	Reinforcement Steel	TATA,SAIL,RINL,IISCO,RATHI
2.	Cement	Ambuja,ACC,JK,Grasim,Ultratech,Birla,L&T,Cement
3.	Structural Steel	TATA,SAIL,RINL,IISCO,ESSAR, ISPAT
4.	Pre- engineered building (PEB) firms	Kirby Building system India ltd ,Interach Building Product limited, Tata blue scope steel ,Lloyd Insulation India ltd, Everest Industries. Ltd. Modern Prefab System Pvt Ltd,Aster Building Solution Pvt.Ltd, Octamec Engineering Ltd,Jindal Mectec Pvt Ltd,Fedders Lloyd Corporation Ltd.
5.	Structural Steel Tubes ISI Marked	TATA, JINDAL , SURYA , SWASTIK
6.	(a) Zinalume colour coated steel sheet(COIL) (b) Profile of Sheet(as per tender specification)	(a)Tata Blue scope, Dongbu Steel ,Union Steel, JSW STEEL Ltd. Kirby Building system India ltd ,Interach Building Product limited, Tata blue scope steel ,Lloyd Insulation India ltd, Everest Industries. Ltd. Modern Prefab System Pvt Ltd,Aster Building Solution Pvt.Ltd, Octamec Engineering Ltd,Jindal Mectec
7.	Polycarbonate Sheet	Sabic Innovative Plastic , Everest
8.	Mineral wool for thermal insulation of ceilings ( Under deck insulation)	Rock wool (india) Ltd. Minwool Rock Fibres Ltd., Lloyd Insulation,
9.	Rolling shutters(ISI marked)	Swastic, Hercules, Shubdwar, M/s Bharat Rolling Shutters Industries Agra, Bengal Rolling Shutter Rama Rolling Shutter Works, Gandhi Entrance Automations Private

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10.	Wind driven air Ventilators	Apurva Enterprises (Mumbai), SVS Wind Driven Turbo Ventilator(Ahmadnagar),Real Green Engineers Pvt.Ltd. Bangalore;Sun Green Ventilation system
		Mumbai, Multi colour, Anchit Ispat Pvt Ltd. (Faridabad),
11.	Synthetic Enamel Paint (1st quality only)	ICI Paint (Dulux), Asian Paint (Apcolite), Berger Paints (Luxol). Goodlass Nerolac Paints (Nerolac), Jenson & Nicholson Paints Ltd (Borolac), Shalimar,
12.	G.I SHEET	ESSAR,JSW,,SAIL
13.	Sheeting Screw	Corrosshield, Buildex,
14.	Chemical for Antitermite treatment	DE- NOCIL Bombay, Pest Control of India, Trishul
15.	Factory made Panelled Door shutter	M/s Goel Brothers Raipur New Industrial Area Raipur (CG) M/s Hindustan Housing factory Ltd- New Delhi M/s Delhi Construction Eqpt Sadar Bazar Delhi M/s Joinery manufacturing Co Calcutta M/s Goyal Industries Faridabad M/s Surbhi Metal (India) Ltd, Jodhpur
16.	Flush doors IS-2191, 2202	M/s Mysore Wood Products M/s Laxmi Doors, Faizabad Road, Chinhat, Lucknow M/s Merino flush doors M/s Poineer Timber Products, Chandigarh, M/S Goyal Industries Faridabad
17.	Fly proof doors (Made out of solid block marine grade)	M/S Laxmi Doors, Faizabad Road, Chinhat, Lucknow, Northern doors Kanpur
18.	Natural Fibre Thermo Composite door/window shutter & frames, roofing sheets etc	Durosam
19.	PVC Panel Door (Solid Core)	Rajshri Plastiwood Limited, Sintex, Hindopan, Marino
20.	Pressed steel door frames/ cupboard and window frames (manufacturers)	M/s SAIL, M/s TATA

