



INDIAN OIL CORPORATION LIMITED

TECHNICAL SPECIFICATION

FOR

LAYING & CONSTRUCTION OF 3LPE COATED CARBON STEEL PIPELINE AND
ASSOCIATED WORKS FOR CITY GAS DISTRIBUTION

TENDER NO.: _____

WORK DESCRIPTION: _____

DOCUMENT NO. : IOCL-CGD-STEEL PIPELINE-SPEC



LAYING & CONSTRUCTION OF 3LPE
COATED CARBON STEEL PIPELINE AND
ASSOCIATED WORKS FOR CITY GAS
DISTRIBUTION

इंडियन ऑयल कॉर्पोरेशन लिमिटेड
(पाईपलाइन प्रभाग) नोएडा

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SECTION-I

TECHNICAL SPECIFICATION FOR PIPELINE CONSTRUCTION



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CHAPTER-1

1. GENERAL

1.1. DEFINITIONS

Definition of Terms

The terms used in the technical document must be understood as follows:

“Approval”	: Means written approval.
“Owner” or “Client”	: Is the principal requesting the works to which the Agreement relates, i.e. INDIAN OIL CORPORATION LIMITED (IOCL).
“Owner’s Representative” Or “PMC” or “EPMC”	: Shall mean Owner’s CONSULTANT.
“Contractor”	: The natural person or legal entity with whom the Owner has concluded Agreement.
TPIA	: Third Part Inspection Agency
“Equipment”	: Means all apparatus, tools and machineries of any kind whatsoever that are necessary for the construction, execution and maintenance of the Works specified in the Agreement.
“Goods and/or Services”	: Depending on the specific case, all or part of the Construction materials, equipment, constructions, appliances, tools, machines, works, etc. that are to be built, assembled, adapted or brought into operation by the Contractor pursuant to the Agreement, including all studies, performances, works and services specified within the Agreement. The terms Goods or Services can be used interchangeably according to the context.
“HDD”	: Horizontal Directional Drilling
Mechanical Completion	: Shall mean completion of all pre-commissioning activities and associated requirements. It also includes completion of all work related to CP and civil activities deemed necessary for completion of precommissioning.
Pre-Commissioning	: It includes mechanical resistance test, tightness/leak test, cleaning including magnetic cleaning, GED survey, dewatering, swabbing, pre-drying activity, Golden Tie-ins connecting the stations and final acceptance dossier (As built document) and all other related activities. It also includes completion of all works related to CP and civil activities.



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Commissioning : It includes final drying, filling the Nitrogen (if required) and commissioning with gas, testing of golden tie-ins welds at Gas MOP, gas-in activity and final acceptance dossier.

1.2. REFERENCE CODES, STANDARDS AND SPECIFICATIONS

Reference has been made in this specification to the latest edition of the following codes, standards and specifications and any other relevant codes/standards,

S. No.	Code No.	Description
1	ASME B.31.8	“Gas Transmission and Distribution Piping Systems” – Latest edition and all Codes it refers to.
2	API RP 1102	“Steel pipelines Crossings Railroads and Highways” – Latest edition.
3	API 1104	“Welding of pipelines and related facilities” – Latest edition.
4	AS/NZS 2885.5	Pipelines – Gas and liquid petroleum – Field Pressure Testing
5	OISD 141	“Design and construction requirements for cross-country hydrocarbon pipeline–” - latest edition.
6	OISD 226	“Natural Gas Transmission Pipelines and City Gas Distribution Network”
7	DIN 30670	“Polyethylene coating for steel pipes and fittings”.
8	DIN 30671	“Thermoset plastic coating for buried steel pipes ”
9	DIN 30672	“Tape and shrinkable materials for the corrosion protection of buried or underwater pipelines without Cathodic protection for use at operating temperatures up to 50°C.”
10	DIN 30673	“Bitumen coatings and linings for steel pipes, fittings and vessels”.
11	DIN 30675-1	“External corrosion protection of buried pipes & range of applications for steel pipes.”
12	DIN 30677	“Protection of buried valves against corrosion coating (external) with duroplastics.”
13	EN 12062	“Non destructive examination of welds – General rules for metallic materials”.
14	EN 12068	Cathodic Protection – External organic coatings for the corrosion protection of buried or immersed steel pipelines used in conjunction with cathodic protection – Tapes and Shrinkable materials
15	IS 8062	“Code of practice for Cathodic protection of steel structures”
16	IS 12944-5	“Paints and Varnishes – Corrosion Protection of Steel Structures by protective paint system “
17	ISO-8502-3	“Preparation of steel substrates before application of paints and related products – Tests for the assessment of surface cleanliness”.
18	ISO 9305	“Seamless steel tubes for pressure purposes full peripheral ultrasonic testing for the detection of transverse imperfections”.
19	ISO 10124	“Seamless & welded (except submerged arc welded) steel tubes for pressure purposes. Ultrasonic testing for the detection of laminar imperfections”.
20	ISO 12094	“Welded steel tubes for pressure purposes. Ultrasonic testing for the detection of laminar imperfections in strips/plates used in the manufacture of welded tubes”.
21	ISO 15741	“Paints and varnishes – friction – reduction coatings for the interior of on – and offshore steel pipelines for non- corrosive gases.”
22	ISO 15590-1	“Petroleum and Natural Gas Industries – Induction bends, fittings and flanges for pipeline transportation system – Part I : Induction Bends”.
23	ISO 21809-3	Petroleum and natural gas industries – External coatings for buried or submerged pipelines used in pipeline transportation systems.

In case of differences between the requirements of this specification and that of the above referred codes, standards and specifications, the requirements of this specification shall govern.



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For the purpose of this specification the following definitions shall hold:

- The words "Shall" and "Must" are mandatory.
- The words "Should", "May" and "Will" are non-mandatory, advisory or recommended.



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CHAPTER-2

2. PRELIMINARY ACTIVITIES

This specification refers to the preliminary activities to be taken prior to digging the trenches.

Prior to construction, CONTRACTOR shall submit a detailed methodology statement for OWNER's approval for installation of pipeline and cable conduit including, but not limited to the following:

- Job procedures for all activities of construction, testing and commissioning of pipeline.
- Suggested diameter of reamed holes to facilitate smooth pulling operation.
- Methodology for bundling pipeline and cable conduit together. (If proposed).
- Minimum distance between entry points for pipeline and cable conduit and suggested methodology to ensure that clear distance between pipeline and cable conduit in as installed condition is 5.0 m.
- Method of pulling pipeline and cable conduit together in a bundle or separately, as applicable.
- Method of preventing the pipeline from rotating during pull-in, to ensure that cable conduit is not damaged during pulling operation, when CONTRACTOR proposes to install pipeline and cable conduit together.
- Method of inspection of cable conduit after installation.
- Method of blowing optical fiber cable.

2.1. EQUIPMENT

The Contractor shall supply all equipment necessary for the execution of the Works, from topographical survey until tests and commissioning operation, including all safety devices necessary to meet worker as well as public safety standards.

2.2. DRAWINGS

The contractual documents indicate the streets where pipelines are to be laid. In order to set up the pipelines routes, the Contractor shall draw-up the following documents.

2.2.1. Survey

The contractor shall carry out a complete topographical survey of each street, in accordance with the general specification "Drawings" showing in particular.

- The limits of public and private lands
- The limits of carriage-ways and side walks
- The above-grounds obstacles.

2.2.2. Construction Drawings

Onto the above mentioned survey drawings, the Contractor shall draw-up:

- a) The underground obstacles



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The Contractor shall carry out a subsurface inspection in order to locate the underground obstacles and the utilities in the total width of the streets, carriage-ways and sidewalks.

The Contractor shall get all available information and drawing from the authorities in charge of underground utilities such as water, electricity, communications, etc.

The Contractor shall carry out the subsurface inspection using a pipe locator and by digging trial-holes.

b) The proposed pipelines routes Public land

The pipeline shall normally be laid in public land, as follows:

- Basic grid

The basic grid pipelines shall be under the carriage-ways, except where they can be laid under the sidewalks, as are the distribution networks pipelines.

- Distribution network

The distribution network pipelines shall be under the sidewalks, not closer to the building line than one meter and to the other utilities than 0.40 meter. If not possible, as proved by trial-holes, they shall then be laid under the carriageways as close as possible to the sidewalks but not under the gutters.

Private land

In case a pipeline section would have to be laid in private land, the Contractor shall obtain from the owner the necessary written authorization on behalf and in liaison with the company, while the construction drawing is being drawn-up.

c) Pipeline equipment locations

The pipeline equipment such as valve chambers, buried valves, connecting box chambers, etc. shall be installed in public land. The pipeline equipment locations shall be shown on the construction drawings.

Whenever possible, the sight holes shall be situated at sidewalk surface level.

The drawing shall be submitted to the Engineer for approval of the survey and of the construction drawings.

The drawings shall be submitted, in the number stipulated by the special specifications at least one month before starting excavation of the streets concerned.

Approval of the drawings shall be needed for obtaining the digging permit.



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Such an approval will not prevent the Engineer from ordering a change of route if unexpected above ground or underground obstacles, or any other difficulties are encountered later on.

2.3. PERMITS

2.3.1. Installation Permits

The Contractor shall obtain from the concerned Authorities such as the Municipality, Administrations, etc the installation permits for installing:

- stores and workshops
- material stock yards
- backfill material yards
- earth spoil dumps
- etc.

2.3.2. Circulation Permit

The Contractor shall obtain from the concerned Authorities the circulation permit for the heavy equipment (cranes, lorries, trucks, etc.) that he may wish to use during the construction of the Works.

Any damage resulting from the use of heavy equipment shall be charged to the Contractor.

2.3.3. Digging Permit

Before any occupation of public land, the Contractor shall request in writing the digging permit from the appropriate authorities, in the way and time stipulated by the special conditions and/or specifications.

2.3.4. Trial-Hole Permit

The Contractor shall request in writing the necessary trial-hole permits from the appropriate authorities in the way and time stipulated by the special conditions and/or specifications.

Moreover the Contractor shall appoint a representative who shall settle any problem raised by the occupation of public land and private land if any. In particular, he shall be in charge of making all necessary arrangements with the traffic police prior to the starting of the work and of dealing with all conflicts arising from the work process. He shall also be in charge of dealing with all problems raised by the different utilities, authorities and private persons.

2.4. STAKING OUT

The Contractor shall give notice to the Engineer, before staking out the pipelines routes.

The pipelines routes shown on the construction drawings shall be confirmed by digging trial-holes.

The final pipeline route set-up, taking consideration of the spotted underground obstacles, shall be marked on the street surface with due agreement of Engineer-in-charge.

The staked out pipeline route shall not be altered without the prior authorization of the Engineer.



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CHAPTER-3

3. RIGHT-OF-WAY / RIGHT OF USE (ROU)

The ROU will be arranged by the contractor. Contractor shall carry out all necessary survey work as per requirements of site conditions. It will be the responsibility of the Contractor to maintain the ROU until completion of the work

In case of encroachment on the ROU or extra land needed during construction, it will be the sole responsibility of the Contractor to relocate all issues (including any compensation) with the relevant land Owner, tenant or authorities. All related cost will be borne by the Contractor

3.1. Statutory Permissions

Owner shall apply for permission for laying of pipeline however obtaining the permission from the statutory authorities, obtaining work permits/ NOC from various statutory authorities having jurisdiction before execution of the works and complying with all stipulations / conditions / recommendations of the said authorities and necessary day to day clearances, approvals from all concerned authorities in respect of pipeline and all related work shall be responsibility of contractor and cost of same shall be deemed to have included in quoted prices. On behalf of the Owner, Contractor shall co-ordinate with the relevant authorities along with the copy of required pipeline route drawings / certificates complete in all respect shall be prepared and submitted by the Contractor well ahead of time so that the actual construction of the work is not delayed for want of the approval / inspection / permission by concerned authorities. The inspection of work by authorities shall be arranged by Contractor and necessary co-ordination and liaison work in this respect shall be the responsibility of the Contractor. However, statutory fees / restoration charges, if any, shall be paid by Owner on production of documentary evidence.

Any change / addition required to be made to meet the requirements of the statutory authorities shall be carried out by the Contractor without any extra cost to OWNER. The inspection and acceptance of the work by statutory authorities shall however, not absolve the Contractor from any of his responsibilities under this contract.

3.2. Staking

Prior to cleaning operations CONTRACTOR shall:

- 1) Install Bench Marks, Intersection Points and other required survey movements.
- 2) Stake markers in the centreline of the pipeline at distance of maximum 100 metres for straight line sections and maximum 10 metres for horizontal bends. Wherever ROW centreline has been staked on ground, CONTRACTOR shall exercise care in accurately staking the pipeline centreline, in consultation with COMPANY.
- 3) Stake two ROW markers at least at every 100 metres.
- 4) Set out a reference line with respect in pipeline centreline at a convenient location. Markers on reference line shall be at a distance of maximum 100m for straight line sections and maximum 10m for horizontal bends.
- 5) Install distance markers locating and indicating special points, such as but not limited to :



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

ROW markers shall be staked out at the boundary limits of Right-of-way wherever possible. ROW markers shall be painted red with numbers painted in white. Number shall be identical to centreline marker number with letters A (left side) and B (right side) added, (looking, in flow direction). Reference markers shall also carry the same information as its corresponding centreline markers.

Markers shall be of suitable material so as to serve their purpose and shall be coloured distinctly for easy identification. CONTRACTOR shall be responsible for the maintenance and replacement of the reference line markers until the permanent pipeline markers are placed and the as-built drawings are submitted and approved.

Any deviation from the approved alignment shall be executed by CONTRACTOR after seeking COMPANY approval in writing prior to clearing operations.

3.3. Monuments

All shrines, monument, border stones, stone walls and the like shall be protected and shall be subjected to no harm during construction. Any violation of the above by the CONTRACTOR shall be brought to the notice of the COMPANY and other concerned authorities. Restoration of the above shall wholly be the responsibility of the CONTRACTOR.

3.4. Fencing

Prior to clearing or grading of the Right-of-way or stringing of pipe, CONTRACTOR shall open fences on or crossing the construction Right-of-way and install temporary gate of sound construction made of similar materials and suitable quality to serve purpose of original fence. Adjacent post shall be adequately braced to prevent slackening of the remainder of the fence. Before such fences are cut and opened, CONTRACTOR shall notify the land owner or tenant, and where practicable, the opening of the fences shall be in accordance with the wishes of said owner and tenant. In all cases where CONTRACTOR removes fences to obtain work route, CONTRACTOR shall provide and install temporary fencing, and on completion of construction shall restore such fencing to its original condition.

CONTRACTOR shall install temporary fencing on either side of ROW where in COMPANY's opinion, it is considered essential to ensure safety and non-interference, especially in areas like grazing lands, villages etc.

Fencing shall be removable type wherever necessary, to permit crossing of traffic. The type of fencing must be suitable for the situation in accordance with user. The pole distance shall not be greater than 6m. The minimum height of the fencing shall be 1.2m above grade. Fencing can consist of one or more rows of smooth wire and/ or of barbed wire.

Fencing shall be continuously maintained and the thorough-ways inspected to be shut during the execution of the work.



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3.5. Row Clearing and Grading

All stumps shall be grubbed for a continuous strip, with a width equal to trench top width plus two metres on either side centred on the pipeline centreline. Further, all stumps will be grubbed from areas of the construction Right-of-way, where Right-of-way grading will be required. Outside of these areas to be graded and the mentioned trench strip, at the option of CONTRACTOR, the stumps may either be grubbed or cut off to ground level. Any stump cut off must be left in a condition suitable for rubber-tyred pipeline equipment traffic.

All grubbed stumps, timber, bush undergrowth and root cut or removed from the Right-of-way shall be disposed of in a manner and method satisfactory to COMPANY, land-owner and/ or tenant, and Government Authorities having jurisdiction and as soon as practical after the initial removal. In no case, it shall be left to interfere with the grading and laying operations. Whenever stumps are grubbed and a hole is left in the ground, CONTRACTOR shall back-fill the hole and compact it to prevent water from gathering in it and creating a big hole.

CONTRACTOR shall grade the pipeline Right-of-way 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 good engineering and construction practices.

CONTRACTOR shall grade sharp points or low points, without prejudice to section 6.0 of this specification, to allow the pipe to be bent and laid within the limits set forth in these specifications and drawings as regards the minimum elastic curvature permitted, and shall drill, blast or excavate any rock or other material which cannot be graded off with ordinary grading equipment in order to make an adequate working space along the pipeline.

No temporary or permanent deposit of any kind of material resulting from clearing and grading shall be permitted in the approach to roads, railways, streams, ditches, drainage ditches and any other position which may hinder the passage and/or the natural water drainage.

The Right-of-Way clearing and grading operations shall in no case involve embankment structures of any type and class without prior approval of the authorities having jurisdiction over the same.

In the case of natural or artificial deposits of loose soil, sand, heaps of earth, or other fill materials, these shall be removed till stable natural ground level is reached so as to ensure the construction of the pipeline ditch is in stable ground.

In the case of Right-of-Way clearing and grading on hillside or in steep slope areas, proper barriers or other structures shall be provided to prevent the removed materials from rolling downhill. The Right-of-Way crossfall shall not exceed 10%.

Wherever the pipeline Right-of-Way runs across plantations, alongside farmyards, built up areas, groups of trees, horticultural spreads, gardens, grass-fields, ditches, roads, paths, railways or any other area with restrictions of some kind, CONTRACTOR shall grade only the minimum area required for digging and constructing the pipeline. In the said places, CONTRACTOR shall carry out the works in such a way that damage done from the pipeline construction is kept to a minimum.

3.6. Provision of Detours

CONTRACTOR shall do all necessary grading and bridging at road, water and other crossings and at other locations where needed, to permit the passage of its men and equipment. It is understood that the CONTRACTOR has recognised such restrictive features of the Right-of-Way and shall provide the



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necessary detours and execute the works without any extra cost to COMPANY. Public travel shall not be inconvenienced nor shall be wholly obstructed at any point.

CONTRACTOR at his own cost shall furnish and maintain watchman detours, lanterns, traffic lights, barricades, signs, wherever necessary to fully protect the public.

CONTRACTOR shall be responsible for moving its equipment and men across or around watercourses. This may require the construction of temporary bridges or culverts. Temporary bridging or access to fording required for Right-of-Way crossing water courses shall be constructed. CONTRACTOR shall ensure that such temporary works shall not interfere with normal water flow, avoid overflows, keep the existing morphology unchanged and shall not unduly damage the banks or 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 COMPANY a copy of such approval.

3.7. Steep and Rocky Terrain

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

In 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, and at no extra cost to COMPANY, Wherever rocky terrain is encountered, grading shall be carried out in all types of solid rocks which cannot be removed until loosened by blasting, drilling, wedging or by other recognised means of quarrying solid rocks.

Where use of explosives is required in connection with Right-of-Way grading and trenching, CONTRACTOR shall comply fully with requirements of the use of explosives as provided under relevant clause of this Specification.

3.8. Off Right-of-Way Damages

CONTRACTOR shall confine all its operations within limits of the Right-of-Way. Any damage to property outside ROW shall be restored or settled to the CONTRACTOR's account.

CONTRACTOR shall promptly settle all off Right-of-Way damage claims. Should CONTRACTOR fail to do so, COMPANY shall give written notice to CONTRACTOR that if CONTRACTOR does not settle such claims within seven days after such notice, COMPANY shall have the authority to settle claims from the account of the CONTRACTOR.

CHAPTER-4

4. DELIVERY, TRANSPORTATION, HANDLING, HAULING, STRING-ING & STORING OF LINE PIPES & OTHER MATERIALS

The CONTRACTOR shall exercise utmost care in handling in pipe and other materials. CONTRACTOR shall be fully responsible for all materials and their identification until such time



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that the pipes and other materials are installed in permanent installation. CONTRACTOR shall be fully responsible for materials, however, method of storage shall be approved by COMPANY.

CONTRACTOR shall reimburse the COMPANY for the cost of replacement of all COMPANY supplied materials damaged during the period in which such materials are in the custody of the CONTRACTOR. It shall be CONTRACTOR's responsibility to unpack any packing for the materials supplied by COMPANY.

4.1. "Taking Over" of Line Pipe

The following stipulations shall apply in case CONTRACT provides for supply of line pipe, bare and/or corrosion coated, by COMPANY.

CONTRACTOR shall receive and 'take over' against requisition, line pipe from the COMPANY's designated place(s) of delivery as defined in the CONTRACT. CONTRACTOR shall perform visual inspection of the bare pipes and coating of the corrosion coated pipes, as the case may be, in the presence of COMPANY and all damages shall be recorded. In the case of corrosion coated pipes CONTRACTOR at his option may carry out holiday detection at a prescribed set voltage and record such holidays, in the presence of COMPANY, at the time of 'taking over'. However, if CONTRACTOR proposes to perform only visual inspection of coating, then repair of all holidays found at the time of laying the pipeline shall be carried out by the CONTRACTOR at no extra cost to COMPANY. The CONTRACTOR shall be entitled to extra compensation for repair and rectification of defects recorded at the time of taking over as per the rate set forth in the "CONTRACT". Repair of all damages after taking over the delivery of the materials shall be to the CONTRACTOR'S cost. In case of delay in handing over of COMPANY supplied material, CONTRACTOR shall be fully responsible for stopping and rearranging means of transportation at no extra cost to the COMPANY.

4.2. Handling and Hauling of Line Pipe

4.2.1. Bare Pipe

CONTRACTOR shall unload, load, stockpile and transport the bare pipes using suitable means and in a manner to avoid denting, flattening, or other damage to pipes. Pipe shall not be allowed to drop or strike objects which will damage the pipe but shall be lifted or lowered from one level to another by suitable equipment. Lifting hooks when used, shall be equipped with a plate curved to fit the curvature of the pipe. In loading pipe on trucks each length shall be lowered to position without dropping and each succeeding length shall rest on special supports on the truck and shall be separated from the adjacent pipes. After loading, suitable chains and padding shall be used to tie the load securely to each bolster. Pipes, when stock piled, shall be placed on suitable skids to keep them clear of the ground and flood water. The CONTRACTOR shall provide all necessary timber or other materials required for the stock-piling. While stacking, the number of allowable layers of bare pipes shall be calculated as per API RP5L1 and shall be agreed with COMPANY. The stacks must be properly secured against sliding and shall consist of pipes of the same diameter and wall thickness. Adjacent stacks of pipes having different dimensional characteristics shall be clearly separated.

Pipes which are damaged at the time of delivery or "taking-over" (when line pipe is supplied by COMPANY), particularly those which are dented, buckled, or otherwise permanently deformed, must be stacked separately and may be transported to the sites only when these defects have been repaired or eliminated.



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ASSOCIATED WORKS FOR CITY GAS
DISTRIBUTION

इंडियन ऑयल कॉर्पोरेशन लिमिटेड
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4.2.2. Corrosion Coated Pipes

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

Use of vacuum lifting equipments is preferred. Hooks may also be used for handling the pipes provided they have sufficient width and depth to fit the inside of the pipe and covered with soft material like rubber, teflon or equivalent, so as not to cause damages to bevel or pipe ends. During hoisting, cables/wire ropes shall have sufficient inclination compared to pipe axis so that they do not come into contact with external coating.

Coated pipes may be handled by means of slings and belts of proper width (minimum 60mm) made of non-metallic/non - abrasive materials. In this case, pipes to be stacked shall be separated row by row to avoid damage by rubbing the coated surface in the process of taking off the slings. Uses of round sectional slings are prohibited.

During handling, suitable handling equipment with proper length of booms shall be used. Fork lifts may be used provided that the arms of the fork lift are covered by suitable pads preferably rubber. Before lifting operations it is essential to ensure that the pipe surface is free from foreign material with sharp edges. Belts/slings when used shall be cleaned to remove hard materials such as stone, gravel etc. Coated pipes shall not be bumped against any other pipe or any other objects. Rolling, skidding or dragging shall be strictly forbidden.

Coated pipes at all times shall be stacked completely clear from the ground 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.

The coated pipes at all times shall 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, for example, consist of dry, germ free straw with a plastic film, otherwise foam rubber may be used. The supports shall be spaced in such a manner so as to avoid permanent bending of the pipes, particularly in case of small diameter pipes with low wall thickness. The pipes shall be stacked so that the uncoated bevelled ends are in line at one end thus making differences in length clearly noticeable.

Stacks shall consist of limited number of layers so that the pressure exercised by the pipe's own weight does not cause damages to the coating. 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 bead of pipes shall be positioned in such a manner so as not to touch the adjacent pipes.

Coated Pipes stacked in open storage yards/dump yards shall be suitably covered on top to decrease direct exposure to sunlight.

The ends of the pipes during handling and stacking shall always be protected with bevel protecters.

The lorries/rail wagons shall be equipped with adequate pipe supports having as many round hollow beds as the number of pipes to be placed on the bottom of the lorry bed. Supports shall be



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provided for at least 10% of the pipe length. 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 shall be free from all nails and staples where pipes are in contact. The second layer and all subsequent layers shall be separated from other layers with adequate number of separating layers of protective material such as straw in plastic covers or otherwise to avoid direct touch between the coated pipes.

All stanchions of lorries/rail wagons used for transportation shall be covered by nonabrasive material like rubber belts or equivalent. Care shall be exercised to properly cover the top of the stanchions and convex portions such as reinforcement of the truck/rail wagon only, rivets etc. to prevent damage to the coated surface.

4.3. Stringing of Pipe

Pipes shall be unloaded from the stringing trucks and lowered to the ground by means of by means of boom tractor or swinging crane or other suitable equipment using lifting devices as mentioned earlier. 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 para. Stringing of pipe shall only be carried out in daylight and after clearing and grading operations have been completed. Pipes shall not be strung along the ROW in rocky areas where blasting may be required, until all blasting is completed and the area cleared of all debris.

The stringing of the pipe on the ROW shall be done in such a manner so as to cause the least interference with the normal use of the land crossed and to avoid damage to and interference with the pipes. The sequence of pipes must be interrupted at suitable intervals, spaced to coincide with passages, roads, railways, water crossings as well as at other places if requested by landowner / tenants to permit use of land.

In case line pipe supply is by different manufacturers, CONTRACTOR shall string all line pipes of one manufacturer before commencing the stringing of line pipes of another manufacturer.

When parallel pipelines are being constructed, bumping against and contact with the strung sections of pipe shall be avoided, whether the stringing of the pipes for the individual lines is carried separately or simultaneously.

The pipe lengths shall be properly spaced in order to make easier the handling during the welding phase.

It shall be the responsibility of the CONTRACTOR to see that pipe is strung as per the approved drawings for the proper placement of pipe by size, thickness, grade and other specifications. Any additional handling of pipes due to failure to comply with the requirements shall be at the CONTRACTORS expense.

4.4. Repair of Damaged pipes

After the pipes have been strung along the ROW, they shall be inspected by the CONTRACTOR and by the COMPANY. All defective pipe ends shall have to be repaired as per the directions of the COMPANY or as per the requirements of this specification.

4.5. Materials other than line pipe



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CONTRACTOR shall receive and take over against requisition all COMPANY supplied materials from COMPANY's designated place(s) of delivery as defined in the CONTRACT. CONTRACTOR shall perform visual inspection and defects, if any noted, shall be recorded separately. The CONTRACTOR shall be entitled to extra compensation for repair and rectification of such defects at the rates set forth in the "CONTRACT".

The CONTRACTOR shall perform the necessary loading, unloading, hauling from points designated by the COMPANY and storing, if necessary, of all materials. The CONTRACTOR shall exercise care in handling, storing and distribution of materials in order to avoid damage and deterioration of these materials and prevent their theft or loss.

Materials excluding line pipe shall be stored in sheltered storages. Such materials shall not be strung on the Right-of-Way but shall be transported in covered conveyances for use only at the time of installation.

CONTRACTOR shall ensure that all valves and whenever applicable, other materials are fitted with suitable end covers of the type approved by COMPANY. Materials with worked surfaces such as flanges, pipe fittings, etc. must be stacked and handled so as to avoid contact with the ground or with substances that could damage them.

The manufacturer's instructions regarding temperature and procedure for storing materials which are subject to alteration of the original properties and characteristics due to unsuitable storage must be strictly complied with and, if required, an adequate heat conditioning shall be provided for these materials.

When supplied in containers and packages they must not be thrown or dropped, not handled using hooks which could damage the container or the materials, either during loading/unloading or during successive handling, until their final use.

Storage of coating materials which are susceptible to deterioration or damages especially due to humidity, exposure to high thermal conditions or other diverse weather conditions, shall be suitably stored and protected. These materials shall be kept permanently in store, supported above the ground in a dry place, protected against the weather and transported for use only at the time and in quantities necessary for immediate application. Deteriorated materials shall not be used and replaced with no extra cost to COMPANY.

4.6. 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 by CONTRACTOR in the presence of COMPANY to either side of the joint



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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 painted on.

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

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.



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CHAPTER-5

5. PREPARATION OF THE STEEL PIPES

This specification refers to the checking, cleaning, cutting and bending of steels pipes before welding.

5.1. MATERIALS AND EQUIPMENT

The Contractor shall supply the materials, equipment, machines and accessories necessary for the preparation of the pipes.

The bending machines shall be fitted with the proper equipment and in particular internal mandrels, if required by the pipe diameter and wall thickness. The wearing parts shall be in good condition and renewed as soon as required.

Any machine producing defective bends shall be immediately replaced.

The electric tools such as brushes and grinders shall be fitted with the regulation safety devices.

5.2. CHECKING THE PIPES

The Contractor shall examine each pipe before its preparation.

Any pipe showing defects, such as distortion, flattened ends, bumps, notches, grooves, scratches, corrosion pits, shall be put aside for examination by the Engineer who may order the rejection, repair or cutting of the pipe in order to eliminate the defect.

5.3. INTERNAL CLEANING

Before assembling the pipes shall be cleaned internally by running a pipe brush.

All operations shall be conducted in such a way as to prevent any foreign matters from entering into the pipelines.

5.4. CLEANING THE ENDS

Before proceeding to the pipes and immediately before executing the root bead, each pipe-end shall be cleaned down to the metal by a rotary wire brush file or grinder, if necessary.

This cleaning shall be carried out on the bevel and land as well as on the inside and outside walls of the pipe and over a distance of at least five (5) centimeters.

5.5. CUTS AND BEVELS

The cuts and bevels shall be made, either with cutting torch and bevelling machine or with any other machine approved by the Engineer.

5.5.1. Straight Pipes

Hand cutting by torch is forbidden.

The plane of the cut shall be perpendicular to the axis of the pipe.



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The rough-cut pipe ends shall be ground so that bevels and lands meet the bevelled pipes specifications.

5.5.2. Mitered Pipes

For the mitered pipes the plane of the cut is not perpendicular to the axis of the pipe: hand cutting by torch is allowed.

The pipe shall be bevelled by grinding.

5.6. DIRECTION – DIVERSION

5.6.1. Flexion

There is no flexion permitted during laying of basic grid steel pipes.

In all other cases the diversion of the pipes in the field shall be carried out by cold bending or by using factory elbows.

5.6.2. Field Cold Bending

The bending of coated pipes in the field shall only be carried out with the approval of the Engineer, all coating repair being the responsibility of the Contractor.

The bending shall be so done as to avoid any flattening or buckling.

Any flattened or buckled pipe shall be rejected.

On longitudinally welded pipe, bending shall be so done that the seam is 15 (fifteen) degrees from the neutral axis of the bend.

When several welded pipes are to be bent together, no bending shall be done on the tie-in-weld.

Out-of-roundness measured across the maximum and minimum cross section at the center of the bend shall not exceed 2.5% of the pipe O.D.

5.6.3. Factory Elbows

The Contractor may use factory elbows or segments cut there from, provided that the arc length measured along the crotch is at least 25.4 mm on pipes 50 mm in diameter and larger.

5.6.4. Mitered 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 mitre bends shall be permitted in the construction of the pipeline. Cutting of factory made bends and cold field bends for any purpose are not permitted.

5.7. TEES



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Whenever the pipelines are to be internally cleaned by scrappers or spheres the Contractor shall weld flush with the branch of the tees the necessary number of guiding bar in order to avoid any blockage.

5.8. CHECKING OF INSIDE SECTION

A pipeline to be cleaned by scrapers after the internal cleaning of foreign, materials the inside section of each straight and bent pipe shall be checked by running a gauge made of two steel plates and approved by the Engineer.

The distance between the plates shall be equal to twice the nominal diameter of the pipe to be checked. The diameter of the plates will be 95% of ID or as given in the specifications/ SCC or as directed by Engineer-in-charge.

Any pipe whether bent or not which does not allow the free run of the gauge shall be rejected.

5.9. REJECTED PIPES

The rejected pipes shall be marked "REJECTED" in red paint.

These pipes shall be immediately removed from the work site by the Contractor hauled and stocked at a depot approved by the Engineer.



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CHAPTER-6

6. PRE-CONSTRUCTION QUALIFICATIONS, INSPECTION & TESTING OF WELD

6.1. ELECTRODE QUALIFICATION TEST (EQT)

Each batch of Electrode shall be qualified in accordance with the ASME SECTION II PART-C, SFA 5.1, SFA 5.5, AWS B4.0, API 1104, PNGRB T4S and other applicable specifications by the CONTRACTOR at his expense

Electrode Qualification test records shall be submitted as per **Annexure-6.1** with respect to the electrodes tested by the CONTRACTOR and submitted for approval of the COMPANY, for each batch of electrode.

6.1.1. Required tests

Test Requirement as per ASME Sec II Part C, SFA 5.1, SFA 5.5					
(Not limited to following tests-refer SFA 5.1, 5.5 for additional tests, if any)					
Electrode	Chemical	All Weld Tensile	Radiography	All weld Impact	Fillet
6010 (2.5mm, 3.2mm)	Yes	Yes	Yes	Yes	Yes
7010 (3.2mm, 4.0mm)	Yes	Yes	Yes	Yes	Yes

6.1.1.1. Radiographic Examination

Groove weld pieces shall be radiographed to evaluate the soundness of the weld metal. In preparation for radiography, the backing shall be removed, and both surfaces of the weld shall be machined or ground smooth. The finished surface of the weld may be flush with the plate or have a reasonably uniform reinforcement not exceeding 3/32 in. (2.4 mm). Both surfaces of the test assembly in the area of the weld shall be smooth enough to avoid difficulty in interpreting the radiograph.

Qualification Requirements as per SFA 5.1 and are reproduced below:

- (1) No cracks, no incomplete fusion or incomplete joint penetration
- (2) No slag inclusions longer than 1/4 in. (6.4 mm) or 1/3 of the thickness of the weld, whichever is greater, or no groups of slag inclusions in line that have an aggregate length greater than the thickness of the weld in a length 12 times the thickness of the weld, except when the distance between the successive inclusions exceeds 6 times the length of the longest inclusions in the group.



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(3) No rounded indications in excess of those permitted by the radiographic standards in according to the grade specified in SFA 5.1

One inch (25 mm) of the weld measured from each end of the assembly shall be excluded from radiographic evaluation.

Any other radiographic requirement as per API 1104 or ASME Sec II Part C shall be applicable for qualification of electrode

6.1.1.2. Chemical Analysis

The sample for analysis shall be taken from weld metal produced with the electrode.

Requirements:

Electrode	Requirement as per SFA 5.1, SFA 5.5 Max Percentage (%)								
	C	Mn	Si	P	S	Ni	Cr	Mo	V
E6010	0.20	1.20	1.00	Not Specified	Not Specified	0.30	0.20	0.30	0.08
E7010-P1	0.20	1.20	0.60	0.03	0.03	1.00	0.30	0.50	0.10

6.1.1.3. All-Weld Tensile test

One all-weld-metal round tension test specimen as specified SFA 5.1 to be tested. For a test plate thickness of 1/2in. [13 mm], the all-weld-metal tension test specimen shall have a nominal diameter of 0.250 in. [6.25 mm]. For a test plate thickness of 3/4 in. [20 mm] or more, the all-weld-metal tension test specimen shall have a nominal diameter of 0.500 in. [12.5 mm]. For all plate thicknesses, the gauge length-to-diameter ratio shall be 4:1.

Test requirements:

Electrode	Tensile Strength		Yield Strength at 0.2% offset		Elongation in gauge length
	ksi	MPa	ksi	MPa	%
E6010	60	414	48	330	22
E7010-P1	70	490	60	415	22

6.1.1.4. Impact Test

Five full-size Charpy V-notch impact test specimens shall be machined from the test assembly as shown in SFA 5.1. Test to performed in accordance with Fracture Toughness Test section of AWS B4.0 or B4.0M.

In evaluating the test results, the lowest and the highest values obtained shall be disregarded. Two of the remaining three values shall equal or exceed the specified minimum average value. One of the three values may be lower than minimum average value, but not lower than the



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single value indicated in Table below (SFA 5.1 & SFA 5.5), and the average of the three shall be not less than the required minimum average value.

Electrode	Test Temp.	Impact Energy	
		Min. Avg.	Min. Single
E6010	-29° C	27 J	20 J
E7010-P1	-29° C	27 J	20 J

6.2. WELDER QUALIFICATION TEST (WQT)

Welders shall be qualified in accordance with the API 1104, PNGRB T4S and other applicable specifications by the CONTRACTOR at his expense. The butt weld test pieces of the qualification test shall meet the radiographic test requirements

The butt weld test pieces of the qualification test shall also meet the requirements of visual inspection and radiographic test requirements specified in this specification and API 1104.

The Contractor will take all the necessary measures to implement the welder qualification tests. The qualification tests will be made using a coupon of a line-pipe.

Every welder will execute a test weld using a qualified procedure. A welder who has successfully completed the qualification test shall be qualified.

A Welder who fails to complete successfully the qualification test session may be given a second opportunity to qualify after mutual agreement between Owner/Contractor as per section 6.7 of API 1104 code. Contractor shall submit the welder qualification test reports to Owner's representative for approval.

CONTRACTOR shall submit the welder qualification test reports in the standard format as shown in **Annexure-6.2** and obtain express approval, before commencement of the work. It shall be the responsibility of CONTRACTOR to carry out qualification tests of welders and obtain written approval, before commencement of works.

Only qualified welders, according to the requirements of API 1104 / IOCL specifications, will be used for the manual welding processes.

Every welder shall execute for his qualification test a weld at least on half the circumference of the pipe starting from the top of the pipe until the bottom. If the W.P.S. specifies a procedure for a single welder, the welder will execute the weld test on the entire circumference of the pipe.

Before production welding is started, the Contractor will submit to the Owner and or the Engineer and/or appointed Third Party Inspection Agency:

- the list of the qualified welders;
- the procedures for which they are qualified;
- the records of the welding performance test;
- the validity dates of the qualifications.



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6.3. WELDING PROCEDURE QUALIFICATIONS

Welding procedure qualification shall be carried out in accordance with the relevant requirements of API 1104 latest edition or other applicable codes and other special requirements of the specification / job requirements by the CONTRACTOR at his expense. The CONTRACTOR shall submit the following welding procedure specification in format as per **Annexure-6.3** (attached) immediately after the receipt of the order.

WPS – 1 : For Mainline & Tie-In welding

WPS – 2 : For Partial Repair

WPS – 3 : For Full Through Repair

WPS – 4 : For station piping

WPS to be in accordance with API 1104 (latest edition)

COMPANY'S inspector will review, check and approve the welding procedure submitted and shall release the procedure for procedure qualification tests. The procedure qualification test shall be carried out by the CONTRACTOR under field conditions at his own expense. A complete set of test results in format as per **Annexure-6.4** (attached) shall be submitted to the COMPANY's Inspector for approval immediately after completing the procedure qualification test and at least 2 weeks before the commencement of actual work.

Standard tests as specified in the code shall be carried out in all cases.

In addition to these, tests, other tests like radiography, macro/ micro examination, hardness tests, dye penetrant examination, charpy V-notch etc. shall be carried out on specimens. It shall be the responsibility of the CONTRACTOR to carry out all the tests required to the satisfaction of the COMPANY's Inspector.

A welding procedure qualification must be performed for:

- each welding procedure used – Mainline Joint, Tie-in joint, Partial Weld Repair, Full through repair, above ground station piping work etc.;
- each diameter and thickness;
- for each type of steel, from a different origin (steel mill and/or pipe mill).

The use of the same welding procedure qualification for different thickness and/or different origin of steel is only acceptable after written approval of the Owner and/or Engineer.

The welding procedure qualification test shall be carried out and qualified on the same line in accordance with requirements of API 1104 (latest edition) and other applicable specifications by the Contractor at his expenses.

The test pieces for welding procedure qualification shall also meet the requirements of visual inspection and radiographic test requirements specified in API 1104 and this specification.



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In addition to the mechanical tests mentioned in API-1104, other tests like macro/micro examination, hardness tests, dye penetration tests, Charpy V-notch (Impact test) etc. shall be carried out on test specimens as per IOCL specifications.

Essential variables for WPS of pipeline shall be in accordance with API 1104.

The welding electrodes/filler wires supplied by the Contractor shall conform to the class specified in the qualified welding specification. The SMYS of electrodes / filler wires shall be equal to or more than the parent material to be welded.

Physical properties of the welds produced by electrodes recommended for the welding of a particular base metal shall not be lower than the minimum values specified for the base metal. The choice of electrode shall be the sole prerogative of the Owner/Owner's Representative.

The Contractor shall submit batch test certificates from the electrode manufacturer giving details of physical and chemical tests carried out for each batch of electrodes to be used.

For each batch, electrode qualification test report shall be submitted as per Annexure – A to the Owner/Owner's Representative for approval.

All electrodes shall be preserved in good condition as recommended by manufacturer. Low- hydrogen electrodes shall be kept in oven. The baking period shall be strictly as per manufacturer's recommendations. The electrodes used shall be free from rust, oil, grease, earth and other foreign materials which affect the quality of welding.

- All other consumables (like shielding gas) equipment and accessories shall be strictly as per applicable standards, codes and instruction of Owner/Owner's Representative.
- The welding process for pipeline shall be shielded metal arc welding (SMAW).
- Acceptance of welding process is in prerogative of Owner/Owner's Representative.
- Shielding Gas - The composition and purity of shielding gas when required by the welding processes other than shielded metal arc welding, when permitted by the Company shall bear the approval of the Owner/Owner's Representative.
- Preheating temperature shall be maintained over the whole length of the joint during welding. Temperature indicating crayons of other indicating devices shall be provided by the Contractor as per instruction of Owner's Representative.
- Post weld heat treatment, wherever required for joints between pipes and fittings, pipe body and supports shall be carried out by the Contractor at his own expense as per relevant specifications, applicable standards and the instructions of the Owner/Owner's Representative.

6.3.1. Qualification of Welding Procedure for Repairs

A separate welding procedure specification shall be qualified for the following two types of repairs:

- i) Full through thickness repair
- ii) Partial thickness repair

Procedure for weld repair shall be qualified as below



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In addition to API 1104, including the special requirements of the specifications and shall also be subjected to radiography, visual inspection and destructive testing.

Maximum length and type of repairs shall be accepted as per API 1104 latest Edition. In addition to API 1104, following mechanical tests shall also be carried out:

- i) Macro/Micro examination
- ii) Hardness test and
- iii) Impact Test

Acceptance criteria for the above tests shall be as per specifications mentioned above and following:

- i) Single pass repair deposit shall not be allowed.
- ii) Only one attempt at root portion shall be allowed. Repairs are limited to a maximum of 30% of circumferential weld length. For repairs, which open the weld root, only 20% of the weld length may be repaired. The minimum length of a repaired area shall be 100mm as measured over the recapped length.

6.3.2. Qualification tests

The pipes for qualification test shall be provided by Owner to Contractor on chargeable basis

These tests are applicable for welding procedure qualifications (all WPS) and production weld test or any other qualification procedures.

6.3.2.1. Visual Inspection

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

6.3.2.2. Non Destructive Examination

The non-destructive examination of one hundred percent (100%) girth welds will be required by the COMPANY.

The non-destructive examination shall mainly consist of Radiographic inspection of a weld. In addition, Ultrasonic Testing & Dye-Penetrant testing may be required for certain critical welds of the pipeline, i.e. tie-ins, golden joints, welding of valves, flanges, randomly selected at COMPANY discretion. All fillet and pipe groove welds other than those are subjected to Radiography, shall be subjected to Dye-Penetrant /MP testing followed by manual Ultrasonic testing (if required).

The non-destructive testing system used for inspecting welds must be approved by the COMPANY.

Acceptance Criteria



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Weld quality is judged on the basis of the acceptability criteria mentioned below:

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

In addition to the API-1104 requirements, the welds containing cracks including crater cracks regardless of size of location are unacceptable.

- a) Cracks including crater cracks regardless of size or location are unacceptable. Repair of weld crack is not allowed and complete joint to be re-welded after cut-out.
- b) Any length of inadequate penetration (Lack of Penetration/Incomplete Penetration) of the root bead as defined by API- 1104 is not acceptable except that root concavity is allowed as per API 1104.
- c) Any amount of incomplete fusion (lack of fusion) at the root of the joint as detailed in API 1104 is considered unacceptable.
- d) Un-repaired burn through areas is unacceptable.

Suitable records shall be maintained by the CONTRACTOR as desired by the COMPANY on the day to day work done on welding, radiography, ultrasonic testing. The CONTRACTOR shall present the records to the COMPANY on day to day basis and whenever demanded, for approval.

1) RADIOGRAPHIC EXAMINATION

All other welds and Tie-in joints having API bevel shall be examined by X-Ray Radiography.

This covers the radiographic inspection of all types of welded joints of the main pipeline.

The welded joints shall include the following

- i. Full girth welds on the mainline construction including double jointing of pipe, if adopted.
- ii. Welds for installation of block valves, insulating joints and other appurtenances and tie-ins.
- iii. Welds at scraper launching and receiving barrels.
- iv. Terminal Piping

Applicable Standards

This specification shall apply in conjunction with the following (all latest edition):

- i. API 1104, Standard for welding Pipelines and Related Facilities.
- ii. ANSI B31.8, Code for Gas Transmission and Distribution Piping Systems.
- iii. ANSI B31.4, Code for Liquid Petroleum Transportation Piping Systems.



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- iv. ASTM E94, Recommended practice for Radiographic Testing.
- v. ASTM E142, Standard Method for Controlling Quality of Radiographic Testing.
- vi. The American Society for Non-destructive Testing. Recommended Practice No. SNT - TC-1A Supplement A.

Procedure

The radiographic examination procedure to be adopted shall be submitted by the CONTRACTOR as per Annexure VI.

The procedure of radiographic examination shall be qualified to the entire satisfaction of COMPANY prior to use. It shall include but not be limited to the following requirements :

- i. 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 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. All parameters recorded during procedure qualification like SFD/ (Source to Film Distance), exposure time, capacity of Radiography machine, type of film used, Image quality indicator, sensitivity and density achieved etc.
- vi. The radiography procedure shall be established for different techniques (like, SWSI DWSI, DWDI, etc.).
- vii. When a complete weld is radiographed in a single exposure using a source inside the pipe, four penetrameters approximately, equally spaced around the circumference shall be used. For radiographs made with the source on the outside, a penetrameter shall be placed on each side of the film with smaller one of the penetrameter tuned towards the end of the film itself.
- viii. Radiographic examinations shall be carried out using X-radiations only. Radiographic examination by Gamma Ray may be allowed, at the discretion of the Owner's Representative in case of inaccessible joints.
- ix. Whenever possible, pipeline welds shall be radiographed by panoramic exposure (360°) method. If it is impossible to place the radiation source inside the pipe, the weld will be inspected with the source on the outside. An overlap of at least 40 mm at the ends of each film shall be required.
- x. The weld joints shall be re-radiographed in case of unsatisfactory quality of the radiography, at the expense of the Contractor.
- xi. All the repaired joints shall be re-radiographed at no extra cost to the Owner. Repair welds shall be indicated with 'R' to indicate repair. Total repaired joints shall be radiographed to compare with original film in order to ensure the repair is correctly attended.
- xii. The final disposition of all unacceptable welds shall be decided by the Owner's Representative.

The CONTRACTOR shall qualify each procedure in the presence of the COMPANY prior to use.

The procedure of radiographic examination shall produce radiographs of sufficient density, clarity and contrast so that defects in the weld or in the pile adjacent to the weld, and the outline and



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holes of the penetrameter are clearly discernible.

All the girth welds of mainline shall be subjected to 100% radiographic examination. The CONTRACTOR shall furnish all the radiographs to the COMPANY, immediately after processing them, together with the corresponding interpretation reports on approved format. The details of the radiographs all along with the joint identification number shall be duly entered in a register and signed by the CONTRACTOR and submitted to the COMPANY for approval.

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 Table-4 of 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.

Three copies of each acceptable radiographic procedure (as per **Annexure-6.5**) and three copies of radiographic qualification records, shall be supplied to COMPANY. One set of the qualifying radiographs on the job shall be kept by the CONTRACTOR's authorised representative to be used as a standard for the quality of production radiographs during the job. The other two sets shall be retained by COMPANY for its permanent record.

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 COMPANY by the CONTRACTOR.

The CONTRACTOR shall, on a daily basis, record for each radiograph (1) radiograph's number, (2) welder's number (3) approximate chainage of weld location, (4) whether or not the welds meet the specified acceptance standards and (5) the nature and approximate location of unacceptable defects observed. It must be possible to relate back to a particular butt weld and welder on piping drawing and pipe line alignment drawing.

Each day's production of processed radiographs shall be properly packaged separately, identified by at least the (1) date, (2) radiographic unit, (3) job locations, (4) starting and ending progress survey stations and (5) shall include original and three copies of the daily radiographic record. The package shall be submitted to the COMPANY daily when possible, but in no event later than noon of the following day.

The CONTRACTOR shall provide all the necessary facilities at site, such as a dark room with controlled temperature, film viewer etc. to enable the COMPANY to examine the radiographs.

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 COMPANY.

COMPANY shall have free access to all the CONTRACTOR's work facilities in the field.

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

Radiation Source

Radiographic examination shall be carried out using x-radiations, Radiographic examination by Gamma rays may be allowed, at the discretion of the COMPANY, in case of inaccessible joints.



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Radiography by Gamma-Ray for tie-in-joints shall be acceptable provided D4 AGFA film or equivalent is used and the required sensitivity obtained.

Whenever possible, pipeline welds will be inspected by placing the radiation source inside the pipe, on the pipeline axis, with a radiation of 6.28 rad. (360°C).

If it is impossible to place the radiation source inside the pipe, the weld will be inspected with the source on the outside. An overlap of at least 40mm at the ends of each film shall be required to ensure that the first and last location increment numbers are common to successive films and to establish that no part of a weld has been omitted.

Level of Quality

The quality level of Radiographic sensitivity required for radiographic inspection shall be 2% of thickness.

Penetrameters

The image quality indicator (IQI) shall be used for the qualification. Radiographic sensitivity shall be measured with the wire image quality indicator (Penetrameter). The penetrameter shall be selected according to DIN54109 or ISO1027 or applicable IQI. For radiographs made with the source on the outside, a penetrameter shall be placed on each side of the film with the smaller wire of the penetrameter turned towards the end of the film itself. When a complete weld is radiographed in a single exposure using a source inside the piping, four penetrameter approximately equally spaced around the circumference shall be used. During the procedure qualification, IQI shall be placed both on the source side and on the film side. The sensitivity obtained with IQI on the source side shall not be less than the values shown in Fig. 6 of this specification.

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 COMPANY may authorise use of types of IQI other than those planned, provided that they conform with recognised 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.

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 radiographed and shall be maintained during radiography.

Protection and care of film

All unexposed films shall be protected and stored properly as per the requirements of API 1104



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standard and ASTM E.94.

The exposed and unexposed film shall be protected from heat, light, 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.

Re-radiography

The weld joints shall be re-radiographed 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 COMPANY in the same manner as 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 COMPANY 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 COMPANY.

Qualification of Radiographers

Pipeline radiographers shall be qualified in accordance with the requirement of API 1104 and to the full satisfaction of COMPANY.

Certification of all the radiographers, qualified as per 16.10.1 above, shall be furnished by the CONTRACTOR to the COMPANY before a radiographer will be permitted to perform production radiography. The certificate record shall include:

- i. Background and Experience Record
- ii. Training Course Record
- iii. Technical Examination Record
- iv. Doctor's report on radiographer's Oaecuer 0-1 acuity eye test.
- v. Date of qualification

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.

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 alongwith necessary documentation.

All radiographs shall become property of the COMPANY.

Equipment and Accessories



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CONTRACTOR shall make necessary arrangement at his own expense, for providing the radiographic equipment, radiographic film and all the accessories for carrying out the radiographic examination for satisfactory and timely completion of the job.

For carrying out the mainline radiographic examination the CONTRACTOR shall be equipped with suitable mobile/ stationary type dark rooms.

These shall have all the required facilities for film processing. Film viewer used shall be equipped with the film illuminator that has a light source of sufficient intensity and suitably controlled to allow viewing film densities upto 4.0 without damaging the film.

Radiation Protection

CONTRACTOR shall be responsible for the protection and personnel monitoring of personnel with or near radiation sources.

The protection and monitoring shall comply with local regulations.

In view of visual hazards in the handling of Radioactive source of material, CONTRACTOR shall be solely responsible for complying with all rules and regulations set forth by Atomic Energy Commission or any other Government agency of India in this regard and COMPANY shall not be responsible and shall be kept indemnified by the CONTRACTOR for default (s) of whatever nature by the CONTRACTOR. Safety equipment as considered adequate by the COMPANY for all necessary personnel shall be made available for use and maintained for immediate and proper use by the CONTRACTOR.

Display of Safety Instructions

The safety provisions shall be brought to the notice of all concerned by display on a notice board at a prominent place at the work spot. The person responsible for the "safety" shall be named by the CONTRACTOR.

Enforcement of Safety Regulations

To ensure effective enforcement of the rules and regulations relating to safety precautions, the arrangement made by CONTRACTOR shall be open to inspection by COMPANY or its representatives.

First Aid and Industrial Injuries

CONTRACTOR shall maintain first aid facilities for its employees and sub-contractors.

CONTRACTOR shall make outside arrangements for ambulance service and for treatment of industrial injuries. Names of those providing these services shall be furnished to COMPANY prior to start of work and their telephone no. shall be posted prominently in CONTRACTOR's field office.

All critical industrial injuries shall be reported promptly to the COMPANY and a copy of CONTRACTOR's report covering each personal injury requiring the attention of physician shall be furnished to the COMPANY.



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No Exemption

Notwithstanding the above there is nothing in these to exempt the CONTRACTOR from the operation of any other act or rules in force

2) ULTRASONIC INSPECTION

Before work begins, the CONTRACTOR shall present a specification describing the proposed U.T. procedure qualification.

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

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

a) Qualification of Ultrasonic Inspection Procedure

The ultrasonic inspection procedure shall be approved by the COMPANY. Before inspection begins, the COMPANY may require the qualification test of the ultrasonic inspection procedure. This specification test consists in testing (under normal operating conditions) some CONTRACTOR welds made according to the same production procedure, where there are typical defects the test intends to detect.

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

b) Test Procedure

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

The surface with which the probes comes into contact shall be free of metal spatter, dirt, iron oxide, and scales of any type; therefore it shall be necessary to clean a strip at least 50mm wide on both sides of the weld with steel wire brushes and anyhow the cleaned strip must be at least wide enough to allow full skip examination.

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.

By way of an example, the equipment shall include but not be limited to the following:-

- Ultrasonic equipment and coupling medium
- Sample sections for calibration of instruments



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- Equipment for cleaning of surface to be examined
- Rules calibrated in centimeters for exact location of the position of defects.

The characteristics of the above - listed instruments and equipment shall guarantee:

- ❖ That the required standards of the inspection procedure, as previously established and approved by the COMPANY, are satisfied.
- ❖ Continuous operation

All the instruments and equipment shall be approved by the COMPANY before being used. The COMPANY has the authority to reject any item which is considered unsuitable. The decision of the COMPANY is final. The CONTRACTOR appointed to carry out ultrasonic inspections shall also ensure the operational efficiency and maintenance of the instruments and equipment, and shall immediately substitute any item rejected by the COMPANY.

All the instruments and equipment necessary for carrying out ultrasonic inspection on site shall satisfy the requirements laid down by the public boards of institutions which regulate 'safety at work'.

c) Ultrasonic Instruments

The Ultrasonic Instruments shall satisfy the following:

- Be pulse-echo type, able to generate, receive and display, on the screen a cathode ray tube (CRT) pulse at frequencies between 1 and 6 MHz. The useful part of the CRT screen shall be at least 70mm wide and at least 50mm high.
- Shall have variable amplification, with steps of 1 or 2 dB over a range of at least 60 dB.
- The regulation control shall be accurate to within ± 1 db and this accuracy shall be certified by the instrument manufacturer.
- May be powered by a battery or an electric generator. In the first case, the autonomy of operation (endurance) of the instrument shall be sufficient to carry on working without frequent interruptions, and the instruments shall be equipped with an automatic switch which switches it off when the battery runs down; in the second case, there must be a voltage stabilising device with a tolerance of ± 2 Volts.

d) Probes

The probes used shall have dimensions, frequencies, and a refraction angle suited to the type of steel, the diameter, the thickness of the pipe and to the joint design.

e) Reference Sample Pieces



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The efficiency of the equipment used, the effective refraction angle of the probe, and the beam output point, shall be checked using a V1 and V2 sample block, IIW type or calibration block ASTM E-428.

For manual Ultrasonic testing and automated Ultrasonic testing, the reference sample pieces shall be as described in API 1104, Nineteenth Edition, para 11.4.5.

f) Calibration

The calibration, qualification of the testing procedure shall be done as provided in API 1104.

g) Regulation of Amplification During Production Testing

Scanning sensitivity shall be as provided in API 1104

h) Qualification of Ultrasonic Testing Operators

Before the inspection begins or during the same inspection, the COMPANY may require a qualification test for the ultrasonic equipment operators.

i) Evaluation of Indications Given by Ultrasonic Tests

Each time that echoes from the weld bead appear during production testing, the instrument amplification shall be altered to coincide with the reference amplification and the probe shall be moved until maximum response is obtained, paying attention all the time of 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 other clauses 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 unfavourably oriented cracks, the same shall be informed to the COMPANY. 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.

6.3.2.3. Destructive Testing

The COMPANY has the authority to order the cutting of up to 0.1% of the total number of welds completed for destructive testing at no extra cost of COMPANY. The destructive testing of weld joints shall be made as per API 1104 and this specification.

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 expense. If the results are unsatisfactory, welding operations shall be suspended and may not be restarted until the causes have been identified and the CONTRACTOR has adopted measures which guarantee acceptable results. If it is necessary in the COMPANY's opinion the



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procedure shall be re-qualified. The weld joint represented by unsatisfactory welds shall stand rejected unless investigation proves otherwise.

Destructive tests to be performed in accordance with API 1104 and IOCL technical specification

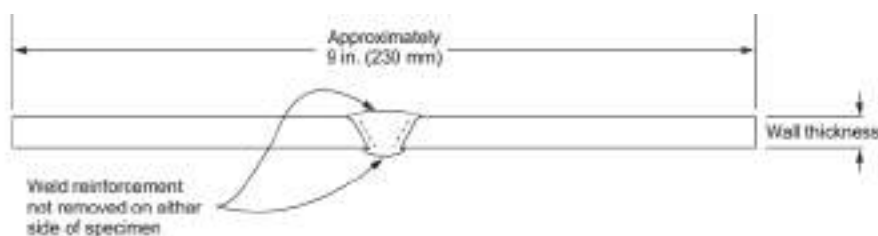
Type & Number of test specimens as per API 1104 & IOCL Specification								
Outside Dia	Tensile Strength	Nick Break	Root Bend	Face Bend	Impact	Macro	Hardness	Total
>4.500 Inch to 12.750 Inch	2	2	2	2	12	2	2	24

1) Tensile test

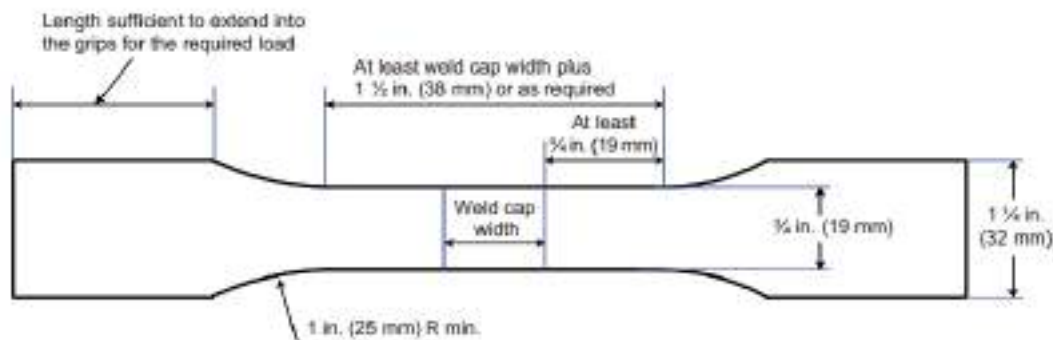
The tensile strength test specimens shall be broken under tensile load using equipment capable of measuring the load at which failure occurs. The tensile strength shall be computed by dividing the maximum load at failure by the smallest cross-sectional area of the specimen, as measured before the load is applied

The full-thickness tensile strength test specimens shall be either of the following types.

The standard specimens shall be prepared as shown in Figure below. The specimens shall be machined so that the sides are smooth and parallel.



The reduced section specimens shall be prepared as shown below. The weld reinforcement may be removed.



Requirements: As per API 1104

The tensile strength of the weld, including the fusion zone of each specimen, shall be greater than or equal to the specified minimum tensile strength (SMTS) of the pipe material.



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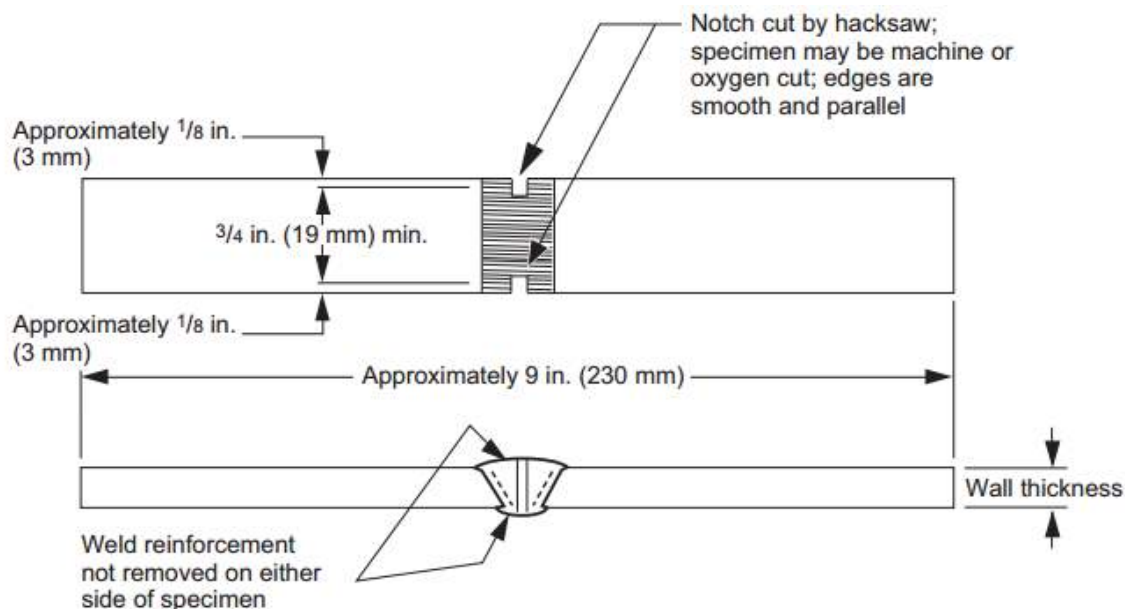
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If the specimen breaks outside the weld and fusion zone (i.e. in the parent metal) at a tensile strength not less than 95 % of that of the SMTS of the pipe material, the weld shall be accepted as meeting the requirements.

Pipe Material	SMYS		SMTS	
	Psi	MPa	psi	MPa
X42	42000	290	60000	414
X46	46000	317	63000	434
X52	52000	359	66000	455
X56	56000	386	71000	490
X60	60000	414	75000	517
X65	65000	448	77000	531

2) Nick Break Test

The nick break test specimens shall be approximately 9 in. (230 mm) long and approximately 1 in. (25 mm) wide as per API 1104. They shall be notched with a hacksaw on each side at the center of the weld, and each notch shall be approximately 3mm deep and the edges shall be smooth and parallel.

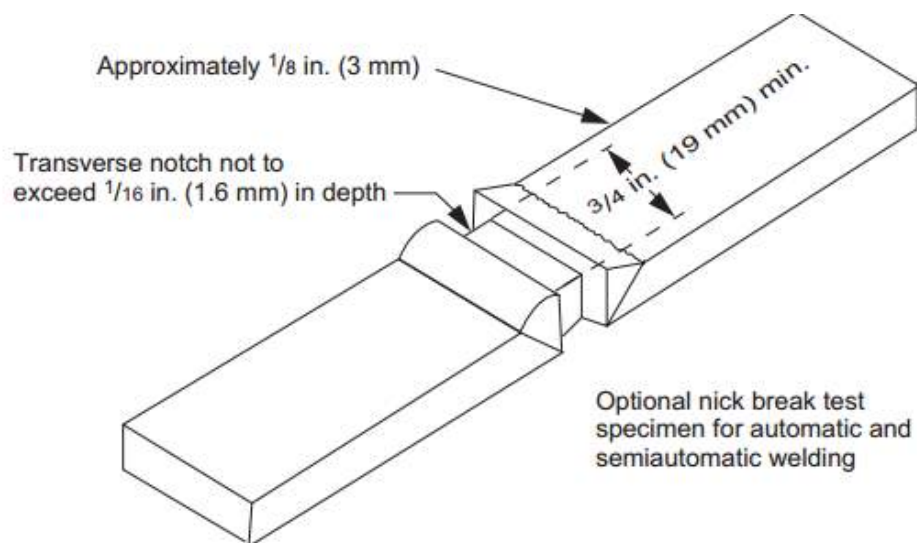


Alternatively, the external reinforcement may be notched to a depth of not more than 1.5 mm measured from the original weld surface (see figure below).



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The nick break specimens shall be broken through the weld by any convenient method (i.e. pulling, bending, or striking). The exposed area of the fracture shall be at least 19 mm wide.

Requirements: as per API 1104

The exposed surfaces of each nick break specimen shall show complete penetration and fusion. The greatest dimension of any gas pocket shall not exceed (1.6 mm), and the combined area of all gas pockets shall not exceed 2 % of the exposed surface area. Slag inclusions shall not be more than 0.8 mm in depth and shall not be more than 3mm or one-half the specified wall thickness in length, whichever is smaller. There shall be at least 13mm separation between adjacent slag inclusions of any size.

For a test weld diameter greater than 323.9 mm, if only one nick break specimen fails, then the specimen may be replaced by two additional nick break specimens from locations near to the failed specimen. If either of the replacement nick break specimens fail, the weld is considered unacceptable.

3) Impact Test

Specimens shall be prepared in accordance with ISO R 148 and ASTM A370. Three test specimens shall be taken from each sample (given below) and they shall be cut and prepared so that their length is transversal and perpendicular to the roller surface. Four type of samples are taken out.

- a. At Weld Metal
- b. At Fusion Line
- c. 2 mm from Fusion Line
- d. 5mm from Fusion Line

The test shall be carried out as per ISO R 148 “Beam impact test V – notch” Test pieces shall be immersed in a thermostatic booth and maintained at the test temperature (0 deg C) for at least 15 minutes.



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In evaluating the test results, the lowest and the highest values obtained shall be disregarded. Two of the remaining three values shall equal or exceed the specified minimum average value. One of the three values may be lower than minimum average value, but not lower than the single value indicated in Table below (SFA 5.1 & SFA 5.5), and the average of the three shall be not less than the required minimum average value.

Sl. No.	Test Specimen in mm	"Average of three Specimens (Note-2) Joules (Min.)"	Minimum Single Value (Note-1) Joules
1.	10.0	27.0	22.0
2.	7.5	21.5	17.0
3.	5.0	18.5	15.0
4.	2.5	10.0	8.0

4) Bend Test (Root Bend & Face Bend)

The root and face bend test specimens shall be approximately 230 mm long and approximately 25 mm wide, and their long edges shall be rounded. The specimen shall not be flattened prior to testing.

The root and face bend specimens shall be bent in a guided-bend test jig as shown in API 1104 except that the dimensions of Jig for guided bend test shall be modified as follows.

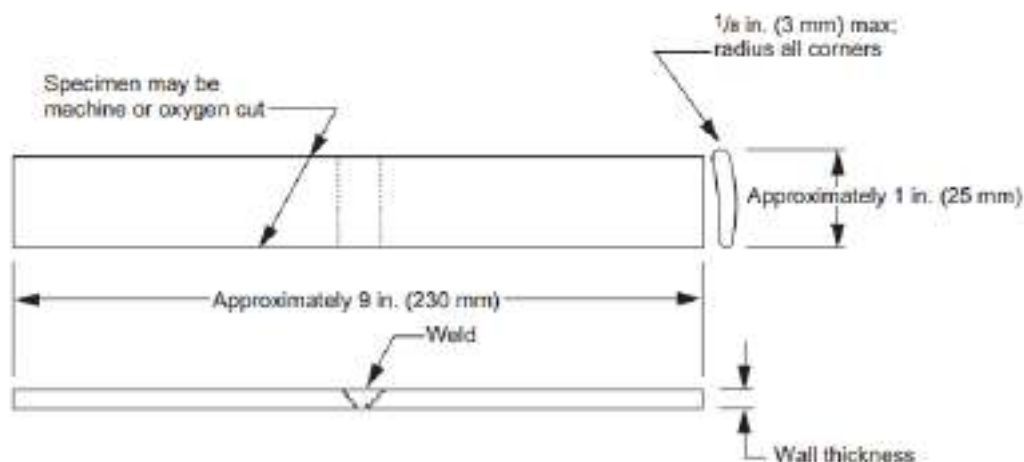
Radius of the plunger $A = 2t$

Radius of the die $B = 3t + 1.6\text{mm}$

Width of the die $C = 50.8$

(t = nominal thickness of specimen)

Face bend specimens shall be placed with the face of the weld toward the gap, and root bend specimens shall be placed with the root of the weld toward the gap. The plunger shall be forced into the gap until the curvature of the specimen is approximately U shaped.



The bend test shall be considered acceptable if no crack or other imperfection exceeding 3mm or one-half the specified wall thickness, whichever is smaller, in any direction is present in the weld or between the weld and the fusion zone after bending. Cracks that originate on the outer radius of the



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bend along the edges of the specimen during testing and that are less than 6mm, measured in any direction, shall not be considered unless obvious imperfections are observed.

5) Macroscopic Inspection

Specimens shall be carefully examined under the microscope, with a magnification of at-least 25 times (25:1). Under macroscopic examination, the welded joints shall show good penetration and fusion.

6) Hardness Test

The prepared macro section is to be used for hardness testing using the Vickers method with 10 kg load in base metal, HAZ and Weld area (atleast 06 indentation each).

The resulting Vickers hardness value at any point shall not exceed 248 HV10. The maximum difference in hardness between the base material and any reading taken on the weld or heat affected zone shall be less than 80 HV10.



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ANNEXURE-6.1

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FORMATE FOR ELECTRODE QUALIFICATION TEST RECORDS

Electrode Qualification Test Record										
Project :										
Client : INDIAN OIL CORPORATION LIMITED										
TPIA :										
Contractor:										
EQT NO.:		Location:		Parameter Sheet No.						
EQT Date:		Welder Name:		Parameter Sheet Dt.						
Electrode AWS Specification:		Electrode Dia:		Welding Process						
Electrode Manufacturer/Brand:		Electrode Batch No.:		Position						
QUALIFICATION RECORD										
S. No.	Test	Result	Report No.	Report Date	Remarks					
A.	Visual Examination	Acceptable	-							
B.	Radiographic Examination	Acceptable	-							
C.	Chemical Analysis	Acceptable	-							
D.	Tensile Test	Acceptable	-							
E.	Imapact Test	Acceptable	-							
F.	Fillet Test	Acceptable	-							
TEST PARAMETERS										
Chemical Analysis										
Electrode		Requirement as per SFA 5.1, SFA 5.5 Max Percentage (%)								
		C	Mn	Si	P	S	Ni	Cr	Mo	V
E6010	Required Values	0.2	1.2	1	Not Specified	Not Specified	0.3	0.2	0.3	0.08
	Obtained Values									
Tensile Test										
Electrode		Tensile Strength		Yield Strength at 0.2% offset		Elongation in gauge length				
		ksi	MPa	ksi	MPa	%				
E6010	Required Values	60	414	48	330	22				
	Obtained Values									
Impact Test										
Electrode	Test Temp.	Average Value				Single Value				
		Required Value		Obtained Value		Required Value		Obtained Value		
E6010	-30° C	27J				20J				
Prepared & Submitted By:		Reviewed By:				Reviewed & Approved By:				
Sign:		Sign:				Sign:				
Name:		Name:				Name:				
Date:		Date:				Date:				
FOR CONTRACTOR		FOR TPIA				FOR EPMC/IOCL				

Annexures:
Parameter Sheet
Site Reports
Lab test reports



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ANNEXURE-6.1 FORMATE FOR ELECTRODE QUALIFICATION TEST RECORDS

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Electrode Qualification Test Record										
Project :										
Client : INDIAN OIL CORPORATION LIMITED										
TPIA :										
Contractor:										
EQT NO.:		Location:					Parameter Sheet No.			
EQT Date:		Welder Name:					Parameter Sheet Dt.			
Electrode AWS Specification:	E7010	Electrode Dia:					Welding Process			
Electrode Manufacturer/Brand:		Electrode Batch No.:					Position			
QUALIFICATION RECORD										
S. No.	Test	Result	Report No.	Report Date	Remarks					
A.	Visual Examination	Acceptable	-							
B.	Radiographic Examination	Acceptable	-							
C.	Chemical Analysis	Acceptable	-							
D.	Tensile Test	Acceptable	-							
E.	Impact Test	Acceptable	-							
F.	Fillet Test	Acceptable	-							
TEST PARAMETERS										
Chemical Analysis										
Electrode		Requirement as per SFA 5.1, SFA 5.5 Max Percentage (%)								
		C	Mn	Si	P	S	Ni	Cr	Mo	V
E7010	Required Values	0.2	1.2	0.6	0.03	0.03	1	0.3	0.5	0.1
	Obtained Values									
Tensile Test										
Electrode		Tensile Strength		Yield Strength at 0.2% offset		Elongation in gauge length				
		ksi	MPa	ksi	MPa	%				
E7010	Required Values	70	490	60	415	22				
	Obtained Values									
Impact Test										
Electrode	Test Temp.	Average Value				Single Value				
		Required Value		Obtained Value		Required Value		Obtained Value		
E7010	-30° C	27J				20J				
Prepared & Submitted By:		Witnessed By:				Reviewed & Approved By:				
Sign:		Sign:				Sign:				
Name:		Name:				Name:				
Date:		Date:				Date:				
FOR CONTRACTOR		FOR TPIA/EPMC				FOR IOCL/EPMC				

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ANNEXURE-6.2
WELDING OPERATOR QUALIFICATION TESTS

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Welder Name _____ Welder. No. _____

Using WPS No. _____ Rev. _____

The above welder is qualified for the following ranges

Variable	Record Actual Values	Qualification Range
Used in Qualification		
Process	_____	_____
Process Type	_____	_____
Backing (metal,		
Weld metal, flux, etc)	_____	_____
Material Spec.	_____ to _____	_____ to _____
Thickness		
Groove	_____	_____
Filler	_____	_____
Diameter		
Groove	_____	_____
Filler	_____	_____
Filler Metal		
Spec. No.	_____	_____
Class	_____	_____
F. No.	_____	_____
Position	_____	_____
Weld Progression	_____	_____
Gas Type	_____	_____
Electrical Characteristics		
Current	_____	_____
Polarity	_____	_____

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Guided Bend Test Results

Type	Result

Radiographic Test Results

For alternative qualification of groove welds by radiography

Radiographic Results_____

Note: Any essential variables in addition to those above shall be recorded.



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ANNEXURE-6.3
FORMAT FOR WELDING PROCEDURE SPECIFICATION



Welding Procedure Specification
(AS PER API 1104 Latest Edition)

Proposed Welding Procedure for:

Name of the Project						
Preliminary WPS No:						
Client						
Welding Process						
Pipe Material with Grade						
Pipe Group						
Pipe Outside Diameter						
Diameter Range						
Wall Thickness of Pipe						
Wall Thickness Range						
Joint Design Sketch						
Weld Technique						
Pre Heat Temperature						
Post weld Heat Treatment						
Filler Metal						
a) Root						
b) Hot, Filler I, Filler II & Capping						
Electrical Characteristic						
Position						
Direction of Welding						
a) Root						
b) Hot, Filler & Capping						
No. of Welders						
Time lapse between Pass						
Type of Line up Clamp						
Removal of Clamp						
Cleaning of All Passes						
Proposed Parameters						
Bead	Electrode	Make	Dia (mm)	Voltage	Current (Amps)	Travel Speed (mm per Minute)
Root Pass						
Hot Pass						
Filler						
Capping						
Contractor		TPIA		IOCL/EPMC		
Name:						
Signature:						
Date:						



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ANNEXURE-6.4 FORMAT FOR WELDING PROCEDURE QUALIFICATION RECORD (PQR)

PROCEDURE QUALIFICATION RECORD (AS PER API 1104 Latest Edition)																
PROJECT:																
CONTRACTOR:																
Procedure Qualification Record for Mainline Welding and Tie-in welding																
Client:	PQR No.:															
TRIA	Rev.:															
Welding Process: SMAW	Date:															
Type: Manual	Ref. WPS:															
Weather:	Rev.:															
Mean Temp.:																
<div> <div> <p>Joint Design:</p> <p>Included Angle: 60°-70°</p> <p>Root Gap: 1.8 mm - 3.4 mm</p> <p>Root Face: 1.5 mm ± 0.8 mm</p> <p>Capping Height: 0.8 mm - 1.6 mm</p> <p>Weld Penetration inside Weld: 0.8 to 2.4 mm</p> </div> <div> </div> </div>																
Material Description																
Material Specification: API 5L	Post Weld Heat Treatment:															
Grade:	Temperature:															
Diameter:	Time:															
	Thickness:															
Gas Composition																
	Shielding															
	Backing															
Electrical Characteristics																
Current Polarity:																
Amps Range:																
Volts Range:																
Techniques																
String or Weave Bead:																
Multipass or Single Pass:																
Multiple or Single Electrode:																
Inter Pass Temperature																
Preheat Temperature:																
Method of Heating:																
Type of Clamps:																
Removal of Clamps:																
Time lapse between completion of Root and start of second run:																
Time lapse between completion of second run and start of third run:																
Maximum time between commencement and completion of weld:																
Initial / Inter pass cleaning:																
Grinding / Power brushing:																
Actual Welding Parameters of Test Coupon																
Layer / Pass	Process	Filler Metal			Polarity	Current (Amp)			Voltage			Speed mm/min	Direction of Welding	No. of Welder	Remarks	
		AWS Class	Brand / Mfr	Dia (mm)		Min	Max	Avg	Min	Max	Avg					
Root																
Hot																
Filler																
Capping																



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PROCEDURE QUALIFICATION RECORD (AS PER API 1104 Latest Edition)			
PROJECT:			
CONTRACTOR:			
Procedure Qualification Record for Mainline Welding and Tie-in welding			
A.	Visual Examination:	Report No.:	Date:
B.	Radiographic Examination:	Report No.:	Date:
C.	Tensile Strength:	Report No.:	Date:
Specimen No.	Width (mm)	Thickness (mm)	Area (sq. mm)
			Ultimate Tensile Load (KN)
			Ultimate Tensile Strength (N/mm ²)
Type of Failure & Location:			
Remarks: (Specified Values-454-700)			
D.	Guide Bend Test:	Acceptable	Report No.:
Type	Identification	Result	Type
Root Bend			Identification
Hook Bend			Result
Remarks: Guide Bend Test Results are Satisfactory			
E.	Notch Break Test:	Acceptable	Report No.:
Type of Test	Identification	Result	
Notch Break Test			
Notch Break Test			
Remarks:			
F.	Macro Test:	Acceptable	Report No.:
Type of Test	Observations	Result	Remarks
Macro Test			
Remarks: Macro Test Results are Satisfactory			
G.	Charpy Impact Test at -20°C:	Acceptable	Report No.:
Specimen Location	Notch Location	Specimen Size (mm)	Impact Value (Joules)
Weld	W/L		Avg. Value
Fusion Line	FL		Results
FL + 2mm	HAZ		Remarks
FL + 5mm	HAZ		
Remarks:			
H.	Hardness Test:	Acceptable	Report No.:
Top (VHN)	Middle (VHN)	Bottom (VHN)	Results
Weld			Remarks
HAZ			
Base			
Remarks:			
I.	Micro Examination:	Acceptable	Report No.:
Type of Test	Observations	Result	Remarks
Remarks:			
Welders:			
1.	Welder Name:	Welder No.:	Date:
Test Conducted At:			
Prepared By:	Checked By:	Reviewed By:	Reviewed & Approved By:
Sign:	Sign:	Sign:	Sign:
Name:	Name:	Name:	Name:
Date:	Date:	Date:	Date:
FOR CONTRACTOR	FOR CONTRACTOR	FOR TPA	FOR IOCL/SPMC



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ANNEXURE-6.5

RADIOGRAPHIC PROCEDURE QUALIFICATION RECORD FOR PIPE WELDING

1. Location :
2. Date of Testing :
3. Name of the Contractor / Agency :
4. Material : Carbon steel / Alloy Steel / Stainless Steel :
4. Technique: DWSI / SWSI / DWDI :
5. Diameter & Thickness :
6. Type of Weld Joint :
7. Radiation Source :
8. Intensifying Screens/Lead Screens :
9. Geometric Relationship :
10. Limit of Film Coverage :
11. Film Type and Make :
12. Exposure Time :
13. Processing :
14. Density :
15. Sensitivity :
16. Type of penetrameter :
(Source side)
17. Type of penetrameter :
(Film side)

Signature of Contractor / Agency with Seal

Approval of IOCL/PMC Representative



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CHAPTER-7

7. SPECIFICATION FOR WELDING OF GAS PIPELINES

7.1. SCOPE

This specification stipulates requirements for fabrication of all types of welded joints of carbon steel main pipeline systems covering the pipeline and its facilities, which will include the following:

- All line pipe joints of the longitudinal and circumferential butt welded and socket welded types.
- Branch connections
- Joints in welded/ fabricated piping components.
- Attachments of castings, forgings, flanges and supports to pipes.
- Attachments of smaller connections for vents/ drainpipes and tapings for instrumentation.
- Welded manifold headers and other sub-assemblies.

7.2. APPLICABLE CODES, STANDARDS & SPECIFICATIONS

All welding works, equipment for welding, heat treatment, other auxiliary functions and the welding personnel shall meet the requirements of the latest editions of the following codes, standards and specifications as listed below :-

- a) Code for Gas Transmission and Distribution Piping System (ANSI B31.8).
- b) Standard for welding of Pipelines and Related Facilities (API 1104).
- c) Specification for welding Electrodes and Filler Materials (ASME Sec. II C).
- d) Non Destructive examination (ASME Sec. V).
- e) Welding and Brazing Qualification, ASME Sec. IX.

7.3. MATERIAL SPECIFICATIONS

In general API X52 carbon steel is used in this specification. The details of material specifications will be given in a welding Specification Chart attached along with other project data sheets or SCC.

The CONTRACTOR will keep a record of test certificates of all the materials for the reference of the welding engineer.

7.4. WELDING CONSUMABLES

The CONTRACTOR shall provide at his own expenses all the welding consumables necessary for the execution of the job such as electrodes, oxygen, acetylene etc. and the same shall be approved in advance by the Purchaser/ Consultant. The welding electrodes/ filler wires supplied by the



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CONTRACTOR shall conform to the class specified in the welding specification chart. The materials shall be of the make approved by the COMPANY.

The electrode shall be suitable for the welding process recommended and base metal used. Physical properties of the welds produced by an electrode recommended for the welding of a particular base metal shall not be lower than the minimum values specified for the base metal unless otherwise specified in Welding Specification Chart and shall correspond to the physical properties of the class of electrode adopted. The choice of electrode shall be made after conducting the required tests on the electrodes as per relevant standards, and shall be the sole prerogative of the COMPANY.

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 electrode to be used.

All electrodes shall be purchased in sealed containers and stored properly to prevent deterioration. The electrodes removed from the containers (except cellulosic coated electrodes) shall be kept in holding ovens at the temperature recommended by the electrode manufacturer. Ovens shall be used for low hydrogen electrodes only. Out-of- the oven time of electrodes, before they are consumed, shall not exceed the limits recommended by the electrode manufacturer. The electrodes shall be handled with care to avoid any damage to the flux covering.

The electrodes used shall be free from rust, oil grease, earth and other foreign matter which affect the quality of welding.

Different grades of electrodes shall be stored separately. Cellulosic electrodes used shall however be used as per specific recommendations of manufacturer.

7.4.1. Shielding Gas

The composition and purity of shielding gas when required by the welding processes other than shielded metal arc welding, when permitted by the COMPANY, shall have prior approval of the COMPANY. Where appropriate, gases or gas mixture of the following quality shall be used.

- argon complying with BS 4365
- carbon dioxide complying with type 1 specified in BS 4105
- Gas mixture that have been proved to be satisfactory as a result of procedure approval tests.

When a gas mixture is used which has specified additions, e.g. 2% O₂, 5% CO₂ the variation of such addition shall not exceed $\pm 10\%$ of that stated. Moisture content shall correspond to a dew point of - 30°C or lower.

7.5. EQUIPMENT & ACCESSORIES

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

All the equipment for performing the heat treatment including transformers, thermocouples, pyro-meters, automatic temperature recorders with suitable calibration arrangements, etc. shall



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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.

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

7.6. WELDING PROCESSES

Welding of various materials under this specification shall be carried out using Shielded Metal Arc Welding process (SMAW) with the approval of the Company. Any other process of welding shall require prior approval from the Company.

The welding electrode shall be of Licoln /Bohler make or as per approved vendor/manufacturer list of IOCL.

7.7. 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.

7.8. ALIGNMENT AND SPACING

Immediately prior to line-up CONTRACTOR shall inspect the pipe ends inside and outside for damage, dents, laminations etc. Pipe for welding shall be set up, correctly spaced, allowing for temperature changes during welding, in correct alignment and shall in no circumstances be sprung into position. Temporary attachments of any kind shall not be welded to the pipe. Welds joining the sections of the pipelines, 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 back pad or other suitable means approved by COMPANY, at least 500mm above the ground, unless approved by the COMPANY in specific cases.



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Seam orientation of welded pipe shall be selected to ensure that at the circumferential welds, the longitudinal welds shall be staggered in the top 90° of the pipeline, or 250mm whichever is the lesser. A longitudinal joint shall pass an appurtenance of a structural element at a minimum distance of 50mm. should a section of the line containing uncompleted welds fall from the skids, the CONTRACTOR shall immediately inform COMPANY.