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21.	Pressed steel door frames/ cupboard and window frames (fabricators)	M/s Loyal safe works Mayapuri, N/Delhi M/s Multiwyn Industrial Corpn Calcutta M/s Metal Window Corpn N/Delhi M/s Chhabra Steel Udyog, 260 Sadar Bazar, Meerut Cantt M/s Delite safe works, Rani Jhansi Road, N/Delhi M/s Ishwar Industries, 175/A Bombay Bazar, Meerut Cantt M/s Chandni Industries, J-142, Patel Nagar 1st, Ghaziabad.
22.	Steel Windows, Ventilators(as per IS-1038 of 1983) & frames pressed steel door/window	M/S Multiwyn Industrial Corpn Calcutta M/S Metal Window Corp N/ Delhi Govind Enterprises, Delhi M/S Chhabra Steel Udyog 260, Sadar Bazar, Meerut Cantt, Agent steel MFG Pvt Ltd, Ahmedabad, Godrej, M/S Chandni Industries, J-142, Patel
23.	Al Section for Al Door/ Window/ Partitions	Hindalco, Indal, Ajit India, Jindal
24.	AluminumI Door/ Window/ Glazing Fabricated and Anodized	M/s Ahlcon M/s Alumilite Pvt Ltd, M/s Ajit India Pvt Ltd, M/s Ramniklal S Raste Agra, Argent Industries, M/s Aluminium Tech Industries, I-2249 DSIDC Narela, Delhi,
25.	Aluminium door and windows Fittings	M/s Elite Enterprises C/6 Shalimar Hardware 133, Jarg Mahal, Dhobitalao Mumbai 400002. M/s Mohan Metal Industries 178/2-A, Bhole Nath Nagar, Shahadara, Delhi 110032.
26.	Automatic Glass Door	Ditec (Gandhi)
27.	Aluminium Grill	Alu Grill, Arihant Aluminium Corporation, Decogrille
28.	Door Closer	Everite, Golden, Gandhi
29.	Floor Spring	Prabhat, Everite
30.	Builders Hardware	M/s Golden Industries Pvt. Ltd., Everite, Solo, Hardwyn
31.	Plywood for general purpose (IS-303)	National Plywood Inds Pvt Ltd, S Fancy lane, 8th floor Calcutta-700001,
32.	Pre laminated Particle board	Kitply, Bhutan board, Ecoboard, Novapan, Archid ply, Merinova, Merino
33.	Laminated Sheets	Formica, Merino Lam, Greenlam, National
34.	Modular Partitions	Godrej, Blowplast
35.	False Ceiling (Mineral Fibre Board)	Armstrong, , Daiken, Luxalon, Llyods, Gypboard, Trac, Aerolite
36.	False Ceiling (POP/ Gypsum Board)	Gypboard, Anchor ceiling tiles, LA

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37.	Aluminium False Ceiling	Lloyds,Armstrong,Luxlon,Trac
38.	Flooring Tiles ( Mosaic / Terrazzo / PCC ) (1st quality only)	M/S Mehtab Tiles, NITCO, Royal Tiles, Gem Tiles, Hindustan Tiles, M/S National Tiles & Industries, Ultra Tiles
39.	Glazed Ceramic Tiles, Non-Skid (Floor/Wall), (1st quality only)	Kajaria, Somany, NITCO. Murudeshwar Ceramic Ltd ( Navin Diamond tile ), Johnson ( Marbonite ), Marbitto, Somany, Orient, Asian
40.	Vitrified/ Designer Vitrified Tiles (1st quality only)	Asian, Marbonite (Johnson), Kerrogres (Kajaria), NITCO, Orient
41.	PVC Tiles/Flooring (IS 3461) (1st quality only)	Marblex Tiles, Krishna Tiles, Polyfin, Armstrong, Wonder floor.
42.	False Flooring	Godrej or equivalent
43.	Glass Mosaic Tiles (1st quality only)	Paladio, Coral, Accura, Bisazza, Italia, Mridul.
44.	Designer Paver Tiles/ Interlocking tiles ISI marked/ Grass-jointed Tiles	Pavit, Ultra, Hindustan, Eurocon, Vyara, National Tiles, Gem, Unistone, Konkrete, Unitle
45.	Glass reinforced Paver block	Unistone or equivalent
46.	Wall care Putty for Base preparation (1st quality only)	Birla Wall care putty, Berger, Jenson & Nicholson, JK White
47.	White Cement (1st quality only)	Birla, JK
48.	Cement based Paints (1st quality only)	Super Snowcem, Duracem, Super Acrocem.
49.	Dry Distemper / Oil bound Distemper (1st quality only)	Goodlass Nerolac Paint, Shalimar Paint, Jenson & Nicholson, Asian Paint, Berger. ICI
50.	Acrylic Washable Distemper (1st quality only)	Asian, Berger, ICI Dulux, Jenson & Nicholson, Nerolac,Shalimar,Garware & Goodlass
51.	Plastic Emulsion Paint (1st quality only)	Asian, Berger, ICI, Nerolac, Jenson & Nicholson, Shalimar,Garware & Goodlass
52.	Exterior Acrylic Emulsion (1st quality only)	ICI (Weathercoat), Excel (Nerolac), Apex (Asian), Berger, Jenson & Nicholson, Shalimar,Garware & Goodlass
53.	Polymer based Paint	STP,CICO
54.	Textured Paint / Wall Tile (1st quality only)	Unitle, Heritage, Spectrum, lokos, Acropaints, Asian