Every effort shall be made to reduce misalignment by the use of the clamp and rotation of the pipes to obtain the best fit. For pipe of same nominal wall thickness offset shall not exceed 1.6mm. The offset may be checked from outside using dial gauges. Any branch connection, sleeve, etc. shall be atleast 150mm from any other weld. The welds for fittings shall be so located that the toe of the weld shall not come within 50 mm 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. When welding pipes of different wall thickness (as directed by COMPANY) a special transition piece shall be used. This shall have a minimum of 1:4 taper. The welds shall be subject to both ultrasonic and radiographic inspection.

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 10" and above. However, in some cases (tie-in welds, flanges, fittings, diameter of pipe 10" etc.) where it is impossible to use internal clamps, an external line-up clamp may be used.

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

When as external line-up clamp is used, all spaces between bars or atleast 60% of the first pass shall be welded before the clamp is released and the pipe remaining 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 bead.

7.9. WEATHER CONDITIONS

The parts 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. The completed welds shall be suitably protected in case of bad weather conditions.

7.10. WELDING

7.10.1. Root Pass

- Root pass shall be made with electrodes/ filler wires recommended in the welding specification chart attached along with other project data sheets. The size of the electrodes used shall be as per the approved welding procedure.
- Position or roll welding (for yard double jointing) may be permitted. Separate procedures shall be submitted and qualified for uphill, downhill, vertical down and roll welding. The vertical up method of welding shall be used for the root pass of the tie-ins, special crossings, fittings



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and special parts, filled 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 (a) the edges are machined or have equivalent preparation (b) 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) The root pass of butt joints shall be executed properly so as to achieve full penetration with complete fusion of the root edges. Weld projection inside the pipe shall not exceed 1.6 mm wherever not specified by the applicable code.
- d) Any deviation desired from the recommended welding technique and electrodes indicated in the welding specification chart shall be adopted only after obtaining express approval of the COMPANY.
- e) Welding shall be continuous and uninterrupted during a pass.
- f) On completion of each run, craters, welding irregularities, slag, etc., shall be removed by grinding and chiselling.
- g) 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.
- h) If external clamp is used, clamp shall only be released after at least 60% of root weld is completed.
- i) Fillet welds shall be made by shielded metal arc welding process irrespective of the thickness and class of piping. Electrode size shall not exceed 3.25mm diameter for socket joints. At least two passes shall be made on socket weld joints
- j) Root pass of fillet weld for branch connection can also be made by GTAW process. However other pass shall be made by SMAW process as mentioned above (point h).
- k) Peening shall not be used.

7.10.2. Joint Completion (Hot/Filler/Capping)

The number of welders and the allowable welding sequences shall be as those laid down in 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/electrode speed shall be approximately same as that established in the Qualified Welding Procedure Specification (QWPS).

The pipe shall always be adequately supported and must not be pumped or shaken during welding. The clamp shall be removed, as indicated in clause 7.8. above. Before starting the second pass, the first pass shall be cleaned and flattened with rotating grinders.

The interruption between completion of the first pass and starting the second pass shall be as stated in the procedure specification.



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For crack prevention a top and bottom reinforcement of at least one electrode shall be applied before lowering the pipe on the skid.

The welding speed selected shall enable production of a bead which is sufficiently thick and which shows no undercutting.

The time lapse between second and third pass shall be as stated in the procedure specification, normally not exceeding five minutes. After completion of the third or following passes, welding operations may be suspended, so allowing the joint to cool down, provided that the thickness of the weld metal deposited is equal to at least 50% of the pipe thickness. Upon restarting, depending on the materials, wall thickness and welding process, a preheating to atleast 100°C shall be carried out. Subsequent passes up 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.

Electrodes 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 electrodes, electrode holder, welding cable shall be removed by grinding in accordance with a procedure approved by COMPANY and the repair checked by ultrasonic, radiographic, magnetic particle or dye penetrant tests which the COMPANY 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.

The completed weld shall be carefully brushed and cleaned and shall appear free from spatters, scales, etc.

These requirements apply not only to completed welds but also to the bare strip at least so wide so as to allow full skid examination at both ends of the pipe to allow a good ultrasonic inspection when it is required.

7.10.3. HEAT TREATMENT

I. Preheating

Preheating, if required, shall be carried out as per the following :

- Preheating requirements for the various materials shall be as per the welding specification. No welding shall be carried out without preheating the joint to 10°C (50°F) when the ambient temperature is below 10 degree.
- Preheating shall be performed using resistance or induction/ heating methods. Preheating by LPG flame with ring burner may be used with the permission of the COMPANY under careful supervision.
- 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



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welding. Temperature indicating crayons or other temperature indicating devices shall be provided by the CONTRACTOR to check the temperature.

II. Post weld Heat Treatment

- a) Post weld heat treatment, wherever required for joints between pipes and fittings, pipe body and supports shall be carried out by the CONTRACTOR at his expense as per the relevant specifications, applicable standards and the instructions of the COMPANY.
- b) The heat treatment of welded joints shall be carried out as per the requirements laid down in ANSI B31.8 and other special requirements mentioned in welding specification chart.
- c) The CONTRACTOR shall submit for the approval of the COMPANY, well before carrying out actual heat treatments the details of the post weld heat treatment procedure, as per Annexure-II attached, that he proposes to adopt for each of the materials/ assembly/ part involved.
- d) Post weld heat treatment shall be done in a furnace or by using an electric resistance or induction heating equipment, as decided by the COMPANY.
- e) While carrying out local post weld heat treatment, technique of application of heat must ensure uniform temperature attainment at all points of the portion being heat treated. Care shall be taken to ensure that width of heated band over which specified post weld heat treatment temperature is attained is atleast as that specified in the relevant applicable standards/ codes.

The width of the heated band centered on the weld shall at least be equal to the width of weld plus 2" (50mm). The temperature gradient shall be such that the length of the material on each side of the weld, at a temperature exceeding half the heat treatment temperature, is atleast $2.5 \sqrt{rt}$ where r is the bore radius and t is the pipe thickness at the weld.

- f) Throughout the cycle of heat treatment, the portion outside the heat band shall be suitably wrapped with insulation so as to avoid any harmful temperature gradient on the exposed surface of pipe. For this purpose temperature at the exposed surface of the pipe shall not be allowed to exceed 400°C.
- g) The temperature attained by the portion under heat treatment shall be recorded by means of thermocouple pyrometers. Adequate number of thermocouples shall be attached to the pipe directly at equally spaced locations along the periphery of the pipe joint. The minimum number of thermocouples attached per joint shall be 2 upto 10" dia and 3 for 12" dia and above. However, the COMPANY can increase the required minimum number of thermocouples to be attached, if found necessary.
- h) Automatic temperature recorders which have been suitably calibrated shall be employed. The calibration chart of each recorder shall be submitted to the COMPANY prior to starting the heat treatment operation and its approval shall be obtained.
- i) Immediately on completion of the heat treatment, the post weld heat treatment charts/ records alongwith the hardness test results on the weld joints (whenever required as per the welding specification chart) shall be submitted to COMPANY for its approval.



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- j) Each joint shall bear an identification number which shall be maintained in the piping sketch to be prepared by the CONTRACTOR. The joint identification number shall appear on the corresponding post weld heat treatment treatment charts. The same identification numbers shall also be followed for identification on corresponding radiographic films. The chart containing the identification number and piping sketch shall be submitted to the COMPANY in suitable folders.
- k) Vickers hardness/ Brinell hardness of the heat affected zone as well as of the weld metal, after heat treatment shall be measured using a suitable hardness tester and shall not exceed the maximum hardness specified in the welding specification chart. The weld joint shall be subjected to reheat treatment, when hardness measured exceeds the specified limit, at the CONTRACTOR'S own expense.

The CONTRACTOR shall arrange for the hardness testing and shall maintain the records of all the joints tested. These records shall be checked by the COMPANY

7.10.4. NIGHT CAPS

At the end of each day's work or every time when joining and welding operations are interrupted, the open ends on the welded strings of pipes shall be capped with a securely closed metal cap or plug as approved by the OWNER so as to prevent the entry of dirt, dust, water or any foreign matter into the pipeline. These covers shall not be removed until the work is to be resumed. The caps/plugs used shall be mechanical type and shall not be attached to pipe by welding or by any other means which may dent, scratch or scar the pipe.

7.10.5. TEMPORARY CAPS

Whenever the welded strings of pipes are left open at intervals to be tied-in later under roads, rail-roads, rivers, marshy area crossings, between two longer sections, etc, temporary caps with a continuous weld run so as to make water tight string as approved by the EIC shall be provided to ends of the pipe string. Temporary caps shall be provided before lowering of the section in the trench.

7.11. INSPECTION AND TESTING

- a) The COMPANY's Inspector shall have free access to all concerned areas, where the actual work is being performed. The CONTRACTOR shall also provide the COMPANY's inspector all means and facilities necessary to carry out inspection.
- b) The COMPANY is entitled to depute its own inspector to the shop or field where pre-fabrication and erection of pipelines are being done, with (but not limited to) the following objectives :-
- To check the conformance to relevant standards/ specifications and suitability of various welding equipment and the welding performance.
 - To supervise the welding procedures qualification.
 - To supervise the welder's performance qualification.



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- iv. To carry out visual/NDT examination of the weldings.
- v. To check whether shop/ field welding is being executed is in conformity with the relevant specification and codes of practice followed in pipe construction.
- c) CONTRACTOR shall intimate sufficiently in advance the commencement of qualification tests, welding works and acceptance tests, to enable the Company's inspector to be present to supervise the same.
- d) All tests shall be carried out as per clause 6.0 of this chapter.
- e) All butt-welded golden joints (i.e. welds joints which are not subjected to pressure testing, shall be subjected to 100% radiography as well as examination by ultrasonic techniques.
- f) All construction and welding of pipelines shall meet the requirements of ASMEB31.8, PNGRB guidelines and OISD-226
- g) Regardless of operating hoop stress as well as location class all carbon steel butt welds in natural gas pipelines shall be subjected to 100% radiographic examination
- h) Production Weld Test

When laying a new pipeline the contractor shall cutout at least one production weld test as per instructions of owner/ owner's representative to satisfaction of jobs.

First Production weld test to be carried out on any joint selected by IOCL from 1st km of welding. Subsequently, IOCL may demand for destructive testing on one production for every 10km of pipeline.

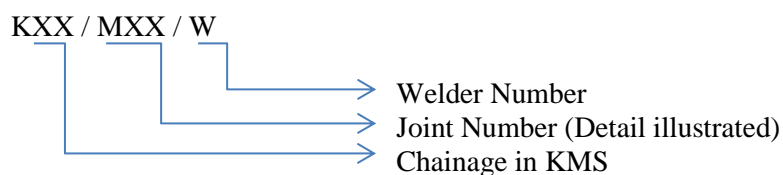
The IOCL has the authority to order the cutting of upto 0.1% of the total number of welds completed for destructive testing at no extra cost of COMPANY. The destructive testing of weld joints shall be made as per Clause 6.3.2.3

7.12. WELD NUMBERING AND WELD DATA RECORDS

7.12.1. Numbering

a) Pipeline

All joints to be welded shall be numbered as indicated below



(Indicative only)

Where:

Joint Number shall start with prefix / suffix as indicated below:



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- MXX - For joint welded as per Mainline Welding Procedure (MJ01, MJ02).
- TXX - For joint welded as per Tie-in procedure (TJ01, TJ02)
- M-XXRW - Where cut outs are given, the first joint is identified by its original joint no. With prefix RW (MJ01RW).
- MXXR, TXXR - Where joint is repaired the suffix R shall be given after the original no (MJ01R)
- RS - Reshoot joint/segment shall be indicated with "RS".
- RT - Retake joints/segments shall be indicated with "RT".

b) Gas station construction and valve stations

In the gas stations, the welds shall be numbered according to the Owner particular numbering system or numbering system approved by him and/or Engineer.

Example of a gas station numbering system (for information only) :

XXXX / STXX / XXXX where;

XXXX = the code number of the installation of the Client

ST = standard 'ST' to indicate 'STATION'

XX = the first two letters of the name of the gas station

9999 = maximum of four figures for the individual weld number.

7.12.2. Applying the weld numbers

The Contractor will submit for approval to the Owner and or the Engineer the way he will indicate the weld number on the pipes.

The Contractor shall apply the weld number next to each weld in a correct and legible manner using an indelible product.

7.12.3. Welding data records

The Contractor shall provide the Owner and/or the Engineer on a daily basis with all the information for inspection and technical files, i.e. for every weld, root head, filler beads and finish beads:

- ❖ the ID of the welders who have carried out the welds; the weld number
- ❖ the date of the execution of the weld
- ❖ the individual numbers of the joined pipes and/or accessories, their grade, nominal thickness, origin and length
- ❖ the WPS used



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- ❖ the number of repairs or cut out welds, the reason for repair and the date of repair.

All these data must be signed by the Owner and or the Engineer/PMC/TPIA.



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CHAPTER-8

8. SPECIFICATION FOR MAINLINE FIELD JOINT COATING

This specification covers the minimum requirements of materials, equipment and installation of field joint anti-corrosion coating of underground onshore factory coated pipelines with either three layer polyethylene or fusion bonded epoxy (FBE) coating by heat shrink wraparound sleeves conforming to DIN EN 12068 - "Cathodic Protection - External Organic Coatings for the Corrosion Protection of Buried or Immersed Steel Pipelines used in Conjunction with Cathodic Protection - Tapes and Shrinkable Materials" and the requirements of this specification. 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 documents included in the Contract between Company and Contractor. Unless specified otherwise, all sections of this specification shall apply to all specifications referred in this specification.

Maximum operating temperature to be considered is 600C. Hence the design temperature for Field Joint coating shall be considered as 60 0C.

All the girth weld joint coating material for buried pipeline section shall confirm to EN 12068 C HT 60UV for C 60 Class as per EN 12068.

Application procedures must take into account the extreme weather condition i.e. high relative humidity, burial temperature above 40 0C.

In case of any dispute between two clauses, decision of IOCL for any procedure/material work shall be final and binding to the contractor.

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
- Visual inspection of joint
- Thickness of installed sleeve
- Adhesion to steel and adjacent line coating
- Holiday detection
- Peel test at (+) 23°C & (+) 60°C on pipe surface & factory applied coating and at over laps (as applicable). If required to achieve the temperature of (+) 60°C, suitable thermal blanket may be used.
- Visual appearance and void after installation on the body, area adjoining the weld



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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 Representative shall witness the tests and inspection. Regular application of field joint coating shall commence only upon successful completion of the pre-qualification 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 re-applied as per the requirements of this specification.

8.1. REFERENCE DOCUMENTS

Reference has been made to the latest edition (edition enforce at the time of floating the enquiry) of the following standards, codes and specifications:

- | | | |
|----|-------------|---|
| a) | ASTM D-149 | Standard Test Methods of Dielectric Breakdown voltage and Dielectric Strength of solid electrical insulating materials at commercial frequencies. |
| b) | ASTM D-257 | Standard Test Methods for D-C Resistance or conductance of insulating materials. |
| c) | ASTM D-570 | Standard Method of Test for Water Absorption of Plastics. |
| d) | 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). |
| e) | ISO:8503-1 | Part-1 : Specification and definitions for ISO surface profile comparator for the assessment of abrasive blast cleaned surfaces. |
| f) | ISO: 8503-4 | Part-4 : Methods for calibration of ISO surface profile comparator and for the determination of surface profile - Stylus instrument procedure. |
| g) | SIS-055900 | Pictorial surface Preparation Standard for Painting Steel Surfaces. |
| h) | SSPC-SP 1 | Steel Structure Painting Council |

In case of conflict between the requirements of this specification and that of above referred documents, the requirements of this specification shall govern.



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The Contractor shall be familiar with the requirements of these documents and shall make them readily available at the site to all personnel concerned with carrying out the works specified in this specification.

8.2. 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 Company's approval.

8.2.1. 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 (Tmax) 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 8.3 of this specification.

Only coating material certified C HT 60 Class as per EN 12068 and DVGW (heat shrinkable material) will be accepted for all material to be coated.

For the buried valve station (moulded piece, valves, elbows etc) Thermoset plastic coatings may be used. It shall be of Type 3 DIN EN 10289.

Underground bare valves if any will be coated with above material.

At the point of transition from the aboveground pipe to underground pipe special coating material FIBAROLL or equivalent to be used over the coated part of U.G. pipe and painted part of A.G. Pipe end overlapping shall be at least 500 mm inside the ground and 500 mm on painted AG line. Minimum thickness shall be 1.5 mm. The application of the material will be as per supplier's specification. Wherever Thrust Boring (Jacking) method is carried out, for mechanical protection of coating of carrier pipe extra layer of hard cold applied tapes C-60 Class as per DIN 30675-1 or Solvent free PUR (1000 microns) as per DIN 30677/2 EP-60 types. Surface preparation (sand blasting) of PE layer shall be appropriate as per applicator's recommendations. The type & thickness of coating must get approved by Owner/Owner's Representative prior to coating.

8.2.1.1. Heat Shrinkable Wraparound Sleeve

Heat shrinkable wrap around sleeve shall consist of radiation cross-linked thermally stabilised, ultraviolet resistant semi-rigid polyolefin backing with a uniform thickness of high shear strength thermoplastic/copolymer hot melt adhesive. The joint coating system may consist of a solvent free epoxy primer applied to the pipe surface prior to sleeve application. The backing shall be coated with thermo chrome paint which will change colour when the desired heat during shrinking is



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attained. The wraparound sleeve shall be supplied in pre-cut sizes to suit the 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)	2.0 mm	1.6 mm
12" (323.9 mm) to 18" (457.2 mm)	2.2 mm	1.8 mm
20" (508.0 mm) to 30" (762.0 mm)	2.5 mm	2.0 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.

Heat shrinkable wraparound field joint coating system manufactured by M/s Seal For Life (Covalence) and M/s Canusa (or any other brand as per approved vendor list) are acceptable for the supply of field joint coating materials. The Contractor shall propose the specific grade of field joint coating system meeting the requirements of this specification from these manufacturers.

Heat shrinkable wraparound Sleeves of M/s SFL and M/s Canusa (any other IOCL approved coating system may also be used)

- ❖ For Open Cut Laying : HTLP-80 heat shrink sleeve of M/s SEAL FOR LIFE
: GTS-80 heat shrink sleeve of M/s CANUSA, CANADA
- ❖ For HDD Laying : DIRAX of M/s Seal for Life India Private Limited
: DDX™ Directional Drilling Kit of M/s Canusa

Only coating material C-60 Class as per EN 12068 and DVGW certified (wrapping tape and heat shrinkable material) will be accepted for all material to be coated.

8.2.1.2. Cold Applied Tapes

Cold applied tape system shall comprise of primer, an inner wrap and an outer wrap. The inner and outer wraps shall be asymmetric 3-ply tape with co-extruded polyethylene carrier film and butyl rubber adhesive layers on both sides. The inner layer of butyl rubber adhesive of inner wrap shall have a thickness of min. 1.0 mm. The inner and outer wraps are to be spirally wrapped with 55% overlap; equivalent to two layers each providing a total minimum thickness of 3.0 mm on the pipe body and 2.5 mm on the weld.

The Contractor shall propose only those cold applied tape coating systems that are approved by IOCL.



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8.2.1.3. Field Joint Coating of 3LPE Coated Pipelines using Viscoelastic Corrosion Prevention Coating System

It shall be used to coat pipe joints wherever surface preparation with abrasive blasting is not possible in city limits. Minimum requirements for primer-less viscoelastic wrap coating materials to be used for the corrosion prevention of field joint coating of steel pipe network for city gas distribution network conforming to the requirements of ISO 21809 Part 3 and operating temperature 60°C. The field joint Coating system shall comprise of primer less viscoelastic tape for corrosion protection of power tool or hand brush cleaned steel girth weld surface followed by a Butyl Rubber based low pre-heat shrink sleeve for mechanical protection and sealing the overlap area of 3LPE Coating.

8.2.1.4. For the buried valve station (moulded piece, valves, elbows etc) High build epoxy coatings may be used. Powercrete R-95 or equivalent as per EN 10289 2004 edition.

8.2.1.5. Underground bare valves if any will be coated with above material.

8.2.2. Functional Requirements of Field Joint Coating

8.2.2.1. Properties of the PE backing and the as applied joint corrosion coating shall be as follows :

Sl. No.	Property	Unit	Requirement	Test Method
i)	Tensile Strength @+25°C	N/mm ²	>12	DIN EN 12068
ii)	Ultimate Elongation % @+ 25°C	%	>250	DIN EN 12068
iii)	Dielectric withstand KV with 1000 Volts/sec	kv	>30	ASTM D 149
iv)	Water absorption @+ 25°C for 24 hours	%	<0.05	ASTM D 570
v)	Volume Resistivity @+25°C	Ohm-cm	>10 ¹⁵	ASTM D 257
vi)	Resistance to thermal aging at 100°C	%	Change in elongation < 250	DIN 30672

8.2.2.2. 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 15mm 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		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	



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Outer to Outer	@23°C	N/mm	1.5	Annexure-C
	T_{max}	N/mm	0.3	
To Pipe Surface	@23°C	N/mm	3.5	
	T_{max}	N/mm	1.0	
To Factory Coating	@23°C	N/mm	3.5	
	T_{max}	N/mm	1.0	

Note: (T_{max} shall be (+) 60°C).

Contractor shall obtain prior approval from Company regarding the manufacturer of the joint coating material. Compete technical details along with test certificates complying with the requirements of clause 8.2.1 & 8.2.2 shall be submitted to Company 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.

Other Tests:

Sl. No.	PROPERTY	UNIT	REQUIREMENT		TEST METHOD
1.	Resistance to impact @ 23°C class C, 30 Blows	J	≥15		EN 12068
2.	Resistance to peel class C at 23°C & 60°C	N/mm width	@ 23° C	@ 60° C	EN 12068
	To Pipe Surface		3.5	1.0	
	To Factory Coating		3.5	1.0	
	Inner to Inner (+)Outer to Inner		1.5	0.3	
	Outer to Outer		1.5	0.3	
3.	Cathodic Disbondment (after 30 days) @ 60°C	mm	15		EN 12068
4.	Resistance to Indentation, @ 23°C & 60°C	mm	≥0.6 (residual thickness)		EN 12068
5.	Lap Shear Strength @ 60°C, between wrapping & metal surface	N/mm ²	>0.05		EN 12068
6.	Specific electric resistance	Ω m ²	10 ⁸		EN 12068

8.2.3. The materials shall not be older than their period of validity at the time of application by CONTRACTOR. Deteriorated/ decomposed material shall be disposed of 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.

8.2.4. 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



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manufacturer's specifications as indicated in the purchase order and as approved by COMPANY. Certificates and data sheets certifying the qualities of the coating materials shall be submitted by CONTRACTOR to COMPANY prior to application. COMPANY reserves the right to have the materials tested by an independent laboratory.

8.2.5. 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.

8.2.6. CONTRACTOR shall provide and maintain mobile facilities which contains all necessary equipment and its spares for cleaning, coating repairs, inspection and tests.

8.2.7. CONTRACTOR shall furnish sufficient number of the following equipment and the required spares as a minimum for inspection and test purpose 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 (Digital Pyrometer with flat probe type contact).
- d) Roughness profile measuring (Stylus) instrument

8.3. APPLICATION PROCEDURE

8.3.1. Preparation of the surfaces to be coated

- a) Surface cleaning shall be as per SA 2½ (ISO 8502-3) for base items and will be achieved by shot or sand blasting. Minimum roughness range to be between 50 and 100 µm. Roughness of prepared surface shall be checked using press-o-film for at least one joint per day or one joint per 10 joints whichever is stringent. Joint shall be selected randomly by TPI/PMC/IOCL representative. Record shall be maintained in field job inspection report.
- b) The application procedure shall be in accordance with manufacturer's instruction and the minimum requirements specified below whichever are the most stringent and shall be demonstrated to and approved by the Company. 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.
- c) 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 until the requirements stated in sections "Inspection" and "Testing" of this specification are met.
- d) 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. Solvent cleaning procedure according to SSPC-SP1 shall be followed.
- e) Each field joint shall be blast cleaned using a closed cycle blasting unit or an open expendable blasting equipment. With the first equipment type, steel or chilled shot and iron grit shall be used and Garnet material with the second one (in case the authority having jurisdiction have no objection, the contractor may adopt sand blasting instead of garnet material). During blast cleaning the pipe surface temperature shall be simultaneously more than 5° and more than 3°C above



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ambient Dew Point, while the ambient Relative Humidity shall not be greater than 85%. Prior to surface cleaning the surface shall be completely dry. The surface shall be cleaned to a grade Sa 2% 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 1 every 10 joints.

Dust grit or foreign matter shall be removed from the cleaned surface by an industrial vacuum 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 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.

If RH is >85%, pipe surface to be suitably pre heated prior to blasting. 4.2.6 Piper temperature immediately prior to blasting shall be minimum 20 degree C. At no time shall the blast cleaning be performed when the relative humidity exceeds 85%.

- f) 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 Company Representative and on permission from Company Representative, such defects shall be removed by filing or grinding. Pipes affected in this manner shall be then re-blast cleaned if the defective area is larger than 50 mm in diameter.
- g) 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.
- h) All steel joint surfaces shall be thoroughly examined before the application of the coating in order to ensure the surface are free of soil, grease, rust, mud, earth or any other foreign matter. All these substances shall be removed before coating, to the procedures herein described.
- i) Protection coating shall be applied on the joints immediately after the completion of cleaning operation.

8.3.2. Application of Heat Shrink Wraparound Sleeves



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Procedure for application of Field Joint Coating shall be qualified as per manufacturer's recommendations. Procedure Qualification Record (PQR) for field joint coating shall be documented and submitted for approval by Contractor prior to start construction work.

The joint coating PQT shall be done under supervision of the manufacturer's personnel during the field trial demonstration and testing work. Presence of manufacturer's representative is a mandatory requirement and the bidders are requested to furnish specific commitment on this. Minimum 5 (FIVE) field joint coating to be carried out under supervision of the joint coating supplier's representative. Application procedure & environment protection methodology demonstrated at the time of field trial shall be strictly followed during the entire work.

In addition to the general requirements stated above, following shall be taken into account :

- a) The wrap around sleeves shall be of a size such that a minimum overlap of 50mm is ensured (after shrinking) on both sides of yard applied corrosion coating of the pipes. The plant coating cut back for pipes is min. 150 mm [(+) 25 mm (-) 0 mm].

In 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 200mm. 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.

- b) Before centering the wraparound sleeve, the bare steel surface shall be preheated with torch moved back and forth over the surface or by induction heating. The minimum preheat temperature shall be as recommended by manufacturer and shall be checked by means of contact type temperature recording thermometer (Digital Pyrometer with flat probe type contract) to check this, approved temperature indicates shall be used. 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.
- c) 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 10mm 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.
- d) 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. 50mm. Gently heat by appropriate torch the backing and the adhesive of the closure and press it firmly into place.
- e) A heat shrinking procedure shall be applied to shrink the sleeve in such a manner to start shrinkage of the sleeve beginning from the center of the sleeve and heat circumferentially around the pipe.



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Continue heating from the center 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.

The complete shrinking of the entire sleeve shall be obtained without undue heating of existing pipe coating and providing due bonding between pipe, sleeve and pipe coating. The installed sleeve shall not be disturbed until the adhesive has solidified.

8.3.3. Application of Cold Applied Tapes

In addition to general requirements stated above following shall be taken care of:-

- Cold applied joint protection tapes shall be of the type which can be applied by spirally wrapping on the pipe.
- 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 10mm 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.
- Approximately 100mm of tape interleaving paper shall be peeled back and tape shall be applied with the adhesive side to the pipe. Whilst continuously removing the interleaving paper, the tape shall be spirally applied to provide a minimum of 55% overlap. Enough 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 of 50mm overlap on to the adjoining yard applied coating. Outer wrap shall also be applied in similar method.

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 200mm. The direction of spiral wrapping in these cases shall be such that the square edge of the wrapping with the joint coating is in the direction opposite to the direction of boring/jacking.

8.4. INSPECTION & TESTING

- Company reserves the right to remove and test one out of every 50 joint coatings or one joint coating out of every day's production whichever is stringent. Contractor shall provide all assistance in removing and testing of field joint coatings.
- From each test sleeve, one or more strips of size 25mm x 200 shall be cut perpendicular to the pipe axis and slowly peeled off.
- The required peel strength shall meet the requirements of clause 8.2.2.2 (b) as applicable for 23°C or 60°C or as per manufacturer's temperature & peel strength chart accepted during PQT of field joint coating whichever is applicable. 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 on bare metal, otherwise, test shall be considered failed. The adhesive layer that remains on the pipe surface shall generally be free of voids



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resulting from air or gas inclusion. In case the peel strength test at a different temperature than that specified in 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.

- d. If the sleeve taken away for test does not meet the requirements, the adjacent two sleeves shall also be removed and inspected.
- e. If the adjacent two sleeves are acceptable the test rate shall be increased to one sleeve in every twenty-five joints or 1 or 2 (if required by IOCL) joint coating out of every day's production whichever is stringent and opined by Company's Representative until Company's Representative is satisfied. The test rate can then be reduced as per clause 8.4 (a).
- f. Contractor shall, at his own cost repair all areas where the coating has been removed for testing by the Company.
- g. If either or both adjacent two sleeves do not meet the requirements, the field coating shall be stopped for further inspection and analysis as follows:
 - 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 Company, already completed field coatings.
 - stop field coating until remedial measures are taken against the causes of such faults, to the entire satisfaction of the Company.

Contractor shall replace all joint coating found or expected to be unacceptable as per section 6.0 of this specification.

After the coating work on welded joints, fittings and repairs to the coating have been completed the coating system as a whole shall be tested with a spark-tester before lowering or jacking the pipeline.

- h. Company Representative reserve the right of 100% removal of sleeves if he is not convinced that the requirements of clause 8.2.2.2 are achieved.
- i. Coating thickness shall be checked by non-destructive methods for each field joints. Average thickness of the as-applied coating on pipe body shall be established based on measurement at min. eight locations i.e. four measurement 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. Company Representative reserves the right to ask for additional measurement at any location on the field joint coating, whenever doubt arises.

The total thickness of heat shrinkable wraparound sleeves in the as applied condition shall be as follows:

Pipe Size	Thickness (mm)
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(Specified Outside Diameter)	On Pipe Body (Min.)	On Weld Bead (Min.)
4" (114.3 mm) to 10" (273.0 mm)	2.0 mm	1.6 mm
12" (323.9 mm) to 18" (457.2 mm)	2.2 mm	1.8 mm
20" (508.0 mm) to 30" (762.0 mm)	2.5 mm	2.0 mm
> 32" (812.8 mm)	3.0 mm	2.5 mm

j. A visual inspection shall be carried out for the following:

- Mastic extrusion on either ends of the sleeve shall be examined. (applicable for heat shrink wraparounds).
- 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.
- Weld bead profile shall be visible through the sleeve.

k. Holiday Inspection

The holiday detector used shall be checked and calibrated daily with an accurate DC voltmeter. The detector electrode shall be in direct contact with the surface of coating to be inspected.

The entire surface of the joint section shall be inspected by means of a full circle holiday detector approved by Company set to a DC voltage of at least 25 kV. Inspection of the sleeves shall be conducted only after the joint has cooled below 50°C. (Applicable for heat shrink wraparounds).

All welded joints will be checked with an holiday detector after application of the welded joint coating in the trench.

l. No field joint shall be covered or lowered in the trench until it has been approved by the Company.

m. Company 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 establish, the Contractor shall be responsible for excavations at such points, repairing the coating, spark testing and backfilling the excavation without extra charge.

n. Cold applied tape or R-95 used for coating purpose on irregular surfaces i.e. elbow & fittings etc. shall be holiday tested at 25 KV

o. Contractor shall furnish sufficient number of the following equipment and the required spares as a minimum for inspection and test purposes for each crew:

- Fully automatic full circle adjustable holiday detector with a visible and audible signal system for inspection of coatings.
- Thickness gauge for measuring thickness.
- Contact type temperature recording thermometer (Digital Pyrometer with flat probe type contact).
- Roughness profile measuring instrument (Stylus), Press-o-films
- Wet film thickness gauge
- Solid state digital thickness gauge for measuring thickness of joint coating.
- Hygrometer to measure Relative Humidity.



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- Cutting tool
- Peet testing equipment

8.5. REPAIRING OF A COATING

Any defects detected will be repaired by the Contractor under the supervision of the Owner and or the Engineer. In places where the coating has been removed, reworked or repaired, the inspection will be conducted by the Contractor by means of a holiday detector under supervision of the Owner and or the Engineer.

In the case of adhesion defects, insufficient thickness of the coating, inaccurate positioning and/or bad impregnation of the reinforcement, the presence of traces of humidity, of air-pocket and solid particles, the coating will be removed and completely repaired.

8.5.1. REPAIR CONSUMABLES:

Repair consumables shall be of following make:

M/s Seal for life or M/s Canusa or M/s CYG Changtong New Material Company Ltd. or any other IOCL approved coating system.

Repair shall be carried out by using polyethylene repair patches pre-coated with hotmelt adhesive to be used in conjunction with a filler adhesive as per manufacturer's recommendation with following consumables.

For Repair of Pipes to laid by Open Trench method:

M/s SFL : PERP Patch -PERP 80, Mastic Perp Filler : S 1137, PERP MELT STICK

For Repair of Pipes to laid by HDD method:

M/s SFL : PERP Patch -PERP 60E, Mastic Perp Filler : S 1182

8.5.2. REPAIR PROCEDURE

1. COSMETIC & PATCH REPAIRS

- PE layer Damages having surface area less than 0.5 cm² or linear cut upto 3 cm should be repaired with PE stick by melting.
- All surface imperfections in coating, which are not reaching up to steel, should be removed either by heating and pressing or by grinding the PE coating. On these type of repairs thickness should be checked which should not be less than the specified coating thickness.
- Damages caused to coating by handling such as scratches, cuts dents & gauges not picked up during holiday test, having a total reduced thickness on damaged portion not less than 2.0 mm and an area not exceeding 20 cm² shall be rebuild by patch only and without exposing to bare metal.
- Defects exceeding the above area or holidays on width not exceeding 300 mm, shall be repaired by exposing the bare metal surface by patch.



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Procedure for patch repair:

- i. Mark the area to be repaired
- ii. Clean the area by grinder, wire brush or emery paper
- iii. If the defects are as per (A), (B) & (C) above, then only abrade the surrounding coating up 50mm beyond the defect, and take the repair patch as per abraded area and put in flame from the adhesive side until the adhesive becomes glossy. Position the precut repair patch over the area and heat until the adhesive melts. Roll out any entrapped air with a roller.
- iv. If the defects are as per (D) above, then remove the loose coating from the defected area, and chamfer the edges, abrade the surrounding area upto 50mm from each edge. Now preheat the exposed area. Fill the exposed area with repair patch. Heat the repair patch and smooth it down with a scrapper to cover all bare metal. Now take the repair patch as per abraded area and put in flame from the adhesive side until the adhesive becomes glossy. Position the precut repair patch over the area and heat until the adhesive melts. Roll out any entrapped air with a roller.
- v. After patch is cool, adhesive is evident on the edges. The patch has fully confirmed to the coating.

2. SLEEVE REPAIRS

- A. Defects exceeding the above and in number not exceeding 2 per pipe and linear lengthy not exceeding 500 mm shall be repaired using Heat shrinkable sleeves as follows and must cover / complete circumference of the pipe.
- B. If coating defects close to coating cut-back, coating shall be removed throughout the entire circumference of the pipe down to steel surface and increase the coating cut back length. If the coating cut back exceeds 170 mm of linear length of pipe than the coating shall be repaired by the use of Heat Shrinkable Sleeves hereby making up the coating cut back length of 130 mm. If the defects exceed 325 mm from the original cut back length the entire coating of the pipe shall be rejected.

Procedure for Sleeve Repair:

- i) Mark the area to be repaired circumferentially.
- ii) Cut and clean up to bare metal, the whole circumferential original coating upto defected length area by grinder, wire brush or emery paper and also abrade the adjacent 3LPE coating upto 50mm minimum.
- iii) Dispense an adequate amount of Part B in to Part A of epoxy in 1:3 ratio and mix homogeneously.
- iv) Preheat the cleaned area and apply the mixed epoxy primer to the bare steel.
- v) Wrap the sleeve loosely around the pipe evenly overlapping the adjacent pipe coating by 50mm or more.
- vi) Press the closure patch, centering over the exposed sleeve ends (overlap to each other – 50mm minimum). Heat the closure patch and run a small roller over the closure patch to seal the ends.
- vii) Start heating the sleeve, begin at the centre of the sleeve and heat circumferentially around the pipe, using a constant paintbrush motion. Continue



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heating towards one end of the sleeve, followed by the other. During shrunk down of sleeve, wrinkles disappear automatically. Run a small roller over the sleeve to push out any trapped air. If necessary area may be reheated to roll out air.

- viii) After sleeve is cool, adhesive is evident on the edges. The sleeve has fully confirmed to the coating

8.5.3. REPAIR CRITERIA

- 1) 3 Holiday / pinhole and individual size should not be more than 0.01 m² per pipe.
- 2) Other defects – 3 repair patches.
- 3) 2 sleeves repairs / pipe.

8.5.4. REPAIR AREA INSPECTION

- 1) Film thickness of sleeve.
- 2) Visual – Smoothness, colour and gloss
- 3) Adhesion

8.5.5. HOLIDAY CHECK

All repairs are acceptable subject to Holiday test at DC voltage of 25 KV or as per manufacturer's requirement.

8.6. DOCUMENTATION

Prior to procurement of coating materials, Contractor shall furnish the following information for qualification of the Manufacturer and material:

- Complete descriptive technical catalogs describing the materials offered along with samples of corrosion coating materials, its properties and application instruction as applicable specifically to the project.
- Reference list of previous supplies, in last 5 years, of the similar material or manufacturer shall be notified to Company, whose approval in writing of all charges shall be obtained before the materials are manufactured.

Contractor shall ensure that the coating materials supplied by him are properly packed and clearly marked with the following :-

- Manufacturer's name
- Material Qualification Certificate Number
- Batch Number
- Date of Manufacturing and date of expiry

Prior to shipment of materials from the Manufacturer's Works. Contractor shall furnish the following documents:



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- Test certificate/results as per Manufacturer's Quality Control Procedure for each batch of materials complying with the requirements of relevant sub-clauses of clause no. 3.2 of this specification.
- Specific application instructions with pictorial illustrations.
- Specific storage and handling instructions.

All documents shall be in English language only.

Prior to start the coating works at site Contractor shall furnish following Owner/ Consultant's approved documents in addition to that mentioned in clause no. 3.4 of this specification.

- Procedure for field joint coating & their repair
- Procedure for repair of pipeline coating defects
- Procedure qualification record
- Inspection test plan
- Inspection format

Final submission of all documents after finish the work shall be as per relevant specification & SCC enclosed with the tender or as per direction of Engineer-incharge



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CHAPTER-9

9. SPECIFICATION FOR FIELD JOINT COATING OF PIPELINE IN HDD CROSSING

This specification establishes the minimum requirements of materials, manpower, equipment and installation of field joint anti-corrosion coating of buried onshore pipelines (for design temperature upto 65°C) factory coated with either three layer polyethylene or fusion bonded epoxy coating, by heat shrink wraparound sleeves conforming to DIN EN 12068 - "Cathodic Protection - External Organic Coatings for the Corrosion Protection of Buried or Immersed Steel Pipelines used in Conjunction with Cathodic Protection - Tapes and Shrinkable Materials" and the requirements of this specification. 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 documents included in the Contract between Owner and Contractor. Unless specified otherwise, all sections of this specification shall apply to all specifications referred in this specification.

9.1. REFERENCE DOCUMENTS

Reference has been made to the latest edition (edition enforce at the time of issue of enquiry) of the following standards, codes and specifications:

EN - 12068	Cathodic Protection – External Organic Coatings for the Corrosion Protection of Buried or Immersed Steel Pipelines used in Conjunction with Cathodic Protection – Tapes and Shrinkable Materials.
ASTM D – 149	Standard Test Methods of Dielectric Breakdown voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial power frequencies.
ASTM D – 257	Standard Test method for D.C. Resistance or conductance of insulating materials.
ASTM D – 570	Standard method of Test for Water Absorption of Plastics.
SIS 055900	Swedish Standard Preparation of Steel Substrates before application of paints and related products visual assessment of surface cleanliness.
SSPC - SP 1	Solvent Cleaning Steel Structure painting Council.
ISO 8501	Preparation of steel substrates before application of paints and related products - Visual assessment of surface cleanliness Part 1 - Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings
ISO 8502	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).
ISO 8503	Preparation of steel substrates before application of paints and related products - Surface roughness characteristics of blast cleaned steel substrates Part 1 - Specification and definitions for ISO surface profile comparator for the assessment of abrasive blast cleaned surfaces Part 2 - Method of Grading of Surface Profile of Abrasive Blast Cleaned Steel - Comparator Procedure Part 4 - Methods for calibration of ISO surface profile comparator and for the determination of surface profile- Stylus instrument procedure
ISO 21809	Petroleum and natural gas industries - External coatings for buried or submerged pipelines used in pipeline transportation systems Part 3 - Field joint coatings

Note: In case of conflict between the requirements of this specification and that of above referred documents, the requirements of this specification shall govern.

The CONTRACTOR shall be familiar with the requirements of these documents and shall make them readily available at the site to all personnel concerned with



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carrying out the works specified in this specification.

9.2. MATERIALS AND EQUIPMENT

Field joint anti-corrosion coating material shall be heat shrinkable wraparound sleeve (fiber reinforced HSS for directional drilling crossings) suitable for a maximum operating temperature of (+) 60°C (Tmax) and shall conform to EN 12068- C HT 60 UV. In addition, the field joint anti corrosion coating shall comply the requirements specified in para 3.2 of this specification.

Fiberglass reinforced Heat shrink wraparound sleeves (HSS) for HDD crossing

Fiberglass reinforced heat shrink sleeve for directional drilling and thrust bore applications shall consists of radiation cross-linked high density fiberglass reinforced polyethylene backing with a uniform thickness of high shear strength copolymer hot melt adhesive. The joint coating system shall consist of a solvent free two component liquid epoxy applied to the pipe surface prior to sleeve application. It shall also have a wear cone for extra protection against pull-through forces. The sleeve shall be supplied in pre-cut sizes to suit the pipe diameter and the overlap requirement.

Thickness of sleeves

The total thickness of fiberglass heat shrinkable wraparound sleeve for HDD crossings in the as applied condition shall be as follows:

Pipe Size (Specified Outside diameter)	Thickness (mm)	
	On Pipe Body (Min.)	On Weld Bead (Min.)
All diameters	3.0	2.8

The fiberglass heat shrink wraparound sleeve shall have the required high shear strength 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 provide the manufacturer with details of fiberglass re-enforced heat shrink sleeve properties and the specific grade of the field joint coating system meeting the requirements of this specification. Contractor shall propose only those coating systems that have been previously used in pipelines of same or higher size indicated in the tender, in a single project for similar operating conditions.

The proposed fiberglass shrink sleeve for HDD Crossing system shall be compatible with and shall have good bonding properties with Three Layer Polyethylene or fusion bonded epoxy coating system.

The plant coating cut back for pipes is min. 150 mm [(+) 25 mm (-) 0 mm].

FUNCTIONAL REQUIREMENTS OF FIELD JOINT COATING

Properties of the fiber glass reinforced radiation cross linked Polyethylene backing shall be as follows:



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S. No.	Properties Properties	Unit	Requirement	Test Method
a.	Bursting Strength of fiber glass reinforced backing @ (+) 25°C	N	≥ 2000	Annexure O of ISO 21809-3 / Annexure F of DIN EN 12068
b.	Dielectric Withstand with 1000Volts/sec	KV	≥ 30	ASTM D149
c.	Water absorption @ (+) 25°C	%	≤ 0.05	ISO 62 / ASTM 570
d.	Electrical Volume Resistivity @ (+) 25°C	Ohm-cm	$\geq 10^{15}$	ASTM D257

Functional properties of joint coating system (as-applied) shall comply with the requirements given below:

S. No.	Properties	Test	Unit	Requirement	Test Method
		temp.			
1	Impact resistance (holiday detection @ 5KV/mm + 5KV)	(+) 23°C	J/mm	≥ 7 . 0	Annexure D of ISO 21809-3
2	Indentation resistance				Annexure E of ISO 21809-3
	- Pressure	T _{max}	N / mm ²	> 10. 0	
	- Residual thickness		mm	≥ 0 . 6	
3	Cathodic disbondment resistance at 28 days @ (-)1.5 V	23°C	mm	≤ 5.0	Annexure G of ISO 21809-3
		T _{max}		≤ 10.0	
4	Peel strength @ Pipe surface	23°C	N/mm	> 5. 0	Annexure H of ISO 21809-3
		T _{max}		> 1. 0	
	Peel strength @ Plant applied coating	23°C		> 5. 0	
		T _{max}		> 1. 0	
5	Hot water immersion @ T _{max} for 100 days				
	Peel strength @ Pipe surface	23°C	P100/Po	≥ 0.75	DIN EN12068 / Annexure H & I of ISO 21809-3
	Peel strength @ Plant applied coating				
6	Lap shear strength at 10mm/min	23°C	N / mm ²	> 6.0	Annexure J of ISO 21809-3
		T _{max}		> 0.6	
7	Thermal ageing resistance (aged @ T _{max} + 20°C)				
	Peel strength @ pipe surface (P ₁₀₀ /P ₇₀)	23°C	-	≥ 0.75	Annexure E of DIN EN12068 / Annexure M of ISO 21809-3
8	Ultraviolet irradiation resistance				
	Ratio of Bursting strength	-	-	1.25 ≥ B _x / B _o ≥ 0.75	Annexure F of DIN EN12068
Note: T _{max} shall be (+) 60°C					

Heat shrinkable wraparound Sleeves of M/s SFL and M/s Canusa (any other IOCL approved coating system may also be used)

❖ For Open Cut Laying : HTLP-80 heat shrink sleeve of M/s SEAL FOR LIFE



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: GTS-80 heat shrink sleeve of M/s CANUSA, CANADA

❖ For HDD Laying : DIRAX of M/s Seal for Life India Private Limited
: DDX™ Directional Drilling Kit of M/s Canusa

Only coating material C-60 Class as per EN 12068 and DVGW certified (wrapping tape and heat shrinkable material) will be accepted for all material to be coated

9.3. APPLICATION PROCEDURE

9.3.1. Preparation of the surfaces to be coated

As per clause 8.3.1 of this specification.

9.3.2. Application Procedure for fiber reinforced Heat Shrink Wraparound Sleeves

In addition to the requirements stated above, following shall be complied with:

The wrap around sleeve shall be of suitable width considering an overlap to the factory coated pipe coating by minimum 50mm on each side for 3LPE coated pipes. Cut back length of the pre-coated pipes at pipe ends shall be 150 mm -0, + 25mm for 3LPE coated 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 I jacking.

Before centering 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 (Digital Pyrometer with flat probe type contact). 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.

Upon pre-heating, the pipe surface shall be applied with two pack epoxy primer of wet film thickness of 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 minimum 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.

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



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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 minimum 50 mm. Gently heat by appropriate torch the backing and the adhesive of the closure and press it firmly into place.

The wraparound sleeve shall be shrunk on pipe joint with a propane torch moved back and forth over the surface when heated above 125°C, the sleeve shall shrink tightly around the substrate on to the wet-primer. At the time of application of the primer, the pipe surface temperature shall be at least 60 degree C at every point. To check this, approved temperature indicators shall be used. Temperature indicating crayons shall not be used.

Heat shrinking procedure shall be applied to shrink the sleeve in such a manner that all entrapped air is removed using gloved hands and hand rollers. The complete shrinking of entire sleeves shall be obtained without undue heating of existing pipe coating and providing due bonding between pipe, sleeve and pipe coating. A thermochrome paint shall be applied a on closure patch to indicate that sufficient heat/ temperature has been obtained.

A heat shrinking procedure shall be applied to shrink the sleeve in such a manner to start shrinkage of the sleeve beginning from the center of the sleeve and heat circumferentially around the pipe. Continue heating from the center towards one end of the sleeve until recovery is completed. In a similar manner, heat and shrink the remaining side. Shrinking is considered to be completed when the adhesive begins to ooze at the sleeve edges all around the circumference.

The complete shrinking of the entire sleeves shall be obtained without undue heating of existing pipe coating and providing due bonding between pipe, sleeve and pipe coating. The installed sleeve shall not be disturbed until the adhesive has solidified.

A sacrificial sleeve is to be installed on the leading edge to function as a wear cone during pull through of the pipe. Wrap the leading edge of the sleeve over the transition of main sleeve – mill coating. The closure is placed away from the main sleeve closure. Pre-heat the inside adhesive layer just next to the closure for a few seconds. Press down to make it stick to the other sheet end. Pre-heat the inside adhesive layer just next to the closure for a few seconds. Press down to make it stick to the other sheet end. Heat the closure area and immediately pat it down with a gloved hand. Shrink the leading-edge sleeve down by moving the torch all around the pipe in a paint brush motion. Make sure the sleeve has fully shrunk and adhesives flow is evident on the both edges. Smooth down the edges of the sleeve with the silicone hand roller.

The sacrificial sleeve is fully recovered when all the following have occurred:

- The sacrificial sleeve is fully conformed to the main sleeve and adjacent coating.
- There are no cold spots or dimples on the sleeve surface.
- Adhesives flow is evident on the both edges after sleeve is cool.

9.4. PRE-QUALIFICATION OF FIELD JOINT COATING SYSTEM

As per chapter-8 of this specification.



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9.5. INSPECTION & TESTING

As per clause 8.4 of this specification. (refer chapter 8)

9.6. REPAIRING OF A COATING

As per clause 8.5 of this specification. (refer chapter 8)

9.7. DOCUMENTATION

As per clause 8.6 of this specification. (refer chapter 8)



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CHAPTER-10

10. SPECIFICATION FOR TRENCHING

This specification refers to the excavation, clearing and finishing of the trenches in which the pipelines are to be laid.

10.1. MATERIALS AND EQUIPMENT

The Contractor shall supply all materials and equipment necessary for the excavation, clearing and finishing works of the trench, for the transport of excavated earth and backfill material, for the draining of the trenches and for any equipment such as bracing, props, casings, channels and pipes required for the proper execution of the works. The Contractor shall obtain from the relevant authorities all the necessary authorization for using these materials and equipment.

10.2. ROUTE

The route of the trench shall be marked on the ground according to the final route determined with the Engineer.

Where the excavation is carried out by hand, the two edges of the trench shall be marked on the ground. Where a machine is used one edge only shall be marked, since the width of the trench depends on the size of the trenching equipment.

The route of the trench shall be such that the axis of the pipeline shall be not less than one meter from the building line, unless otherwise requested by Engineer for specific reasons.

Should obstacles be encountered, the Contractor shall dig trial holes around these obstacles until a route is accepted by the Engineer.

In all cases, it shall be the responsibility of the Contractor to check for the existence of any and all underground utilities along the route of the trench. Omission on the construction drawings shall not be considered as the nonexistence of underground utilities or obstacles. The Contractor shall in particular make provision for any new facilities having been laid after the Construction drawings were drawn-up.

10.3. EXCAVATION

CONTRACTOR shall apply any method approved by OWNER, dig the pipeline trench on the cleared and graded ROW. In cultivable land and other areas specially designated by the OWNER, the CONTRACTOR shall strip top-soil to a depth of 30 cm to the full anticipated width of the ditch and store this material separately along the ROW to allow replacement of this material on top of the backfilled ditch. Suitable crossings shall be provided and maintained over the open ROW, wherever necessary, to permit general public, property owners or his tenants to cross or move stock or equipment from one side of the trench to the other. 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 Contractor shall trench to the specified depth and width. In large and busy streets the maximum total length and duration of open trench shall be given in the special specifications or as decided by Engineer-in-charge.

The maximum length of open trench may be extended subject to the approval of the Engineer.



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The sides of the trench shall be cleared of any roughness which could damage the coating of the pipes during lowering-in.

The bottom of the trench shall be uniformly graded and free from stones, rocks, pebbles, gravel or other objects which could damage the coating.

Underground facilities, such as water pipes, electric cables, telephone cables, located within the limit of the trench shall be carefully exposed by hand excavation.

The Contractor shall be liable for all damages and injuries caused to encountered utilities and shall deal with the matter with the appropriate authorities

10.4. SIZE OF THE TRENCH

The width of the trench shall be the outside diameter of the pipe plus 0.20 meter.

The minimum depth of the trench shall be such as to provide a cover over the crown of the pipe as specified in the Specifications/ SCC.

When necessary, in case of obstacle crossings, tie-ins, etc. It shall be the responsibility of the Contractor to make the trench wider and deeper than specified above in order to have sufficient working space.

At obstacles crossings or underground utilities or works, the trench shall be excavated to a depth giving the minimum clearance specified in the specification "Obstacle crossings and special passages."

Unless otherwise stated in particular cross section drawings, the clear spacing between the gas pipeline and other petroleum pipeline will be between min 0.50 m and other utilities shall be 300mm at crossing point and min. 3.0 m when the pipeline is running parallel to the utilities (PNGRB T4S). Wherever it is possible the minimum distance must be increased

10.4.1. Minimum depth

The trench shall be excavated to a minimum width so as to provide, on both sides of the installed pipeline, a clearance as indicated in the job standards/drawings and to a depth sufficient to provide the minimum cover as indicated below. The dimensions in the table below shall govern except as noted herein or as shown on the job standards or detailed construction drawings or as required by authorities having jurisdiction, whichever is greatest. Minimum depth of cover shall be measured from the top of pipe corrosion/concrete surface/casing of the pipe with respect to top of graded working strip or top of road or top of hill whichever is lower. Fill material in working strip shall not be considered to add to the depth of cover. However, surface of fill material placed to fill hollows may be used to determine the depth of cover subject to prior approval by Owner.

Wherever, Steel and MDPE pipeline shall be laid in same trench, Orientation and Cover of both pipelines shall be as per the drawing attached with Tender or as advised by IOCL/PMC. However, Steel pipeline cover be no less than 1.2m anywhere in the stretch.



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S. No	Location	Minimum Top Cover in Meters
1	Normal surface i.e. Road & Residential Areas	1.2
2	Minor Water Crossings/Canals	1.5
3	Drainage ditches at road	1.5
4	Rocky area	1.0
5	Uncased/Cased Road Crossings	1.5
6	Rail Road Crossings	1.8 (OR as per approved railway guideline/drawing)
7	Other Areas	1.2
8	Major Water Crossings / Canals	5 (below scour depth)
9	HDD/Micro-tunneling	2.5 (below scour depth)

Trenching to all depth in all types of soil including soft & hard rock etc. In any circumstances contractor is not entitled to claim extra payments for excavation of increased depth due to site conditions / crossings / utilities and ground level differences etc. however in certain special cases with prior written approval of owner / owner's representative extra excavation may be paid.

At points where the contour of the earth may require extra depth to fit the minimum radius of the bend as specified in the specification or to eliminate unnecessary bending of the pipe according to customary good pipeline practice, or where a deep trench is required at the approaches to crossings of roadways, railroads, rivers, streams, drainage ditches, etc. Contractor shall excavate such additional depths without any cost/time implication.

A minimum separation of three meter should be maintained between the steel pipeline and footing of transmission tower/electrical poles/any other utilities.

In case of rivers/water bodies which are prone to scour and erosion, adequate safe cover (minimum 2.5 metre) shall be provided below the predicted scour profile expected during the lifetime of the pipeline.

The depth of cover shall be determined as per latest edition of OISD 141.

10.5. Appearance of the Trench Bottom and Trench Walls

The trench shall be cut to a grade that will provide a firm, uniform and continuous support for the pipe. Bends shall be made in the pipe at significant changes in grade of the trench. Owner reserves the right to set the grade of the trench and locate the bends if so desired, in which case CONTRACTOR shall excavate, at no extra cost, the trench and bend the pipe to such a grade. Owner desires to reduce to a minimum the required number of bends to lay the pipe to conform to the general contour of the ground and maintain a normal cover. This can be accomplished by cutting the trench slightly deeper at the crest of ridges and by gradually deepening the trench in approaches to crossings. Such trenching work shall be done by CONTRACTOR at no extra cost to the Owner.



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CONTRACTOR shall keep the trench in good condition until the pipe is laid, and no claim is to be made to the Owner by reason of its caving either before or after pipe is laid. All lumber, sheet-piling jacks or other materials that may be necessary to shore the trench, in order to prevent caving are to be furnished and removed by CONTRACTOR.

CONTRACTOR shall dewater, if necessary, using well point system or other suitable systems, shore or do what else might be required to excavate the trench, install the pipe in it and backfill the trench as per instruction of Owner's Representative.

CONTRACTOR shall excavate and maintain the pipeline trench on the staked centre line of the pipeline taking into account the curves of the pipeline. CONTRACTOR shall, by any method approved by Owner, dig the pipeline trench on the cleared and graded Right-of-Way. 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. 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.

10.6. CLEARING

a) Removal of Obstacles

The Contractor shall clear the work-site of any obstacles such as stocks of road building materials, sight holes, temporary barracks, etc. in agreement with the appropriate authorities.

The Contractor shall settle the matter with the appropriate authorities even if a new obstacle appears after construction drawings have been drawn-up.

b) Circulation

The Contractor shall carry out all clearing work necessary for the free and safe circulation of pedestrians and road users.

The Contractor shall ensure the free and safe trench crossing for pedestrians and vehicles.

Wherever the trench is excavated along or across streets, roads and sidewalks the Contractor shall install temporary bridges for pedestrians and vehicles as specified in the Specifications/ SCC. Steel plates shall be installed on the whole length of road crossings, so that the roads crossed by the trench are not narrowed.

c) Modifications of Traffic

Wherever, due to the dimension of the streets or the traffic condition, it will be necessary to modify, limit, divert or even stop temporarily the traffic, the Contractor shall deal with the Municipality and Police authorities and inform the Engineer-in-charge of the arrangements agreed upon.

10.7. REMOVAL OF ROAD SURFACINGS

Road surfacing shall be removed by appropriate cutters, in the case of asphalt, bitumen or cement surfacing. Cobbles, slabs, bricks or ceramic paving-stones shall be removed with care for possible reuse. Materials unsuitable for reuse shall immediately be removed from the site as digging proceeds. Materials suitable for reuse shall tidily be piled-up as directed by the Engineer.



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Excavated surfaces to be restored to original condition after laying of pipeline as per the instruction EIC.

10.8. SHEETING AND BRACING OR PROPPING

i. Trench

The Contractor shall carry out the sheeting or bracing wherever required by the nature of the ground and/or the depth of the trench, and whenever the Engineer so requires.

Sheeting or bracing shall not be removed until the backfilling progress allows their removal without any risk of injury to the personal or damage to the coating.

The Contractor shall be responsible for the application of the safety regulations in force and for the consequences of inadequate or insufficient safety measures.

ii. Existing Structures

Any structure which may be damaged during the excavation work shall be protected.

Trenches, located near electricity poles, lamp-posts or foundations shall be propped; the propping shall be kept until the end of the backfilling and left if necessary.

Wherever underground lines or utilities interfere with construction work, the Contractor shall take the necessary measures to preserve the continuous use of the utilities during and after the gaslines construction work in accordance with the concerned authorities requests.

The Contractor shall be responsible for the consequences of inadequate or insufficient safety measures.

10.9. DEWATERING

a. In The Trench

The Contractor shall keep the trench free from water.

The Contractor shall provide pumps, shoring equipment and all equipment and material required to maintain the trench in good condition until the pipe is laid and the trench backfilled.

b. Outside of The Trench

The excavated materials shall not interfere with the flow of water when the trench passes alongside a road; this flow shall be maintained by a drain or if necessary by deviating the opposite gutter.

The excavated of the trench shall not interrupt the flow of water. At each street crossing, a gutter shall be tunneled and underpinned by means of planks. If the gutter cannot be kept in use it shall be replaced by a duct.

10.10. JOINT HOLES



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Where tie-ins are to be made in the bottom of the trench, the Contractor shall dig joint holes in order to allow unrestricted welding coating and wrapping as well as the relevant inspections.

10.11. EXCAVATED MATERIAL

The excavated material shall be placed in such a way as to avoid any inconveniences to property owner, or interference to the circulation of pedestrians or vehicles as well as to the operation of near-by installations. The excavated material shall be piled up in such a way that they enable the watering of the trees. No excavated material shall be piled up in the road crossings.

To prevent the excavated stone and earth from falling into the trench, a strip 20 cm wide shall be left clear between the edge of the trench and the bottom of the pile of excavated earth. This width may be increased according to the nature of the ground and the atmospheric conditions.

Wherever necessary, the Engineer may require the excavated material to be removed from the site and to be kept at a dump yard until the trench is to be back filled and to be brought back to the site for backfilling.

When the excavated material is judged by the Engineer to be unsuitable for re-use, the Contractor shall remove it from the site as the digging of the trench proceeds and shall supply in its place suitable material approved by the Engineer.

10.12. SIGNALING, FENCING AND LIGHTING

- Signaling

Site Identification

Each site shall be provided with an identification board mentioning the reason for the work and the names of the Company, the Contractor and the Consulting Engineer, as stipulated in the Specifications and SCC.

Traffic Signals

At both ends of the trench the Contractor shall install 2 traffic signs one immediately close to the trench and the other ahead, as required by the Engineer.

- Fencing

The Contractor shall fence all working areas using hard barricades. He shall also fence both sides of temporary bridges, when required by the Engineer.

- Lighting

The Contractor shall install lights around all working areas in accordance with the Specifications/ SCC. The voltage shall conform to the safety regulations in force.

The Contractor shall install signaling, fencing and lighting of all trial-holes, trench section and other excavations.

The Contractor shall provide watchmen wherever deemed necessary for the safety of the public and of the workers, in particular as regards working sites, on site material stockage, temporary dumping yards, etc.



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10.13. SAND PADDING AND SOFT SOIL PADDING IN HARD ROCKY AREA / OTHER AREAS
AND SIEMIC FAULT LOCATIONS

10.13.1. SAND PADDING

In all cases where rock or gravel or Moorum or hard soil is encountered in the bottom of the trench, trench padding / Rock Shield Materials and sand bags, approved by OWNER shall be provided to safeguard the pipe coating. The extent of trench padding (length) shall be decided by OWNER. In those areas that are to be padded, the trench shall be deeper by at least 150mm or the thickness of the sand bags whichever is more. The trench shall be evenly and sufficiently padded to keep the pipe, when in place, at least 150mm above the bottom of excavated trench. Supports shall be provided for the pipeline by use of sand bags or intermittent transverse berms in the ditch bottom comprising rock-free material, with a width of 15-20 cm and at an interval of approximately 7 metres. Acceptable padding shall be placed under the pipeline before its installation and around it after installation, to establish at both sides and on top of the pipe a permanent layer of padding. The thickness of compacted padding shall be at least 150mm. Padding materials that are approved by the OWNER shall be sand containing no gravel, rock, or lumps of hard soil.

10.13.2. SOFT SOIL PADDING

In all cases where rock or gravel or moorum or hard soil is encountered in the bottom of the trench, trench padding, Rock Shield Materials and sand/soft soil bags as approved by Engineer-in-Charge, shall be provided to safeguard the pipe coating. Padding materials shall be soft graded soil containing no gravel, rock, or lumps of hard soil. The soft graded soil for padding shall pass through sieve size ASTM-10 or ISO-2.00. Acceptable padding shall be placed under the pipeline before its installation and around it after installation, to establish at both sides and on top of the pipe a permanent layer of padding. The thickness of compacted padding shall be at least 150mm.

The trench shall be deeper by at least 150mm. The trench shall be evenly and sufficiently padded to keep the pipe, when in place, at least 150mm above the bottom of excavated trench.

At seismic fault locations, in addition to the above requirements of padding material, in case the dugout soil is clayey in nature (undrained shear strength $> 0.5 \text{ T/m}^2$), the local soil shall be replaced by engineered (cohesion less) backfill having angle of friction not more than 27 degrees and the same shall be loosely compacted (unit weight $< 1.8 \text{ T/m}^3$). In case of undrained shear strength of the dugout soil $\leq 0.5 \text{ T/m}^2$ the dugout soil itself can be used as backfill. The trench shall be deeper by at least 500 mm. The trench shall be evenly and sufficiently padded to keep the pipe, when in place, at least 500 mm above the bottom of excavated trench. Acceptable padding shall be placed under the pipeline before its installation and around it after installation, to establish at both sides and on top of the pipe a permanent layer of padding. The thickness of compacted padding shall be at least 500mm.

Supports shall be provided for the pipeline by use of sand/soft soil bags or intermittent transverse berms in the ditch bottom comprising gravel/rock-free material, with a width of 15- 20 cm and at an interval of approximately 7 meters.



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Note: In all cases, primarily sand padding is to be provided. In case of non-availability of sand, which may affect the project schedule, soft soil padding may be used after verification/certification by Engineer in Charge for non-availability of sand.

10.14. ROCK-TRENCHING AND BLASTING

The expression “Rock Trenching” shall, in these specifications, means trench excavation(s) on the ROW to the specification requirements that cannot be performed by mechanical means such as ditching machinery, rock plough, back hoe, ripper and other mechanical means or by manual digging employing ordinary pick axes, shovels and crowbars but that can be performed only by pneumatic tools or by drilling and blasting or by chiselling out or by use of rock saws or bucket wheel ditching machines or hydraulic rock breaker or any suitable method relatively faster.

The following procedure will apply in areas requiring rock trenching, namely :-

- I. Normal clearing and grading operations will be carried out on the ROW, thereafter normal trenching operations, will be carried by deploying excavators, back-hoe etc.
- II. If trenching cannot be completed by said operations the CONTRACTOR shall deploy D-9/D-8 Dozer with ripper, etc. followed by shovel of adequate capacity.
- III. If the desired depth of trench cannot be achieved by this method, CONTRACTOR shall obtain the clearance of the OWNER for ROCK TRENCHING. The decision of the OWNER shall be final as to the necessity of rock trenching.
- IV. Should rock trenching be found to be necessary after deployment of ripper and shovel, the excavated material shall be cleared from the trench and measurements/levels of the trench taken and recorded in the manner prescribed by the OWNER.
- V. On receipt of clearance for rock trenching, blasting or other appropriate operations shall be carried out to attain the requisite trench dimensions. Every possible precautions shall be taken to prevent injuries & damages to persons & properties during blasting operations which shall be performed in accordance with the rules for blasting mentioned in the respective chapter herein. CONTRACTOR shall obtain necessary permits for transportation, storage & use of explosives and comply with the laws, rules & regulations of the respective government agencies having jurisdiction thereof. No blasting will be allowed without prior and due notice given by CONTRACTOR to the OWNER, Government authorities, land owners, property occupants, adjacent work crews and other concerned parties. CONTRACTOR shall employ only such workmen who have enough experience in the type of work to be performed, to supervise, and in handling of explosives

Areas to be blasted are to be categorised as follows :

- a) Where blasting is to be carried out beyond 50 metres away from any existing pipelines or structures (either above or below ground) the CONTRACTOR shall submit his proposed blasting procedure and perform a trial blast for the OWNER's approval.
- b) Where blasting is to be carried at a clear distance between 50 and 15 metres from any existing pipeline or structure (either above or below ground) CONTRACTOR shall submit a procedure for controlled blasting e.g. break-holes, slit trench etc. which will also detail out safety



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precautions to safeguard the existing pipeline. This procedure will be approved by the OWNER prior to commencement and performing a trial blast.

- c) Where blasting is to be carried at a clear distance between 15 and 5 metres from any existing pipeline or structure (either above or below ground) Contractor shall submit the procedure for controlled blasting as at “b” above. All other statutory regulations, specification shall be as per concerned chapter for blasting herein.
- d) No blasting is allowed within 5 metres at a clear distance from any existing pipeline or structure (either above or below ground).

Blasting and removal of debris shall be carried out prior to stringing of the pipes.

Ground vibration due to blasting near the existing structures shall be continuously monitored using certified instruments to be provided by CONTRACTOR and approved by the OWNER and the peak particle velocities shall not exceed 50 mm/sec.

The OWNER reserves the right to refuse blasting where possible danger exist to property, existing utilities or other structures. In such locations other methods for extracting rock shall be proposed by CONTRACTOR and shall be approved by the OWNER

Removal of scattered rock and debris caused by the blasting from the ROW and/or adjacent property, shall be performed by CONTRACTOR as part of his work.

CONTRACTOR shall dig the pipeline trench by the method approved by the OWNER.

A daily record of the locations, measurement and quantities of rock trench excavations shall be made by the CONTRACTOR and submitted immediately to the OWNER.

CONTRACTOR shall be responsible for all rock disposals to the OWNER's satisfaction.

10.15. PROTECTION OF TRENCH

CONTRACTOR shall keep the trench in good condition until the pipe is laid, and no claim is to be made to the OWNER by reason of its caving either before or after pipe is laid. All timber, sheet-piling jacks or other materials that may be necessary to shore the trench, in order to prevent caving are to be furnished and removed by CONTRACTOR. CONTRACTOR shall dewater if necessary, using well point system or other suitable systems, shore or do what else might be required to excavate the trench, install the pipe in it and backfill the trench in accordance with these specifications. Where the line is to be laid in sand or earth dunes, the trench shall be cut until firmly packed soil that does not move with the wind and water is reached. Such excavated material is to be removed away from the trench line and disposed off by the CONTRACTOR but shall not be disposed off into the depressions along the ditch line.

10.16. PROTECTION OF UNDERGROUND UTILITIES AND SPECIAL METHODS

CONTRACTOR shall obtain plans and full details of all existing and planned underground services from the relevant Local Authorities and shall follow these plans closely at all times during the performance of work. CONTRACTOR shall be responsible for location and protection of all



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underground lines and structures. In special locations, the use of trenching machine/backhoe may result in damage to property and subsurface structures likely to be encountered during excavation. At such places, CONTRACTOR shall excavate the trench manually to same specifications. Where the pipeline crosses other underground utilities/ structures, CONTRACTOR shall first manually excavate to a depth the utilities/structures are located. Temporary under pinning, or any other type of supports and other protective devices necessary to keep the interfering structure intact shall be provided by CONTRACTOR at his own cost and shall be of such design as to ensure against their possible failure. Despite all precautions, if any damages to any structure/ utility etc., occur, the authority concerned shall be contacted by the CONTRACTOR and repair shall forth with be carried out by the CONTRACTOR at his own expense under the direction and to the satisfaction of the OWNER & the concerned authority. If CONTRACTOR fails to repair in reasonable time, OWNER reserves the right to have the repair executed at the cost of CONTRACTOR.

10.17. ENCROACHMENTS AND WORKING NEAR OTHER UTILITIES

In locations, where pipeline is to be laid in the body of a road, canal, dyke or other locations under jurisdiction of Government/Public Bodies, the CONTRACTOR shall perform such work on obtaining the written permission from the respective Govt./Public bodies under whose jurisdiction it falls without extra compensation, according to the requirement of concerned Authorities. When it becomes necessary that CONTRACTOR has to resort to hand digging, well point, erection of sheet piling or any other special construction method in these areas, no extra compensation shall be paid to the CONTRACTOR. CONTRACTOR shall contact the Authorities concerned in order to become familiar with their requirements. In locations, where the pipeline has to be laid more or less parallel to an existing pipeline, cable and/or other utilities in the ROW, CONTRACTOR shall perform the work to the satisfaction of the Authority of the existing pipeline/ cable/utility. In such locations CONTRACTOR shall perform work in such a way that even under the worst weather and flooding conditions, the existing pipeline/utilities remain stable and shall neither become undermined nor have the tendency to slide towards the trench. CONTRACTOR shall be liable for any damage occurring to, or resulting from damage to other pipelines, under ground structures/utilities.

10.18. PROVISIONS FOR NEGATIVE BUOYANCY TO THE PIPE

CONTRACTOR shall check if up-floating danger is present in open trench and then shall take appropriate measures to prevent up-floating, such as applying soil dams and de-watering of trench or temporary filling of water into the line (in exceptional cases). In some stretches, if up-floating of the pipeline after back-filling is reckoned with, such stretches will be indicated in the drawings. If such stretches requiring negative buoyancy are encountered during construction, which are not indicated in drawing but required in the opinion of the OWNER, CONTRACTOR shall provide negative buoyancy to the pipe as mentioned herein. Floating of the pipeline can be prevented by following method :

- Weighting by applying a continuous concrete coating around the pipe.
- By providing concrete anchor blocks at designed intervals.

Wherever continuous concrete coating is used, it shall conform to the provisions of specifications given in the respective Chapter of this volume unless indicated otherwise in the drawing.



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CHAPTER-11

11. SPECIFICATION FOR LOWERING IN

This specification refers to the lowering-in of the pipelines.

11.1. EQUIPMENT

The Contractor shall supply the equipment necessary for lifting, handling a lowering- in the pipelines and for protecting their coating; the list and the characteristics of the equipment shall be approved by the Engineer.

The lifting equipment shall be provided in sufficient quantity and having strength adapted to the characteristics of the pipeline and to the lowering-in methods in order that the pipelines suffer no unusually heavy stresses during the lowering operations.

The lifting equipment accessories such as roller cradles, slings, wedges shall be such that no damages are caused to the coating.

The dimension and type shall be approved by the Engineer.

Contractor shall provide fitness certificate of machineries proposed to be used for lowering of pipeline. Test certificates of lifting equipment accessories such as roller cradles, slings, wedges shall be submitted by Contractor to the IOC/PMC.

11.2. CAPPING PIPELINE SECTIONS

Before lowering-in a pipeline section, both ends shall be capped in such a way as to prevent stones and earth from entering the pipeline section during the lowering in operations. The caps shall be of a type approved by the Engineer and shall be removed just before welding.

11.3. LOWERING-IN

The Contractor shall carry out the lowering-in immediately after the Engineer has checked:

- The quality and the quantity of lifting and handling machines and devices; width non-abrasive slings or bets shall be used for lowering-in the pipelines. All lowering-in devices and padded skids shall be subject to close inspection to ensure that the coating is not damaged before the pipe reaches the bottom of the trench.
- The good condition of the coating and its quality of insulation; when the pipeline is constructed with previously coated pipes, not lowered-in directly but placed on skids above or beside the trench the quality of the coating shall be systematically checked, and any necessary repairs shall be carried out in conformity with the specification.
- The good condition of the trench; when the coated pipeline is to be lowered-in the bottom shall be free of brushes, skids, piped, crops, rocks, hard lumps of earth or clay, sticks, so that the protective coating shall not be punctured nor abraded.

Before lowering-in the pipelines the trench shall be padded with a minimum 10 cm compacted padding such as sand or a soft material agreed by the Engineer.

Immediately after lowering-in the pipelines, the Contractor shall place 20 cm of soft material over them. Pipe Cover to be measured at each joint before backfilling and level sheet to be maintained for entire pipeline.



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When a flexion laying of the pipeline is authorized the pipes shall be maintained in the middle of the trench by means of sandbags.

Whenever pipeline is laid under tension, as a result of assembly error (for example incorrect positioning of bends in trench), the trench shall be rectified or in exceptional cases a new assembly/pipeline section shall be prepared as per site situation, to be approved by IOCL/PMC, so that it fits the excavation and the laying bed without any stress in the pipe section.

Laying shall be carried out under safe conditions so as to avoid stresses and temporary deformations in the pipeline.

Contractor Shall deploy skilled riggers for lowering of pipeline in safe manner.

Contractor shall submit pipe book upto Joint coating part to Owner's Representative. After certification of the pipe book only lowering in can be started. Prior to lowering in; a complete check by a full circle holiday detector for pipe coating and field joint coating in presence of Owner's Representative shall be carried out and all damages noted shall be repaired at Contractor's cost.

Before pipeline lowering & pipe string, Holiday test shall be carried out at 25 KV

11.4. FLOODED TRENCH

When the trench contains water or mud the trench shall be dried and cleaned before lowering-in any of the pipeline sections.

However, for certain locations of a limited length the Contractor may propose for the approval of the Engineer a procedure which, without drying out the trench enables the pipeline sections to be normally laid in the bottom of the trench.



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CHAPTER-12

12. SPECIFICATION FOR BACKFILLING THE TRENCH

This specification refers to the backfilling of the trench after the lowering-in of the gas pipelines and to the reconditioning of the surface after the completion of the works.

12.1. MATERIALS AND EQUIPMENT

The Contractor shall supply the materials and equipment necessary for backfilling the trench and reconditioning the surface in particular:

- The soft materials necessary for protecting the pipeline when they are not present in the backfill
- New backfill material to replace that which is considered unsuitable by the Engineer
- The materials necessary for reconditioning the surface
- The equipment required for hauling, backfilling, compacting and reconditioning

The materials and equipment, as well as their conditions of use shall be approved by the Engineer.

12.2. BACKFILLING

The backfilling of the trench shall follow the lowering-in of the pipe so that the coating is not exposed to excessive temperature variations and the Contractor shall carry out the backfilling operations as soon as the Engineer has checked in particular:

- The good condition of the coating and any coating's mechanical protection
- The onsite availability materials necessary for the restoration of drains where a crossing over drained areas is involved as well as the onsite availability of warning devices to be installed.
- The quality of the backfill material which has been brought in

12.2.1. Soft Layer (Lower Part)

The pipelines shall be surrounded with sand or approved soft material under on the sides of and above.

Soft layer of stone free earth, coming from the excavated material may also be used for above purpose if suitable. Sifting the earth on the work site shall be forbidden.

The used of salty sands or sands composed of grains with sharp edges shall be forbidden.

In all cases, backfilling shall be carried out to the satisfaction of the Engineer and so that no damage can be caused to the pipe coating.

The trench shall be backfilled to 10 cm above the pipe with light soil or sand. The light soil or sand must be free of all hard objects (stones, gravels, material that has been broken up, etc.) that might damage the coating. Filling in around the pipe must be carried out in such a way that all voids are filled so that later no subsidence of any kind will occur. As a matter of principle, all the different layers of earth shall be replaced as they were excavated.

If the excavated material contains no light soil or sand that could serve for this first backfill without changing the characteristics of the excavated material in relation to the surrounding subsoil, the



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Contractor shall provide for the importation of light soil or sand. The use of salty sand, gravel, coal slag, iron slag, etc. is forbidden.

In certain special cases, the Owner and/or the Engineer may stipulate methods of protection during the course of the works that are better suited to the local circumstances

Back-filling Systems

TYPE OF FILLING SOIL	BACKFILLING SYSTEM
good filling earth	backfill with excavated soil
crushed rocky soil from the trencher	apply geo-textile fabric, min. thickness 8 mm. Fill in with excavated soil
medium rocky soil (1) particles < 30 mm	sand bed of 20 cm in trench bottom (2) apply geo-textile (3) or rock shield (5) fill in with excavated soil max. 0/30
rocky soil with (1) particles > 30 mm	sand bed to 30 cm above and 20 cm under the pipe (2) or non-rotting interlocking wooden lathes, thickness min. 15 mm (4) or geo-textile fabric or rock shield (5) with infill with particles smaller than 30 mm(3) to 30 cm above and 20 cm under the pipe

- Filling method to be approved by Owner and/or the Engineer. Drop height of the filling soil must be limited to the absolute minimum.
- Filling with sand-bed only applicable on flat terrain. On sloping terrain, an alternative protection method shall be used.
- Geo-textile fabric must be approved by the Owner - and/or the Engineer min. thickness 8 mm.
- Non-rotting interlocking wooden lathes, min. thickness 15 mm, must be approved by the Owner and/or the Engineer.
- Rock shield protection must be approved by the Owner and/or Engineer.
- The Contractor is free to propose to the Owner and/or the Engineer another backfilling method which is taking into account the abovementioned remarks as far as the pipeline coating is well protected from any kind of damages.

Only an approved (by the Owner and/or the Engineer) alternative backfilling method is applicable.

12.2.2. Above the Soft Layer (upper Part)

After the soft layer a warning device as specified in the material specifications/ SCC shall be placed 0.20 m above the upper tangent of the pipeline. When two pipelines are to be laid in the same trench the Contractor shall place two warning devices.

Then the backfilling shall be completed with the excavated material by 0.15 m thick layers, each layer being compacted by machines following a procedure approved by the Engineer.

12.3. WARNING TAPE

A warning tape made of 1.0 mm thick and 300 mm wide PE material (Yellow Color) shall be laid as per standard drawing. Warning mat shall be supplied by the contractor.

12.4. TEMPORARY RECONDITIONING

12.4.1. Normal



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Unless otherwise mentioned in the special conditions and/or special specifications the Contractor shall provide a temporary reconditioning, which must be carried out immediately after backfilling and compacting by reusing digging materials; after compacting, the top the backfill shall be 5 cm above the ground level.

12.4.2. Reinforced

Wherever a reinforced temporary reconditioning is required as specified in the special conditions and/or special specifications or as required by the Engineer, the Contractor shall carry out the reconditioning by using of the following means:

- A mixture of earth and cement at 50 kg. Of cement per cubic meter of earth for the last thirty centimeters of the backfill and a 5 cm thick tarmac layer at the surface
- backfilling the trench with sand and then for the last 20 cm at 15 cm thick lean concrete layer and 5 cm thick tarmac layer.

In all cases the Contractor shall remove any excess excavated material occasioned by the earthworks and shall haul it to the agreed dump area.

Any nearby area which have been damaged or weakened by the execution of the trench shall be restored.

The temporary reconditioning shall be performed in such a way that the level does not exceed that of the surrounding ground by more than five centimeters.

The surfaces of backfilled trenches shall be kept constantly fit for traffic until the time of final resurfacing.

12.5. PROTECTION OF BACKFILL

One steep slopes where flowing water is likely to run through the trench, thus wasting out the backfill the Contractor shall install the necessary protection as directed by the Engineer.

12.6. CLEANING

The Contractor shall clean the work site as the backfilling proceeds. Cleaning shall be carried out by means of light equipment so as to minimize public inconvenience.

12.7. FINAL RESURFACING

Unless otherwise mentioned in the special condition and/or special specification and as soon as possible after the backfilling of the trench, the Contractor shall proceed to resurface the land occupied for the execution of the works, the same as the original, in accordance with the relevant authorities' requirements.

He shall clear the ground of equipment, pipe crops and debris of all kinds.

He shall restore to an identical condition, the accesses, fencing, ditches, banks, supporting walls and generally all structures destroyed, damaged or moved for the execution of the works.

12.8. OBSTACLES



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The conditions for executing the backfilling and the reconditioning of the surface where an obstacle is involved are defined in the specification "Obstacle crossings and special passages".

12.9. SETTLEMENT OF DAMAGES

The Contractor shall be responsible for any damage caused to various public or private structures, arresting from the works or access to the site, the occupation of land for installing Contractor's stockyard, offices and workshops.

The Contractor shall make settlement with the owner or relevant authorities and get from them a letter of discharge as formal acknowledgment that the reconditioning and repairs have been properly carried out ; a copy of this letter of discharge shall be given to the Engineer-in-charge.

This document does not release the Contractor from these responsibilities concerning work which may prove to be necessary up until the final acceptance of the installations.

12.10. WORKING SPREAD LIMITATIONS

CONTRACTOR shall, in general, observe the following maximum distances between the working mainline spread:

Between ROW grading, clearing and Trenching	:	03 Kms
Between Welding & lowering	:	02 Kms
Between lowering and Backfilling	:	Only tie-in pits can be kept open with proper barrication
Between backfilling and final clean-up	:	0.5 Kms

The above limitations do not apply to point spreads such as continuous rock blasting, river crossing, etc.

Any deviations from the above shall require prior approval of COMPANY. COMPANY reserves the right to stop the work, in case the approved spread limitations are exceeded and CONTRACTOR shall not be paid any compensation for stoppage of work.



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CHAPTER-13

13. SPECIFICATION FOR TIEING-IN

The unconnected sections of the pipe line 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 overlapping, uncovered pipe of sufficient length to absorb, without inducing excessive stresses in the steel, small displacements necessary for perfect alignment and connection of the ends.

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.

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 radiographically examined.

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 COMPANY.

If a pup end cannot be avoided for tie-in, the minimum length that shall be added is 1.0 meters and two or more such pups shall not be welded together. All cut-off lengths greater than 1.0 meters shall be moved ahead in order to be welded into the pipeline at a suitable location. Tie-in with two or more pups may be used provided that they each have minimum length of 1.0 meter and are separated by an entire length of pipe. In case of requirement of lesser length of pup-piece, approval from EIC/PMC is to be taken, however length of pup-piece should not be less than 500mm in any case.

In connecting pipes, special items, fittings and equipment where different wall thickness are to be welded, CONTRACTOR shall follow the procedures indicated in ANSI B31.8/ANSI B31.4, as applicable. The required tapering shall be done by CONTRACTOR at no extra cost to COMPANY.

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, fittings with different wall thicknesses are readily available

The connection of two the pipeline sections (for golden tie-in welds i.e. joint that is not subjected to hydro test) will be made only after completion of the testing, cleaning and drying of the pipeline sections. The Contractor must submit his job procedure for Owner/Owner's Representative's approval.

All tie-ins Welds (called "Golden Welds") which have not been the subject to Pressure Final Testing shall be 100% Radiographic and ultra-sonic controlled (steel Welds) and tightness tested under gas pressure (all Welds/joints) in presence of Owner/Owner's representative or Third Party Inspection Agency and duly 3.2 Certified.

If any trench is required to be re-excavated for Tie-in joint, it shall be done suitably by contractor without any additional cost.



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CHAPTER-14

14. SPECIFICATION FOR OBSTACLES CROSSING AND SPECIAL PASSAGES

This specification refers to the crossing of obstacles encountered during the pipeline's construction. In addition to this chapter, CONTRACTOR to refer chapter 16 (Specification for Pipeline Crossings) for detailed specification for crossing work.

14.1. WORK SCHEDULE

In order to reduce as far as possible, the duration of the works and to cause the least disturbance to users, the Contractors shall indicate in his general work schedule the most convenient time for crossing the obstacles according to their nature.

The Contractor shall follow the requirements of the relevant authorities or owners of the roads, above ground structures and buried utilities, which may direct traffic the procedure of crossing the resurfacing of the grounds, the safety measures, etc.

The Contractor shall be responsible for any damage and accidents which may arise from disturbances brought to the traffic and to the safety of the roads to the flow of water to the various utilities or be caused by the non-observance of the above mentioned requirements.

14.2. NOTIFICATION OF THE RELEVANT AUTHORITIES OR OWNERS

Before beginning the works the Contractor shall notify in writing the relevant authorities or owners a copy of this correspondence shall be sent to the Engineer.

14.3. CROSSING OR ABOVE GROUND OBSTACLES

14.3.1. Crossing of Railways or Highways

The crossing shall be carried out:

- by horizontal boring using steel casings
- or horizontal directional drilling (HDD)
- or in a trench with or without casing as required

The above crossing can be done as per method, approved by concerned authority.

14.3.2. Boring and crossing with steel casing

The Contractor shall study each crossing to be executed by boring in order to take adequate measures adapted to actual conditions of crossing.