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55.	Flexible board for Expansion joint	STP or equivalent
56.	Grout	Shrinkomp, Fosroc, Fairmate
57.	Integral water proofing compound	STP, Pidilite, Fosroc, CICO, Sika.
58.	Concrete Admixture	Pidilite, Fosroc, CICO, Sika.
59.	Water proofing for cementitious surface IS-2645	Acrocrete & Acrocote, CICO, Fosroc, STP
60.	Bituminous Product	M/s Faridabad Spinning & Woolen Mills Pvt Ltd, 837, SP Mukherjee Marg Delhi, M/s STP Ltd (Formerly Shalimar Tar Products) M/s Bitufelt Pvt Ltd 123/377 Fazalm Ganj Kanpur 208012, Texas, Texas India Ltd,
61.	Hardeners	Ironite, Ferrok, Hardonate
62.	Construction Chemicals	Choksey, CICO, Forsroc, Sika
63.	Non Metallic Surface Hardners	CICO, Fosroc, STP, Sika
64.	Corrugated, Semi Corrugated & AC Sheets (IS-459-1970, IS-2098)	M/s Everest Bldg Products Ltd Jata Sankar Bosa Marg Muland (west) Bombay 400080, M/s Ramco AC Sheets "SWASTIK", M/s Eternit Everest Ltd, UP Asbestos Ltd
65.	GI Sheet ISI Marked	Multicolor, TATA, Bluescope, JSW, Colour Plus, Interarch, Lloyds, Jindal,
66.	Sheet Glass /Structural Glazing	Hindustan Pilkington Glass Works, Saint Gobain, Modi
67.	Multiell / Multiwall Polycarbonate Panel	M/s Coxwell Domes Engineering , Delhi, M/s Lexan , M/s Gallina India Pvt. Ltd.
68.	Stainless Steel Cladding	Jindal
69.	Punch Tape Concertina Coil	Global Technocrat, S.G.Engineers Delhi
70.	Punch Tape In Plastic Spool	Global Technocrat, S.G.Engineers Delhi
71.	Stainless Steel Railing	Jindal
72.	FRP/ HDPE Garbage Bins	Sintex, Swift, Nutech, Sheetal
73.	Thermoplastic Road Marking Paint	Shalimark (STP)
74.	Bollard	STP
75.	Cateye	TATA, STP
	Readymade Speed	STP
77.	Fountain	Ripples, Green Evolutions, Agritech Services, Premier
78.	Multi-Vent	Multicolor

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79.	Sanitary ware	Neycer Kermag (standard), Hindustan Sanitary Ware (1st quality), Parryware (superfine), Cera (1st quality), Classica (1st /
80.	WC seat cover ISI Marked	Parryware, Neycer Kermag (standard), Hindustan Sanitary Ware (1st quality), Cera (1st quality), Classica (1st / standard)
81.	PVC Flushing Cistern IS: 774-1984 (ISI Certified)	Parryware, Hindustan Sanitary Wares, Cera.
82.	Faucets & Taps, Stop Valves & Pillar Taps, Surgical basin mixer, Shower rose etc.	Gem, Parko, Parryware, HSW, Jaquar, Orient
83.	Kitchen Stainless Steel Sink	Diamond, Nirali, Neel Kanth, Jayna
84.	Looking Mirror	Saint Gobain, Modi Float, Triveni Float Glass, Crown, Atul, Ashai
85.	Ready made Bathroom Cabinets	Commander Gratings (I) Pvt Ltd, Gratology Cabinet, A-4 Sector Viii Noida-202701, Alpina, Cera.
86.	Float Valve	Leader, Bombay Metal & Alloy Co, Bombay superflow.
87.	SGSW Pipes (IS-651) ISI Marked	Perfect Agra, Devraj Ind Gaziabad, Buran, RK, Prince,
88.	CI (Centrifugally Cast) Pipes for sewage disposal ISI marked	NICCO, SRIF, A-1 Singhal Casting Co Agra, Jindal Saw, Kesoram, NECO
89.	PVC rain water/sewage pipes (IS-4985)	Reliance, Finolex, Supreme, Kisan, Prince, Hindustan Plastic & machine corporation, Polypack industries (P) Ltd.
90.	HDPE Water storage Tanks (Rotational Moulded)	Sintex, Swift, Nutech, Sheetal
91.	Cast Iron Pipes and Fittings	Hindustan Engineering Products Company Calcutta, S.L.C., Standard approved manufacturers of any other brand of fittings
92.	RCC Pipes	Indian Hume Pipe Company, Delhi / Allahabad / Chandigarh / Lucknow; Hindustan Pressure Pipes, Kolhapur; Dhere Concrete Products, Pune or any other approved manufacturer conforming B.I.S.
93.	Brass Fittings	Leader Engineering Works, Jalandhar; L & K Mathura; Luster Sanitary, Jalandhar; Annapurna Metal Works, Calcutta; Neta Metal Works, Jalandhar; Honey Industrial
94.	C.P. Fittings	Ego Metal Works, Ballabgarh; Jaquar Industries, Delhi; Soma Plumbing Fixtures Limited, Calcutta; Gem Sanitary Appliances Pvt. Ltd., Delhi; Essco Sanitations, Delhi; Bilmet,