The length of boring shall be limited to the accuracy of the boring equipment and the possibility of the Contractor to install the coated pipe inside the crossing without damaging the coating.

The Contractor shall carry out the necessary excavation work for the installation and operation of the boring equipment.

The Contractor shall be responsible for the good hold of the structure over the boring and shall carry out all the necessary reinforcing work such as planning, sheeting-piles bracing and propping.



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The depth of the boring shall be such that in all cases a minimum distance as stipulated in SCC/approved drawing is kept between the crown of the casing and the level of the railway or highway surface.

The steel casing shall have an outside diameter of at least fifteen (15) cm. Larger than the outside pipe diameter or as approved in crossing drawing; it must be perfectly water-tight rectilinear and welded without internal burring.

Should the casing not be supplied by the Company, its wall thickness and grade of steel shall be approved by the Engineer as per specification.

The casing shall be extended up to the limit of the right-of-way of the railway or the highway.

A double coating with outer wrap if required shall be applied along the whole length of the pipeline contained within the casing and shall be extended beyond the casing by one meter on both sides.

Insulators shall be fit on the coated pipe so that:

- The distance between insulators takes into account the weight of the pipe filled with water and the load permissible per insulator.
- An insulator is placed as near as possible to the ends of the casing and is doubled by a second insulator at the most fifty (50) cm away.
- The portion of the anchor bolts extending beyond the insulator after being tightened shall be cut off in order to prevent any contact with the casing.

During the sliding into the casing, the advance of the pipe section must be progressive and controlled so that the coating is not damaged.

Immediately after sliding the pipeline into the casing, end seals shall be fitted at both ends of the casing and fixed by solid stainless steel straps.

Both ends of the casing shall be equipped with vent pipes in accordance with typical attached drawing.

Immediately after completion of the crossing, the contractor shall proceed to apply an electrical insulation test and any insulation defect discovered shall be sought out and repaired to the satisfaction of the Engineer.

14.3.3. Crossing in open trench with steel casing

The crossing of highway in open trench shall be carried out in two sections or more to allow the continuity of traffic, as requested by the relevant authorities.

The specifications for digging, backfilling and reconditioning shall be applied and the contractor shall make provisions in excavating the trench to keep the minimum distance of one meter or as per SCC/approved drawing whichever is higher between the crown of the casing and the road surface.

14.3.4. Crossing in open trench without steel casing



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The specifications for digging, lowering-in, backfilling and reconditioning the road surface shall be applied.

A double coating with outer warp shall be applied on the pipe if required.

The Contractor shall provide temporary bridges, traffic and warning signs, flashing lights, fencing, etc. including provisions for watchmen as required by the relevant authorities.

14.3.5. Crossing of Canals

Canals shall be crossed in open trenches dug in the streambed, in such way that the distance between the upper tangent of the coated pipe and the cleaned out bottom to its normal depth is at least equal to 0.80 m according to the depth of the ditch or canal.

This distance may be reduced to 0.50 m with the agreement of the Engineer.

The flow of water shall be diverted by means of temporary ducts or canals.

The specifications for digging shall be applied.

A reinforced concrete slab at least 0.10 m thick shall be laid over the soft earth or sand layer of backfill above the pipe.

The dimensions of the slab shall be :

- width : pipe OD plus 0.40 m.
- Length : ditch or canal width plus 0.40m

The structure of the ditch or canal shall be reconditioned.

The reconditioning of the drainage and irrigation canals includes the works and supply of materials and equipment required to return these canals to their water-tight condition (concrete or clay structures, sheeting piles, etc).

Should the Contractor for his own convenience request the concerned authorities to move or put out of service an electric or telephone line, he shall bear all the corresponding expenses.

14.4. CROSSING OF UNDERGROUND OBSTACLES

14.4.1. Cables, Pipelines and Other Utilities

The Contractor shall be responsible to verify the existence and location of underground obstacles and utilities along the route of the trench.

The use of mechanical excavation shall be restricted in sections of the route where such ditches or utilities are located.

The Contractor shall make all provisions to increase the size of the trench according to the size of the encountered obstacle in order to allow sufficient working space and maintain the specified clearance between the pipe and the crossed underground obstacles and utilities.

The minimum clearance should be as shown in typical drawings or drawings approved by EIC.



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The minimum clearance be reduced for any reason, the Contractor shall install adequate mechanical protection agreed by the Engineer-in-Charge.

14.4.2. Masonry Work

As far as possible, any masonry work encountered shall be crossed in such a manner that a minimum clearance of 20 cm be left.

If a pipeline passes through a masonry work a plastic sleeve, with the agreement of the concerned authority or owner, shall be placed In the masonry.

The specifications for lowering-in, backfilling and reconditioning of the surface shall be applied.

The Contractor shall inform the Engineer, and the relevant authorities personal wherever the above obstacles and utilities are encountered. All damages or injuries to these works shall be immediately repaired to the satisfaction of all the concerned parties.

The Contractor shall provide all the necessary traffic and warning signs fencing, safeguards to prevent damages and injuries to the roads and street users.

14.5. PARLLEL ROUTES

In case of parallel routes for a gas pipeline and other utility, a minimum distance of 0.40 m shall be left between the lines one the horizontal plane of the gas distribution pipeline ; the minimum distance between two gas pipelines shall be 0.30 m.

If necessary, this minimum distance can be less than specified here above, upon the approval of the concerned authorities and of the Engineer-in-Charge.

14.6. SPECIAL PASSAGES

When a gas pipeline is to be placed at the side of a structure such as a bridge, building, wall etc. the pipeline can be placed:

- On supports, with or without casing
- Suspended directly or in a gutter
- Fixed to the wall by collars and mechanically protected.

The construction drawings derived from all justificatory calculations shall be drawn up by the Contractor and submitted to the Engineer for approval in accordance with the provision of the specification "Documents drawn up by the Contractor"

The number, dimension, shapes and distribution of the supports, shall be studied and designed, account being taken of the nature and shape of the supporting, structures the value of climatic stresses (wind, ice, snow) of vibration phenomena (excess dynamic pressure, traffic etc.)

14.6.1. Supported Pipeline

Metallic supports shall be fixed onto the structure

The supports shall have:



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- A sliding surface to enable movement in any direction in the plane of the pipeline
- Side stops to prevent the pipeline from falling.

A plastic material shall be placed between the pipeline and the sliding surface of the support, allowing:

- The lengthwise movement of the pipeline, in order to prevent it from leaving its sliding plane.
- The sideways movement of the pipeline without it being able to rock against nor touch the support stops
- The electrical insulation of the pipeline

The plastic material can be either fitted on the supports or wound around the pipeline

14.6.2. Suspended Pipeline

In this case, metal cradles shall be sealed within the masonry.

A plastic wrap shall be wound around the pipeline, at each cradle, allowing:

- the lengthwise movement of the pipeline
- the electrical insulation of the pipeline from the cradle

The diameter of the cradles shall be adapted to the pipeline diameter in order to maximize the contact surface between the pipeline and each cradle.

When the pipeline is placed in a suspended duct, the pipeline shall be electrically insulated from the duct.

14.6.3. Pipeline Fixed by Collars

When a pipeline is fixed onto a wall by means of metal collars, the pipeline shall be electrically insulated from the collars by a plastic adhesive tape wound around the pipe or by any other insulating device approved by the Engineer.

If required by the Engineer the pipeline shall be mechanically protected against possible damage. The protecting device shall be metallic and electrically insulated from the pipeline.

14.6.4. Galleries

In case a gas pipeline is to be placed in gallery, it shall be fixed onto the wall by means of supports, cradles or collars or any other device approved by the Engineer. The pipeline location within the gallery shall be determined by the Contractor in accordance with this specification and in agreement with the concerned authorized requirements.

The gallery shall be visitable and ventilated; the Contractor shall provide the necessary mechanical protection of the pipeline at the gallery crossings and passage intersections.



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CHAPTER-15

15. SPECIAL INSTALLATIONS ON THE PIPELINE.

15.1. General

In addition to constructing the pipeline, CONTRACTOR shall also install certain other auxiliary facilities and appurtenances.

CONTRACTOR shall do all work necessary at each of the installations to provide facilities which are complete in all respects and ready for operation.

Without limiting the generality thereof, the work required to complete the installations shall, where applicable, include all site surveys, site preparation, filling, grading, fencing, foundations, installation of block valves, side valves, pipe work, pipe supports, pressure gauges, mechanical facilities, civil work, painting, installation of all electrical equipments, motors, cables, conduit, wiring and fixtures and hooking up of same; installation of all instruments, piping, valves and fittings; mount all instruments and make all piping and electronic connections, etc.

On completion, all elements of each installation shall be checked out and tested for full and correct operation in the presence of and to the satisfaction of COMPANY. All work shall be carried out strictly in accordance with the appropriate codes, the approved drawings, and this and other related specifications.

CONTRACTOR shall fabricate all piping and install valves and fittings as required by the detailed engineering drawings prepared by him and approved by COMPANY.

Stainless steel lines will be "swaged" using permanent fittings installed with a hydraulic device.

CONTRACTOR shall ensure that the piping assemblies are not in a strain prior to the final bolting or welding. CONTRACTOR shall also ensure that all equipment and piping are thoroughly swabbed clean of all dust, refuse, welding-splatter, scale, or any potentially detachable matter prior to the tie-in or final bolting.

15.2. Dimensional tolerances.

These tolerances apply to in line items and corrections for other lines. These tolerances can be executed on items such as vents, drains, dummy supports, field supports, temperature and pressure connections, where the deviation will not affect another spool.

General dimension such as face to face, face or end to end, face or end to center, and center to center : ± 3 mm.

Inclination of flange face from true in any direction: 4 mm per meter.

Displacement of branch connection from indicated location: ± 1.6 mm. When multiple branches are involved, the displacement of the branches shall not exceed 3mm from a common point.

Rotation of flange bolt holes shall not exceed 1.6 mm.



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15.3. Flanged connections.

CONTRACTOR shall ensure that all flange faces are parallel and centered, according to standard practice, prior to final bolting. CONTRACTOR shall not use bolting forces as a means for attaining alignment. A gasket of proper size and quality shall be installed between the flanges at each joint.

Bolts shall be tightened in diagonal sequence and shall be centered with equal amounts of thread visible on both sides. Bolts shall be uniformly tightened to produce a leak-proof joint. Bolts that yield during tightening shall be removed and discarded. It is mandatory that a torque wrench is used for bolt tightening.

Threaded connections.

Damaged threads shall be cut from the end of a run and the pipe shall be rethreaded.

CONTRACTOR shall properly align all threaded joints. Pipe entering unions shall be true to centreline so the union will not be forced during tightening. The threaded pipe shall not project through fittings to cause interference with valves or other operating mechanisms.

Except for the threaded connections of instruments, which will require periodic testing and maintenance, all threaded connections shall be seal welded. The latter joints shall be made up without pipe joint compound and with a minimum of oil from the threaded cutter. Seal welds should taper into the pipe with as little discontinuity as possible and should cover all threads.

Welded connections

Where the Ends of the piping components being welded have an internal surface misalignment exceeding 1.6mm, 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 the specification "Specification for welding of pipelines and related facilities".

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

15.4. Civil Work

Civil work shall be provided in accordance with Specifications issued for the purpose.

15.5. Painting

All exposed surfaces like piping, valves, structures, and miscellaneous appurtenances shall be painted in accordance with the specifications issued for this purpose. The corrosion coating on pipe surface will extend approximately 0.3 meter above the finish grade and it will be necessary for CONTRACTOR to provide a clean interface at the junction of the protective coating and the paint.

15.6. Coating of buried-Installations, etc.

All buried valves, insulating joints, flowtees, bends, other in-line fittings and appurtenances shall be coated with minimum three coats of High build epoxy coatings. Powercrete R-95 or equivalent as per EN 10289 2004 or any other equivalent suitable COMPANY approved coating at no extra cost to the COMPANY. For buried pipes heat shrink tapes conforming to COMPANY's specification shall be



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used. CONTRACTOR shall submit to COMPANY a report used alongwith all the test certificates. Only after obtaining written approval from the COMPANY, CONTRACTOR shall commence the work of coating.

15.7. Clean-up

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.

15.8. Installation of Valves and Valve Stations

Block and sectionalizing valve stations shall be installed as shown on the approved drawings. It is CONTRACTOR's responsibility to have the units completely assembled, tested and made fully functional including all related instruments etc. Tender drawings for valve assembly are only for reference purpose, CONTRACTOR shall fabricate valves assembly as per drawing by EIC at the time of pipeline construction. No additional cost shall be paid due to change in drawing of valve assembly.

Care shall be taken to avoid entry of sand particles etc. to valve body, seals etc. during transportation, storage, assembly and installation.

For valves and piping installed below ground and/or above ground, the anti-corrosion coating/painting shall be as per the requirements of the relevant specifications issued for the purpose. The anti-corrosion coating below ground shall extend upto 300mm above grade at the lowest point.

Sectionalizing valves shall be installed on sections of the pipeline in the horizontal position only or with an inclination not greater than that allowed by the valve manufacturer. Installation shall be done in such a way that there is no strain in the welded joint while the pipeline at upstream and downstream sides are straight.

During the fabrication of valve assembly or execution of the in-line connection welding, the propagation of heat to the valve body (ball seat & seal) shall be avoided. To achieve this, the joint shall be kept cold by means of nags/gunny bags continuously wetted.

All valves shall always be handled using equipment and methods to avoid impact, shaking and other stresses. In particular, the equipment and tools for lifting and handling shall never be done through hand wheel, valve stem, joints and other parts which may suffer damage.

All sectionalizing valve and any other inline assemblies shall be prefabricated and tested hydrostatically & pneumatically (using air or nitrogen for seat/seal test) ex-situ as per applicable specification/API-6D. If any seal/seat leakage is found, same shall be repaired by contractor in coordination with valve manufacturer at no extra cost to the IOCL. If valve is Non-repairable the same should be replaced with fresh valve and the assembly shall be tested again at no additional cost to IOCL. All such assemblies shall be installed at the locations shown in the drawings only after successful completion of the hydrostatic test and dewatering. Thereafter the ends of the assembly shall be closed off. CONTRACTOR shall carry out necessary excavation, cutting, bevelling and welding of the tie-ins required for the installation of such assembly. The tie-in joints shall be radiographically examined over 100% length and/or 100% ultrasonically examined prior to backfilling. All works shall be executed in accordance with the relevant specifications issued for the purpose.



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The civil and structural work shall be carried out in accordance with the relevant specifications issued for the purpose and in accordance with the approved drawings as directed by COMPANY. This work as a minimum shall include clearing, grading, fencing, foundations, etc, as required. All above ground structures shall be painted as per the specification and colour code given by the COMPANY.

If required, a suitable concrete foundation as directed by COMPANY shall be constructed on which the valve shall be firmly installed, after embedding an insulating sheet of hard polyethylene with a thickness of atleast 5mm or equivalent. Such insulating sheet is also to be installed under pipe clamps, between walls of chamber is steel pipeline etc.

Valves with flow arrows shall be installed according to the normal flow in the pipeline. During, welding, the valves shall be in fully open position. In addition all manufacturer's instructions shall be followed..

GENERAL DIMENSION

- Minimum clearance between any element of valve assembly and valve chamber floor-20 cm.
- Distance between upper generatrix of main pipeline and road pavement surface must be at least equal to the contract defined cover.

Inside Dimension of a valve chamber

The inside dimensions must allow:

- The installation and/or operation of the various valve assembly components (pipes, valves, fittings, valve motorizations).
- The movement of maintenance and operation staff.

CIVIL WORKS

The civil and structural work shall be carried out in accordance with the relevant specifications issued for the purpose and in accordance with the approved drawings as directed by COMPANY. This work as a minimum shall include clearing, grading, fencing, foundations, etc, as required. All above ground structures shall be painted as per the specification and colour code given by the COMPANY.

Concrete:

As per applicable standards.

General Water Tightness

The valve chamber has to be water proof the side walls and bottom have to withstand an outside hydrostatic pressure of at least 1 bar.

Camber Covering

- Must generally speaking, comply with distribution granting Authorities specifications and/ or recommendations.



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- Must be water tight.
- It includes an access cover, less than 60kg. to enable access, by a man-through a standing ladder into chamber.
- Must be able to support a maximum load of 25 tons, its design has to be such as to allow top side to be filled with the same material as the surface, roadway of pavement (concrete, asphalt, slabs etc.).
- Must be lockable and withstand external efforts.
- Must bear the mark "GAS".

15.9. Installation of Scraper Launchers and Receivers

Scraper stations shall be fabricated and installed as per the approved drawings and whenever applicable as per the requirements of clause 15.8 of this specification. It is CONTRACTOR's responsibility to have the units completely assembled, tested and made fully functional including all instruments & related piping.

The civil and structural works for the scraper stations shall be carried out as per the relevant specifications, in accordance with the drawings and as directed by the COMPANY. The work as a minimum shall include site survey, site preparation, clearing, grading, fencing, foundations, etc. as required.

It shall be CONTRACTORS responsibility to maintain elevations shown on the approved drawings and to carry out any pipework adjustments, necessary for this purpose. Field cuts shall be square and accurate and field welds shall not be performed under stress of pipe ends.

The painting for the scraper stations shall be carried out as per "Specifications for Painting". The underground sections shall be coated as specified for the pipeline upto atleast 300mm above grade.

The hydrostatic testing of the scraper stations shall be executed after installation in accordance with the relevant specification issued for the purpose.

15.10. Installation of Insulation Joints

Insulation joints shall be installed at the locations shown in the drawings.

CONTRACTOR shall obtain approval from the COMPANY before installation of the insulation joints.

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.

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

The in-line inserting shall be made on the buried pipeline; care shall be taken to operate at an external temperature as close as possible to the pipeline operating temperature.

The joints shall be inserted on straight sections and laid on a fine sand bed.



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During the execution of the in-line connection welding, the propagation of heat shall be avoided. To achieve this, the joint shall be kept cold by means of nags continuously wetted.

Insulating joints shall be electrically tested before welding into the pipeline. The electrical conductance test shall be carried out using a Megger. Measurement of the insulation resistance across the joints shall be approx. one (1) Mega Ohm. The tests shall be repeated after installation and welding of the joint into the pipeline to verify that the assembly is undamaged.



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CHAPTER-16

16. SPECIFICATION FOR PIPELINE CROSSINGS

The CONTRACTOR shall assist to obtain necessary permission for laying the pipeline across roads, rail roads, and water course crossings including canals and all other crossings falling enroute from the authorities having jurisdiction. CONTRACTOR shall make all arrangements for safe-guarding the roads, etc. and the verges and/or banks thereof and the buried services with appropriate provisions. Highways, Main-roads and Rail-roads and their verges and banks of water course 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 OWNER and the concerned authorities. CONTRACTOR shall never unnecessarily hamper the interest of the users of the roads, rail-roads, buried services and/or water courses. The water flow shall not be dammed. CONTRACTOR shall prepare detailed report for all major water course crossings and cased crossings, containing the following :

- Time schedule
- Working method with equipment
- Test procedure
- Manning
- Calculations of temporary works
- Soil investigations, wherever required
- Any other survey/investigation/ report pertaining to crossings required by the OWNER.

Such works shall be carried out without any extra cost to the OWNER. These all are required to be approved by the OWNER before commencing the work.

16.1. RAILWAY, ROAD & CART-TRACK CROSSINGS

16.1.1. The work under these crossings shall include necessary clearing, grading and trenching to the required depths and widths, welding of casing (if required) and carrier pipes, radiographic inspection of welds, joint coating, hydrostatic testing of carrier pipe, lowering-in, backfilling, clean-up, restoration to the original condition and further strengthening and protective works, testing, installation of assemblies, insulators and seals, vent pipes & vent pipe tops and temporary work such as sheet piling, bridges, etc.

The work shall be carried out in accordance with the approved drawings issued by the OWNER and job standards, as directed by the OWNER and to the satisfaction of the OWNER and the authorities having jurisdiction over the facility crossed. The work carried out for road & rail-road crossings shall meet the minimum requirements of API RP 1102, latest edition.

The section of the pipeline used for the cased crossings shall be hydrostatically tested at a pressure producing as per requirement of PNGRB T4S or at 75bar prior to installation and as per specifications mentioned in the relevant chapter of this section. Test pressure shall be retained in the pipeline for minimum 4 hours duration. Testing shall be carried out before field joint coating.



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Before the installation work of crossings is started, the CONTRACTOR shall provide suitable barricades, temporary bridge/by pass work (especially where roads/cart-tracks are open-cut) with railing, if required by the OWNER for safety of traffic. Adequate traffic warning signals and/or traffic lights and suitable diversions shall be provided as directed by the OWNER/Authority having jurisdiction over these areas. Such diversions shall not cross the pipeline where it has already been installed, unless proper safeguarding at the OWNER's opinion is ensured. In approaches to road and railway crossings, CONTRACTOR shall eliminate unnecessary bending of pipe to conform to the contour of ground by gradually deepening the ditch at such approaches without any extra cost to the OWNER. The pipe at the crossing shall be laid straight without bends. In case of open cut road/cart track crossing, CONTRACTOR shall restore the road/cart track immediately after lowering and backfilling.

16.1.2. Cased crossings

In all cases concerning railways, highways or heavy traffic road crossings, whenever the Competent Authorities do not permit open excavations, the casing installation shall be carried out by boring or jacking, unless this is impossible because of the nature of the ground. For cased crossings, 3 LPE/ 3LPU (external three-layer high performance poly-urethane coating) coated carrier pipes shall only be used and separate detailed drawings issued by the OWNER for individual crossing shall be applicable, including all further related specifications.

Before start of the boring/jacking, CONTRACTOR shall execute a soil investigation and determine the ground water table level in proximity of canals or at crossings where deep excavation in unstable soil is required. Based on these investigations CONTRACTOR shall review the construction drawings. During the execution of the 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 regularly to be inspected and rendered by CONTRACTOR and reported to the OWNER. To safeguard the stability of the bore-pit, CONTRACTOR shall, if necessary in the OWNER's opinion, use a closed sheet piling which shall extend at least over 50% of the depth in undisturbed soil. If the boring pit is less than 7 m deep, the contractor may use trench boxes or shoring, as well as sheet piling. The length of the boring shall be in accordance with the width of the crossing (road, railroad, etc.) on either side with minimum 0.6m extra.

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. The backfill in the boring and exit pits shall be compacted in 15 cm layers to 90% modified proctor density using mechanical compactors. If the excavated soil is not suitable for compaction, it shall be replaced, or mixed as appropriate, with imported backfill that will reach the required compaction. The pits will be de-watered before backfilling and compaction. Compaction shall extend from the bottom of the pits to the underside of the carried pipe. An acceptance report shall be prepared for each cased crossing, signed by the CONTRACTOR and OWNER's inspector, certifying that the specified compaction has been achieved. In addition, the CONTRACTOR is explicitly responsible to procure any geo-technical data required at each cased crossing site to adhere to these procedures, as well as identifying other mechanisms of potentially significant differential settlements, such as may occur from changes in soil moisture contents.



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The diameter of the hole for a bored section shall have a hole diameter as close as practicable to the outside diameter of the casing pipe. If excessive void or too large hole results, or if it is necessary in the opinion of the 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 the OWNER. Equipment used for installation of casing pipe shall be of the type approved by the OWNER.

Welding of the carrier, casing and vent pipes shall be carried out in accordance with the welding specifications given herein and as per API-1104. Before welding, the single length of each 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. 100% radiographic inspection of weld joints of the carrier pipe shall also have to be carried out.

The outer surface of the casing pipe shall be painted with two coats of anti-corrosive bitumastic paint over a coat of suitable primer. It shall be insured that the paint is dry before insertion of the pipe.

Vent pipes with tops shall be provided on both ends of the casing. The assembly of vent pipe units as approved by the 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.

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.

Insulators, as approved by the OWNER, shall be securely fastened to the pipe with interlocking system and fixtures firmly tightened. The number of insulators and spacing shall be as shown in the approved for construction drawings or at 1.0 metres c/c (whichever is more stringent). At the end of both sides of the casing, a double set of insulators shall be installed.

In case HDPE conduit (for OFC) installation work or MDPE Pipeline is included alongwith Mainline in the scope of work, HDPE Conduit/MDPE Pipe shall be firmly secured with Carrier pipe, by suitable means, after fastening of insulators on the carrier pipe. The orientation of insulators shall be so kept to facilitate proper fixing of the HDPE conduit/ MDPE pipe with the carrier pipe.

Before casing end seals are placed, the annular space between the casing pipes and the carrier pipes, at both the ends, shall be packed tightly with jute and bitumen. Casing end seals shall then be provided at both ends of the casing (already tightly packed with jute and bitumen) for sealing the annular space between casing pipe and carrier pipe so as to prevent ingress of moisture / water. Application Procedure for Casing End Seal with Duct and OFC cable as per relevant specification chapter shall be adopted.

The Procedure for Installation of casing end seal with Duct and Fibre Optic Cable shall be demonstrated at site and approved by Manufacturer's authorised representative. The presence of



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manufacturer's representative for procedure demonstration and qualification of skilled personnel shall be ensured by Contractor which is mandatory before further applications of casing end seal is carried out. Only skilled personnel who have been qualified in presence of manufacturers representative shall be allowed to carry out the work.

CONTRACTOR shall provide insulators, end seals, vent pipes & vent pipe tops as per the specifications stipulated in the bid document and exhibit drawings.

Care must be taken in pushing or pulling carrier pipe alongwith HDPE conduit & OFC or MDPE Pipe or both (wherever applicable) into the casing so that the pipe is centred in the casing and that the pushing or pulling force is evenly and constantly applied. Therefore, no internal high/low may exist to avoid damages to the insulators and / or the HDPE conduit/MDPE Pipe. A nose piece having a diameter of the pipe shall be welded on the front end of the carrier pipe to facilitate installation of the carrier pipe properly in the casing and to keep it dry and clean.

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 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. These tests shall show at least a resistance of 1 (one) Mega ohm. After backfilling and compaction, additional tests shall be conducted to determine if the casing is electrically shorted to pipe. If the installation is found to be shorted, CONTRACTOR shall make the necessary corrections and repairs at his cost, unless a test to the satisfaction of the OWNER is obtained.

At the cased crossing locations, the earth has to be properly compacted, upto 90% Proctor density, to a distance of minimum 12.0m from the end of casing pipe on both the sides, so as to ensure that the carrier pipe rests firmly on the earthen base so compacted & does not undergo any differential settlement with respect to the pipeline section lying within the casing pipe. A suitable RCC support for supporting the carrier pipe shall be provided at 2 m from the end of casing pipe on either side of cased crossing. The height of support shall be decided as per site requirements. Sand bags / other cushioning material like neoprene rubber sheet shall be placed between pipe and top of RCC support so that there is no damage to pipe/ coating and the carrier pipe shall firmly rest on the same.

The Carrier pipe shall be brought to the desired level for crossing by providing natural gradient in trench excavation from sufficient distance. Field bends, for meeting the mainline trench gradient on either side, shall be avoided so as to keep provision for any future widening of Highway / Railways.

Refer clause 16.8 for specification of material used in Cased Crossing

16.1.3. Uncased crossings (open cut)

Across minor roads/cart-tracks the pipeline shall be laid by open cut method as per the general specifications stipulated in clause 16.1.1 herein. Uncased road crossings shall be deemed to be part of the mainline and all specifications shall be accordingly applied. Uncased road/cart-track crossings shall be provided with heavy wall thickness pipe, if required, except few cart-tracks where nominal wall thickness pipe shall be provided as per the details given in construction drawings.



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For uncased crossings, exhibit drawings issued by the Owner and all further specifications shall be applicable.

16.2. CROSSINGS FOR UNDERGROUND FACILITIES

The pipeline under construction shall pass 500 mm below all 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 are guaranteed. The minimum clearance required between pipeline and the existing facility shall be 500 mm.

Whenever buried services in the ROW are to be crossed, CONTRACTOR shall safeguard the buried facilities and the required protecting precaution shall be executed as approved by owner.

For buried services to be crossed by boring, if necessary, the provisions laid thereon in clause no 16.1.2 shall apply.

16.3. MINOR WATER COURSE CROSSINGS

Minor water course crossings are the crossings with ponds, ditches, water courses, minor rivers, streams etc. whether the bed(s) contain(s) water or not, and not being specified as major water course crossings as per clause no. 16.4 herein.

Normal carrier pipe shall be used for such crossings and construction specification shall be as mentioned in subsequent paragraphs.

For minor water course crossings, exhibit drawing issued by the OWNER and all further specifications shall be applicable.

Before start of construction, Contractor shall prepare construction drawing, work method to be adopted to safeguard the existing facilities and time schedule to be approved by Owner.

NOTE : MINIMUM DEPTH OF COVER OVER THE PIPE SHALL BE 1.5 M.

Whenever minor water course in the ROW are to be crossed, CONTRACTOR shall install bridges temporary by pass work and further comply with the provisions as laid down in this specification.

In crossings of water courses with either moderate flow rate or of torrential nature with marked and unpredictable flooding, an adequate survey shall be carried out before starting the work with the object of determining what precautions are necessary and the most favorable period for executing the work.

In case of crossings of water courses for which no special methods of laying are required, a pipe section of a size as per the approved drawings shall be assembled and subsequently laid. Bends shall be as per OWNER requirement.



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Before start of construction, CONTRACTOR shall execute soil investigation for the minor water courses to adopt construction methodology safeguarding the existing facilities and shall prepare construction drawing, work method and time schedule to be approved by Owner.

The depth of the existing bottom of a minor water course crossing shall be determined in relation to the adjacent ground level by taking the average of minimum four measurements.

CONTRACTOR shall take special care to check with the responsible authorities for special conditions applying to working on, over, under or through minor water course crossings and CONTRACTOR shall comply with any such conditions. Written arrangements with authorities shall be drawn up in co-operation with the OWNER.

The CONTRACTOR shall arrange temporary installation of diversions as may be necessary, to ensure the effective functioning of these water courses crossed, to the entire satisfaction of the concerned Local Authorities as well as the OWNER.

Banks and trenches of minor water course shall be backfilled with soil which is to be approved by the OWNER and be thoroughly compacted to prevent soil and bank erosion as per the drawings and standards to the satisfaction of authorities having jurisdiction thereof and the OWNER. After the trench has been backfilled and during the clean up works, the minor water course crossing shall be cleaned at least across the whole width of the ROW. In case of lined canal/water course crossing the contractor shall restore immediately the lining of the canal/water course upto the satisfaction of the concerned authority and OWNER. In case, of failure to do so the OWNER reserves the right to restore the same at the risk and cost of the CONTRACTOR.

Minor water course crossing shall be deemed to be part of the mainline and shall be paid therefor accordingly without entitlement to any extra compensation. However, concrete sheathing, rock shield, if specified, shall be paid extra in accordance with the relative item in the Schedule of Rates.

16.4. MAJOR WATER COURSE CROSSINGS

Contractor shall do and perform all work necessary to lay the pipeline underground across the major water courses (major canals/ rivers) classified specifically as submerged crossings. Contractor shall be compensated for submerged crossings in accordance with the relative item in the Schedule of Rates.

Pipes shall be laid horizontally under the major water courses/ river bed from the fixed line point and if sag bends are required they will be set for into the bank. The cover over the pipe from the deepest bed level as specified in the relative drawing shall be provided. The pipes used for these crossings shall be extra heavy or normal wall pipes as stipulated in the construction drawings. Concrete weights as shown in the relative construction drawing shall be provided by the contractor, and these shall be paid for in accordance with the relative item in the Schedule of Rates. It may be mentioned that all welded joints in these crossings shall be (100% of the weld joints) radio-graphically inspected. Prior to commencement of the work, the contractor shall execute soil investigation for the major water course wherever felt necessary by him to adopt construction methodology safeguarding the existing facilities and submit to the OWNER for approval an outline of its proposed methods for the installation of these submerged crossings. Approval by OWNER of



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the methods used by the contractor shall not relieve the contractor of sole responsibility for the crossing installation operations.

The clauses and sub-clauses mentioned hereof specify the minimum requirements for the various activities to be carried out by CONTRACTOR for the execution of Major water course crossings. Unless specified otherwise, the requirements for the construction of cross-country pipelines as per this specification shall also apply for major watercourse crossings.

NOTE : MINIMUM DEPTH OF COVER SHALL BE KEPT AS 2.5 M OR AS INDICATED IN THE APPROVED DRAWINGS.

16.4.1. Construction

The CONTRACTOR shall review all the drawings issued by the OWNER before its implementation for construction so that the CONTRACTOR shall in no way be relieved from the sole responsibility for safe and satisfactory installation of the crossings.

CONTRACTOR shall comply with all the conditions and requirements issued by authorities having jurisdiction in the area where the work is to be performed. If no public roads exist, CONTRACTOR shall arrange for space for his work area at no extra cost to the Company.

CONTRACTOR shall excavate the trench in all kinds of soil including rock for the water course crossing in conformity with the drawings. Excavation of the trench shall be executed as accurately as possible. The equipment deployed and work method applied shall be approved by the OWNER and the authorities involved. The trench shall be excavated by suitable methods to such depth as required to provide the minimum cover and the pipeline configuration as specified. The trench shall be subject to inspection by the OWNER prior to installation of the pipe. As far as applicable, other construction operations (grading through final clean up) shall be done in accordance with the requirements of the applicable sections of this specifications. The pipeline profile of the crossing shall be followed as accurately as possible. Before laying, the trench shall be cleaned and levelled. CONTRACTOR can not request a compensation if his work is hampered or delayed due to weather conditions or any obstacles.

CONTRACTOR is fully responsible for the execution of the blasting, if any, excavation-work, hopping of the spoil, transportation, dumping on land or in water, all to be executed in agreement with authorities, land owners and the OWNER. Any damage suffered by CONTRACTOR due to the presence of obstacles and/or materials causing hindrance, shall pertain to CONTRACTOR's risk. The interests of the land users shall be reckoned with in the widest sense, including the water surfaces where dredging work is executed. All safety measures and instructions prescribed by authorities or the OWNER shall be precisely executed by CONTRACTOR and his personnel. CONTRACTOR shall take care of the necessary permits, if any.

CONTRACTOR can be obliged to 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



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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 the OWNER.

Immediately before installation of the water course crossing in the excavated trench, CONTRACTOR shall prepare a profile of the trench bottom along the surveyed centre line of the water course crossing for comparison with the reference profile. CONTRACTOR shall also make cross-sections of the trench at intervals of not more than 10m. All profile and cross section measurements shall be taken as specified and shall be witnessed by the OWNER. These data shall be submitted to the OWNER for approval and the OWNER will approve or reject the trench excavation as completed. CONTRACTOR shall grade the trench in such a manner so 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 5.0 m. In submerged sections, where rock or gravel is encountered in the bottom of the trench, concrete enveloping shall be provided as per exhibit drawing. Blasting, if any, and padding shall be included in the work at no extra cost to the OWNER. Blasting shall be done after obtaining prior permission from the OWNER.

16.4.2. Spoil

Spoil which is not dumped on and including spoil acquired after cleaning the water course crossing trench, shall be transported and dumped in places, designated thereto by agreement between CONTRACTOR and authorities and approved by the OWNER. Spoil shall be transported in (split) barges; only those barges shall be used that avoid spilling during transportation due to incorrect closing of the flaps, etc. Spoil which is dumped outside the designated places shall be removed by CONTRACTOR at first notice by the OWNER.

16.4.3. Dykes, dams and weirs

CONTRACTOR shall install temporary provisions in the existing dykes, dams, etc. to prevent flooding of low areas.

Therefore, in general, in existing dykes, dams, etc. a double substituting weir must be installed before start of excavation in the existing dyke 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 movement caused by boats, Motor Launch etc. cause no slides/cave-ins of the dyke or dam.

16.4.4. Continuous concrete coating/ sheathing for Submerged Crossing

CONTRACTOR shall provide concrete coating/ sheathing as per clause 16.8 & 16.9 over the pipeline in accordance with the relevant chapter of this section. CONTRACTOR shall coat the weld joints in order to arrive at a continuously concrete coated pipeline. However, this concrete coating shall be applied after the hydrostatic pre-test.

a) Pre-testing

CONTRACTOR shall pre-test the pipeline sections of all major watercourse crossings before installation as per approved procedure. Joint coating of the welds shall be done after this pre-test.



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The section of the pipeline corresponding to the crossing shall, before installation, be subjected to hydrostatic pre-testing at a pressure of 75 bar or as per requirement of PNGRB T4S/ASME B 31.8. The pressure shall be maintained in the pipeline for at least four hours and recorded by dial type pressure gauge having minimum least count of 0.200 kg/cm². During the test, 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 pipe material supplied by the OWNER the repairs shall be done free of cost, to the satisfaction of the OWNER.

b) Installation

CONTRACTOR shall submit a detailed scheme for the method he proposes to adopt for installing the pipeline to the OWNER 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 the OWNER for approval.

CONTRACTOR shall perform all work required to install the water course crossings, including the possible appurtenances indicated in the approved drawings. The water course crossings shall be installed in such a manner so as to comply with the requirements and conditions stated by the authorities issuing the permits. CONTRACTOR shall pay special attention to minimise any damage to embankments and dykes in the vicinity of water course crossings.

The equipment for lowering-in 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 course crossing section has been installed in place, CONTRACTOR shall fill this section including the pertaining land sections with water for the final testing. CONTRACTOR shall tie-in the water course crossing section to the land section and/or dyke section, not earlier than one week after the water course crossing section filled with water has been completely backfilled. CONTRACTOR shall check if the position and depth of the water course

crossing are in accordance with the approved drawing, by means of a profile of the pipeline, before and after the water course crossing section is filled with water. CONTRACTOR shall lower each pipeline section which is not sufficiently deep by dredging or jetting the underlying ground. 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 either trench or the pipe alignment or to both so that, the pipe, when finally in position in the trench, shall fully meet the specifications, failing which CONTRACTOR may be asked to remove the pipeline. This shall be done at no extra cost to the OWNER.

c) Backfilling

Backfilling of the water course-crossing section under water shall be performed as follows :

1. The bottom of the waterway 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 the



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OWNER. In case another material other than the original spoil is required, this shall be supplied and backfilled by CONTRACTOR without extra cost to the OWNER.

Wherever boulders, rock, gravel and other hard objects are encountered they shall not be placed directly on the pipe. Sufficient earth, sand or selected and approved backfill material shall be backfilled initially around and over the pipe to provide a protective padding or cushion extending to a minimum thickness of 50cm around the pipe before backfilling remainder of the trench with excavated or other material.

2. Backfilling progress of the trench shall be checked continuously, and a daily progress report shall be made in triplicate and handed over to the OWNER.
3. CONTRACTOR shall consult the authorities in respect to all requirements to be fulfilled during the execution of the work.
4. All embankments and/or dykes shall be reinstated to their original state, unless otherwise prescribed in the approved drawings or by the competent authorities or the OWNER.
5. All remaining spoil-deposits shall be cleaned by CONTRACTOR to the satisfaction of OWNER. Bank excavation shall be backfilled and thoroughly compacted to prevent soil and bank erosion.
6. Backfilling of the land section of the water course crossings shall be executed in accordance with Chapter-12.

16.5. FINAL (POST INSTALLATION) HYDROTEST

After laying operations, the CONTRACTOR shall run a gauging 'pig' through the pipe. The complete section of major watercourse crossing must be hydrostatically tested immediately after the approved backfilling of the trench strictly as per relevant chapter of this specifications/this tender. After temperature stabilization, pressure (as required) shall be retained in the pipeline for a minimum 24 hours and recorded by mano-thermograph. Should there develop any failure on account of defect in Contractor's supplied material or workmanship, the Contractor shall repair the same free of cost to the OWNER.

After completion of the land sections CONTRACTOR shall re-test all the crossings already pre-tested and the major watercourse crossing already undergone hydrotest, together with the final land section in order to arrive at a complete tested total pipeline.

16.6. POST-CONSTRUCTION SURVEY

After laying of the pipeline, the OWNER shall carry out a post-construction survey of the crossing jointly with CONTRACTOR. Any defects brought to the notice of CONTRACTOR shall be promptly corrected by CONTRACTOR at his own expense to the complete satisfaction of the OWNER.

16.7. BANK PROTECTION



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After laying the pipeline, prior to restoration of the ROW, protection of the banks/ side slopes of the river/ canal/ nala crossings shall be carried out as detailed below :

- a) Prior to completion of backfilling of excavated trench, dressed stones of size (200 to 300mm size) shall be laid in two layers upto a width of 5 m on either side of the excavated trench in addition to the excavated trench portion. Stones shall be kept in position by enveloping with GI chain link fencing 3"x3" size, 8 SWG, packed together and tied at the ends by GI wires of suitable size, except that the stones shall be laid in two layers and shall be laid upto a width of 5 m on either side of the excavated trench in addition to the excavated trench portion.
- b) The Contractor shall submit for Owner's approval the detailed execution drawing and methodology of execution and shall execute the work as per approved procedure.
- c) Bank protection as detailed above shall be provided at all submerged crossing locations and if required, at some of the minor watercourse crossings as directed by the Owner or by the authorities.

16.8. MATERIALS FOR CASED CROSSING AND ROCK SHIELD MATERIAL

All materials supplied by Contractor which may be used in the permanent work shall be of standard quality manufactured by renowned concerns conforming to Indian Standard Specifications (latest edition) or equivalent and shall bear ISI mark as far as possible unless otherwise approved by the Engineer-in-Charge. The Contractor shall get all materials approved by the Engineer-in-Charge prior to procurement of the same in bulk and also before using in works. The Engineer-in-Charge shall have the right to determine suitability of any or all of the materials for incorporation in the work. Any material procured or brought to site and not conforming to specifications, the CONTRACTOR shall have to remove the same immediately from site at his own expenses & without any claim for compensation due to such rejection. Should it be decided by the Engineer-in-Charge to conduct any tests for material before being approved, the cost of such tests shall be borne by the CONTRACTOR.

16.8.1. **CASING END SEAL**

This specification covers the minimum requirements of design, material, fabrication and supply of casing end seals intended to be used for pipeline cased crossings.

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.

16.8.1.1. Design

The seals shall be wraparound type suitable for the casing and carrier pipe diameters 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.



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The design of the casing end seals shall permit easy installation of the seal to the cased pipeline crossing and it shall provide moisture-proof seals when installed for the entire anticipated life of the buried pipeline.

Contractor shall obtain prior approval from the Owner on casing end seals manufacturer, design, drawings, quality assurance and application methods.

16.8.1.2. Material

The wraparound type casing end seals shall be made of heat shrinkable fibreglass reinforced radiation cross-linked polyethylene with an adhesive having a melt point suitable for the pipeline service temperature and ambient temperatures foreseen during construction. End seal material shall be resistant to heat, cold, vibration, impact, abrasion, corrosive fluids, disbonding, organic and bio-deterioration. Manufacturer shall confirm compatibility of end seals with the coating of the carrier.

Casing end seals shall meet the following minimum property requirements:

	Property	Minimum value	Test method
a)	Backing (sleeve & 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 hrs	ASTM D 2671
b)	Adhesive		
	Ring & ball softening point	90 °C	ASTM E 28
	Lap shear	60 °C – 25 psi 23 °C – 250 psi (2 inch /minute)	ASTM D 1002
c)	System (as applied)		
	Peel strength (to casing and carrier pipe and closure patch)	5 psi (10 inch / minute)	ASTM D 1000

Manufacturer shall furnish material test certificates of the components used in the assembly of casing end seals as per the requirements of this specification.

16.8.1.3. Installation

The wraparound heat shrinkable casing end seals shall be installed as per the installation procedure prescribed by the manufacturer. Prior to field application, the Contractor shall submit the procedure for installation of the end seals, for the approval of the Owner. Preliminary application Procedure for Casing End Seal with Duct and OFC cable is given in the relevant chapter of this specification.

16.8.2. CASING INSULATOR:

The casing insulator to be supplied by the Contractor shall be of high density polyethylene product injection moulded to provide insulators of highest density. It should have low co-efficient of friction and should be able to slide easily inside the casing. It should be completely resistant to impact factor of 4 ft-lbs/in notched, dielectric strength (short time / 1/8" thickness) 500 volts per 0.001".

Tensile strength : 4000 psi at 20 in/min



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Elongation : 25% — 20 in/min
Abrasion resistance : Taber index 5 — 7

POWERCRETE casing insulators of M/s Raychem make may also be used.

The insulators should be able to fit on the carrier pipes with coating with tolerances for over/under thickness and should have adequate clearance between the carrier pipe and the casing.

The spacing between the casing insulators of high density polyethylene shall be @ 1.0m c/c. In the case of POWERCRETE casing insulators, the spacing shall be @ 2.0m c/c with a provision of two numbers of casing insulators (adjacent to each other) at both the ends of the casing.

16.8.3. VENT PIPE, VENT PIPE TOPS AND PIPES FOR PIPELINE MARKERS

80mm nominal bore MS Pipe medium quality having wall thickness 4.05 mm of make conforming to the latest edition of IS-1239 (Part-I) specifications with weighing 8.64 Kg/m, to be supplied in length of 3 metre and above.

Casing vent pipe tops shall be fabricated out of 80 mm nominal bore medium described above, including the filter in galvanised sheet iron welded at the end labour etc. complete as per the exhibit drawing.

16.8.4. ROCK SHIELD MATERIAL

Rock shield shall be of extruded polyethylene mesh and meet the requirements below:

Sl. No.	Property	Test Method	Value
1.	Thickness	ASTM D-1777	0.16 inch
2.	Compressive strength	ASTM D-1621	25,000 psf
3.	Polymer		Polyethylene
4.	Impact resistance	ASTM G-14	100 in/lb

The Contractor shall submit the technical literature and details of rock shield materials. The application procedure of the system will be in strict adherence to the procedure laid by the manufacturer.

The Contractor shall obtain prior approval from the Engineer-in-Charge for the rock shield material and its application procedure.

16.9. CONCRETE WEIGHT COATING



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This specification covers the minimum requirements for the materials and application of concrete coating to the exterior surface of line pipes.

16.9.1. REFERENCE CODES

Reference has been made in this specification to the latest editions of the following codes and standards.

- a) IS : 4948 : Welded steel wire fabric for general use.
- b) IS : 383: Coarse & fine aggregates from natural resources for concrete.
- c) IS : 516: Methods of test for strength of concrete.
- d) IS : 7320 : Slump test apparatus.
- e) IS : 269: Ordinary portland cement.
- f) IS : 2386: Methods of test for aggregate for concrete.
 - i) IS : 2386(Part-I) : Particle size & shape.
 - ii) IS : 2386(Part-II) : Estimation of deleterious materials and organic impurities.
 - iii) IS : 2386(Part-III): Specific gravity, density, voids, absorption & bulking.
 - iv) IS : 2386(Part-IV) : Mechanical properties.
 - v) IS : 2386(Part-V) : Soundness.
 - vi) IS : 2386(Part-VI) : Measuring mortar making properties of fine aggregate.
- g) IS : 456: Code of practice for plain and reinforced concrete.
- h) IS : 6441 : Methods of test for concrete products.
- i) IS : 6909: Supersulphate cements

In case of conflict between the requirements of this specification and the documents referred above, the requirements of this specification shall govern.

16.9.2. MATERIALS

The CONTRACTOR shall supply all the materials necessary for the work performance. All materials supplied by the CONTRACTOR, which in the opinion of the OWNER, do not comply with the appropriate specifications shall be rejected and immediately removed from site by CONTRACTOR at his expense.

Cement

Ordinary Portland Cement in accordance with IS:269 shall be used unless otherwise specified. Regarding the acceptance, rejection, storage, preservations, etc. the CONTRACTOR shall comply with IS:269. Cement which has hardened or partially set shall not be used. Test certificates from the cement Manufacturer shall be supplied to the OWNER for every lot of cement delivered to site.

Sulphate resistant cement in accordance with IS:6909 shall be used in marshy areas where the water is saline.



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Aggregate

Fine aggregates used shall be graded from coarse aggregates, according to IS:383. Unless otherwise specified, stone aggregate shall be 10mm nominal size.

Sand

Sand shall be clean and free from injurious amounts of salt, alkali, deleterious substances or organic impurities and shall conform to IS:383. Sand shall be tested for organic impurities as per IS:2386(part-II).

Water

The water shall preferably be limpid, fresh and clean and shall not contain chloride and sulphates, and especially it shall be free from magnesium salts. It shall conform to the requirements specified in IS:456. Water from each sources shall be tested by the CONTRACTOR at his expense and test certificates shall be submitted to the OWNER for approval before use.

Other Aggregates

Iron or barium ore aggregate may be substituted for sand to produce a denser concrete weight coating. Any substitution of materials shall have prior approval of the OWNER.

Reinforcement

Concrete coating shall be reinforced by a layer or layers of steel reinforcement according to the provisions herein after described.

Reinforcement shall consist of welded steel wire fabric manufactured in flat sheets or in rolls (ribbon mesh) and shall conform to IS:4948.

Steel wires shall be galvanised at finished size. The diameter of the wire and spacing of wires (mesh dimensions) shall be selected according to the following criteria.

Wire fabric manufactured in flat sheets shall be 2 x 4 inches max. steel wire mesh of 13 gauge steel wire (2.4 mm) min. each way.

Wire fabric manufactured in rolls (ribbon mesh) shall be of 1 x 2.5 inches mesh size of 14 gauge steel wire (2mm).

The above dimensions will be applied unless otherwise specified by designs. As a rule wire fabric (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.

16.9.3. COATING REQUIREMENTS

Pipes shall be concrete coated to a minimum thickness as specified in the relevant drawings. The concrete unit weight shall be minimum 2400 Kg/m³ and the concrete mix shall be 1:1 1/2:3 (1 cement : 1 1/2 coarse sand: 3 graded stone aggregates) with cube compressive strength not less than 210 kg/cm² in 28 days and 140 Kg/cm² in 7 days, during work tests conducted in accordance with IS: 516.



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16.9.4. APPLICATION METHOD

Concrete coating shall be applied either using casting or impingement method. Any alteration or modifications to the methods described in this 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, particularly regarding concrete coating sizing and shape, concrete coating specific gravity, concrete coating compression strength, placement and layers of steel reinforcement.

The CONTRACTOR shall select concrete coating application method after evaluating the design minimum requirements, the scale of work involved and the time schedule. After selection, the CONTRACTOR shall submit to the OWNER, prior to commencement of work, the procedure/method of application for approval.

16.9.5. EQUIPMENT

The equipment used for performing the concrete coating shall be capable of doing so with a reasonable degree of uniformity with respect to thickness, density and strength. The proportioning equipment and procedure shall be of the type to assure consistently proportioned materials by weight and the mixes and shall ensure thorough mixing of all materials. Any equipment that tends to separate the ingredients shall not be used.

16.9.6. MEASUREMENT AND LOGGING

All measurements as mentioned below shall be taken during the work stages and clearly logged in a proper log-book. A special log-book shall be used for recording tests and trial results. A log-book shall refer to pipe lengths having the same nominal diameter, and steel wall thickness. The following shall be subject to measurement and logging for each pipe length.

a) Line Pipe

- 1) Field identification number (F)
- 2) Mill serial number (M)
- 3) Length (L)
- 4) Weight (BW)
- 5) Average outside diameter (OD)

b) Concrete coating

- 1) Batch identification number (B)
- 2) Date of placing of concrete coating (T)
- 3) Average concrete coating thickness (CT)
- 4) "Wet weight" of concrete coated pipe and date of weighing (WW)
- 5) "Dry Weight" of concrete coated pipe (weight and date of weighing or related weight 28days after placing of concrete and so identifiable) (DW)



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The log-book shall have spaces (a, b and c) to be filled with the values, derived from calculation, as indicated below :

- a) "Unit dry weight" of concrete coated pipe (UDW)
- b) "Negative buoyancy" (unit) of concrete coated pipe (UNB)
- c) Unit saturated weight of concrete coated pipe (USW)

No concrete placing shall be allowed before items 1 through 5 listed at previous point 16.9.6 (a), have been logged.

16.9.7. PROCEDURES QUALIFICATION

Before commencement of the work, CONTRACTOR shall perform all tests, either in laboratory or in field and trials necessary to properly select type of mix and concrete placing procedures.

The type of mix, i.e. the correct combination of the cement, aggregates and water shall at first be determined and to this purpose, not less than 5 samples of concrete shall be prepared. For each mix the following shall be accurately checked and recorded:

- Proportions and weights of the respective materials used
- the water/cement ratio
- the grading of the aggregates

Samples shall be prepared and tested in accordance with IS:2386 (Part III) to determine the dry specific gravity of the concrete and the saturated weight after immersion.

Test for concrete specific gravity at intermediate time (7days after coating) shall be performed. 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.

The mix so determined, shall be then used for sampling of concrete to be submitted to compressive strength tests. For this purpose, five samples at least shall be tested according to IS : 516.

To consider as final the type of mix, dry specific gravity and compression strength of concrete shall result not lower than the minimum requirement.

As soon as the mix type is selected, trials shall be performed by concrete coating application on pipe lengths to test the placing procedure of the concrete. The following shall be determined according to application method used:

- workability of the concrete and pouring or cement gun rates.
- number of pouring or passes required to meet the concrete coating thickness as specified.
- duration of vibration depending upon the workability of the concrete and the effectiveness of the vibrator sets.



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16.9.8. APPLICATION OF REINFORCEMENT AND CONCRETE COATING

16.9.8.1. Concrete mixing

The components of the concrete mix shall be weight-batched before mixing by a proper weight-batcher. Batch shall be based on weight of single components with an accuracy within $\pm 1.0\%$ of the values corresponding to the selected type of mix.

A water meter accurate to within $\pm 1.0\%$ of the indicated values shall be used for adding water to the mix.

The calibration of the weight-batcher and the water meter shall be checked at frequent intervals. Two test cylinders each per day shall be obtained from batches and tested at the end of 7 (seven) days after coating, for compressive strength and specific gravity.

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. Slump tests according to IS:7320 shall be conducted for this purpose.

The maximum slump shall result, as a rule, within 10 to 15cm.

16.9.8.2. Pipe length preparation

Prior to placing of reinforcement, the protective coating of each pipe length shall be carefully inspected and, 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.

When the concrete coating is formed in sections, spacing material of suitable type (i.e. sheets of polystyrene foam or similar) shall be used and installed around the pipe for spaces between sections. Pipes supported at their ends, when so required during concrete placing, shall be adequately braced with interior struts or rings to prevent undue flexure or ovalisation during coating and handling before stock- piling.

16.9.8.3. Reinforcement application

Reinforcement shall be placed around the pipe in such a way as to cover the whole pipe length or sections to be concrete coated. The reinforcement shall terminate at a distance of 37.5 to 40 cm from the ends of each length of pipe.

When the concrete coating is formed in sections, steel reinforcement layers shall not remain exposed in the spaces between continuous concrete coating section.

When casting method is used for placing of concrete coating, reinforcement shall rest on synthetic resin spacers forming a "crown" whose number shall be such as to avoid any contact with the pipe's protective coating. Spacing between the two consecutive "crown" centres shall be 500 to 1000 mm.

When impingement method is used for placing of concrete coating, placement of reinforcement could start after first layer of concrete has been applied to the pipe section, so that it has the same



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function of spacers. In this case, CONTRACTOR shall demonstrate that the process used is such as to assure no contact between steel reinforcement and pipe protective coating.

Splices and attachments shall be done by binding with soft steel wire of 1.5 mm diameter. Circular and longitudinal joints of wire fabric in sheets shall be lapped at least for one mesh. When wire fabric in rolls (ribbon mesh) is used, the spiral lap shall be one mesh while the spliced lap shall be three meshes.

One layer of reinforcing steel shall be provided for concrete thickness upto 50mm and two layers of reinforcing steel shall be provided for concrete thickness beyond 50mm. If application method requires more than one pass concrete, one reinforcement layer for each pass is to be applied independently of concrete coating thickness.

16.9.8.4. Concrete placing

Concrete shall be placed within a maximum of 45 minutes from the time of mixing (adding water to mix) and shall be handled in such a way to prevent aggregate segregation and excessive moisture loss. Concrete containers shall continuously be kept clean and free from hardened or partially hardened concrete.

The connecting procedures shall be such as to permit a reasonable workability and a concrete coating surface smooth and uniform. To this purpose the workability could be improved by adding to the mix an admixture of suitable type approved by OWNER.

If casting method is used, once reinforcement and mould have been applied around the pipe, concrete mix shall be poured through an opening on the upper section of the same mould. Concrete shall not be poured from a height greater than 1 meter.

During pouring of concrete, vibrator sets applied inside of pipe or outside the mould shall vibrate the mix so as to obtain the best possible compactness. Pouring rate and duration of vibration shall be such as to achieve proper consolidation of concrete and to avoid over vibration, causing segregation.

If impingement method is used, 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. Concrete shall be injected at high velocity against the exterior surface of pipe or shall be applied by an equivalent method to produce a hard, tight-adhering coating of the specified thickness.

No casting shall be interrupted or passes shall be stopped for more than 45 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.

Suitable means shall be provided to ensure that the temperature of the concrete, when placed, does not exceed 32 degree C. Where necessary aggregate stockpiles and pipe lengths to be coated shall be shielded from direct sunshine. When evaporation rates are high, aggregate shall be sprayed with water, due allowance being made for the extra water, in the concrete mix design.



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Surface against which concrete has to be placed (moulds, reinforcement, pipe) shall also be sprayed with water to prevent excessive loss of water from the fresh concrete. The maximum time interval from adding water to mix and final concrete placing shall be 45 minutes. Concrete placing shall be completed as quickly as possible and exposed surfaces immediately shall be covered to reduce excessive evaporation of water from the concrete.

All pipes shall be kept clean and free from cement concrete and grout either inside or outside of the uncoated sections. Cement concrete and grout accidentally present on said surfaces after concrete placing completion shall be fully removed before their setting.

Metal bevel protectors shall be kept in place throughout the coating application and after work.

The coating at each end of the pipe shall be bevelled to a slope of approximately two-to-one (2:1). It shall terminate about 50mm short of the end of the corrosion coating applied on the pipe surface. Curing 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 sections shall be handled gently by suitable means to prevent undue distortion.

Curing shall be performed in accordance with IS:456 using sealing compound. The 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 protective coating or pipe. The application of the curing compound shall take place 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 4days. During which period the freshly coated pipes shall not be disturbed and the pipe surface shall be kept wet during day light hours for seven days after application of the concrete coating.

Before handling and hauling the concrete pipes, a check should be made to make sure that the concrete coating is cured. Stacking and shipment of the coated pipes shall be initiated only after seven days provided that the concrete coating suffers no damage.

16.9.8.5. Tolerances

CONTRACTOR shall maintain a surface tolerance of 8 mm (5/16") maximum for the radial distance between high and low areas of the surfaces. The diameter of each coated pipe shall be obtained at three (3) or more points, spaced at equal intervals between the end points.

The acceptable weight tolerance for any single pipe shall be limited to plus five (5) or minus two (2) per cent of the weight required to produce the necessary negative buoyancy. The average negative buoyancy for all pipes coated in one day shall not be less than that specified. The negative buoyancy shall be calculated using total weight of the pipe with concrete and corrosion coating.



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16.9.8.6. Weighing

Minimum one test pipe shall be selected from the day's production during the course of production. The OWNER retains the option to require additional submerged weight tests.

All weighing of concrete coated pipe lengths shall be performed using suitable weighing device having an accuracy of one-half of one percent (0.5%). Calibration of the weighing device shall be checked at frequent intervals to the satisfaction of the OWNER.

Concrete coated test pipe shall be weighed as soon as it is feasible to move it after concrete placing and shall mark the weight on the inside of the pipe with paint. The weight mark shall be followed with letters "WW" meaning Wet weight.

The CONTRACTOR shall also weigh selected test pipe when dry prior to use and after the 28 days of placing of concrete and mark the weight with paint on the inside of the pipe. The weight mark shall be followed with letters "DW" meaning Dry Weight.

16.9.8.7. Inspection and tests

After curing every length of concrete coated pipe shall be non-destructively tested by such means as "ringing" to determine if any suspected defects are present. In case this procedure indicates faulty coating, concrete cores shall be removed from coating and inspected. When defective coating appears from cores, the concrete coating shall be removed from the pipe lengths at the OWNER's advice.

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. To 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.

During the test and before delivering 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 shall be repaired as mentioned in subsequent paragraph. Repairable concrete coatings shall be clearly marked, while the non repairable ones shall be removed from the pipe lengths.

During the whole time of works, in addition to the tests as required at clause 16.9.8.1, crushing strength test may be required by OWNER by removing samples from the coating whenever its wall thickness allows it.

One for every twenty concrete coated pipe lengths if the scale of work or production is small, shall be submitted to water absorption test as follows:

- the concrete coated pipe shall be weighed in air when dry and the weight recorded as "dry weight";
- the pipe length shall be completely submerged in water of known specific gravity, and so kept for a period as hereinafter indicated;



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- the submerged pipe length shall be weighed at 6 hours interval of continuous submergence till water saturation is reached and the time and weight data recorded. The last weight shall be recorded as saturated weight". Reaching "water saturation" shall mean that the difference between the two last consecutive weightings at 6 hours intervals are not differing, more than accuracy of weighing device.

16.9.8.8. Repairs

The following repairs will be permitted to coating due to unavoidable damage in handling and in storage (This applies only to concrete that has hardened).

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.

Damage due to spalling of an area of less than 0.1m² (1 square foot) where the remaining concrete is sound may be accepted without repairs. Damage due to spalling of an area of more than 0.1m² and less than 0.3m² 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 undercut 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 required area at the top and shall be moist cured for a minimum of 36 (thirty six) hours before further handling.

Should the damaged area be more than 0.3m², coating shall be removed around the entire damaged area. A repair shall be made by satisfactorily restoring the reinforcing; 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 100mm (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 a minimum of 36 hours before further handling.

16.9.9. CAUSES FOR REJECTION

Causes for the rejection of the concrete coating shall include but not limited to the following:

- Coating that does not meet the requirements of acceptable weight tolerances specified in this specification.
- Improper placement of the reinforcing steel.
- Coating damaged in handling or storage that is considered by the OWNER to be excessive and beyond repair.
- Lack of insulation between steel reinforcement and pipe.
- Unfinished coatings that are allowed to remain unfinished for a period of time exceeding 45 minutes as in case of break-down or otherwise.
- Anything else not conforming to the specification.



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- Acceptance shall be delayed, when pipe lengths having an acceptable concrete coating shows cement concrete, grout, sand, mud, etc. on the inside and on the uncoated surfaces of the pipe or defects on steel pipe especially at bevelled ends till the cleaning and repairing completion.

16.9.10. MARKING

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. The minimum marking requirements are described herein below.

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.

16.9.11. UNLOADING, TRANSPORT, STORING AND HAULING

Once the pipe sections have been taken on charge, the CONTRACTOR, complying with Special Conditions of Contract, shall execute their transport together with other material, either supplied by him or by the OWNER, from the reception site to the concrete coating yard and after concrete coating completion and acceptance, to delivery point at laying field or storage areas as previously established providing each time the necessary storage.

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.

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. Provisions shall be taken to prevent contamination, maintain the cleanliness and against effects of hot or cold weather or other particular climatic condition.

During the operations of loading, unloading and piling, the pipe sections shall be handled in such a way to avoid dents, cuts, cracks and other damages especially at bevelled ends or damages to protective and/or concrete coating.

Stacking of coated pipes shall be carried out on surface previously levelled and coated with a layer of sieved earth or sand to prevent coatings from being damaged and water and mud entering inside the pipe.

Stacks shall consist of a limited number of layers such that the pressure exercised by the pipe's 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 surfaces.



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Stacks shall be suitably secured against falling down and shall consist of pipe sections having the same diameter, steel and concrete coating wall thickness. Stacking of pipe in storage yard shall be done on brick pedestal with no abrasive 25 mm thick rubber/PE sheet.



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CHAPTER-17

**17. SPECIFICATION FOR PIPELINE CROSSING/LAYING BY HORIZONTAL DIRECTIONAL
DRILLING (HDD) METHOD**

17.1. GENERAL

This specification covers the minimum requirements for various activities to be carried out by the Contractor for the engineering and construction of pipeline crossing using directional drilling method.

This specification shall be read in conjunction with the requirements of specification and other documents included in the CONTRACT between owner and Contractor.

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..

Contractor shall take full responsibility for the stability and safety of all operation and methods involved in the work.

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.

Contractor shall be deemed to have obtained all necessary information with regard to risks, contingencies and all other circumstances, which may influence the work.

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.

Contractor shall provide free of charge reasonable facilities to Owner's personnel to witness all stages of construction.

Contractor shall carry out Site survey and finalize of exact length of pipe line / quantities of various items, location of exit entry point, depth etc.

Contractor shall submit a detailed methodology of the works drawn up on the basis of the start and end dates for the works as stipulated in the special condition of contract (SCC). The various phases of the work must be included in this programme in so far as they are applicable to the works also Preparation of detailed project schedule in MS project or equivalent

17.2. REFERENCE DOCUMENTS

Reference has been made in this specification to the latest edition (edition enforce at the time of issue of enquiry) of the following codes, standards and specifications :

- a. ASME B 31.4 : Pipeline Transportation Systems for Liquid



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Hydrocarbons and Other Liquids.

- b. ASME B 31.8 : Gas Transmission and Distribution Piping Systems.
- c. OISD 226 : Natural Gas Transmission Pipeline and City Gas Distribution Network.

In case of conflict between the requirements of this specification and the above referred documents, the requirements of this specification shall govern.

17.3. SURVEY OF TRENCHLESS LOCATIONS

CONTRACTOR shall carry out survey of trenchless location which comprises of topographical/bathymetric, hydrological surveys, geotechnical investigations like bore log details at his own cost for execution of works if required.

OWNER does not assume any responsibility with regard to the correctness of the data furnished in the Bid Document. It shall be the responsibility of the CONTRACTOR to verify/establish the correctness and utility of this data to the extent required by him. Also, it shall be the responsibility of the CONTRACTOR to collect/generate any/all data required by him.

17.4. STATUTORY PERMISSIONS

Owner shall apply for permission for laying of pipeline however obtaining the permission from the statutory authorities, obtaining work permits/ NOC from various statutory authorities having jurisdiction before execution of the works and complying with all stipulations / conditions / recommendations of the said authorities and necessary day to day clearances, approvals from all concerned authorities in respect of pipeline and all related work shall be responsibility of contractor and cost of same shall be deemed to have included in quoted prices. On behalf of the Owner, Contractor shall co-ordinate with the relevant authorities along with the copy of required pipeline route drawings / certificates complete in all respect shall be prepared and submitted by the Contractor well ahead of time so that the actual construction of the work is not delayed for want of the approval / inspection / permission by concerned authorities. The inspection of work by authorities shall be arranged by Contractor and necessary co-ordination and liaison work in this respect shall be the responsibility of the Contractor. However, statutory fees / restoration charges, if any, shall be paid by Owner on production of documentary evidence.

Any change / addition required to be made to meet the requirements of the statutory authorities shall be carried out by the Contractor without any extra cost to OWNER. The inspection and acceptance of the work by statutory authorities shall however, not absolve the Contractor from any of his responsibilities under this contract.

17.5. PRIORITIES OF LAYING WORK

Owner may, at its sole option, assign priority of construction to any section or to any part/segment of the geographical area. Contractor shall comply with such priority of execution and carry out construction work at any location given by Owner without any time and cost implication to the Owner. The HDD location may be at any place far away from Contractor's present construction site. Design and drawings of every HDD location shall be checked and approved by EIC and Consultant well before commencement of the Work.



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17.6. TEMPORARY SPACE FOR PIPE STRING AND HDD RIG

CONTRACTOR shall arrange at his own cost for any space requirement for construction of pipeline string and placement of HDD Rig for carrying out HDD work. Owner will not be responsible for providing any space/land/RoU.

The ROU will be arranged by the contractor. Contractor shall carry out all necessary survey work as per requirements of site conditions. It will be the responsibility of the Contractor to maintain the ROU until completion of the work

In case of encroachment on the ROU or extra land needed during construction, it will be the sole responsibility of the Contractor to relocate all issues (including any compensation) with the relevant land Owner, tenant or authorities. All related cost will be borne by the Contractor.

For access route to the working strip the Contractor will be responsible to negotiate with the relevant Owner, tenant or authorities. Any deemed compensation will be borne by the Contractor

17.7. DESIGN AND ENGINEERING

The Design and Operating conditions for the Pipeline crossings are as below:

Maximum Operation Pressure	: 35 Barg
Design Pressure	: 49 Barg
Design Temperature	: 60° C (Max.) 0°C (Min.)

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. Contractor shall furnish all engineering design calculation and crossing drawings etc. to owner for their approval prior to execution of the work.

Within the entire limits of crossing, the minimum cover to top of coated pipe shall be as specified in the Special Conditions of Contract (SCC).

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 the scope of work in SCC or in approved for construction crossing drawing / crossing profile.

For Road Crossing	:	1.4 m	from	top of road to top of pipe.
For railroad crossing	:	1.7 m	from	base of Rail to top of pipe.
For canal crossing	:	1.5 m	from	lowest bed level to top of pipe.

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.

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.



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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.

17.7.1 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.

17.7.2 Back-reamed hole and Pipeline Interface

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

Contractor shall indicated what maximum shear stress in the pipeline coating will result from his choice of above parameters and other characteristics described in this section.

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.

17.7.3 Contractor shall determine in the minimum allowable elastic bend radius for pipe from the following consideration:

a. Maximum Longitudinal Stress During Installation

Total maximum longitudinal stress in the pipeline due to tension and bending at any location shall not exceed 90% of the SMYS of the pipe material.

Contractor shall, in order to check this requirement, evaluate the maximum tensile forces to which the pipeline is subjected to at any phase of its installation during the pulling operation.

b. Maximum Equivalent Stress During Final Hydrostatic Test

After installation, the pipeline shall be hydrostatically tested to a minimum test pressure equal to 1.4 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.

c. Maximum Equivalent Stress During Service

Permissible values of maximum equivalent stress during services shall be governed by the



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requirements of ANSI B 31.8/B 31.4 as applicable. The details of pipeline operating parameters are provided in the Special Conditions of Contract.

17.7.4 The minimum allowable radius of curvature for the pipeline shall not be less than 1000 times the Nominal Diameter(ND).

Contractor shall submit all calculations for Company's approval alongwith procedure.

17.7.5 Pipeline Configuration along the Support String Before Entry Point

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.

Contractor shall furnish all calculation and specify the number of required supports, description of the supports, their co-ordinates and capacity in metric tons.

Contractor shall also furnish a drawing of the launching ramp indicating the pipeline configuration.

The distance between each roller shall also be specified and justified.

Contractor shall, based on result of design and engineering carried out by him, prepare construction drawings for the crossing and shall submit the same for Owner's approval. Construction drawings shall indicate the pipeline profile with levels furnished at sufficient intervals for proper control during construction. Other relevant details viz., entry and exit angles, radius of bends, etc. shall also be indicated. Contractor shall also calculated the total length of pipeline required as well as the maximum tension required on the pull head of the rig.

All construction works shall be carried out in accordance with the construction drawings approved by Owner.

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.

17.7.6 Drilling profile

The Contractor shall specify and submit to the Owner for approval his final profile with detailed engineering calculations and the different parameters or their limited value which define the location and configuration of the drilled path.

These parameters are:

- entry point
- exit point
- entry angle
- exit angle
- PI elevation
- radius of curvature.

It is acceptable that the entry and exit will vary from the design proposed location. They have to be



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located inside an area (5 x 10 m) centred around the proposed location, 10 m shall be measured parallel to the HDD alignment.

Except if otherwise specified and accepted by the Owner, the minimum radius shall be not less than 1000 times the Nominal Diameter(ND).

The predetermined theoretical profile shall be closely adhered to when drilling the pilot hole. The permitted deviation shall not exceed 2 m laterally and 1 m vertically from the approved theoretical profile.

17.7.7 PIPELINE CALCULATION

The Contractor will submit for approval to the Owner and Third Party Inspection agency the stress calculation as described in the Deutsche standard NEN 3650 and NEN 3651 or equivalent.

The following phases should be analyzed in the pipeline design process:

i. Predisposition of the launching catenary

Before the pulling operation, the pipeline is outside the bore-hole and has a configuration which allows it to enter the hole. During this phase, the only bending moment is due to the curvature of the catenary and the weight. The pipeline should be designed so that it behaves elastically.

ii. Pull-back operation

In this phase the pipeline will be pulled back through the bore-hole.

The following forces should be considered :

- bending moment due to curvature of the hole;
- friction force between the pipe and drilling mud including the friction due to extra cables/sleeves attached to the string;
- friction force inside the hole, at the location where the soil reaction occurs; stress due to soil reaction;
- the Contractor will specify the means he intends to use in order to reduce the friction during the pull-back operation.

The resultant stress should be calculated and the pipeline designed to behave elastically.

iii. Operating conditions :

In this phase the loads acting on the pipeline are:

- bending moment due to curvature of the hole;
- internal pressure of the gas;
- temperature difference of the line between the pipe-laying and operating conditions;
- dead loads
- Vertical soil load at the top of the pipe can be calculated for different pipe laying conditions.

The following effects should be combined for the purposes of calculating the resultant stress :

- calculated longitudinal effects on the entire pipeline system;



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- calculated effects on the cross-section of the pipeline.

The stress/strain shall not exceed the relevant allowable stress.

The effects of soil load on the cross-section of the pipe may be analysed. This analysis should be carried out at the deepest point reached in drilling.

17.7.8 CONSTRUCTION

Contractor shall comply with all the conditions and requirements issued by Authorities having jurisdiction in the area where the work is to be performed.

If no public road exists, Contractor shall arrange on his own for access to his work area at no extra cost to owner.

Installation Procedure

Contractor shall, before commencing any work at site, submit for Owner's approval a detailed installation procedure.

The installation procedure as a minimum shall include the following:

- Project Organisation Chart:
This shall indicate Contractor's organisational set-up at site and manpower deployment.
- Details of fabrication yard and launching areas.
- Details of Equipment :
- Contractor shall furnish the complete list of all equipment to be deployed for preparation of pipe string and installation of crossing. Technical characteristics and capacity of each equipment including instrumentation, monitoring and control equipment shall be furnished in details.
- Pipeline string preparation details (hauling, stringing, welding etc.)
- Hydrostatic test procedure (pre and post installation)
- Disposal methodology of bentonite slurry.
- Method of installation covering all steps of construction, viz. Rig up, Pilot hole, Back-Reaming, Pulling Down, Backfilling etc.
- Calculation for maximum pulling forces on the rig and recommended maximum pulling velocity.
- Time schedule for construction.

The time schedule shall be in accordance with overall time schedule for the project.

Approval by Owner of the methods used by Contractor shall in no way relieve Contractor from the sole responsibility for safe and satisfactory installation, working and operational use of the pipeline crossing.



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Pipe String Preparation

Complete pipe string shall be prepared as a single string for pulling. Welding, radiographic inspection of joints and joint coating of the string shall be performed in accordance with the respective applicable specifications included in the Contract document.

Pre-testing

Contractor shall hydrostatically pre-test the complete pipe string of each crossing before installation as per approved procedure for a minimum period of 24 hours.

After pre-testing, joint coating of the welds shall be done as per specification for specific field joint coating of pipeline for HDD crossing included in the contract document

The section of the pipeline corresponding to the crossing shall, before installation, be subjected to hydrostatic test pressure as stipulated in the Special Conditions of Contract. During the test, Contractor shall check all welds for leakage. Failure, if any, during the test shall be rectified by the Contractor.

Gauging

Before pre and post installation hydrostatic testing, Contractor shall prove the diameter of the pipeline by passing a gauging 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 required for the purpose.

Installation

Installation shall be done in accordance with approval installation procedure.

The lateral offset of the actual exit point of the pilot hole from the calculated and theoretical exit point shall not exceed half per cent (0.5%) of the length of the crossing.

The length tolerance shall not exceed one per cent of the crossing length, subject to the condition that the actual exit point shall not be within the limits of crossing as defined in the approved drawings.

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 a smooth pull-back of the pipeline.

Contractor shall be responsible for maintaining the drilled hole till such time the pipeline is pulled in.

During pulling operation, the buoyancy of the pipeline shall be controlled by suitable approved



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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.

Contractor shall be responsible for the integrity of the corrosion coating.

Before pull-back operation, megger test shall be done for the entire pipeline (externally corrosion coated) string made for crossing by HDD method.

After pull-back operation to ensure the integrity of pipeline coating, again megger test shall be done for the bored string before tied-in to the mainline pipe. The megger value before & after pulling operation of the pipeline string shall be nearly same and acceptable to Owner.

However, if, in Owner's opinion, the integrity of external corrosion coating of bored pipeline string is not established as required, then further in order to ensure the integrity of coating of the bored pipeline string, megger test of the coating shall be carried out in accordance with the following steps:

- a) The test must be carried out before the bored pipe is tied-in to the mainline pipe
- b) Measure the natural potential of the bored pipe at both ends.
- c) Set up the temporary impressed current system with a digital multimeter connected to measure the output current. Position the test electrode anode as far from the bored pipe as interconnecting cable will allow and no closer than 10 meters.
- d) Place the reference electrode at the remote end (opposite to impressed current system) to monitor the bored pipe potential
- e) Impress a current into the bored pipe start at Zero amp. and increase slowly until the bored pipe potential is depressed to 1.5 V with respect to the reference electrode.
- f) Note the current from the digital multimeter and calculate the current density.
- g) The desirable value of calculated current density should be less than 70 micro ampere per square meter of drilled pipe surface in contact with the soil.

If Contractor again fails to establish the integrity of coating of the bored pipeline string and the same is not acceptable to Owner, the above works shall not be continued further until the cause analysed and rectified by the Contractor to the entire satisfaction of Owner.

17.8. METHODOLOGY OF SHALLOW HDD

Following shall also be applicable for shallow HDD / laying of pipeline along the road by HDD in addition all other clause of this specification.



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Entry side Location

At the entry point, Rig shall be placed at angle of 2 degree to 5 degrees on the ground or in pre-excavated pit of 1.5 meter as per site feasibility. The Rig shall be placed approximately 10-15m away from the limit of RoW of the subject crossing. Maximum depth of profile from the entry ground level shall be 3 meters. A starter pit of 3m depth shall be excavated at the immediate edge of the crossing RoW limit and the carrier pipe shall be finally pulled upto the edge of starter pit.

Exit Location Site

The exit location provides adequate pipe string lay down space for the proposed crossings. Exit site shall have an excavated pipe trench of 3 m depth upto the length of carrier pipe string. Punch out of pilot drill shall be done in Exit pit itself.

Pilot Hole Drilling

At cased crossing locations, the carrier Pipe string shall be installed horizontally at 90- degree angle. Radius of curvature shall not be constrained in this as pipe has to be installed in straight section only.

Minimum radius of curvature of 100-200m (according to diameter of drill pipe) shall be considered to build the curve.

In order to directionally deviate the hole, HDD operator shall deploy the use of a bent bit. When the bent bit is rotated to a particular quadrant, the pilot hole will be redirected in that direction. This process is repeated until the bit is advanced along the predetermined path and exits the exit location. A regular recording of the progression of the pilot hole drill pipes shall be maintained at site.

Reaming Operations

The reamer is then attached to the leading pipe to start ream operation.

A. Reaming

Once the lead pieces are taken off, a suitable barrel reamer will be attached to the trailing end of the drill string at the surface exit location. The reaming shall be done in multiple stages depending upon the soil strata encountered before reaching to final hole diameter of the hole i.e. 18" diameter.

This will then be rotated by the rig and advanced in to the borehole. A section of drill pipe will then be added consecutively to the trailing end of the reamer as the reamer is being rotated and drawn along the borehole in the direction of the rig side location.

B. Swab pass

While pulling the reamer back to the entry side, if the driller feels that the hole is not conditioned or if there is a collapse of the hole, additional swab passes shall be made. High yield bentonite with quick gelling characteristics shall be used to preserve the integrity of the borehole during the swab pass. Pulling will be done within 12 hours from swab pass.

C. Welded Pipe String Preparation



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The welded carrier pipe string shall be lowered in the exit side trench and shall be placed on suitable sized rollers and the string shall be in the same line as the drilled hole from entry side to exit side.

D. Product Pipe Attachment

A pull head swivel assembly shall be pre welded to the carrier pipe string, which will be in the trench. The drill string shall be attached to the pull back assembly attached to the leading end of the carrier pipe.

E. Carrier Pipe Pull Back and Installation

Once the reaming and swab passes are completed, the pipeline shall be positioned perfectly in line with the bore hole. Once aligned, the pulling apparatus will then be attached to the leading end of the drill pipe string and the product pipes will be fed gently in to the bore hole. Since the diameter of the pipe is not very large, the pipe will be slightly buoyant.

Pullback will continue until the leading end of the carrier pipe reaches the edge of the starter pit. As the pipe string is being pulled in to the open borehole, drilling fluid is pumped through the rotating jet swivel. This aids in the further suspension of the drilled solids that may be in the hole. These solids are removed by the viscosity of the fluid coming out when the pipe displaces the drilling fluids in the open hole. A Regular recording of the progression of the pulling process, the pulling log shall be maintained at site.

F. Drilling Fluid and Disposal

Bentonite will be used on the all phases of the project. Bentonite used shall be of high yield and high gel strength, suitable for HDD operations. Bentonite shall be disposed of in a suitable manner as per specifications.

17.9. PROTECTION OF UNDERGROUND UTILITIES AND SPECIAL METHODS

CONTRACTOR shall obtain plans and full details of all existing and planned underground services from the relevant local authorities and be responsible for location and protection of the same. The CONTRACTOR shall fully co-ordinate with all local and related statutory bodies for clearances and permissions.

Where the pipeline crosses other underground utilities/structures, CONTRACTOR shall first give a written intimation to concern utility agencies on behalf of Owner and there after manual excavation to a desired depth to locate the utilities/structures.

The CONTRACTOR, at his own cost shall design and provide any temporary supports such as under pinning or any other type and other protective devices as necessary to keep the interfering structure intact.

In case, any damage to structure/utility etc. occur despite all precautions, CONTRACTOR shall inform to Owner/ Authority/Utility agency regarding the damage and repair shall forthwith be carried out by the CONTRACTOR at his expense under the direction and to the satisfaction of OWNER and the concerned Authority/Utility agency. If CONTRACTOR fails to repair in reasonable time, Owner reserves the right to have the repair executed at the cost of the CONTRACTOR. Any demand against the damaged utility from the authority/ Utility agency to Owner shall be recovered from the contractor.



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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 50 cm free clearance from the obstacle or as specified in the drawings or such greater minimum distances as may be required by authorities having jurisdiction. Also, in all cases, the minimum covers shall be maintained as specified in the technical specification..

Whenever any utility/facility, etc. is encountered within the length of the pipeline to be installed by drilling, such utility/facility crossing shall be executed as part of the HDD crossing works at no extra cost/time to OWNER. Qualified length of HDD shall be specified for Payment purpose and approved by EIC/Consultant.

17.10. OPTICAL FIBRE CABLE

Two HDPE duct for OFC cable (one spare) shall be placed during laying of HDPE duct for OFC cable by HDD method and one nos. HDPE duct for OFC cable shall be placed during laying of HDPE duct for OFC cable by moling method. Contractor shall be responsible for damage free pulling of the HDPE duct. If required, contractor may also provide steel casing for safe pulling of the HDPE duct without any cost.

Wherever HDPE duct shall be inserted into MS Conduit, either separate HDD for MS conduit or Bundle pulling shall be done according to BOQ/SOR.

17.11. LAYING OF MDPE PIPELINE WITH STEEL PIPELINE

If MDPE Gas pipeline to be laid along with steel pipeline, it should be laid as per IOCL specifications for laying of MDPE pipeline.

Separate pulling, maintain a distance of minimum 500mm from steel line, is to be done if MDPE line is proposed to be laid with steel line. In vertical plane, MDPE line should always be at lower depth than steel line so that MDPE line is above steel line.

In case bundle pulling is proposed due to non-availability of space or any other site restriction, same shall be done only after approval of EIC. Contract shall submit the procedure for installation using bundle pulling for approval of IOCL/PMC. Contractor shall be responsible for damage free pulling of the MDPE & Steel pipeline.

Post installation of MDPE section by bundle pulling, contractor shall perform pneumatic pressure test of that individual MDPE section at a pressure of 1.4times of MAOP.

17.12. Final Hydrostatic Test

The complete crossing section shall be tested after installation. The test pressure shall be as stipulated in the Special Conditions of Contract. After temperature stabilisation, pressure shall be retained in the pipeline for a period of 24 hours and recorded by manothermograph. The hydrostatic testing shall be carried out in accordance with approved procedures and specification detailed elsewhere in the document.

17.9.1 Test Procedure



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Contractor shall prepare for Company's approval a hydrostatic test procedure manual for pre-testing and post-installation testing of pipeline. The test procedure manual shall include, but shall not be limited to, the following items:

- a. For the pipe section to be tested, a diagram indicating all fittings, vents, valves, temporary connections, relevant elevations and ratings. The diagram shall also indicate injection locations and intake and discharge lines.
- b. Estimated amount of test water, water source, including required concentration of corrosion inhibitors and additives, procedure for inhibitor injection and control of concentration.
- c. Filling and flushing procedures, including a complete description of all proposed equipment and instruments (including spares), their location and set-up.
- d. The type and sequence of pigs and the pig tracking system for cleaning and removal of air pockets, pig inspection procedures, including procedure to be followed in case the gauging pig indicates damage.
- e. Procedures for levelling and stabilization after filling and for pressurization and to allow for temperature stabilization.
- 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. All calculations including air-volume calculations and pressure change due to temperature change calculations.
- h. Procedure for detection and location of leaks.
- i. Procedure for safe dewatering the pipeline section after testing, including a complete description of all proposed equipment and instruments (including spares), their location and set-up, the type and sequence of pigs and the pig tracking system along with the pig specifications.
- j. Forms for recording the testing data.

Contractor shall furnish all necessary equipment & instrumentation for performing the work including all temporary piping, hydro test header and scraper launcher / receiver etc.

The test medium shall be fresh water to be arranged 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. Contractor shall provide Company approved corrosion inhibitors, oxygen scavengers and bactericides to be added to the test water. Contractor shall furnish and install all temporary piping, which may be necessary to connect from source of water to its pumps and manifolds / tankage.

Before filling operation, Contractor shall clean the pipeline by air driven pigs provided with spring



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loaded brushes and cups to remove all mill scale, rust / sand from the internal of pipe sections.

The hydrostatic test shall be considered as positive if pressure has kept a constant value throughout the test duration, except for changes due to temperature effects, and there is no abrupt pressure drop throughout the test duration.

If test section fails to maintain the specified test pressure after isolation, Contractor shall determine by search the location of leakage or failure. All leaks and failures within the pipe wall or longitudinal seam 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 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 welding specification contained herein. 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 the approved procedures.

All work of reinstating line pipe, to replace failures, shall be done in accordance with the specifications contained herein.

Contractor shall haul and stockpile all damaged and defective pipes to storage locations designated by the Company. All cracks and splits resulting from failures shall be coated with an application of grease to preserve the characteristics of failures from corrosion. Joints 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.

After completion of successful hydrotest of the above portion, the pipeline shall be capped and buried. Pipeline end position on the banks shall be marked on the ground by installing location markers on both banks approved by Company.