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95.	Stone Ware (Salt-Glazed) Pipes	Hind Ceramics Limited, Orissa; Ceramic Industries Limited, Sambalpur; Shrikamakshi Agencies, Madras; Binary Udyog Pvt. Limited, Howrah; Tirumati Moulds Limited, Nagpur; Kiran Potteries, Hyderabad; Perfect Sanitary
96.	Asbestos Cement Pipes and Fittings	Ganga Asbestos Limited, U.P.; Hyderabad Asbestos Cement Products Limited; J.K. Super Pipe Industries, Nanded; Konark Cement and Asbestos Limited, Orissa; Maharashtra Asbestos Limited, Bombay; Poddar Industrial Corporation, Patna;
97.	HDPE pipes and fittings	ORI-PLAST,HASTI

## **STRUCTURE**

<b>Sl. No.</b>	<b>Items/Name of Products</b>	<b>Makes/Brands/Manufactures</b>
1	Structural Steel	SAIL / TATA / RINL / IISCO / ESSAR / ISPAT
2	Structural Steel Tubes ISI Marked	TATA / JINDAL / SURYA / SWASTIK
3	Synthetic Enamel Paint Ist Quality only	ICI Paint (Deluxe), Asian Paint (Apcolite), Shalimar Paint (Superlac), Goodlass, Nerolac Paint(Nerolac), Berger Paints

Any materials not fully specified in these specification and which may be offered for use in the works shall be subject to approval of Engineer, without which it shall not be used anywhere in the construction works.

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### 3. LIST OF SUPPLIERS OF MAJOR BOUGHT-OUT ITEMS

#### C. (ELECTRICAL)

##### i) Air Conditioner

1. O General
2. Daikin
3. Hitachi

##### ii) Batteries (Lead Acid)


1. Amco Batteries Ltd.
2. Exide Industries Ltd.
3. HBLNIFE Power System Ltd.
4. Amara Raja Batteries Ltd.

##### iii) Batteries (Nickel Cadmium)


1. Amco Batteries Ltd.
2. HBLNIFE Power Systems Ltd.

##### iv) Batteries Charger/DC-DC Converter

1. Amara Raja Power System (P) Ltd.
2. BCH.
3. Chhabi Electricals Pvt. Ltd.
4. Caldyne Automatics Limited
5. Dubas
6. HBL Nife Power Systems Ltd.
7. Universal Industries Products

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8. Universal Instrument Mfg Co Pvt Ltd
- v) **Cable – Fire Alarm & Communication Cables**
1. Cords Cable Industries Ltd.
  2. CMI
  3. Delton cables Ltd.
  4. ELKAY Telelinks
  5. KEI Industries Ltd.
  6. Reliance Engineers Ltd.
- vi) **Cable – HT (XLPE)**
1. Universal Cable Ltd.
  2. KEI Industries Ltd.
  3. Industrial Cables
  4. NICCO Corporation Ltd.
  5. Uniflex
  6. Polycab.
  7. Torrent cables Ltd.
- vii) **Cable – LT Power and Control**
1. Cords Cable Industries Ltd.
  2. Universal Cable Ltd.
  3. KEI Industries Ltd.
  4. Havells.
  5. Delton
  6. Elkay Telelinks
  7. Evershine Electricals
  8. Ecko
  9. Ravin
  10. Rallison.
  11. Suyog
  12. Netco
  13. Uniflex
  14. Paramount
  15. Gloster
  16. Associated cables Pvt Ltd.
  17. CMI

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18. Gemscab
19. Industrial cables
20. NICCO
21. Polycab
22. Torrent

**viii) Cable – Gland**

1. .Baliga
2. .Comet
3. Flexpro
4. Flameproof
5. FCG
6. Electro Werke
7. Dowels
8. CCI

**ix) Cable – Lugs**

1. Dowels
2. Jainson
3. Ismal

**x) Cable – Tray**


1. Ercon Composites
2. Yamuna Power & Infrastructure Ltd.

**xi) Cable Termination and Jointing Kit**

1. CCI
2. Raychem
3. M-Seal

**xii) Ceiling/Exhaust/Pedestal Fans & Circulators**

1. Bajaj Electricals Ltd.
2. Crompton Greaves Ltd.

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3. Khaitan Electricals Ltd.
4. Havell's

**xiii) Contractors – AC Power**

1. Andrew Yule
2. ABB
3. BHEL
4. C&S
5. Havell's
6. L&T
7. Schneider
8. Siemens Ltd.
9. Telemecanique

**xiv) Control Transformer**


1. AE
2. Indushree
3. Intra Vidyut
4. Kalpa Elektrikals
5. Transpower Industries Ltd.
6. Siemens

**xv) DG Set**

1. Sterling and Wilson.
2. GD ankalesaria.
3. Deev Genset.
4. Jackson
5. Sudheer Gensets.
6. Power Engineering(India) Pvt Ltd.

**xvi) Earthing Materials**

1. Rukmani Electrical & Components Pvt Ltd.
2. Indiana Grating Pvt Ltd.
3. Jef Techno Solutions Pvt Ltd

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Flame proof LDB's/ JB,s/Control Station/ switches

7. FCG
8. Sudhir
9. Prompt Engineering Works
10. Flame Proof equipments pvt. Ltd.
11. Baliga Lighting Equipments Pvt. Ltd.
12. Flexpro Electricals Pvt. Ltd.