17.9.2 Permanent Pipeline Markers

On both banks of each river crossing, Contractor shall install a Navigable Waterway Pipeline Crossing Warning Sign in accordance with Std. No. MEC/S/05/21/05. Contractor shall supply all materials and fabricate and install the markers as per reference drawing. Wherever feasible, the pipeline markers shall be installed on the embankments, however, exact location shall be decided based on site conditions and as directed by Company.

17.9.3 Fencing

Wherever specified, Contractor shall supply all materials and install G.I. Wire Chain link security fencing of size 10 m x 10 m x 25 m high with lockable steel gate around the pipe ends and test stations for temporary C.P. on both sides of each river crossing.

17.9.4 Idle Time Preservation of Pipeline

When so stated in the Contract, Contractor shall supply all materials and consumable including



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water and inhibitor and shall install all piping connections, valves, instrumentation, etc., and perform all works for preservation of pipeline by pressurization with inhibited water. Contractor shall use approved inhibitors and shall determine the required dosages of inhibitors and pressure for idle time preservation of the pipeline for a period of maximum six months from the date of completion of construction. Corrosion inhibitors and dosages shall be subject to Company's approval prior to use.

17.9.5 Final Clean up

After completion of construction, Contractor shall clear the site of all balance material and debris and bentonite slurry. All balance pipe lengths shall be returned to Owner's designated stock yard(s). Site/ ROW shall be cleared to the complete satisfaction of the land owner's and authorities having jurisdiction. All such works shall be done at no extra cost to Owner. The Owner shall be indemnified against any/ all claims arising as a result thereof.

Contractor shall arrange for safe disposal of all surplus soil and bentonite slurry & corrosion inhibited test water so as to avoid any harm to the environment / occupants at locations duly approved by authorities and pollution control boards having jurisdiction and/or as instructed by Company without any extra cost.

17.13. DOCUMENTATION

In addition to the documents specified elsewhere in this specification. Contractor shall submit to the Owner the following documents/ records.

- Copies of the permits obtained from authorities having jurisdiction.
- Records of pre and post installation hydrostatic testing.
- Record of non-destructive testing of welds.
- Detailed drilling log and downhole data, including, but not limited to, the following :
 - i) Torque and pulling/pushing force
 - ii) Data on drilling fluid.
 - Density
 - Type of mud and additive employed.
 - Mixing, pumping and cleaning.
- Wash and drill pipe data, viz.,
 - i) Dimension and material properties.
 - ii) Data on API classification.
 - iii) Age of and type of inspection previously carried out on these pipes.
- Permits obtained from authorities having jurisdiction for the various works.
- Plan & profile of the drilled hole along with the water level variations.
- Records of hydrostatic pre-testing and final testing.



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- Record of Non Destructive Testing of welds.
- Clearance certificates from the landowners and Authorities having jurisdiction regarding satisfactory clean-up and restoration of pipeline RoU and work areas.
- Clearance certificate from the land owners and authorities having jurisdiction regarding satisfactory clean-up and restoration of the pipeline ROW and work sites.

After completion of construction, Contractor shall prepare and furnish six sets of copies and two sets of reproducible of 'As-built' for the crossings. As built drawings shall , as a minimum include the following information

- True profile of the crossing along the pipeline.
- True profile of the pipeline as installed and the depth of cover to top of pipe at regular intervals.
- Location of entry and exit point and angles of entry and exit alongwith lateral offset of exit point from the original pipeline alignment.
- Location and angle of field bends
- Location of pipeline markers.
- All As-Built drawings shall be prepared using software AutoCAD Release 2000 or above. Manually drafted drawings are not acceptable to Company. In addition, to the hard copies, as-built drawings shall also be submitted in electronic media i.e. CD / DVD.

All documents shall be in English language.



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CHAPTER-18

18. SPECIFICATION FOR HYDROTESTING OF PIPELINE

18.1. SCOPE

This specification covers the minimum requirements of supply, works and operations to be performed by CONTRACTOR for hydrostatic testing of cross-country steel pipelines transporting hydrocarbons in liquid or gaseous phase under high pressure. This specification shall be read in conjunction with the conditions of all specifications and documents included in the CONTRACT between COMPANY and CONTRACTOR.

18.2. REFERENCE CODES, STANDARDS AND SPECIFICATIONS

Reference has been made in this specification to the latest edition/ revision of the following codes, standards and specifications.

a	ANSI B 31.8	Gas Transmission and Distribution Piping Systems.
b	ANSI B 31.4	Liquid Petroleum Transportation Piping Systems.
c	API RP 1110	Pressure Testing of Liquid Petroleum Pipelines.
d	ASME Sec. VIII Div-	Boiler & Pressure Vessel Code.
e	OISD 226	Natural Gas Transmission Pipelines and City Gas Distribution
d	EIL's Standard Specification No. 6-71-0055	Hydrostatic Testing Procedure and Calculations

18.3. GENERAL

Hydrostatic test shall be performed on the entire length of the pipeline. Hydrostatic test shall be performed in accordance with approved Hydrostatic Test Diagrams for each test section. The maximum length of each test section shall not exceed 50 kms.

For pipeline sections 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 pretested sections shall be tested again alongwith the entire pipeline.

Hydrostatic test shall commence only after mechanical and civil works completion, i.e., all welds have been accepted and the pipeline has been laid and backfilled according to the specifications. Hydrostatic test shall include those sections which have been previously tested, viz. Rail/ road crossing, major water crossings including test on banks and in place after installation, and scraper traps at the terminals. CONTRACTOR shall perform all works required for hydrostatic testing after obtaining prior written approval from the COMPANY.

The pipeline shall be tested in accordance with the requirements of the latest edition of ANSI B 31.8 or ANSI B 31.4, OISD 226 as applicable, and requirements laid down in this specification.

18.4. HYDROSTATIC TEST PROCEDURE MANUAL

CONTRACTOR shall prepare for COMPANY's approval a hydrostatic test procedure manual. The



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procedure shall strictly comply with the requirements of this specification and shall be submitted to COMPANY for approval well in advance. The procedure manual shall include all temporary materials & equipment, but not be limited to the following items:

- a) For the systems to be tested, a diagram indicating all fittings, vents, valves, temporary connections, relevant elevations and ratings. The diagram shall also indicate injection locations and intake and discharge lines.
- b) Estimated amount of test water, water sources, including required concentration of corrosion inhibitors and additives, procedure for inhibitor injection and control of concentration.
- c) Filling and flushing procedures, including a complete description of all proposed equipment and instruments (including spares), their location and set-up.
- d) The type and sequence of pigs and the pig tracking systems for cleaning and removal of air pockets. Pig inspection procedures, including procedure to be followed in case the calliper pig indicates damage.
- e) Procedures for leveling and stabilization after filling and for pressurization and to allow for temperature stabilization.
- 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 detection and location of leaks.
- h) Procedure for dewatering the pipeline section(s) after testing, including a complete description of all proposed equipment and instruments, (including spares), their location and set-up, the type and sequence of pigs and the pig tracking system along with the pig specifications.
- i) Forms for recording the test data.

18.5. TEST DURATION AND PRESSURE

The duration of hydrostatic test shall be a minimum of 24 hours after stabilization and the test pressure shall be as indicated in the approved hydrostatic test diagram

Unless specified otherwise in the CONTRACT, the hydrostatic test pressure shall be 1.4 times the design pressure for pipeline.

18.6. EQUIPMENT AND INSTRUMENTATION

The CONTRACTOR shall furnish all necessary equipment for performing the work as stated in cleaning, flushing, filling, levelling, stabilizing, testing and dewatering procedures. This shall include the following:

- a) Pigs for filling , cleaning and gauging including
 - Cleaning pigs with spring loaded steel wire brushes except for internal coated pipes. In this case pigs to be provided with nylon / polyurethane brushes.



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- Four cup batching pigs
- Calliper pigs with gauge plate diameter equal to 95% of the heavy wall pipe in the pipe sections. Gauging pig fitted with gauge plate.

The CONTRACTOR shall provide sufficient number of pigs including spares.

- b) Fill pumps : The CONTRACTOR shall determine the type and number of fill pumps in order to guarantee the following :

Differential head 20% greater than the maximum required.

Flow rate : $200\text{m}^3 / \text{hr. min.}$; $1000\text{m}^3 / \text{hr. max.}$

If a single pump is used, a standby unit must be available.

- c) Variable speed positive displacement pumps equipped with a stroke counter to pressurise the line with a known stroke and capable of exceeding the maximum test pressure by at least 20 bar.
- d) Two positive displacement meters to measure the volume of water used for filling the line. These meters shall be provided with a calibration certificate not older than one month.
- e) Portable tanks of sufficient size to provide a continuous supply of water to the pump during pressurizing.
- f) Bourdon pressure gauges of suitable pressure range and accuracy.
- g) Dead weight testers with an accuracy of 0.01 bar measuring in increments of 0.05 bar provided with a calibration certificate not older than one month.
- h) Two 48 hours recording pressure gauges tested with charts and ink gauges tested with dead weight tester prior to use. These shall be installed at the test heads.
- i) Pressure recording charts.
- j) Two temperature recorders for fill water.
- k) Thermocouples for measuring the pipe wall temperature.
- l) Two laboratory thermometers 0°C to 60°C range, accuracy ± 0.1 degree to be used in thermowells.
- m) Means to measure the volume of water necessary to drop the line pressure by 0.5 bar (container on scales or graduated cylinder).
- n) Injection facilities to inject additives into the test medium in the required proportions.
- o) 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.



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- p) The temporary scraper traps shall be installed according to the testing sections fixed in the test procedure manual. Proper piping and valuing 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.

- q) Thermocouples for assuring the temperature of the pipe wall shall be installed on the pipeline to be tested:

- 1 thermocouple at about 500m distance from the pumping head.
- 1 thermocouple every 2500m of the pipe the spacing may be increased to maximum 5000m depending on the terrain and nature of sub-soil along the alignment of section.
- 1 thermocouple at about 500m distance from the terminal head.

The spacing may be increased to maximum 5000 metre depending on the terrain and nature of sub soil along the alignment of test section.

Thermocouples shall be attached on the external surface of the pipe after removal of external coating and shall be adequately protected and COMPANY's coating instructions shall be followed.

18.7. PROCEDURES

Equipment and/or parts which need not or must not be subjected to the test pressures, must be disconnected or separated from the pipeline to be tested.

If the difference of minimum and maximum atmosphere temperature should cause thermal instability on the pipe section directly exposed to atmospheric condition, the scraper traps 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., which shall be tested separately.

The test medium shall be soft non-aggressive water furnished 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 subject to its degree of cleanliness, the possibility of obtaining a pre determined salinity neutralization and the use of corrosion inhibitors, this at the sole discretion of COMPANY. CONTRACTOR shall provide COMPANY approved corrosion inhibitors, oxygen scavengers and bactericides to be added to the test water. The CONTRACTOR shall furnish and install all temporary piping which may be necessary to connect from source of water to its pumps and manifolds/ tankage.

Before filling operation the CONTRACTOR shall clean the pipeline by air driven pigs provided with spring loaded bushes and chisels to remove all mill scale rust/ sand from the inside of pipe section. For this purpose temporary headers for air cleaning shall be attached to the pipeline. The number of pig runs is depending upon the cleaning results and shall be determined by the COMPANY at site.

"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 tolerance shall not be considered. A 10mm thick aluminium plate shall be used for making gauge plate.



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Gauging to be done only after approval from EIC.

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 is not 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 gauging, pipeline will be flushed with minimum 10% of the volume of test section and water shall be filled with corrosion inhibitor by propelling minimum 2 pigs with water column of 100 meters. Then the second pig shall be launched by pumping the inhibited water till the second pig is received at the other end.

The thermal stabilisation and pressurisation can now be started".

a) Thermal Stabilization

After a check has been made to confirm if the pressure has attained at least 1 bar (g) on the highest section, 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.

b) Pressurisation

Pressurisation shall be performed in the presence of COMPANY at 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 increment between 80% to 90% of test pressure as recorded by the dead weight tester;
- each 0.5 bar increment between 90% of test pressure to full test pressure as recorded by the dead weight tester.

The pressurizing shall be cycled according to the following sequence:

- a) Pressurize to 50% of test pressure, hold pressure for 1 hour.
- b) Drop pressure to static head of test section at test head.
- c) Pressurize to 75% of test pressure, hold pressure for 1 hour.



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- d) Drop pressure to static head of test section at the test head.
- e) 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 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.

c) 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_i). 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 18.12 of this specification.

If no air is present in the length under test:

$$\frac{V_i}{V_p} = 1$$

In order that the above ratio is acceptable, it shall not differ from 1 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_i / V_p 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 test pressure.

d) Testing

After the section has been pressurized and the air volume test has given acceptable results the test pressure shall be held for a minimum of 24 hours after stabilization. After temperature and pressure has stabilized, the injection pump shall be disconnected and all connections at the test heads shall be checked for leakage. 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:

- Every one hour pressure measurements from dead weight testers.
- Every two hours the ambient temperature and the pipe temperature at the thermocouples.



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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.

18.8. ACCEPTANCE

The hydrostatic test shall be considered as passed if pressure has kept a constant value throughout the test duration, except for change due to temperature effects. Such change shall be evaluated as described under clause 12.2 of this specification.

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.

If test section fails to maintain the specified test pressure after isolation, 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 joint or joints in which leakage or failure occurs. 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 'Specification for Welding Pipelines and Related Facilities'. Where failure 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.

The cost of repairs or replacements, followed by refilling and repressurizing 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 for furnishing all labour, equipment, materials, except those materials furnished by the COMPANY, and transportation necessary to repair and repressurize the section of the pipeline to the pressure at the time of recognition of leak or line failure. CONTRACTOR shall be entitled for compensation as per the provisions of the CONTRACT. All work of reinstalling line pipe, to replace pipe failures shall be done in accordance with the relevant specification included in the CONTRACT.

CONTRACTOR shall haul and stockpile all damaged and defective pipes to storage locations designated by the COMPANY. All cracks and splice resulting from failures 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.

18.9. TERMINATION

After the positive results of testing and collection of all data the test shall be terminated upon written approval given by the COMPANY.

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 developed 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



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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. Foam pigs shall then be passed in order to complete the line dewatering. CONTRACTOR shall use a number of foam pigs, each in different colors/ 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.

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 start of dewatering and disposal of hydrotest water, a procedure for treatment of inhibited water to prevent pollution shall be submitted by contractor to owner/ consultant for review and approval.

Upon completion of the testing and dewatering operation, any provisional traps 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.

18.10. 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:

- the cleaning, flushing, filling and testing procedures used;
- schematic layout of cleaning, filling and testing facilities;
- instruments calibration certificates;
- a profile of the pipeline that shows the test sites, all instrument and injection connections;
- pipe filling logs and records;
- additive specification, required concentration and additive injection records;
- pig specifications;
- pig inspection records including photographs of the damages;
- records of gauging pig survey and photographs;
- pressurization and stabilization records;
- Pressure and temperature recording charts with appropriate information inscribed thereon;
- Temperature data along the pipeline; dead weight tester logs and recording; 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 photograph of all leaks.

18.11. MEASUREMENTS

a) **Water Amount Measurement**



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The water volume added to the section to be tested shall be measured during the filling stage through a positive displacement meter (a turbine meter may also be used). In the calculation, as per clause 12.1 of this specification, use shall be made of the geometrical volume of the section in question.

b) Pressure Measurement

Pressure shall be measured with a dead weight tester with an accuracy of 0.01 bar that shall permit readings of at least 0.05 bar.

During the test the pressure shall be recorded by means of a pressure recorder featuring the following specification.

Accuracy	: $\pm 0.1\%$ of the full-scale value
Recording	: continuous on tape or disk, graph width 100mm
Feed	: 20mm/h for tape diagrams, 7.5°/h for disk diagrams
Recording	: to be such as to record pressure between 50% and 90% of the diagram width.

The pressure recorder shall be checked by means of dead weight tester at the beginning, during and at the end of the hydrostatic test.

A pressure gauge tested with dead weight tester shall be connected in parallel to the dead weight tester at the test head.

c) Temperature Measurements

Water temperature shall be taken at every 2 hours through the thermocouple that have been installed on the pipe wall along the section under test on the pipe wall.

Further the temperature measurement shall be taken :

- During the filling operation
- During the thermal stabilization stage
- During the hydrostatic test

The thermocouple's sensitivity shall enable temperature readings with an accuracy of $\pm 0.2^{\circ}\text{C}$.

- a) Water temperature shall also be measured on the pump delivery by means of a recording thermometer (temperature recorder) throughout the filling stage.

The recording thermometer shall have the following features :

Accuracy $\pm 1\%$ of the scale range



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Scale - 10° to + 40° C

Recording: Continuous on tape or disk, diagram within 100mm

Feed : 20mm/h for tape diagrams, 7.5°/h for disk diagrams.

- b) Ground temperature shall be taken by measuring pipe temperature at the thermocouple prior to starting the filling operation.
- c) 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 $\pm 1\%$ of the scale range Scale - 0° to + 60° C

Recording: Continuous on tape or disk, diagram width 100mm

Feed : 20mm/h for tape diagrams, 7.5°/h for disk diagrams.

18.12. 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:

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

Where:

V_p = computed water amount required to raise by P the pressure in the section to be tested (m^3).

V_t = geometrical volume of the section (m^3)

$A P$ = Pressure rise (bar) r_i = nominal inner radius of the pipe (mm) t = nominal pipe thickness (mm)

A = isothermal compressibility value for water at the pressurization temperature in the P range (bar. $^{-1}$) $\times 10^6$.

(Refer water compressibility factor vs pressure and temperature chart). For temperature above 30°C the values may be extrapolated.



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K = a dimensionless coefficient that is equal to a value of 1.02 for longitudinally welded pipe.

- 1.1 The pressure change due to a water temperature change shall be calculated by the following formula:

B

$$\Delta P = \frac{B}{0.884 r_i / t + A} \Delta T$$

Where,

ΔP = pressure change resulting from a temperature change (bar)

ΔT = algebraical 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 ($^{\circ}\text{C}^{-1}$) $\times 10^6$

(Refer table - A)

A = Isothermal compressibility value of water as estimated at the pressure and temperature values obtained at the end of test (bar^{-1}) $\times 10^6$ (Refer Figure 1)

r_i = nominal inner radius of the pipe (mm).

t = nominal thickness of pipe (mm).

18.13. PRECAUTIONS DURING THE TEST

In addition to all that has been expressly described in the procedures for carrying out the tests, the following additional requirements shall be complied with:

Provision shall be made for the installation of no-admittance signs to unauthorized personnel from the roads to the R.O.W.

Signs stating "PIPE UNDER TEST-KEEP OFF" with local language translation shall be placed where the pipeline is uncovered, and particularly where the provisional traps and stations are located. Such areas shall be suitably fenced in such a way as to prevent access of unauthorized personnel. No unauthorized personnel shall be closer than 40 m to the pipeline or equipment under test.

Provisional scraper traps shall be installed in compliance with methods and suitable locations so that their rupture cannot cause any injuries to the personnel or third parties.

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.



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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. All thermocouple installed in the pipeline shall be removed and damaged corrosion coating shall be repaired using COMPANY approved materials and procedure.

18.14. 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 to be agreed upon with the COMPANY at a later stage. CONTRACTOR shall obtain necessary approval from the COMPANY of the procedure and the type and quantity of the inhibitors used before commencement of the works.



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TABLE – A

Bar	$^{\circ}\text{C}$	1	2	3	4	5	6	7	8
0.981		-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	-70.40	-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		-81.90	-63.84	-46.43	-29.60	-13.36	+2.36	+17.57	+32.31
60		-78.47	-60.55	-42.27	-26.58	-10.46	+5.15	+22.89	+34.85
70		-75.03	-57.25	-40.10	-23.54	-7.56	+7.92	+22.89	+37.39
80		-71.60	-53.96	-36.94	-20.51	-4.65	+10.70	+25.55	+39.94
90		-68.16	-50.66	-33.77	-17.47	-1.73	+13.50	+28.23	+42.50
100		-64.72	-47.35	-30.60	-14.43	+1.18	+16.29	+30.90	+45.05
110		-61.28	-44.05	-27.43	-11.38	+4.10	+19.08	+33.58	+47.61
120		-57.84	-40.74	-24.26	-8.34	+7.02	+21.88	+36.26	+50.18
130		-54.40	-37.44	-21.08	-5.29	+9.95	+24.68	+38.94	+52.75
140		-50.96	-34.13	-17.90	-2.25	+12.87	+27.49	+41.63	+55.32
150		-47.53	-30.83	-14.73	+0.80	+15.79	+30.29	+44.31	+57.89
160		-44.10	-27.53	-11.56	+3.85	+18.72	+33.10	+47.00	+60.46
170		-40.67	-24.23	-8.40	+6.89	+21.64	+35.90	+49.69	+63.04
180		-37.24	-20.94	-5.23	+9.94	+24.56	+38.70	+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	+30.40	+44.30	+57.75	+70.77
210		-27.02	-11.09	+4.25	+19.04	+33.31	+47.10	+60.43	+73.34
220		-23.63	-7.82	+7.40	+22.06	+36.22	+49.90	+63.12	+75.90
230		-20.24	-4.56	+10.54	+25.08	+39.13	+52.69	+65.80	+78.48
240		-16.87	-1.30	+13.67	+28.10	+42.03	+55.48	+68.48	+81.05
250		-13.50	+1.94	+16.79	+31.11	+44.92	+58.26	+71.15	+83.61
260		-10.14	+5.17	+19.90	+34.12	+47.81	+61.04	+73.81	+86.81
270		-6.80	+8.39	+23.00	+37.11	+50.69	+63.80	+76.48	+88.73
280		-3.48	+11.60	+26.11	+40.09	+53.56	+66.57	+79.14	+91.29
290		-0.17	+14.80	+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

DIFFERENCE BETWEEN THE WATER THERMAL EXPANSION FACTOR AND THE STEEL
THERMAL EXPANSION FACTOR ($^{\circ}\text{C}^{-1}$) (10^{-6})



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TABLE - A

Bar	°C	2	10	11	12	13	14	15
0.981		+34.82	+4922	+63.20	+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	+95.70	+ 108.26	+120.49
40		+44.18	+58.14	+71.70	+84.87	+97.68	+ 110.14	+ 122.28
50		+46.60	+60.45	+73.90	+86.96	+99.68	+ 112.04	+ 124.07
60		+49.02	+62.76	+76.10	+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	+67.40	+80.53	+93.29	+ 105.69	+ 117.76	+ 129.50
90		+56.32	+69.73	+82.75	+95.41	+ 107.70	+ 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	+83.80	+96.18	+108.21	+ 119.90	+ 131.20	+ 142.37
160		+73.51	+86.15	+18.43	+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		+88.30	+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	+ 157.30
240		+93.22	+105.03	+116.48	+ 127.60	+ 138.42	+ 148.93	+ 159.18
250		+95.69	+107.39	+ 118.74	+ 129.76	+ 140.48	+ 150.90	161.05
260		+98.14	+109.74	+ 121.00	+ 131.92	+ 142.54	+ 152.87	+162.93
270		+100.60	+112.10	+ 123.25	+134.08	+ 144.61	+ 154.84	+164.81
280		+103.05	+ 114.44	+ 125.50	+136.24	+ 146.67	+ 156.84	+166.69
290		+105.50	+ 116.79	+ 127.75	+138.39	+ 148.73	+ 158.78	+168.57
300		+107.94	+119.13	+ 130.00	+140.54	+ 150.79	+ 160.75	+ 170.45

DIFFERENCE BETWEEN THE WATER THERMAL EXPANSION FACTOR AND THE STEEL
THERMAL

EXPANSION FACTOR (° C ⁻¹) (10 ⁻⁶)



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TABLE - A

Bar	°C	16	17	18	19	20	21	22	23
0.981		+ 127.52	+139.41	+151.00	+162.31	+ 173.37	+ 184.18	+ 194.75	+205.08
10		+ 129.02	+ 140.83	+152.36	+ 163.58	+ 174.56	+ 185.30	+ 195.79	+206.07
20		+ 130.71	+ 142.42	+153.85	+ 165.00	+ 175.90	+ 186.55	+ 196.96	+207.16
30		+ 132.40	+ 144.02	+ 155.35	+ 166.42	+ 177.23	+187.80	+ 198.14	+208.26
40		+ 134.10	+ 145.62	+ 156.87	+ 167.85	+ 178.58	+189.07	+ 199.33	+209.37
50		+135.80	+ 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	+163.00	+ 173.64	+ 184.03	+194.20	+204.14	+213.88
90		+ 142.67	+ 153.75	+164.56	+ 175.10	+ 185.41	+195.50	+205.36	+215.03
100		+ 144.42	+ 155.40	+166.11	+ 176.58	+ 186.80	+196.80	+206.59	+216.17
110		146.15	+ 157.04	+ 167.66	+ 178.05	+ 188.20	+198.12	+207.82	+217.33
120		+ 147.90	+ 158.70	+169.24	+ 179.54	+ 189.59	+199.44	+209.06	+218.49
130		+ 149.65	+160.36	+170.81	+ 181.02	+ 191.00	+200.75	+210.31	+219.66
140		+ 151.40	+162.03	+172.39	+ 182.51	+ 192.41	+202.09	+211.56	+220.84
150		+ 153.16	+163.70	+173.98	+ 184.00	+ 193.82	+203.42	+212.81	+222.02
160		+ 154.93	+165.37	+175.56	+ 185.51	+ 195.24	+204.76	+214.08	+223.20
170		+156.69	+167.05	+ 177.15	+ 187.02	+ 196.66	+206.10	+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	+208.80	+217.89	+226.79
200		+ 162.01	+ 172.10	+181.95	+ 191.57	+200.97	+210.16	+219.17	+227.99
210		+163.80	+ 173.80	+183.55	+ 193.09	+202.40	+211.53	+220.46	+229.20
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	+205.30	+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	+208.20	+217.00	+225.63	+234.08
260		+172.73	+182.30	+191.63	+200.75	+209.66	+218.40	+226.93	+235.31
270		+ 174.53	+184.00	+193.25	+202.29	+211.12	+219.77	+228.24	+236.54
280		+ 176.32	+185.70	+194.88	+203.83	+212.59	+221.16	+229.55	+237.77
290		+ 178.11	+ 187.42	+196.50	+205.37	+214.05	+222.54	+230.86	+239.01
300		+179.90	+189.13	+198.13	+206.92	+215.51	+223.93	+232.18	+240.26

DIFFERENCE BETWEEN THE WATER THERMAL EXPANSION FACTOR AND THE STEEL
THERMAL

EXPANSION FACTOR (° C ⁻¹) (10 ⁻⁶)



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TABLE - A

Bar	°C	24	25	26	27	28	29	30
0.981		+215.22	+215.14	+234.88	+244.41	+253.79	+263.00	+272.03
10		+216.13	+225.99	+235.66	+245.13	+254.44	+264.59	+272.57
20		+217.15	+226.94	+236.53	+245.94	+255.18	+264.27	+273.18
30		+218.18	+227.88	+237.41	+246.75	+255.93	+264.95	+273.80
40		+219.21	+228.85	+238.30	+247.58	+256.69	+265.64	+274.42
50		+220.25	+229.82	+239.20	+248.40	+257.45	+266.33	+275.07
60		+221.30	+230.79	+240.11	+249.24	+258.22	+267.04	+275.70
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	+248.47	+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	+254.40	+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	+283.20
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	+276.80	+284.64
200		+236.64	+245.12	+253.45	+261.63	+269.67	+277.59	+285.37
210		+237.77	+246.18	+254.45	+262.50	+270.54	+278.39	+286.11
220		+238.91	+247.26	+255.45	+263.49	+271.40	+279.19	+286.85
230		+240.06	+248.33	+256.46	+264.43	+272.28	+280.00	+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	+291.40
290		+247.01	+254.86	+262.57	+270.15	+277.61	+284.95	+292.18
300		+248.18	+255.96	+263.60	+271.11	+278.51	+285.79	+292.95

DIFFERENCE BETWEEN THE WATER THERMAL EXPANSION FACTOR AND THE STEEL
THERMAL

EXPANSION FACTOR ($^{\circ}\text{C}^{-1}$) (10^{-6})



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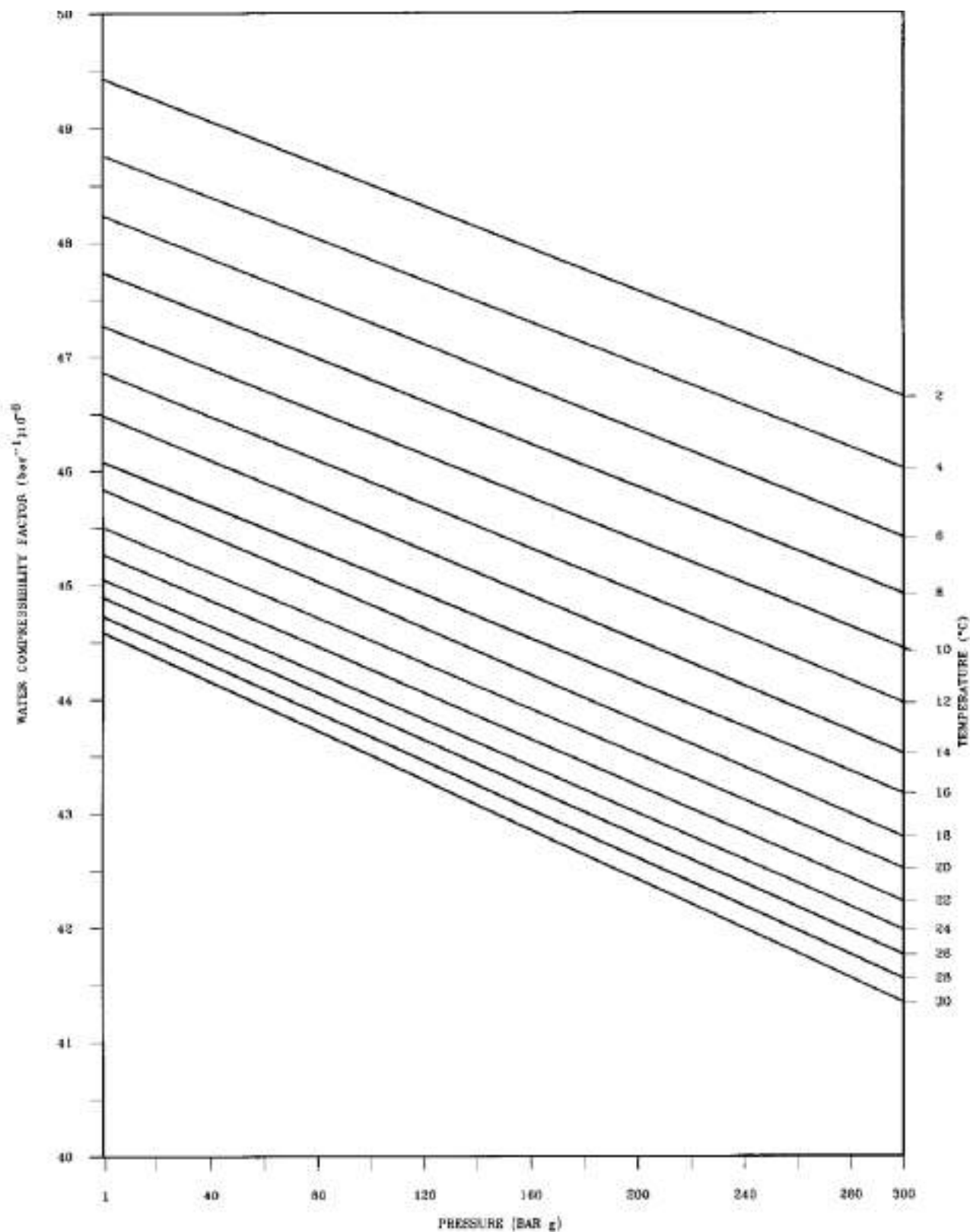


FIG 1. WATER COMPRESSIBILITY FACTOR v/s. PRESSURE AND TEMPERATURE



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CHAPTER-19

19. SPECIFICATION FOR CLEANING, SWABBING & DRYING OF PIPELINE

Contractor shall prepare detailed procedures for flushing of Pipeline/terminal piping, dewatering, swabbing, and drying of the pipeline, covering all aspects of work for company's approval. This shall include, but not limited to, the sequence and description of all operations, data on materials, equipment, instruments, consumables, communications systems, necessary calculations, detailed time schedule and organisation chart.

The Contractor shall be responsible for demonstrating the successful completion of all the activities. All necessary work to perform the job successfully including necessary modifications required shall be the responsibility of the Contractor.

Contractor shall design and supply all temporary line connections, valves, instruments, etc. as required during the various operations.

In the event of any detail which is not fully addressed, it is warranted by Contractor that work shall be performed in accordance with company's specification and the best recognised practices in the on-shore pipeline industry.

19.1. DEWATERING

During the dewatering operation the major quantity of hydrotest water shall be removed from the main pipeline and distribution network. It is the responsibility of the Contractor to develop suitable dewatering procedure and submit for Company's approval.

The disposal of the water shall be performed such that no harm is done to the environment.

The dewatering operation shall consist of number of dewatering pig runs when air is used as propellant for pig trains.

Bi-directional cup pigs shall be used and will be suitable for traversing the entire length of the pipeline/ pipe segment being dewatered. Contractor shall ensure that all the pigs are designed to prevent damage to the pipeline internal coating, if any.

The Contractor shall propose the minimum speed and the back pressure of the pigs in order that continuous operation will be performed without the pig getting stuck. Contractor shall submit all the calculations regarding this procedure and a contingency plan for implementation in case the pigs get stuck.

Contractor shall provide a suitable compressor for oil-free air with sufficient capacity and pressure.

Upon arrival of the pigs at the receiving end the Contractor in the presence of Company's representative shall remove the pigs without delay.



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Before proceeding to the next stage of operation Contractor shall ensure that bulk of the water has been removed from the pipeline. Contractor shall specify when the dewatering phase is finished and shall obtain approval of the company before proceeding to the next phase.

19.2. SWABBING

The swabbing operation is meant to reduce the remaining water in the pipeline to bring the pipeline into touch dry condition. Swabbing operation shall be carried out to ensure that there is no free water left inside the pipeline. This is done by driving number of swabbing pigs so that the weight increase in pig before and after the swabbing operation is not more than 20% of the initial weight of the pig. The Contractor shall submit the detailed procedure along with the duration of the swabbing operation and obtain approval of the company before starting the operation.

The Contractor shall ensure that the swabbing operation is considered to be completed when it is established that there is no free water left in the pipeline and the pipeline has achieved a touch dry condition. This shall be subject to company's approval.

19.3. DRYING

After completion of an entire pipeline system, the Contractor shall carry out drying of pipeline system if required by EIC.

Pipeline shall be dried upto dew point of -80°C .

Drying procedure shall be proposed and submitted by Contractor to Owner's Representative for approval



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CHAPTER-20

20. SPECIFICATION FOR PIPELINE MARKERS

20.1. 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 a pipeline network.

This specification shall be read in conjunction with the conditions of all specifications and documents included in the CONTRACT between COMPANY and CONTRACTOR.

20.2. 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.

20.3. GENERAL

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 drainage and as directed by EIC.

The pipeline markers shall be fabricated, painted (Painting shall be in accordance with the IOCL Standard Specification for Shop & Field Painting) and installed in accordance with the IOCL standard drawings included herein. Before start of fabrication of the markers, CONTRACTOR shall prepare and submit for COMPANY's approval the detailed scheme for the marker plates as applicable for the project.

The pipeline markers shall be installed, as far as possible, at locations such that to cause no hindrance to the regular use of the land or to the traffic.

20.4. KILOMETRE MARKERS

Kilometre markers shall in general be installed along the pipeline at every one (1) kilometre interval. Markers shall indicate cumulative distance in kilometres from the reference station, as directed by COMPANY. A kilometre marker is not required if the relative length between its location and any pipeline warning sign is less than 200 metres. Refer IOCL Standard Drawings issued with this tender or supplied by EIC during execution of work.

20.5. PIPELINE WARNING SIGN

Pipeline Warning Sign shall in general be installed at

<u>National and State Highway Crossings</u>	(2	<u>Nos.</u>
<u>Other Road Crossings</u>	(1	<u>No.)</u>
<u>Railway Crossings</u>	(2	<u>Nos.</u>



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Minor Water Crossings (less than 15m width) (1 No.)

Minor Water Crossings (above 15m width) (2 Nos.)

Major Water Crossings (2 Nos.)

Valve Station (1 No.)

- And at any other location as shown in the approved drawings and as directed by the COMPANY.

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 IOCL Standard Drawing

Warning Markers shall also indicate cumulative distance (chainage) in kilometres from the reference station, as directed by COMPANY.

20.6. Pipeline MARKERS

Pipeline markers shall be fabricated and installed as per the drawings at every 50 metres interval along the entire pipeline route. These shall be installed on either side of the pipeline alignment to define the ROW boundary limits. These shall also be installed at pipeline turning points to maintain the continuity of the ROW limits. Refer IOCL Standard Drawings issued with this tender or supplied by EIC during execution of work.



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CHAPTER-21

21. SPECIFICATION FOR CLEAN-UP AND RESTORATION OF RIGHT OF WAY

CONTRACTOR shall restore the ROW and all sites used for the construction of pipelines, water crossing and other structures in accordance with COMPANY's instructions, and deliver them to the satisfaction of COMPANY.

21.1. Surplus Materials

The following stipulations shall apply in case CONTRACT provides for supply of line pipe, bare and/or corrosion coated, by COMPANY.

All surplus and defective materials supplied by COMPANY shall be collected by CONTRACTOR and delivered to designated stockpile areas.

Only complete lengths of pipe element will be taken back by the Company. All other pipe surplus as the responsibility of contractor. Before termination of leak tests the contractor will draw up a final account of the pipes & transmit to Company 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

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.

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.

Only the material supplied by the Company 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 Disposal

21.2. Surplus Materials

The ROW shall be cleared of all rubbish, broken skids, empty cans, card board, sacks, stamps, trash, and leftover construction material. All burnable matter shall be burned, but only after obtaining appropriate permits for such burning. If burning is not allowed, CONTRACTOR shall haul the clean-up material to approved dumping area. All scrap metal and unburnable material shall be disposed of,



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in an appropriate manner, but never be buried in the ROW.

Surplus soil can only be removed from the Owner's plot after authorisation by COMPANY.

All dumping fees connected with the disposal of materials shall be to the account of CONTRACTOR.

All loose stones and rock exposed by the construction operations and scattered over the ROW or adjacent grounds shall be removed by CONTRACTOR and be transported to a location considered suitable by the authorities having jurisdiction, for satisfactory disposal. For stones, gravel or other hard material which may be buried in the trench the provisions of the specifications shall apply with the understanding that the use of the land by the land-owner and/or tenant will not be interfered with.

All road/pavement surfaces damaged during pipeline laying work and any other damage around RoU done during construction work shall be completely restored to original condition as per the requirement of authority/property owner and as directed by the EIC.

21.3. Temporary Structures

All auxiliary structures such as bridges, culverts, sheet piling, posts, signs, etc., which were erected or installed by CONTRACTOR as temporary measure, shall be removed. However, it may be necessary to remove the fence of ROW during the maintenance period.

21.4. Repair of Damage

Damages to roads, bridges, private property shall be repaired by CONTRACTOR. All fences and other structures which are damaged during construction shall be restored to original condition.

Slopes, water course sides or banks which have been partially or totally demolished during the execution of the works shall be properly consolidated and restored without waiting for their natural consolidation and settling.

All boundary stones which have been moved or removed during the work must be reset in their original location to the satisfaction of the landowner concerned.

On completion of clean-up, the ROW shall be restored to such stable and usable condition as may be reasonably consistent with the condition of the ROW prior to laying the pipeline. The COMPANY shall be completely indemnified and held harmless by CONTRACTOR from any and against all claims, demands, losses, expenses etc. that may arise in this behalf or the COMPANY may anyway suffer or sustain, relative to, arising out of, or in connection with same. The COMPANY may require from the CONTRACTOR signed Releases from land owners regarding satisfactory indemnification and restoration of their lands.

Special precautions shall be taken near slopes prone to erosions and landslides. All necessary steps shall be taken to ensure the rapid growth of grass by providing wicker barriers and by regulating the drainage of surface waters.

All cadastral or geodetic markers which may have been removed during the execution of the works shall be restored in their exact position.

Ditches for which no instructions for restoration have been issued, or restoration cannot be done according to existing banks because of the absence of it, shall be restored as instructed by COMPANY. The bed of ditches crossed by the pipeline, shall be cleaned over the full width or the



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ROW, also outside the ROW if necessary. This restoration might involve the supply and installation proper materials for backfill and protection, sodding or other precautions to prevent erosion or guarantee the stability. Work has to be done after deliberation and acceptance of the authorities and COMPANY. Other field drains have to be restored by hand and/or special equipment to be used for that purpose as soon as possible and if necessary, also outside the ROW.

Any subsidence, cave-ins, wash-outs, which have been caused during the pipeline construction and maintenance, caused by whatever reason within the edge of ditches and open drains, shall be repaired by CONTRACTOR immediately or at first notice given by COMPANY.

After the clean-up, the ROW of pastures has to remain fenced and to be removed during the maintenance period. When agricultural and other traffic (requested by tenant) have to cross the ROW the cross-overs have to be fenced with the same material as the ROW. If necessary, special materials have to be used to allow traffic on the cross-over. Fencing of the right-of-way as specified shall not be removed until CONTRACTOR has obtained written permission by COMPANY. In general this has to be done during the maintenance period.

All openings in or damage to the fence or enclosures shall be repaired by installing new fencing of quality which shall be at least equal to the parts damaged or removed. Provisional gates shall be removed and replaced with new fencing. All repairs to fences and enclosures shall be carried out to the complete satisfaction of COMPANY, land owner and/or tenant.

If, in the opinion of COMPANY, the sod in pasture land has been damaged by vehicles and wheel tracks are visible, the ROW shall be tilled with a disc-harrow or rotary cultivator several times. The damaged sod shall be firmly cut up and thoroughly mixed through the top-soil. In general the ROW has also to be ripped. After this procedure no closed-in layers must be found and sufficiently loose top-soil 25 to 30cm thick must be present. The whole procedure has to be approved by COMPANY. Subsequently, the entire ROW which is part of pasture land, shall be prepared for seeding and fertilized according to the instructions of COMPANY.

In crop fields the tillage shall consist of passing over the land several times with a disc harrow, cultivating with a spading machine, or plow, to a depth of approx. 20 cm. In general the ROW has also to be ripped. After this cultivation process no closed-in layers must be found in the ROW. The equipment used and methods adopted shall require the approval of COMPANY. Ripping, has to be done with rippers with a distance of 50 cm between the ripper blades. The type to be used shall be approved by COMPANY.

A sapling of any plant/tree uprooted or cut during construction shall be planted along the route as per the direction of the COMPANY and in accordance with the Forest Preservation Act, 1981. The cost of sapling and its plantation shall be to CONTRACTOR's account.

The ROW and the backfilled trench in particular has to be finished in such a way that after settlement of the soil the fields are at their original level.

If during the maintenance period certain parts of the ROW are lower than the original level, COMPANY can order CONTRACTOR to bring these parts to the original level. If the level of the ROW for clean-up is ordered by COMPANY, risk of above mentioned additional restoration shall not be to CONTRACTORS account.

In cases where heavy damage has occurred to the structure of the subsoil as a result of special circumstances, COMPANY reserves the right to order CONTRACTOR to carry out special work. Said special work can include:



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- spading with dragline (depth 30 - 80 cm);
- spading with dragline (depth 80 - 100 cm);
- fertilizing;
- Cover with sand.

If during clean-up operations, soil shortages become apparent outside the trench, CONTRACTOR shall supplement said soil shortage using suitable materials, approved by COMPANY.

If site and/or climatic conditions should render this necessary, COMPANY shall have the right to order CONTRACTOR to suspend certain parts of the WORK related to the clean-up and postpone it to a later date.

If on site, as a result of the work and after careful backfilling and compacting, a subsoil surplus exists, this shall be worked up by grading and compacting below the subsoil top layer and as a rule this shall be done in the same plot of land. It shall not be permitted to remove the surplus from the plot concerned, unless it concerns rejected soil which has to be removed. Working up surplus soil or removal of rejected soil shall be considered to pertain to the WORK.

To work a soil surplus into the ground CONTRACTOR shall remove an additional strip of top soil beside the trench. Next the upper layer of sub-soil shall also be removed. Both soil types shall be stored separately across a width depending on the size of the soil surplus. The soil surplus shall then be distributed across the trench thus widened, after which it shall be graded and compacted and subsequently the top layer of subsoil and the top-soil shall be replaced in the correct order, in accordance with the Specifications.

In case COMPANY has given prior permission for mixed excavation of the sub-soil as well as in cases where COMPANY deems mixed excavation permissible, the above provision of separate storage of the upper layer of sub-soil shall not apply to the working up of the soil surplus.

In cases where the soil surplus can be worked up in other plots where soil shortages have arisen due to the WORK, this shall only be done after prior permission by landowner, land-user and COMPANY.

21.5. Soil Shortages

If due to unforeseen circumstances during backfilling and compacting there isn't enough soil to fill the trench properly, or to install the crown height as stipulated, CONTRACTOR shall supply the necessary backfill material.

Soil shortages shall be supplemented and applied before the top-soil is replaced.

The soil to be supplied shall be worked up in those locations and into those layers where a soil shortage has been established. The quality of the supplemented soil shall be equal to that of the shortage.

21.6. MAINTENANCE DURING DEFECTS LIABILITY PERIOD

Defects liability Period is defined as period of liability in the CONTRACT/GCC/SCC.



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COMPANY reserves the right to carry out instrumented pigging survey of the completed pipeline.

CONTRACTOR shall be responsible for making good with all possible speed at his expense any defect in or damage to any portion of the Work which may appear or occur during the Defects liability Period and which arise either:

- a) From any defective material (other than supplied by COMPANY), workmanship or design (other than a design made, furnished or specified by COMPANY and for which CONTRACTOR has disclaimed responsibility in writing), or
- b) From any act or omission of CONTRACTOR done or omitted during the said period.

If such defect shall appear or damage occur, COMPANY 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, COMPANY 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.



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CHAPTER-22

22. MDPE PIPELINE LAYING WITH STEEL LINE

Scope includes laying of MDPE pipeline in excavated trench with or without casing ; insertion of the carrier pipe in casing pipe (on case to case basis) laying of warning mat electro-fusion of joints and re-installation of pre-cast slabs as per specification after instruction of EIC / Site Engineer of Owner.

For laying of MDPE pipeline, PNGRB specification (T4S) & ASME B31.8 shall be followed.

22.1. MOLING

The Manual Moling shall be carried out as per the requirement specified by Owner / Owner's representative and approved procedures. The contractor has to carry out survey of the underground utilities before going for the Moling to avoid any damage to other utilities. No extra payment will be made for any trial/abandoned pits made during the survey. The supply of all equipment required for carrying out moling work is in contractor's scope. The type of moling to be carried out i.e. with or without casing shall be at the discretion of Owner and prior approval is to be taken before starting the Moling.

For Moling the contractor shall ensure that the size of the hole shall not be more than 20% of the size of the casing/carrier pipes whichever is applicable. After completion of Moling the hole shall be properly compacted / filled with soil by watering and by approved procedures.

The length of the Hole (excluding the sizes of the pits on both ends) shall be considered for the measurement of Moling length.

22.2. HDD

Bundle pulling of MDPE pipes with steel line is not allowed. MDPE pipe is to be laid separately maintain at least 500mm gap from steel network. Depth of MDPE pipe shall be less than that of steel pipe.

MDPE pipe shall always be laid before steel line while laying the pipeline by HDD method.

Contractor shall prepare and submit HDD plan, procedure and profile design for approval prior to construction work.

22.3. JOINTING OF POLYETHYLENE PIPE

The procedure for jointing of PE pipe and fittings machines is attached as Annexure #2 and as per Specification for ELECTROFUSION FOR PE PIPES AND FITTINGS. Only Bar coded into electro-fusion machine (Automatically Readable) that can read the bar code of the fittings automatically shall be used for joining of the MDPE pipes/fittings. Manual feeding Electro-fusion machines are not acceptable for jointing purpose. The contractor has to submit the certificate of calibration of Fusion machine at the time of start of work and at fixed intervals as per the instructions of Owner. Contractor



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shall ensure that the machines are always available at site. No stoppage of work due to the non-availability of machines shall be allowed.

The contractor shall flush the Pipeline with air to remove dust, water, mud etc. before fusing the joints. Before jointing, the Contractor shall place packing sand under the pipes on both sides of the joint to keep the pipes in line and at the correct alignment during the jointing process. The jointing process shall start only after Alignment clamps with the correct size are aligned with the pipe and coupler during the electro-fusion cycle.

The Contractor shall ensure that polyethylene pipe is only cut with an approved plastic pipe-cutting tool (Rotary Cutter up to 63mm/Guillotine Cutter for 63mm and above). Before fusion is attempted, the contractor shall remove the oxidized surface of the pipe using Universal Scraper up to 63mm/Rotary Peeler for 63 mm and above before inserting into the electro-fusion coupler. The tool must remove a layer of 0.1mm to 0.4mm from the outer surface of the polyethylene pipe. No fusion will be allowed without clamping device and the approved cutting tools (Hack saw shall not be allowed for cutting the pipe).

The contractor has to supply all the consumables required for carrying fusion of the joints (like tissue paper, napkin, acetone etc.).

If, upon inspection, the EIC determines a joint is defective, Contractor shall remove the joint by an approved method. The cost of replacing joint shall be borne by the Contractor including the cost of pipe and fittings removed.

For electro-fusion joining, the contractor must bring own tools, tackles and equipment's. Only, approved Jointers shall carry out fusion of all joints. Contractors shall provide the list of jointers to be used on the job and make arrangements for Qualification Testing of the jointers in presence of Owner / Owner's representative as per the standard procedures. All approved Jointers shall bear identity cards signed by Owner / Owner's representative during fusion job and shall furnish the same on demand by Owner / Owner's representative. Applicable penalties shall be levied, in case; it is found that fusion is being carried by non-qualified jointers as per the provisions made in Special Conditions of the Contract.

Contractor shall arrange generator along with voltage stabilizer for power supply to fusion machine. Taking power connection from electric poles, connections without written permission from the concerned authorities or residential premises is strictly not permitted.

Equipment

- The control box input supply to be from a nominal 240V generator, which is normally of approximately 5kVA capacity. The nominal output of the generator is to be 240V +15%, I 0% between no load and full load. Control boxes are to include safety devices to prevent excessive voltages being present at the control box output. The safety device shall operate in less than 0.5s.

Note that extension leads are not to be used on the control box outlet connections.

WARNING: Control boxes are not intrinsically safe and must therefore not be taken into the trench.



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- A mechanical pipe surface preparation tool is to be used before fusion is attempted. The tool is to be capable of removing the oxidized surface of the pipe in excess of the insertion depth. The tool is to remove a layer of surface material 0.20.4 mm thick from the outer surface of the pipe preferably in a continuous strip of swarf over that length and round of the pipe.
- Pipe clamps for restraining, aligning and re-rounding the pipes in the fusion process are to be used.
- Pipe cutters with saw and saw guide.
- Protection against adverse weather conditions.

ELECTRO FUSION JOINTING PROCEDURE

Preparation

- a. Ensure there is sufficient space to permit access to the jointing area. In a trench, a minimum clearance of 150 mm is required.
- b. Check that the pipe ends to be jointed are cut square to the axis of the pipe and any burrs removed.
- c. Wipe pipe ends using clean lint-free material to remove traces of dirt or mud, etc...
- d. Mark the area over which the oxidized pipe surface is to be removed, i.e. In excess of the insertion depth, on each pipe to be jointed by placing the socket of the bagged fitting alongside the pipe end. Trace a line round the circumference at the appropriate distance from the end of the pipe using a felt tip pen or similar.

Note that the fitting should not be removed from the packaging at this stage.

- e. Connect the electro fusion control box input leads to the generator.
- f. Check that the reset stop button, if fitted on the control box, is in the correct mode.
- g. Using the pipe end preparation tool, remove the entire surface of the pipe uniformly, preferably in continuous swarf over the area identified, i.e. In excess of the insertion depth.
- h. A mechanical scraper could be used however; there is a considerable risk that the end preparation will not be adequate with the use of such a tool.

Note that the prepared pipe surface should not be touched by hand.

- i. Remove the fitting from its packing and clean the scraped area of the pipe surface and the bore of the fitting with a disposable wipe impregnated with Iso-propanol/Acetone. Ensure the prepared surfaces are completely dry before proceeding.

Note that while Iso-propanol is a suitable cleaner, its use is subject to local Health and Safety Regulations.

- j. Check that the pipe clamps are of the correct size for the pipes to be jointed.
- k. Insert the pipe ends into the fitting so that they are in contact with the center stop.
- l. Using the pipe clamps, secure the pipes so that they cannot move during the fusion cycle. Check that the pipe ends and the fitting are correctly aligned.
- m. Check that there is sufficient fuel for the generator to finish the joint. Start the generator and check that it is functioning correctly.
- n. Switch on the control box.
- o. Connect the control box output leads to the fitting terminals and check that they have been fully inserted.
- p. If required by the control box enter the fusion jointing time into the control box timer. The jointing time is indicated on the fitting. Check the correct time is shown on the control box display.



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Note 1: Automatic control boxes are available which obviate the need to enter the fusion time.

Note 2: Gloves and goggles should be worn during the Fusion process.

- q. Press the start button on the control box and check that the heating cycle is proceeding as indicated on the display.
- r. On completion of the heating cycle, the melt indicators should have risen. If there is no apparent move in the melt indicators, the joint should be cut out and a fresh joint made (See note 3 below).
- s. If a satisfactory joint has been made, the joint is to be left in the clamps for the cooling time specified on the fitting or the automatic control box.

Note 3: If the fusion cycle terminates before completion of the countdown, check for faults as indicated by the control box warning lights and check that there is adequate fuel in the generator. DO NOT attempt a second fusion cycle within one hour of cooling of joint at Ambient Temperature of the first attempt.

22.4. Testing

All MDPE pipelines shall be water cleaned & pneumatically tested as per ASME B31.8.

MDPE pipeline shall be tested at 6.0bar pressure for 24 hours.

22.5. Repair of MDPE Pipeline

Any damage occurred in MDPE section for any reason shall be repaired by Contractor without any extra cost to the owner. After necessary repair, pressure testing shall again be carried out in MDPE section.



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CHAPTER-23

23. SPECIFICATION FOR PURGING AND COMMISSIONING

This specification refers to the preparatory and execution operations for purging and commissioning a gas distribution network.

Prior to commence purging and commissioning, contractor shall submit following for approval

- Nitrogen Pugging plan and procedure
- Line diagram of entire network planned for purging/commissioning
- List of equipment and machineries
- Purity certificate of Nitrogen
- Drawing for purging/commissioning header
- Drawing for vent pipe assembly

Purging/Commissioning shall be in accordance to the “Petroleum and Natural Gas Regulatory Board (Commissioning and Gas Charging in Steel Pipelines for City or Local Natural Gas Distribution Networks) Guidelines, 2016”

1.0 Definitions.

In these specification, unless the context otherwise requires,-

- (a) “direct purging” means the displacement of air by natural gas or vice versa;
- (b) “purging” means to free a gas conduit of air or gas, or a mixture of gas and air;
- (c) “displacement purging” means purging to a specified end-point with minimal mixing of incoming and outgoing gases;
- (d) “Engineer In-charge or responsible engineer” means the qualified engineer appointed by IOCL who will be responsible for the application of all or part of these regulation;
- (e) “indirect purging” means the displacement of natural gas by inert gas followed by displacement by air or vice versa;
- (f) “inert gas” means any gas or mixture of gases which will neither burn nor support combustion;
- (g) “Lower Flammable Limit (L.F.L)” means the concentration of flammable gas, vapor or mist in air above which combustion can be sustained. The term may be considered equivalent to the term “lower explosive limit” (L.E.L) e.g. for methane, LFL= 5 % gas in air;
- (h) “purge end-point” means a pre-specified mixture of components, chosen so that hazardous mixtures cannot be formed at any stage of the purging operation;
- (i) “purge pressure” means the (inlet) pressure in the pipe during purging ;
- (j) “purge velocity” means the velocity of the purge gas in the pipe being purged;
- (k) “purge volume” means the theoretical volume of the purge medium to complete the purge;
- (l) “slug purging” means purging by the formation of a barrier of inert fluid between natural gas and air;
- (m) “stratification” means the situation where low density gas (e.g. natural gas) flows over the higher density gas (e.g. air or nitrogen) or, where high density gas flows under low density gas;
- (n) “vent velocity” means velocity of the purge gas in the vent pipe.

2.0 MATERIALS AND EQUIPMENT



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The Contractor shall supply all materials and equipment and instruments necessary for:

- Purging the pipelines from air to nitrogen and nitrogen to gas (oxygen meter, hydrocarbon meter etc)
- Supervising the purging operations.
- Checking that the performance of the accessories conform to the contract.
- Adjusting the accessories.
- Commissioning the pipeline.

The contractor shall also supply and have ready on site:

- The replacement materials such as valve operation indicators, plastic caps for casing, etc. which may be damaged during the start-up operations. If such materials are taken from the spare to be supplied by the contractor they shall be immediately replaced
- Safety equipment such as fire extinguishers, gas masks, gas analyzers etc., to ensure labour and public safety.

3.0 WORK SCHEDULE

The contractor shall draw-up and submit a purging schedule to the Engineer's approval, in the conditions specified in the specification "Documents drawn-up by the contractor".

This schedule shall specify:

- The portion of network to be purged.
- The characteristics of the works to be purged.
- The operation sequence and the description of the equipment intended to be used.
- The staff intended to be mobilized including the necessary specialist and technicians of the manufacturers of the materials if necessary.

4.0 SAFETY PRECAUTIONS

The contractor may not proceed to the purging until safeguards have been placed around the installations and works, where they are needed in application of the safety regulations.

The contractor shall be required to satisfy any public regulations. He shall, where necessary, obtain permission from the concerned Authorities before beginning any operations, and he shall take all the necessary precautions to ensure safety of persons and properties during the purging operations, these precautions must be made known to all persons concerned and if necessary shall be publicized.

Adequate no. of Safety gadgets, personal protective equipments, emergency handling facilities, sign boards, do and don'ts etc as required in the commissioning document should be positioned and available at designated place before start of commissioning activities. A minimum of following shall be ensured at all purging sites.



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- A minimum of 2 dry powder type extinguishers (5 kg) should be available on all purging /venting sites.
- Smoking, naked light or other sources of ignition should be prohibited. Warning signage/ pictograms like “NO SMOKING” and “NO NAKED LIGHTS” should be prominently displayed around the work site, including at vent points.
- Electrical continuity bonds (copper) need to be fitted across separated metallic pipes prior to purging operation.
- Adequate hearing protection should be available, where required.
- It should be emphasized that purged gas other than air is potentially dangerous leading to asphyxiation and information to prevent asphyxiation should be provided in procedure.

5.0 REPAIRS

The contractor shall replace as quickly as possible any parts and devices supplied by himself and proving to be defective.

6.0 PERFORMANCE DEFECTS

If the performances of the accessories do not meet the contract requirements, the contractor shall take any necessary steps to remedy the situations as soon as possible, even by installing any additional device which might prove necessary.

7.0 CERTIFICATE OF COMPLETION

When the following are completed in accordance with the contractor provisions:

- The network is completely constructed and all accessory installations are installed and tested including telecommunication cables if any.
- The network is purged from air to gas.
- It prove to be tight.
- The accessory performances prove to conform to be contract.
- The accessories are adjusted to the operation conditions.
- All connections are made, all marker plates and signs are installed.
- The site test certificate regarding the works have been signed by the Engineer.
- The factory test certificate regarding the materials have been handed over to the Engineer by the Contractor.
- The spare parts and tools have been handed over to the company by the contractor.
- The technical records have been handed over to the Engineer by the Contractor.

The Engineer shall deliver the certificate of completion regarding the network or concerned portion of network to the contractor.

8.0 Pre-Commissioning checks.

Prior to commissioning, the entire pipeline system shall be checked with respect to the “as built drawings” and other design specifications. The pre-commissioning checks should include, but not limited to, following, namely:-



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a) Tightness test.

The tightness test (pneumatic) should be completed at a pressure of at least 2 bar(g) with air or any inert gas for steel network), after completion of all mechanical activities including hydro test, cleaning and drying process. For low pressure network tightness test should be done at least at operating / working pressure.

Once the pipeline is connected with live line for purging/ gas-in, it should be commissioned immediately and completed as a continuous process.

b) Function-test of field equipment and system.

The supports, route markers, valves, instruments, controls, interlocks etc. are adequately installed and physically checked along the pipeline. All the valves / equipment are checked for intended applications by simulating the operation condition before the gas is introduced to ensure that each valve is operating correctly. The pipeline and allied systems, including safety systems shall be fully function-tested. The pressure and temperature gauges shall be calibrated prior to use before installation.

c) Survey of the pipeline.

A detailed survey (preferably through line walk) of the pipeline route shall be carried out to confirm that no leakage is observed along the pipeline alignment and at the associated equipments & installations and also to ensure that proper fittings / supports, route markers, SV installation as applicable etc. have been installed along the network. Ensure all points other than purging & venting are in closed condition.

d) Purging in the Pipeline.

The entire primary network, which is ready and proposed for commissioning, shall be purged with air or Inert Gas at positive pressure of not less than 2 bar(g). Reading of Pressure Gauge installed at each Inlet point, Exit point and other specific points {like Sectionalizing valves (SVs) and Tap off Points (TOPs)} shall be noted in a specified format.

e) Checking of Communication System.

Availability of proper communication system should be checked and confirmed to the Commissioning In-charge.

9.0 Vent Design.

Design of vent pipe wherever applicable should be as below:

- Minimum height of vent pipe shall be 3 metres above working level. It should be vertically installed and should discharge to open air;
- Vent pipe should be sited at least 5 meters downwind of possible sources of ignition or potential sources of ignition;
- Vent pipe should be firmly supported and sited where vented gas will not drift in to a



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residential area;

- Vent pipe should be metallic, as the gas velocities involved could generate static electricity in polyethylene vent pipes;
- Vent pipe should be properly earthed and not fitted with a flame trap.

10.0 Safety Audit.

Before start of commissioning works, contractor shall help IOCL to carry out a Safety Audit, the relevant details of which shall be recorded on the Safety Checklist in accordance with the Technical & Safety Guidelines as per Technical standards and ERDMP.

The Audit shall verify that:

- a) All Commissioning personnel have been made aware of the safety hazards of the operations to be undertaken.
- b) Procedures & Documents including those for possible emergencies shall be developed and followed.
- c) The agreed area has been cordoned off.
- d) Communications are working satisfactorily.
- e) Work Permit is issued to the relevant agency.

11.0 Commissioning Preparation.

After completion of the pre-commissioning checks, the pipeline network is considered to be ready for the commissioning.

Written procedures shall be prepared to ensure that operations are carried out in a safe manner.

The commissioning basically consists of the following steps:

- a) Freeing of the primary network of O₂ & moisture (i.e. pipeline, SVs, and TOPs).
- b) Freeing of the primary network of O₂ should be done by air or inert gas purging propelled by Natural Gas.
- c) Venting shall be carried out at the respective stations / vent points / end points as and when found necessary.
- d) The pipeline section shall be in proper condition before the gas is to be injected into it. The pipeline section shall be dried properly as per the specification and entire pipeline shall be purged as per the pre-commissioning procedure laid in this specification.
- e) All SVs and TOPs having branch lines for future shall be isolated by means of Blinds at downstream.
- f) All Tee-offs in-between lines shall be isolated by means of Blinds at downstream of the first Isolation valve of the TOPs.
- g) Schematic Drawing of the entire primary network shall be made available to Commissioning In- charge (CI) and other persons as per the directions of CI.

12.0 Purging and Commissioning.

- (a) Direct Purging.

Direct Purging is NOT allowed.



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(b) Indirect Purging.

Purge end-points testing for indirect purging should be as per table below using suitable instrument.

Operation	End-point
Commissioning	Using N ₂
Air to inert	< 1% oxygen
Inert to natural gas	Normally > 95% v/v natural gas (corresponding to 90% gas in air reading on a suitable instrument when calibrated for methane)
Decommissioning	Maximum of 2% Natural gas (40% of LFL). Two consecutive readings at an interval of 10 minutes shall be recorded
Natural gas to inert	Maximum of 5% natural gas
Inert to air	> 20% oxygen

13.0 Commissioning Process.

- Valves are checked for respective opening / closing positions.
- Check Line Pressure. In case of any over pressure in the line, open the Vent & Drain Valves and depressurize the line.
- Close all the Vent Valves.
- Open the Vent Line if any.
- Nitrogen flow rate shall be controlled by opening / closing the inlet purging valve.
- Ensure proper Nitrogen Purging at first Vent point next to the starting point.
- After Confirmation from vent point, open the valve.
- Record the line pressure at every 10 minutes interval.
- Ensure Positive Pressure (not less than 1.5 kg/cm²) for Nitrogen Purging in the entire Pipeline.
- After ensuring the nitrogen purging, close purging valve.
- Remove the Nitrogen Purging Connection and install a Blind / Plug and Close the Valve.
- Gas-in to be started after confirmation of readiness at all stations with closed valves in closed position.
- Gas Inlet valve to be opened for 50 angle (crack open) and simultaneously nitrogen shall be vented. With further valve opening, Pipeline shall be pressurized up to 5 kg/cm² at first SV installations (or end point if primary network is less than 2.5 kms). Gas availability shall be ensured at this point by LEL / Methane detector and shall be communicated back to Control Station.
- Subsequently, each section of Pipeline shall be pressurized so that entire ML network is free from Nitrogen and is pressurized with Natural Gas at a pressure of 5 kg/cm² up to end of the pipeline.
- Hold the pressure of 5 kg/cm² for a minimum of 01 hour and check the entire ML network for No Leakage.
- If any leakage is observed, it shall be recorded and arrested properly. No Leakage condition shall be recorded at each location of the ML network (i.e. pipeline, SVs, and TOPs).
- In No Leakage condition, Natural Gas Inlet Valve shall be further opened to increase Line Pressure to 10 kg/cm².



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- r) Hold the pressure of 10 kg/cm² for minimum 01 hour and check the entire ML network for No Leakage.
- s) Repeat the above mentioned process in the steps of 10 kg/cm² until the MAOP of the ML network is reached.
- t) Final Leak test to be carried out at Maximum Allowable Operating Pressure (MAOP).
- u) Valve position is to be recorded in the Specified Format and shall be maintained as per post Gas-In valve status.

14.0 Commissioning Records.

The commissioning records should as a minimum include, but not limited to, following, namely:-

- (a) Cleaning, swabbing and drying procedures.
- (b) Cleaning, swabbing and drying results.
- (c) Functional-testing of pipeline monitoring instruments.
- (d) Control equipment systems.
- (e) Completed pre-start checklist.
- (f) Purging report.
- (g) Commissioning report.

15.0 Report Formats



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REPORT FORMATS- PRE NITROGEN / INERT GAS IN VALVES POSITION CHECK LIST

Name of Client: _____ Station/Area/location: _____
Report No.: _____ Date: _____

Details of Steel Pipe Line/ Section:

Dia(Ø)		From/Point/ location)	
Length, Mtr		To (Point/ location)	



S.N	Valve No.	Type of Valve	Position	Remarks/ O.K./ Not O.K.
Witnessed by :				
Organization	Contractor		TPIA / Consultant	Client
Name				
Signature				
Date				



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POST NATURAL GAS IN VALVES POSITION CHECK LIST

Name of Entity: _____ Station/Area/location: _____
Report No.: _____ Date : _____

Details of Steel Pipe Line/ Section:

Dia(Ø)		From (Point/ location)	
Length, Mtr		To (Point/ location)	

S.N	Valve No.	Type of Valve	Position	Checked	Found Position	Remarks/O.K./ Not O.K.
Witnessed by :						
Organization		Contractor	TPIA / Consultant		Client	
Name						
Signature						
Date						



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▲ **NITROGEN / INERT GAS PURGING RECORD**

Name of Entity: _____ Station/Area/location: _____
Report No.: _____ Date: _____

Details of Steel Pipe Line/ Section:

Dia(Ø)		From (Point/ location)	
Length, Mtr		To (Point/ location)	

<u>S.N</u>	Time	P/L Purging Pressure(Bar)	Temp (°C)	Inert gas Flow Vol (M ³)	%age of HC in the vent	Remarks

Witnessed by :

Organization	Contractor	TPIA / Consultant	Client
Name			
Signature			
Date			



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NITROGEN/INERT GAS PURGING REPORT

Name of Entity: _____ Station/Area/location: _____
Report No.: _____ Date: _____

Details of Steel Pipe Line/ Section:

Dia(Ø)		From (Point/ location)	
Length, Mtr		To (Point/ location)	

S. N	Subject	Detail description	
1.	Reason of purging	To lower the percentage of O2 to the acceptable limit (< 1%), moisture within specified limits	
2.	Estimated duration of work		
3.	Type of purging		
4.	Purging Media	Nitrogen / Inert Gas	
5.	Start Date & Time		
6.	Finish Date & Time		
7.	Total Duration		
8.	Calculated Volume <u>reqd</u> to purge		
9.	Actual Volume Used		
10.	Inlet Pressure		
11.	Outlet Pressure		
12.	Final pressure after packing		
13.	Injection Point		
14.	Sampling Point		
15.	Acceptance Criteria		
16.	Final O2% achieved		
Witnessed by:			
Organization	Contractor	TPIA / Consultant	Client
Name			
Signature			
Date			



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COMMISSIONING REPORT

Name of Entity: _____ Station/Area/location: _____
Report No.: _____ Date: _____

Details of Steel Pipe Line/ Section:

Dia(Ø)		From (Point/ location)	
Length, Mtr		To (Point/ location)	

S. N	Subject	Detail description
1.	Name of the Company	
2.	Equipment to be charged	
3.	Location of the Equipment	
4.	Reason of Charging	Gas Pipeline Commissioning
5.	Estimated duration of Work	
6.	Type of Charging	Nitrogen Propelled by Natural Gas
7.	Charging Media	Inert / Nitrogen / Natural Gas
8.	Start Date & Time	
9.	Finish Date & Time	
10.	Total Duration	
11.	Final Pressure after Packing	
12.	Sampling Point	
13.	Acceptance Criteria	Oxygen < 1%, moisture within specified limits
14.	Final filling media	Natural Gas

Remarks:

Witnessed by:			
Organization	Contractor	TPIA / Consultant	Client
Name			
Signature			
Date			



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GAS CHARGING REPORT

Name of Entity: _____ Station/Area/location: _____

Report No.: _____ Date: _____

Details of Steel Pipe Line/ Section:

Dia(Ø)		From (Point/ location)	
Length, Mtr		To (Point/ location)	

S. N	Subject	Detail Description		
1.	Name of the Company			
2.	Equipment to be charged			
3.	Location of the Equipment			
4.	Reason of Charging	To lower the Oxygen to the acceptable limit (<1%), moisture as specified		
5.	Estimated duration of Work			
6.	Type of Charging			
7.	Charging Media	Nitrogen/Inert/ Natural Gas		
8.	Start Date & Time			
9.	Finish Date & Time			
10.	Total Duration			
11.	Calculated Volume required			
12.	To charge			
13.	Actual vol. Used			
14.	Inlet pressure			
15.	Outlet pressure			
16.	Final Pressure after Packing			
17.	Charging point			
18.	Sampling Point			
19.	Acceptance Criteria	Oxygen < 1%, moisture within specified limits		
20.	Final LEL achieved	100%LEL		
21.	<u>Remarks :</u>			
22.	Witnessed by:			
Organization		Contractor	TPIA / Consultant	Client
Name				
Signature				
Date				



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SECTION-II

TECHNICAL SPECIFICATION FOR PIPING FABRICATION AND ERECTION



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1.0 GENERAL

This specification covers general requirements of fabrication and erection of aboveground and trench piping systems at site. The specification covers the scope of work of contractor, basis of work to be carried out by contractor and standards, specifications and normal practice to be followed during fabrication and erection by the contractor.

2.0 SCOPE

Generally, the scope of work of contractor shall include the following:

- 2.1 Transportation of required piping materials, pipe support and all other necessary piping materials from Owner's storage point or contractor's storage point (in case of contractor's scope of supply) to work site / shop including raising store requisitions for issue of materials in the prescribed format & maintaining an account of the materials received from Owner's stores.

Contractor's Scope of Supply:

All fittings & valves below 4" shall be supplied by contractor which shall be paid as per relevant SOR.

Gaskets, Studs & Bolts installed in flanged joint shall be supplied by Contractor. It is to be noted that all temporary gaskets used for testing purpose shall be supplied by the contractor without any cost to the owner. Contractor shall replenish the gaskets after final testing.

- 2.1.1 Piping materials include the following but not limited to the same.

- a. Pipes (All sizes and schedule)
- b. Flanges (All sizes, types & Pressure ratings).
- c. Fittings (All sizes, types and schedule)
- d. Valves (All sizes, types and Ratings)
- e. Gaskets (All sizes, types & Ratings)
- f. Bolts, Nuts or M/C Bolts (All types)
- g. Expansion Joint / Bellows (All types)
- h. Specialty items like online filters, ejectors, sample coolers, steam traps, strainers, air traps etc.
- i. Online instruments like control valve, orifice flange, rotameter, safety valves etc.

- 2.2 Shop & field fabrication and erection of piping in accordance with documents listed under Cl. 3.0 i.e. 'BASIS OF WORK' including erection of all piping materials enumerated above.

- 2.3 Fabrication and erection of pipe supports like shoe, saddle, guide, stops, anchors, clips, cradles, hangers, turn buckles, supporting fixtures, bracket cantilevers, struts, teeposts including erection of spring supports and sway braces.

- 2.4 Modifications like providing additional cleats, extension of stem of valve, locking arrangement of valves etc. as and when required.



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- 2.5 Preparation of Isometrics, bill of materials, supporting details of all NON-IBR lines upto 2-1/2" within the unit battery limit and get subsequent approval from Engineer-in-Charge as and when called for.
- 2.6 Obtaining approval for drawings prepared by Contractor from statutory authority, if required.
- 2.7 Radiography, stress relieving, dye penetration, magnetic particle test etc. as required in specification.
- 2.8 Performing PMI using alloy analysers.
- 2.9 Casting of concrete pedestals and fabrication & erection of small structures for pipe supports including supply of necessary materials.
- 2.10 Providing insert plates from concrete structures and repair of platform gratings around pipe openings.
- 2.11 Making material reconciliation statement and return of Owner's supplied left over materials to Owner's store.
- 2.12 Flushing and testing of all piping systems as per standard specification for inspection, flushing and testing of piping systems.

3.0 BASIS FOR WORK

- 3.1 The complete piping work shall be carried out in accordance with the following
 - 3.1.1 "Approved for Construction" drawings and sketches issued by IOCL/PMC to the Contractor - Plans and/or Isometrics.
 - 3.1.2 Approved Process licensor's standards and specifications.
 - 3.1.3 Drawings, sketches and documents prepared by Contractor duly approved by Engineer-in-Charge/PMC (such as isometrics and offsite piping etc.)
 - 3.1.4 Construction job procedures prepared by Contractor and approved by IOCL/PMC.
 - 3.1.5 IOCL specifications/documents as below:
 - Process and Instrument Diagram.
 - Piping Materials Specification
 - Piping support standards.
 - Line list / Number
 - Piping support index.
 - Standard specification of NDT Requirement of Piping
 - Welding specification charts for piping classes.
 - Standard specification for Pressure Testing of Erected Piping System.
 - Welding specification for fabrication of piping
 - Any other specifications attached with Piping Material Specification or special condition of contract.



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- Procedure for storage, preservation and positive identification of materials at Contractors works / stores.

3.1.6 Applicable codes, standards

- ASME B 31.3 :Process Piping
- ASME Sec. VIII :Rules for Construction of Pressure Vessels.
- IBR Regulation
- IS: 823 :Code for procedure for Manual Metal Arc Welding of Mild Steel (for structural steel).

Note : All codes referred shall be latest edition.

3.2 Deviations

Where a deviation from the "Basis of Work" and approved job procedure described above is required or where the basis of work does not cover a particular situation, the matter shall be brought to the notice of Engineer - in - Charge and the work carried out only after obtaining written approval from Engineer – in – Charge in each case.

4.0 FABRICATION

4.1 Piping Material

Pipe, pipe fittings, flanges, valves, gaskets, studs bolts etc. used in a given piping system shall be strictly as per the "Piping Material Specification" for the "Pipe Class" specified for that system. To ensure the above requirement, all piping material supplied by the Owner / Contractor shall have proper identification marks as per relevant standards / IOCL's specifications. Contractor shall provide identification marks on left over pipe lengths wherever marked up pipe lengths have been fabricated / erected. Material traceability is to be maintained for each material for Hydrogen service and other exotic materials by way of transferring heat number, etc. (hard punching) as per approved procedure. This shall be in addition to colour coding for all piping materials to avoid mix-up.

4.2 Fabrication

All fabrication shall be carried out in accordance with piping general arrangement drawings, (prepared by CONTRACTOR and approved by IOCL/PMC) including this specification and codes as specified in section 3.0.

CONTRACTOR shall be responsible for working to the exact dimensions as per the approved drawings.

Flange bolt holes shall generally straddle the established centre lines unless other orientation is required and as called out in approved drawings.

Threading shall be NPT as per ANSI B 1.20.1. Threading shall preferably be done after bending, forging or heat treatment operation. However if it is not possible, precaution shall be taken to protect threading against deformation. Thread shall be clean cut with no burrs or stripping. Dies shall be new, sharp and properly designed for piping material. Ends shall be reamed to remove burrs.

All threaded joints shall be aligned properly. The pipe entering unions shall be true to centrelines so as to avoid forcing of union coupling during make up. Damaged threads shall be cut from the end of run and the pipe shall be rethreaded.

Immediately before testing the piping, all threads of pipe and fittings shall be thoroughly cleared of



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cuttings, fuel oil or other foreign matter. The male threads shall be sealed with thread sealant and the piping made up sufficiently for the thread to seize. Sealant shall be teflon tape.

Seal welding of threaded connections when specified shall include the first block valve, cover all threads. The joint shall be cleaned of all cutting oil and other foreign material and made up dry to full thread engagement. Instrument threaded connections which are frequently subjected to testing and maintenance shall not be seal welded.

All threaded connections shall be protected from rusting by applying greases or oil when in operating condition.

When socket weld fittings or valves are used, pipe shall be spaced approximately 1/16" to avoid bottoming which could result in excessive weld stress.

Where the ends of the piping components being welded have an internal surface misalignment exceeding 1.6mm, the wall of the component extending internally shall be trimmed by machining so that the adjoining internal surface will approximately flush.

For the purpose of common understanding the construction job procedure, to be submitted by the contractor, shall include proposal for

- Maximizing prefabrication, inspection and testing at fabrication shop with minimum field joints.
- Positive material identification, handling, storage & preservation.

4.3 Dimensional Tolerances

The Contractor shall be responsible for working to the dimensions shown on the approved drawings. However, the Contractor shall bear in mind that there may be variations between the dimensions shown in the drawing and those actually existing at site due to minor variations in the location of equipments, inserts, structures etc. To take care of these variations "Field Welds" shall be provided during piping fabrication. An extra pipe length of 100 mm over and above the dimensions indicated in the drawing may be left on one side of the pipe at each of the field welds. During erection, the pipe end with extra length at each field weld, shall be cut to obtain the actual dimension occurring at site. Isometrics, if supplied may have the field welds marked on them. However, it is the responsibility of the Contractor to provide adequate number of field welds. In any case no extra claims will be entertained from the Contractor on this account. Wherever errors / omissions occur in drawings and Bills of Materials it shall be the Contractor's responsibility to notify the Engineer-in-Charge prior to fabrication or erection.

4.4 Pipe Joints

The piping class of each line specifies the type of pipe joints to be adopted. In general, joining of lines 2" and above in process and utility piping shall be accomplished by butt welds. Joining of lines 1-1/2" and below shall be by socket welding / butt welding / threaded joints as specified in "Piping Material Specifications". However, in piping 1-1/2" and below where socket welding/ threaded joints are specified butt - welds may be used with the approval of Engineer- in-Charge for pipe to pipe joining in long runs of piping.

Flange joints shall be used at connections to Vessels, Equipment's, Valves and where required for ease of erection and maintenance as indicated in drawings.

4.5 Butt Welded and Socket Welded Piping

End preparation, alignment and fit-up of pipe pieces to be welded, welding, pre-heat, post- heating and heat treatment shall be as described in the welding specification and NDT specification.



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4.6 Screwed Piping

In general, Galvanized piping shall have threads as per IS: 554 or ANSI B 1.20.1 NPT as required to match threads on fittings, valves etc. All other piping shall have threads as per ANSI B 1.20.1, tapered unless specified otherwise.

Threads shall be clean cut, without any burrs or stripping and the ends shall be reamed. Threading of pipes shall be done preferably after bending, forging or heat treating operations. If this is not possible, threads shall be gauge checked and chased after welding heat treatment etc.

During assembly of threaded joints, all threads of pipes and fittings shall be thoroughly cleaned of cuttings, dirt, oil or any other foreign matter. The male threads shall be coated with thread sealant and the joint tightened sufficiently for the threads to seize and give a leak proof joint.

Threaded joints to be seal-welded shall be cleaned of all foreign matter, including sealant and made up to full thread engagement before seal welding.

4.7 Flange Connections

All flange facings shall be true and perpendicular to the axis of pipe to which they are attached. Flanged bolt holes shall straddle the normal centrelines unless different orientation is shown in the drawing.

Wherever a spectacle blind is to be provided, drilling and tapping for the jack screws in the flange, shall be done before welding it to the pipe.

4.8 Branch Connections

Branch connections shall be as indicated in the piping material specifications. For end preparation, alignment, spacing, fit-up and welding of branch connections refer welding specifications. Templates shall be used wherever required to ensure accurate cutting and proper fit-up.

For all branch connections accomplished either by pipe to pipe connections or by using forged tees the rates quoted for piping shall be inclusive of this work.

Reinforcement pads shall be provided wherever indicated in drawings/ specifications etc.

4.9 Bending

Bending shall be as per ASME B31.3 except that corrugated or creased bends shall not be used.

Cold bends for lines 1-1/2" and below, with a bend radius of 5 times the nominal diameter shall be used as required in place of elbows wherever allowed by piping specifications. Bending of pipes 2" and above may be required in some cases.

The completed bend shall have a smooth surface, free from cracks, buckles, wrinkles, bulges, flat spots and other serious defects. They shall be true to dimensions. The flattening of a bend, as measured by the difference between the maximum and minimum diameters at any cross-section, shall not exceed 8% and 3% of the nominal outside diameter, for internal and external pressure respectively.

4.10 Forging and forming

Forging and forming of small bore fittings, like reducing nipples for piping 1-1/2" and below, shall be as per ASME B 31.3.

Fabricated Reducers - Mitre bends not permitted



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4.11 Cutting and Trimming of Standard Fittings & Pipes

Components like pipes, elbows, couplings, half-couplings etc. shall be cut / trimmed / edge prepared wherever required to meet fabrication and erection requirements, as per drawings and instructions of Engineer-in-Charge. Nipples as required shall be prepared from straight length piping.

4.12 Shop Fabrication / Prefabrication

The purpose of shop fabrication or pre-fabrication is to minimise work during erection to the extent possible. Piping spool, after fabrication, shall be stacked with proper identification marks, so as facilitate their withdrawal at any time during erection. During this period all flange (gasket contact faces) and threads shall be adequately fabricated by coating with a removable rust preventive. Care shall also be taken to avoid any physical damage to flange faces and threads.

4.13 Miscellaneous

Contractor shall fabricate miscellaneous elements like flash pot, seal pot, sample cooler, supporting elements like turn buckles, extension of spindles and interlocking arrangement of valves, operating platforms as required by Engineer-in-Charge.

Spun Concrete Lining

The work of inside spun concrete lining of pipes and specials of diameter 3" and above shall be done as per material specifications and special condition contract.

5.0 WELDING

Welding of pipelines shall be done as per applicable codes ASME B31.8, API 1104, ASME Section IX

6.0 ERECTION

6.1 Cleaning of Piping before Erection

Before erection all pre-fabricated spool pieces, pipes, fittings etc. shall be cleaned inside and outside by suitable means. The cleaning process shall include removal of all foreign matter such as scale, sand, weld spatter chips etc. by wire brushes, cleaning tools etc. and blowing with compressed air/or flushing out with water. Special cleaning requirements for some services, if any shall be as specified in the piping material specification or isometric or line list.

6.2 Piping Routing

No deviations from the piping route indicated in drawings shall be permitted without the consent of Engineer-in-Charge.

Pipe to pipe, pipe to structure / equipments distances / clearances as shown in the drawings shall be strictly followed as these clearances may be required for the free expansion of piping / equipment. No deviations from these clearances shall be permissible without the approval of Engineer-in-Charge.

In case of fouling of a line with other piping, structure, equipment etc. the matter shall be brought to the notice of Engineer-in-Charge and corrective action shall be taken as per his instructions.

6.3 Slopes

Slopes specified for various lines in the drawings / P&ID shall be maintained by the Contractor. Corrective action shall be taken by the Contractor in consultation with Engineer-in-Charge wherever



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the Contractor is not able to maintain the specified slope.

6.4 Expansion Joints / Bellows

Installation of Expansion Joints/Bellows shall be as follows:

All Expansion joints / Bellows shall be installed in accordance with the specification and installation drawings, supplied to the Contractor.

Upon receipt, the Contractor shall remove the Expansion Joints/ Bellows from the case(s) and check for any damage occurred during transit.

The Contractor shall bring to the notice of the Engineer-in-Charge any damage done to the bellows / corrugations, hinges, tie-rods, flanges / weld ends etc.

Each Expansion Joint / Bellow shall be blown free of dust / foreign matter with compressed air or cleaned with a piece of cloth.

For handling and installation of Expansion Joints, great care shall be taken while aligning. An Expansion Joints shall never be slinged from bellows corrugations / external shrouds, tie / rods, angles.

An Expansion Joints / Bellow shall preferably be slinged from the end pipes / flanges or on the middle pipe. Expansion Joints stop blocks shall be carefully removed after hydrostatic testing.

Angles welded to the flanges or weld ends shall be trimmed by saw as per manufacturer's instructions and the flanges or weld ends shall be ground smooth.

The pipe ends in which the Expansion Joint is to be installed shall be perfectly aligned or shall have specified lateral deflection as noted on the relevant drawings.

The pipe ends / flanges shall be spaced at a distance specified in the drawings.

The Expansion Joint shall be placed between the mating pipe ends / flanges and shall be tack welded/bolted.

The mating pipes shall again be checked for correct alignment.

Butt-welding shall be carried out at each end of the expansion joint. For flanged Expansion Joint, the mating flanges shall be bolted.

After the Expansion Joint is installed, the Contractor shall ensure that the mating pipes and Expansion Joints are in correct alignment and that the pipes are well supported and guided.

The Expansion Joint shall not have any lateral deflection. The Contractor shall maintain parallelism of restraining rings or bellows convolutions.

Precautions

- For carrying out welding, earthing lead shall not be attached with the Expansion Joint.
- The Expansion bellow shall be protected from arc weld spot and welding spatter.
- Hydrostatic Testing of the system having Expansion Joint shall be performed with shipping lugs in position. These lugs shall be removed after testing and certification is over.

6.5 Flange Connections

While fitting up mating flanges, care shall be exercised to properly align the pipes and to check the flanges for trueness, so that faces of the flanges can be pulled together, without inducing any stresses in the pipes and the equipment nozzles. Extra care shall be taken for flange connections to pumps, turbines, compressors, cold boxes, air coolers etc. The flange connections to these equipments shall be



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checked for misalignment, excessive gap etc. after the final alignment of the equipment is over. The joint shall be made up after obtaining approval of Engineer-in-Charge.

Temporary protective covers shall be retained on all flange connections of pumps, turbines, compressors and other similar equipments, until the piping is finally connected, so as to avoid any foreign material from entering these equipments.

The assembly of a flange joint shall be done in such a way that the gasket between these flange faces is uniformly compressed. To achieve these bolts shall be tightened in a proper sequence. All bolts shall extend completely through their nuts but not more than 1/4".

Steel to C.I. flange joints shall be made up with extreme care, tightening the bolts uniformly after bringing flange flush with gaskets with accurate pattern and lateral alignment.

6.6 Vents and Drains

High point vents and low point drains shall be provided as per the instructions of Engineer-in-Charge, even if these are not shown in the drawings. The details of vents and drains shall be as per piping material specifications / job standards.

6.7 Valves

Valves shall be installed with spindle / actuator orientation / position as shown in the layout drawings. In case of any difficulty in doing this or if the spindle orientation / position is not shown in the drawings, the Engineer-in-Charge shall be consulted and work done as per his instructions. Care shall be exercised to ensure that globe valves, check valves, and other uni-directional valves are installed with the "Flow direction arrow" on the valve body pointing in the correct direction. If the direction of the arrow is not marked on such valves, this shall be done in the presence of Engineer-in-Charge before installation.

Fabrication of stem extensions, locking arrangements and interlocking arrangements of valves (if called for), shall be carried out as per drawings / instructions of Engineer-in-Charge.

6.8 Instruments

Installation of in-line instruments such as restriction orifices, control valves, safety valves, relief valves, rotameters, orifice flange assembly, venturimeters, flowmeters etc. shall form a part of piping erection work.

Fabrication and erection of piping upto first block valve / nozzle / flange for installation of offline Instruments for measurement of level, pressure, temperature, flow etc. shall also form part of piping construction work. The

limits of piping and instrumentation work will be shown in drawings / standards / specifications. Orientations / locations of take-offs for temperature, pressure, flow, level connections etc. shown in drawings shall be maintained.

Flushing and testing of piping systems which include instruments mentioned above and the precautions to be taken are covered in flushing, testing and inspection of piping. Care shall be exercised and adequate precautions taken to avoid damage and entry foreign matter into instruments during transportation, installation, testing etc.

6.9 Line Mounted Equipment / Items

Installation of line mounted items like filters, strainers, steam traps, air traps, desuperheaters, ejectors, samples coolers, mixers, flame arrestors, sight glasses etc. including their supporting arrangements shall



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form part of piping erection work.

6.10 Bolts and Nuts

The Contractor shall apply molycoat grease mixed with graphite powder (unless otherwise specified in piping classes) to all bolts and nuts during storage, after erection and wherever flange connections are broken and made-up for any purpose whatsoever. The grease and graphite powder shall be supplied by the Contractor within the rates for piping work.

6.11 Pipe Supports

Pipe supports are designed and located to effectively sustain the weight and thermal effects of the piping system and to prevent its vibrations. Location and design pipe supports will be shown in drawing for lines 2" NB. However, any extra supports desired by Engineer-in-Charge shall also be installed.

No pipe shoe / cradle shall be offset unless specifically shown in the drawings.

Hanger rods shall be installed inclined in a direction opposite to the direction in which the pipe moves during expansion.

Preset pins of all spring supports shall be removed only after hydrostatic testing and insulation is over. Springs shall be checked for the range of movement and adjusted if necessary to obtain the correct positioning in cold condition. These shall be subsequently adjusted to hot setting in operating condition. The following points shall be checked after installation, with the Engineer-in-Charge and necessary confirmation in writing obtained certifying that :

- All restraints have been installed correctly.
- Clearances have been maintained as per support Drawings.
- Insulation does not restrict thermal expansion.
- All temporary tack welds provided during erection have been fully removed.
- All welded supports have been fully welded.

Location and design of pipe supports shown in approved drawings and support drawings shall be strictly followed.

Supports shall be installed in such a way that they do not contribute to over stressing of a line.

Fabrication and erection of additional supporting elements and structural fixtures which in COMPANY's view are required for proper supporting of the system, shall be carried out by CONTRACTOR at no extra cost.

All temporary supports, elements required for alignment, erection and assembly shall be removed after completion of work.

6.12 Equipment hook-up

Prior to hook-up, the alignment and trueness of flange faces shall be checked to ensure that no undue stresses shall be induced in the system while hooking up.

7.0 INSPECTION & TESTING

7.1 CONTRACTOR shall provide all facilities/ assistance to IOCL for proper execution of their inspection without any extra charge.

7.2 All piping work shall be subjected to inspection by IOCL/PMC at any time during fabrication. CONTRACTOR shall furnish detailed work programme sufficiently in advance, in order to enable



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IOCL to arrange for inspection.

- 7.3 All joints shall be 100% radiographed. If radiography is not possible due to space constraints, joints shall be ultrasonically tested.
- 7.4 All joints of weldolet, socklotes, nipples etc. shall be tested using Magnetic Particle Inspection (MPI). Magnetic particle inspection on the external surface. ASME code, section VIII, division 1, appendix VI.

8.0 PROTECTIVE COATING

- 8.1 All above ground piping system shall be applied with protective coating/painting in accordance with specification for shop & field coating (clause 11.0).
- 8.2 All underground portion of piping system shall be coated with three layer polyethylene coating. CONTRACTOR shall prepare procedure for epoxy painting of buried pipeline for approval of COMPANY. Procedure shall include surface preparation, brand and type of coating to be adopted. Coating of pipes shall not commence without approval of coating procedure. Total dry film thickness to be achieved shall not be less than 300 microns. Compatible primer and finish coat as recommended by coating manufacturer shall only be applied. Coating integrity shall be checked by "Holiday detector" over full length of coated pipe work. Coating to be supplied by CONTRACTOR shall be suitable for design temperature.
- 8.3 Once the Coating has been accepted by IOCL/PMC, backfilling operation can be started. In order to protect coated pipe from damage, the excavated trench shall be examined for stone, rock and any other hard substance detrimental to coating. All such substances shall be removed before lowering the pipe in the trench. COMPANY may ask for a 100mm padding of clear sand under and above pipeline in rocky or otherwise hard soil area. No additional payment on account of padding shall however be admissible.

9.0 FLUSHING

Completed piping systems shall be flushed by CONTRACTOR with fresh water, to clean the pipe of all dirt, debris, and foreign material. CONTRACTOR shall prepare a procedure for flushing of the system for approval of TNGCL/PMC. Flushing shall not be commenced without approval of flushing procedure.

- 9.1 CONTRACTOR shall perform all activities like dismantling and reinstalling of all strainers, in line instruments etc. before and after completion of flushing.
- 9.2 Flushing shall be considered as complete only after inspection and approval by COMPANY.
- 9.3 Disposal of muck and flushing media shall be arranged by CONTRACTOR as directed by IOCL/PMC, in such a manner that it does not spoil the adjacent installation. CONTRACTOR shall obtain IOCL/PMC approval regarding the place and method to be adopted for disposal of debris.
- 9.4 Record of flushing giving following details shall be submitted by CONTRACTOR to IOCL/PMC for its approval and records:
- Date of Flushing
 - Identification of line: flushed-line Number



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10.0 HYDROSTATIC TESTING

Completed piping system as approved by Owner/PMC shall be hydrostatically tested in the presence of Owner/ PMC. The general requirements of hydrostatic testing shall be in accordance with codes specified in Section-I.

CONTRACTOR shall prepare hydrostatic test procedure based on specified codes. The hydrostatic test shall commence only after approval of procedure by IOCL/PMC.

Piping system shall be hydrostatically tested to a pressure corresponding to 1.4 times the design pressure.

Fresh water shall be used as test media. CONTRACTOR shall locate the source of water supply and arrange for transportation of water to test site. CONTRACTOR shall arrange at his own cost the water analysis and confirm that water is suitable for testing. In case any corrosion inhibitor is added, the same shall be done after approval of IOCL/PMC.

Lines repaired subsequent to hydrostatic test shall be retested using the same procedure as originally adopted. However IOCL/PMC may waive such retest in case of minor repairs by taking precautionary measures to ensure sound construction.

All equipment and instruments used for hydrostatic test shall be approved by IOCL/PMC before start of tests.

Pressure gauges shall be installed on line to measure test pressures. In case of longer lines two or more pressure gauges shall be installed as directed by COMPANY. One gauge shall be installed at the discharge of the pressurising pump. Pressure gauge used for hydrostatic testing shall be calibrated with dead weight tester in the presence of Engineer-in-charge. Range of pressure gauge shall generally be 1.5 times the test pressure.

Orifice plates and restriction orifices shall not be installed until hydrostatic testing is completed. Temporary gaskets shall be used during testing.

First block valve of pressure instruments shall be half open & plugged at the time of hydrostatic testing. Temperature connections shall be blanked off during testing.

All equipments, in line instruments, relief valves shall be disconnected from piping system by means of blinds during testing. Control valves shall be replaced by spool pieces during testing.

High point vents and low point drain required for testing in addition to those marked in the drawings shall be provided by CONTRACTOR at his own cost.

All welded and screwed joints shall be kept clean for detecting leaks during testing.

Test pressure shall be maintained long enough to facilitate complete inspection of the system. Minimum duration of test shall be 6 hours unless otherwise specified. Pressurising equipment shall be isolated immediately after test pressure is attained.

After successful completion of hydrostatic testing, the piping system shall be dewatered. All lines shall be completely dried using compressed air. CONTRACTOR shall make his own arrangement for supply of compressed air. Drying of lines shall be considered complete on approval IOCL/PMC.

The records in duplicate shall be prepared and submitted by CONTRACTOR as below:

- Date of test
- Identification of pipe tested - line number
- Test pressure
- Test results
- Signature of CONTRACTOR
- Approval signature by IOCL/ PMC.



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11.0 SHOP & FIELD PAINTING

11.1 General

This specification covers the general requirement of painting works for the following:

- Surface preparation for painting.
- Painting scheme for various equipment, pipe, valve, structure.
- Inspection and testing

All works shall be carried out in accordance with the sequence mentioned herein and the job shall be carried out with the best workmanship as specified herein and as instructed by the technical representative of the paint manufacturer.

The primer, intermediate and finish paint materials shall be of specified brand from any one of the manufacturers as indicated in clause 8.1.0 hereof.

It shall be ensured by the Contractor that the primer, intermediate paint and finish paint are procured from the same manufacturer in order to ensure compatibility and for achieving best results of epoxy coating. The same brands of primer, intermediate paint and finish paint shall be used throughout the work. The solvent and other chemical ingredients, their proportion and method of mixing etc., shall be as per the instruction of the technical representative of the paint manufacturer.

It shall be the responsibility of Contractor to ensure that :

- That the surface preparation has been done to the specification.
- The application of primer and subsequent coats of painting have been done conforming to the requirements of the paint manufacturer.
- That the specified Dry Film Thickness (without negative tolerance) has been achieved in every coat of Primer/Paint.
- That the shelf life of Primer and the paints used in the work had not expired.

Colours for painting the finishing of paints shall be as per instructions and directions from Engineer-in-Charge. Manufacturer's standard colour cards showing the colours shall be submitted to the Engineer-in-Charge for prior approval before the work is commenced.

The scope of painting work is inclusive of providing different identification color bands for piping of various products and flow directions on all the piping at various locations as required and as per the instructions of Site Engineer / EIC.

Different types of Valves installed in the piping of various products etc., shall be painted with different colors of finish paint for identification purpose as per specification and instructions of the Site Engineer / EIC.

Scaffolding, gangways, ladders and other fixtures necessary for painting works shall be of good quality. Welding of the above fixtures on the piping or equipment is not permitted.

The width of the brushes shall conform to IS:384-1964.

All paint application shall be done as per manufacturer recommendation.



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If a second layer is required to reach prescribed thickness, this shall be applied in accordance with over coating time prescribed by manufacturer.

Coating temperature shall be minimum 3°C above dew point temperature.

Relative humidity shall not be higher than 85%.

All surface contaminants shall be removed prior to coating.

Temperature range at the time of application as per manufacturer of the product.

Coating should not be applied during rain fog or mist or when there is free moisture on the prepared surface.

Components shall not be backfilled until the coating is completely cured in accordance with the hardness recommended by the manufacturer.

11.2 MATERIAL

All primer, paint materials, solvents etc., shall be brought to the work site in original packages or tins bearing the manufacturer's brand name in undisturbed condition and shall be used without any adulteration and be thinned only in accordance with the instructions of the authorised representative of the paint manufacturer.

All paints shall be stored in covered place at the job site in a neat and clean storage place. The paint should not come in contact with moisture under any circumstances.

Care shall also be taken in storing the primer, epoxy intermediate paint, finishing, thinner etc., to prevent their damage from fire. Oil rags shall be kept in closed metal containers.

The original packages and tins shall not be opened until they are inspected by the authorised site representative of paint manufacturer and approved Site Engineer.

No substitution of primer and paint materials will be permitted either from the specified brands or from the approved list of paint manufacturers as listed.

The paint materials of any of the following paint manufacturers shall be utilized in painting :

1. M/s. Shalimar Paints.
2. M/s. Asian Paints.
3. M/s. Berger Paints.
4. M/s. Akzo Nobel Paints.
5. M/s. Grauer & Weil (India) Ltd (Earlier Known as Bombay Paints) .
6. M/s. Ameron Paints
7. M/s. Sigma coatings
8. M/s Hempel Paints (India) Pvt. Ltd.
9. M/s Carboline - India
10. M/s Jotun India Pvt. Ltd. (subsidiary of Jotun A/S, Norway)
11. Amchem Products Pvt. Ltd.
12. Rhino Linings Corporation
13. TIB Chemicals

The Contractor shall inform the Engineer-in-Charge of the detailed arrangements made/ entered into by him with the prospective paint manufacturer for unhindered supply of paint materials, ensuring availability of technical representative of the paint manufacturers at the time of



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application of their material and their agreement to furnish necessary quality certificates to the Owner as specified in clause 1.4.0 hereof.

The Contractor shall obtain the approval of Engineer-in-Charge before placing Purchase Order for supply of the paint material.

11.3 Surface Preparation

All steel surfaces shall be cleaned by abrasive blasting before application of primer. Prior to final preparation of the surface by abrasive blasting, the steel surface shall be cleaned of dust and grease and the heavier layers of rust and weld splatter shall be removed by chipping with sharp edges. Any additional thickness of capping in weld joint shall be chipped and ground to ensure an even surface for painting.

The Contractor shall provide all equipments and tools required for the abrasive blast cleaning including abrasive blasting equipments and compressor. The compressors shall have air delivery ratio of 270 cft /minute at constant pressures of 120 psig and be provided with moisture traps.

Only approved quality abrasive shall be used for the abrasive blasting. The abrasive used shall be dry and free from any other impurities like clay etc.,

The abrasive blasting operation shall be carried out in the daytime. Blast cleaning operation shall not be undertaken in high humid condition (when the relative humidity exceeds 85%).

The abrasive-blasted surface shall conform to Swedish Standard SIS-055900-1967 SA 2 ½ or to USA Specification SSPC-SP10 or British Standard BS-4232 Second quality or equivalent.

The abrasive-blasted surface shall have a shining and near white metal appearance and the surface roughness shall be 60 - 75 microns in accordance with ISO 4287-1.

After abrasive-blast cleaning, the surface shall be dry brushed to remove abrasive dust and silica deposits.

Determination of the surface condition suitable for applying coating shall be made by Owner. If, in the judgment of Third Party Inspector/ Owner, the surface is not cleaned and suitable for coating, such pipe shall be re-cleaned at Contractor's/Vendor expense.

Pipe once rejected shall not be coated until Third Party Inspector/ Owner has re-examined and approved the pipe for coating.

The surface prepared shall be approved after inspection by the Engineer - in - Charge/ Site Engineer before the application of primer

The cleaning and coating operation should be protected from rain, high humidity, surface moisture, dust, foreign material and other potential contaminants that would affect the finished product. If Third Party Inspector/ Owner determines that any of the above conditions exist, operations shall stop until conditions are suitable for the coating application.

Pipe which has flash rusted or has not been coated within four hours after cleaning shall be completely re-blasted prior to coating application.



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11.4 Application of Paints:

Primer:

The primer shall be applied to the cleaned surface before any soiling or deterioration occurs. The cleared areas should receive the first coat well before the night fall.

Paints:

All paints shall be spread evenly and carefully on clean metallic surface. No coat of paint shall be applied on a wet or damp surface. In no case the second coat shall commence until the preceding coat is dry and hard with due regard to the effect of temp. and weather conditions upon drying time.

Painting shall not be carried out when the weather conditions are cold or in damp weather. Painting during winter shall be carried out only when the temp. is above 15 deg. C and when the surface is dry.

Drying time for materials containing oil shall be 3 days for paints.

Above Ground Process Piping:

The primer coat shall consist of a full-bodied and evenly spread coat of anticorrosive primer. The time elapsed between first (primer coat) and subsequent coat shall be as per paint manufacturer's recommendation. The second and subsequent coats shall consist of full bodied and evenly spread coats of oil proof exterior finished paint as specified in the painting schedule.

The valves supplied for installation have already been primed by the manufacturer. However, painting as defined in the painting schedule is to be carried out. The name plate of the valves should not be painted.

Hand wheels of the valves be painted as specified. Tag numbers of the valves should be written with colour specified.

All fire water lines shall be painted with finish paint of FIRE RED colour (Shade no.-536 of IS 5:2007).

The properties of paint material shall be at least but not limited to as mentioned in relevant clause 11.7

11.5 PAINT FOR UNDER GROUND PIPING

For coating of External surface of underground pipes, **100% solvent free Poly Urethane / High Build Solvent Free Liquid Epoxy Coating** is envisaged. The contractor has to carry out coating for all underground pipes, pipe joints, flanges, fittings etc.,

Vendor may choose/opt for any of the above mentioned coating systems for external coating of underground piping with prior intimation and approval of Engineer-In-Charge/Site Engineer.

The coating operation which includes cleaning of pipe, heating and applying the coating on line pipes shall be performed under the application of 100% solvent free Poly Urethane / High Build Solvent Free Liquid Epoxy Coating systems. Inspection of the coating of the pipe shall be performed by qualified inspectors.



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The properties of 100% solvent free Poly Urethane Coating material shall be as mentioned in Annexure M3-1.

The properties of High Build Solvent Free Liquid Epoxy Coating material shall be as mentioned in Annexure M3-2.

The external surface of the cleaned pipe conforming to specifications for "surface preparation" shall be immediately coated with 100% solvent free Poly Urethane / High Build Solvent free Epoxy coating in accordance with relevant standard, this specification and with procedures approved by Owner.

Minimum total thickness (dry film thickness-DFT) of finished coating shall be **800 microns** as specified. This coating thickness should be obtained preferably with single coat of the coating system or as per paint manufacturer recommendation. This coating thickness requirement shall be met over the weld seam also (in case of pipe joints). Coating thickness shall be uniform all along the surface.

Dry film thickness measurement shall be done as per Annexure A of EN10289 / EN10290.

Coating thickness of the coated pipeline shall be measured at the beginning of coating operation to ensure proper thickness.

All holidays, pinholes in the coating operations shall be immediately repaired. The damaged area shall be thoroughly cleaned before re-coating.

Equipment :

All structural steel, piping and other unprotected steel surfaces which come along with the main equipment shall be thoroughly dressed, abrasive blasted, primer coated and finish coated as per the painting system indicated below. In case the manufacturer supply, the manufacturer's application instructions, the same shall be strictly adhered. In any case the minimum dry film thickness shall not be less than 250 microns.

Equipment and machinery whose paint is damaged during transit after taking over by the Contractor or during erection shall be suitably painted by the Contractor at his own cost to the satisfaction of Site Engineer.

Painting System :

The following painting scheme is envisaged in respect of mechanical items to be incorporated in the station works:

Painting scheme :



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Sl.	Type of Paint / Coating System	No. of Coats	Min. DFT / coat	Total DFT (min.)
I.	For all Piping, Valves (Above ground etc,			
a.	Zinc Ethyl Silicate Primer	1	65 μm	265μm
b.	High build Epoxy MIO Intermediate Paint	1	100 μm	
c.	Isocyanate Aliphatic Poly-Urethane(PU) Finish Paint	2	50 μm	
II.	For Pipe supports, Valve supports, Anchor supports, Walkways, Hand Rails, Platforms etc.			
a.	Zinc Phosphate Primer	1	70 μm	250 μm
b.	High build Epoxy MIO Intermediate coat	1	100 μm	
c.	High build Epoxy coating	2	40 μm each coat	

11.6 Inspection:

The painting works shall be inspected at different stage to ensure that :

- The equipments, tools and tackles used for surface preparation are in order.
- The surface preparation is as per the specifications.
- Priming of surface prepared is carried out within the time as per the specifications.
- No painting is done when there is danger of dew/ moisture/high humid condition or during monsoon.
- The paint drums are mixed thoroughly prior to application. The drums shall be inspected to see that no sediment is left in them.
- The mixed paint is applied within the time specified by the manufacturer.
- Each coat is applied properly to level, smooth and free from runs and holidays.
- Each coat is allowed to dry as per the paint manufacturer's recommendations before the next coat is applied.
- The total paint system is allowed to cure as per the paint manufacturer's recommendations. The following test shall be carried out in order to ensure that the epoxy paint has cured properly:
- A swab of cotton/wool soaked in Methyl Iso Butyl Ketone (MIBK) is laid on the painted surface. After one hour there should not be any softening of the painted surface. If softening is noticed, the painted surface should be allowed to cure for a further period of one or two days and tested again.



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- The specified dry film thickness is achieved in each coat of primer/finish paint. Calibrated Wet/dry film thickness gauges shall be arranged by the Contractor to measure film thickness of each coat as well as the total paint system.

Painting shall be inspected and any defective work shall be re-done without extra cost to the Owner.

11.7 SPECIFIC REQUIREMENTS FOR THE PAINTS:-

Zinc Ethyl Silicate Primer:

- a. Zinc content in DFT shall not be less than 85%.
- b. Volume of solids should not be less than 60% (% volume of solids).
- c. The zinc purity shall not be less than 98%
- d. Application by airless spray only (Plural Feed gun is preferable) with manufacturer recommended thinners and application guidelines
- e. Wherever zinc silicate primer is used a mist coat of epoxy zinc phosphate/ epoxy based MIO shall be used before full thickness MIO application.

High Build Epoxy Zinc Phosphate Primer:

- a. High build polyamide cured epoxy zinc phosphate primer shall have solid content of minimum 55% (% volume of solids).
- b. The pigment % by weight to be stated by paint manufacturer.
- c. The primer shall be compatible to the solvent free high build epoxy and coal tar epoxy over coat.
- d. Application by airless spray only (Plural Feed gun is preferable) with manufacturer recommended thinners and application guidelines.

High Build MIO :

- a. The solid content shall not be less than 80% (% volume of solids).
- b. Application by spray with manufacturer recommended thinners and application guidelines.
- c. Application by airless spray only (Plural Feed gun is preferable) with manufacturer recommended thinners and application guidelines.

Aliphatic Isocyanate Polyurethane Paint:

- a. Volume of solids shall not be less than 50 % (% volume of solids).
- b. The gloss retention shall not be less than 80% when exposed to 1000 hrs in QUV lamp.
- c. Application by spray with manufacturer recommended thinners and application guidelines.
- d. The Shade mentioned is tentative. Engineer-in-Charge reserves the right to choose the shade/shades and the contractor shall provide the same without any extra cost to owner.
- e. Application by airless spray only (Plural Feed gun is preferable) with manufacturer recommended thinners and application guidelines.

High Build Epoxy Finish Paint:

- a. Volume of solids shall not be less than 60 % (% volume of solids).



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- b. Application by spray/brush with manufacturer recommended thinners and application guidelines.
- c. The Shade mentioned is tentative. Engineer-in-Charge reserves the right to choose the shade/shades and the contractor shall provide the same without any extra cost to owner.
- d. Application by airless spray/ brush only (Plural Feed gun is preferable) with manufacturer recommended thinners and application guidelines

11.8 LIST OF APPROVED PAINT MANUFACTURERS AND THEIR ACCEPTABLE BRANDS

The contractor shall obtain approval of paint brands to be used, from the Engineer-In-Charge before supply of paint material. List of approved paint brands has been appended below. Apart from the vendors detailed in the list, the bidder may propose any other vendor having credentials for supply of respective items. In such cases the bidder is to provide experience details/ credentials / track records etc. of the Vendors for consideration and approval of the Owner.

Name of Paint	Berger Paints	Asian Paints	Akzo Nobel Paints	Sigma Coatings (M/s PPG India)	Amercoat (M/s PPG PMC), Formerly Ameron	Hempel Paints	Jotun Paints	Carboline Paints
Ethyl Zinc Silicate Primer	Zinc Anode 304 MZ	APCOSIL 605	Interzinc 12	Sigmazinc 158	Dimetecote 9	Hempel Galvosil 15700	Resist 86	Carbozinc 11
Polyamide Cured High Build Epoxy Zinc Phosphate Primer	Eplux 13 HB Primer	APCODUR EHB Zinc Phosphate Primer	Intergard 251	Sigmacover 256	Amercoat 68 HS	Hempadur fast dry 15590	Penguard Express/ Jotaguard Zn phosphate	Carboguard 193 HB ZPP
Polyamide cured epoxy High build MIO	Eplux 455 HB MIO	APCODUR EPOXY HS MIO	Intergard 475 HS	Sigmacover 435	Amerlock 400 MIO	Hempadur mastic 47550	Penguard Express MIO	Carboguard 893
Aliphatic Isocyanate Polyurethane Finish paint	Bergerthane 41 S/G PU Finish	APCOTHANE HB PU Finish	Interthane 990	Sigmadur 520	Amercoat 450 HS	Hempalin 12050	Hard Top XP	Carbothane 134 HG
Polyamide Cured High Build Epoxy Finish paint	Epilux 89 high build finish	APCODUR EPOXY 420 HS	Intergard 410	Sigmacover 456	Amercoat 385	Hempathane topcoat 55930	Penguard Express	Carboguard 193 HB ZPP



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11.9 LIST OF MEASURING INSTRUMENTS REQUIRED:

Description of the instrument	Purpose	Calibration
Surface Profile meter	For determination of the surface profile of the blast cleaned surface.	Required at the beginning of the work
Replica tape (Press-o-film)	Plastic backed tape having foam like material for getting mirror image of the blasted surface once pressed on to it.	If required.
Hygrometer	Instrument with dry and wet bulb thermometer used with standard table for determination of dew point and relative humidity.	Required.
Surface thermometer	Special instrument to measure the substrate temperature.	Required
Magnetic type dry film thickness meter (Elcometer)	For testing the DFT (dry film thickness) of paint.	Required for every single operation.
Clean white cloth	For detection of oil in compressed air.	N/A
Holiday detector	Low voltage coating flaw detection.	Required
Adhesion testers	Field instrument to measure adhesion.	Required.
Wet film thickness gauge	A rigid plate with notches for determining the thickness of the coating film.	Required.

11.10 QUALITY ASSURANCE DURING PAINTING:

SI No	Step	Action to be taken
1	Prior to abrasive blasting	a. Check the quality of abrasive and ensure that it meets the specification. b. Ensure that the substrate is free from oil patches, weld spatters etc., c. Check compressor performance. d. Chloride content to be checked by conductivity test or by indicative tests like chlortest or equivalent for both abrasive and substrate. e. If chloride content is above that specified in. Removal of chloride is to be done as per approved method. f. Test compressor for oil and water contamination. g. Check substrate temperature. h. Check ambient temperature. i. Check dew point.
2	After each blast cleaning stoppage	a. Test compressor for oil and water contamination. b. Check substrate temperature. c. Check relative humidity and dew point. d. Check ambient temperature.
3	After abrasive blasting	a) Check visual cleanliness. b) Check surface profile.
4	Immediately prior to coating application.	a. Check quantity of paint used. b. Check ambient conditions. c. Check surface for cleanliness.
5	During coating application.	a. Check mixing of paint components. b. Check application methods. c. Check WFT (wet film thickness) of the coating
6	After completion of each coat	a. Check intercoat time interval before allowing clearance for subsequent coat. b. Check painting equipments. c. Check DFT of the paint surface
7	After completion of finish coat	a. Check final DFT. b. Check for pinholes by holiday and ensure rectification. c. Check adhesion of paint to substrate.
8	Immediately after manufacturer's recommended curing period.	a. Check curing by MIBK/ MEK rub test.



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(पाईपलाइन प्रभाग) नोएडा

Annexure – M3-1

Specification for 100% solvent free Poly Urethane-Coating Material for External Coating of underground piping

S. no.	Properties	Requirements	Test Method
Physical & Chemical Properties:			
1.	Coating/Lining System	100% volume solids rigid/ elastomeric polyurethane	
2.	Recommended Coating/lining Thickness	Minimum 1000 microns	EN10290
3.	Adhesion to steel (min.) (Elcometer Pull Off)	> 10MPa	ASTM-D4541/EN24624
4.	Surface Hardness (Cured Film)	75 ± 10 Shore D	ASTM D2240 / ISO 868
5.	Operating Temperatures	(-) 35 deg C to (+) 60 deg C	
6.	Salt Spray (6000Hrs	No EFFECT	ASTM - B117-73
7.	Cathodic disbondment after 28 days, @ 20degC	Maximum disbondment of 5.0 mm radius. 28 days, @ 20degC	(ASTM G-95 modified to 28 days) /
		Average ≤8mm over 8 measurements, Maximum-10 mm 28 days@ 23±2°C	As per Annexure E of EN10290
8.	Impact resistance	No cracking , no holiday at 5 Nm/mm (minimum)	ASTM G-14 on steel Pipe/ EN-10290
9.	Abrasion Resistance	WEIGHT LOSS 0.03 g (Maximum)	D 4060 (weight loss after 1000 cycles using CS 17 wheel and 1 kg load)
10.	Cross cut adhesion to pipe surface	Rating 1	As per Annexure A of EN10290
11.	Indentation resistance at 10 N/mm ²	30% of intial measured coating thickness @ max service temperature ± 2°C	As per Annexure H of EN10290/ as per ISO-21809
12.	Specific electrical insulation	10 ⁶ Ω m2 for Class A @ 23±2°C	As per Annexure F of EN10290



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	resistance, R_{s100}	after 100 days. $10^4 \Omega \text{ m}^2$ for Class A after 30 days @ max. service temperature $\pm 2^\circ\text{C}$	/as per ISO-21809
Inspection for Quality Assurance at Field			
13.	Dew point	Ambient Temperature should be > Dew Point By 3°C Min.	Hygrometer
14.	Relative Humidity	Less than 85%	Hygrometer
15.	Surface Temperature	Min 5°C , Max 70°C	Surface thermometer
16.	Surface Preparation	By abrasive blasting	
17.	Grade of Cleanliness	SSPC SP-10/ Swedish SA 2 ½	Testex Tape/ Surface Comparator
18.	Surface Profile	Min. 75 Microns	Profile Gauge
19.	Dry Film Thickness-DFT	1000 microns	Electromagnetic thickness gauge
20.	Adhesion test (Pull Off)	> 10MPa	
21.	Holiday testing at @ 5 volts per micron	No Holiday	Holiday Testing Machine

Note:

- Lab test report is to be submitted for review in respect of Physical properties of coating material and Performance Test of Coating Material as mentioned above. The test shall be conducted in accordance with the standard mentioned in the table above and result should match the values required by the relevant standard or the values shown in the table. In case of any discrepancies the value mentioned in the latest edition of the respective codes/standards shall be applicable.
- The contractor to depute technically competent QA/QC engineer for inspection before and during application process.



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Annexure – M3-2

Specifications for High Build Solvent Free Liquid Epoxy Coating-Coating Material for External Coating of
Underground Piping

Sl. no.	Properties	Requirements	Test Method
Physical & Chemical properties			
1.	Coating/Lining System	High Build Solvent Free Liquid Epoxy	
2.	Recommended Coating/lining Thickness	Min. 800 micron	EN10289
3.	Adhesion to steel (min.)	> 10MPa	ASTM-D4541/ EN24624
4.	Dielectric strength (min)	400 V/mil (15 V/ μ m)	ASTM D149
5.	Hardness Shore D	75 (min)	ASTM D2240
6.	Tabor Abrasion	> 30 cycles/micron of material loss	ASTM D4060
7.	Impact Resistance (40 mils)	5 Joules	ASTM G-14-88
8.	Cathodic Disbondment after 30 days, @ 23°C	< 5.0 mm	ASTM G-8
9.	Flexibility (degree per pipe dia.)	~ 0.5 degree	NACE RP-0394
10.	Thin Film water Absorption	< 0.15%	ASTM D-3289-03
Inspection for Quality Assurance			
11.	Dew point	Ambient Temperature should be > Dew Point By 3° C Min.	Hygrometer
12.	Relative Humidity	Less than 85%	Hygrometer
13.	Surface Temperature	Min 10°C, Max 70°C	Surface thermometer
14.	Surface Preparation	By abrasive blasting	
15.	Grade of Cleanliness	SSPC SP-10/ Swedish Std. SA 2 ½	Testex Tape/ Surface Comparator



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16.	Surface Profile	Min. 75 Microns	Profile Gauge
17.	Film Thickness-DFT	1000 microns	Electromagnetic thickness gauge
18.	Pull off Adhesion test	> 10MPa	ASTM D-4541 / EN10289
19.	Holiday testing at @ 5 volts per micron	No Holiday	Holiday Testing Machine

Note:

- Lab test report is to be submitted for review in respect of Physical properties of coating material and Performance Test of Coating Material as mentioned above. The test shall be conducted in accordance with the standard mentioned in the table above and result should match the values required by the relevant standard or the values shown in the table. In case of any discrepancies the value mentioned in the latest edition of the respective codes/standards shall be applicable.
- The contractor to depute technically competent QA/QC engineer for inspection before and during application process.



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SECTION-III

SPECIFICATION FOR HDPE LAYING AND OPTICAL FIBRE CABLE BLOWING WORKS



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1. SPECIFICATIONS OF SUPPLIES AND SERVICES TO BE COVERED UNDER MAINLINE FOR
HDPE LAYING AND OPTICAL FIBRE CABLE BLOWING WORKS

1.1. SPECIFICATIONS OF PERMANENTLY LUBRICATED HIGH DENSITY POLYETHYLENE DUCTS
(PLB HDPE DUCTS)

Refer to document No. IOCL-TC-SPECSW-HDPE for HDPE conduit specifications.

1.2. ELECTRONIC MARKER LOCATOR UNIT WITH CABLE/ PIPE LOCATOR & SHEATH FAULT
LOCATOR

Refer to document No. IOCL-TC-SPECS -ELE LOCATOR for specifications.

1.3. JOINTING KIT

Refer to document No. IOCL-TC-SPECS-JOINTKIT for specifications.

1.4. WARNING TAPE

Refer to document No. IOCL-TC-SPECS- WARTAPE for specifications.

1.5. RFiD DISK TYPE ELECTRONIC MARKER

Refer to document No. IOCL-TC-SPECS – RFID MARKER for specifications.

2. Despatch of Material:

The contractor shall not dispatch any material without approval of Owner. Contractor shall submit the test certificates of all the supply items to the Engineer-in-charge. Engineer-in-charge may decide to carry out inspection of material at the works of manufacturer at his sole discretion. Test equipments, tools / tackles etc. shall be arranged by the contractor for inspection by IOCL representatives. All cost incurred shall be borne by contractor. However, expenses towards travelling, boarding / lodging of IOCL representatives shall be borne by Owner.

3. LAYING OF OPTICAL FIBRE CABLES

The 24 fibre metal free Optical Fibre Cable of nominal diameter 16-18 mm (approx.) suitable for underground installation in ducts shall be supplied by Owner for laying/ blowing in HDPE conduits.

The Owner shall issue factory tested OFC to the contractor. Prior to installation, the Contractor shall physically see the cable for any damage and test the Owner supplied OFC using the Optical Time Domain Reflectometer (OTDR).



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After laying through the HDPE, the Contractor shall again test the cable and take OTDR traces. The post installation OTDR traces (hard copy and soft copy) shall be submitted to Engineer-in-charge for review. Testing shall be performed on each fibre.

No variation in the test parameters indicates the quality of the cable blowing works. The cable laying is liable for rejection if the variation in test parameters is observed. Under such conditions, the contractor shall be responsible to supply and install tested cables in the defective stretch without any extra cost to the Owner. The above testing procedure shall be performed for replaced cable also. All costs towards replacement of the damaged cables including supply of the cable shall be borne by the contractor. Contractor to note that the cable to be supplied as replacement shall be similar in design to the Owner supplied cable.

All left over OFC after laying shall be thoroughly tested before handing over to the Owner along with the test reports. If any discontinuity / point loss beyond 0.1 dB in any fibre is found, the cable shall not be accepted by Owner.

4. TESTING & DOCUMENTATION :

Bidder shall install and test all their supply & installation items to full satisfaction of EIC/ Site engineer.

All drawings/ documents related to this work shall be submitted by bidder to EIC/ Site Engineer for their approval.

All supply items / items used in installation will be got approved by EIC/ Site engineer before procurement. The supply items shall be of approved makes enclosed as per Annexure-I.

Finally 06 copies of As Built Drawings (in hard copy) with 01 soft copy in suitable CD media for work executed shall be submitted by contractor after execution of work. The drawings shall include as built layout drawings. Distribution- 4 sets of documents to be handed over to EIC/ Site Engineer at site & 2 sets to be handed over at IOCL Pipelines Head Office.

**TECHNICAL SPECIFICATIONS FOR
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STANDARD SPECIFICATION NO. : IOCL-TC-SPEC-ELE LOCATOR

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**TECHNICAL SPECIFICATIONS FOR
ELECTRONIC LOCATOR AND RFID
MARKER**



**STANDARD SPECIFICATION NO. :
IOCL-TC-SPEC-ELE LOC-REV00**

1.0 ABBREVIATIONS

BIS	Bureau of Indian Standards
BOM	Bill of Material
CCoE	Chief Controller of Explosives
QA	Quality Assurance
QAP	Quality Assurance Plan
QC	Quality Certificate

2.0 SCOPE OF SPECIFICATION

2.1 This specification covers design, manufacture, testing, supply of Electronic Marker and Locator unit.

2.2 In the event of conflict between this standard specification, datasheets, job specifications, statutory regulations, related standards & codes etc the following order of priority shall be applicable:

- a) Statutory regulations
- b) Engineering Design Basis
- c) Datasheets
- d) Job specifications
- e) Standard specification
- f) Related standards & codes

If any parameter/specification is not mentioned/ defined in higher priority/precedence document, the minimum requirements for same in lower higher priority/precedence document shall prevail.

2.3 The Electronic Locator system is a precise method of using electronic markers at the OFC Joint locations and subsequently using the Electronic Marker Locator Unit to locate these Electronic Markers at underground OFC joint locations at the time of maintenance. The system shall consist of underground buried electronic RFI markers and an electronic marker locator unit. The locator unit shall also be capable of locating cables/ pipes and location of sheath (earth return) faults.

3.0 BID REQUIREMENTS

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- 3.1 Bid shall be strictly in line with tender/purchase requisition requirements and bidding instructions attached elsewhere in tender/document.
- 3.2 Expression like “can offer if required, will be decided later” etc. are not acceptable.
- 3.3 In case no deviations/ exceptions to these specifications are mentioned, it shall be taken as granted that contractor/vendor/bidder agrees in totality to the customer's specification and requirements. Only those technical deviations shall be considered for review, where contractor/vendor/bidder has valid technical reason for proposed deviation. The proposed technical deviation shall be clearly indicated in prescribed tender deviation format (enclosed elsewhere in document) and shall have all backup documents justifying the proposed deviation.
- 3.4 All documentation & bid shall be in English language only.
- 3.5 Documents as per the attached list to be submitted.

4.0 ENVIRONMENTAL CONDITIONS

- 4.1 All equipment shall withstand prevailing temperature, humidity, dust and salt atmosphere in Indian environments and shall be rated to the specified capacity taking all de-ratings into consideration. It shall operate within specifications for the parameters given below :-

Sl. No.	Functionality/ Description	Minimum Specifications
1.	Operating temperature	-10 °C to +55 °C

5.0 ELECTROMAGNETIC COMPATIBILITY(EMC)

- 5.1 The instrument shall conform to all the applicable EMC requirements as per the following standards and limits indicated therein:

Sl. No.	Functionality/ Description	Minimum Specifications
1.	Conducted and radiated emissions	To comply with class A of CISPR 11(1990) (INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE)
2.	Electrostatic discharge	To comply with IEC 1000-4-2

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Sl. No.	Functionality/Description	Minimum Specifications
		(INTERNATIONAL ELECTROTECHNICAL COMMISSION) under following test levels: Contact discharge level 2 (-4KV) Air discharge level 3 (-8KV)
3.	Fast transients Common mode (burst)	To comply with IEC 1000-4-4 under LEVEL2 (1 KV for power lines, 0.5 KV for signal control lines)
4.	Immunity	To comply with the following: a. IEC1000-4-3 test level 2 (Test field strength of 3V/m) b. Surges common and differential mode: To comply with IEC 1000-4-5 under test levels of 0.5 kV for differential mode and 1 kV for common mode

6.0 INTRODUCTION

6.1 The Electronic Marker locator unit shall be capable of locating disk type RFI^D markers as well as passive markers suitable for Oil & Gas applications. The i^D type electronic markers shall be placed at every joint location on the OFC joint pits underground along the cable route. The marker locator unit should be such that it can be able to detect the buried electronic marker while approaching it from either side of the pipeline. The OFC joint pit shall be underground at a depth of 1 metre (approx.) from the ground level at every joint location. The electronic marker should be detectable by the marker locator unit from anywhere within a radius of minimum 7 to 8 feet from the centre of the marker. The marker locator should also be able to provide marker depth estimation. The electronic marker locator unit should have read & write capability to read/ write information from/ to the RFI^D Electronic markers.

Apart from the features stated above, the Electronic Marker Locator Unit should have the following additional features:-

1. Locating conductor or sheath (earth return) faults.
2. Tracing the path of underground cables and metallic pipes with estimated depth.

The Electronic marker locator unit with cable/ pipe locator & sheath fault locator shall

consist of the following main sub-systems/ parts:

1. Electronic Marker Locator/ Cable, Pipe Locator Unit (Receiver Unit)
2. Transmitter Unit

7.0 SPECIFICATIONS

7.1 The minimum technical specifications of Electronic Locaor are as below:-

Sl. No.	Functionality/ Description	Minimum Specifications
1.	<i>General requirements:</i>	<ol style="list-style-type: none"> 1. The Electronic Locator System shall be fully solid state and field proven employing state of the art technology. 2. The instrument shall be portable and light weight. The actual dimensions and weight of the instrument shall be furnished by the contractor. 3. All connectors and cables shall be of low loss, suitably shielded, reliable and of standard type to ensure failure free operation over long periods and under specified environmental conditions. 4. The mechanical design and construction of each card/ unit shall be inherently robust and rigid under all conditions of operation, adjustment, replacement, storage and transport. 5. The instrument shall have self cooling arrangement without use of fans. 6. All controls, switches and indicators shall be clearly marked to show their circuit designation and functions. 7. Marker Locator Unit should have the facility of writing/ storing data in the RFiD electronic markers such as Joint no., Chainage, location, placement date etc. The locator should also have the facility to read the data stored in the RFiD electronic marker. 8. All required software along with cables, connectors and accessories shall be supplied with the unit for interfacing the Electronic Marker Locator Unit with Laptop/ Computer and storing/ downloading, uploading electronic marker related data. 9. The Electronic Marker Locator Unit shall be supplied with Transmitter, two sets of transmitter connection leads, capacitive coupler/ clamp, ground rod, earth frame for locating earth return faults, carrying case, cables, connectors and accessories complete in all respects required for carrying out the features/ functions as detailed in specifications. 10. Installation of RFiD Electronic Markers at OFC Joint

Sl. No.	Functionality/ Description	Minimum Specifications
		Pit locations, writing/ storing data in the Electronic Markers during installation shall be the responsibility of contractor.
2.	OPERATIONAL REQUIREMENTS:	<ol style="list-style-type: none"> The Electronic Locator System shall be able to pin-point earmarked buried telecom facilities such as cables, joints etc. using the electronic markers. It should also be able to locate the route of pipes/ cables with depth estimation, locating conductor or sheath (earth return) faults. The Marker Locator shall generate and transmit a specific frequency signal to the buried electronic marker. The Electronic Marker, tuned to this frequency, reflects the signal back to the locator. The locator verifies the reflected signal picked up through the probe and the location is indicated with an audible & visual indication. The instrument shall be provided with sensitivity control facility. All switches / controls on front panel of shall have suitable safeguards against accidental operation. The instrument shall be adequately safeguarded to prevent entry of dust, insects and lizards.
C. TECHNICAL REQUIREMENTS		
1	Cable route tracing mode	Radio Frequency Mode
2	Accuracy of location	The electronic locator system shall be capable of locating the marker buried 1 meter below ground level. The system shall work up to minimum distance of 8 feet between locator and marker
3	Transmitter frequencies	<i>Suitable for Oil & Gas applications (82.1 KHz to 83.9 KHz)</i>
4	Frequency Tolerance and drift	$< \pm 1\%$
5	Transmitter output power	Up to 12 W max.
6	Antenna	Included. Bidder to specify details.
7	Receiver 'PEAK' Reception 'NULL'	<p>Detects the radio frequencies reflected by the buried marker. The locator shall have facilities of peak & null reception with directional peak indication.</p> <p>Tone/deflection shall be at highest Tone/deflection shall be weak or cancelled.</p>

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Sl. No.	Functionality/ Description	Minimum Specifications
	Reception:	
8	GPS Communication capability	Yes
9	Indications	Audible & visual indication
10	Power requirements	a) Transmitter/ Receiver to work on rechargeable / dry cells for outdoor working. The cells used shall be of standard type and most commonly used.. b) Low battery indication to be provided c) The manufacturer shall furnish the power consumption of the instrument.
11	Dimensions & weight	The electronic locator with its probe, transmitter and accessories shall be portable, compact and robust. Details to be specified and furnished by the bidder.
12	Cabinet/ Casting for locator	Suitable sheet metal or reinforced plastic
13	Maintenance Requirements	1.The calibration of the instrument shall be valid for one year. 2.The instrument shall have easy access for servicing and maintenance. 3.Ratings and types of fuses used are to be indicated by the supplier. 4.The manufacturer/ supplier shall furnish the list of recommended spares for three years maintenance. 5.The supplier shall have maintenance/repair facility in India. Supplier should guarantee the spares so long as the instrument is in service, at least for 10 years from the date of supply. The owner would like to stock spares as and when the supplier decides to close down the production of the offered equipment. In such an event, supplier shall give two years notice to the owner so as to stock the spares.
14	Quality Requirements:	1.The instrument shall be manufactured in accordance with international quality standards for which the manufacturer should be duly accredited. However, owner may consider acceptance of the instrument from manufacturer who is not is not accredited as above on a case by case basis. 2.The instrument shall be environment-friendly and the applicable tests shall be for environmental category 'D' including those for dust, vibration and corrosion.

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Sl. No.	Functionality/ Description	Minimum Specifications
15	Safety Requirements	1.The operating personnel should be protected against shock hazards as per IS 8437(1993). 2.The instrument shall conform to IS 9858(1981). 3.The instrument should follow proper construction practice to minimise unintended radiation due to leakage from any gap or monitoring points. All unused ports and monitoring points should be terminated. The power flux density shall not exceed 1Mw /sq. cm at a distance of 2.5 cm.

7.2 The minimum technical specifications of RFID Disk Type Electronic Marker are as below:-

Sl. No.	Functionality/ Description	Minimum Specifications
1.	Casing	The electronic marker which is buried underground shall be RFID Disk type Electronic Marker. Its casing shall be made of HDPE or any other suitable engineering material, suitable for underground burial. It shall not be affected by chemicals, minerals and temperature variations normally found in underground environments. It shall not be prone to damage due to rodents or any other insects in the underground environment.
2.	Storage	The RFID Electronic Marker should have the facility of storing data such as Joint no., Chainage, location, placement date etc. It shall be possible to carry out multiple unlimited read/ write operations on the electronic markers to write/ store the data. The said data shall be written using the marker locator unit.
3.	Compatibility	Data stored in the Electronic Marker should be readable by the locator in the detection range of the marker
4.	Installation	The marker shall be buried clear of (with a minimum clearance of 30 cm all round) any metallic objects such as water conduits, power cables etc. and when the marker is buried as stated herein the electronic locator system shall not be affected by such objects.

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8.0 ACCESSORIES

8.1 The flowing accessories are required along with the locator. The supplier shall provide one complete set of:

1. All the necessary accessories like antenna, connecting cables etc. as required for proper operation of the instrument. Types of connectors, adapters and accessories of the approved quality shall be clearly indicated in the operating manuals.
2. Special tools, extender boards, extender cables and accessories essential for installation, operation, maintenance and repair of the instrument shall be clearly indicated and supplied along with the instrument as per the owner's requirement.
3. For ease of transportation and safety of the instrument, suitable carrying case shall be supplied.

9.0 DOCUMENTS

9.1 Following documents to be submitted by the vendor / bidder during different stages

1. Technical literature in English with complete layout, detailed block schematic of the unit shall be provided. All aspects of installation, operation, maintenance and repair shall be covered in the manual. The manual should include the following:

Along with the Bid (1 Set):	a) Filled in specifications sheet, data sheet and deviation statement. b) Make of the offered electronic locator
Upon Placement of PO for Owner's Approval (2 Sets, within 15 days):	a) Quality Assurance Plan b) Testing & Inspection Plan
Along with the material (02 sets)	a) Packing list b) Inspection report c) Installation, operation and maintenance manual d) Safety measures to be observed in handling test instrument: e) Precautions for setting up, measurements and maintenance; f) Test equipment required for routine maintenance and

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	<p>calibration including their procedures;</p> <p>g) Illustration of internal and external mechanical parts.</p> <p>c) Procedure for trouble shooting of instrument shall be provided. Test fixtures and accessories required for repair shall also be indicated. Systematic trouble shooting charts shall be given for the probable faults with their remedial actions</p>
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10.0 INSPECTION & TESTING:

10.1 Electronic Locator

It shall be the bidder's total responsibility to arrange one time on-site demonstration of all features & functionalities of the Instrument at the time of handing over of the system. The demonstration shall be given by the OEM's representative at each station where the Electronic Marker Locator Unit with Cable/ Pipe Locator & Sheath Fault Locator is to be supplied as per SOR.

10.2 RFiD Markers

Sl.No	Test	Procedure
1.	Tensile strength & elongation:	The tensile strength at yield for finished material shall be 20 N/sq.mm minimum & elongation at break shall not be less than 350%.
2.	Thermal stress crack resistance test:	The marker shall be under compression load of 10 Kg at a temperature of 55 deg C for 750 hours. There shall not be any indication of stress cracking or split on the surface of the marker.

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3.	Hot, Cold Cycle Test	The marker is kept between –10 deg C and 55 deg C for one week. There shall not be any indication of stress cracking.
4.	Seal Test	This consists of one minute immersion in mineral oil at 100 deg C. The sealing shall not show any functional abnormalities.

11.0 REVIEW & APPROVAL:

- 11.1 The contractor/vendor/bidder shall thoroughly review and approve contractor/vendor/bidder's drawings & QAP for the instrument including sub-package items, as applicable, before forwarding to Owner for further review and / approval. Only the approved drawings & QAP duly stamped and signed by a competent engineer of the contractor/vendor/bidder shall be sent to the Company.
- 11.2 Contractor/vendor/bidder shall not place the order without obtaining prior approval from the company.

12.0 PREPARATION FOR SHIPMENT:

- 12.1 The Locator shall be packed separately with sufficient protection in the original manufacturer's boxes. Each package shall be identified with purchase order number and content list in a weatherproof envelope.
- 12.2 A desiccant shall be provided inside all enclosures to prevent moisture damage due to high humidity.

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TECHNICAL SPECIFICATIONS FOR
HDPE CONDUIT



STANDARD SPECIFICATION NO. :
IOCL-TC-SPEC-RFI D MARKER -REV00

TECHNICAL SPECIFICATIONS FOR
RFID MARKER

STANDARD SPECIFICATION NO. : IOCL-TC-SPEC-RFID MARKER

1.0 ABBREVIATIONS

BIS	Bureau of Indian Standards
BOM	Bill of Material
CCoE	Chief Controller of Explosives
QA	Quality Assurance
QAP	Quality Assurance Plan
QC	Quality Certificate

2.0 SPECIFICATIONS

The minimum technical specifications of RFI D Disk Type Electronic Marker are as below:-

Sl. No.	Functionality/ Description	Minimum Specifications
1.	Casing	The electronic marker which is buried underground shall be RFI D Disk type Electronic Marker. Its casing shall be made of HDPE or any other suitable engineering material, suitable for underground burial. It shall not be affected by chemicals, minerals and temperature variations normally found in underground environments. It shall not be prone to damage due to rodents or any other insects in the underground environment.
2.	Storage	The RFI D Electronic Marker should have the facility of storing data such as Joint no., Chainage, location, placement date etc. It shall be possible to carry out multiple unlimited read/ write operations on the electronic markers to write/ store the data. The said data shall be written using the marker locator unit.
3.	Compatibility	Data stored in the Electronic Marker should be readable by the locator in the detection range of the marker
4.	Installtion	The marker shall be buried clear of (with a minimum clearance of 30 cm all round) any metallic objects such as water conduits, power cables etc. and when the marker is buried as stated herein the electronic locator system shall not be affected by such objects.

3.0 INSPECTION & TESTING:

Sl.No	Test	Procedure
1.	Tensile strength & elongation:	The tensile strength at yield for finished material shall be 20 N/sq.mm minimum & elongation at break shall not be less than 350%.
2.	Thermal stress crack resistance test:	The marker shall be under compression load of 10 Kg at a temperature of 55 deg C for 750 hours. There shall not be any indication of stress cracking or split on the surface of the marker.
3.	Hot, Cold Cycle Test	The marker is kept between -10 deg C and 55 deg C for one week. There shall not be any indication of stress cracking.
4.	Seal Test	This consists of one minute immersion in mineral oil at 100 deg C. The sealing shall not show any functional abnormalities.

**TECHNICAL SPECIFICATIONS FOR
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STANDARD SPECIFICATION NO. : IOCL-TC-SPEC-HDPE

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1.0 ABBREVIATIONS

BIS	Bureau of Indian Standards
BOM	Bill of Material
CCoE	Chief Controller of Explosives
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QAP	Quality Assurance Plan
QC	Quality Certificate

2.0 SCOPE OF SPECIFICATION

- 2.1 This specification covers design, manufacture, testing, supply of HDPE conduit.
- 2.2 In the event of conflict between this standard specification, datasheets, job specifications, statutory regulations, related standards & codes etc the following order of priority shall be applicable:
- IS-7328
 - Statutory regulations
 - Engineering Design Basis
 - Datasheets
 - Job specifications
 - Standard specification
 - Related standards & codes
- If any parameter/specification is not mentioned/ defined in higher priority/precedence document, the minimum requirements for same in lower higher priority/precedence document shall prevail.
- 2.3 The HDPE conduit to be supplied and installed shall be as per the requirements indicated in the specifications and datasheets.
- 2.4 Approval of purchase specification does not absolve the contactor from supplying material of proven design as per the specification.
- 2.5 Subsequent to qualification, any change in make/model offered shall normally not permit. However, in such eventualities where either the model has been withdrawn/unavailable/ delivery is unavoidably getting delayed, the owner may consider changes upon submission of proof of such eventuality.

TECHNICAL SPECIFICATIONS FOR HDPE CONDUIT



STANDARD SPECIFICATION NO. :
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- 2.6 The HDPE conduit is to be supplied with required accessories, other fittings & fixtures and accessories for ready field installation of HDPE as mentioned in datasheet.

3.0 BID REQUIREMENTS

- 3.1 Bid shall be strictly in line with tender/purchase requisition requirements and bidding instructions attached elsewhere in tender/document.
- 3.2 Expression like “can offer if required, will be decided later” etc. are not acceptable.
- 3.3 In case no deviations/ exceptions to these specifications are mentioned, it shall be taken as granted that contractor/vendor/bidder agrees in totality to the customer's specification and requirements. Only those technical deviations shall be considered for review, where contractor/vendor/bidder has valid technical reason for proposed deviation. The proposed technical deviation shall be clearly indicated in prescribed tender deviation format (enclosed elsewhere in document) and shall have all backup documents justifying the proposed deviation.
- 3.4 All documentation & bid shall be in English language only.
- 3.5 Documents as per the attached list to be submitted.

4.0 ENVIRONMENTAL CONDITIONS

- 4.1 All equipment shall withstand prevailing temperature, humidity, dust and salt atmosphere in Indian environments and shall be rated to the specified capacity taking all de-ratings into consideration. It shall operate within specifications for the parameters given below :-

Sl. No.	Functionality/ Description	Minimum Specifications
1.	Heat Deflection Temperature at 45 gms /mm ²	65 Deg C minimum, when tested as per ASTM D 648
2.	Environmental Stress Crack Resistance, When tested with 10% Igepal, CO 0630 Solution at 50 Deg C	96 hours, when tested as per ASTM D 1693. No cracks should be visible
3.	Weathering in artificial UV light (Specimen shall be as per ASTM D 638 Type-IV) and cut from compression moulded sheet.	After exposure for 720 hrs, the tensile strength shall be tested. The variation shall not be greater than 20% compared to tensile strength (20 N/mm ² minimum, when tested as per ASTM D 638, Type-IV specimens)

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Sl. No.	Functionality/ Description	Minimum Specifications
4.	Oxidative Induction Time (in Aluminum Pan)	30 minutes minimum, when tested as per Annexure-I of GR
5.	UV Stabilizer	Hindered Amine Light Stabilizer. Minimum 0.15% when analysed as per FT-IR method.

5.0 SPECIFICATIONS

5.1 The minimum technical specifications of the HDPE conduit are as below:-

Sl. No.	Functionality/ Description	Minimum Specifications
A.	Material	
1.	Outer Layer:	<p>a. The base HDPE resin used for the outer layer of the PLB HDPE ducts shall conform to any designation of IS-7328</p> <p>b. Density - 0.940 to 0.958 g / cc at 27 deg C when tested as per IS: 2530 or IS:7328</p> <p>c. Melt Flow Rate (MFR) - 0.2 to 1.1 g / 10 minutes at 190 deg C & 5 Kg load, when tested as per IS:2530</p> <p>d. Tensile Strength at Yield - 20 N/mm² minimum, when tested as per ASTM D 638, Type-IV specimens</p> <p>e. Elongation at break >600%, when tested as per ASTM D 638, Type-IV specimens</p> <p>f. Flexural Modulus at 1% strain - 690 N/mm² minimum, when tested as per ASTM D 790</p> <p>g. Hardness, Shore-D - Between 60 and 65 units, when tested as per ASTM D 2240</p>
2.	Inner Layer	The inner lubrication material shall be of friction reducing polymeric material which shall be integral with HDPE layer. The lubrication materials shall have no toxic or dermatic hazards for safe handling. In the finished PLB HDPE duct, the co-extruded inner layer of solid permanent lubricant shall be integral part with HDPE and shall be white in colour and clearly visible in cross- section of the duct. The density of the inner layer

**TECHNICAL SPECIFICATIONS FOR
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Sl. No.	Functionality/ Description	Minimum Specifications	
		<p>material shall be between 0.940 and 0.958 gms / cc at 27 Deg C.</p> <p>The inner layer of solid permanent lubricant shall be continuous all through and shall not come out during storage, usage and throughout the life of the duct.</p>	
3.	Raw Material	<p>The anti-oxidants used shall be physiologically harmless None of the additives shall be used separately or together in quantities as to impair long term physical and chemical properties of the duct.</p> <p>Single pass rework materials of the same composition produced from the manufacturer's own production shall be used and it shall not exceed 10% in any case. The raw material used for extrusion shall be dried to bring the moisture content to less than 0.1%</p> <p>Suitable UV stabilizers shall be used for manufacture of the duct to protect UV degradation, when stored in open for a minimum of 8 months.</p> <p>The raw material used in the manufacture of the duct shall be such that the service life of the duct and all its accessories can be expected to be more that 50 years including the life of permanent lubricant.</p>	
B.	Dimensional Details	For 50 mm O.D	For 40 mm O.D
4.	Outer diameter	50 mm + 0.4 mm	40 mm + 0.4 mm
5.	Standard length of drum	As per datasheet	As per datasheet
6.	Wall Thickness	4 + 0.4 mm	3.5+ 0.2 mm
7.	Thickness of inner layer	Minimum 0.28 mm, Maximum 0.42 mm	Minimum 0.28 mm, Maximum 0.42 mm
C.	Other Parameters		
8.	Tensile strength at yield when tested at a machine speed of 50 mm/min	20 N / sq mm or better	
9.	Elongation	Min. 500%	
10.	Test Pressure	6 Kg/cm ² min.	
11.	Internal coefficient of friction	0.06 (max)	

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**TECHNICAL SPECIFICATIONS FOR
HDPE CONDUIT**



**STANDARD SPECIFICATION NO. :
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Sl. No.	Functionality/ Description	Minimum Specifications
	w.r.t OFC	
12.	Lubrication	Permanently lubricated for blowing of OFC cable.

NOTE: The raw materials shall contain required additives such as anti-oxidants, UV stabilizers etc. in the raw material itself so as to meet the above parameters

- 5.2 **Source Approval:** The HDPE raw material used in the manufacture of ducts shall have source approval of CACT.

6.0 ACCESSORIES

The flowing accessories as required for jointing the ducts shall be supplied by the contractor along with the ducts:

- 6.1 **Plastic Coupler (Push-fit type/ Compression type):** It is used to couple two ducts. The design of the same shall be simple, easy to install and shall provide air tight and water tight joint between the two ducts. The coupler shall ensure that the two ducts are butted smoothly without any step formation in the inner surface. The jointing shall meet the air pressure test of 15 Kg / cm² for a minimum period of 2 hours without any leakage.
- 6.2 **End Plug:** This is for sealing the ends of the empty ducts prior to installation of the optical fibre cable to prevent the entry of dirt, water, moisture, insects / rodents etc.
- 6.3 **Cable Sealing plug:** This shall be used to seal the ends of the duct perfectly after the cable is installed in the duct in order to prevent the entry of dirt, water, moisture, insects / rodents etc. This is required to be installed at all the places where cable has come out of the duct either for jointing or entry into the building as required. The sealing plug shall be capable of accommodating standard sizes of optical fibre cable taking into account the variation in diameter due to tolerance limits etc.
- 6.4 **End Cap:** This cap shall be made of hard rubber/suitable plastic material, shall be fitted into both the ends of the duct coil after manufacturing the duct to avoid entry of dust, mud and rain water into the duct during transit and storage.
- 6.5 No part of the accessory shall be made of metal.
- 6.6 The 'End Plug' and 'Cable sealing plug' shall be tested for air tightness with a pressure of 1 bar for 30 minutes.

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**TECHNICAL SPECIFICATIONS FOR
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- 6.7 Pulling force required to pull out two pieces of duct joined by the coupler :** The pulling force required shall be a minimum of 320 kgf for 40 mm duct. The test may be conducted by loading the coupler joined by two pieces of duct for 15 minutes using a dead load.
- 6.8 Ageing test for accessories:** The accessories viz coupler, end plug and cable sealing plug shall be subjected to an ageing test. In this test, the accessory under test shall be installed on a piece or pieces of duct as the case may be. It shall then be tested for tightness as per the GR and it shall pass the test. The accessory thus installed shall then be aged in an air circulating oven at 70 ± 2 Deg C for 168 hours. At the end of period, it shall be allowed to cool to room temperature and then be tested for tightness as per the GR and it shall pass the test.
- 6.9** The HDPE pipe and HDPE duct accessories shall be of same make.

7.0 DOCUMENTS

Following documents to be submitted by the vendor / bidder during different stages

1. Along with the Bid (1 Set):	a) Filled in specifications sheet, data sheet and deviation statement. b) Make of the offered HDPE conduit c) Valid TEC certificate for the offered HDPE makes. d) Source approval of CACT
2. Upon Placement of PO for Owner's Approval (2 Sets, within 15 days):	a) Quality Assurance Plan b) Testing & Inspection Plan c) Valid TEC certificate for the offered HDPE makes.
3. After Inspection, for Dispatch Clearance (02 Sets)	a) Inspection report. b) Inspection release note c) Guarantee/Warranty certificates. d) Valid TEC certificate for the offered HDPE makes
4. Along with the material (02 sets)	a) Packing list b) Inspection report

TECHNICAL SPECIFICATIONS FOR HDPE CONDUIT



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- c) Inspection release note
- d) Guarantee certificates
- d) Valid TEC certificate for the offered HDPE makes

8.0 INSPECTION & TESTING:

- 8.1 The Contractor/vendor/bidder's quality plan shall include a comprehensive fully documented inspection and testing plan specific to the project.
- 8.2 Factory inspection of HDPE pipes and jointing kit/ coupler shall be witnessed by the Owner / Owner's representative. Contractor shall be equipped with all facilities and equipments to test the HDPE pipe samples as per below mentioned codes. If any specification, parameters from the sample drawn is found to be not meeting the specified requirements the inspectors shall be free to reject the entire lot without any cost implication to the Owner.
- 8.3 Before carrying out the inspection by Owner / Owner's representative, the contractor shall carry out the in house inspection of the manufactured HDPE and submit the results for Owner's review. *Following tests shall be carried out by the contractor on the manufactured HDPE:*

Sl. No.	Test Description	Reference
1.	Outside Diameter	GR/TX/CDS-008/03/MAR-11 (amendment No.1 Dated 25/28.03.2013)
2.	Ovality	GR/TX/CDS-008/03/MAR-11 (amendment No.1 Dated 25/28.03.2013)
3.	Length	GR/TX/CDS-008/03/MAR-11 (amendment No.1 Dated 25/28.03.2013)
4.	Visual	GR/TX/CDS-008/03/MAR-11 (amendment No.1 Dated 25/28.03.2013)
5.	Reversion Test	GR/TX/CDS-008/03/MAR-11 (amendment No.1 Dated 25/28.03.2013)
6.	Tensile Strength & Elongation	GR/TX/CDS-008/03/MAR-11 (amendment No.1 Dated 25/28.03.2013)
7.	Oxidation	GR/TX/CDS-008/03/MAR-11 (amendment No.1 Dated 25/28.03.2013)

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Sl. No.	Test Description	Reference
	Induction Time	25/28.03.2013)
8.	Environmental Stress Crack Resistance (E.S.C.R)	GR/TX/CDS-008/03/MAR-11 (amendment No.1 Dated 25/28.03.2013)
9.	Internal Co-efficient of Friction	GR/TX/CDS-008/03/MAR-11 (amendment No.1 Dated 25/28.03.2013)
10.	Hydraulic Characteristic	GR/TX/CDS-008/03/MAR-11 (amendment No.1 Dated 25/28.03.2013)
11.	Impact Strength	GR/TX/CDS-008/03/MAR-11 (amendment No.1 Dated 25/28.03.2013)
12.	The ash content of the colour master batch	should not be more than 12% when tested as per the following method: “About 1 gm of the sample under test shall be taken and dried at 105 Deg C for two hours in a platinum or glazed porcelain or silica or quartz crucible. The weight of the sample shall be noted. Subsequently, the sample with the crucible shall be transferred to a muffle furnace maintained at 600 ± 50 Deg C and allowed to remain there for three hours. The ash content may be calculated as a percentage of the weight of the original sample.”
13.	Crush Resistance	Samples of the duct of $150 \text{ mm} \pm 2 \text{ mm}$ in length shall be subjected to a dead load of not less than 50 kg for one minute and shall be allowed to recover for 5 minutes. The deflection with load on and after recovery shall not exceed 10% and 2% respectively.
14.	Mandrel test	A 150 mm long mandrel of diameter 3 mm less than the internal diameter of the duct shall be passed through a 5 meter length of the duct, freely throughout the length, when the duct is bent to a radius of 5 meters.
15.	Ovality Test	a. Ovality is the difference between the maximum outside diameter and the minimum outside diameter at the same

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**TECHNICAL SPECIFICATIONS FOR
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Sl. No.	Test Description	Reference
		cross section of the duct, at 300 mm away from the end. The ovality shall not exceed 1.4 mm, when measured as per IS:4984.
16.	Coil Set	The PLB HDPE duct shall unroll off the drums without snaking or waving having zero coil set. Thus the duct shall lay straight into the trench without re-coiling. For this purpose, when a minimum length of 50 meters duct taken from the coil and laid on the ground, it shall be straight without any bends or kinks and without deformation, except 5 meters from each end.
17.	Optical Fibre Cable Blowing Test	For this test an Optical Fibre Cable of 15 mm (approx.) diameter shall be installed by blowing of the cable in a length of 1 Km of the duct. The duct shall be laid with bends in the horizontal and vertical planes and a raise in the middle at 45 deg angle from horizontal axis. The 1 Km section shall include two couplings at suitable locations as shown in the figure. The OFC shall then be blown out. It shall be inspected for any visual damage. The OFC shall then be blown in again. It shall be possible to blow in the OFC through 1 Km duct, each time in not more than 35 minutes. There shall be no visible damage to OFC.
18.	Density	The density of the duct shall be between 0.940 and 0.958 gms/cc at 27 deg. C and shall not differ from that of the raw material by more than 0.003 gms / cc, when tested as per IS:2530 or IS:7328. The same test method shall be used for determining the density of the raw material as well as the completed duct. The test will be conducted by collecting raw material from the hopper during extrusion and finished duct made from the same material
19.	Melt Flow Rate (MFR):	The change in the MFR caused by processing of raw material into the duct i.e the difference between the measured value for the outer layer material from the duct and the measured value for the raw material shall not be more than 30%, when tested as per IS: 2530. The test will

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Sl. No.	Test Description	Reference
		be conducted by collecting the raw material from the hopper during extrusion and finished duct made from the same material.
20.	Ash Content	The ash content of duct shall not be more than 0.3% when tested as per method described in clause no. 3.13.3.2 g.
21.	UV Stabiliser Test	The test shall be conducted on specimens taken (as per type IV of ASTM D 638) from the duct. The ageing shall be done with UV-B lamps at a typical irradiance of 0.63 W/Sq. m/nm as per cycle no. 2 of ASTM G 154.
22.	Fading	The duct shall be tested for the fading of colours as per ASTM D 1712. There shall be no discolouration.

9.0 Identification Marking: The duct shall be prominently marked with indelible ink, with the following information at every meter to enable identification of the pipe. The size of the ink markings shall be distinct, clearly and easily visible.

- IOCL
- Telephone Symbol
- Manufacturer's Name
- Name of the duct and size
- Specific Serial Number of the duct
- Date of manufacturing
- Sequential Length Marking at every meter

10.0 REVIEW & APPROVAL:

10.1 The contractor/vendor/bidder shall thoroughly review and approve contractor/vendor/bidder's drawings & QAP for the instrument including sub-package items, as applicable, before forwarding to Owner for further review and / approval. Only the approved drawings & QAP duly stamped and signed by a competent engineer of the contractor/vendor/bidder shall be sent to the Company.

**TECHNICAL SPECIFICATIONS FOR
HDPE CONDUIT**



**STANDARD SPECIFICATION NO. :
IOCL-TC-SPEC-HDPE-REV00**

10.2 Contractor/vendor/bidder shall not place the order without obtaining prior approval from the company.

11.0 PREPARATION FOR SHIPMENT:

11.1 The HDPE shall be packed separately with sufficient protection in the original manufacturer's boxes. Each package shall be identified with purchase order number and content list in a weatherproof envelope.

11.2 A desiccant shall be provided inside all enclosures to prevent moisture damage due to high humidity.

TECHNICAL SPECIFICATIONS FOR JOINTING KIT

STANDARD SPECIFICATION NO. : IOCL-TC-SPEC-JOINTKIT

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1.0 ABBREVIATIONS

BIS	Bureau of Indian Standards
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2.0 SPECIFICATIONS

The minimum technical specifications of the Fibre Cable Joint Kit are as below:-

Sl. No.	Functionality/ Description	Minimum Specifications
1.	Dimensions	Bidder to specify. Bidder to note that the dimensions length shall be suitable for installation in the RCC joint enclosure.
2.	Features	a. Water tight b. Dust Proof c. Light weight d. Corrosion Resistant e. Suitable for underground installation f. High Reliability g. Minimal maintenance
Capacity		
3.	No. of cable entry points	4 ports (2 incoming and 2 outgoing cables)
4.	Diameter of cable entry	Suitable for optical fibre cable of diameter 15 mm approx.
5.	No. of splices per tray	Splice tray shall be suitable for splicing 2 cable of 24 fibres each
6.	No. of trays per closure	2 Nos.
7.	No. of fibres / closure	Maximum 48 Fibres
8.	Sealing	Water tight and dust free
9.	Cable entries	Normally closed and shall be opened as and when required.
10.	Material metal parts exposed to environment, if any	Stainless Steel and corrosion resistant

TECHNICAL SPECIFICATIONS FOR JOINTING KIT



STANDARD SPECIFICATION NO. :
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Sl. No.	Functionality/ Description	Minimum Specifications
11.	Properties of plastic material used	Light weight, corrosion resistant, high impact bearing and compatible with metal and other materials used in splice closure like connectors, trays etc.

3.0 ACCESSORIES

Jointing kits shall be dust proof (no dust ingress) and protected against submersion (suitable for continuous immersion in saline water) and shall be complete with splice cassettes (adequate for 24 fibre cable), splice protection, support hardware & accessories to secure the jointing kit to circular jointing pit.

4.0 INSPECTION & TESTING:

a) Water Ingress Test

The cable joint kit shall be assembled along with a continuous piece of cable passing through. The jointing kit shall then be secured at the bottom of an immersion tank containing water upto a height of 3.0 m with the help of UV detectable dyes added to the water and joint kit shall be immersed for duration of 24 hours at normal room temperature. The joint kit will then be opened as per the specified procedure and visually examined for any ingress of water. It shall be declared to have passed in case there is no water present inside the kit. The joint kit shall be closed again and the same test shall be repeated. The joint kit shall pass the test in case there is no water present inside the joint kit.

b) Impact Test

The cable joint kit shall be kept on a metal platform. A weight of 2 kgs cylindrical type having radius of R 50 mm at striking end will be made to strike the joint kit at the middle after having been released from a height of 500 mm for 5 times at approx. 10 secs interval. The joint kit will be declared to have passed the test in case there are no cracks or fracture inside or outside of the kit.

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 460 mm thick. The joint kit shall then be allowed to topple and fall freely from a height of 2000 mm. The joint kit will be declared to have passed the test in case there is no visible damage to the jointing kit.

**TECHNICAL SPECIFICATIONS FOR
JOINTING KIT**



**STANDARD SPECIFICATION NO. :
IOCL-TC-SPEC-JOINTKIT-REV00**

d) Pulling test

The joint kit 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 kit.

e) Static load test

The assembled cable joint kit shall be kept on a platform with dimension more than that of cable joint kit. 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 kit. Weights shall be gradually placed on the mandrel till the weight becomes 250 kgs. The joint kit shall be kept under the weight for a period of 24 hours. The joint kit shall be declared to have passed the test in case there is no visible damage.

f) Chemical Test as per ASTM D414

g) Biological Test as per ASTM G-21

TECHNICAL SPECIFICATIONS FOR
WARNING TAPE



STANDARD SPECIFICATION NO. :
IOCL-TC-SPEC-WARTAPE-REV00

TECHNICAL SPECIFICATIONS FOR
WARNING TAPE

STANDARD SPECIFICATION NO. : IOCL-TC-SPEC-WARTAPE

TECHNICAL SPECIFICATIONS FOR WARNING TAPE



STANDARD SPECIFICATION NO. :
IOCL-TC-SPEC-WARTAPE-REV00

1.0 ABBREVIATIONS

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CCoE	Chief Controller of Explosives
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QC	Quality Certificate

2.0 SPECIFICATIONS

2.1 The minimum technical specifications of the warning tape are as below:-

Sl. No.	Functionality/ Description	Minimum Specifications
1.	Usage	Warning for underground 'Optical Fibre Cable'
2.	Width	150 mm
3.	Thickness	0.1 mm
4.	Feature	Chemical drug durable, petroleum oil durable, high / low temperature durable
5.	Colour Code	Red Colour with black printing
6.	Material	LDPE / PVC
7.	Printing	Non removable permanent ink printing
8.	Marking on tape	<u>"WARNING – IOCL OPTICAL FIBRE CABLE BELOW"</u> (in Hindi, English and local language) at regular interval of one meter



LAYING & CONSTRUCTION OF 3LPE
COATED CARBON STEEL PIPELINE AND
ASSOCIATED WORKS FOR CITY GAS
DISTRIBUTION

इंडियन ऑयल कॉर्पोरेशन लिमिटेड
(पाइपलाइन प्रभाग) नोएडा

SECTION-IV

SPECIFICATION TEMPORARY CATHODIC PROTECTION



LAYING & CONSTRUCTION OF 3LPE
COATED CARBON STEEL PIPELINE AND
ASSOCIATED WORKS FOR CITY GAS
DISTRIBUTION

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 IndianOil PIPELINES DIVISION TECHNICAL SPECIFICATIONS FOR TEMPORARY CATHODIC PROTECTION STANDARD SPECIFICATION NO. : IOCL-PL-ELEC-TMP-CP		Tender no. - Technical specifications	
IOCL-PL-ELEC-TMP-CP PIPELINES DIVISION	Sign. of Approving Authority		
	Implementation date	01.01.2016	
	Reviewed by		
	Checked by		
	Prepared by		
		SPJM(E)	CPJM(E)
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LAYING & CONSTRUCTION OF 3LPE
COATED CARBON STEEL PIPELINE AND
ASSOCIATED WORKS FOR CITY GAS
DISTRIBUTION

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(पाईपलाइन प्रभाग) नोएडा

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	<p style="text-align: center;">TEMPORARY CATHODIC PROTECTION WORKS</p> <p>1.0.0 GUIDELINES FOR DETAILED ENGINEERING OF TEMPORARY CP SYSTEM:</p> <p>1.0.1 The entire new liquid/Gas hydrocarbon Pipeline shall be protected by temporary cathodic protection, through sacrificial Magnesium anodes.</p> <p>1.0.2 The sacrificial anode system shall be engineered and installed in such a way that maximum length of pipeline is protected for a single installation so as to minimize the number of anode installation and its connection / disconnection to the main pipeline based on soil resistivity survey data enclosed herewith.</p> <p>1.0.3 A typical installation of sacrificial anodes is given in exhibit drawing no. 9200-99900-404-809-01 or revised latter.</p> <p>1.1.0 Scheme for installation of sacrificial anode:</p> <p>After installation of Mainline Pipes in R.O.W., Magnesium anodes (Mg anode) of 5 Kg (approx) of requisite no. shall be installed at predesigned distances. While choosing the location of installation of Mg anode, it shall be installed along with Test Lead Point (TLP), keeping in view of other criteria for TLP location and shall not be installed directly to pipe in isolation.</p> <p>Apart from that, at the locations of HDD crossings with 500 m long or above 2 nos. of Mg anodes are to be provided each at the entry and exit points, respectively at each of the crossings.</p> <p>For HDD crossings with less than 500 m, only one Mg anode shall be provided at either end.</p> <p>1.1.1.1 All sacrificial anodes are to be connected with pipeline through test station with an isolating link and variable resistor, if required.</p> <p>1.1.1.2 Areas where strong current interferences are encountered, CONTRACTOR shall suggest suitable remedial measures for the approval of the OWNER.</p> <p>1.1.1.3 All sacrificial Magnesium anode locations shall be predesigned test stations (TLP) locations, no separate test stations shall be provided for these anodes without written permission of EIC.</p>	
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	<p>1.2.0 MANUAL TEST STATIONS:</p> <p>Manual test station (As per specified type of A, B, C, D, E, DMV & DAC) shall be provided along the main pipeline ROW for monitoring the performance of the cathodic protection system at an intervals approximately 1000 meters and not exceeding 1000 meters in inhabited areas at approachable locations. These test stations shall be in alignment with the existing test stations if available in the ROW as far as practicable as per the instructions of site engineer / EIC. In addition to above, test stations, shall also be provided at the following locations;</p> <ul style="list-style-type: none">a) Type A- located at every alternate KMb) Type B- located at every alternate KM and between two type A TLP.c) At crossing & bonding of other pipelines Type-C.d) At both sides of major water, road and rail crossings and all cased crossings. (Type -D). For casing length more than 20 m, two D type TLPs shall be provided.e) At all insulating joints. (Type -E)f) At crossings of AC/DC electric traction system .g) At vulnerable locations with drastic changes in soil resistivity.h) At HT overhead line crossings and selected locations where HT overhead line is 66 KV & above in the vicinity of the main pipeline (parallel). (Type-DAC)i) In the vicinity of DC network or grounding systems where interference problems are suspected.j) At MOV locations.(Type-DMV)k) Within the battery limits of plants as requiredl) Both sides of river in case river is more than 50 m wide. <p>The locations of all the test stations shall be marked with their connection schemes and other relevant information on alignment sheets as a part of detailed engineering. A detailed test station schedule shall also be prepared and approved by the owner.</p> <p>1.2.1.1 Final scheme of protection shall be frozen at the time of detail engineering approval.</p>	<p>Page 2 of 25</p>
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1.3.0 CRITERIA OF PROTECTION:

Criteria for determining the adequacy of protection to buried pipeline as defined in NACE's code RP-01-69 shall be binding here. However, essential requirements of cathodic protection are reproduced below:

- 1.3.1.1 The structure-to-electrolyte potential measurement for steel structures, in soil, shall be between (-)0.95 and (-)1.20 volts, with respect to a copper/copper sulphate reference electrode.
- 1.3.1.2 A negative voltage swing of at least 300 millivolts between pipeline and saturated Copper/copper sulphate reference cell, in contact with earth directly above the pipeline shall be achieved. This criteria shall be applied to pipelines not in local contact with dissimilar metal.
- 1.3.1.3 Additional criterion of protection shall apply to such construction where protection cannot be determined by any of the above methods. In such a case, two reference electrodes of identical construction shall be used to verify that pipeline is receiving protective current. Reference electrodes shall be balanced within two millivolts when placed "end-to-end" and reading taken with a voltmeter. Now one of these electrodes shall be placed over the pipeline and the other electrode at a distance of 3 m from the side of the pipeline. The resulting reading shall indicate a drop in the earth enclosed between the two electrodes. The polarity of electrode away from the pipeline shall be positive with reference to the electrode over the pipeline which is the desired condition and shall indicate protective current pickup of the pipeline. These observations shall be repeated at least at three typical locations over a selected span.

1.4.0 DESIGN CRITERIA:

- 1.4.1.1 Following shall be used as general guideline:

a) Protection current density :

Pipeline Surrounding soil with	Minimum protection current density in Micro-Ampere / Sq. M	
	DFBE	3 LPE
Soil resistivity ≥ 10 ohm m	50	25
Soil resistivity < 10 ohm m	75	50

b) Coating Resistance (OHM-M) : 23000-30000 Ohms/M (DL FBE)
: 11000-23000 Ohms/M (3LPE)



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c) Minimum coating efficiency	: 98.5 percent
d) Factor of safety	: 2
e) Design Life of anodes	: Minimum 2 (two) years.
f) Diameter of pipeline	: Details like OD, thickness & grade of pipeline enclosed elsewhere in the tender document).
1.4.1.2 SYSTEM GUARANTEE: The contractor shall stand guarantee for CP system engineering, its implementation, functioning and its efficiency for complete design life.	
2.0.0 TECHNICAL SPECIFICATION FOR TEMPORARY CP SYSTEM:	
2.1.0 INTENT: The intent of this specification is to set forth the requirements for the installation of galvanic temporary cathodic protection system for the underground pipelines coming under the scope of this section of bid. Typical sacrificial anode installation details are provided here, with provision of variable connection possibilities and CONTRACTOR shall be required to produce working drawings covering all possible installations for the OWNER'S approval before construction can be taken up.	
2.2.0 SCHEME OF PROTECTION:	
2.2.1	A typical installation of sacrificial Mg anode drawing is enclosed vide exhibit drawing no. 9200-99900-404-609-02 or latest revision and 9200-99900-40402-287-01 or latest is in this document for the general guidance of the CONTRACTOR where in most of the elements of these typical installations are indicated alongwith their indicated sizes. This drawing has to be read with materials and equipments specifications. Actual anode installation locations shall be decided at site, in consultation with the OWNER.
2.2.2	A typical single line single anode protective installation shall consist of a cable to-pipeline joint, the cabling from this joint to the terminal of the test-station, and installation of Mg Anode, including its backfilling and laying of anode tail cable from the anode trench to the test lead post and its interconnection with the cable from pipe etc.



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2.2.3	However, attempts shall be made that test stations shall be installed coinciding with the locations with those intended for the permanent C.P. system. Where other services are running in close vicinity or crossing the R.O.W., provision for interference testing may also be required to be made.
2.2.4	All material and equipment duly approved by the OWNER shall be installed in accordance with these specifications, approved drawings and manufacturer's recommendations.
2.2.5	The installation of this system shall be supervised by an individual from the CONTRACTOR'S side whose qualification and experience have been duly approved by the OWNER or by any recognized professional body of repute duly approved by owner.
2.3.0	STORAGE AND INSTALLATION:
2.3.1	Storage arrangements shall be approved by the OWNER. Packaged anodes damaged as a result of improper handling or due to any other reason, shall be re-packaged to OWNER'S satisfaction. Location of Anode installation shall be approved by the OWNER which may, however, be slightly changed to clear obstructions in R.O.W. and the OWNER'S consent obtained thereto.
2.3.2	Packaged Mg anodes duly fabricated at suitable location shall be installed completely dry and shall be lowered into augured holes by rope slings or by grasping cloth together and separated from the protected pipeline at least 3 meter with suitable length of anode tail which shall also run and terminate into the test station. A brass connecting link shall be used at test station to connect the terminals of anode tail and the cable lead coming from the pipeline. Anode tail shall not be used for lowering the anode in the hole.
2.3.3	The anode tail shall be backfilled with fine soil in 150 mm compacted layers. No damage should be done to anode or its tail during this operation. If immediate testing is to be performed, water should be added only after backfilling and compacting up to at least 15 cms above anode level. About 7.5 liters of water may be used. Balance of backfilling and compaction may be completed after soaking.
2.3.4	However, provision for inserting suitable resistance and current shunts in the circuit may be required to be made for testing complete installation at site. For making pipe-to-soil potential measurement a similar cable lead shall be drawn from the pipeline and terminated into test station. a portable saturated copper/copper-sulphate reference cell with a long enough lead shall be used for pipe-to-soil potential observations.