**xvii) High Mast**

1. Bajaj Electricals Limited
2. Crompton Greaves Limited.
3. Philips India Limited
4. Surya Roshani

**xviii) High Voltage PCC/ MCC panels**


1. BHEL
2. Control and Switchgear
3. Siemens
4. Tricolite Electrical Industries
5. Schneider
6. CGL
7. L&T

**xix) Indicating Lamps**

1. Alstom Ltd.
2. BCH
3. L&T Ltd.
4. Siemens Ltd.
5. Vaishno Electricals

**xx) Indicating Meters**

1. ABB
2. AMCO
3. AE

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4. Alstom Ltd. (EE)
5. Conzerv/Schneider
6. Elecon Measurement Pvt. Ltd.
7. HPL Electric & Power Pvt. Ltd.
8. MECO Instruments Ltd.
9. Minilec
10. Rishabh Instruments Pvt. Ltd.
11. Trinity energy system
12. kaycee
13. Salzer

**xxi) Lighting Fixtures**


1. GE Lighting Pvt. Ltd.
2. Bajaj Electricals Ltd.
3. Crompton Greaves Ltd.
4. Philips India Ltd.

**xxii) Lighting Fixtures – Flameproof**

1. Bajaj Electricals Ltd.
2. Baliga Lighting Equipment Pvt. Ltd.
3. Crompton Greaves Ltd.
4. CEAG Flameproof Controlgear Pvt. Ltd.
5. Flexpro Electricals Pvt. Ltd.
6. Philips India Ltd.
7. Sudhir Switchgears Pvt. Ltd.
8. FCG.

**xxiii) Miniature Circuit Breakers (MCBs) and Lighting DB**

1. ABB
2. Hagger
3. Havell's India Ltd.
4. Indo Asian Fusegear Ltd.
5. Legrand
6. MDS Switchgear Ltd.
7. Schneider

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8. Siemens Ltd.

9. HPL

**xxiv) Moulded Case Circuit Breaker (MCCBs)**

1. ABB

2. Andrew yule

3. Larsen & Toubro

4. Schneider

5. Siemens

6. Control and Switchgear

**xxv) Protection Relays – Thermal**

1. BCH

2. L&T Ltd.

3. Siemens Ltd.

4. Telemenchanique & Controls (India) Ltd.

**xxvi) Low Voltage Power Control Center (PCC)/ MCC/ PDB/ MLDB/ LDB**

1. ABB

2. BCH

3. C & S

4. Elecmech Switchgear & Instrumentation

5. KMG ATOZ

6. L&T

7. Pyrotech Electronics Pvt. Ltd.

8. Risha control Engineers Pvt. Ltd.

9. Siemens

10. Tricolite Electrical Industries

11. Unilec Engineers Ltd.

12. Vidyut Control India Pvt. Ltd.


13. Control and Schematic

14. Zenith Engineering

**xxvii) Push Buttons**

1. BCH

2. Alstom Ltd.

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3. L&T
4. Siemens Ltd.
5. Telemenchanique & Controls (India) Ltd.
6. Vaishno Electricals

**xxviii) Switches - Control**

1. BCH
2. Easum Reyrolle Relays & Devices Ltd.
3. Alstom
4. Kaycee Industries Ltd.
5. L&T
6. Siemens Ltd.

**xxix) Switches – 5/15A Piano/ Plate, Switch Socket**

1. Anchor Electronics & Electricals Pvt. Ltd.
2. Kingal Electricals Pvt. Ltd.
3. North-West Switchgear Ltd.

**xxx) Switch Socket Outlets (Industrial)**


1. Alstom Ltd.
2. Best & Crompton Engineering Ltd.
3. BCH
4. Crompton Greaves Ltd.
5. Essen Engineering Company Pvt. Ltd.

**xxxii) Solar Modules**

1. Tata BP Solar (I) Ltd.
2. REIL, Jaipur.
3. CEIL, Sahibabad.
4. HBL Power

**xxxii) Solar Street Lighting**

1. Tata BP Solar (I) Ltd.
2. REIL, Jaipur.

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3. CEIL, Sahibabad.

4. HBL.

**xxxiii) Terminals Blocks**

1. Connectwell

2. Controls & Switchgear Co. Ltd.

3. Elmex Controls Pvt. Ltd.

4. Essen Engineering Co. Pvt. Ltd.

**xxxiv) Transformers**

1. ABB

2. Andrew Yule

3. Areva

4. BHEL

5. Bharat Bijlee

6. Crompton Greaves

7. EMCO Ltd.

8. Intra Vidyut

9. Indushree

10. Indcoil

11. Kirloskar

12. Skippers Electricals

13. Transformers & Rectifiers (I) Ltd.

14. Voltamp

**xxxv) UPS System and Inverter**

1. DB Power

2. Aplab

3. Keltron


4. Hi-Rel

5. Dubas

6. Toshiba Corporation

7. Fuzi Electric Co Ltd

**xxxvi) GI-Octogonal Pole**


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1. Bajaj
2. Transrail
3. Wipro