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2.3.5	Anodes shall be installed as per approved scheme/drawings and any change required for any reason shall not be allowed without the OWNER'S approval.
2.4.0	GPS COORDINATE MARKING AND DISCONNECTION:
2.4.1	The GPS coordinate of the TLP and Magnesium anode shall be submitted to the owner after completion of installation for the entire line. These references shall be used to locate the TLP if damaged, and magnesium anode, during removal for handing over to the owner, after commissioning of Permanent CP system. The GPS coordinates recorded shall be of accuracy better than 1m, for which DGPS shall be used for recording. The format for recording the location of TLP and Magnesium anode is given as annexure.
2.4.2	The temporary galvanic anode shall be kept buried till the commissioning of permanent cathodic protection system. The same shall be disconnected only upon commissioning of Permanent CP system or in the event of over protection.
2.5.0	CABLE TO PIPE CONNECTIONS: All cable connections to the pipeline and protected structures shall be made by Thermit welding process before hydro testing of the pipeline. For operating line / line with product only pin brazing shall be used. The detailed procedures & precautions to be served will be strictly as per guidelines as detailed in exhibit drawing no. 9200-99900-404-608-01 or latest revision.. In no case cable shall be connected at the seam of the pipe.
2.6.0	REPAIR OF DAMAGED COATING: The Coat & Wrap removed for the purpose of Thermit welding the lead cable to the pipe shall be duly repaired by the contractor including supply of its material. The coating being yard coated, Dual layer FBE / 3LPE type proper material and method to be chosen for repairing of coating. However, a typical coating material as detailed in material specification may be referred for guidance. The contractor should submit the detailed procedure for such repair for approval of the owner.



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2.7.0 INSTALLATION OF CORROSION COUPON FOR 'OFF' POTENTIAL MEASUREMENT :

In order to facilitate measurement of 'off' potential and thereby assessing IR drop in the PSP measurement, A coupon made of similar pipe material having a coating similar to that on the pipeline except for a defined bare area (simulated holiday) shall be installed buried in the soil near the pipeline. This coupon shall be connected to the pipeline through an accessible test link. The coupon lead cable shall be wired through Test Lead post's pipe and shall be terminated at a suitable terminal in the Test Lead box. During the time of PSP measurement this test link will be removed and relinked through a mechanical On/Off toggle switch (required to be connected at the time of measurement only), which will facilitate measuring instant 'OFF' potential of coupon thereby determining 'IR drop' in the soil.

Coupons of size 4" x 2" shall be cut from a coated pipe. The cut out coupon shall be grinded on all its edges to strip the loose metal if any. The coated pipe (external coating only) shall be provided by OWNER for preparation of coupons. One face of this coupon which corresponds to the internal surface of pipe will not be having any coating. This face of the coupon shall be cleaned properly and then an area of around 4 mm dia shall be covered with an adhesive tape. The coupon lead wire shall then be firmly soldered as per the specified procedure detailed earlier and shall be sealed with Epoxy encapsulation. The coupon then shall be dipped in same coating liquid as that of the mainline pipe so as to provide a coating over the entire surface. Coating material shall be supplied by OWNER. After the coating is cured the adhesive tape shall be removed so as to provide a bare spot-simulating the holiday. While positioning the coupon buried at pipeline depth this surface of the coupon wherein holiday is simulated shall be positioned facing back to pipeline. These coupons are required to be installed at designated TLP along the entire pipeline length that shall be decided during detail engineering of the TCP.

For coupons to be used along with DAC type TLP under HT line crossing, the bare metal shall be 1 sq. mm only.

2.8.0 INSTALLATION OF TEST LEAD POINTS

2.8.1 As soon as sections of the pipeline are laid and before backfilling, the Contractor shall supply and install Test Lead Points conforming to types A, B, C, D, E, DAC & DMV as indicated in relevant drawing at locations to be specified by the Site Engineer. In general, there shall be at least one test lead point (A or B Type) provided at about 1 Km interval along the pipeline in an



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inter leaved manner. Test lead points conforming to Type-D shall be provided at locations of all Railway/Road/cased crossings and those conforming to Type-B shall be provided one each in between two consecutive A type TLPs. The locations and the number of test lead points of various types to be installed shall be decided by the Site Engineer. Type-E shall be provided for insulating coupling joints at exit and entry of RCPs. IPS and at the exit and entry point of originating Pump station and Terminal station respectively. A typical test connection scheme no. 9200-99900-404-601-05 or revised latter is enclosed for reference.

Type DMV shall be provided at motor operated valves and type DAC shall be provided near HT line crossings.

2.8.2

The test lead points consist of a weather proof test lead box made up of sheet steel with a minimum 200 mm x 160 mm x 6 mm bakelite strip fitted inside, a M.S. pipe of 100 mm nominal dia heavy gauge conforming to IS:1239, threaded and connected to the test lead box at one end, with a Tee connection at the other end for taking out the lead cable and with a mild steel base plate welded at bottom measuring 250 mm x 200 mm x 6 mm, cement concrete grouted underground and for bolting the TLP post to the foundation MS galvanised anchor bolt M 10 x 150 shall be used. The test lead box shall be weatherproof and vandal proof and shall facilitate godrej concealed lock with master key locking etc. The test lead box shall be at a minimum height of 0.5 m above ground. The TLP box shall be installed at 1.2 M from the pipeline on the narrower side of the ROW.

The TLP box has to be hinged and fixed further with the help of many studs and nuts as a step towards vandal proofing. All cable connections shall be from inside onto brass studs fixed on bakelite strip with studs projecting outside the box, kept fastened with the box plate surface to facilitate easy access from outside for taking PSP readings.

A shelf has to be provided inside door of the TLP box for keeping PSP record card / drawing.

The bakelite strip inside the test lead box shall have minimum Nine terminals or as per drawing with 6 mm brass bolts and ON/OFF toggle switch for corrosion coupon, with double nuts and washers. Length of the bolts shall be around 50 mm. The test lead point from the pipeline shall be brought upto the bakelite strip and connected to one of the brass terminal bolts by using a copper cable end lug of appropriate size connected to the end of the lead cable either by soldering or by crimping. The connection of the cable lead to the pipeline shall be by Themit / Cad welding or Pin Brazing as per requirement.



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2.8.3 In the test lead points conforming to Type-A, there shall be lead cable 6.0 mm² XLPE insulated PVC sheathed armoured single core copper conductor cable one each for the two connection made at 300 mm distance apart on the pipeline as shown in relevant drawing. The colours of the cables used shall be red for one connection made on UP-stream pipeline and blue for the second connection made at the downstream Pipeline with respect to mid point of two connections. Due care should be taken so that the Thermit welding of the lead cable is not made in any case at the seam of the pipe.

In the case of test lead boxes conforming to Type-B there will be two cables leads (one of size 6.0 Sq mm & other of 10.0 Sq mm size) from the immediate point & two cable leads from the remote point as figured in the relevant drawings. The colour of the cable lead for both remote & immediate point will be of same type for each point as made for Type-A i.e. red colour for upstream connection & blue for the down stream section with respect to mid point of these two upstream & down stream connection. The specification of 6.0 Sq mm & 10 Sq. mm cable is XLPE insulated & PVC sheathed, armoured single core tinned copper conductor.

For Type-C TLP's, there will be five cables (3 of size 6 mm² & 2 of size 25 mm²) two from the pipe to be protected & and one from pipe to TLP for corrosion coupon and two from the adjacent (foreign) pipe. The colour for 6 mm² cables connected to protected pipe will be red & that from foreign pipe will be blue. The colour for 25 mm² cables will be green. The specification of 6.0 Sq mm & 25 Sq. mm cable is XLPE insulated & PVC sheathed, armoured single core tinned copper conductor.

At locations of cased crossings where the test lead points conform to Type-D, there shall be 4 separate lead cables, two from the carrier pipe and two from the casing pipe brought to the bakelite strip provided in the test lead box and these shall be both 6.0 mm² single core copper conductor flexible cable, and the lead cable from carrier pipe shall be red for the one connection made at up-stream & blue for the connection made at the down-stream on the carrier pipe and those from casing pipe shall be black in colour. Thus blue and red colour wires respectively will be for carrier pipe and Black colour wires will be for casing pipe. The above 4 lead wires shall be connected to separate brass terminal bolts of the bakelite strip within the test lead boxes in the same manner as described above.

In the cases of Test lead box conforming of Type-E, the guideline for selecting colour will be of the same as used in Type-B. The colour of the lead cables for the grounding cell shall be of green colour. The size of the cable leads (6 Sq.mm and 25 Sq.mm) and the method and manner of connection both to the



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	pipe and to the bakelite strip shall be the same as indicated above in these specifications. Both the lead connections shall be separately connected in the test lead box. The different type of TLPs will be as per the relevant drawing.
2.8.4	The test lead boxes and the MS pipe etc before installation shall be cleaned and the affected area be painted with two coats of Zinc Rich Primer followed by three coats of approved shade of epoxy paint achieving total paint thickness not less than 120 microns (DFT), Fourth Finish coat shall be done at site before handing over. Painting shall be done after preparing surface by sand blasting to SA 2.5.
2.8.5	The location of the test lead point shall be indicated by painting the pipeline chainage, TLP No. etc on the Pipe/TLP Box in the manner shown in relevant drawing apart from the details to be included in the Name plate as indicated in the relevant drawing. The requisite quantities of paint and primer etc. shall be supplied by Contractor at no cost to Owner and shall be applied at defect / dent etc. after installation and before handing over.
2.8.6	It shall be the endeavor of the contractor to see that jointing of CP cables to the pipe are mostly made at the "Cut back areas" of the pipe wherever possible. In case the jointing is made at the "Cut back areas", no separate PERP repair patch is required, as the same will be taken care with joint coating sleeve itself. Where the yard coating is removed for the purpose of cables jointing to pipe, PERP repair patch or equivalent detailed earlier should be used for repairing the damaged coating.
2.9.0	MATERIAL/ EQUIPMENT SPECIFICATION FOR TEMPORARY CATHODIC PROTECTION SYSTEM
2.9.1	This specification of each system and equipment shall be furnished by the CONTRACTOR. However, certain minimum requirement for the major materials are highlighted in this section.
2.9.2	All the equipment shall be new and supplied by approved, reputed manufacturers.
2.9.3	System/Equipment design shall be suitable for the service conditions prevailing at individual sites and shall be complete with all necessary weather and anti- corrosion protection including tropicalisation to prevent damage due to climate, saline atmosphere, dust and corrosive vapours.
2.9.4	Owner's representatives may visit the works during manufacturing of various equipments to assess the progress of work as well as ascertain that, only good quality raw material is used for the same. Contractor shall provide all necessary assistance.



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- 2.9.5 Prior to procurement of materials and fabrication, the CONTRACTOR shall be required to submit the drawings for OWNER's approval.
- 2.9.6 Prior to approval of drawings, the CONTRACTOR shall submit the material specification for the OWNER's approval, for the following items:
- Cable/Conductors
 - Anodes
 - Sealing/Coating Material
 - Back-fill Materials
 - Resistance Wires
 - Measurement Shunts
 - Thermit-Welding Materials and Equipment for thermit welding
 - Test Station Boxes
 - Bond Stations
 - Coupons
- 2.9.7 Procedure for installation and making of various kinds of Thermit-welding joints shall be submitted for the OWNER's approval.
- 2.9.8 Sources of procurement of material and fabrication of equipments shall be specified for OWNER's approval. The following sample material shall be submitted to the EIC for his approval.

Sl. No.	Item	Unit	Qty.
1)	Magnesium anode, packaged in specially backfilled cloth bag complete with 6M anode tail.	No.	1
2)	Heat-Shrink anode cap	No.	1
3)	Special backfill material	M ³	0.2
4)	XLPE insulated PVC Sheathed Copper cable of size 10 sq.mm	M	6
5)	Thermit-Welding cartridge	No.	2
6)	Cable-to-pipe joint sealing	No.	2
7)	Terminal box-cum-Test Station	No.	1

REMARKS:

The length of anode cable-tail has been specified as 6M and shall be considered as the minimum length required. Cable tail shall be long enough to reach the terminal box without any joint in between. A typical installation of Mg. anode having drawing no 9200-99900-404-609-02 is enclosed for reference.



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2.9.9 MATERIAL SPECIFICATION (FOR MAGNESIUM ANODE)

The Mg anode shall be high manganese, magnesium alloy anode, each with 5 kg weight or as mentioned in SOR, and shall conform to the following metallurgical composition, Potential and consumption rate :

Element	Percent (By Weight)	Percent (By Weight)
Zinc	0.03 (max)	2.5 - 3.5%
Aluminium (Al)	0.01 (max)	5.3 - 6.7 %
Manganese (Mn)	0.5-1.3	0.25 - 0.4%
Copper (Cu)	0.02 (max)	0.05% max
Iron (Fe)	0.03 (max)	0.03% max
Nickel (Ni)	0.001 (max)	0.003% max
Other elements total	0.30 (max)	0.30 (max)
Magnesium (Mg)	Balance	Balance

Performance :

Mg anode output	1230 Amp Hours/kg	1230 Amp Hours/kg
Mg Anode consumption rate	7.9 kg/(A.Yr) max	7.9 kg/(A.Yr) max.
Anode open circuit potential	1.75V w.r.t. CCE	1.50V w.r.t. CCE
Anode utilization factor	80%	80%

Note:

Contractor shall furnish spectrographic analysis report indicating composition details.

Test report shall be furnished from government approved laboratory/ NABL certified laboratory, preferably from IIT, Bombay, Powai.

2.9.10 Zinc Anode

The Zinc Anode shall conform to the requirements of ASTM-B 418 standard. The metallurgical composition of anode, potential and consumption rates of anode shall be as follows :

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a) Metallurgical Composition

Element	Weight (Type I)	Weight (Type II)
Aluminium	0.1-0.5 %	0.005% max
Cadmium	0.025 – 0.07% max	0.003% max
Copper	0.005% max	0.002% max
Iron	0.005% max	0.0014 % max
Lead	0.006% max	0.003% max
Others	0.01% max	-
Zinc	Balance	Balance

- b) Anode open circuit potential 1.1 volts 1.1 volts
- c) Anode consumption rate 11.24 Kg/(A.Yr) max 11.24 Kg/(A.Yr) max
- d) Anode utilization factor 80% 80%

Anodes of Type I shall be used for sea water, brackish water or saline electrolyte application and Anode of Type II shall be used for freshwater, backfill and soil applications. The anode (other than ribbon anode) shall be packaged with special backfill.

The anodes shall be provided with cable tail of sufficient length (minimum 10 m) without any intermediate joint in the cable with loop of 0.5 m provided at each anode and test station ends. The anode shall be prepackaged with special backfill (Gypsum 75%, Bentonite 20%, Sodium Sulphate 5%) adequately so that the performance of anodes is not affected by the carbonates, bicarbonates, nitrates etc, present in the soil. In any case the thickness of the backfill shall not be less than 50 mm on all sides of the anode.

Each Zinc anode shall be of minimum 10 Kg net weight. The anode and cable terminations shall be suitable for the anticipated fault current at the location of installation.

2.9.11 SPECIAL BACKFILL

Special backfill composition:

Compound	Percent
Gypsum	75
Bentonite	20
Sodium Sulphate	5



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	<p>2.9.13 CABLES</p> <p><u>Anode tail cable:</u></p> <p>Cables shall be of XLPE insulation and shall consist of stranded tinned copper conductor of size 1 X 10 Sq.mm.</p> <p><u>Reference cell cable:</u></p> <p>Cables shall be of Primary insulation of XLPE, over sheathing jacket of PVC and shall consist of GI wire armoured stranded copper conductor of size 6 sq.mm.</p> <p><u>Current measurement cable:</u></p> <p>Cables shall be of Primary insulation of XLPE, over sheathing jacket of PVC and shall consist of steel wire armoured stranded copper conductor of size 10 sq.mm.</p> <p><u>25 sq.mm Cable :</u></p> <p>Cables shall be of Primary insulation of XLPE, over sheathing jacket of PVC and shall consist of steel wire armoured stranded copper conductor of size 25 sq.mm.</p>
	<p>2.9.14 SPECIFICATION FOR CABLE LAYING:</p> <p>Cables shall be laid in accordance with approved layout drawings. No joint shall be permitted in a single run of anode and cathode cable. Cable route shall be carefully measured and cables cut to required length including required loops.</p> <p>All cables will be required to be laid at a depth of 1.5 m (5 ft.) in sand under brick cover, backfilled with normal soil & then routes marked with Polyethylene cable warning mats placed at a depth of 0.9 meter from the finished grade.</p>
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In case of above ground cable installation, all cables shall be laid in G.I. conduit of sufficiently large size, with all fittings, fixtures and accessories. All underground unarmoured cables shall run through PE sleeve. Distant measurement cables and permanent reference cables along the pipeline shall be carried along the top of the carrier pipe by securely strapping it with adhesive tape or equivalent.

All underground cables should be enclosed by G.I. pipe of proper size while passing through road/rail crossings.

2.9.15 TEST STATIONS:

Test stations for monitoring of cathodic protection system shall be provided at suitable places as per design guidelines. All test stations shall have weather proof enclosure, having degree of protection IP-55 as defined in IS-2147 with lockable door provided with Godrej/NISHA make concealed lock with master key. Bidder to submit the certificate for weatherproof enclosure along with the fabrication drawing. Enclosure shall be made of sheet steel of at least 1.8 mm thickness, and shall be suitable for M.S. post mounting.

Name plate should be provided inside each test station giving the following information :

1. Distance of test station from Pipeline alignment.
2. Schematic test station connection diagram
3. Chainage location and serial no. of Test Station.

The serial no. of test station and Chainage location shall be written on the Outer side of the front door and on the pipe in an uniform manner using oil based long lasting paint. Contractor shall take specific approval on the quality and colour of the paint from Owner.

A typical fabrication and installation test station exhibit drawing no. 9200-99900-404-603-02 or revised latter is enclosed.

Data Sheet:

Construction : Metal clad- cold rolled sheet steel of minimum 1.8 mm Thickness or concrete box as per SOR

Installation : MS tubular post mounting or concrete post as per SOR

Enclosure : Dust & weather proof with IP-55 degree protection and having theft proof arrangement.

Cable entries: At bottom through MS tubular post




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INDICATIVE MATERIAL LIST FOR TEST STATIONS			
An indicative material list is given below for a single different type of Test lead post installation. Actual details shall be as per approved drawing & specifications only.			
Type A			
1.	XLPE insulated copper cable size of 6 sq. mm	m	As per site conditions
2.	Thermit welding / equivalent exothermic type welding cartridge	Nos.	-do-
3.	Cable to pipe joint & sealing	Nos.	-do-
4.	MS pipe of 4 inch dia or, as per approved drawing with a base plate welded at the bottom	Nos.	1
5.	Terminal plate in TLP box (TLP Box size minimum 250 mm x 250 mm x 200 mm)	Nos.	1
6.	Corrosion Coupon with XLPE insulated copper cable size of 6 sq.mm & Toggle switch	Nos.	Wherever approved
Type B			
1.	XLPE insulated copper cable size of 6 sq. mm	m.	As per site conditions
2.	XLPE insulated copper cable size of 10 sq. mm	m	-do-
3.	Thermit welding/ equivalent exothermic type welding cartridge	Nos.	-do-
4.	Cable to pipe joint & sealing	Nos.	-do-
5.	MS pipe of 4 inch dia or, as per approved drawing with a base plate welded at the bottom	Nos.	1
6.	Terminal plate in TLP box (TLP Box size minimum 250 mm x 250 mm x 200 mm)	Nos.	1
7.	Corrosion Coupon with XLPE insulated copper cable size of 6 sq.mm & Toggle switch	No	Wherever approved
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Type C

1.	XLPE insulated copper cable size of 6 sq. mm	m	As per site conditions
2.	XLPE insulated copper cable size of 25 sq. mm	m	-do-
3.	Thermit welding/ equivalent exothermic type welding cartridge	Nos.	-do-
4.	Cable to pipe joint & sealing	Nos.	-do-
5.	MS pipe of 4 inch dia or, as per approved drawing with a base plate welded at the bottom	Nos.	1
6.	Terminal plate in TLP box (TLP Box size minimum 250 mm x 250 mm x 200 mm)	Nos.	1
7.	Corrosion Coupon with XLPE insulated copper cable size of 6 sq.mm & Toggle switch	No	Wherever approved
8.	Bonding to be done as per site requirements	Nos.	As per site conditions

Type D

1.	XLPE insulated copper cable size of 6 sq. mm	m	As per site conditions
2.	Thermit welding/ equivalent exothermic type welding cartridge	Nos.	-do-
3.	Cable to pipe joint & sealing	Nos.	-do-
4.	MS pipe of 4 inch dia or, as per approved drawing with a base plate welded at the bottom	Nos.	1
5.	Terminal plate in TLP box (TLP Box size minimum 250 mm x 250 mm x 200 mm)	Nos.	1
6.	Corrosion Coupon with XLPE insulated copper cable size of 6 sq.mm & Toggle switch	No	Wherever approved



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Tender no. – Technical specifications			
Type E / Type DMV			
1.	XLPE insulated copper cable size of 6 sq. mm	m	As per site conditions
2.	XLPE insulated copper cable size of 25 sq. mm	m	-do-
3.	Thermit welding/ equivalent exothermic type welding cartridge .	Nos.	-do-
4.	Cable to pipe joint & sealing	Nos.	-do-
5.	MS pipe of 4 inch dia or, as per approved drawing with a base plate welded at the bottom	Nos.	1
6.	Terminal plate in TLP box (TLP Box size minimum 450 mm x 450 mm x 300 mm) approximately. As this is a flame proof box, size may vary.	Nos.	1
7.	Corrosion Coupon with XLPE insulated copper cable size of 6 sq.mm & Toggle switch	No.	Wherever approved
Type DAC			
1.	XLPE insulated copper cable size of 6 sq. mm	m	As per site conditions
2.	XLPE insulated copper cable size of 25 sq. mm	m	-do-
3.	Thermit welding/ equivalent exothermic type welding cartridge .	Nos.	-do-
4.	Cable to pipe joint & sealing	Nos.	-do-
5.	MS pipe of 4 inch dia or, as per approved drawing with a base plate welded at the bottom	Nos.	1
6.	Terminal plate in TLP box (TLP Box size minimum 250 mm x 250 mm x 200 mm)	Nos.	1
7.	Corrosion Coupon with XLPE insulated copper cable size of 6 sq.mm & Toggle switch	No.	Wherever approved
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Note : In Arid land / with no danger of water flooding on the TLP footing, the DAC shall be installed inside foundation as per attached standard drawing STD-794. Accordingly the foundation and TLP shall be installed during temporary Cathodic Protection System design even before actual AC interference study.

2.9.16 CONCRETE TEST STATIONS:

The concrete Test Stations may be installed in coastal area with high corrosive environment or in any other locations so decided during design stage as per standard drawing.

2.10.0 CLEAN-UP:

The trenching and cutting involved in installation of anodes and associated cabling shall be restored to original condition after installations.

2.11.0 TEST AND MEASUREMENT:

2.11.1 Natural pipe-to-soil potentials shall be measured at each test station location prior to connecting anodes. This observation shall be repeated after connecting the anodes and allowing sufficient polarization time. Current output of each installed anode shall also be measured to ensure that it does not exceed output current capacity. If such a situation arises then output current of anode shall be controlled by insertion of resistance element in the anode circuits. Each installation shall become individually operational as soon as it is completed. Integrity of insulating joints, wherever provided shall also be ensured before connection of anode(s) begins.

On completion of the entire system sector-wise, measurement of pipe-to-soil potentials shall be taken. Measurements to be repeated once in a month and readings to be submitted for OWNER'S review as per satisfaction of Site Engineer / EIC.

2.11.2 Measurement shall be taken at test stations along the common high voltage transmission R.O.W. If hazardous induced voltages are detected, corrective measures shall be taken.

2.11.3 In case of under protection on any part of the pipeline, CONTRACTOR shall carry out necessary additions/modifications after obtaining the approval from EIC/ Site Engineer. The mainline intended to be protected shall be polarized to at least (-) 0.95 volt in soil w.r.t. Cu/CuSo₄ half-cell and (-)0.90 volt in water w.r.t. silver/silver chloride half cell for acceptable protection level of pipeline. All observations carried out shall be duly tabulated and recorded for submission to OWNER for his approval and reference.



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2.12.0	REPAIR OF COATING DAMAGE: <p>The damaged coating, made for the welding of test lead/cathode cable/bonding cable is to be repaired with PERP repair system. The specification is detailed below :</p> <p>The material required for repairing the coating at the welding areas of TLPs comprises two parts. First, the PERP filler and above it PERP repair patch are required to be applied. The repair system of damaged DL FBE coatings / 3LPE coating as the case may be, should be done with PERP system or any equivalent. The system should resist abrasion and penetration. The contractor may select RAYCHEM make PERP repair or equivalent system.</p> <p>However, party should submit alongwith the tender, technical literature/brochure of the repair system so selected for approval of the owner. The application procedure of the system will be in strict adherence to the procedure laid by the manufacturer and on owner's approval only.</p> <p>These PERP filler/REPAIR tape are available in Rolls. Generally, one roll of repair patch (425 mm wide) is required with three rolls of (50 mm wide) of PERP filler mastic. It is considered that one roll of PERP patch & three rolls of PERP filler will generally be sufficient to repair 230 damage area of 1 sq. inch or less.</p>
2.13.0	CODES AND STANDARDS
2.13.1	All the materials used and workmanship applied in the system shall comply with acceptable industry standards and codes. A list of acceptable codes and standards is furnished below for general guidance. In the event of any conflict between listed standards and the requirements of this specification, the requirements of this specification shall govern. Any other equivalent International/Indian codes or standards may be used in lieu of the listed codes with prior approval of the OWNER.
2.13.1.1	Latest editions of the following codes and standards are to be considered. This list is only to provide guidelines and is not exhaustive:
BS : 729	Zinc coating on iron and steel articles.
BS : 1589	Marking of main connections and small wiring.
IS : 7098 (Part-1)	XLPE insulated cables
BS :CP:2008	Protection of iron and steel structures from corrosion.
BS :7361	Cathodic Protection

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RS-CP:1013	Earthing
NACE RP-01-69	Recommended Practice control of External corrosion on underground or submerged metallic piping systems.
NACE RP-02-86	Recommended practice - The electrical isolation of Cathodically protected pipelines.
ASTM D 512 (81)	Test method for chloride ions in water.
ASTM D 516 (82)	Test method for sulphate ions in water.
ASTM D 1125 (82)	Test method for electrical conductivity and resistivity of water.
ASTM D 1126 (80)	Test method for hardness in water.
ASTM D 1293 (84)	Test method for pH of water.
ASTM D 1886 (78)	Test method for particulate and dissolved matter in water.
ASTM G 51 (84)	Test method for pH of soil for use in corrosion testing.
ASTM G 57 (84)	Method for field measurement of soil resistivity using the Wenner's four electrode method.

* Welding Codes ASME Section 9

- 2.13.1.2 All equipments and work covered under these specifications shall comply with all currently applicable statutory regulations and safety codes of local and state authorities.

2.14.0 DRAWINGS AND DOCUMENTS

2.14.1 GENERAL

- 2.14.1.1 Within two weeks after award of work, CONTRACTOR shall submit the list of all drawings, data, manuals, procedures, schedule for approval, identifying each by a number and descriptive title and giving the schedule data. This list shall be revised and extended, as necessary, during the progress of work.

- 2.14.1.2 Drawings/documents submitted for approval/reference/ record shall be signed by authorized representatives of CONTRACTOR. All drawings and documents shall be in English and shall follow metric system. Number of copies for each



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<p>submission shall be as follows :</p> <table border="0"><tr><td>a. For review</td><td>One soft and one hard copy</td></tr><tr><td>b. For approval</td><td>One soft and one hard copy</td></tr><tr><td>c. For reference/records</td><td>Four copies</td></tr><tr><td>d. Drawings issued for execution/construction</td><td>Six copies</td></tr><tr><td>e. Final/As built drawings</td><td>4 copies & 1 set of reproducible</td></tr><tr><td>f. Operation/Maintenance Manual, Vendor data</td><td>Four copies</td></tr></table>		a. For review	One soft and one hard copy	b. For approval	One soft and one hard copy	c. For reference/records	Four copies	d. Drawings issued for execution/construction	Six copies	e. Final/As built drawings	4 copies & 1 set of reproducible	f. Operation/Maintenance Manual, Vendor data	Four copies
a. For review	One soft and one hard copy												
b. For approval	One soft and one hard copy												
c. For reference/records	Four copies												
d. Drawings issued for execution/construction	Six copies												
e. Final/As built drawings	4 copies & 1 set of reproducible												
f. Operation/Maintenance Manual, Vendor data	Four copies												
<p>2.14.1.3 All drawings shall show the following particulars in the lower right hand corner, in addition to CONTRACTOR'S Name :</p> <table border="0"><tr><td>a. OWNER's name</td></tr><tr><td>b. Project title</td></tr><tr><td>c. Title of drawing</td></tr><tr><td>d. Scale</td></tr><tr><td>e. Date of drawing</td></tr><tr><td>f. Drawing number</td></tr><tr><td>g. Space for OWNER's reference.</td></tr></table> <p>In addition to the information provided on the drawings, each drawing shall carry revision number, date of revision and brief details of revisions carried out.</p>		a. OWNER's name	b. Project title	c. Title of drawing	d. Scale	e. Date of drawing	f. Drawing number	g. Space for OWNER's reference.					
a. OWNER's name													
b. Project title													
c. Title of drawing													
d. Scale													
e. Date of drawing													
f. Drawing number													
g. Space for OWNER's reference.													
<p>2.14.1.4 Drawings submitted by CONTRACTOR for review/ approval shall be returned to CONTRACTOR duly commented. It shall be the responsibility of the CONTRACTOR to correctly incorporate all the comments conveyed by OWNER on the drawings.</p>													
<p>2.14.1.5 Any drawings prepared by CONTRACTOR & approved by OWNER shall be considered as a part of the specification. However, examination and approval of the drawings by OWNER shall not relieve the CONTRACTOR of his responsibility of engineering and performance guarantee.</p>													
<p>2.14.1.6 If, any time before the completion of work changes are made necessitating revision of approved drawings, CONTRACTOR shall make such revisions and proceed in the same routine as for the original approval.</p>													
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2.14.2 DRAWINGS AND CERTIFICATION TEMPORARY C.P. SYSTEM

CONTRACTOR shall within two weeks after award of work be required to submit following drawings for OWNER's approval prior to procurement of materials and fabrication.

- a) Sacrificial anode fabrication drawings
- b) Fabrication, installation and connection scheme drawings with following variations :
 - Single anode installation
 - Multi anode installation
- c) Fabrication and installation of test station and connection schemes
- d) Procedure for Thermit welded jointing / Pin Brazing
- e) Marked alignment sheets for installation and identification alongwith a separate schedule of Test Station.

3.0 Specification of Pearson Survey

Pearson survey shall be carried out on cross country pipeline on or before permanent CP system is installed. It is recommended that the backfill is settled before commencing the survey on that particular section. Sacrificial anodes connected to the section of pipeline shall be disconnected before injection of AC signal.

The procedure shall be in line with NACE above ground survey procedure TM0109 or as approved by owner.

The Pearson Survey Equipment shall have the following characteristics:

The equipment shall be used for locating pipeline defects on cross country buried pipelines, without access to the surface of pipeline. The equipment shall be capable of pipeline location, Pearson type holiday detection and short location in an effective manner.

The equipment shall have a transmitter connected to pipe and remote earth and shall deliver signal. The oscillator may have multiple frequency output but must have at least one audio frequency output. The equipment shall have number of steps to change voltage level and sensitivity.

The receiver shall have a high gain amplifier and receive this audio signal after attenuating interferences. A loud speaker with volume control option shall be available which shall get disconnected once the headphones are plugged on.



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DISTRIBUTION

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4.0 Approved Vendor List of Materials

Description	Vendor
Cables	M/s Gloster Industrial M/s Cable corporation of India M/s Universal M/s Torrent M/s Polycab M/s Nicco M/s KEC international M/s Uniflex M/s KEI M/s Havells M/s Crystal cable Industries M/s Finolex M/s Ravin
Magnesium anodes	M/s Metal founders, Mumbai M/s Scientific Metal Engineers, Karaikudi M/s Shakti Enterprises, Ahmedabad M/s Sargam Metals Pvt. Ltd. Chennai
Zinc anodes	M/s Metal founders, Mumbai M/s Scientific Metal Engineers, Karaikudi M/s Shakti Enterprises, Ahmedabad M/s Sargam Metals Pvt. Ltd. Chennai
Thermit Welding cartridge	M/s Cadweld M/s Thermoweld M/s Safetrack M/s BAC
Pin Brazing Equipment	M/s BAC
Pearson Survey Equipment	Bidder to specify M/s Tinker & Razor Bidder to Specify



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Technical specifications		Tender no. _____	
 IndianOil			
PIPELINES DIVISION			
TECHNICAL SPECIFICATIONS FOR TEMPORARY CATHODIC PROTECTION FOR HDD CROSSINGS			
STANDARD SPECIFICATION NO. : IOCL-PL-ELEC-HDD-TCP			
IOCL-PL-ELEC- TMP-CP PIPELINES DIVISION	Sign. of Approving Authority	 CGM(PI-E)	
	Implementation date	29.01.2019	
	Reviewed by	 GM(PI-E)	
	Checked by	 CPJM(E)	 DGM(PI-E)
	Prepared by	 SPJM(E)	
 IndianOil	SPECIFICATION FOR TCP FOR HDD CROSSINGS PIPELINE PROJECT		



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**TEMPORARY CATHODIC PROTECTION FOR HDD CROSSINGS OF
CROSSCOUNTRY PIPELINES**

The intent of this specification is to provide temporary cathodic protection to pipeline section after mainline pipe laid through horizontal directional drilling. The specification covers the material requirement with specification, design of CP system, drawings and the procedure.

The temporary cathodic protection shall be provided through sacrificial anodes. These anodes shall be connected with pipeline through test station with an isolating link and variable resistor.

All sacrificial Magnesium anode locations shall be predesigned test stations (TLP) land, no separate test stations shall be provided for these anodes.

Direct connection of sacrificial anode to pipeline is not allowed.

CRITERIA OF PROTECTION:

Criteria for determining the adequacy of protection to buried pipeline as defined in NACE's code RP-01-69 shall be binding here. However, essential requirements of cathodic protection are reproduced below:

The structure-to-electrolyte polarised potential measurement for steel structures, in soil, shall be between (-) 0.85 and (-)1.20 volts, with respect to a copper/copper sulphate reference electrode.

A negative voltage swing of at least 300 millivolts between pipeline and saturated Copper/copper sulphate reference cell, in contact with earth directly above the pipeline shall be achieved. This criteria shall be applied to pipelines not in local contact with dissimilar metal.

For the test purpose the anode at one end to be connected and the Potential shift in the other end shall be noted and vice-versa as no other point on the HDD crossing section is likely to be approachable.

QUANTITY OF SACRIFICIAL ANODE :

Sacrificial Magnesium Anodes shall be used for protection of HDD crossing section of pipeline till it is connected to the mainline section and Impressed cathodic Protection System is commissioned.

The number of Sacrificial anodes shall be connected to both ends of the section through test stations.



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Number of Magnesium anodes for HDD sections is as follows :

Surface Area of Pipe in HDD Xing	Number of Anodes	Remarks
<1500 sq. m	1 each side of HDD Xing	Magnesium anode 5 kg each
>1500 <2500 sq. m	2 each side of HDD Xing	Magnesium anode 5 kg each
>2500 sq. m	3 each side of HDD Xing	Magnesium anode 5 kg each

The requirement has been considered with 3 LPE coating on the pipe section, which is used for HDD crossings and for a maximum period of 3 years.

Surface area of API 5L pipe for various diameters used for cross country pipeline is given below for easy reference :

Pipe Diameter	Surface Area (m ²) per 1000 m of pipe	Pipe Diameter	Surface Area (m ²) per 1000 m of pipe
6.625"	528.5 ✓	22"	1756 ✓
8.625"	688.2 ✓	24"	1915 ✓
10.75"	857.7 ✓	28"	2235 ✓
12.75"	1017 ✓	30"	2394 ✓
14"	1117 ✓	36"	2873 ✓
16"	1277 ✓	42"	3352 ✓
18"	1436 ✓	48"	3830 ✓

SCHEME OF PROTECTION:

A typical installation of sacrificial Mg anode drawing is enclosed as drawing STD-489-03 (9200-99900-404-609-03) or latest revision and drawing no. STD-784-01 (9200-99900-40402-287-01) or latest is in this document for the general guidance of the CONTRACTOR where in most of the elements of these typical installations are indicated along with their indicated sizes. This drawing has to be read with materials and equipments specifications.

Actual anode installation locations shall be decided at site, in consultation with the OWNER.

A typical single line single anode protective installation shall consist of a cable to-pipeline joint, the cabling from this joint to the terminal of the test-station, and installation of Mg Anode, including its backfilling and laying of anode tail cable from the anode trench to the test lead post and its interconnection with the cable from pipe etc.

All material and equipment duly approved by the OWNER shall be installed in accordance with these specifications, approved drawings and manufacturer's recommendations.



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The installation of this system shall be supervised by an individual from the CONTRACTOR'S side whose qualification and experience have been duly approved by the OWNER or by any recognized professional body of repute duly approved by owner.

MATERIAL/ EQUIPMENT SPECIFICATION FOR TEMPORARY CATHODIC PROTECTION SYSTEM

All the equipment shall be new and supplied by approved, reputed manufacturers.

System/Equipment design shall be suitable for the service conditions prevailing at individual sites and shall be complete with all necessary weather and anti-corrosion protection including tropicalisation to prevent damage due to climate, saline atmosphere, dust and corrosive vapours.

Owner's representatives may visit the works during manufacturing of various equipments to assess the progress of work as well as ascertain that, only good quality raw material is used for the same. Contractor shall provide all necessary assistance.

Sources of procurement of material and fabrication of equipments shall be specified for OWNER's approval.

SL. No.	Item	Unit	Qty.
1	Type A test station with MS pipe of 4 inch dia or, as per approved drawing with a base plate welded at the bottom and Terminal plate in TLP box (TLP Box size minimum 250 mm x 250 mm x 200 mm)	No.	One on each side of HDD crossing
2	Magnesium anode, packaged in specially backfilled cloth bag complete with 6M anode tail.	No.	1
3	Heat-Shrink anode cap	No.	1
4	Special backfill material	m ³	0.2
5	XLPE insulated PVC Sheathed Copper cable of size 10 sq.mm	m	6
6	Thermit-Welding cartridge	No.	2
7	Cable-to-pipe joint sealing	No.	2

The length of anode cable-tail has been specified as 6M and shall be considered as the minimum length required. Cable tail shall be long enough to reach the terminal box without any joint in between.




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	Type A type Test station shall be provided at both ends of crossing. The construction details of the Test station shall be as per Standard drawing STD-483-03 latest revision.	
	Test stations for monitoring of cathodic protection system shall be provided at suitable places as per design guidelines. All test stations shall have weather proof enclosure, having degree of protection IP-55 as defined in IS-2147 with lockable door provided with Godrej/NISHA make concealed lock with master key. Bidder to submit the certificate for weatherproof enclosure along with the fabrication drawing. Enclosure shall be made of sheet steel of at least 1.8 mm thickness, and shall be suitable for M.S. post mounting.	
	Name plate should be provided inside each test station giving the following information :	
	1. Distance of test station from Pipeline alignment.	
	2. Schematic test station connection diagram	
	3. Chainage location	
	The chainage location shall be written on the outer side of the front door and on the pipe in an uniform manner using oil based long lasting paint.	
	A typical fabrication and installation test station exhibit STD-483-03 i.e. drawing no. 9200-99900-404-603-03 or revised latter is enclosed.	
	Data Sheet:	
Construction : Metal clad- cold rolled sheet steel of minimum 1.8 mm Thickness or concrete box as per SOR		
Installation : MS tubular post mounting or concrete post as per SOR		
Enclosure : Dust & weather proof with IP-55 degree protection and having theft proof arrangement.		
Cable entries: At bottom through MS tubular post		
MATERIAL SPECIFICATION (FOR MAGNESIUM ANODE)		
The Mg anode shall be high manganese, magnesium alloy anode, each with 5 kg weight or as mentioned in SOR, and shall conform to the following		
<ul style="list-style-type: none">metallurgical composition,potential andconsumption rate		
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Element	Percent (By Weight)
Zinc	0.03 (max)
Aluminium (Al)	0.01 (max)
Manganese (Mn)	0.5-1.3
Copper (Cu)	0.02 (max)
Iron (Fe)	0.03 (max)
Nickel (Ni)	0.001 (max)
Other elements total	0.30 (max)
Magnesium (Mg)	Balance

Performance :

Mg anode output	1230 Amp Hours/kg
Mg Anode consumption rate	7.9 kg/(A.Yr) max.
Anode open circuit potential	1.75V w.r.t. CCE
Anode utilization factor	80%

Type Test report from government approved laboratory/ NABL certified laboratory, preferably from IIT, Bombay, Powai, not older than seven years shall be furnished along with internal test certificate during inspection.

SPECIAL BACKFILL

Special backfill composition:

Compound	Percent
Gypsum	75
Bentonite	20
Sodium Sulphate	5

HEAT-SHRUNK ANODE CAP / PVC CAP

These caps may be moulded out of radiation cross linked polyethylene material which shall be heat shrinkable or PVC caps matching the anode size. Material characteristics shall be furnished by the CONTRACTOR for approval of the OWNER.

Approved vendor list for Heat shrunk cap for anode to cable joint –
M/s Raychem, USA & M/s Matcor USA.



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CABLES

Anode tail cable:

Cables shall be of XLPE insulation and shall consist of stranded tinned copper conductor of size 1 X 10 Sq.mm.

Reference cell cable:

Cables shall be of Primary insulation of XLPE, over sheathing jacket of PVC and shall consist of GI wire armoured stranded copper conductor of size 6 sq.mm.

Lead cables:

6.0 mm² XLPE insulated PVC sheathed armoured single core copper conductor cable one each for the two connections. The colours of the cables used shall be red for one connection made on upstream pipeline and blue for the second connection made at the downstream pipeline.

STORAGE AND INSTALLATION:

Storage arrangements shall be approved by the OWNER. Packaged anodes damaged as a result of improper handling or due to any other reason, shall be re-packaged to OWNER'S satisfaction. Location of Anode Installation shall be approved by the OWNER which may, however, be slightly changed to clear obstructions in R.O.W. and the OWNER'S consent obtained thereto.

Packaged Mg anodes duly fabricated at suitable location shall be installed completely dry and shall be lowered into augured holes by rope slings or by grasping cloth together and separated from the protected pipeline at least 3 meter with suitable length of anode tail which shall also run and terminate into the test station. A brass connecting link shall be used at test station to connect the terminals of anode tail and the cable lead coming from the pipeline. Anode tail shall not be used for lowering the anode in the hole.

The anode tail shall be backfilled with fine soil in 150 mm compacted layers. No damage should be done to anode or its tail during this operation. If immediate testing is to be performed, water should be added only after backfilling and compacting up to at least 15 cms above anode level. About 7.5 liters of water may be used. Balance of backfilling and compaction may be completed after soaking.

However, provision for inserting suitable resistance and current shunts in the circuit may be required to be made for testing complete installation at site. For making pipe-to-soil potential measurement a similar cable lead shall be drawn from the pipeline and terminated into test station. a portable saturated copper/copper-sulphate reference cell with a long enough lead shall be used for pipe-to-soil potential observations.



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Anodes shall be installed as per approved scheme/drawings and any change required for any reason shall not be allowed without the OWNER'S approval.

GPS COORDINATE MARKING AND DISCONNECTION:

The GPS coordinate of the TLP and Magnesium anode shall be submitted to the owner after completion of installation for the entire line. These references shall be used to locate the TLP if damaged, and magnesium anode, during removal for handing over to the owner, after commissioning of Permanent CP system.

The temporary galvanic anode shall be kept buried till the commissioning of permanent cathodic protection system. The same shall be disconnected only upon commissioning of Permanent CP system or in the event of over protection.

CABLE TO PIPE CONNECTIONS:

All cable connections to the pipeline and protected structures shall be made by Thermit welding process before hydro testing of the pipeline.

For operating line / line with product only pin brazing shall be used.

The detailed procedures & precautions to be served will be strictly as per guidelines as detailed in exhibit drawing no. STD-488-01 (9200-99900-404-608-01) or latest revision. **In no case cable shall be connected at the seam of the pipe.**

INSTALLATION OF TEST LEAD POINTS

As soon as sections of the pipeline are laid / pulled, the Contractor shall supply and install Test Lead Points conforming to types A as indicated in relevant drawing at locations to be specified by the Site Engineer. In general, there shall be at least one test lead point (A Type) provided at both ends. A typical test connection scheme drawing no. STD-481-06 (9200-99900-404-601-06) or revised latter is enclosed for reference.

The test lead points consist of a weather proof test lead box made up of sheet steel with a minimum 200 mm x 160 mm x 6 mm bakelite strip fitted inside, a M.S. pipe of 100 mm nominal dia heavy gauge conforming to IS:1239, threaded and connected to the test lead box at one end, with a Tee connection at the other end for taking out the lead cable and with a mild steel base plate welded at bottom measuring 250 mm x 200 mm x 6 mm, cement concrete grouted underground and for bolting the TLP post to the foundation MS galvanised anchor bolt M 10 x 150 shall be used. The test lead box shall be weatherproof and vandal proof and shall facilitate godrej concealed lock with master key locking etc. The test lead box shall be at a minimum height of 0.5 m above ground. The TLP box shall be installed at 1.2 M from the pipeline on the narrower side of the ROW.



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The TLP box has to be hinged and fixed further with the help of many studs and nuts as a step towards vandal proofing. All cable connections shall be from inside onto brass studs fixed on bakelite strip with studs projecting outside the box, kept fastened with the box plate surface to facilitate easy access from outside for taking PSP readings.

A shelf has to be provided inside door of the TLP box for keeping PSP record card / drawing.

The bakelite strip inside the test lead box shall have minimum Nine terminals or as per drawing with 6 mm brass bolts and ON/OFF toggle switch for corrosion coupon, with double nuts and washers. Length of the bolts shall be around 50 mm. The test lead point from the pipeline shall be brought upto the bakelite strip and connected to one of the brass terminal bolts by using a copper cable end lug of appropriate size connected to the end of the lead cable either by soldering or by crimping. The connection of the cable lead to the pipeline shall be by Thermit / Cad welding.

In the test lead points conforming to Type-A, there shall be lead cable 6.0 mm² XLPE insulated PVC sheathed armoured single core copper conductor cable one each for the two connection made at 300 mm distance apart on the pipeline as shown in relevant drawing. The colours of the cables used shall be red for one connection made on UP-stream pipeline and blue for the second connection made at the downstream Pipeline with respect to mid point of two connections. Due care should be taken so that the Thermit welding of the lead cable is not made in any case at the seam of the pipe.

The test lead boxes and the MS pipe etc before installation shall be cleaned and the affected area be painted with two coats of Zinc Rich Primer followed by three coats of approved shade of epoxy paint achieving total paint thickness not less than 120 microns (DFT). Fourth Finish coat shall be done at site before handing over. Painting shall be done after preparing surface by sand blasting to SA 2.5.

The location of the test lead point shall be indicated by painting the pipeline chainage, TLP No. etc on the Pipe/TLP Box in the manner shown in relevant drawing apart from the details to be included in the Name plate as indicated in the relevant drawing. The requisite quantities of paint and primer etc. shall be supplied by Contractor at no cost to Owner and shall be applied at defect / dent etc. after installation and before handing over.

It shall be the endeavor of the contractor to see that jointing of CP cables to the pipe are mostly made at the "Cut back areas" of the pipe wherever possible. In case the jointing is made at the "Cut back areas", no separate PERP repair patch is required, as the same will be taken care with joint coating sleeve itself.

REPAIR OF COATING DAMAGE:

The damaged coating, made for the welding of test lead/cathode cable/bonding cable is to be repaired with PERP repair system. The specification is detailed below :

The material required for repairing the coating at the welding areas of TLP's comprises two parts.



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First, the PERP filler and above it PERP repair patch are required to be applied. The repair system of damaged 3LPE coating as the case may be, should be done with PERP system or any equivalent. The system should resist abrasion and penetration. The contractor may select RAYCHEM make PERP repair or equivalent system.

However, party should submit technical literature/brochure of the repair system so selected for approval of the owner. The application procedure of the system will be in strict adherence to the procedure laid by the manufacturer and on owner's approval only.

These PERP filler/REPAIR tape are available in Rolls. Generally, one roll of repair patch (425 mm wide) is required with three rolls of (50 mm wide) of PERP filler mastic. It is considered that one roll of PERP patch & three rolls of PERP filler will generally be sufficient to repair 230 damage area of 1 sq. inch or less.

SPECIFICATION FOR CABLE LAYING:

Cables shall be laid in accordance with approved layout drawings. No joint shall be permitted in a single run of anode and cathode cable. Cable route shall be carefully measured and cables cut to required length including required loops.

All cables will be required to be laid at a depth of 1.5 m (5 ft.) in sand, backfilled with normal soil & then routes marked with Polyethylene cable warning mats placed at a depth of 0.9 meter from the finished grade.

TEST AND MEASUREMENT of PIPE TO SOIL POTENTIAL AND CURRENT :

Natural pipe-to-soil potentials shall be measured at each test station location prior to connecting anodes. This observation shall be repeated after connecting the anodes and allowing sufficient polarization time. Current output of each installed anode shall also be measured to ensure that it does not exceed output current capacity. If such a situation arises then output current of anode shall be controlled by insertion of resistance element in the anode circuits. Each installation shall become individually operational as soon as it is completed. Integrity of insulating joints, wherever provided shall also be ensured before connection of anode(s) begins.

On completion of the entire system sector-wise, measurement of pipe-to-soil potentials shall be taken. Measurements to be repeated once in a month and readings to be submitted for OWNER'S review as per satisfaction of Site Engineer / EIC.

In case of under protection on any part of the pipeline, CONTRACTOR shall carry out necessary additions/modifications after obtaining the approval from EIC/ Site Engineer. The mainline intended to be protected shall be polarized to at least (-) 0.85 volt in soil w.r.t. Cu/CuSo4 half-cell

All observations carried out shall be duly tabulated and recorded for submission to OWNER for his approval and reference.



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Technical specifications		Tender no. _____
CLEAN-UP: The trenching and cutting involved in installation of anodes and associated cabling shall be restored to original condition after installations.		
DRAWINGS AND CERTIFICATION : CONTRACTOR shall follow owners standard drawings for Fabrication and installation of Test Station (STD-483-03 or later), Terminal arrangement (STD-481-06 or later), Magnesium anodes STD-784-01 or later) and their installation (STD-489-03 or later), Thermit welding (STD-488-01 or later). Any other drawing required by vendor for completion of job shall be approved by EIC for which the vendor shall submit drawing within two weeks after award of work.		
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	SPECIFICATION FOR TCP FOR HDD CROSSINGS PIPELINE PROJECT	



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Technical specifications

Tender no. _____

CODES AND STANDARDS

All the materials used and workmanship applied in the system shall comply with acceptable industry standards and codes. A list of acceptable codes and standards is furnished below for general guidance. In the event of any conflict between listed standards and the requirements of this specification, the requirements of this specification shall govern. Any other equivalent International/Indian codes or standards may be used in lieu of the listed codes with prior approval of the OWNER.

Latest editions of the following codes and standards are to be considered. This list is only to provide guidelines and is not exhaustive:

BS : 729	Zinc coating on iron and steel articles.
BS : 1589	Marking of main connections and small wiring.
IS : 7098 (Part-1)	XLPE insulated cables
BS :CP-2008	Protection of iron and steel structures from corrosion.
BS :7361	Cathodic Protection
RS:CP:1013	Earthing
NACE RP-01-69	Recommended Practice control of External corrosion on underground or submerged metallic piping systems.
NACE RP-02-86	Recommended practice - The electrical isolation of Cathodically protected pipelines.

All equipments and work covered under these specifications shall comply with all currently applicable statutory regulations and safety codes of local and state authorities.



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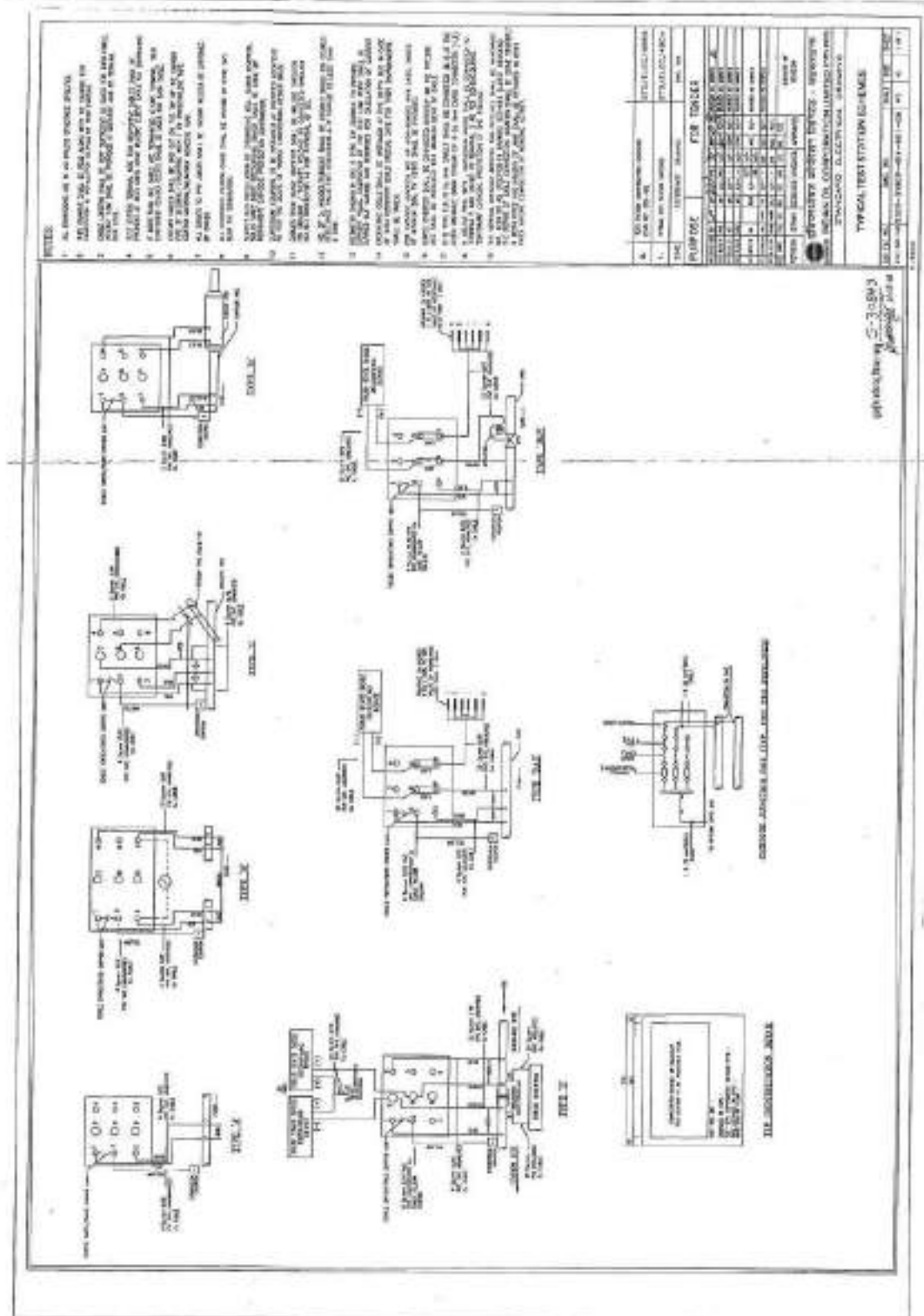
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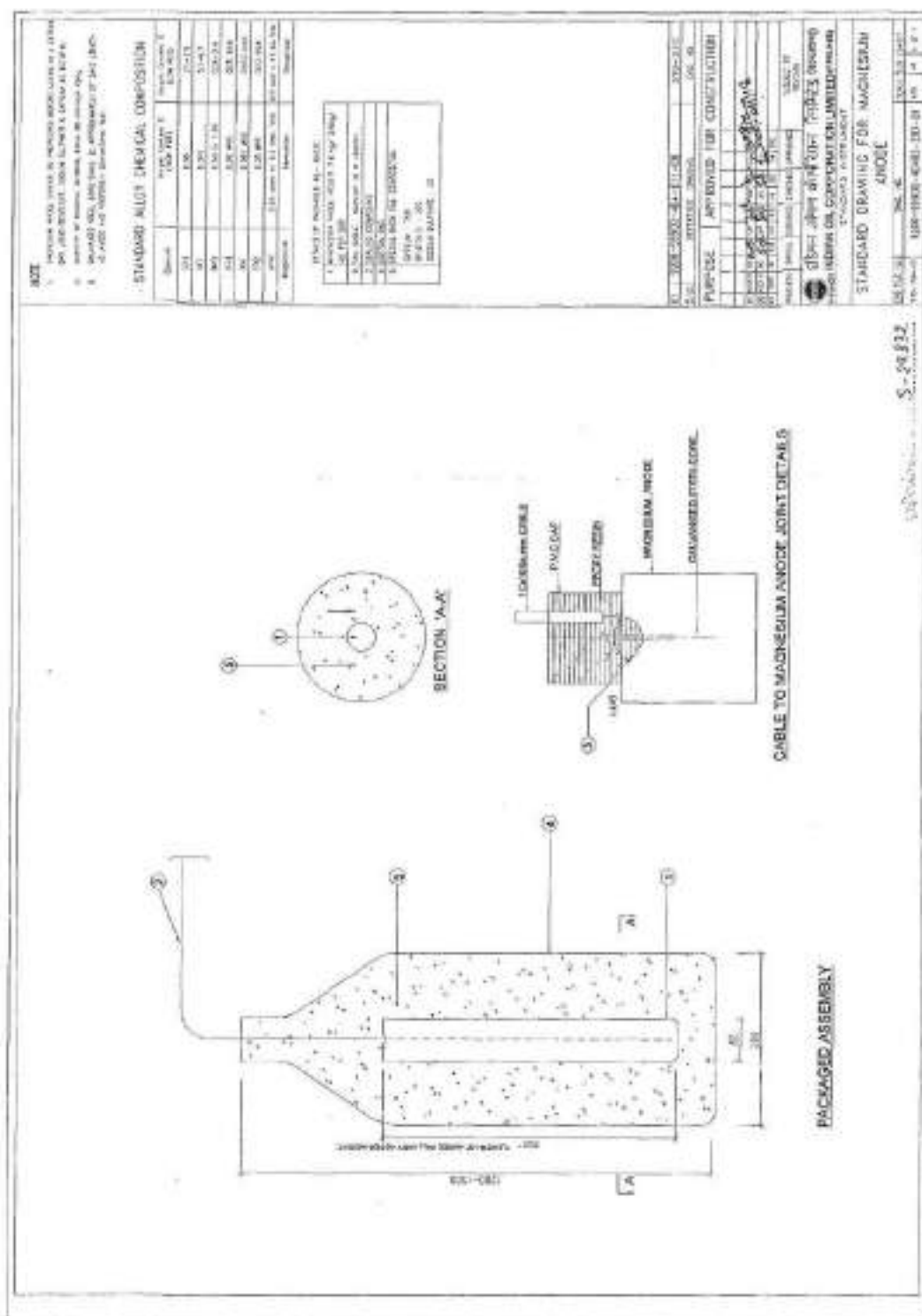
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	APPROVED VENDOR LIST OF MATERIALS									
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SECTION-V

TECHNICAL SPECIFICATION FOR LAYING OF MDPE MAIN PIPELINES AND SERVICE PIPELINES



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1.0 GENERAL INFORMATION

1.1 Nature of Contract

The contractor shall be paid on a Schedule of Rates basis. He shall execute the work and perform his obligations under the contract, and IOCL shall pay the contractor for measured quantity of each item of work actually carried out under the contract. Payment shall be at the rate for the work set out in the agreed Schedule of Rates.

2.0 SCOPE OF WORK

Generally the following shall constitute the Contractor's scope of work :

- 2.1 Plan and prepare a schedule for execution and work implementation as per QA/QC plans to be issued by IOCL. Contractor has to submit the Construction/ Execution procedures before commencement of work.
- 2.2 Assist in obtaining permissions from land owing agencies for road cutting for laying of pipelines. Liaisoning with concerned authorities during execution of the job.
- 2.3 Prior to start of Construction activities, Contractor shall carry out area and crossings survey and prepare drawings for proposed gas pipe line laying and submit to IOCL for approval.
- 2.4 Receipt of free issue items from IOCL's designated stores, loading, transportation, unloading at Contractor's stores near project sites.
- 2.5 Proper storing, stacking, identification, providing security, and insurance, during storage, laying and upto handing over of pipelines.
- 2.6 Making trial pits to determine the underground utilities /services such as existing pipelines, Cables (Electrical/Communication), Conduits, U/G drainage, Sewers, tunnels, Subways foundations etc, and deciding optimum routes and depths for laying the pipelines based on the route plans provided in the tender.
- 2.7 Obtaining the approval for optimum route and ROU from the concerned authority and EIC. Grading the ROU as per requirement for proper movement of workmen, equipment and QA/QC personnel.
- 2.8 Wherever required the grass/ turfing, pavement, linings, drains roads and other such 'pucca' area shall be locally removed to facilitate trenching and pipe laying works. The same is to be reinstated as original.
- 2.9 Supply & Installation of Safety/ Warning Signs, barricading of the entire route to be trenched. Pits to be similarly barricaded along the warning sign.
- 2.10 To make trenches with stable slopes but restricting minimum disturbance to above ground/underground services/ installation as per specifications and approved route plans; keep the trenches free from water and soil till placement of pipes;
- 2.11 Uncoiling/ stringing the PE pipes of required sizes (i.e. 20, 32, 63, 90, & 125 mm) pipes into trenches as per specification.



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- 2.12 Joining the pipe ends with fittings and valves by approved electrofusion techniques as per specification.
- 2.13 Installation of pipe fittings/installation like elbow, tee, reducers, tapping saddles, joints, connectors, transition fittings, valves, sleeves etc. including construction of supports, valves pits, inspection chambers etc. as per specification.
- 2.14 Laying pipeline using trench less technology methods with or without casing pipes as per specification and as directed by EIC.
- 2.15 Supply & Laying of HDPE duct as casing pipe wherever applicable, alongwith MDPE Pipe.
- 2.16 Supply of good quality GI sleeves, MS enamel coated sleeves, concrete casing pipes, sand and other material, fittings to be supplied by the Contractor as per provisions of tender.
- 2.17 Back filling and compaction by jumping jack compactor using approved 'good' soil or using excavated earth or borrow earth as per requirement and specification and replacement of tiles, slabs removed during the excavation. Cleaning all unserviceable material, debris, excess earth near trenches etc to designated disposal area.
- 2.18 Carrying out pneumatic testing and purging as per specifications and approved procedures; providing all tools, tackles, instruments, manpower and other related accessories for carrying out the testing of pipes.
- 2.19 Nitrogen purging (including supply), commissioning & gas charging of tested pipeline as per approved procedure.
- 2.20 Restoration of existing ground features such as grass/ turfing, paving, roads, drains, concrete, floral beds, fencing, tiles, flooring masonry etc. to original condition and to match with adjoining conditions- functionally and aesthetically upto the entire satisfaction of IOCL any other third party agency designated by IOCL and local authorities, failing which, it will be done at the risk and cost of the contractor. Obtaining satisfactory completion certificates for the restoration work done from the concerned authorities.
- 2.21 Installing of permanent site markers, warning signs, valve chamber etc.
- 2.22 Returning surplus material to IOCL stores, reconciliation of free issue material/ consumables if supplied by IOCL and obtaining 'no objection certificates' from IOCL.
- 2.23 Handing over the completed works to IOCL for their operation / use purposes.
- 2.24 Maintaining the completed pipelines/installation for any defect, failures during defect liability period.
- 2.25 Preparation and submission of As-built drawings, details of crossings, utility graphs, measurement sheets and deviation statements on completion / commissioning of work by way of drawing, sketches and tables.
- 2.26 Any other activity (ies) not mentioned/ covered explicitly above, but otherwise required for satisfactory completion/ operation/ safety/ statutory/ maintenance of the works shall also be covered under the Scope of work and has to be completed by the Contractor within specified schedule at no extra cost to IOCL.



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3.0 MATERIAL, LABOUR, PLANT AND EQUIPMENT

3.1 Owner's Scope of Supply (Free Issue Item)

Free Issue Materials shall be issued to the Contractor from the designated store(s) of IOCL. Contractor shall be responsible for lifting the free issue materials from Owner's storage point(s) and transporting the same to work site(s) at his own cost.

1. MDPE Pipes

3.2 Supplied by the Contractor

All material consumables required except free issue material for completion of work.

The Contractor shall provide the skilled labour, tools, material and equipment necessary for the proper execution of the Work. This will include but not be limited to list of specialized items included in the enclosure furnished herewith.

3.2.1 Equipment & Machinery

All vehicular type machinery shall be in good working order and shall not cause spillage of oil or grease. To avoid damage to paved surfaces the Contractor will provide pads of timber or thick rubber under the hydraulic feet or outriggers of machinery.

In addition to above, the contractor must have dedicated bar coded electrofusion (Automatically readable) machine with power generator (at any point of time minimum 2 nos.), Pipe Cutters (like circular guillotine), End Scrapers, Pipe Straightener, approved Top loading clamp for fusing saddle tapping tee, clamps of all sizes for Electro-fusion fittings, re-rounding tools and test ends etc. for pipes of following diameters 180mm, 125mm, 90mm, 63mm, 32mm & 20mm for this project. Contractor has to arrange his own all equipments for trenchless crossings such as HDD, Moling & rock cutting equipment, HDPE fusion equipment at the site whenever required.

Contractor must also have to arrange his own equipment for restoration work like water tanker and jumping jack compactor for compaction of backfilled trenches and roller and other required equipment/ machinery for asphalting/ road works.

3.2.2 Imported Backfill and Material

The Contractor shall be responsible to arrange the supply of any imported backfill including approved Sweet earth/ Coarse Sand and aggregate etc. Payment for the supply of sand only is included in Schedule of Rates. The other soils shall be supplied without any cost implication to Owner. In case specified trench depths are not achieved & if directed by Engineer-incharge Contractor to provide concrete casing pipes/ slabs or cement concrete, without any cost implication to Owner.



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3.2.3 Other Materials

The Contractor shall supply the following items where required.

- All materials required for form work, trench support and temporary trench crossings.
- All sign boards, barricades, tin sheets, lights and protective equipment.
- All minor items not expressly mentioned in the Contract but which are necessary for the satisfactory completion and performance of the Work under this Contract.
- Permanent markers as shown in the drawings enclosed in the tender.

3.2.4 Manpower

The contractor shall provide the skilled labour, tools, materials, and equipment necessary for the proper execution.

3.2.5 Acquisition, Receipt, & Storage Of Materials

In case of material supplied by owner than the contractor shall collect all materials from IOCL store between working hours following all documentation procedures laid down and as directed by EIC. The contractor shall at the time of receipt of material physically examine all materials and notify the EIC immediately of any damage . Any damage not recorded at the time of inspection done by contractor will be deemed not to have existed at the time of receipt of material . Cost of repair , rectification , replacement will be borne by the contractor. Any defective material found during the time of installation will noted and forwarded to stores for replacement immediately with P.O reference and only with written approval of EIC. The contractor shall ensure that no defective material shall be returned to store at the time of closure of contract.

The contractor shall maintain permanent locked store preferably near site in so that all the material are stored in such a manner so as to prevent and damage to the materials from scratching , gouging , indentation , excessive heat or by contact with any sharp objects and chemicals. The contractor shall maintain log book at their respective stores stating issue and availability of free issue material as a given day. Further the contractor is required to undertake and submit an inventory of materials every month to Owners/Owners Representative (mandatory).

4.0 PROGRESS OF WORK

The Contractor shall proceed with the Work under the Contract with due expedition and without delay.

The EIC may direct in what order and at what time the various stages or parts of the work under the Contract shall be performed. Contractor has to regularly submit daily progress reports, weekly progress reports, graphs with utilities, testing reports, material consumption and inventory reports, deviation statements etc.



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5.0 APPROVALS

Contractor has to assist in getting permissions, obtain statutory approval/ clearances for laying of pipelines. However, IOCL will pay the departmental charges and Bank Guarantees for getting the clearances. It is the contractor's responsibility to inform and co-ordinate the concerned local authorities and also other utility agencies before commencement of work at site. To ensure smooth execution of the work on a day to day basis, the contractor has to liaison with respective authorities and obtains necessary approvals.

6.0 REFERENCE SPECIFICATION, CODES AND STANDARDS

The contractor shall carry out the work in accordance with the requirement of latest relevant applicable standards, this specification, IOCL's Engineering Standards; relevant Oil India Safety Directorate (OISD) norms, ASME B31.8 – Gas Transmission and Distribution Piping Systems; Australian Standard 3723 – Installation and Maintenance of Plastics Pipe Systems for Gas; and the American Gas Association Document – Purging Principles and Practice. ISO:4437/ IS: 14885 for underground polyethylene pipes and IOCL's approved procedures.

Should the contractor find any discrepancy, ambiguity or conflict in or between any of the Standards and the contract documents, then this should be promptly referred to the Engineer-in-Charge (EIC) for his decision, which shall be considered binding on the contractor.

7.0 SAFETY

The Contractor shall conform to the requirements outlined elsewhere in the tender document. In addition, the Contractor shall observe safe working practices in the storage and handling of cleaning fluids, flammable fluids, etc, and ensure smoking or naked flames are not permitted in the vicinity when these materials are being used.

Trench walls shall be battered with sufficient slope in order to minimize a trench collapse. Where there is a danger of an earth slide or collapse, the trench shall remain open for the minimum time possible with proper barricading. The Contractor is to ensure that no person enters a trench, which is of a depth of 1.5 meters or greater, unless the trench has adequate shoring or the sides are battered to such an extent as to prevent a trench collapse.

The Contractor shall also protect all work sites with warning signs, barricades and night lighting. The Contractor shall inspect all fenced excavations daily, and maintain them in good order.

The trenches/ pits shall not be kept open in night times. However in case the same is essential the same shall be properly barricaded with proper lighting arrangements & manned.



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The Contractor shall provide all safety equipments like helmets, boots, etc. to the labour which are necessary for safe working practice. Any accident causing injury to any person or damage to property or equipment shall be reported to the EIC.

Where the EIC determines that the work is being performed by the Contractor in an unsafe manner, he may suspend the Work until corrective action is taken by the Contractor.

For further details refer Attached HSE technical specification.

8.0 ROUTE SURVEY

8.1 Plans detailing the size, operating pressure and approximate location of the proposed mains, connections and associated regulator installations will be issued to the contractor at the start of the works.

8.2 The final alignment of mains will be worked out at site in consultations with the site engineers after route survey and trial pits, at his cost, have been carried out. Any change in routing from the issued drawings due to site constraint will be notified to EIC & his specific written approval shall be obtained before carrying out the job.

8.3 Service Lines

8.3.1 A survey will be conducted jointly by IOCL/ third party inspection and the contractor at each premises or housing colony to be supplied. The survey record will note customer details, the potential gas supply points and proposed regulator positions and estimates of material quantities. The contractor's representatives will make a sketch of the agreed pipe routes if necessary.

8.3.2 The contractor will be responsible for contacting the customer and making the necessary arrangements for access, and appointments to carry out the work. Contractor shall maintain job card and complaint books at site. IOCL will not be responsible for any time lost due to broken appointments or disputes with customers.

9.0 ORGANIZATION OF WORK

9.1 All construction work will be carried out as per direction of EIC, and this will be the primary point of contact between the contractor and IOCL on site. All work will be issued and sanctioned through the EIC and site control exercised by Site Engineer IOCL. The contractor shall ensure that technical quality standards are maintained, that construction is carried out cost effectively and that a good customer and public image of IOCL is maintained.

9.2 Contractor shall designate RCM who will be the single point coordinator to interact with EIC/Consultant/TPIA and authorized to attend review meetings, receive materials, authorized to sign



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documents, claims and receive payments etc. Contractor shall submit the organization chart stating that in charge of projects, store, QA/QC and take approval from the owner.

- 9.3 The contractor will appoint his own supervisors of minimum number instructed by EIC. These personnel will be responsible to the SE for monitoring construction standards and for ensuring that all detailed technical requirements are met on each and every job which is undertaken. The contractor's supervisor(s) will have day to day liaison with the SE, and will provide the SE with technical reports and audits, and other management information as is required on work progress and construction quality standards.
- 9.4 The contractor's supervisor shall have mobile telephones or pagers to ensure that they can be contacted at all times. The contractor will also nominate one person who can be contacted if necessary out of hours, for the duration of the works. The contractor's supervisor will have access to transport at all times to allow them to visit sites and attend meetings with IOCL as is required. The normal day to day issue of work instructions, communication between IOCL and the contractor's supervisor and the SE. No deviation from the approved technical specification / issued construction drawings shall be undertaken without written approval of EIC.
- 9.5 Contractor shall maintain a Project site office, Material store with following facilities:
- Telephone, Mobile phones, Fax machine, printers/Scanning/Xerox machines, Computer with e-mail facility
 - 1 No. four wheeler with driver for suit survey, meetings etc, with Owner/Owners representative. Also it shall be well equipped with tools and tackles for attending any emergency complaints and ongoing execution work.

On award of the contract, The contractor shall establish and submit documentary evidence for above Which will be verified by owner before of the work order .Any delay and non-compliance of above may result into the termination of contract

10.0 STRUCTURES, SERVICES AND OTHER PROPERTY

10.1 Location of Underground Utilities

The contractor shall locate all buried utility pipes, underground cables, water mains and other obstructions intersecting or adjacent to the Works, and shall make available the necessary labour to expose and record the depth of cover over all obstructions in advance of excavation. This shall be done far enough in advance of excavation to facilitate gradual change in grade or position found necessary to clear any obstructions.



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In addition, the contractor shall excavate trial pits as necessary to determine the pipe route. The number of trial pits will be agreed with the EIC in advance of any excavation. In any event, trial pits shall be made at intervals of a maximum of 30 meters. Restoration of the abandoned trial pits and trenches shall be the contractor's responsibility. No payments shall be made for such type of jobs.

There will be no additional payments in respect of abandoned trenches incurred because of insufficient or inadequate trial pits, or any associated lost time or delays.

10.2 Protection of Structures and Utilities

The Contractor shall at his own cost, support and protect all buildings, walls, fences or other structures and all utilities e.g. Electrical cables, Telephone Cables, Water pipelines, Sewer pipelines etc., and property which may, unless so protected, be damaged as a result of the execution of the works. He shall also comply with the requirements in the specification relating to protective measures applicable to particular operations or kind of work. Special care shall be taken while laying Pipelines near the trees.

10.3 Interference with Traffic, Street Drainage and General Public

The Work shall be executed in such a manner as to cause a minimum of inconvenience to persons requiring to use public or private roads, lanes, thoroughfares, walkways, rights-of use or passages through which the Works are to be executed. The trench shall be back filled, compacted, leveled and extra earth shall be removed immediately after laying of pipeline to avoid public inconvenience. Closure of roads, etc, shall not be permitted without the approval of the EIC.

The Contractor shall comply with all local Authorities requirements to traffic, and keep roads open to traffic, and maintain access to and within any private property.

Wherever the pipe route crosses driveways, access tracks or entrances to private properties, the Contractor shall give the owner, occupier or relevant authority at least 24 hours prior notice of intended commencement of excavation and shall be restricted to pass through.

The Contractor shall not, in any circumstance, use a private driveway, access track or entrance without the prior approval of the EIC.

The Contractor shall provide suitable access where necessary in the form of temporary bridges, culverts, flumes, etc, of a size and type approved by the EIC.

The Contractor shall comply with all relevant road Laws. Where limits and/or speed limits have been placed in the vicinity of the Works, the Contractor shall provide for the necessary movement of plant and equipment in accordance with the requirements of the relevant authority.

The Contractor shall not obstruct any drainage pipes or channels in any road but shall deviate them where necessary and use all proper measures to provide for the free passage of water.

The Contractor shall deliver the completed works after proper cleaning of the site.



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The contractor shall conduct his operations at all times, with a view to minimizing as far as practicable noise from plant and other objectionable nuisance (e.g. oil leakage).

11.0 TRENCHING

The Contractor shall perform the excavation works so as to enable the pipe to be laid in conformity with the levels, depths, slopes, curves, dimensions and instructions shown on the Drawings, Specifications or as otherwise directed by the EIC.

Contractor shall excavate and maintain the pipeline trench on staked centerline as per approved alignment sheets taking into account the horizontal curves of the pipelines.

While trenching care shall be taken to ensure that all underground structures and utilities are disturbed to the minimum. Suitable crossing shall be provided and maintained over the ROU wherever necessary to permit general public, property owners or his tenants to cross or move stock or equipment from side of the trench or another.

Trenching shall be made with sufficient slopes on sides in order to minimize collapsing of the trench. On slopes wherever there is danger of landslides, the pipeline trench shall be maintained open only for the time strictly necessary. IOCL may require excavation by hand tools, local rerouting and limiting the period of executing of the works. Before trench cuts through water table, proper drainage shall be ensured, both near the ditch and ROU in order to guarantee the soil stability.

The Contractor shall ensure that trench bottom is maintained in the square form as far as possible, with equipment, so as to avoid/ minimize the hand grading at the bottom of the trench. The Contractor shall do all such handwork in the trench as required to free the bottom of trench from loose rock, pebbles and to trim protruding roots from the bottom and sidewalls of the trench.

11.1 Depth of Trench

The minimum depth of cover shall be measured from top of pipe to the top of undisturbed surface of the soil or top of the graded working strip or top of road or top of rail, whichever is lower.

The depth of the trench will be such as to provided minimum cover as stipulated below:

a) For Distribution Main and Service Lines

i) Minor Water Crossing/ Canal	1.5 meter
ii) Uncased/ Cased Road Crossing	1.5 meter
iii) Rail/ Road Cased Crossing	1.5 meter
iv) Normal Areas	1.0 meter

The minimum depth as mentioned above may be greater than as may be required by Government/ Public authorities under jurisdictions. The Contractor shall perform such work without extra compensation, according to the requirement of concerned authorities.



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In cases of Drain/ Culvert crossing through open cut where excavation cut is more than 1.5m, the extra excavation shall be paid in quantity basis. The rate shall include backfilling as specified. No separate payment is chargeable for extra excavation and includes backfilling as well.

In case the depth could not be achieved due to practical problems and the same is demonstrated, EIC after examining thoroughly and considering the codes and standards may allow the contractor to provide suitable protection by way of concrete casing pipes or slabs without extra cost to IOCL.

11.2 Width of Trench

The width of the trench shall be wide enough to provide bedding around the pipe and to prevent damage to the pipe inside the trench. Unless otherwise directed by the EIC and where ground conditions permit, the minimum distance from the inside edge of the trench wall to the outside of the pipe shall be as per drawing enclosed herewith.

11.3 Trench Base

The trench bottom shall be cut or trimmed to provide a uniform bedding for the pipe, and shall be free of stones, metal, wood, vegetation, clods of earth or other debris before placement of the pipe. Hard rock is defined as trench material with a single piece dimension exceeding 1.5 m in length which cannot be removed other than by the use of pneumatic chisel/drill or sledge hammer and chisel. Excavation through soil mixed with boulders that have been used for a road base will not be considered as hard rock for the purposes of payment.

11.4 Clearances

Unless otherwise approved, the following clearances shall be maintained between the external wall of the gas pipe and the external surface of other underground assets in the vicinity of the Works.

- ❖ 150mm where the gas pipe crosses other assets, other than electric cables, whereupon the clearance shall be 300 mm.
- ❖ 300mm where the gas pipe is on a similar alignment to the other assets. Where the above clearances cannot be achieved, or in other special circumstances, the EIC may approve/specify protection with concrete/MS coated pipe, etc. The protective material shall be supplied and installed by the Contractor at his cost.

11.5 Under Ground Interferences

The Contractor shall locate and expose manually all underground facilities if any during trenching. Safety barriers, if required shall be erected to prevent any damages or accident. On locations where pipeline is laid under the existing facilities and near the approaches to the crossing, the trench shall be gradually deepened to avoid sharp bends.



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All sewers, drains, ditches and other natural waterways encountered while trenching shall be maintained open and functional by providing proper temporary installations if required. Suitable dewatering pumps shall be deployed to dewater, if required.

Whenever it is permitted by Authorities and/ or IOCL to open cut paved road crossing, or where line is routed within the road pavement, the Contractor shall remove the paving in accordance with the restrictions and requirements of the authorities having jurisdiction thereof as directed by IOCL. After laying the pipeline, backfilling shall be immediately performed and all the areas connected with the works shall be temporarily restored. In case of damage to any of above referred structures/ utilities the contractor shall be responsible for repairs/ replacement at his own cost, which shall be carried out to satisfaction of concerned authorities, resident and IOCL.

11.6 Others

Throughout the period of execution of such work, the Contractor shall provide and use warning signs, traffic lights or lanterns, barricades, fencing, watchman etc. as required by the local authorities having jurisdiction and/ or IOCL.

For all roads, paths, walkways etc. that are open-cut, the Contractor shall provided temporary diversions properly constructed to allow the passage of normal traffic with the minimum of inconvenience and interruptions. The paving shall be restored to its original condition after the pipeline is installed.

The Contractor shall excavate to additional depth at all the points where the contour of the earth may require extra depth, or where as deep trench is required at the approaches to crossings of roadways, railroads, rivers, streams, drainage ditches without any extra cost implication to IOCL.

The Contractor shall excavate all such aforesaid depths as may be required at no extra cost of IOCL.

The trench shall be cut to a grade that will provide a firm, uniform and continuous support for the pipe.

The Contractor shall take conducive measures to ensure the protection of underground utilities as per the instructions of IOCL or relevant authorities.

Where the pipeline crosses underground utilities/ structures, Contractor shall first manually excavate to a depth and in such a manner that the utilities/ structures are located, then proceed with the conventional methods.

The locations, where the pipeline has to be laid more or less parallel to an existing pipeline cable and/ or other utilities in the Right-of-way the Contractor shall maintain proper distances and perform the work to the satisfaction of IOCL and other utility agencies. In such locations, the Contractor shall perform work in such a way that even under the worst weather and flooding conditions, the existing pipeline/ utilities remain stable and shall neither become undermined nor have the tendency to slide towards the trench.



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11.7 Bedding

The contractor shall ensure that the pipe when placed in the trench is supported and surrounded by a bed of screened excavated soil, which shall be stone free and have a maximum grit size of 5mm in order to ensure no damage occurs to the pipe.

However in case of rocky soil, the bedding shall be done with approved/ good quality packing sand, subject to the approval of the EIC, the size distribution of the sand/ shall be the same as per soil. The packing sand shall be placed to a minimum thickness of 150mm around the pipe in case of rocky terrain.

Unless directed by the EIC the quantity of bedding & surrounding sand shall confirm to specifications. There shall be no void space in packing sand around the pipe.

12.0 LAYING

Laying of MDPE pipelines shall commence only after ensuring proper dimensions and clean surface of the trench. The trench bottom shall be free from the presence of cuts, stones, roots, debris, stakes, rock projections upto 150mm below underside of pipe and any other material which could lead of perforation/ tearing of the pipe wall. After ensuring above the MDPE pipe coil shall be uncoiled smoothly through proper equipment's/ care inside the trench ensuring no damage to pipe coil during laying. The Contractor must ensure that pipe

caps are provided before lowering of pipeline. The trench after this can be released for back filling leaving adequate lengths open at the ends, for jointing.

Where given specific approval by the EIC a pipe may pass through an open drain or nallah. Where this is permitted the pipe shall be installed inside a concrete or steel sleeve for protection. The sleeve material shall be procured and laid by the Contractor. In general the GI Sleeve and MS sleeves material specification shall be confirming to IS 1239 (Heavy Duty) specification of reputed make. The payment for the length of pipe in the sleeve will be made as per SOR. All other work necessary to break through the walls of the obstruction, and to seal the annulus between the pipe and the sleeve and the sleeve and the wall, shall be deemed to be included in the rates.

Open ends of pipe placed in the trench shall be securely capped or plugged to prevent the ingress of water or other matter. The Contractor is to ensure that nothing enters the inside of the pipe during the laying process as this could cause a future blockage or regulator malfunction due to dust, etc.

Service lines shall be installed in accordance with the drawing enclosed. Note that the service pipe rises out of the ground at the customer's premises within a GI sleeve pipe. The vertical portion of the sleeve shall be fixed to the wall of the premises in a secure manner. A bending tool shall be used to bend the GI sleeve pipe so that it has the appropriate curvature and is free of kinks. The bending of the sleeve, its fitting and clamping, and the installation of the transition fitting excluding service-isolating valve, is all included in the service connection rate. A rate is included in the SOR for the provision of sleeves for PE laying. Any installation without inspection and approval may lead to penalties as Special condition of contract.



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A bending tool shall be used to bend the GI sleeve pipe so that it has the appropriate curvature and is free of Kinks. The installation of the GI sleeve for service lines shall be done by sealing the annulus, firm fixing of the GI sleeves with concrete mix, breaking through any obstructions & their subsequent restoration to the satisfaction of the EIC.

The contractor shall supply the GI sleeves (Heavy duty OF IS:1239 reputed make) respectively for domestic & commercial / Industrial installation. The vertical portion of the sleeves shall be fixed to the wall of the premises in a secure manner. The service line shall be installed in accordance with drawing enclosed. The material test certificates / inspection reports shall be inspected by TPIA/OWNER before installation.

Valves shall be installed at locations shown on the Design Plan or as directed by the EIC and joined with PE pipes by electro-fusion techniques. The valves shall be supported on a bed of fine fill of grit size not greater than 5mm to achieve equivalent support as the incoming and outgoing pipe work.

Laying graphs with details of depth, length, offsets from fixed references, other utility crossings, fittings, size of casing pipe used for the pipeline shall be prepared on daily basis and submitted to Site Engineers of the Owner for approval. These details will be further incorporated into As-Built Drawings.

13.0 JOINTING OF POLYETHYLENE PIPE

The procedure for jointing of PE pipe and fittings is enclosed. Only Bar coded electro-fusion machine (Automatically Readable) that can read the bar code of the fittings automatically shall be used for jointing of MDPE pipe / fittings. Manual feeding electro-fusion machines are not acceptable for jointing purpose. The Contractor has to submit the certificate of calibration of Fusion machine at the time of start of work and at fixed intervals as per the instruction of owner. Contractor shall ensure that the machines are always available at site, no stoppage of work due to the non availability of machines.