**xxxvii) List Of Recommended Manufacturers for Heater**

1. Escorts Limited, Faridabad, Haryana
2. Spherehot / Kanti Lal Chuni Lal & Sons Appliances Pvt Ltd.Surat
3. Kerone, Bhayander(E), Thane - 401105
4. Excel Heaters, Andheri (West), Mumbai - 400 053, India
5. Nirmal Industrial Controls Pvt. Ltd. , Mulund(W), Mumbai - 400 080

**NOTE:** - Item/Vendor, which are not listed above, shall be subject to prior approval from Client/Consultant.

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#### 4. LIST OF MATERIALS OF APPROVED BRAND AND/ OR MANUFACTURE

##### D. (INSTRUMENTATION)


##### I. OFC

Manufacture/Procurement, Testing and supply of suitable OFC Joint closures including all necessary accessories of any of the following make:

1. Raychem
2. 3M
3. Siemens
4. Any other make from the approved vendor list of client with supporting paper

##### II. METERING SKID

1. M/s Chemtrols Industries Ltd., Mumbai
2. M/s Daniel Measurement Solutions Pvt Ltd, Vadodara.
3. M/s Elster-Instromet India Pvt Ltd, Vadodara
4. M/s INEL Gas Controls Pvt Ltd, Vadodara.
5. M/s Nirmal Industrial Controls Pvt. Ltd., Mumbai
6. M/s Oswal Industries Limited, Ahmedabad
7. M/s Autometer energytech ltd, NOIDA
8. M/s Rockwin Flowmeter india Pvt Ltd, Ghaziabad.
9. M/s Intromet international Ny Rajkmakeriaan 9, B-2910, Essen , Belgium. [Email:- sales@instromet.be](mailto:sales@instromet.be)
10. M/s Pietro Fiorentini Spa, 20124, Milino, Itally, sales@fiorentini.com
11. M/s FMC Measurement Solutions , 6 Braidway , thetford, Norfolk, IP24 1 JA, England. Email- phil.lamming@fmcti.com


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12. M/s Petrogas Gas system BV, Doesburgweg, 7 , 203 PL  
Gouda, PO Box 20, 2800, AA Gouda Netherland. Email-  
info@petrogas.nl
13. Tormene Gas technology SpA, via campolongo, 97, 35020 –  
Due carrare (Padova) Italy email – tormene@tormene.it
14. M/s ODS BV, Donk 6, 2291 Berendrecht, Netherland,  
Email: - info@odsbv.nl
15. M/s RMG Regel + Messtechnik GmbH Osterholzstr, 45, D-  
34123 Kassel, Germany email- rmg@rmg.de  
Gerhard.lembke@rmg.de

### III. **PRESSURE GAUGES**

1. AN Instruments Pvt Ltd
2. Badotherm Process Instruments  
Pvt
3. Baumer Bourdon Haenni S.A.S
4. British Rototherm Co Ltd
5. Budenberg Gauge Co Ltd
6. Dresser Inc
7. Forbes Marshall (Hyd) Pvt Ltd
8. General Instrument Consortium
9. H. Guru Instruments (South India) Pvt Ltd
10. Manometer (India) Pvt Ltd
11. Nagano Keiki Seisakusho Ltd
12. Hirlekar Precision, India
13. Waaree Instruments Ltd
14. Walchandnagar Industries Ltd (Tiwac Divn)
15. Wika Alexander Wiegand & Co GmbH
16. Wika Instruments India Pvt Ltd
17. Ashcroft India Pvt Ltd.

### IV. **TEMPERATURE GAUGES**

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1. AN Instruments Pvt Ltd.
2. Badotherm Process Instruments B.V.
3. Bourdon Haenni S.A.
4. Dresser Inc.
5. General Instruments Consortium
6. H. Guru Instruments (South India) Pvt. Ltd
7. Nagano Keiki Seisakusho Ltd
6. Sbeletro Mechanicals
8. TRAC

**XI. FIELD INSTRUMENTS  
(P, DP, F, L, T)**


1. ABB Ltd
2. Honeywell
3. Fuji Electric Instruments Co Ltd
4. Yokogawa
5. Invensys India Pvt.Ltd

**XII. FLOW COMPUTERS**

1. Emerson
2. Instromet International (Belgium)
3. FMC Measurement Solutions (UK)
4. RMG (Germany)
5. OMNI Flow Computers Inc.
6. Thermo Fisher, USA

**XIII. PRESSURE REGULATOR AND SLAM SHUT VALVE**


1. Pietro Fiorentini S.P.A. (Italy)
2. Emerson
3. RMG-Regel Messtechnik (Germany)

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4. Mokveld Valves BV (Netherlands)
5. Schlumberger (USA)
6. Gorter Controls B V (Netherlands)
7. Instromet International NV
8. Nirmal Industrial Controls Pvt Ltd. (up to 6" size only)
9. ESME Valves Ltd
10. Kaye & Macdonald Inc.
11. Nuovo Pignone S.P.A (Italy) (GE Oil Co.)
12. Richards Industries (Formerly Treloar)
13. Samson AG Mess-und Regeltechnik
14. Tormene Gas Technology
15. Dresser Inc, USA (upto 8" size, 300# class only)

**XIV. PRESSURE SAFETY VALVES**

1. Keystone Valves (India) Pvt. Ltd.
2. Larson & Toubro Ltd.
3. Lesser GmbH & Co KG
4. Mekaster Engg Ltd..
5. Tyco Sanmar Ltd. (New Delhi)
6. Anderson Greenwood Crosby
7. BHEL (Trichy)
8. Curtiss Wright Flow Control Corporation
9. Dresser Inc.
10. Fukui Seisakusho Co. Ltd
11. Nakakita Seisakusho Co Ltd
12. Nuovo Pignone S.P.A (Italy) (GE Oil co)
13. Parcol S.P.A
14. Safety Systems UK Ltd
15. Tai Milano S.P.A
16. Weir Valves & Controls France
17. Bliss Anand Pvt Ltd.


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**XV. FLOW CONTROL VALVES**

1. Fouress Engg. (New Delhi)
2. Fisher Xomox (New Delhi)
3. MIL Control Ltd. (Noida)
4. KOSO India Pvt Ltd
5. Samson Control (Thane)
6. Dresser Valves India Pvt Ltd.
7. Fisher Controls
8. Valvitalia Italy
9. CCI Valve technology
10. Flowserve Pvt Ltd.
11. Metso Singapore Pvt Ltd.
12. Instrumentation Ltd Palghat
13. Dresser Inc. USA

**XVI. CONTROL PANEL & ACCESSORIES**

1. Keltron Controls Ltd., Kerala
2. Elechmec Corporation Ltd., Mumbai
3. Industrial Controls & Appliances Pvt. Ltd.,
4. Alstom System Ltd., Noida
5. Emerson Process Management (I) Pvt. Ltd.
6. ABB Instruments Ltd., New Delhi
7. Larsen & Toubro Ltd.
8. Control & Automation, New Delhi
9. GE Fanuc Systems Pvt. Ltd., New Delhi
10. Rockwell Automation (I) Ltd., Ghaziabad
11. Honeywell Automation Ltd.
12. Rittal
13. Pyrotech Elcronics Pvt Ltd.

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14. Positronics Pvt Ltd.
15. Electronics Corporation of India Ltd.


**XVII. JUNCTION BOXES AND CABLES GLANDS**

1. Ex-Protecta
2. Flameproof Control Gears
3. Baliga
4. Flexpro Electricals

**XVIII. CONTROL AND SIGNAL CABLES**

1. Associated Cables
2. Brook
3. Associated Flexibles & Wires (Pvt) Ltd
4. Universal Cables Ltd,India
5. Delton Cables Ltd, India
6. KEI Industries Ltd INDIA
7. CMI Limited
8. Cords Cable Industries Ltd, India
9. Elkay Telelinks (P) Ltd., India
10. Udey Pyrocables Pvt Ltd, India
11. Goyolene Fibres (I) Pvt Ltd, India
12. Netco Cable Industries Pvt Ltd, India
13. Nicco Corporation Ltd, India
14. Paramount Communications Ltd, India
15. Polycab Wires Pvt Ltd, India
16. Radiant Cables Pvt Ltd, India
17. Reliance Engineers Ltd., India
18. Suyog Electricals Ltd, India
19. Thermo Cables Ltd

**XIX. INDICATORS & CONTROLLERS**

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1. Yokogawa  
 2. Eurotherm Chessel  
 3. Honeywell  
 4. Emerson
- XX. BARRIERS**

1. MTL  
 2. STHAL  
 3. P&F  
 4. Phoenix

**XXI. GAS CHROMATOGRAPH**


1. ABB  
 2. Emerson  
 3. Instromet International, NV  
 4. RMG Regal+Messtechnik GmbH  
 5. Yokogawa

**XXII. I/P CONVERTERS**

1. ABB  
 2. Emerson  
 3. IMI Watson Smith Ltd.  
 4. Moore Controls Ltd  
 5. Shreyas Instruments Pvt Ltd, India  
 6. Thermo Brandt Instruments

**XXIII. SS FITTINGS, INSTRUMENT VALVES & MANIFOLDS**

1. Aura Inc.  
 2. Hoke  
 3. Excelsior Engg Works, India  
 4. Parker  
 5. Swagelok Co.

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6. Swastic Engineering Works, India
7. Comfit & Valves Pvt.Ltd
8. Arya Crafts & Engg.Pvt. Ltd

**XXIV. SS TUBES**

1. Sandvik
2. Hoke
3. Parker
4. Swagelok Co.
5. Heavy metal & tubes LTD
6. Nuclear Fuel Complex .India
7. Ratnamani Metal & Tube Ltd
8. Jindal Saw