The contractor shall flush the Pipeline with air to remove dust, water, mud etc. before fusing the joints.

Before jointing, the Contractor shall place packing sand under the pipes on both sides of the joint to keep the pipes in line and at the correct alignment during the jointing process. Alignment clamps with the correct size shells should be used to align the pipe during the electro-fusion cycle.

The Contractor shall ensure that polyethylene pipe is only cut with an approved plastic pipe cutting tool. Before fusion is attempted he shall remove the oxidized surface of the pipe to be inserted into the electro-fusion coupling. The tool must remove a layer of 0.1 mm to 0.4 mm from the outer surface of the polyethylene pipe. It may also be noted that no fusion will be allowed without clamping device and only the approved cutting tools (Hack Saw shall not be allowed for cutting the Pipe) shall be used.



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The contractor has to supply all the consumables required for carrying fusion of the joints (like cloth/ paper napkin, acetone etc.).

If, upon inspection, the EIC determines a joint is defective, Contractor shall remove the joint by an approved method. The cost of this work shall be borne by the Contractor.

For electro-fusion jointing, the contractor must bring own tools, tackles and equipments.

Contractor shall arrange generator for power supply for fusion machine. Taking power connection from electric poles, connections without written permission from concerned authorities or residential premises is strictly not permitted.

Only, Approved Jointers shall carry out fusion of all joints. Contractors shall provide the list of jointers to be used on the job and make arrangements for qualification Testing of the jointers in presence of Owner / Owner's representative. All approved Jointers shall bear Identity cards signed by Owner/Owner's representative.

Taking power connection from electric poles, connection without written permission from the concerned authorities or residential premises is strictly prohibited

14.0 BACKFILLING

Backfilling shall be done after ensuring that appurtenance have been properly fitted and the pipe is following the ditch profile at the required depth that will provide the required cover and has a bed which is free of extraneous material and which allows the pipe to rest smoothly and evenly. Dewatering shall be carried out prior to backfilling. No backfilling shall be allowed if the trench is not completely dewatered. Prior to backfilling it should be ensured that the post padding where required of compacted thickness 150mm is put over and around the pipe immediately after lowering.

Backfilling shall be carried out immediately after the post padding where required has been completed in the trench, inspected and approved by IOCL, so as to provide a natural anchorage for the pipe, avoiding, sliding down of trench sides and pipe moment in the trench. If immediate backfilling is not possible, a padding of at least 200mm of earth, free of rock and hard lumps shall be placed over and around the pipe and coating.

The backfill material shall contain no extraneous material and/ or hard lumps of soil, which could damage the pipe and/ or coating or leave voids in the backfilled trench. In case, it is required and directed by EIC, screening of the backfill material shall be carried out with specified equipment before backfilling the trench.

The surplus material shall be neatly crowned directly over the trench and the adjacent excavated areas on both sides of the trench to such a height which will, in IOCL opinion of provide adequately for future settlement of the trench backfill during the maintenance period and thereafter. The down shall be high enough to prevent the formation of the depression in the soil when backfill has settled into its permanent position should depression occur after backfill, Contractor shall be responsible for remedial work at no extra cost to Company. Surplus material, including rock, left from this operation shall be disposed off to the satisfaction of land owner or authority having jurisdiction at no extra cost to IOCL.



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Where small pieces of rock, gravel, lumps of hard soil or like materials are encountered at the time of trench excavation, sufficient earth or select backfill materials shall be placed around and over the pipe to form a protective cushion extending at least to a height of 150mm above the top of the pipe. Select backfill materials for padding that are acceptable shall be screened soil, containing no gravel. All these works shall be carried out by Contractor at no extra cost to IOCL. Loose rock may be returned to the trench after the required selected backfill material has been placed, provided the rock placed in the ditch will not interfere with the use of the land by landowner, or tenant.

In case where hard rock is encountered or as desired by EIC sand padding is to be provided upto height of 150mm around the pipe.

When the trench has been dug through drive ways or roads, all backfilling shall be executed with suitable material in layers as approved by IOCL and shall be thoroughly compacted. Special compaction methods as specified may be adopted. All costs incurred there upon shall be borne by the Contractor.

Trenches excavated in dikes which are the properties of railways or which are parts of main roads shall be graded and backfilled in their original profile and condition. If necessary, new and/ or special backfill materials shall be supplied and worked-up to.

PE Warning Grid/Mat 1mm thick and 300mm wide will be placed on distribution main and on service lines inside premises, after backfill of the trench upto a height of 300mm on the top of the carrier pipes. The warning grid is to be unrolled centrally over the pipe section and thereafter further backfilling will commence.

Backfilling activity shall include proper compaction by jumping jack compactor and watering in layers of 150mm above the warning mat. Proper crowning of not more than 150mm shall be done. All the excavated material required to be used during the Restoration process shall be stacked and kept separately and properly. Wherever Road cutting/ Tiles removal/ PCC cutting has been done during excavation for laying, the area shall be back filled and compacted immediately so that no inconvenience is caused to the general public.

Electro-fusion of joints is to be undertaken immediately after lowering and the activity shall not be kept pending for lack of Electro-fusion jointing. The backfilling shall be considered complete only after the joint is completed.

Debris and other surplus material shall be removed immediately after the back filling.

The contractor shall not be entitled for 30% payment on laying & backfilling till the above activities are completed.

15.0 MOLING:

The Moling shall be carried out as per the requirement specified by IOCL, and approved procedures. The contractor has to carry out thorough survey of the underground utilities before going for the Moling, to avoid the damage to the other utilities.



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No extra payment will be made for any trial/ abandoned pits made during the survey. The supply of all equipment, power required for carrying out moling work, is in contractor's scope. The type of moling to be carried out i.e., Manual/ Machine with or without casing shall be at the discretion of IOCL. A prior approval is to be taken before starting the moling.

For manual Moling the contractor shall ensure that the size of the hole shall not be more than 20% of the size of the casing / carrier pipe whichever is applicable. After completion of Manual moling the hole shall be properly compacted / filled with soil by watering and by approved procedures, the pits shall be backfilled, compacted & restored. The rate for such crossing work by using casing pipe & carrier pipe or only carrier pipe shall be payable as per Schedule of Rates. **No separate payment shall be made for pulling the carrier pipe.**

In case of Machine Moling a standard procedure is attached herewith in Annexure for reference.

The rate for such crossing work by using casing pipe shall be provided in Schedule of Rates. No separate payment shall be made for pulling the carrier pipe. In case Casing pipe is not laid during Moling then rates payable shall be as per Schedule of Rates.

The rates for Moling, as indicated in SOR, are payable as per the size of the casing/ carrier pipe and are inclusive of excavation of pits, backfilling, compaction, restoration, jointing and insertion of carrier pie. Any damages occurred to other utilities during the Moling operation shall be immediately notified and rectified by the contractor without any cost implication to IOCL.

The length of the Hole (excluding the sizes of the pits on both ends) shall be considered for the measurement of Moling length. However, intermediate pits will consider in the moling length.

16.0 BORING/RAMMING/DIRECTIONAL DRILLING

One of the above techniques is required to be carried out by the Contractor where conventional trenching/Moling is not possible viz. railways, major waterways, highways, roads etc. Details of such crossings shall be obtained by the Contractor, and construction drawings shall be prepared by the Contractor in consultation with IOCL. Execution of the work shall be based on the IOCL approved drawings. The contractor has to do the thorough survey of the underground utilities before commencement of BORING/ RAMMING/ DIRECTIONAL DRILLING to avoid the damage to the other utilities. No extra payment will be made for any trail/ abandoned pits made during the survey. The supply of all equipments is in Contractors scope. Work to be carried out in accordance with API - 1102.

Once the work is allotted, Any delay in mobilizing / non – availability of HDD machines as per site requirement and conditions shall result in levying of penalties on daily basis as per SCC.

The type of HDD to be carried out i.e. conventional (with or without casing) shall be at the discretion of IOCL/ IOCL. And prior approval is to be taken before starting the HDD.

The rates for HDD, as indicated in SOR, are payable as per the size of the carrier pipe and are inclusive of excavation of pits, backfilling, compaction, jointing and insertion of carrier pipe and restoration of pits. For HDD with casing pipe no separate payment shall be made for pulling of the carrier pipe, the rate quoted by the Contractor shall be inclusive of pulling carrier pipe.



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Any damages occurred to other utilities during the HDD operation shall be immediately notified and rectified by the Contractor without any cost implications to IOCL.

The length of the HOLE (excluding the sizes of the pits on both ends) shall be considered of HDD length. Once the work allotted, any delay in mobilizing / Non availability of HDD machines as per site requirement and conditions shall result in levying of penalties on daily basis as per SCC.

17.0 CASING PIPE

The tentative sizes of the HDPE casing pipe for Moling/ HDD shall be as follows:-

Size of MDPE pipe	Size of HDPE pipe
20 mm	50mm
32 mm	75 mm
63 mm	125 mm
90mm	180mm
125mm	250mm
180 mm	315 mm

However, size of the casing pipe may vary according to length of the carrier pipe and requirement of laying of OFC Duct.

18.0 RESTORATION

Wherever the restoration is required, the roads, footpaths (including roads and footpaths inside colonies) shall be restored to original condition, and the same shall be done as per concerned local authorities norms and to the satisfaction of the concerned local Authority. To retard curing of the installed concrete, wet sack cloth is to be placed on the finished surface and kept damp for a period of 36 hours.

Where slabs and blocks are to be restored, the level of the compacted subbase is to be adjusted according to the slab/block thickness. The slabs or blocks should be laid on moist bedding material, which should be graded sand, mortar or mortar mix. The slabs or blocks should be tapped into position to ensure they do not rock after laying.

The restored slabs or blocks should match the surrounding surface levels. Joint widths should match the existing conditions, and be filled with a dry or wet mix of mortar.

The sketch for restoration of Road, Footpath, Channel is enclosed herewith and is indicative. However, the restoration shall be done in accordance with the norms of concerned land owning agencies.



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Turf shall be replaced in highly developed grassed area. In lesser-developed grassed areas topsoil should be replaced during the restoration process.

Where permanent surface restorations cannot be completed immediately, the Contractor shall provide and maintain a suitable temporary running surface for vehicular traffic and pedestrians. The Contractor will be responsible for the maintenance of all restoration carried out, for the duration of the Contract guarantee period.

The Contractor is to ensure the restoration work is properly supervised, and that the material used is suitable for the purpose and properly compacted. Where the required standards are not achieved the Contractor will be required to replace the defective restoration work.

Note that Payment for pipe laying will only be authorized on initial satisfactory restoration, and where the sites has been cleared of all surplus materials, etc.

Contractor has to obtain the clearance certificate from the concerned local authorities after completion of the restoration work. The restoration specification specified in the tender is only a typical specification and the contractor has to carry out restoration as per latest version of the (PWD/IRC) specification to its original condition and also to the entire satisfaction of land owner (Private/Public).

The expenditure incurred towards testing of the material used for restoration as per applicable standards, shall be borne by the contractor.

19.0 TESTING

Pressure testing will be carried out with compressed air. Compressed air will be provided by Contractor for testing purposes and is to be included in the rates.

For main pipelines work the Contractor shall perform progressive pressure testing to avoid having to find leaks in long lengths of pipe. The test pressure shall be 6.0 bar(g), and there shall be no unaccountable pressure loss during the test period.

Test procedure with sketches showing the pipeline to be tested, vent points, gauge location, and inlet pressure print is to be prepared & got approved by EIC. For main line the test duration shall be 24 hrs. With these tests the pressure should be allowed to stabilize for a period of 30 minutes after pressurization. The holding period may then commence and continue for 24 hours. Measuring instruments shall have been calibrated and their accuracy and sensitivity confirmed. For testing of Network, calibrated pressure gauges of suitable range shall be supplied by the contractor. The pressure gauges shall be calibrated from time to time as desired by Engineer-in-Charge. All testing shall be witnessed and approved by the EIC or his delegated representative. Tie-in joints may be tested at working pressure following commissioning.

For service lines in some cases testing will be carried out independently of the testing of the mains for which the test duration may be reduced to 4 hrs. The service testing in this case will be performed after the service installation is complete but before the service tee has been tapped. Also in some cases the tapping of the service tee will be delayed pending the completion and purging of the main pipelines.



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20.0 PURGING

Purging shall be carried out in accordance with the principles defined in the American Gas Association publication 'Purging Principles and Practice'.

Nitrogen required for purging will also be provided by the Contractor. Nitrogen shall be supplied in labeled, tested and certified cylinders, and completed with all necessary regulators, hoses and connections, which will be in good condition and working order.

In addition the Contractor shall submit and get approved a Purging Plan before commencing any purging work. The Plan shall include, but not be limited to, the provision of the following materials and equipment: Personal safety equipment, Fire extinguisher, Purging adapter, Purge stack with flame trap and gas sampling point, Gas sampling equipment (may be gas leak detector), squash-off tool, Polyethylene connecting pipe work.

The Plan shall also include the purging process along with detail on the sequence of events. The process is to also specifically mention the need to lay a wet cloth over the PE main and in contact with the ground, to disperse static electricity during the purging work.

A purge stack with flame trap shall be used when purging services. Care shall be taken to ensure that the purge outlet is so located that vent gas cannot drift into buildings.

21.0 VALVE PIT

The valve pit shall be constructed in accordance with APPROVED drawing & payment shall be as per SOR.

The construction of valve chambers shall be taken up immediately after installation of valve pit.

21.1 Workmanship

The excavation work shall be done at a location given by Engineer-in-Charge. All care shall be taken not to damage existing facilities and surface of construction shall be restored to its original state. Sandbags to be placed below pipeline without disturbing the layed pipe. Gunny bags and Sand should be of approved quality.

Precast RC slab shall be placed as indicated in the drawing issued to the contractor. PCC to be placed below the pipe as indicated. Once PCC is set sand is to be filled and properly rammed so that pipe and precast concrete blocks are firmly placed.

Valve will be supplied without the operating stem. Contractor has to supply the operating stem with a handle for the valves of the different sizes. The Contractor has to take prior approval for design and material specification of the stem for installation. Approved quality sand is to be placed in between area.

Surrounding area to be properly cleared and PCC to be placed around the location where precast slab with CI Manhole cover is placed. The RC precast slab to be laid in level and finished smooth.



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22.0 PERMANENT MARKERS

- 22.1 Permanent Marker (As per typical Drawings Placed at Tender) shall be installed on the ROU at regular intervals as per the instructions of the EIC immediately after laying of the pipeline. The installation of the type of the Permanent Marker shall be decided by the EIC depending on the site condition. The Markers shall be painted before installation as per the approved procedure. The supply of the paint and painting as per the specification is in contractor's scope. Separate payment for installation of the markers shall be paid to the Contractor as per the SOR item.
- 22.2 The artwork shown in the drawing is typical for all the markers. The contractor must take prior approval for the artwork from EIC before installation of Markers. The artwork must have IOCL's logo and specify the location of the pipeline from the marker.

Guidelines:

- The installation of these markers shall be such that in between two pole markers two RCC markers are installed with spacing of 50 Mtrs on either side. However, Pole markers shall be installed at all the tapping / Branching points in the mainline.
- Interval between any two RCC markers for mainline (180mm to 63mm) shall not be more than 50 m.
- Pole marker or RCC marker shall be installed near to valve chambers on mainline & inside the pockets respectively for indication.
- Pole marker with foundation shall be installed after two RCC marker as per drawings.
- The entry and exit pits for laying of pipeline by HDD/ Moiling for road crossings shall be marked by pole markers or RCC markers depending upon the site condition.
- In addition to the above, pole markers with foundation (As per drawings) shall be installed outside societies / Areas as per the instruction of the site in charge.
- For the distribution network 32 mm & 20 mm pipe, plate markers shall be installed as per the site condition and direction of the site in charge.

23.0 ASSISTANCE IN COMMISSIONING

- 23.1 Contractor shall provide the required personnel, Vehicles, labour, supervision, tools, equipment, instruments and technical assistance for performance tests and commissioning activities as per requirement of IOCL.



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24.0 STANDARD OF WORK

- 24.1 All work carried out under this contract shall be to standards, codes of practice, construction procedures and other technical requirements as defined in the technical specifications.
- 24.2 The manpower deployed on the respective work shall be adequately trained & shall have necessary skills to executive / supervise the work. However, the assessment on the qualification of the personal shall be at the discretion of EIC.
- 24.3 Fusion operators and other skilled personnel shall be approved by IOCL and identification cards duly signed by EIC shall be issued to them. Only those personnel who are approved by EIC shall be allowed to execute the critical activities like joining of PE Pipes.

25.0 RECORDING (AS-BUILT DRAWINGS)

- 25.1 The Contractor will be required to submit computerized as-built drawings duly certified by EIC in A0/ A1 sheet form at 1:200 scale with six sets of prints plus soft copy. The as-built drawing shall be submitted on area wise as specified. The bill of materials used for the particular area shall be specified on the drawings. The Contractor shall use the area and crossing survey drawings prepared by them as reference. On-site sketches, picking up key reference points, shall be made during the installation of services. The lengths, depths of installed pipe work, changes in direction, major fittings, etc, shall be recorded together with appropriate references to other services crossed and in the proximity of the gas pipe .
- 25.2 Distance of pipeline from permanent property /structure should be provided at least every 20 meters. If there is any change in alignment/orientation and offset distance etc. of the pipeline in between the above said 20 meters, the same shall be clearly mentioned in the as laid. Gas objects (off valve, tees, elbows, couplers , T.F, etc shall be shown as block objects (which from a single node to connect) with respect owners symbol and legend. The as laid drawing shall be as per the legends provided by EIC.
- 25.3 Details & offset distances from other utilities present should be given in as laid drawing. If there is any change in the depth of pipeline , the same shall be clearly marked with details in the as laid drawings. The details of additional protection provided must be mentioned.
- 25.4 Details of the PE stop off valve and other fittings used should be shown with adequate information and orientation. Technical deviation (if any) should be provided with reference to the buildings and permanent structure around, and the same should be cited clearly with all relevant details. Complete details of nallah crossings should be shown in a separate sketch Name of roads , major landmarks and buildings should be mentioned appropriately for reference.
- 25.5 Proper Chainage shall be mentioned on all the drawings to be referred with continuation reference.



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- 25.6 Direction of gas flow should be indicated in each drawing.
- 25.7 Land based features shown on the drawing shall match the exact distance as they were on real ground with respect to scale ratio (1:200)
- 25.8 The details shall be prepared in standard format using Map Info/AUTOCAD
- 25.9 Map and submitted in CD ROM. Contractor shall also make the item wise material consumption report for the respective areas in a soft copy and to be submitted along with the as-built drawings.

26.0 Civil Works

- 26.1 The contractor has to supply the adequate materials and skilled manpower for the completion of all the civil works. The contractors shall also insure that the work carried out as per the detail mentioned in the schedule of rates. Special care should be taken at the time of labours working in depths/lifting of the skids by hydras/ cranes considering all the safety guidelines. The contractors has to ensure that sample of all the material shall be inspected and approved by EIC before carrying out installation or erection work. The contractor has to submit the test certificates for all the materials to be used at the site. The construction shall be carried out strictly as per the drawings provided by the IOCL. The party shall ensure extra / Surplus / malba shall be immediately removed from the site after completion of the job. Separate payment shall be made as per the SOR.



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SECTION-VI

SPECIFICATION FOR CIVIL/STRUCTURAL WORKS



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**PART-I : TECHNICAL SPECIFICATION FOR SITE CLEARING, AREA GRADING, EXCAVATION
AND EARTHWORK**

1.0 SCOPE

This Specification defines the basic requirements for Clearing, Area Grading, Excavation & Earth Work.

2.0 REFERENCE DOCUMENTS

IS 2720 Method of test for Soils (Parts 1 to 40)

IS 4988 Glossary of terms and classification of earth moving machinery Parts 1, 2, 3, 4 and 5

IS 10379 Code of Practice for Field Control of
Soils IS 3764 Excavation Work - Code of
Safety

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 EARTHWORKS

4.1 COMMON EXCAVATION

Common Excavation shall mean excavation in any material. All common excavated material shall be classified as suitable or unsuitable according to 4.2.2 and 4.2.3 below.

4.2 SUITABLE MATERIAL

The fill material shall be granular, well graded, compactable, and possess good drainage characteristics, and no swelling properties. It shall be free of vegetation, any organic matters and other impurities. In extraordinary circumstances expansive soil of free swell index, less than 50 % may be used, however approval shall be sought from the Owner/Owner's Representative.

The proposed fill material shall be tested to determine its suitability. However, filling material shall have Liquid limit between 20-35 and Plasticity index shall not be more than 12.



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4.3 UNSUITABLE MATERIAL

The following type of material will be considered unsuitable for filling:

1. Material with vegetation and shrubs
2. Material in frozen condition or susceptible to combustion
3. Material resulting in leaching of embankment.
4. Any material which classifies as CH, OH, OL, LI as per IS: 1498
5. Material with swelling index more than 50.

4.4 GENERAL SITE PREPARATION

4.4.1 CLEARING

The Plot area shall be cleared of all materials above or at the natural ground surface. Materials to be cleared include trees, bushes, vegetation, and obstructions. However, in certain specified areas like green belts, trees and bushes shall be retained and preserved.

4.4.2 GRUBBING

The entire area within the limits of clearing shall have all stumps and roots removed.

4.4.3 STRIPPING

All turf and topsoil shall be stripped from the natural ground level upto 250 mm below NGL and if the black cotton soil found then the same shall be removed upto 500 mm or as directed by the Owner/Owner's Representative.

4.4.4 DISPOSAL

Debris from clearing operations shall be burned or disposed off in a manner approved by Owner/Owner's Representative. Material too wet to burn shall be piled in windrows for later burning. Material from grubbing operations shall be removed to the designated spoils disposal areas.

4.4.5 GROUND MARKERS

A suitable number of permanent ground markers, shall be constructed before any setting-out work is commenced. Temporary Reference Monuments shall be constructed when and where required, as approved by the Owner/Owner's Representative.

5.0 BULK EXCAVATION

Excavations and cut and fill areas shall be kept free of water by pumping, temporary ditches or other approved means. The surface of cut and fill shall be sloped to prevent ponding. Excavation shall be performed to the lines and levels shown on the drawings.



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Slope of cuttings and embankments shall be as shown on the drawings. Excavation beyond the limits shown on the drawings shall be replaced with approved material, compacted in accordance with this Specification.

All excavated material shall be separately stockpiled for re-use or taken to the designated storage area, as directed by the Owner/Owner's Representative. Where cut areas have been reduced to level; any unsuitable material apparent at the surface shall be separately excavated and the resulting pockets filled with suitable material and compacted in accordance with this Specification. In case of blasting of rock, Contractor shall prepare and submit a comprehensive procedure to the Owner/Owner's Representative for approval. The blasting in rock shall only be carried out with the prior written approval of, and under the supervision of a certified Blasting Engineer. All local regulations shall be complied with. Adequate safety precautions shall be carried out by means of Timber Shoring, Sheet Piling or similar protective measures as directed by the Owner/Owner's Representative, to ensure the safety of existing structures, utility and other installations in accordance with IS 3764.

If in-situ material at specified foundation depth does not meet the bearing capacity requirements, it shall be removed to the depth as directed and filled with approved material and method.

6.0 FILL

6.1 PREPARATION FOR FILL

Only approved suitable material from excavation/stockpiles or approved borrow pit soil shall be used, as described in Clause 4.2.2. The proposed methods to be used in fill operations for the compaction of material shall be approved prior to starting of work. Before filling commences the area shall be proof rolled with at least four passes of a 10-ton vibratory roller.

6.2 PLACEMENT OF FILL

The Contractor shall at least 7 days before commencement of placement submit the following to the Owner/Owner's Representative:

The dry density of fill material against moisture content plot and values of maximum dry density and the optimum moisture content obtained in accordance with IS 2720 (Part 7) using the light compaction method.

Proposed method of placing the fill in maximum lifts of 200 mm to achieve the requirement of 95% maximum dry density as determined from the above information. The maximum thickness for placing fill material layer in large areas shall be maximum 300 mm and is determined by field tests and governed by type of compaction equipment.

Once the above information is approved by the Owner/Owner's Representative, it shall form the basis for compaction. Fill shall be compacted to at least 95% of the maximum dry density. Places inaccessible to rollers shall be compacted with mechanical/plate compactor or hand tampers.



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Plant areas within the primary roads and paved areas which do not contain equipment or buildings shall after completion of cut, fill, compaction, and final grading be proof rolled with at least four passes of a 10 ton vibratory roller. Field density tests are not required.

Field density test (sand replacement) at bottoms of excavations for individual foundations shall be carried out at the rate of 1 per foundation or every 10 sq. m of foundation on plan whichever is the greater. The final requirement of these tests to suit strata conditions shall be determined by the Field Engineer.

In areas to be paved, the sub-grade will normally be graded to the under side of paving level, but in predominantly fill areas the filling operation may be temporarily halted, at an agreed lower level, until after the construction of equipment foundations.

6.3 BROKEN ROCK FILL

Sound clean broken rock to a maximum size of 150 mm may be used as fill material subject to the approval of the Owner/Owner's Representative. All voids are to be filled with approved fine material.

The rock material shall be spread in layers not exceeding 400mm compacted thickness and shall be compacted by a minimum of 5 passes of a vibratory roller having a static weight 8-10 tonnes and until there are no signs of deformation.

7.0 TOLERANCES

The grade shall be properly shaped to the required elevations and parallel to the required surface. The elevation of any point and the line of any edge or centre of the earthworks shall conform to that shown on the drawing within the tolerances of ± 50 mm to final grade and slopes.

8.0 EMBANKMENTS

Embankments shall be formed of suitable material as described in Clause 4.2.4. The material shall be built up evenly over the full width of the embankment. The surface shall be maintained, at all times, with sufficient camber to enable surface water to drain off.

9.0 EARTHWORK FOR FOUNDATIONS

9.1 EXCAVATION FOR FOUNDATIONS

Excavation shall be generally performed in accordance with Clause 5.0.

9.2 PREPARATION

The bottom of any excavation ready to receive the permanent works shall be mechanically compacted using a vibrating plate or suitable sized roller and any soft spots or pockets of unsuitable material exposed, shall be excavated and replaced as approved by Owner/Owner's Representative.



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Precautions shall be taken to protect the bottom of the excavation, and should the bottom of the excavated material become unsuitable, either by exposure to weather conditions, water, or due to lapse of time between excavation and subsequent works, it shall be removed and replaced.

9.3 INSPECTION

When the bottom of any excavation is prepared, further work shall not proceed until the excavated bearing surface is approved.

9.4 PROTECTION

Following completion of the excavation, and preparation of the bottom of the excavation to receive the permanent works, and once approval has been given, the blinding concrete, polythene membrane or such other protection as may be called for on the drawings shall be immediately applied.

10.0 BACKFILLING

Backfilling of all foundations/trenches shall not be carried out until the foundations or structures within the excavation have been approved and approval to commence backfill has been given. The backfill material shall normally be the material excavated from the pit or trench. Boulders, lumps of concrete and other foreign matter shall be excluded. The backfill shall be placed and compacted evenly around the structure in layers not exceeding 200 mm and to 95% maximum dry density as determined under Clause 6.2 above. Mechanical compaction shall be used wherever possible and accordingly the thickness of layers adjusted. Care shall be taken during backfill operations to prevent damage to the permanent works. Compacting within 1 m of existing structures shall be performed by hand operated compactors. In particular damage to waterproof membranes/cables etc. shall be repaired before backfilling is continued. Planking, strutting, trench sheets and other supports in excavations shall be removed as backfilling proceeds to maintain the stability of the side until backfill is completed. Temporary supports shall not be left in the ground.

Areas of settlement or areas of fill that do not comply with the required tolerances shall be investigated to determine the extent of non-conformance. Soft spots shall be excavated to remove all unsuitable material, which shall be replaced with suitable material and re-compacted to the required density. High spots shall be scarified and excess material removed as necessary, the area shall then be re-compacted to the required density.

11.0 ACCEPTANCE CRITERIA

The SITE CLEARING, AREA GRADING, EXCAVATION AND EARTHWORK shall fulfill the above said criteria unless otherwise mentioned.

12.0 PAYMENT

All payments shall be made as per SOR basis.



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PART-II: TECHNICAL SPECIFICATION FOR STRUCTURAL CONCRETE

1.0 SCOPE

This Specification covers the general requirement for plain and reinforced concrete to be used as in-situ and pre-cast concrete. It covers:

- Materials for batching, mixing, transporting, placing, curing, protecting, repairing, finishing and testing of concrete.
- Materials for & construction of, all formwork for cast in-situ concrete.
- Materials for & the bending & fixing of, steel reinforcement for concrete.
- The finishing of formed & unformed surfaces of concrete.
- The casting, handling & placing of pre-cast concrete units.
- Material for & the use or application of, mortars, grout & rendering.

2.0 REFERENCE DOCUMENTS

IS-SP23	Handbook on Concrete Mixes
IS-269	Sand Cement Dry Pack Grout
IS-280	Binding Wire
IS-383	Coarse and fine aggregates from natural sources for concrete
IS-432 (Part 1 & 2)	Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement
IS-455	Portland slag cement
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-1343	Code of practice for prestressed concrete
IS-1489 (Part 1 & 2)	Portland pozzolana cement
IS-1786	High strength deformed steel bars and wires for concrete reinforcement
IS-1791	Batch type concrete mixers
IS-2386 (Part 1 to 8)	Methods of test for aggregates for concrete
IS-2502	Code of practice for bending and fixing of bars for concrete reinforcement
IS 2645	Specification for integral cement water proofing compounds
IS 3025	Method of sampling and testing water
IS-3085	Method of test for permeability of cement mortar and concrete
IS-3096	Safety Code for scaffolds and ladders



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IS-3370 (Part 1 to 4)	Code of practice for concrete structures for the storage of liquids
IS 3812	Specification for fly ash for use as pozzolana and admixture
IS-4082	Recommendation on staking and storage of construction materials at site
IS-4926	Ready mixed concrete
IS-5525	Recommendations for detailing of reinforcement in reinforced concrete works
IS-5816	Method of test for splitting tensile strength of concrete cylinders
IS-6461 (Part 2 to 12)	Glossary of terms relating to cement concrete
IS-7861 (Part 1 & 2)	Code of practice for extreme weather concreting
IS-8041	Rapid hardening Portland cement
IS-8112	43 Grade ordinary Portland cement
IS-12269	53 grade ordinary Portland cement
IS 8142	Method of test for determining setting time of concrete by penetration resistance
IS-9013	Method of making, curing and determining compressive strength of accelerated cured concrete test specimens
IS-9103	Admixtures for concrete

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 MATERIAL

4.1 CEMENTS

The following cement types shall be used:

- Grade 43 OPC to IS 8112.
- Grade 53 OPC to IS 12269.
- Factory blended Portland Pozzolana Cement (PPC) contain fly ash grade 1 to IS 3812.
- Rapid hardening Portland cement to IS 8041.
- Sulphate resisting cement to IS 12330.



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- Cement with pulverized fuel ash.

Note: Cement delivered hot from the factory shall not be used until its temperature is below 35 C.

4.1.1 TESTS AND ANALYSIS

Manufacturer's certificates shall be provided confirming that cement delivered to the site has been tested and found to comply with the requirements of the appropriate Standard. If the same is not available the sample shall be sent to Lab for test and for every 100 MT test to be carried out. If a subsequent test on any consignment of cement shows it does not comply with Specification requirements, then the whole consignment shall be removed immediately from the site.

Access to the cement store shall be provided during working hours for the purpose of sampling the cement for further testing.

4.1.2 CEMENT STORE

Cement shall be kept at all times in covered storage in an approved manner.

No cement shall be kept on the site longer than three months before use. Any cement, which is stored on site in excess of 90 days, shall be tested in accordance with relevant Indian Standard prior to use. Sufficient cement for one week's consumption shall be available at all times. Cement shall be used in the sequence in which it is delivered.

The cement store for bagged cement shall be a weatherproof building or shed, ventilated, lit and free of dampness. The size will be sufficient to hold enough cement for continuous execution of the works. Bags for cement shall be lined in polythene or other damp-proof material. If cement in bulk is to be used, prior approval must be obtained.

4.2 AGGREGATES

4.2.1 GENERAL

All 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.

In general, coarse aggregate shall be max. 20 mm. However, this may be increased to a maximum of 40mm for certain structures/foundations, as shown on the drawings or directed by the Owner/Owner's Representative.



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4.2.2 SAMPLING AND TESTING

Sampling and testing of aggregates shall be carried out in accordance with IS 2386. If adequate laboratory facilities do not exist on site, samples must be sent to a convenient approved testing laboratory. Samples of fine and coarse aggregate shall be sent in suitable airtight containers. Chlorides and other contents in the coarse aggregates and fine aggregates shall be limited as follows:

4.2.2.1 COURSE AGGREGATES

Chlorides as CL 0.03% Max.

Sulphates as SO_3 0.40% Max.

4.2.2.2 FINE AGGREGATES

Chlorides as CL 0.06% Max.

Sulphates as SO_3 0.40% Max.

Any aggregates that do not meet the requirements of the relevant standards shall not be used in the works.

4.2.3 STORAGE

Sufficient quantities of each type of aggregate shall be maintained on site at all times to ensure continuity of work.

Each type and grading of aggregate shall be stored separately in such a manner that mixing of the various size particles shall not occur. The floors of the storage areas at the batching plants shall be of concrete or other approved material, and shall be sloped sufficiently to ensure adequate drainage of surplus water.

A random check for dust contamination in the stock pile shall be carried prior to loading the batch plant bins with aggregates.

As a minimum, aggregate storage shall satisfy the requirements of IS 4082.

4.3 WATER

Water used for the following shall be free of dirt, chemicals organic materials and litter in suspension conforming to IS 456 clause 4.3 and tested to IS 3025:

4.4 ADMIXTURES

4.4.1 GENERAL

Admixtures conforming to IS 9103 may be used subject to approval. In no circumstances shall admixtures containing chlorides or other corrosive agents be allowed. No air entraining agents



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shall be used without prior trials and approval. Sample of packed admixtures shall be obtained as per IS 3535. The Contractor shall prove compatibility with the type of cement used.

4.4.2 SUPER PLASTICIZERS

In hot weather, after trials and approval, a naphthalene sulphate retarding super plasticizer can be used to increase workability of the concrete and retard the initial set. The concrete mix with plasticizer shall comply with IS 1199 and IS 8142 respectively. The plasticizer shall be of approved brands. Confirmation shall be obtained that the super plasticizer is compatible with any Pozzolana, which is used.

5.0 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.

5.1 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 produced 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 3.5N/mm^2 shall be used as a basis for designing a mix.



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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.

TABLE OF CONCRETE MIXES			
Concrete Grade	Minimum Qty of cement Kg/m ³	Maximum free water-cement ratio	Characteristics strength 150 mm Cube
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:

- Concrete containing 40 mm max. size aggregate 4.0%±1.0%
- Concrete containing 20 mm max. size aggregate 5.0%±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 N/mm² at 28 days.

5.1.1 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.

5.1.1.1 TRIAL MIXES

5.1.1.2 STRUCTURAL CONCRETE

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



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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.

Maximum Water Cement Ratio in Cement Concrete to Ensure Durability under specified exposure		
Condition of Exposure	Concrete	
	Plain	Reinforced
Mild	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		
Moderate	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		
Severe	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



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Minimum Cement Content (Ref IS 456, Table 5)		
Plain Concrete		
Exposure	Min. Grade of Concrete	Min. Cement Content (kg/m³)
Mild	-	220
Moderate	M15	240
Severe	M20	250
Very Severe	M20	260
Extreme	M25	280
Reinforced Concrete		
Exposure	Min. Grade of Concrete	Min. Cement Content (kg/m³)
Mild	M20	300
Moderate	M25	300
Severe	M30	320
Very Severe	M35	340
Extreme	M40	360

5.1.2 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/m³ 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

5.2 BATCHING

In proportioning concrete, the quantity of both cement and aggregate shall be determined by weight. In case uniformity of aggregate has been established over a period of time. 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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6.0 FORMWORK

6.1 GENERAL

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.

6.2 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.

6.3 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:



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Walls, Columns and vertical faces of all structural members	24 to 48 hours as may be decided by the Engineer
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 deshuttering, the bolts will be removed to loosen the shuttering plates. The depression will be sealed using suitable concrete sealant.

6.4 SURFACE FINISHES FROM FORMWORK

Generally formwork shall be specified as either wrought or unwrought depending on the required surface finish.

6.5 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.

6.6 WROUGHT FORMWORK



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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.

Concrete containing honeycombing, major air holes or similar defects shall be cut out and replaced as directed. No repair shall be executed without approval.

6.7 TIES

Where it is required to use internal ties and spacers, their type, spacing and use 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.

6.8 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 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.

6.9 FORMWORK FOR VIBRATED CONCRETE



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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.

6.10 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.

7.0 CONSTRUCTION JOINTS

7.1 GENERAL

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 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 close 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.

7.2 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.



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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.

7.3 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.

7.4 JOINT FILLERS

Joint fillers and sealing compounds shall comply to IS 1834, IS 1838 and IS 11433.

8.0 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.

8.1 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.

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.

8.2 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



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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.

8.3 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.

8.4 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.

8.5 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.

8.6 TOLERANCES ON PLACING

Reinforcement shall be placed within the following tolerances:

For effective depth 200 mm or less + 10 mm

For effective depth more than 200 mm + 15 mm.

8.7 TYING OF REINFORCEMENT



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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.

9.0 TRANSPORTING, PLACING, COMPACTING AND CURING OF CONCRETE

9.1 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.

9.2 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. Immediately before concrete placement, surfaces of previously placed concrete, which shall be in contact with the concrete to be placed, shall be covered with a bonding mortar grout. 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.



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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.

9.3 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.

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/ m² in 72 hours. Curing compound shall be used where conventional curing by water cannot be accomplished, following approval of construction manager.

10.0 PROTECTIVE COATINGS

The protective coating for underground and over ground structures will be decided on case-to-case basis based on duty conditions and the importance of the structure and the same shall be described in detail in the project specific specification and drawings. In general, method 'A' or 'B' shall be followed.

METHOD A

Concrete shall be cast or placed onto polythene sheeting 1000 gauge laid over the concrete blinding. Overlap shall be 150 mm and the sheeting shall extend 150 mm beyond the edge of



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all foundations. Approved membranes are 'Visqueen' by I.C.I. Plastics or 'Duraplane' by British Cellophane Ltd. or approved equal.

Surfaces below ground level shall be coated with two coats of a proprietary combined curing compound and damp proof membrane (DPM).

A square scrape master sample shall be taken to determine the weight of specified thickness of coating from a 300 mm x 300 mm patch. The weight can then be compared with test samples. Concrete shall also be wrapped in 1000 gauge polythene sheeting.

Backfill material shall be select fill material so as to avoid damage to protective coatings. Exposed external concrete surfaces for a depth of 150 mm below ground level and 300 mm above, or to the underside of base plate, whichever is the lowest, shall be primed with a low viscosity primer and coated with two coats of a light grey colored epoxy paint with a minimum thickness of 125 microns per coat. This will protect the concrete in the splash zone against ingress of aggressive salts. Application trials shall be carried out on the chosen coating. Concrete surface preparation and application shall be strictly in accordance with the Manufacturer's recommendations.

METHOD B

Concrete shall be cast or placed onto polythene sheeting 1000 gauge laid over the concrete blinding. Overlap shall be 150 mm and the sheeting shall extend 150 mm beyond the edge of all foundations. Approved membranes are "Visqueen" by I.C.I plastics or "Duraplane" by British Cellophane Ltd. or approved equal.

After the foundations have been painted as specified below the 150 mm extension shall be folded up flush with the sides of foundations.

Surfaces below ground level shall be coated with 3 coats of modified bitumen to give a total coat thickness of 1mm. A square scrape master sample shall be taken to determine the weight of specified thickness of coating from a 300 mm x 300 mm patch. The weight can then be compared with test samples.

Backfill material shall be select fill material so as to avoid damage to protective coatings. Exposed external concrete surfaces for a depth of 150mm below ground level and 300mm above, or to the underside of base plate, whichever is the lowest, shall be primed with a low viscosity primer and coated with two coats of a light grey colored epoxy paint with a minimum thickness of 125 microns per coat. This will protect the concrete in the splash zone against ingress of aggressive salts. Application trials shall be carried out on the chosen coating. Concrete surface preparation and application shall be strictly in accordance with the Manufacturer's recommendations. Where saline water has been used to compact site fill surface protection for concrete below ground level shall be as per Method A except that wrapping with 1000-gauge polythene can be omitted.

Where fresh water has been used to compact site fill no applied protection is required.



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10.1 EXTERNAL SURFACES EXPOSED TO SALINE WATERS

Details shall be specified on construction drawings.

11.0 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.

11.1 PLACING CONCRETE WITHIN THE TIDAL RANGE

When concreting is to be carried out under tidal conditions the CONTRACTOR shall ensure that concrete is placed and compacted before the seawater rises to the level of the concrete so placed.

No concrete shall be disturbed after salt water has made contact with it. The top surface of the concrete shall be covered after the initial set has taken place, to protect it against water action if there is any risk of this occurring.

The CONTRACTOR shall submit to the CONSTRUCTION MANAGER for approval details of the proposed method for complying with these requirements.

11.2 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%.



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12.0 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.

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.

13.0 OPTIONAL TESTS

If the Engineer feels that the materials, i.e. cement, aggregates, reinforcement, and water, are not in accordance with specification or if specified concrete strengths are not obtained, he may order tests to be carried out on these materials in an approved laboratory as per relevant IS



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codes. The Contractor shall not be required to bear the costs of such tests unless they reveal defective material workmanship. If the works cubes do not give the stipulated strengths, the Engineer reserves the right to ask the Contractor to dismantle and reconstruct such unacceptable work at the Contractor's cost. In such a case, any other tests such as load tests, taking out concrete cores and tests on cores, sonic testing etc shall be carried out by the Contractor if directed by the Engineer. The Contractor shall carry out all such tests at his own cost.

14.0 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.

15.0 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.

16.0 SPECIAL REQUIREMENTS FOR LIQUID RETAINING

16.1 STRUCTURES

To ensure that strength, durability and impermeability will be adequate for liquid retaining structures; the minimum cement content shall be 330 kg/m³. A maximum water/cement ratio of 0.45 shall be used. For reinforced concrete the cement content shall not exceed 400 kg/m³ when ordinary Portland cement is used.

In general, external type PVC water bars, minimum 230 mm wide, are preferred and shall be incorporated where suitable in all construction and expansion joints as shown on the drawings. Intersection pieces shall be factory made. Only butt jointing of identical sections shall be carried out on site, strictly in accordance with manufactures specifications. Care shall be taken at all times to ensure that water bars are not perforated or damaged in any way, concrete shall be carefully placed and compacted to ensure dense impervious concrete. Particular attention shall be paid to the placing and vibration of the concrete to ensure well-compacted concrete around the ribs of the water bars. At all joints the concrete shall be placed up to the centre line of the water bar.

16.2 TESTING OF LIQUID RETAINING STRUCTURES

For a test of liquid retention, the structure shall be cleaned and initially filled to the normal level with the specified liquid (usually water) at a uniform rate of not greater than 2 m in 24h. When first filled, the liquid level shall be maintained by the addition of further liquid for a stabilizing period of seven days. After the stabilizing period the level of the liquid surface shall be recorded at 24h intervals for a test period of 7 days. During this 7 day test period, the total permissible drop in level, after allowing for evaporation, shall not exceed 40 mm.



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Notwithstanding the satisfactory completion of the test, any evidence of seepage of the liquid at the outside face of the liquid retaining walls shall be given remedial treatment from the liquid face. Should the structure not satisfy the 7 day test, then after completion of the remedial work, it shall be retested.

16.3 TESTING OF ROOF

The roof of liquid retaining structures shall be watertight and shall be tested on completion by flooding the roof with water to a minimum depth of 25 mm for 24 hours or longer. The roof shall be considered satisfactory, if no leaks or damp patches show on the soffit. Should the structure not satisfy the test, remedial work shall be carried out after obtaining the Engineer's approval. After completion of the remedial work it shall be retested in accordance with this clause. Waterproofing to the roof shall be completed as soon as possible after satisfactory testing.

17.0 PLUM CONCRETE

Stone aggregate of size up to 300-mm cube, but less than 1/3 of the least dimension to be concreted, called plums, shall not exceed 20% of total volume of finished concrete, and they shall be well dispersed throughout the mass. This shall be achieved by placing a layer of normal concrete, then spreading the plums, followed by another layer of concrete and so on. Each layer shall be of such thickness as to ensure at least 100 mm of concrete around each plum. Care must be taken to ensure that no air is trapped underneath the stones and that the concrete does not work away from their underside. The plums must have no adhesive coating.

18.0 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 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.

19.0 INITIAL SETTING TIME

The initial setting time shall be not less than % 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.



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20.0 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.

21.0 PRECAST CONCRETE

21.1 GENERAL

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.

21.2 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.

21.3 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.

21.4 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.

21.5 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 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



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rapid hardening cement is used. No methods of accelerated curing shall be used without prior approval.

21.6 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.

21.7 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.

22.0 GROUTING

22.1 GENERAL

- 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 grout 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.

22.2 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.

22.3 GROUT TYPES

SAND CEMENT DRY PACK AND ORDINARY MORTAR GROUT

- Cement shall be Portland cement and shall conform to the requirements of IS 269.



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- 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/mm² at 7 days.

NON-SHRINK CEMENT BASED GROUT

- 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/mm² 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/mm² at 7 days.

22.4 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 in 1 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.

22.5 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.

22.6 SURFACE PREPARATION



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- 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.

22.7 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.
- 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.

22.8 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.

22.9 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.



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- 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.

22.10 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 grout shall be maintained between 4°C and 32 °C during grouting and for a minimum of 24 hours thereafter.

22.11 Testing

Field-testing of non-shrink grouts shall be as directed by Construction Manager. Contractor shall be responsible for preparing, storage, curing and transporting the test samples to a laboratory for testing, as required by Construction Manager.

23.0 ACCEPTANCE CRITERIA

The STRUCTURAL CONCRETE shall fulfill the above said criteria unless otherwise mentioned.

24.0 PAYMENT

All payments shall be made as per SOR basis.



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PART-III: TECHNICAL SPECIFICATION FOR STRUCTURAL STEEL

1.0 SCOPE

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 REFERENCE DOCUMENTS

IS 800	Code of Practice for General Construction in Steel
IS 801	Code of Practice for use of Cold Formed Light Gauge Steel Structural Members in General Building Construction
IS-806	Code of Practice for use of Steel Tubes in General Building Construction
IS 808	Dimensions for Hot Rolled Steel Beam, Column, Channel and Angle Sections
IS 814	Covered Electrodes for Manual Arc Welding of Carbon and Carbon Manganese Steel - Specification
IS 816	Code of Practice for Use of Metal Arc Welding for General Construction in Mild Steel
IS 817	Code of Practice for Training and Testing of Metal arc Welders
IS 817	(Part 1) Manual arc welding
IS 822	Code of Practice for Inspection of Welds
IS 919	(Part 1) Recommendation for limits and fits for engineering.
IS 1161	Steel tubes for Structural purposes.
IS 1182	Recommended practice for radiographic examination of fusion welded butt joints in steel plates
IS 1363	Specification for Hexagon head bolts, screws and nuts of product Grade C (Parts 1 to 3)
IS 1367	(All Parts) Technical supply of Threaded Steel Fasteners



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IS 1395	Specification for Low and Medium Alloy Steel Covered Electrodes for Manual Metal Arc Welding
IS 1852	Rolling and cutting tolerances for hot rolled steel products
IS 1977	Specification for Structural Steel (Ordinary Quality)
IS 2062	Steel for General Structural Purposes - Specification
IS 2074	Ready mixed paint, red oxide, zinc chromate priming.
IS 3658	Code of Practice for Liquid Penetrant Flaw Detection (DPI)
IS 3757	Specification for High Strength Structural Bolts
IS 4000	High Strength Bolts in Steel Structures - Code of Practice
IS 4260	Ultrasonic Testing of weld in ferritic steel.
IS 4759	Hot-dip zinc coatings on structural steel and other allied products
IS 4923	Hollow Steel Sections for Structural Use.
IS 5334	Code of Practice for magnetic practice flaw detection of welds
IS 5372	Taper Washers for channels
IS 5374	Taper Washers for I beams
IS 6610	Heavy Washers for Steel Structures
IS 6623	High Strength Structural Nuts
IS 6419	Specification for Welding Rods and Bare Electrodes for Gas Shielded Arc Welding of Structural Steels.
IS 6639	Specification for Hexagon Bolts for Steel Structures.
IS 6649	Hardened & tempered washers for high strength structural bolts and nuts
IS 7205	Safety code for erection of structural steelwork
IS 7215	Tolerances for fabrication of steel structures.



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IS 7307 (Part 1)	Approval Tests for Welding Procedures
IS 7310 (Part 1)	Approval Tests for welders working to approved Welding Procedure
IS 8500	Structural steel Micro alloyed.
IS 9595	Recommendation for Metal arc welding of Carbon and Carbon Manganese Steels
IS 12843	Tolerances for erection of steel structures.
BS 3692	ISO metric precision hexagon bolts, screws and nuts. Specification
BS 4921	sherardised coatings on Iron and Steel
BS 5289	Visual Inspection of Fusion Welded Joints

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 MATERIALS

4.1 GENERAL

- 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.

4.2 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.



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- 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 4923. Steel Tubes shall conform to IS 1161.

4.3 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
- 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 sherardised in accordance with BS 4921.

4.4 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.

4.5 STEEL GRATING AND STAIR TREADS

Steel grating and stair treads shall be open grid rectangular pattern complying with Standard drawings.

5.0 CONNECTION DESIGN AND FABRICATION DRAWINGS



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5.1 GENERAL

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.

5.2 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 the 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.

6.0 FABRICATION

6.1 GENERAL

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 20mm, 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 jigged. 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.



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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.

6.2 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.

6.3 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.

6.4 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.

6.5 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.



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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.

6.6 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.

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.

6.7 JOINTS IN COMPRESSION

Abutting surfaces dependent on contact for the transmission of load shall be within the specified tolerances.

6.8 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



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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.

7.0 ERECTION

7.1 GENERAL

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.

7.2 WELDING



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7.2.1 GENERAL

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.

7.2.2 PREPARATION OF MEMBER FOR WELDING

7.2.2.1 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.

7.2.2.2 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.

7.2.2.3 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.



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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.

7.2.2.4 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.

7.2.3 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.

7.2.4 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.



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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

7.3 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 cased shall be unpainted and maintained in a clean condition and free from loose rust, oil, loose scale and other deleterious matter. 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:

- bolts with grade 4 nuts (IS-1363, IS-1367/BS 4190)
- 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 diameter shall not be used in the same structure, except for holding down bolts.



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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	Torque to be Applied (Nm) For Bolt Class 8.8 of IS 3757
M20	476
M24	822
M30	1630
M35	2850

7.4 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.

7.5 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.

7.6 ALIGNMENT



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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.

7.7 CLEARING Away

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.

7.8 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.

8.0 INSPECTION

8.1 GENERAL

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.

8.2 TESTS ON WELDING

The Contractor shall carry out the following non-destructive testing of welds at his own cost in the presence of the Engineer's Inspector:

BUTT WELDS

Radiographic tests shall be carried out in accordance with IS 1182 or as appropriate, or ultrasonic tests in accordance with IS 4260 on a random 10% of the welds. Welds shall be accepted as satisfactory if the defects are within the limits stated in IS 7310.

FILLET WELDS



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Liquid penetrant tests shall be carried out in accordance with IS 3658 or magnetic particle tests in accordance with IS 5334 on a random 5% of the welds. Welds shall be accepted as satisfactory the defects are within the limits stated in IS 7310.

If the results of the weld tests are unsatisfactory, the defective welds shall be repaired by methods approved by the Engineer-In-Charge. All repaired welds shall be re-tested.

For each weld which is judged to be unsatisfactory a further test shall be carried out on a different randomly selected weld.

In addition to the tests specified above the Contractor shall carry out such further tests as may be required by the Engineer-In-Charge.

8.3 SCOPE AND FREQUENCY OF INSPECTION

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 on the following, and where called for on the design drawings:

- Fillet welds with throat thickness greater than 15 mm, shall be MPI tested.
- Fillet welds where the connecting material is greater than 20 mm, shall be MPI tested.
- Butt-welds where the connecting material is less than 20 mm, shall be DPI tested.
- Butt-welds where the connecting material is greater than 20 mm, shall be ultrasonically tested. Non-destructive testing shall be carried out for the first ten identified joints of each type, having the same basic dimensions, material grade and weld geometry, welded to the same procedures.

Thereafter one in ten joints of each type shall be tested.

Where welding is used during erection, random testing of welds by MPI/DPI shall be carried out at the discretion of the Site Engineer.

The acceptance criteria for any welding shall be in accordance with IS 9595 or BS 5135 Category A.

9.0 TOLERANCES

9.1 GENERAL

Structural steel work shall be fabricated, and erected within the tolerances specified in IS 7215 and IS 12843 with the exception of those items specified below.

9.2 PERMISSIBLE DEVIATIONS

The erection of steel framed structures shall be controlled in such a way that the following Permissible Deviations (PD) for the completed structure are not exceeded.



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9.1.1.1	Position	
Item		P.D
a)	Permissible deviation between designed and actual position of any erected column at Base	± 8
b)	Permissible deviation between designed and actual position of any erected column at Base	
	10m Centres	± 10
	20m Centres	± 15
	50m Centres	± 25
	100m Centres and Over	± 40
9.1.1.2	Plumb	
Unless otherwise specified, the level of a beam shall be taken as the top of the upper flange		
a)	Permissible deviation between designed and actual levels of the base of any column to erected	± 3
b)	Permissible deviation between designed and actual levels of any beam at the junction with the column	±5
	When the beam is up to 6m from grade	±5
	When the beam is above 6m and upto 10m grade	±8
	When the beam is above 10m from grade	±12
c)	Notwithstanding the above the maximum difference between the levels at the ends of a beam shall be:	±5
	For length of beam up to 6m between column centres	±4
	For length of beam up to 6m and up to 10m between column centres	±6
	For length of beam above 10m Between column centres	±8

10.0 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.

11.0 RECOMMENDED SEQUENCE OF ERECTION PROCEDURE FOR ROOF TRUSS

Columns shall be bolted firm on the foundation, if they are in structural.

Erection of truss shall start from one of gable ends



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After erection of gable truss, secure the gable truss in position by holding down bolts and tie it up with guy ropes two on either side of the truss. Guy ropes shall not be tied to the building columns, but to separate anchors driven firm into the ground. Erect the next truss adjacent to gable and secure it well with the gable truss through purlins before releasing the truss from erection tackles.

Secure rafter and tie level horizontal bracings, tie runners where these are provided before erecting the next trust.

Erect the next truss only after securing gable truss and the adjacent truss. Continue this procedure for all successive trusses.

12.0 PAINTING

12.1 GENERAL

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.

12.2 TOUCH-UP PAINTING

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.

13.0 HOLDING DOWN BOLTS

Bolts shall be turned from M.S. rounds conforming to IS 2062 and IS 432 grade 1.

Nuts and washers shall conform to IS 1363 and IS 3138.

Threading shall be coarse conforming to IS 1367 and IS 4218 Sleeves shall be M.S. Tubes - medium to IS 1239

For projection of bolt, property class and other relevant details reference design drawing shall be followed.

14.0 ACCEPTANCE CRITERIA



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The STRUCTURAL STEEL WORK shall fulfill the above said criteria unless otherwise mentioned.

15.0 PAYMENT

All payments shall be made as per SOR basis.

	<h2>FIELD QUALITY ASSURANCE PLAN</h2>
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FIELD QUALITY ASSURANCE PLAN

The contractor shall carry out the following minimum testes, unless otherwise mentioned and as directed by the Engineer-in-charge at his own expense. The Engineer-in-charge reserves the right to ask the contractor to carry out any further tests on the materials which is being used in the project.

Based on the guidelines mentioned in this clause, Contractor to provide detailed FQAP for approval of OWNER/PMC.

For particle size test, it is recommended that the set of sieves and weighing machines be arranged by the contractor at site. Necessary qualified manpower for conduction of the tests also to be arranged by the contractor.

For crushing strength of concrete, it is recommended that the contractor arrange the compression testing machine at the site along with the calibration certificate for gauge.

In case, if any of the machine comes to repairs and tests could not be carried out at the site, contractor shall arrange to transport the material to an approved laboratory to carry out the tests. All transports and labour costs also are to be borne by contractor.

The Tests listed in QAP are minimum requirement. Contractor shall provide a field quality assurance plan with formats for record of test results for all the works considering requirements of this specification and other relevant specification document/IS Codes. Field Quality Plan approved by OWNER/PMC shall be followed for all the works under scope of the tender. Cost of all tests shall be borne by the Contractor.

All tests shall be recorded in forms acceptable to the Engineer-In-Charge.

The contractor shall submit work procedure documents (step to step works activity) for each works and get it approved from OWNER/PMC prior to start any work. All works shall be carried out in sequential manner based on approves work procedure documents.



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1: Executed By: Contractor		P: Performer	H: Hold Point		MRIE: Material Receiving Inspection		W.O. NO.: Date:				
2: By PMC		W: Witness	RM/S: Random/ Surveillance		WPS: Welding Procedure		TS: Technical Specification				
3: By OWNER		R: Drawing	Drg: Drawing		PQR: Procedure Qualification Record		WQT: Welder Qualification Test				
Sl No.	Activity Description	Nature of Check	Method of check	Extent of Check	Ref. Document	Acceptance Standard	Format of Records	Inspection By			Remarks
								1	2	3	
1	Material for Civil Foundation (PVC Pipes, Pipe Fittings, Cement, Aggregates Water, Structural steel, Reinforcement steel etc.)	Visual, Dimensional, Marking verification and Review of MTC	Visual & Verification	100 %	P.O. Approved drawings / TS	Applicable material Spec. / Manufacturer TC	Raw Material Inspection Report	P	RR		
1a	Cement	Visual Inspection, Compressive Strength, Initial & Final Setting Time, Soundness, Fineness, Chemical Composition, Visual Storage Inspection	Submission of Manufacturers TC for each batch	100 %	P.O. Approved drawings / TS	IS 269 / 8112 / 12269 / IS 1489 / IS 455	Batch TC	P	R	R	
1b	Coarse Aggregates	Visual Inspection, Flakiness, Index, Sieve Analysis, Crushing	At the start of work & thereafter for	100 %	As per Tech. Spec. IS 383, IS 2386, IS 2340	As per Tech. Spec. IS 383, IS 2386, IS 2340 & Tech Spec.	Test Report	P	R	R	

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Sl No.	Activity Description	Nature of Check	Method of check	Extent of Check	Ref. Document	Acceptance Standard	Format of Records	Inspection By			Remarks
								1	2	3	
		Value Abrasion Value, Water Absorption, Soundness, Deteriorous Materials, Specific Gravity	every change of source, before mix design.		& Tech Spec.						
1c	Fine Aggregates	Sieve Analysis, Bulking of sand, Silt Content, Bulk Density Specific Gravity	Visual & Verification	Minimum twice a week / 40 M3 per source	IS 383, IS 2386, IS 2340 & Tech Spec.	IS 383, IS 2386, IS 2340 & Tech Spec.	Test Report	P	R	R	
1d	Water	Visual Inspection, Tet for presence of Acid, Alkali, Organic materials / salts, etc. & PH volume	Visual & Verification	Once in a month	IS CODE & TS	Limit No.: Less than 6	Test Report	P	R	R	PH value of water shall be within range of 6.5 to 9
1e	Reinforcement	Visual, Dimension	Visual &	100 %	P.O. Appr	Applicable material	Raw Material	P	R	R	

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Sl No.	Activity Description	Nature of Check	Method of check	Extent of Check	Ref. Document	Acceptance Standard	Format of Records	Inspect ion By			Remarks
								1	2	3	
	Steel	nal, Marking verification and review of MTC	Verifi cation		oved drawi ngs / TS and IS 1786	Spec / Manufact urer TC	al Inspect ion Report				
1f	Laterite	Visual Inspection Compressive strength & physical dimensions Scaffolding Size of stone	Visual & Verifi cation	100 %	P.O. Appr oved drawi ngs / TS and IS 1786	Applicabl e material Spec / Manufact urer TC	Raw Materi al Inspect ion Report				
1g	Structural Steel	Visual, Dimensional, Marking verification and Review of MTC	Visual & Verifi cation	100 %	P.O. Appr oved drawi ngs / TS and IS 1786	Applicabl e material Spec / Manufact urer TC	Raw Materi al Inspect ion Report	P	R	R	
2	Earth work										
2a	Earth Work (Excavation)	Check Layout, pre & post level, dimension & depth, Side slope & other safety	Visual , Dimensional	100 %	As per site condition Tech. Spec / IS 3764	Approved Drawing, IS CODE & TS	-	P	V	R	

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Sl No.	Activity Description	Nature of Check	Method of check	Extent of Check	Ref. Document	Acceptance Standard	Format of Records	Inspection By			Remarks
								1	2	3	
		consideration									
2b	Earth Work (Filling)	Edge preparation, Optimum Moisture content, laboratory dry density, max. & min. dry density (for sand), Field dry density / compaction factor / relative density.	Visual, Dimensional	100 %	Tech. Spec. / IS 2720	Approved Drawing, IS CODE & TS	Test Report	P	V	R	
3	Form Work										
3a	Material	Visual, verification and review of MTC	Visual & Verification	100 %	P.O., Approved Drg / TS	Applicable material Spec / Manufacturer TC	Raw Material Inspection Report	P	R	R	
3b	Staging	Visual Inspection, Verticality of Props, Fixity of Props & bracing,	Visual & Verification	100 %	Appd. Procedure, TS/ Drawing	Appd. Procedure, TS/ Drawing	-	P	V	R	

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Sl No.	Activity Description	Nature of Check	Method of check	Extent of Check	Ref. Document	Acceptance Standard	Format of Records	Inspection By			Remarks
								1	2	3	
		Bearing area under props, Fixity of nails clamps, Bolts.									
3c	Shuttering	Visual Inspection for alignment, Verticality & Fixity of support, Level checking	Visual, Dimensional	100 %	Appd. Procedure, TS/ Drawing	Appd. Procedure, TS/ Drawing	Pour Card	P	R	R	
3d	De-Shuttering	Stripping time for bottom & side	Visual	100 %	Appd. Procedure, TS/ Drawing	Appd. Procedure, TS/ Drawing	Pour Card	P	R	R	
5	Reinforcement Work										
5a	Bar Bending	Visual Inspection Prepare & Check for Bending Schedule Linearity, shape, size & no.	Visual, Dimensional	100 %	Appd. Procedure, TS/ Drawing	Appd. Procedure, TS/ Drawing	Bar Bending Schedule	P	V	R	



FIELD QUALITY ASSURANCE PLAN

1: Executed By: Contractor		P: Performer	H: Hold Point		MRIE: Material Receiving Inspection		W.O. NO.: Date:				
2: By PMC		W: Witness	RM/S: Random/ Surveillance		WPS: Welding Procedure		TS: Technical Specification				
3: By OWNER		R: Drawing	Drg: Drawing		PQR: Procedure Qualification Record		WQT: Welder Qualification Test				
Sl No.	Activity Description	Nature of Check	Method of check	Extent of Check	Ref. Document	Acceptance Standard	Format of Records	Inspection By			Remarks
								1	2	3	
		of Bars									
5b	Bar Fixing	Size & Mix of cover block Location & no. of Bars Typing of Bars, Lapping	Visual , Dimensional	100 %	Appd . Procedure, TS/ Drawing	Appd. Procedure , TS/ Drawing	Bar Bending Schedule	p	V	R	
6	Concrete Work										
6a	Concrete Work (Other than Ready Mix)	Design Mix, Inspection of Ingredients	For each grade of mx initially from approved engineering college & thereafter trial mixes at site for any change in condition	100 %	IS 1026 2 / IS 456 / Tech. Spec.	Appd. Procedure , TS/ Drawing	Test Report	p	V	R	



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Sl No.	Activity Description	Nature of Check	Method of check	Extent of Check	Ref. Document	Acceptance Standard	Format of Records	Inspection By			Remarks
								1	2	3	
			and aggregate source								
6b	Concrete Work Ready Mix	Design Mix, Quality of Ingredients	Submission of manufacturers Mix Design & TC for each grade of Mix Submission of manufacturers Tests Reports	100 %	IS 10262 / IS 456 / Tech. Spec.	Appd. Procedure, TS/ Drawing	Mix Design Report	p	V	R	
6c	During Concreting	Scaffolding for walkway Calibration of Weigh Batcher/ batching plant Batching of	Visual & Verification	100 %	IS CODE / Tech Spec.	Appd. Procedure, TS/ Drawing	Cube Register / Pour card / Sketch, Calibration Certificate	p	V	R	

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Sl No.	Activity Description	Nature of Check	Method of check	Extent of Check	Ref. Document	Acceptance Standard	Format of Records	Inspection By			Remarks
								1	2	3	
		materials Slump Cone Tests Compaction Compressive strength test sample Level Checking Construction Joint, Specific gravity									
6d	Pot Concreting	Visual Inspection after De-Shuttering Calibration of cube testing machine (Pressure Gauge), Strength test	Visual & Verification	100 %	IS CODE / Tech Spec.	Appd. Procedure, TS/ Drawing	Cube Test Report	P	V	R	
7	Excavation										
7a	Excavation in Soil	Check layout, spot level	visual, Dimensional	100 %	IS CODE / Tech Spec.	Appd. Procedure, TS/ Drawing	Level Records	P	S	R	
7b	Filling	Visual	visual,	100	IS	Appd.	Test	P	S	R	

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Sl No.	Activity Description	Nature of Check	Method of check	Extent of Check	Ref. Document	Acceptance Standard	Format of Records	Inspection By			Remarks
								1	2	3	
	in Soil	inspection of filling materials Lab dry density OMC Grain size analysis / after berg limits, plasticity index and dry density Field dry density	Dimensional	%	COD E / Tech Spec.	Procedure, TS/ Drawing	Report				
8	Masonry										
8a	RR Masonry	Visual Inspection of stones Wetting of stones Cement mortar proportion Staging / Scaffolding Bond stones, quoins Thickness of Joints Plumb, line and level Raking	visual, Dimensional	100 %	IS CODE / Tech Spec.	Appd. Procedure, TS/ Drawing		P	R	R	

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Sl No.	Activity Description	Nature of Check	Method of check	Extent of Check	Ref. Document	Acceptance Standard	Format of Records	Inspection By			Remarks
								1	2	3	
		out Joints, Curing									
8b	Brick Masonry	Minimum average compressive strength	Tested in accordance with IS 3495	Samples of each type of brick as per IS 5454; not less than 1 in 5,000	IS 3495 (Part 1) IS 5454	As given in the code IS 3495 for a particular class of work	Test report	P	R	R	
		Water absorption		Samples of each type of brick as per IS 5454; not less than 1 in 5,000	IS 3495 (Part 2)	Shall not be more than 20% by its dry weight for class 5 brick when soaked in cold water for 24 hours. Refer code for other class.	Test report	P	R	R	
9	Pointing										
	Pointing	Raking &	Visual	100 %	IS COD	Appd. Procedure		P	R	R	

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Sl No.	Activity Description	Nature of Check	Method of check	Extent of Check	Ref. Document	Acceptance Standard	Format of Records	Inspection By			Remarks
								1	2	3	
		Cleaning, Washing of Joints, Cement Mortar Proportion Curing			E / Tech Spec.	, TS/ Drawing					
10	Sub-Base (WMM / WBM)										
10a	Coarse aggregates	Loss Angles, abrasion value or aggregate Impact value, Flakiness index. Grading requirement	Lab Field	Per 200 m3 Per 100 m3	IS2386 Spec	IS2386 Spec	Test report	P	R	R	
10b	Fine Aggregate	Deleterious Materials	Lab	As per EIC	IS2386 Spec	IS2386 Spec	Test report	P	R	R	

LEGEND: -

Hold: Do not proceed till inspectors clear the item / activities, H - HOLD

Witness: Intimation for inspection request to be given to inspector, wait for 24 hours or written clearance from inspector, whichever is earlier, (W-Witness)

Review: Job can be performed, Inspector to review relevant records (R-Review)

Inspection of bought out items at sub vendor's works shall be carried out by TPL as per approved QA plan for bought out items.

R/W - Review or Witness, Rm - Random witness, A- Approval.

Note:

	<h2>FIELD QUALITY ASSURANCE PLAN</h2>
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Sl No.	Activity Description	Nature of Check	Method of check	Extent of Check	Ref. Document	Acceptance Standard	Format of Records	Inspection By			Remarks
								1	2	3	
<p>The Tests listed in QAP are minimum requirement. Contractor shall provide a field quality assurance plan with formats for record of test results for all the works considering requirements of this specification and other relevant specification document/IS Codes. Field Quality Plan approved by OWNER/PMC shall be followed for all the works under scope of the tender. Cost of all tests shall be borne by the Contractor.</p> <p>All tests shall be recorded in forms acceptable to the Engineer-in-charge.</p>											



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PART-IV: SPECIFICATION FOR ANTI BUOYANCY MEASURES

1.0 SCOPE

- 1.1 This specification defines the minimum technical requirements for the materials, application, inspection, handling and other activities for external concrete weight coating of pipeline.

2.0 DEFINITIONS

For this specification the following definitions shall apply:

OWNER : INDIANOIL (IOCL)

CONTRACTOR: The Company name as such in the deed.

SHALL/MUST/IS TO BE: A mandatory requirement

SHOULD: A non-mandatory requirement, advisory or recommendation

3.0 REFERENCE DOCUMENTS

- 3.1 Reference has been made in this specification to the following codes and standards:

ASTM A-185	Specification for steel welded wire Reinforcement, Plain for concrete reinforcement.
ASTM C-642	Test method for Specific gravity, absorption and voids in hardened concrete.
ASTM C-138 :	Test method for Unit weight, yield and air content of concrete.
ASTM C-309	Specification for Liquid membrane forming compounds for curing concrete.
ASTM A-82	Specification for steel wire, plain, for concrete reinforcement.
ASTM C-39	Test method for Compressive strength of cylindrical concrete specimens.
IS - 269	Indian Standard Specification for Ordinary and Low Heat Portland Cement. (1959; Reaffirmed 1999)



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IS – 456

Plain and Reinforced Concrete – Code of
Practice (3rd Revision – 2000)

IS – 6909

Indian Standard Specification for
Supersulphated Cement(1990; Reaffirmed
1997)

IS-8112

Indian Standard Specification for High Strength
Ordinary Portland Cement.

IS-383

Indian Standard Specification for Coarse and
Fine Aggregates from Natural Sources for
Concrete.

IS-2386 (PART I thru'
VIII)

Indian Standard Methods of test for aggregates
for concrete.

IS-516

Method of test for strength of concrete.

4.0 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.

4.1 Cement

4.1.1 Portland Cement (conforming to IS-269), or High Strength Ordinary Portland Cement (conforming to IS-8112) shall be used.

4.1.2 Supersulphated Cement shall be (conforming to IS 6909) used wherever the soil is corrosive.

4.1.3 Cement which has hardened or partially set or which has become lumpy shall not be used.

4.1.4 Test Certificates from the cement Manufacturer shall be supplied to the Owner for all batches of cement delivered to site.

4.1.5 Cement which is more than six months old shall not be acceptable.

4.1.6 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.



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4.2 Aggregates

4.2.1 Aggregate shall comply with the requirements of IS:383 and shall be tested in accordance with IS:2386.

4.2.2 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.

4.2.3 Coarse Aggregates

Use of coarse aggregates shall be subjected to Owner's approval.

4.2.4 Aggregates shall be clean and free from injurious amounts of salt, alkali, deleterious substances or organic impurities.

4.3 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 Owner's representative for approval.

4.4 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.

4.4.1 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.

4.4.2 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.

Wire fabric manufactured in rolls (ribbon mesh) shall be 1 x 2.5 inches of 14 gauge U.S. steel wires (2mm wire). The above dimensions will be applied unless otherwise specified by OWNER. 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.

5.0 COATING REQUIREMENTS



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Pipes shall be concrete coated to a thickness as specified in the relevant drawings and as per the design documents.

Property	Concrete shall conform to the following:
Concrete Density	2500 Kg/m ³
Compressive Strength (After 7 Days)	170 Kg/cm ²
Compressive Strength (After 28 Days)	250 Kg/cm ²

Contractor shall be permitted to select any proportioning of materials to achieve the specified requirements of concrete density and weight

6.0 APPLICATION METHOD

Concrete coating shall be applied by 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 ensure the basic characteristics of concrete coating in compliance with the minimum requirements of this specification.

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.

7.0 EQUIPMENT

The equipment used for performing the concrete coating shall be capable of doing so with a reasonable degree of uniformity with respect to thickness, density 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

8.0 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.



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8.1 The logging methodology shall include minimum the following details:

a) Line pipe

- 1) Field identification number
- 2) Mill serial Number
- 3) Length (m)
- 4) Weight (kg)
- 5) Average outside diameter (mm)

b) Corrosion Coating

- 1) Type of coating
- 2) Thickness of coating (mm)
- 3) Weight of coated pipe (kg)
- 4) Date of corrosion coating application

c) Concrete Weight Coating

- 1) Batch identification number
- 2) Date of placing of concrete coating.
- 3) Average concrete coating thickness.
- 4) Wet weight of coated pipe (weight and date of weighing)
- 5) "Dry weight" of concrete coated pipe
(Weight and date of weighing or related weight 28 days after placing of concrete and so identifiable).
- 6) "Unit dry weight" of concrete coated pipe.
- 7) "Negative buoyancy" (unit) of concrete coated pipe

8.2 No concrete placing shall be done before items 1 to 7 listed above have been logged. In addition, each batch / shift shall be identified and logged against cube samples taken for compressive strength and dry density.

9.0 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.

9.1 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.

9.2 Samples shall be prepared and tested in accordance with ASTM C-642 to determine the dry specific gravity (28 days after placing).

9.3 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.



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- 9.4 The mix so determined shall then be used for sampling of concrete to be submitted to compressive strength tests as per ASTM C39 / IS 516.
- 9.5 Frequency of sampling for tests for density and compressive strength of concrete shall be as follows:

Quantity* of Concrete (m ³)	Number of Samples
Upto 25	3
26 to 50	4
51 and above	4 samples and one additional sample for each additional 50 m ³ or part thereof.
* Quantity is the volume of concrete to be used for each qualified mix.	

10.0 APPLICATION OF REINFORCEMENT AND CONCRETE COATING

- 10.1 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.
- 10.2 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.

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.

10.3 Reinforcement application

- 10.3.1 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.
- 10.3.2 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 50 mm from the finished concrete coating at the pipe ends.
- 10.3.3 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.
- 10.3.4 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.



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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.

10.4 Concrete placing

10.4.1 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.

10.4.2 Placement of concrete shall be upto the specified thickness in one continuous course, allowance being made for splices of reinforcement and providing reinforcement in the right location.

10.4.3 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.

10.4.4 All pipes shall be kept clean and free from cement, concrete and grout either inside or outside of the uncoated sections.

10.4.5 The coatings at each end of the pipe shall be bevelled to a slope of approximately two-to-one (2:1).

10.4.6 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.

10.5 Winter concrete coating

10.5.1 In ambient temperatures below 4 Degree 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 Degree C in the vicinity of the concrete.

10.5.2 Storing and curing of coated pipe shall not take place at temperatures below 1.5 Degree C, until the concrete has aged sufficiently to have achieved a crushing strength of at least 10 N/mm².

10.6 Reclaimed concrete

10.6.1 Use of reclaimed rebound shall be done only with the written permission of the Owner and to the satisfaction of the Owner's inspector.

10.6.2 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.



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10.6.3 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.

10.7 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.

10.8 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.

10.9 Curing

10.9.1 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.

10.9.2 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.

11.0 TOLERANCES

11.1 Contractor shall maintain a surface tolerance of + 6mm on outside diameter of the coated pipes measured by diameter tape. The diameter of each coated pipe shall be obtained at five (5) points, spaced at equal intervals between end points.

11.2 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.

11.3 Acceptable weight tolerance from the approved mix, during production shall be as follows:



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- i) + 3% for each type of aggregate
- ii) + 2% for aggregate as a whole
- iii) + 3% for the total quantity of water
- iv) + 3% for cement

12.0 WEIGHING

- 12.1 The test specimen shall be selected at equal intervals during the course of production.
- 12.2 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

13.0 INSPECTION AND TEST

- 13.1 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.
- 13.2 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 atleast a point of exposed steel reinforcement whenever the latter shall terminate inside of concrete coating.
- 13.3 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.

14.0 COATING OF FIELD JOINTS

- 14.1 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.
- 14.2 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 galvanised 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.

- 14.3 The composition of the concrete shall be the same as that of the concrete coating of the pipe.
- 14.4 When moulds are used if approved by the OWNER, 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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15.0 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 hardened).

- 15.1 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.
- 15.2 Damage due to spalling of an area of less than 0.1 m² (1 square foot) where the remaining concrete is sound will be accepted without repairs.
- 15.3 Damage due to spalling of an area of more than 0.1 m² and less than 0.3 m² 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.

Should the damaged area be more than 0.3 m², 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.

16.0 MARKING

- 16.1 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.
- 16.2 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.

17.0 UNLOADING, TRANSPORTATION, STORING AND HAULING

- 17.1 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 climatological condition.
- 17.2 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.



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- 17.3 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 surfaces.



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SECTION-VII

SPECIFICATION FOR CONTRACTOR SUPPLIED MATERIALS



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1. SCOPE OF SUPPLY

1.1. Materials to be supplied by Owner as Free Issue Material

Owner shall supply only the following materials as free issue from its designated storage point:

- 3 LPE Coated Line Pipe of API 5L X 52 (HFW / SAW / SMLS) with externally corrosion coated (three layer polyethylene coating) of size and wall thickness - specified NB 8"x 6.4 mm thk, & 4" x 6.4 mm thk.
- All types of valves of sizes (2" & above) and 300# ratings.
- MDPE Pipes
- OFC Cable

Free Issue Material shall be issued to the Contractor from the designated store(s) of Owner. Contractor shall be responsible for lifting the free issue material from Owner's storage point(s) and transporting the same to work site(s) at his own cost. Contractor shall also return balance material after completion of work to owner's designated stores at above mentioned location (s) as directed by owner / owner's representative.

1.2. Material to be supplied by Contractor

The procurement and supply, in sequence and at the appropriate time of all materials and consumable required for completion of the WORK as defined in the contract except the material specifically listed under clause 1.1, shall be entirely the Contractor's responsibility and item rates quoted for the execution of the contract shall be inclusive of supply of all these materials. The materials are, but not limited to, as follows applicable for carbon steel pipeline/piping:

- 3D Bends of all required sizes.
- All Pipe and Pipe fittings like elbows, flow tees, reducers, weldolets, sockolets, nipples, flanges, blind flanges, spectacle blinds etc. Sizes (All sizes)
- All types of valves of all sizes (Below 2") and specified ratings.
- 40 mm HDPE Telecom duct
- Insulating Joint wherever required.
- 1.0 mm thick, 300 mm wide PE warning mat.
- All consumable for welding such as oxygen, acetylene, inert gases and all types of electrodes, filler wire, solder wire, brazing rods, flux etc. for welding/cutting and soldering purposes.
- All materials for all types of pipeline markers including paints conforming to normal corrosive environment as per specification & tender document, cement, sand, reinforcement steel etc.
- All equipment and consumables required for hydrostatic testing like filling pumps, flow meter, compressor, pressure gauge (Approved Make) and temperature gauges, thermocouples, corrosion inhibitor for water used for hydrostatic testing, including water for testing etc.



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- All materials required for continuous concrete coating for providing negative buoyancy, to the pipeline wherever required.
- All materials and consumable required for external field weld joint coating and protective coating of bends, tee as per specifications including supply of coating materials.
- All material and consumable items required for external coating to the buried piping, flanges, valves, etc.,
- All materials required for repair of damaged corrosion coating of line pipe.
- Bare Casing pipe (Size - 4" NB for HDPE Telecom Duct) of material IS3589 FE 410 / API 5L Gr. B or equivalent shall be procured by contractor for the crossing. If required by the Owner.
- Bare Casing pipe (All required sizes) of material IS3589 FE 410 / API 5L Gr. B or equivalent shall be procured by contractor for the crossing. Thickness Calculation of the same shall be submitted by the contractor for approval as per applicable codes & statutory requirement.
- Casing insulators and end seals are to be required for steel casing pipe.
- All materials required for sand/soft soil padding around pipeline and select approved quality backfill, bank stabilization of water crossings, etc.
- All materials required for repair/restoration of pavements, roads, bunds other structures affected/damaged by Contractor's construction activities. Materials shall be equivalent/superior to those used for original construction of the facility.
- All materials/compressed air/pigs as required for cleaning, gauging, filling. Dewatering, swabbing for CS pipeline etc.
- All temporary materials required for filling, pressurizing and dewatering in connection with hydrostatic testing including pipes, flanges, blind flanges, fittings, temporary gaskets, nuts, bolts, clamps, strainers etc. required for fabrication of test headers and all consumables.
- All types of bolts, studs, nuts and gaskets of all sizes and ratings, thickness as required for the permanent installation in piping system in accordance with the relevant material specification. All fittings like elbows, tees, reducers, weldolets, nipples, flanges, blind flanges, spectacle blind flanges, valves, pipes pressure gauge (with calibration certificates) of sizes 2" NB & below and of all ratings.
- Contractor shall submit the MTC and all inspection reports for the bought-out items.
- All types of coating and painting materials including primers, paints, solvents, sand blasting materials, cleaning agents, compressed air etc. shall be suitable for normal corrosive environment.
- All steel materials such as structural steels, reinforcement steels and steel for all types of supports, foundations, ladders, platforms, etc.
- All materials and equipment required for all types of tests such as radiography/ultrasonic testing, magnetic particle and dye penetrate examination.
- Shims, wedges, fire blankets and packing plates (machined wherever required).
- All materials for civil and structural works, grouting etc., including casing end seals required in pit.
- All safety tools/tackles/devices/apparatus/equipment, etc. including ladders and scaffolding as required.
- All materials for corrosion protection of buried piping, pipe fittings, valves etc.
- All materials, equipment, labour for required pre-commissioning / commissioning works including supply of required quantity of Nitrogen.
- All materials and consumables related to jointing of HDPE duct.



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- MDPE Valves and fittings of all sizes and ratings.
- Pressure Gauges:
 - Pressure gauge dial shall be white, non rusting plastic with black figures. Pointers shall have external micrometer adjustment for gauge zero adjustment.
 - Pressure gauges shall be weatherproof with dial size of 150 mm and shall have features like screwed bezels, externally adjustable zero, over range protection and blowout discs. Pressure gauge sensing element shall be SS 316 and movement material shall of SS 304, as a minimum. The design of pressure gauges shall conform to IS 3624 Pressure gauges shall have an accuracy of $\pm 1\%$ of UR V as a minimum.
 - Over range protector and pulsation dampener, whenever used, shall be of SS 304, as a minimum. Pulsation dampeners shall be used for all pulsating services. These shall be floating pin type, externally mounted and externally adjustable.
 - Connection shall normally be 1/2" NPTM bottom.
 - Cases shall normally be cast aluminium alloy or black phenol and weatherproof to IP-55 as per IEC-529/IS-2147. Blow-out discs shall be provided for all gauges.
 - Ranges shall be so specified that the gauge normally operates in the middle third of the scale and shall conform to IS 3624 standard dials wherever possible.
 - Shatter proof glass shall be provided for pressure gauges.
- All pipe & pipe fitting including bends, flanges etc of size 2" NB & below.
- Field jointing coating material (Heat shrink sleeve).
- Cold applied tape.
- All other materials not specifically listed herein, but required for the successful execution of the work. & satisfaction of the owner/ owner's representative.
- Rock Shield: Supply and installation of rock shield is in contractor scope. Rock shield shall provide external pipe protection from backfill rock damage and/or abrasion damage during pipe operation of the exterior coating;
 - Minimum thickness of 6.4mm, flexible PVC (polyvinyl chloride), strand extruded rock shield pads. The rock shield shall be extruded from an elastomeric plastic material of which the basic resin is prime virgin polyvinyl chloride. The PVC compound shall not contain any scrapped, reclaimed or recycled material whatsoever. Minimum weight of rock shield should be 0.825 lbs/square foot. Rock shield is to be constructed of randomly extruded strands of elastomeric PVC plastic and must be bi-directional. This means that it should sufficiently protect the pipe regardless which side of the rock shield faces the pipe. The color of the rock shield shall be yellow to provide higher visibility to third party excavators.
 - Performance Requirements as follows:

Property Test Method Required Limits-Impact Resistance ASTM G-13 (Modified), Protection integrity < 6" rock drop

Must be constructed from PVC plastic ASTM D-2240 Durometer 78 (+ / - 3)

Cathodic Protection Shielding Flange method on free film Matrix must allow passage of CP current



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Impact resistance : ASTM G-13 testing consists of the following parameters:

35 lbs of stones, $\frac{3}{4}$ " in diameter

Dropped from a height of 6 ft. through a funneling chute onto the test surface

This test is repeated 10 times or until a holiday (defect / damage) is discovered. If no holiday is present after 10 repetitions, the product is said to have passed. Provide non-metallic banding or durable filament tape to affix rock shield securely to the pipe.

- INSTALLATION

Rock shield pads shall be affixed to pipe utilizing non-metallic bands of filament tape.

Spacing of non-metallic banding shall not exceed 80 cm on center.

Rock shield shall completely encircle the pipe with a minimum overlap of 10 cm. Overlap shall be located at the bottom radius (6 o'clock position).

Back-fill should be "shaded" into the trench during back-fill procedure. Back fill shall not be dumped directly on protected pipe.

Manufacturer's (Rock Shield) recommendations shall be followed.

1.3. The fittings & flanges have to be delivered in accordance to the particular specification: Codes, Norms and standards (latest revision); but not limited to:

ANSI B16.5 ANSI B16.9 ANSI B 16.11

ANSI B16.28 Pipe flanges and flanged fittings

Factory - made wrought steel butt welding fittings. Forged steel fittings

Wrought steel butt welding short radius elbows and returns

ANSI B31.3 ASME code for process piping.

ANSI B31.8 Gas transmission and distribution piping systems.

ANSI B36.10 Welded and seamless wrought steel pipe

ANSI B16.25 Butt Welding Ends

ASTM A 105/ Forging, carbon steel, for piping components.

A 105 M

ASTM A 203 Pressure vessel plates, alloy steel, nickels

ASTM A 234/ Piping, fittings of wrought carbon steel and alloy steel for moderate and

A 234 M



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ASTM A 333 elevated temperatures

Seamless and welded steel pipe for low temperature

ASTM A 350/ Forging, carbon and low alloy steel, requiring notch toughness testing for

A 350 M piping components.

ASTM A 370 Mechanical testing of steel products.