**XXV. GAS DETECTION SYSTEM**

1. Crowcon Detection Instruments Ltd
2. Detection Instruments (I) Pvt Ltd
3. Detector Electronics Corporation
4. Drager Safety AG & Co. KGAA
5. General Monitors Ireland Ltd
6. Mine Safety Appliances Company
7. MSA – Mines Safety Appliances (India) Ltd
8. Industrial Scientific Oldham France S.A.
9. Riken Keiki Co Ltd
10. Simrad Optronics Icare
11. Honeywell Analytics
12. Net Safety Monitoring Inc.
13. Simtronics SAS

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## 5. LIST OF RECOMMENDED MANUFACTURERS


### E. (SHOP & FIELD PAINTING)

#### I. Indian Vendors

1. Asian Paints(I) Ltd.
2. Berger Paints Ltd.
3. Goodlass Nerlolac Paints Ltd.
4. Jenson And Nicholson Paint Ltd & chokuGu Jenson & Nicholson Ltd.
5. Shalimar Paints Ltd.
6. Sigma Coating, Mumabai
7. CDC Carboline Ltd.
8. Premier Products Ltd.
9. Coromandel Paints & Chemicals Ltd.
10. Anupam Enterprises
11. Grand Polycoats
12. Bombay Paints Ltd.
13. Vanaprabha Esters & Glycer, Mumbai
14. Sunil Paints and Varnishes Pvt. Ltd.
15. Courtaulds Coating & Sealants India (Pvt.) Ltd.
16. Mark-chem Incorporated, Mumbai (for phosphating chemicals only)
17. VCM Polyurethane Paint (for polyurethane Paint only)


#### II. Foreign Vendors for Overseas Products

1. Sigma Coating, Singapore
2. Ameron, USA
3. Kansai Paint, Japan
4. Hempel Paint, USA
5. Valspar Corporation, USA
6. Courtaulds Coating, UK.

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**Notes:**

1. Bidder can select equipment of two different makes, selected from this VENDOR LIST and mention the same in the checklist for technical evaluation attached with the tender. The offered bid must include filled datasheet indicating make, model, size, rating of offered instrument/ equipment duly supported by sizing calculation of offered equipment (wherever applicable).
2. Vendors who have already supplied above equipment in other terminals of GAIL (I) Ltd, shall also be considered qualified for this tender provided the supplied equipment are commissioned and running successfully and they have not been put on holiday in list of Client/LEPL/ Other PSU
3. Equipment / Instruments of any make which is offered by one bidder and acceptable to GAIL (I) Ltd shall be accepted for other bidder also. After placement of order, on request of the successful bidder list of other qualified makes for a particular item (for which successful bidder wants to change the vendor) shall be provided.
4. Bidder shall take prior approval of the make / model no of the offered item and it shall be from the list given above. However additional vendors will be considered in exceptional cases, provided they have supplied for similar application to reputed gas transmission/distribution companies, in quantities at least half the numbers being supplied for this tender, and working satisfactorily for minimum 6 months. Documentary evidence substantiating above shall be submitted for taking approval.
5. For procuring bought out items from vendors other than those listed above, the same may be acceptable subject to the following:
  - a) The vendor/ supplier of bought out item(s) is a manufacturer/ supplier of said item(s) for intended services and the sizes being offered is in their regular manufacturing supply range.
  - b) Should have supplied at least one single random length (i.e. 5.5 meters to 6.5 meters) for item assorted pipes / tubes and for other items, which are to be supplied in quantity on number-basis (other than assorted pipes / tubes) minimum 01 (One) number of same or higher in terms of size and rating as required for intended services. The bidder should enclose documentary evidences i.e. PO copies, Inspection Certificate etc. for the above, along with their bids.

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- 6 For any other item(s) for which the vendor list is not provided, bidders can supply those item(s) from vendors/ suppliers who have earlier supplied same item(s) for the intended services in earlier projects and the item(s) offered is in their regular manufacturing/ supply range. The bidder is not required to enclose documentary evidences (PO copies, Inspection Certificate etc.) along with their offer, however in case of successful bidder, these documents shall require to be submitted by them within 30 days from date of Placement of Order for approval to CLIENT / LEPL.
  
- 7 The details of vendors indicated in this list are based on the information available with LEPL, Contractor shall verify capabilities of each vendor for producing the required quantity with. PMC does not guarantee any responsibility on the performance of the vendor. It is the contractor's responsibility to verify the correct status of vendor and quality control of each parties and also to expedite the material in time.

**6. MANUFACTURE LIST FOR TELECOM BOUGHT OUT ITEMS**

**Fiber Optic Cable and Accessories**

**Vendor Details**

1. Aksh Optifibre Limited
2. Vindhya Telelink Limited
3. Finolex Cables Ltd
4. RPG Cables Limited
5. Tamilnadu telecommunication Limited
6. UM Cables Limited
7. Himachal Futuristic Communications Limited
8. Birla Ericsson Optical Limited
9. Uniflex Cables Ltd
10. Sterlite Optical technologies Limited

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