ASTM A 420/ A 420 M

Piping fittings of wrought carbon steel and alloy steel for low temperature service.

ASTM E 112 Standard methods for determining the average grain size.

MSS SP 25 Standard marking system for valves, fittings, flanges and unions.

MSS SP 55 Quality standard for steel castings for valves, flanges and fittings and other piping components (visual method).

MSS SP 75 Specification for high test wrought butt welding fittings. ASME Boiler and Pressure Vessel code.

MSS SP 44 Specification for Steel Pipeline Flanges

MSS SP 97 Specification for Forged Carbon steel branch outlet fittings – Socket, Threaded and Butt Welding ends.

DIN 2413 Design of Steel Pressure Pipes

EN 10204 Type of Inspection documents

ISO 148 Metallic Material - Charpy Pendulum impact test



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A. SPECIFICATION FOR CASING INSULATORS AND END SEALS

PART – A CASING INSULATORS

1.0 SCOPE

This specification covers the minimum requirements of design, material, manufacture and supply of casing insulators intended to be used for cased pipeline crossings.

2.0 FUNCTION

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:

- Resist cold flow and will not soften at design temperature.
- Resist corrosion
- Resist mechanical damage while being pulled into the casing.
- 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 assure a permanent support to the carrier pipe.

3.0 DESIGN

The arrangement of insulator shall be generally in accordance with Fig. 3.0. It shall be made in segments duly held together with cadmium plated bolts and nuts, to be supplied with casing insulators.

The number of segments shall be two for pipe diameters upto 12" (generally). For larger diameters, the number of segments may be more than two, but their number shall be kept minimum.

The skid height shall be such that it is slightly less than the value obtained by following formula.

Casing internal dia-carrier outer dia

Manufacturer shall obtain prior approval from COMPANY on casing insulators drawings/designs.



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4.0 MATERIAL

Casing insulators shall be made of injection moulded high density polyethylene or other material equivalent or superior as approved by COMPANY and shall meet the following specifications:

Property	Value	ASTM Test Method
Dielectric strength	450-500 Volts/Mil	D-149
Compressive strength	3200 psi	D-695i
Tensile strength	3100-5000	D-638, D-651
Impact strength	4.0 ft. 1b./inch of notch	D-256
Water Absorption	0.01%	D-570

5.0 INSPECTION AND TESTING

Manufacturer shall furnish material test certificates of the components used in the assembly of casing insulations as per the requirements of clause 4.0 of this specification.

PART-B CASING END-SEALS

1.0 **SCOPE**

This specification covers the minimum requirements of design, material, fabrication and supply of casing end-seals intended to be used for pipeline cased crossings.

2.0 **FUNCTION**

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.

3.0 **DESIGN**

The scale shall be suitable for the casing and carrier pipe diameters 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-scale shall permit easy installation of the seal to the cased pipeline crossing.



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It shall provide moisture-proof seals when installed for the entire anticipated life of the buried pipeline.

Manufacturer shall obtain prior approval from COMPANY on casing end seals design/drawings.

4.0 **MATERIAL**

The casing end-scale shall be made of head shrink high density radiation cross linked polyethylene with an adhesive having a melt point suitable for the pipeline service temperature and ambient temperatures foreseen during construction. End-seals material shall be resistant to heat, cold, vibration, impact, abrasion, corrosive fluids, disbonding, organic and bio-deterioration. Manufacturer shall confirm compatibility of end seals with carrier pipe coating.

Casing end seals shall meet following minimum property requirements:

<u>Property</u>	<u>Minimum Value</u>	<u>Test Method</u>
a) 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 225°C, 4 hours)	ASTM D-2671
b) Adhesive		
Ring and Ball softening point	90°C	ASTM E-28
Lap Shear	60°C - 25 psi	ASTM D-1002



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23°C - 250 psi

(2 inch/min)

c) System (as applied)

Peel strength	5 pli	ASTM
(To casing and carrier pipe and closure patch)	(10 inch/min.)	D-1000

5.0 INSPECTION AND TESTING

Manufacturer shall furnish material test certificates of the components used in the assembly of casing end-seals as per the requirements of this specification.

PART-C SUPPLEMENTARY REQUIREMENTS

- 1.0 The Manufacturer shall replace, at no extra cost, any material not conforming to the material and performance requirements of this specification.
- 2.0 Manufacturer shall submit detailed specification of the materials used in the assemblies, along with instructions for handling, use and installation of the material for COMPANY approval prior to procurement.
- 3.0 Manufacturer shall submit all the documents, test reports, records and other information in six copies to the COMPANY for record after approval as per clause 2.0 above.



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B. TECHNICAL SPECIFICATION FOR WARNING MATS

SPECIFICATION FOR PE ANTI RODENT WARNING MATS FOR PIPELINE

Purpose	For using as a warning sign for Underground Pipeline
Width	D + 300 mm, D – Dia of Line Pipe
Thickness	1.0 mm thick
Material of the mat	The material shall be of high density Polyethylene of virgin quality and non Biodegradable type. It shall have Non Hazardous, Non Toxic and Anti – Rodent properties.
Colour of the mat	Golden Yellow with letters printed in RED of nondeletable type with high abrasion resistant.
Art Work	<p>A sample piece of 30mm wide and 200mm long of every batch shall be checked by immersing in 20% solution of Ammonium Sulphide for period of 2 weeks at a temperature of 15°C for colour intactness of the strip.</p> <p>Copy of Art work is enclosed at Page 4.</p> <p>The Art work shall be printed in English and local language alternatively at every 1 mtr distance.</p>
Mechanical Properties of HDPE Tensile Strength	Minimum 200 kg/cm ²
Elongation at Break	Minimum 175%
Bundle Length	1.0 mm thick warning mat shall be supplied as 100 mtrs length in each bundle packed in PE Woven sack material.
Tests	<p>Minimum following test has to be done with each batch of warning mat</p> <p>❖ Tensile Strength test</p>



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	<ul style="list-style-type: none"> ❖ Elongation test ❖ Impact Strength test ❖ Color fastness test ❖ Heat Stability test ❖ Print Stability test ❖ Oxidation Induction test ❖ ESCR test ❖ Melt Flow Rate test ❖ Anti-Rodent Test. ❖ UV Stabilizer Test ❖ DSC Scan Test of Raw Material & Finish Goods.
Test Certificates	Vendor has to submit the all test certificates to Purchaser
Inspection	The manufacturer has to submit the QAP before commencement of production. Inspection of the material will be done at vendor's works by Client Representative. Vendor has to submit all test reports before inspection call. Any test failed during the inspection for the offered lot, the total lot will be rejected.
Documentation	Vendor shall submit all test reports including document regarding Toxicology data & ROHS compliance, documentary evidence regarding Non-biocide product, value of Lethal Dosage (LD), value of % dermal toxicity, details of active ingredient in the product and final inspection reports along with the supply of materials.

C. SPECIFICATION OF PIPE FITTINGS

1.0 Scope

- 1.1. This Specification shall be used in combination with enclosed "Specific requirement of Project".
- 1.2. "Specific requirement of project" indicates size, schedule/rating of pipe fittings, quantity, connecting pipe thickness, connecting pipe material grade, fluid characteristics, any additional tests and requirements, any modification to this specification based on particular project design conditions and requirements.
- 1.3. This specification defines the technical requirements for the design, materials, manufacturing, testing and inspection, marking and shipment of the weld end seamless and welded carbon steel fittings such as elbows, tees and reducers.
- 1.4. This specification is applicable only to non-sour service and for onshore crude oil, petroleum products, Natural Gas and LPG pipeline.
- 1.5. This specification is applicable for pipe fittings equivalent to pressure rating 150# to 900#.
- 1.6. This specification is applicable for pipe fittings from size ½" to 48" with applicable pressure rating as specified.

2.0 Reference codes and standards

- 2.1. Unless otherwise specified, requirements of the latest editions of the referenced Codes and Standards at time of purchase order to be used.
- 2.2. Reference codes and standards to be used in conjunction with this specification.
- 2.3. Order of precedence of applicable documents shall be as under:
 1. Specific requirement of project.
 2. This specification
 3. Reference codes and standards

Table-1: Reference codes and standards

S.No.	Reference	Description
1.	ISO 15590-2	Petroleum and natural gas industries — Induction bends, fittings and flanges for pipeline transportation systems — Part 2: Fittings
2.	ASME B16.25	Butt welding Ends
3.	ASME B 16.9	Factory-Made Wrought Butt welding Fittings
4.	ASME B31.4	Pipeline Transportation Systems for Liquid Hydrocarbons and other Liquids



PIPELINES

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S.No.	Reference	Description
5.	ASME B31.8	Gas Transmission and Distribution Piping Systems
6.	ASME section V	Boiler and Pressure Vessel Code. Non-destructive Examination
7.	ASME section VIII	Boiler and Pressure Vessel code - Section VIII: Pressure Vessels Design
8.	API 5L	Specification for Line pipe
9.	MSS SP 75	High-Strength, Wrought, Butt-Welding Fittings
10.	ASTM A 370	Test Methods and Definitions for Mechanical testing of Steel Products
11.	A 860/A 860M	Standard Specification for Wrought High-Strength Low-Alloy Steel Butt-Welding Fittings
12.	ASTM E 10	Test method for Brinell Hardness of Metallic Materials
13.	ASTM E 23	Method for Notched Bar Impact Testing of Metallic Materials
14.	ISO 148	Charpy impact test (V-notch)

3.0 **Design:**

- 3.1. Pipe fittings shall comply with the requirements of ASME B16.9/MSS SP 75 as indicated in this specification and as per "specific requirement of project".
- 3.2. Pressure-temperature ratings shall be as per ASME B16.9/MSS SP 75/ISO 15590-2.
- 3.3. The capability of the fitting to withstand internal pressure shall equal or exceed that of the matching pipe. The design calculations and/or results of proof testing shall be available for review at the manufacturer's facility and the same to be submitted to purchaser.
- 3.4. Wall thickness of fittings shall not be less than the connecting pipe thickness indicated in any case.

Note: For Natural Gas service, connecting pipe thickness shall be as per PMS (Piping Material Specification).

- 3.5. Nominal bore of fittings shall be that of the connecting pipeline.
- 3.6. The welding end of fittings shall be in accordance with Figure 1 of MSS-SP-75 for wall thickness (of intended connecting pipe) of 19 mm (0.88 in.) and less. For thicker walls greater than 19, Figure 2 of MSS-SP-75 to be referred.
- 3.7. If the SMYS of the fitting material is less than that of the matching pipe, the minimum thickness of the fitting end shall be increased such that the product of its thickness times its SMYS shall at least equal the product of the specified wall thickness and the SMYS of the matching pipe, in accordance with MSS SP-75.



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- 3.8. When the fitting thickness at the welding end is greater than the adjoining pipe, the joint design shall be as shown in any of the three sketches in Figure 3 of MSS-SP-75.
- 3.9. If SMYS of the fitting material and pipe to be joined are equal, then weld end thickness of pipe fittings shall be same as that of pipe.
- 3.10. Fittings such as tees, elbows and reducers shall be seamless type for sizes $\leq 16"$ NB and shall be welded type for sizes $\geq 18"$ NB.
- 3.11. Fittings shall conform to dimensional standard as per MSS-SP-75 for size 16" and larger and as per ASME B 16.9 for size less than 16".
- 3.12. For the tees installed in main pig receiving line, barred tees to be used. The bars shall be made of mild steel and shall be welded with full penetration welds. No. of vertical bars shall be 3nos. with no cross brace up to 12" branch size, 5 nos. vertical bars with one cross brace for branch size 14" to 24" , 6 nos vertical bars with two cross brace for branch size above 24". Vendor to be provided detailed drawing of barred tee with detailed dimensional drawing for approval. For Natural gas Service, Flow Tee shall be installed in piggable sections.
- 3.13. Welders and welding operators shall be qualified in accordance with ASME IX.
- 3.14. Welding and repair welding shall be performed in accordance with procedures qualified in accordance with ASME IX. Procedure qualification shall include Charpy V-Notch test for weld/HAZ and hardness test.
- 3.15. Weld repairs are only permitted to welds. Repair welding in base material is not permitted.
- 3.16. WPS shall be submitted to purchaser for approval before start of work. Any previously approved WPS, PQR and WQT can also be submitted for purchaser review and clearance.
- 3.17. Fittings shall not contain girth welds.
- 3.18. All fittings shall be heat-treated (normalized) irrespective of pressure rating in accordance with ISO 15590-2 Clause 8.3.3. Record and graph shall be maintained of each heat treatment batch. Procedure for heat treatment to be submitted to purchaser for approval.
- 3.19. The reinforcement of inside weld seam shall be removed for a distance of 100 mm from each end of the welded fittings.

4.0 Pipe Fittings material

4.1. General

- 4.1.1. Raw material used for fittings shall be of fully-killed steel. It shall have a grain size of ASTM 7 or finer, as defined in ASTM E 112
- 4.1.2. High-frequency welded and helical-seam submerged-arc welding pipes shall not be used.
- 4.1.3. Fittings shall be made from following material grade meeting the requirements of this specification, applicable codes and material specification.



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Note: Materials for pipe fittings for Natural Gas service shall be in accordance with PMS (Piping Material Specification) attached along with the tender.

Table-2A: Material grade for pipe fittings (for crude oil and product pipelines)

Pressure rating	Sizes	Material grade
150#	For all sizes	ASTM A 234 WPB
300#	Up to 18"	ASTM A 234 WPB
	≥ 20" to ≤28"	WPHY-52
	≥32" to ≤48"	WPHY-60
600#	Up to 6"	ASTM A 234 WPB
	≥ 8" to ≤14"	WPHY-52
	≥ 16" to ≤20"	WPHY-60
	≥ 22" to ≤28"	WPHY-65
	≥ 30" to ≤36"	WPHY-70
900#	Up to 6"	ASTM A 234 WPB
	≥ 8" to ≤10"	WPHY-60
	≥ 12" to ≤24"	WPHY-70

Table-2B: Material grade for pipe fittings (for LPG/NG piping)

Pressure rating	Sizes	Material grade
300#	Up to 6" size	ASTM A420 Gr.WPL6 (for drain, vent, cold flare, SV station bypass piping and other low temperature piping)
	≥8" to ≤16"	ASTM A 234 WPB (For 8" size, if low temperature is specified, then ASTM A420 Gr.WPL6 to be selected)
	≥ 18" to ≤24"	WPHY-52
600#	Up to 6" size	ASTM A420 Gr.WPL6 (for drain, vent, cold flare, SV station bypass piping and other low temperature piping)
	≥ 8" to ≤10"	WPHY-52. (For 8" size, if low temperature is specified, then ASTM A420 Gr.WPL6 to be selected)



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	$\geq 12''$ to $\leq 14''$	WPHY-60
	$\geq 16''$ to $\leq 24''$	WPHY-70

4.2. Chemical composition

- 4.2.1. Manufacturer shall carry out a chemical analysis on each heat of steel used and also on two products per heat.
- 4.2.2. Chemical composition of fittings material shall be as per Table-4 (Class C) of ISO 15590-2.
- 4.2.3. Maximum Carbon Equivalent shall be 0.43% when calculated with the following formula:
 $CE = C + \frac{Mn}{6} + \frac{(Cr+Mo+V)}{5} + \frac{(Cu+Ni)}{15}$
- 4.2.4. If any chemical analysis (both raw material and product) fails to meet the requirements stated above, the whole heat shall be rejected or each individual product shall be fully analysed and all products failing to meet the requirements shall be rejected.

5.1. General

- 5.1.1. Testing and inspection shall be carried out on fittings after final heat treatment.
- 5.1.2. Chemical, Mechanical, impact Testing shall be carried out for each heat under each lot and each heat treatment batch unless otherwise specified.
- 5.1.3. Test pieces for all destructive testing shall be taken from finished fitting. All inspection and testing cost shall be included in cost of fittings itself.
- 5.1.4. Test pieces shall be prepared in accordance with ISO 377. If thermal cutting has been used to remove samples, the full extent of the heat-affected region shall be removed during the preparation of the test pieces.
- 5.1.5. All fittings shall be visually inspected. The internal and external surfaces of the fittings shall be free from any strikes, gauges and other detrimental defects.
- 5.1.6. Summary of testing, inspection requirements and extent of testing are detailed in Table-3
All stage inspection shall be carried out by third party Inspection agency engaged by the vendor. However, final inspection shall be carried out by owner's designated third party inspection agency and/or IOCL as per approved QAP.

Table-3: Summary of testing, inspection requirements and extent of testing

S.No.	Tests	Sample frequency	Inspection by TPI and/or IOCL
1.	Heat analysis (raw material)	One per heat	Review
2.	Product analysis	Two per heat	100% Witness



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S.No.	Tests	Sample frequency			Inspection by TPI and/or IOCL
3.	Tensile testing-Base	One per heat			100% Witness
4.	Transverse weld tensile	One per heat			100% Witness
5.	Guided bend test (weld seam)	One per heat			100% Witness
6.	Impact testing-Base	One per heat			100% Witness
7.	Impact testing- weld seam	One per heat			100% Witness
8.	Through thickness Hardness	One per heat			100% Witness
9.	Metallography	One per heat			100% Witness
10.	Visual inspection	For all fittings			100% witness
11.	Ultrasonic Testing of bevel and weld ends for lamination cracks/other defects up to a length of 50 mm.	For all fittings			100% witness
12.	Ultrasonic testing of fitting body (≥16" size)	20% or min. 2 nos. whichever is higher			Witness as specified
13.	Radiography of weld seam (Butt welding) and repair welds, if any	For all welded fittings			100% witness
14.	Physical and Dimensional Check	Rating	Size	Quantity ^c	Vendor to check 100% dimensions for all fittings. TPI/IOCL will carry out random witness of fittings as specified depending on size and rating.
		150# & 300#	≤16"	20% or min. 2 nos. whichever is higher.	
			≥18"	100%	
		600# & 900#	≤8"	20% or min. 2 nos. whichever is higher	
			≥10"	100%	
15.	Hydro testing	Rating	Size	Quantity ^c	Witness as specified.
		150# & 300#	≤16"	20% or min. 2 nos. whichever is higher.	



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S.No.	Tests	Sample frequency		Inspection by TPI and/or IOCL
			≥18"	100%
		600# & 900#	≤8"	20% or min. 2 nos. whichever is higher
			≥ 10"	100%

Note:

- If fittings are made in different lots, then destructive testing to be carried out for each heat under each lot and each heat treatment batch.
- All samples drawn for testing to be witnessed by TPI and/or IOCL.
- If order quantity is less than 2, minimum 1 no. to be witnessed.
- Vendor shall carry out hydrostatic testing with pressure as specified below:

Table-4: Hydrotest pressure of pipe fitting

Rating	Design pressure at Ambient temperature (kg/cm2g)	Hydrotest pressure at ambient temperature (kg/cm2g)
150#	19.5	29
300#	50.6	76
600#	101.3	152
900#	151.8	228

- The fitting, which has been hydro tested, shall be clearly identified by marking.



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- f) The party shall provide extra lengths at the ends to enable hydro test for all the fittings. The edges are to be machined only after hydrotest.
- g) No visual bulging is allowed during hydrotest for any of the fitting.
- h) Acceptance standards of Radiography of weld joints and repair welds shall be as per API 1104.
- i) Any lamination larger than 6.35 mm shall not be acceptable in weld end ultrasonic testing.
- j) Welds which cannot be radiographed shall be checked by ultrasonic testing upon purchaser approval.
- k) Purchaser's Inspector reserves the right to perform stage wise inspection and witness tests as per this specification at Manufacturer's works prior to shipment. Manufacturer shall provide reasonable notice of time and shall provide, without charge, reasonable access and facilities required for inspection to purchaser's inspector.

6.1. Tensile testing:

- 6.1.1. Sample orientation of tensile test is as per ISO 15590-2 Clause 9.4.2.1. For welded fittings, weld tensile specimens shall be taken as shown in Table-6.
- 6.1.2. Tensile tests shall be carried out in accordance with ASTM A370.
- 6.1.3. Tensile properties of base sample tested shall meet values as per material specification grade indicated in MSS-SP-75/ASME B16.9 as applicable w.r.t yield strength, ultimate strength, elongation.
- 6.1.4. For transverse weld tensile, test result shall meet tensile strength values of respective grade as indicated in MSS-SP-75/ASME B16.9 as applicable

6.2. Charpy V-notch impact test:

- 6.2.1. Charpy V-notch test pieces shall be prepared in accordance with ASTM A370/ ISO 148-1 with the axis of the notch perpendicular to the fitting surface.
- 6.2.2. The orientation of test piece shall be as per Table-6 and size of the test pieces shall be as follows:
 - 6.2.2.1. If transverse specimen of 10 mm is not possible, then sub-size specimen can be taken. For sub size test pieces, the minimum required absorbed energy values shall be adjusted in accordance with ASTM A370.
 - 6.2.2.2. If transverse test pieces with a minimum width of 5 mm are not possible, longitudinal test pieces with the greatest possible width between 10 mm and 5 mm shall be used.
- 6.2.3. % shear area at the fracture surface to be reported.
- 6.2.4. Each set of impact tests shall consist of three adjacent test pieces.
- 6.2.5. The impact test temperature shall be 0°C for petroleum and crude oil service and -29°C for LPG service unless otherwise specified. For low temperature carbon steel material, impact energy and testing temperature shall be as per respective material grade specification. **For Natural Gas**



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service, impact energy and testing temperature shall be as per PMS (Piping Material Specification).

- 6.2.6. Min. average and min. individual value for transverse direction shall meet the following requirements.

Table-5: Impact energy for different pipe fitting grade

Material grade	Min. Average Value (J)	Min. individual value (J)
ASTM A234 WPB	27	22
WPHY 52 (360)	36	30
WPHY 60 (415)	42	35
WPHY 65 (450)	45	38
WPHY 70 (485)	50	40

- 6.2.7. The minimum average and individual Charpy V-notch values when testing test pieces taken in the longitudinal direction shall be at least 1.5 times the values stated for transverse test pieces.

6.3. Hardness requirements

- 6.3.1. Through thickness hardness testing shall be performed as ISO 15590-2 Clause 9.4.4
6.3.2. No hardness reading shall exceed 248 HV10

6.4. Metallographic examination

- 6.4.1. Metallographic examination shall be performed as ISO 15590-2 Clause 9.4.6.
6.4.2. The specimens for metallographic examination shall be examined, prior to hardness testing, at a magnification of not less than $\times 100$. Grain-size measurement shall be performed in accordance with ASTM E 112. The minimum average grain size number shall be 7.

Table-6: Sample/Test piece location

Type of fitting	Sample location
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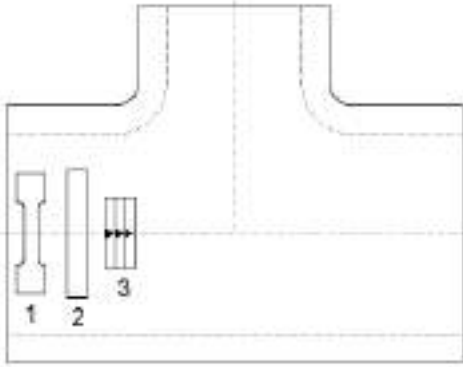
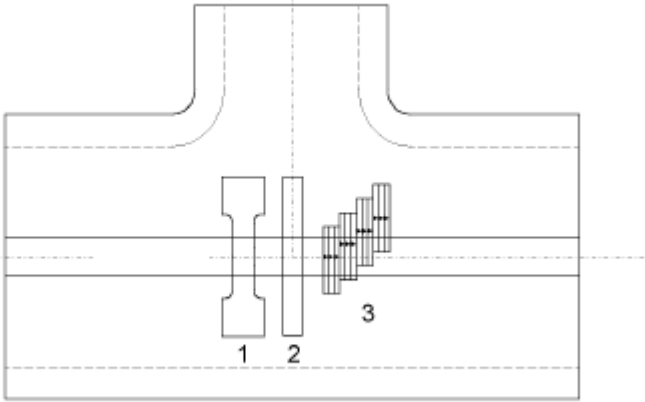
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Type of fitting	Sample location
Extruded Tee	 <p>1 – Transverse Base tensile sample, 2- Macro/Hardness sample, 3- Impact sample with notch perpendicular to plate surface</p>
Welded Tee	 <p>1 – Transverse Base tensile sample, 2- Macro/Hardness sample, 3- Impact sample with notch perpendicular to plate surface</p>



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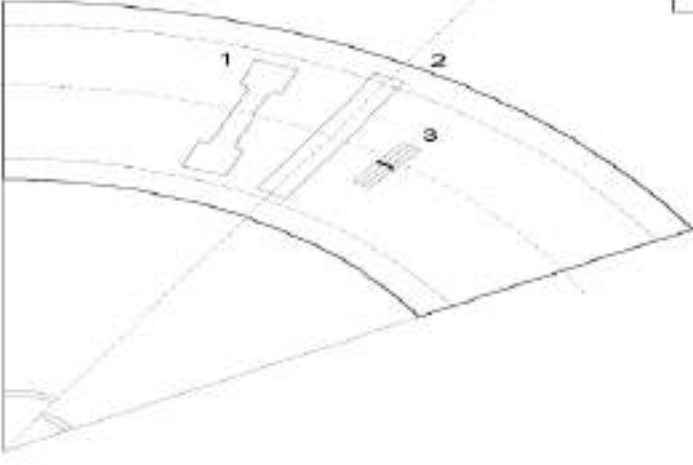
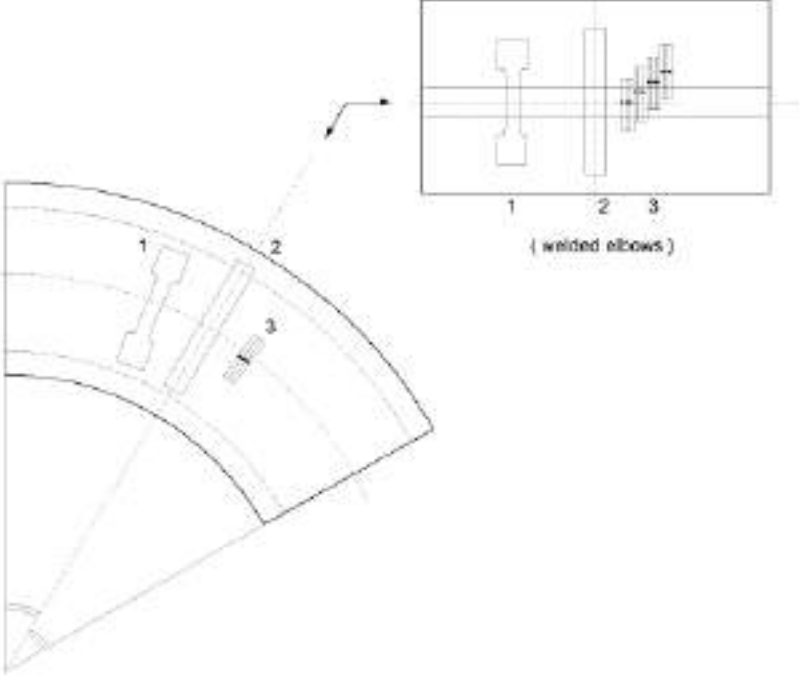
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Type of fitting	Sample location
Elbow	 <p>1 – Transverse Base tensile sample, 2- Macro/Hardness sample, 3- Impact sample with notch perpendicular to plate surface</p>
Welded Elbow	 <p>1 – Transverse Base tensile sample, 2- Macro/Hardness sample, 3- Impact sample with notch perpendicular to plate surface</p>



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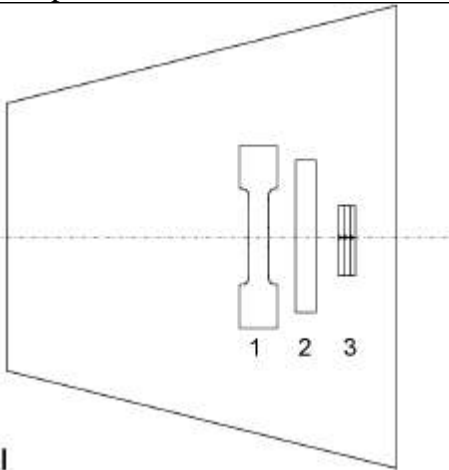
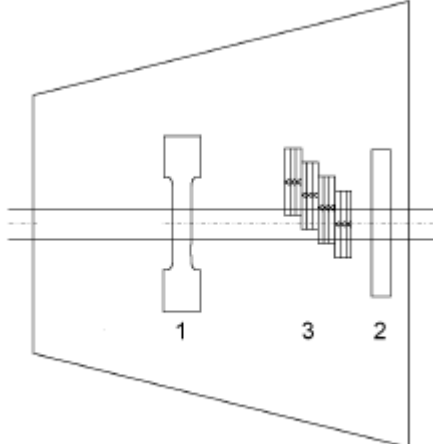
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Type of fitting	Sample location
Reducer	 <p>1 – Transverse Base tensile sample, 2- Macro/Hardness sample, 3- Impact sample with notch perpendicular to plate surface</p>
Welded Reducer	 <p>1 – Transverse Base tensile sample, 2- Macro/Hardness sample, 3- Impact sample with notch perpendicular to plate surface</p>



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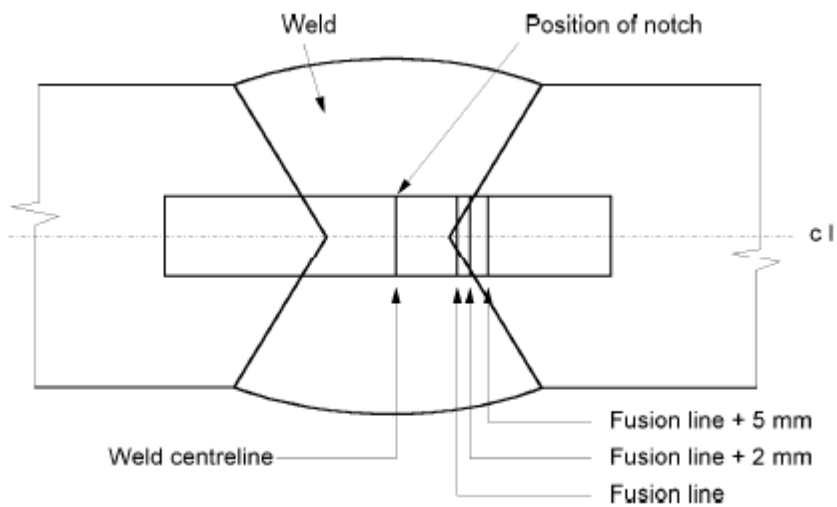
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Type of fitting	Sample location
Charpy Impact test location	

6.5. **Non destructive testing:**

Fittings shall be subject to the following inspection:

- 6.5.1. Ultrasonic testing of weld ends: The final 50 mm wide band of each weld end of the fitting shall be UT inspected for the detection of laminar imperfections in accordance with ISO 11496. The reference standard shall be a flat bottom hole. This 50-mm band shall extend from the intersection of the weld bevel and fitting outside diameter back along the body of the fitting. Laminar imperfections shall not exceed a length of 6 mm in the circumferential direction and their area shall not exceed 100 mm²
- 6.5.2. The bevel faces shall be machined and shall be free from cracks, laminations, notches, scores, pits etc.
- 6.5.3. Ultrasonic testing of fitting body:

- **Ultrasonic examination for laminations :**

In case the fitting is welded type, the area adjacent to the weld shall be tested in accordance with ISO 13663. Acceptance level E1.

Plate for welded fittings may be examined ultrasonically in accordance with ISO 12094 before forming using an oscillating scanning pattern. Acceptance level B1 for the body, and E1 for the longitudinal edges.

- **Ultrasonic examination for imperfections than other laminations:**



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Fittings made from seamless pipe shall be examined using ultrasonic examination in accordance with ISO 9303 for longitudinal and ISO 9305 for transverse imperfections. Acceptance levels: for both ISO 9303 and ISO 9305 Class L2 subcategory C.

6.5.4. Final NDT shall be carried out after heat treatment and hydro testing.

7.0 Gauging:

The ends of each fitting shall be tested for out-of-roundness using an internal ring gauge with a diameter of 5 mm less than the nominal internal diameter. The gauge shall pass freely into each end of the fitting when held normal to the fitting axis. For bends (> 8") the internal diameter shall be verified by passing a double gauge plate through each bend. The gauge shall have two parallel 6 mm thick aluminium plates, each a minimum of 92 % of the nominal pipe ID, separated by a distance of 100 mm.

8.0 Dimensional requirements and Tolerance:

Butt weld end thickness of fittings shall not be less than the connecting pipe thickness. Other dimensional requirements and tolerance shall be as per ASME B 16.9 for size ≤ 14" and as per MSS-SP-75 for size ≥ 16".

9.0 Marking

9.1. Marking shall be such that complete traceability is demonstrated in all stages of manufacture.

9.2. One or both ends of each fitting shall be marked with the following information:

1. Purchase Order and Item number
2. Fitting material grade
3. Nominal wall thickness at fitting ends/pipe schedule
4. Manufacturer's name/logo/trade mark
5. DN / NPS
6. Serial no. and Heat number
7. Heat Treatment batch number
8. TPI witnessed mark on fittings tested.

9.3. For fittings designed with a lower SMYS than the matching pipe, both the fitting designation and the intended matching pipe grade shall be marked.

9.4. For fittings of DN 100 and larger, markings shall be executed in block capitals of minimum height of 19 mm. For smaller fittings, the character height shall be appropriate. Identification markings shall not be applied on weld bevels.

9.5. Markings shall be made with indelible paint on the inside surface or, if it is not possible to mark on the inside surface (i.e. for smaller diameter fittings <10"), on the outside.



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10.0 Handling, storage and packing

Manufacturer shall ensure that all finished fittings are handled and stored in such a manner so as to preserve the machined faces and general surface condition of the fitting. The manufacturer shall ensure that all fittings are adequately protected against corrosion during transportation and storage by applying proper rust protective coating. Manufacturer shall take suitable corrective action if damage is observed by the Inspector/IOCL site representative due to inadequate handling or storage conditions.

11.0 Documentation

~~11.1.~~ DELETED

11.2. After purchase order

- Confirmation on standard quality assurance plan as per Annexure-III
- Sketch showing test specimen location for each test for the size of fittings proposed under each heat.
- Manufacturing drawing of steel fittings for each size and rating with tolerance where SMYS of fitting \leq SMYS of connecting pipe.
- Design calculations and/or results of proof testing for all sizes and rating of fittings indicated in purchase order.
- WPS, PQR and WQT as per ASME IX
- Procedure for NDT viz. Radiography and Ultrasonic testing
- Procedure for Heat treatment.

11.3. At the time of Despatch for each lot

- List of fittings produced/lot – size and rating, quantity, heat no.
- Manufacturer test/Mill certificate to signify compliance with specification.
- Raw material test certificate from original steel manufacturer
- Duly witnessed/reviewed documents, as applicable, as per QAP from TPI.
- Record of Heat treatment with graph, date of heat treatment for all size and rating along with Heat no.
- All Mechanical, chemical test, Hardness, impact, NDT test reports and certificates
- Dimensional inspection test reports.
- All other documents as indicated in QAP.
- The fittings shall be guaranteed by the vendor against defective materials, poor workmanship, improper design and failure in normal usage within 18 months from the date of supply.



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- The supplied fittings shall be guaranteed for withstanding hydrostatic testing along with the piping system at a pressure of 1.5 times the pressure rating specified in the summary of requirement.

Note –QAP for the Pipe fittings is attached as Annexure-VIIC-1



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STANDARD QUALITY ASSURANCE PLAN FOR PIPE FITTINGS

5. No.	Stages/ operation	Characteristics	Category	Type/ Method of check	Quantum of check	Reference documents	Acceptance Norms	Record	Scope of inspection	
									Vendor	TPI and/or IOCL
1	Raw material	1. Manufacturing process of steel	Critical	Verification with MTC	Each heat	Applicable Material Spec./STD/ IOCL-MECH-PF-061	Applicable Material Spec./STD/ IOCL-MECH-PF-061	MTC and Material incoming register	Perform	Review
		2. Chemical composition		Spectro Analysis	Each heat					
2	Forming/ Welding/ Machining	Visual, Dimension and alignment	Critical	Measurement	100%	STD Manufacturing Procedure /Internal Quality Procedure	STD Manufacturing Procedure /Internal Quality Procedure	Internal Quality documents	Perform	Review
3	Heat Treatment- Normalizing	Heat Treatment Cycle	Major	Verification of Heat Treatment Cycle	Each Heat Treatment batch	As per Material Spec./STD/ IOCL-MECH-PF-061	As per Material Spec./STD/ IOCL-MECH-PF-061	Heat Treatment Graph	Perform	Review
4	Mechanical testing	1. Tensile Test-Base (TS, YS, % RA, % EL)	Major	Tensile testing Machine	1 sample per heat Refer Note-2	As per Material & testing Spec./STD/ IOCL-MECH-PF-061	As per Material & testing Spec./ STD/ IOCL-MECH-PF-061	MTR & TC	Perform	Witness
		2. Tensile Test-weld (UTS)								
		3. Guided bend test								
		4. Hardness								
		5. Charpy V-Notch-Base and weld seam								
		6. Micro test								
		7. Product chemical analysis								
<div></div> <div>IOCL-MECH-PF-061 (Annexure-VIIC-1)</div>										
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STANDARD QUALITY ASSURANCE PLAN FOR PIPE FITTINGS

S. No.	Stages/ operation	Characteristics	Category	Type/ Method of check	Quantum of check	Reference documents	Acceptance Norms	Record	Scope of inspection	
									Vendor	TPI and/or IOCL
5	NDT- Ultrasonic Testing	UT of bevel and weld ends for lamination cracks/ defects up to width of 50 mm from the end.	Major	Ultrasonic flaw detector	100%	As per IOCL-MECH-PF-061	As per IOCL-MECH-PF-061	MTR & TC	Perform	Witness
6	NDT- Ultrasonic Testing	UT of fitting body	Major	Ultrasonic flaw detector	20% or min 2 nos. whichever is higher	As per IOCL-MECH-PF-061	As per IOCL-MECH-PF-061	MTR & TC	Perform	Witness
7	NDT- Radiography	RT of weld seam and any repair weld	Major	Radiography	100%	As per IOCL-MECH-PF-061	As per IOCL-MECH-PF-061	MTR & TC	Perform	Witness
8	Hydrotesting	Leakage testing	Major		150# & 300# 20% or min. 2 nos. whichever is higher for ≤16" 100% ≥18" 600# & 900# 20% or min. 2 nos. whichever is higher ≤8" 100% ≥ 10"	As per IOCL-MECH-PF-061	No visible leakage at 1.5 times the pressure rating	Hydrotest report	Perform	Witness
6	Final Inspection	Visual	Major	Visual	100%	As per Material Spec./STD/ IOCL-MECH-PF-061	As per Material Spec./STD/ IOCL-MECH-PF-061	MTR & TC	Perform	Witness
					150# & 300#					
					20% or min 2 nos. whichever is higher for ≤16"					
					100% for sizes ≥ 18"					
					600# & 900#					
					20% or min. 2 nos. whichever is higher for ≤8"					
					100% for sizes					


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	Prepared by		Reviewed by	
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S. No.	Stages/ operation	Characteristics	Category	Type/ Method of check	Quantum of check	Reference documents	Acceptance Norms	Record	Scope of inspection	
									Vendor	TPI and/or IOCL
7	Marking and Rust prevention, packing	Marking, color coding, Rust prevention & Packing	Major	Visual	100% ≥10"	As per Material Spec./STD/ IOCL-MECH-PF-061	As per Material Spec./STD/ IOCL-MECH-PF-061	MTR & TC	Perform	Random witness
8	Certification/ Warranty, Guarantee Certificates	As per EN 10204 Type 3.2/ Manufacturer's test certificate	Major	Verification of PO Spec. & QAP	100%	As per Material Spec./STD/ IOCL-MECH-PF-061	As per Material Spec./STD/ IOCL-MECH-PF-061	MTR & TC	Perform	Review
9	Release note.	Inspection Release note	Major	Verification of PO Spec. & QAP	100%	As per Material Spec./STD/ IOCL-MECH-PF-061	As per Material Spec./STD/ IOCL-MECH-PF-061	Release note	Hold	Review
10	Shipping & Packing	Verification of Surface coating/type of packing	Major	-	-	As per Material Spec./STD/ IOCL-MECH-PF-061	As per Material Spec./STD/ IOCL-MECH-PF-061	Shipping document/ Packing list	Hold	Review

Note.:

- In case, sub-vendor is performing operations/testing, the same is to be witnessed by vendor and relevant test certificates, reports, registers will be reviewed and/ or witnessed by TPI and/or IOCL as applicable.
- If fittings are made in different lots, then tensile test, guided bend test, impact test, Hardness and Metallography to be carried out for each heat under each lot and each heat treatment batch.
- All samples drawn for testing to be witnessed by TPI and/or IOCL.
- If order quantity is less than 2, minimum 1 no. to be witnessed.

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5. Fittings inspected by TPI and/or IOCL shall be clearly identified by marking.
6. Purchaser's Inspector reserves the right to perform stage wise inspection and witness tests as per this specification at Manufacturer's works prior to shipment. Manufacturer shall provide reasonable notice of time and shall provide, without charge, reasonable access and facilities required for inspection to purchaser's inspector.
7. Reference IOCL specification - IOCL-MECH-PF-061, Rev-1
8. Reference codes and standards as per IOCL-MECH-PF-061 Clause No.2.0
9. Material grade of fittings shall be as per technical specification IOCL-MECH-PF-061 – Table 2.
10. Manufacturing and Dimensions of Fittings shall be as per technical specification IOCL-MECH-PF-061 –: Clause No.7 unless otherwise specified
11. Color coding: Circumferential color band of 25 mm width in fitting
 - For ASTM A420 Gr. WPL6, SMLS- material grade fitting – Yellow color
 - For WPHY 52- Material grade fitting – Green color
 - For WPHY 60 -Material grade fitting -Red color
 - For WPHY 65 -Material grade fitting -White color
 - For WPHY 70 -material grade fitting –Purple/Violet color
 - For ASTM A234 WPB -material grade fitting – No color coding.

Legends : STD-Standard, PO– Purchase Order, UT – Ultrasonic examination, NDT-Non destructive testing, Spec.- Specification, MTC-Material test certificate, TC-Test certificate, MTR-Material test report

All the NDT / Heat Treatment / Special manufacturing procedures have to be specially approved by purchaser or only previously approved procedures have to be used upon review by purchaser.

In case of conflict between specific requirements of project, technical Spec., purchasing documents, contract documents and ITP, more stringent conditions shall be applicable. The document describes generally the requirements pertaining to all types of fittings. Requirements specific to particular item are only applicable

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D. Specifications of Carbon Steel Flanges

1.0 Scope

- 1.1. This Specification shall be used in combination with enclosed "Specific requirement of Project".
- 1.2. "Specific requirement of project" indicates size, rating of flange, quantity, connecting pipe thickness, connecting pipe material grade, fluid characteristics, any additional tests and requirements, any modification to this specification based on particular project design conditions and requirements.
- 1.3. This specification defines the technical requirements for the design, materials, manufacturing, testing and inspection, marking and shipment of forged carbon steel flanges of the welding neck type, blind flange and Slip on Flanges.
- 1.4. This specification is applicable only to non-sour service and for onshore crude oil, petroleum products, Natural Gas and LPG service.
- 1.5. This specification is applicable for flanges of pressure rating 150# to 900#.
- 1.6. This specification is applicable for flanges from size ½" to 48" with applicable pressure rating as specified.

2.0 Reference codes and standards

- 2.1. Unless otherwise specified, requirements of the latest editions of the referenced Codes and Standards at time of purchase order to be used.
- 2.2. Reference codes and standards to be used in conjunction with this specification.
- 2.3. Order of precedence of applicable documents shall be as under:

1. Specific requirement of project (As per Annexure-I)
2. This specification
3. Reference codes and standards

S.No.	Reference	Description
1.	ISO 15590-3	Petroleum and natural gas industries — Induction bends, fittings and flanges for pipeline transportation systems — Part 3: Flanges
2.	ASME B16.25	Butt welding Ends
3.	ASME B 16.20	Ring-Joint Gaskets and Grooves for Steel Pipe Flanges
4.	ASME B16.47	Large Diameter Steel Flanges NPS 26 Through NPS 60 Metric/Inch Standard
5.	ASME B 16.5	Pipe flanges and flanged fittings
6.	ASME B31.4	Pipeline Transportation Systems for Liquid Hydrocarbons and



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S.No.	Reference	Description
		other Liquids
7.	ASME B31.8	Gas Transmission and Distribution Piping Systems
8.	ASME section V	Boiler and Pressure Vessel Code. Non-destructive Examination
9.	ASME section VIII	Boiler and Pressure Vessel code - Section VIII: Pressure Vessels Design
10.	API 5L	Specification for Line pipe
11.	MSS SP 44	Steel pipe line flanges
12.	ASTM A 370	Test Methods and Definitions for Mechanical testing of Steel Products
13.	ASTM A 388/A 388M	Practice for Ultrasonic Examination of Heavy Steel Forgings
14.	ASTM A 694/A 694M	Specification for Forgings, Carbon and Alloy Steel for Pipe, Flanges, Fittings, Valves and Parts for High – Pressure Transmission Services
15.	ASTM E 10	Test method for Brinell Hardness of Metallic Materials
16.	ASTM E 23	Method for Notched Bar Impact Testing of Metallic Materials
17.	ASTM E 709	Guide for Practice of Magnetic Particle Examination
18.	ISO 148	Charpy impact test (V-notch)
19.	AWWA C207	Steel Pipe Flanges for Waterworks Service, Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm)

3.0 Design:

- 3.1. Flanges shall comply with the requirements of ASME B16.5/ASME B16.47/MSS SP 44 as indicated in this specification and as per “specific requirement of project”.
- 3.2. Pressure-temperature ratings shall be as per MSS SP 44/ISO 15590-3
- 3.3. Flanges shall be made from forging material meeting the requirements of this specification, applicable codes and material specification.
- 3.4. The dimensions of flanges shall be as per ASME B16.5 for NPS ½” to 24” (except 22”), ASME B16.47 Series A/MSS SP-44 for 22” size and from NPS 26” to 36” and ASME B16.47 series B for above 36”.
- 3.5. Design factor of flanges shall be 0.6 and the flanges are to be guaranteed by vendor for Hydrotest pressure of 1.5 times the pressure rating.
- 3.6. Wall thickness of flange weld neck (hub) shall not be less than the connecting pipe thickness indicated in any case.



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Note: For Natural Gas service, connecting pipe thickness shall be as per PMS (Piping Material Specification).

- 3.7. Pipe flanges end thickness and grade shall be selected in such a way that flange meets the design stress criteria mentioned in Annex-A of MSS-SP-44.
- 3.8. Nominal bore of WNRF shall be that of the connecting pipeline.
- 3.9. Bore of slip on flanges shall suit the outside diameter of matching pipe.
- 3.10. The welding end shall be in accordance with Figure 2 of MSS-SP-44 for wall thickness (of intended connecting pipe) of 22 mm (0.88 in.) and less. For thicker walls greater than 22, Figure 3 of MSS-SP-44 to be referred.
- 3.11. When the mechanical (specified minimum yield strength) properties of all sections of the flanges are equal to or higher than those of the pipe to be matched, the hub dimensions to be maintained same as those indicated in ASME B16.5/ASME B16.47/MSS-SP-44 as applicable.
- 3.12. When the specified minimum yield strength of any portion of flange is less than that specified for the pipe to be matched, the minimum thickness of the hub at the welding end shall be such that the product of its thickness times its yield strength shall be at least equal to the product of the specified nominal wall thickness and minimum specified yield strength of the pipe to be matched in accordance with MSS-SP-44.
- 3.13. When the hub thickness at the welding end is greater than the adjoining pipe, the joint design shall be as shown in any of the three sketches in Figure 1 of MSS-SP-44.
- 3.14. Unless otherwise specified, raised face shall be used for flange rating 150# to 900#.
- 3.15. Flange facings shall be in accordance with MSS SP 44/ASME B 16.47 and ANSI B 16.5, as applicable. Flange Facing Finish Imperfections shall not exceed the dimensions shown in Table 11 of MSS SP 44. Adjacent imperfections shall be separated by a distance of at least four times the permissible radial projection. Protrusions above the separations are not allowed.
- 3.16. The surface finish of raised face and flat face of all flanges shall have serrated concentric surface finish with an average roughness of 3.2 μm (125 μin) to 6.3 μm (250 μin).
- 3.17. AWWA type flanges shall be as per AWWA C207 Class E with Hub type and to be supplied with flat face.
- 3.18. Steel forgings to be used in the manufacture of AWWA flanges and mechanical and chemical properties shall meet clause 4.1.3.1 of AWWA C207.

4.0 Flange material

4.1. Chemical composition

- 4.1.1. All flange forged material shall be fully killed and made to fine grain practice.



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- 4.1.2. All flanges shall be normalised irrespective of size and rating. Vendor shall submit the heat treatment procedure for purchaser's approval. A record (heat treat chart) shall be maintained of each heat treatment batch and shall be included in the inspection document.
- 4.1.3. The final microstructure produced after heat treatment shall be uniform with average grain size of ASTM 7 or finer as per ASTM E 112.
- 4.1.4. Manufacturer shall carry out a chemical analysis on each heat of steel used and also on two products per heat.
- 4.1.5. Chemical composition of flanges shall be as per Table-4 of ISO 15590-3 with the following changes.
- Nitrogen concentration shall be limited to 0.012% Max.
 - V+Nb+Ti shall not exceed 0.15%
 - Cr+Mo+Ni+Cu shall not exceed 0.6%.
- 4.1.6. Maximum Carbon Equivalent shall be 0.43% when calculated with the following formula:

$$CE = C + \frac{Mn}{6} + \frac{(Cr+Mo+V)}{5} + \frac{Cu+Ni}{15}$$
- 4.1.7. If any chemical analysis (both raw material and product) fails to meet the requirements stated above, the whole heat shall be rejected or each individual product shall be fully analysed and all products failing to meet the requirements shall be rejected.

4.2. Material grade

Flange material shall comply with as per the requirements indicated below unless otherwise specified. Please refer specific requirement of project for connecting pipe thickness and grade.

For Natural Gas service, Flange material shall be as per PMS (Piping Material Specification) enclosed along with the tender.

Material grade for flanges (for crude oil and product pipelines)

Material grade	Flange type	Pressure rating			
		150#	300#	600#	900#
ASTM A105	WNRF/SORF/BLRF	1/2"-48"	1/2"-18"	1/2"-6"	1/2"-6"
ASTM A694 F52	WNRF/BLRF	-	20"-28"	8"-14"	-
ASTM A694 F60/F65/F70#	WNRF/BLRF	-	30"-48"	16"-36"	8"-24"



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Material grade for flanges (for LPG piping)

Material grade	Flange type	Pressure rating	
		300#	600#
ASTM A350 LF2 Cl2	WNRF/BLRF	1/2"-6"	1/2"-6"
ASTM A105	WNRF/BLRF	8"-16"	-
ASTM A694 F52	WNRF/BLRF	18"-24"	8"-10"
ASTM A694 F60/F65/F70#	WNRF/BLRF	-	12"-24"

Note:

1. # - If flange material SMYS is less than connecting pipe SMYS, then clause 3.10 & 3.11 to be followed.
2. For 8" size, if low temperature is specified, then ASTM A350 LF2 to be selected.

5.0 Manufacturing & Dimensional requirements

Manufacturing & Dimensional requirements of flanges shall be as per following:

Details	Up to 20" & 24"	22" & 26" to 36"	> 36" (only for 150# and 300#)
For WNRF & BLRF Flange			
a Manufacturing & Dimension	ANSI B 16.5 / MSS SP 44 (12"-24")	ANSI B 16.47 Series A / MSS SP 44	ASME B16.47 Series B
For SORF Flanges (for 150# only)			
b Manufacturing, Dimensions	ANSI B 16.5	AWWA C207 Class E	AWWA C207 Class E

6.0 Inspection and testing:

6.1. General instruction

- 6.1.1. Test pieces shall be prepared in accordance with ISO 377. If thermal cutting has been used to remove samples, the full extent of the heat-affected region shall be removed during the preparation of the test pieces.



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6.1.2. Mechanical testing samples shall consist of sacrificial forging. The testing of separately forged bars should not be permitted. All inspection and testing cost shall be included in cost of flange itself.

6.2. Summary of testing, inspection and extent of testing:

All stage inspection shall be carried out by third party Inspection agency engaged by the vendor. However, final inspection shall be carried out by owner's designated third party inspection agency and/or IOCL as per approved QAP.

S.No.	Tests	Sample frequency		Inspection
1	Heat analysis (raw material)	One per heat		Review
2	Product analysis	Two per heat		100% Witness
3	Tensile testing, Impact testing, Hardness and Metallography	One per heat/lot/each heat treatment batch		100% Witness
4	Visual inspection	For all flanges		100% witness
5	Ultrasonic Testing of weld ends for lamination cracks/other defects up to a width of 50 mm from weld end	For all flanges		100% witness
6	Physical and Dimensional Check	150# & 300#	20% or min. 2 nos. whichever is higher for sizes $\leq 16''$	100% witness
			100% for sizes $\geq 18''$	
		600#	100%	
		900#	100%	

Note:

- If fittings are made in different lots, then destructive testing to be carried out for each heat under each lot and each heat treatment batch.
- All samples drawn for testing to be witnessed by TPI and/or IOCL.
- If order quantity is less than 2, minimum 1 no. to be witnessed.
- Flanges inspected by TPI and/or IOCL shall be clearly identified by marking
- Purchaser's Inspector reserves the right to perform stage wise inspection and witness tests as per this specification at Manufacturer's works prior to shipment. Manufacturer shall provide reasonable



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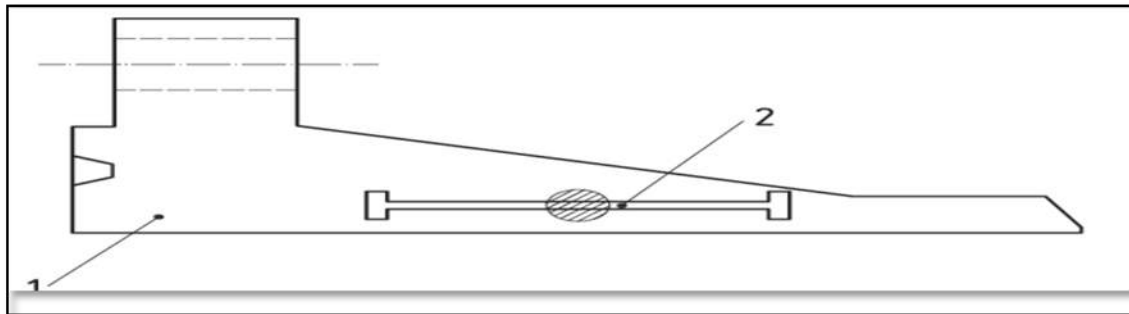
notice of time and shall provide, without charge, reasonable access and facilities required for inspection to purchaser's inspector.

6.3. Tensile testing:

6.3.1. Tensile tests shall be carried out in accordance with ASTM A 370.

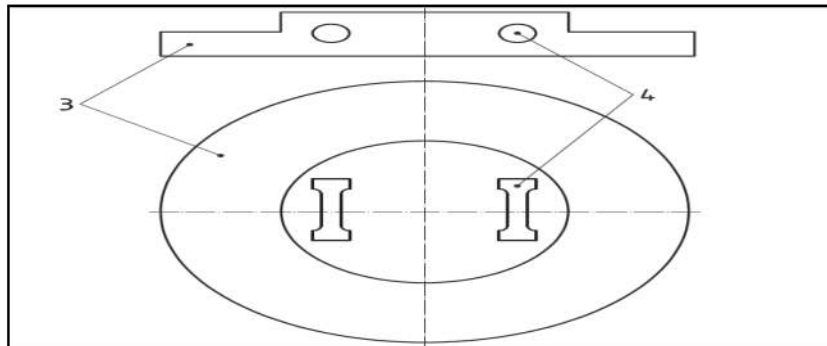
6.3.2. Sample orientation of tensile test is as per ISO 15590-3.

6.3.3. For weld-neck flanges:



Note: Marking 1- Welding neck flange, Marking 2- Longitudinal tensile specimen.

6.3.4. For Blind flanges:



Note: Marking 3- Blind flange, 4- Transverse tensile specimen.

6.3.5. Tensile properties of sample tested shall meet values as per material specification grade indicated viz. ASTM 105/ASTM A694 w.r.t yield strength, ultimate strength, elongation.

6.4. Charpy V-notch impact test:



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- 6.4.1. Charpy V-notch test pieces shall be prepared in accordance with ASTM A 370/ ISO 148-1 with the axis of the notch perpendicular to the flange surface.
- 6.4.2. The orientation and size of the test pieces shall be as follows:
- 6.4.2.1. Actual location of specimen shall be that nearest to the welded end from which 10 mm × 10 mm Charpy specimens can be taken.
- 6.4.2.2. If transverse specimen of 10 mm is not possible, then sub-size specimen can be taken.
- 6.4.2.3. If transverse test pieces with a minimum width of 5 mm are not possible, longitudinal test pieces with the greatest possible width between 10 mm and 5 mm shall be used.
- 6.4.3. % shear area at the fracture surface to be reported.
- 6.4.4. Each set of impact tests shall consist of three adjacent test pieces.
- 6.4.5. The impact test temperature shall be 0°C for petroleum and crude oil service and -29°C for LPG service. For low temperature carbon steel material, impact energy and testing temperature shall be as per respective material grade specification.
- 6.4.6. Min. average and min. individual value for transverse direction shall meet the following requirements.

Material grade	Min. Average Value (J)	Min. individual value (J)
ASTM A105	27	22
F52 (360)	36	30
F60 (415)	42	35
F65 (450)	45	38
F70 (485)	50	40

- 6.4.7. The minimum average and individual Charpy V-notch values when testing test pieces taken in the longitudinal direction shall be at least 1.5 times the values stated for transverse test pieces.

6.4.8. For Natural Gas Service, impact test shall be carried out as per PMS (Piping Material Specification) enclosed along with the tender.

6.5. Hardness requirements

- 6.5.1. Three through thickness macro sections shall be taken at 120 ° intervals from the hub and ring of the test flange.
- 6.5.2. Three hardness traverses shall be made on each macro section as follows:
- 1.5±0.5 mm from the outer surface
 - Mid-thickness
 - 1.5±0.5 mm from the inner surface
- 6.5.3. Each traverse shall consist of five indents.
- 6.5.4. No hardness reading shall exceed 248 HV10

6.6. Non destructive testing:



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Flanges shall be subject to the following inspection:

- 6.6.1. Ultrasonic inspection as specified - Ultrasonic testing shall be carried out in accordance with ASME V or ASTM A 388/A 388M.
 - The final 50 mm of weld end of the flange shall be UT inspected for the detection of laminar imperfections in accordance with ISO 11496. The reference standard shall be a flat bottom hole.
- 6.6.2. The bevel faces shall be machined and shall be free from cracks, laminations, notches, scores, pits etc.
- 6.6.3. 100% visual inspection of internal and external surfaces- Forgings shall comply with the workmanship, finish and appearance requirements of ASTM A 694/ASTM A105.
- 6.6.4. Final NDT shall be carried out after heat treatment with the forging in the finish-machined condition.

6.7. Hydrostatic testing

Hydrostatic testing of flanges is not required unless otherwise specified. Flanged joints may be subjected to system hydrostatic tests at a pressure limited to 1.5 times the pressure rating. The manufacturer shall certify and guarantee that the flange can withstand the hydrostatic test pressures.

6.8. Dimensional requirements:

- 6.8.1. WNRF and Blind Flanges shall be machined according to the dimensions of ASME B16.5 for sizes up to 24" (except 22"), as per MSS SP 44/ASME B 16.47 series A for sizes 22" and above 24" to 36" and as per ASME B16.47 series B for sizes above 36".
- 6.8.2. For slip on flanges, dimensions shall be as per ASME B 16.5 for sizes up to 24" and as per AWWA C207 Class E (275PSI) hub type for size above 24".
- 6.8.3. If flange material SMYS is less than connecting pipe SMYS, then clause 3.10 & 3.11 to be followed.

6.9. Tolerance:

Tolerances shall be as per ASME B 16.5 for sizes $\leq 10"$ and as per MSS-SP-44 for sizes $> 10"$

6.10. Repair of defects

Minor surface defects on flanges shall be ground out leaving a smooth gradual profile provided that the wall thickness is not reduced below the tolerances specified. Any ground areas (except for cosmetic grinding) shall be examined by ultrasonic inspection. Forgings containing larger defects shall be rejected. Repair welding of forgings is not allowed.

7.0 Marking

- 7.1. Marking shall be such that complete traceability is demonstrated in all stages of manufacture.



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7.2. Each flange shall be clearly identified on the outside rim using the following marking

7.3. Each flange shall be marked as a minimum with the following information:

1. Company's name/logo/trade mark
2. DN / NPS
3. Wall thickness/pipe schedule
4. Class
5. Serial no. and Heat number
6. Purchase order No.
7. Material grade of forging
8. TPI witnessed mark on flange tested.

8.0 **Handling, storage and packing**

Manufacturer shall ensure that all finished flanges are handled and stored in such a manner so as to preserve the machined faces and general surface condition of the forging. The manufacturer shall ensure that all flanges are adequately protected against corrosion during transportation and storage by applying proper rust protective coating.

Manufacturer shall take suitable corrective action if damage is observed by the Inspector/IOCL site representative due to inadequate handling or storage conditions.

9.0 **Documentation**

9.1. ~~During bid submission~~ (Vendor as per approved vendor list)

9.2. After purchase order

- Confirmation on Standard Quality assurance procedure (As per Annexure-III)
- Sketch showing test specimen location for each test for the size of flange proposed under each heat.
- Manufacturing drawing of steel flange for each size and rating with tolerance where SMYS of flange \leq SMYS of connecting pipe.

9.3. At the time of Despatch for each lot

- List of flanges produced – size and rating, quantity, heat no.
- Manufacturer test/Mill certificate to signify compliance with specification.
- Raw material test certificate from original steel manufacturer
- Duly witnessed/reviewed documents, as applicable, as per QAP from TPI.
- Record of Heat treatment with graph, date of heat treatment for all size and rating along with Heat no.
- All Mechanical, chemical test, Hardness, impact, NDT test reports and certificates
- Dimensional inspection test reports.



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- All other documents as indicated in QAP.
- The flange shall be guaranteed by the vendor against defective materials, poor workmanship, improper design and failure in normal usage within 18 months from the date of supply.
- The supplied flanges shall be guaranteed for withstanding hydrostatic testing along with the piping system at a pressure of 1.5 times the pressure rating specified in the summary of requirement.

Note: QAP for Carbon Steel Flanges is attached as Annexure – VIID-1



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S. No.	Stages/ operation	Characteristics	Category	Type/ Method of check	Quantum of check	Reference documents	Acceptance Norms	Record	Scope of Inspection	
									Vendor	TPI and/or IOCL
1	Raw material	1. Manufacturing process of steel	Critical	Verification with MTC	Each heat	Applicable Material Spec./STD/ IOCL-MECH-FLANGES-66	Applicable Material Spec./STD/ IOCL-MECH-FLANGES-66	MTC and Material incoming register	Perform	Review
		2. Chemical composition		Spectro Analysis	Each heat					
2	Forging	1. Reduction ratio	Critical	Measurement	Minimum 1 per size	STD Manufacturing Procedure	STD Manufacturing Procedure	Forging process record / Internal Register	Perform	Review
		2. Temperature during forging		Optical Pyrometer						
		3. Forging dimensions		Measurement	100%		ASME B16.5/ ASME B16.47/ MSS-SP-44 as applicable			
3	Heat Treatment	Heat Treatment Cycle	Major	Verification of Heat Treatment Cycle	Each Heat Treatment batch	As per Material Spec./STD/ IOCL-MECH-FLANGES-66	As per Material Spec./ STD/ IOCL-MECH-FLANGES-66	Heat Treatment Graph	Perform	Review
4	Mechanical testing	1. Tensile Test (TS, YS, % RA, % EL)	Major	Tensile testing Machine	1 sample per heat Refer Note-2	As per Material & testing Spec./STD/ IOCL-MECH-FLANGES-66	As per Material & testing Spec./ STD/ IOCL-MECH-FLANGES-66	MTR & TC	Perform	Witness
		2. Hardness		Hardness tester						
		3. Charpy V-Notch		Impact testing machine						
		4. Micro test		Metallography						
		5. Product chemical analysis		Spectro Analysis	Two samples per heat Refer Note-2					

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S. No.	Stages/ operation	Characteristics	Category	Type/ Method of check	Quantum of check		Reference documents	Acceptance Norms	Record	Scope of Inspection	
										Vendor	TPI and/or IOCL
5	NDT- Ultrasonic Testing	UT of bevel and weld ends for lamination cracks/ defects up to a length of 50 mm from the end.	Major	Ultrasonic flaw detector	100%		As per Material & testing Spec./STD/ IOCL-MECH-FLANGES-66	As per Material & testing Spec./STD/ IOCL-MECH-FLANGES-66	MTR & TC	Perform	Witness
6	Final Inspection	Visual	Major	Visual	100%		As per Material Spec./STD/ IOCL-MECH-FLANGES-66	As per Material Spec./STD/ IOCL-MECH-FLANGES-66	MTR & TC	Peform	Witness
		Dimension		Measurement	150#	20% or min 2 nos. whichever is higher for ≤16"					
					300#	100% for sizes ≥ 18"					
					600#	100%					
					900#	100%					
7	Marking and Rust prevention, packing	Marking, color coding, Rust prevention & Packing	Major	Visual	100%		As per Material Spec./STD/ IOCL-MECH-FLANGES-66	As per Material Spec./STD/ IOCL-MECH-FLANGES-66	MTR & TC	Peform	Random witness
8	Certification/ Warranty, Gurantee Certificates	As per EN 10204 Type 3.2/ Manufacturer's test certificate	Major	Verification of PO Spec. & QAP	100%		As per Material Spec./STD/ IOCL-MECH-FLANGES-66	As per Material Spec./STD/ IOCL-MECH-FLANGES-66	MTR & TC	Peform	Review
9	Release note.	Inspection Release note	Major	Verification of PO Spec. & QAP	100%		As per Material Spec./STD/ IOCL-MECH-FLANGES-66	As per Material Spec./STD/ IOCL-MECH-FLANGES-66	Release note	Hold	Review
10	Shipping & Packing	Verification of Surface coating/type	Major	-	-		As per Material Spec./STD/	As per Material Spec./STD/	Shipping document/	Hold	Review

	IOCL-MECH-FLANGES-066 (Annexure-VIID-1)			
		Prepared by	Reviewed by	Approved by
		Rev	02	
		Date		

STANDARD QUALITY ASSURANCE PLAN FOR STEEL FLANGES


S. No.	Stages/operation	Characteristics	Category	Type/Method of check	Quantum of check	Reference documents	Acceptance Norms	Record	Scope of Inspection	
									Vendor	TPI and/or IOCL
		of packing				IOCL-MECH-FLANGES-66	IOCL-MECH-FLANGES-66	Packing list		

Note :

1. In case, sub-vendor is performing operations/forging/testing, the same is to be witnessed by vendor and relevant test certificates, reports, registers will be reviewed and/or witnessed by TPI and/or IOCL as applicable.
2. If flanges are made in different lots, then tensile test, impact test, Hardness and Metallography to be carried out for each heat under each lot and each heat treatment batch.
3. All samples drawn for testing to be witnessed by TPI and/or IOCL.
4. If order quantity is less than 2, minimum 1 no. to be witnessed.
5. Flanges inspected by TPI and/or IOCL shall be clearly identified by marking.
6. Purchaser's Inspector reserves the right to perform stage wise inspection and witness tests as per this specification at Manufacturer's works prior to shipment. Manufacturer shall provide reasonable notice of time and shall provide, without charge, reasonable access and facilities required for inspection to purchaser's inspector.
7. Reference IOCL specification - IOCL-MECH-FLANGES-066, Rev-2
8. Reference codes and standards as per IOCL-MECH-FLANGES-066 Clause No.2.0
9. Material grade of flanges shall be as per technical specification IOCL-MECH-FLANGES-066 Clause No.4.2.
10. Manufacturing and Dimensions of Flanges shall be as per technical specification IOCL-MECH-FLANGES-066 Clause No.5 unless otherwise specified
11. Color coding: Circumferential color band of 25 mm width in flange hub in WNRF and line of 25 mm width in BLRF
 For ASTM A350 LF2 Cl2 material grade flange – Yellow color
 For ASTM A694 F52 material grade flange – Green color
 For ASTM A694 F60 material grade flange -Red color
 For ASTM A694 F65 material grade flange -White color
 For ASTM A694 F70 material grade flange –Purple/Violet color
 For ASTM A105 – No color coding.


Legends : STD-Standard, PO– Purchase Order, UT – Ultrasonic examination, NDT-Non destructive testing, Spec.- Specification, MTC-Material test certificate, TC-Test certificate, MTR-Material test report

All the NDT / Heat Treatment / Special manufacturing procedures have to be specially approved or only previously approved procedures have to be used.

	IOCL-MECH-FLANGES-066 (Annexure-VIID-1)			
		Prepared by	Reviewed by	Approved by
		Rev	02	
		Date		
PIPELINES				

STANDARD QUALITY ASSURANCE PLAN FOR STEEL FLANGES

In case of conflict between specific requirements of project, technical Spec., purchasing documents, contract documents and ITP, more stringent conditions shall be applicable. The document describes generally the requirements pertaining to all types of Flanges. Requirements specific to particular item are only applicable

 PIPELINES	IOCL-MECH-FLANGES-066 (Annexure-VIID-1)			
		Prepared by	Reviewed by	Approved by
		Rev	02	
		Date		

E. TECHNICAL SPECIFICATION FOR SPIRAL WOUND METALLIC GASKET

Clause	Area	Description	Requirements/Remarks
1.0	Scope	Design, manufacture, testing, inspection and supply of spiral wound metallic gaskets for raised face carbon steel forged flanges.	Rating and Quantity as per specific requirement of the project
2.0	Service	Liquid Hydrocarbon/LPG/ Natural Gas/Water	
3.0	Design and Codes	<p>Size of Gasket - Suitable for WNRF/BLRF/SORF (up to 24") manufactured to –</p> <ul style="list-style-type: none"> ▪ ANSI B 16.5 standard up to 24" size except 22" ▪ MSS SP 44/ASME B16.47 Series A for flanges 22" and between 26" – 36" ▪ ASME B16.47 Series B for sizes more than 36". 	<p>The gasket configuration shall be as per ASME B 16.20 with SS 316L spiral strip + graphite filler (Grafoil) + SS 316L inner compression ring + Carbon Steel outer (centering) rings. Material of Inner Compression ring shall be same as Spiral Strip material</p> <p>Filler material for spiral wound gaskets shall not have any colour or dye. Colour coding shall be as per ASME B 16.20</p>
4.0	Material -	As per ASME B 16.20 standard	
5.0	Testing and Inspection	i) Dimensional Check	W-10% or minimum 1 no. whichever is higher for each rating and size
		2) Physical and Chemical properties	<p>Review -100% Manufacturer's Raw material test certificate for filler material and spiral material, inner and outer ring for each heat as per applicable material specification.</p> <p><i>All stage inspection shall be carried out by third party Inspection agency engaged by the vendor. However, final inspection shall be carried out by owner's designated third party</i></p>



PIPELINES

IOCL-MECH-SWMG-062

Document No.: IOCL-CGD-STEEL PIPELINE-SPEC

Rev. No. 0.0

Date 03.02.2021

Clause	Area	Description			Requirements/Remarks
		3)	Compression and Sealability recovery test	Review-100% Manufacturer's test certificate for Compression and Sealability recovery test for gasket to be submitted for each size and rating.	<i>inspection agency and/or IOCL as per approved QAP</i>
6.0	Marking & Packing	The centering ring of each spiral wound gasket shall be permanently marked with the following information <ul style="list-style-type: none">- Nominal size- Pressure rating- Winding material mark as “ANSI type 316”.- Filler material mark as “Grafoil”.- Identification ASME B 16.20- Temperature- centering and inner ring metal abbreviation- flange identification. (ASME B16.5/16.47 A/16.47B/MSS-SP-44)- Manufacturer’s name and trademark			Gaskets of different types and sizes shall be placed in separate shipping containers and each container clearly marked with the size, rating, material specification and item code
7.0	Documentation	i) With Bid			
		a) Supply record of similar size and rating. b) Dimensional drawing indicating material grade, design code etc.			c) Compliance letter from the manufacturer that the gasket shall be manufactured as per the furnished specification
		ii) After Order, for approval (In 4 sets)			
		a) Dimensional drawing indicating material grade, design code etc. b) Inspection and test plan(ITP)			b) Testing and inspection plan.
		iii) After Inspection for dispatch clearance (In 4 sets)			
		1. Inspection report and certification as per requirement of code /ITP			



PIPELINES

IOCL-MECH-SWMG-062

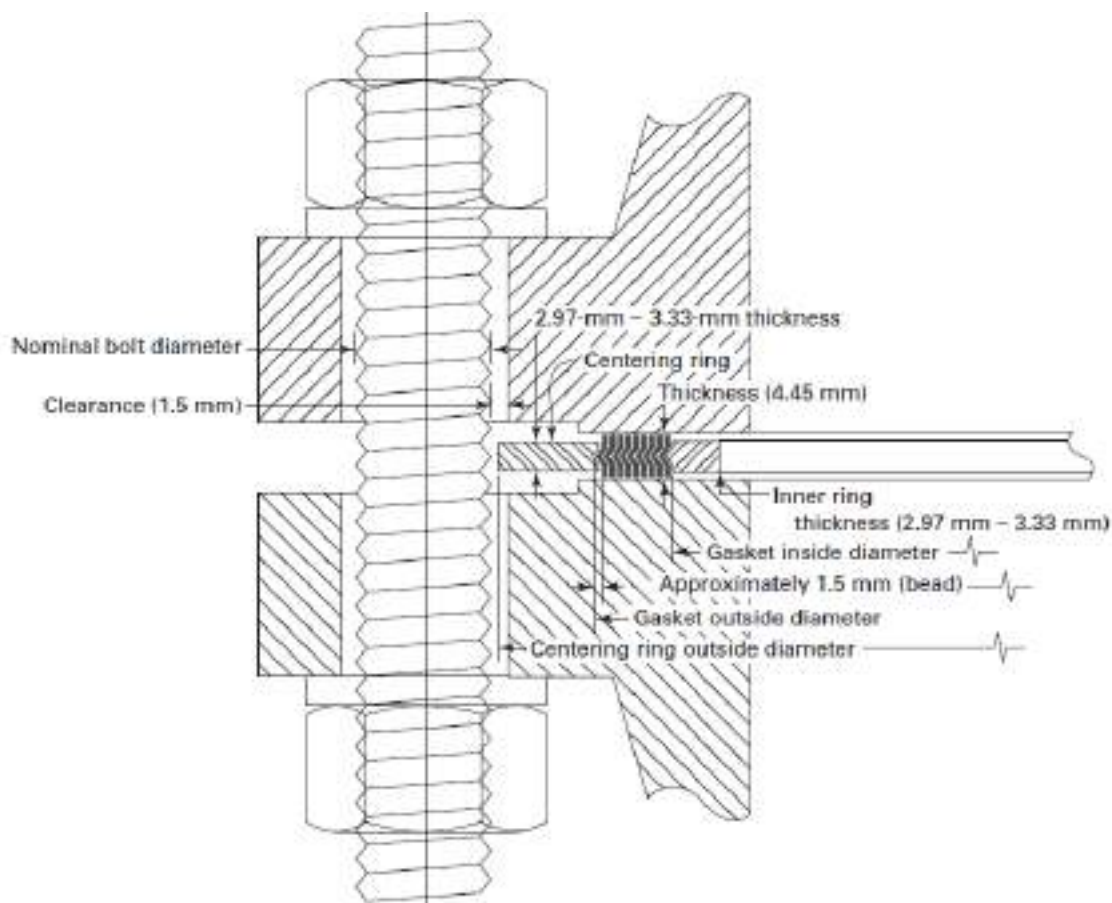
Document No.: IOCL-CGD-STEEL PIPELINE-SPEC

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Date 03.02.2021

Clause	Area	Description	Requirements/Remarks
8.0	Warranty	<ul style="list-style-type: none"> Vendor to furnish guarantee that supplied gaskets shall withstand the hydrostatic testing at the pressure up to 1.5 times the pressure rating specified in the specific requirement. 	<ul style="list-style-type: none"> All gaskets shall be free of any defects due to design, manufacture and material.

SPIRAL WOUND METALLIC GASKET



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F, TECHNICAL SPECIFICATION FOR STEEL FASTENERS

Clause	Area	Description	Requirements/ Remarks
1.0	Scope	Design, manufacture, testing, inspection and supply of alloy steel bolting materials, nuts and washers for valves, flanges etc. Each bolt shall be supplied with matching two nuts and two washers.	Nominal size (Diameter & Length) as per specific requirement of the project.
2.0	Service	Crude/Petroleum Products/Water/LPG/ Natural Gas	As specified
3.0	Design and Codes Materials for fasteners for Natural Gas service shall be in accordance with PMS (Piping Material Specification) attached along with the tender.	Stud Bolts: ASTM A 193 Gr. B7/ Gr. B7M for normal service ASTM A320 Gr. L7 for low temperature	Dimensions of stud bolts and nuts: ANSI B 18.2.1/ANSI B 18.2.2
		Nuts: ASTM A 194 Gr.2H/ Gr.4/ Gr.7 for normal service ASTM A194M for low temperature	Threading for stud bolts and nuts and tolerance of threads: ANSI B 1.1
		Washers: Toughened mild steel	Testing of steel fasteners (All supplements included) as per relevant codes
		Tolerance for material: ASTM A 29 and ANSI B 1.1	Proof load test on nuts: ASTM A 194
		Bolting details: ANSI B16.5	
4.0	Provisions	<i>Bolting material covers studs, nuts and washers.</i> Nuts shall be of hexagonal shape.	For 1 inch and smaller in diameter, all stud bolts and nuts threaded in accordance with coarse series (UNC) and for 1 1/8 inch and larger in diameter with 8 pitch thread series (8 UN) of the Code ANSI B 1.1 Class 2 A fit.
5.0	Inspection & Testing	i) Check of chemical analysis and certificate.	All test as specified in code shall be carried out by manufacturer at their works. Test certificates including records/results of ladle analysis to be supplied just after testing but not later than despatch of the material.
		ii) Check of mechanical analysis and certificate.	
		iii) Physical Dimensional Check (W- Random)	<i>All stage inspection shall be carried out by third party Inspection agency engaged by the vendor. However,</i>



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Date 03.02.2021

Clause	Area	Description			Requirements/ Remarks
		iv)	Final documentation check	R	<i>final inspection shall be carried out by owner's designated third party inspection agency and/or IOCL as per approved QAP.</i> R - Review, W – Witness
6.0	Painting	Brush Cleaning + Rust Preventive Coating			
7.0	Marking	Stud Bolts			Material & manufacturer's identification mark stamped as per code
		Nuts			Material & manufacturer's identification mark stamped as per code
8.0	Documentation	i) With Bid-			
		a) Supply record			
		ii) After Inspection for Dispatch Clearance (In 4 sets)			
		Inspection report and certification as per requirement of code			
9.0	Shipment	After testing and before shipment, all stud bolts, nuts and washers shall be cleaned of dirt, dust, rust, mill scales etc. and the threads shall be properly greased before packing them in wooden crates for avoiding formation of rust.			Stud bolts, nuts and washers of same size shall be supplied in lots with the sizes and item description clearly marked on the respective wooden crates. Along with the materials, the manufacturer shall enclose three copies of packing list.
10.0	Warranty	All fasteners shall be free of any defects due to design, manufacture and material.			



PIPELINES

IOCL– MECH-FAST-063

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Rev. No. 0.0

Date 03.02.2021

G. SPECIFICATION FOR HALF COUPLING & NIPPLE

Clause	Area	Description	Requirements / Remarks
1.0	Scope	Design, manufacture, testing and supply of Butt-welded steel nipples and half couplings	Rating and Quantity as per specific requirement of the project.
2.0	Service	Natural Gas	
3.0	Design and codes	<u>A) Specific Requirement for Nipple</u>	
		Code of Conformity-	ANSI B 16.9/ASME B36.10
		Ends -	Butt-welded and plain bevel
		Material -	ASTM A350 LF2/ASTM A333 Gr.6
		Pressure rating-	6000 lbs.
		Normalized or quenched and tempered. Tempering temperature shall not be less than 1100 ⁰ F.	
		<u>B) Specific Requirement for Half Couplings</u>	
		Code of Conformity-	- ANSI B 16.11
		Ends -	Socket-weld ends
		Material -	ASTM A350 LF2
		Pressure rating-	6000 lbs.
		Normalized or quenched and tempered. Tempering temperature shall not be less than 1100 ⁰ F.	
		<u>Materials for Natural Gas service shall be in accordance with PMS (Piping Material Specification) attached along with the tender.</u>	
4.0	Testing	<ul style="list-style-type: none"> All tests as specified in code shall be carried out at manufacturer's works Test certificates (material test) review and physical dimensional check shall be carried out by owner or authorized third party inspector. <p><i>All stage inspection shall be carried out by third party Inspection agency engaged by the vendor. However, final inspection shall be carried out by owner's designated third party inspection agency and/or IOCL as per approved QAP</i></p>	
5.0	Painting	Brush Cleaning + Rust Preventive Coating	
6.0	Documentation	i) With Bid	
		a) Supply record	
		ii) After inspection for Despatch clearance (In 4 sets)	
		a) Inspection report and certification as per requirement of code.	
7.0	Shipment	<ul style="list-style-type: none"> All fittings shall be dried and packed properly for shipment. All openings shall be properly covered before packing. 	



PIPELINES

IOCL-MECH-HC & NIP-064

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Clause	Area	Description	Requirements / Remarks
8.0	Warranty	<ul style="list-style-type: none"> The vendor shall guarantee that the supplied nipples and half couplings shall successfully withstand the applicable hydrostatic test pressure of connecting pipes as per ASME 31.8 standard, during hydro-test of pipes at field 	<ul style="list-style-type: none"> All nipples and half couplings shall be free of any defects due to design, manufacture and material. Any defective nipples and half couplings, so detected within one year of operation or 18 months from the date of supply shall be replaced free of cost by the supplier.



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IOCL-MECH-HC & NIP-064

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H. SPECIFICATION FOR WELD-O-LET

Clause	Area	Description	Requirements / Remarks
1.0	Scope	Design, manufacture, testing and supply of weld-o-lets for branch connections for the piping system	Rating, Quantity and size of Run pipe & Outlet pipe as per specific requirement of the project
2.0	Service	Natural Gas	
3.0	Design and Codes	Manufactured in accordance with MSS-SP 97 (Integrally Reinforced Forged Branch Outlet Fittings)	
4.0	Provisions	<p>Maximum working pressure for design of Weld-O-Lets shall be as follows:</p> <p>a) For ANSI 150 Sr.- 275 Psi b) For ANSI 300 Sr.- 720 Psi c) For ANSI 400 Sr.- 960 Psi d) For ANSI 600 Sr.- 1440 Psi</p> <p>Weld ends shall have a bevel of 30 deg. (+ 5° – 0°) measured from a line drawn perpendicular to the axis of the pipe with a root face of 1/16" ± 1/32". Root face is square and normal to the bore.</p> <p>The weld-O-lets shall be able to withstand hydrostatic test pressure as per the following:</p> <p>a) 412.50 psi (150#) b) 1080.0 psi (300#) c) 1440.0 psi (400#) d) 2160.0 psi (600#)</p>	
5.0	Material	ASTM A350 LF2 Materials for Natural Gas service shall be in accordance with PMS (Piping Material Specification) attached along with the tender.	
6.0	Testing	As per MSS-SP 97 <i>All stage inspection shall be carried out by third party Inspection agency engaged by the vendor. However, final inspection shall be carried out by owner's designated third party inspection agency and/or IOCL as per approved QAP</i>	
7.0	Painting	Brush Cleaning + Rust Preventive Coating	
8.0	Documentation	<p>With Bid</p> <p>a) Supply record of similar Weld-o-lets in past.</p> <p>After inspection for Despatch (In 4 sets)</p> <p>a) Inspection report and certification as per requirement of code MSS-SP-97</p>	
9.0	Warranty	<p>▪ Vendor to guarantee that supplied weld-o-let shall withstand the hydrostatic testing as given above at site.</p>	<p>▪ All weld-O-lets are to be free of any defects due to design, manufacture and material. Any defective Weld-O-lets, so detected during one year of service or within 18 months of supply shall be replaced free of cost by the supplier.</p>

Note:

- The minimum wall thickness anywhere in the Weld-O-let shall be in line with thickness for various schedule requirements and shall comply the requirement of hydro test value as specified in the clause 4.0 of the specification.



PIPELINES

IOCL– MECH-WOL-065

Document No.: IOCL-CGD-STEEL PIPELINE-SPEC

Rev. No. 0.0

Date 03.02.2021

I. SPECIFICATION FOR SPECTACLE BLIND

Clause	Area	Description	Requirement / Remark
1.0	Scope	Design, Manufacture, Testing, Inspection and Supply of hand wheel operated Spectacle Blind	Rating and Quantity as specified
2.0	Service	Natural Gas	As specified in "Specific Requirement for the Project"
3.0	Specific Requirement	Spectacle blinds as per ASME 16.48 Fasteners for connecting WNRF Flanges (stud with 2 nuts & 4 washers) Serrated facing	Spectacle blinds (figure 8 blanks) Flanges offered shall be installed between flanges WNRF/SORF manufactured as per the dimensions in ANSI B 16.5 latest edition Length of the Stud shall be sufficient to accommodate Spectacle Blinds, WNRF flange, Nuts and washers.
4.0	Codes & Standards	Manufacturing Dimension	ASME B16.48 for sizes up to 24" Relevant API/BS standard for sizes above 24". To suit Flanges as per ANSI B 16.5
5.0	Materials of conformity <u>Materials for Natural Gas service shall be in accordance with PMS (Piping Material Specification) attached along with the tender.</u>	Blind	ASTM A105 / ASTM A350 LF2 as per PMS
		Stud	ASTM A 193 Gr B7/ ASTM A320 Gr. L7 as per PMS
		Nut	ASTM A 194 (Gr. 2H) / ASTM A194 Gr. 7as per PMS
6.0	Inspection & Test	As per ASME 16.48 As per approved QAP	<i>All stage inspection shall be carried out by third party Inspection agency engaged by the vendor. However, final inspection shall be carried out by owner's designated third party inspection agency and/or IOCL as per approved QAP</i>
7.0	Painting	Brush Cleaning + Rust Preventive Coating	
8.0	Documentation	With Bid	
		Dimensional drawing Bill of material and material of conformity Supply record for similar size and rating.	



IOCL-MECH-SB-127

Document No.: IOCL-CGD-STEEL PIPELINE-SPEC

Rev. No. 0.0

Date 03.02.2021

Clause	Area	Description	Requirement / Remark
		After Placement of Purchase Order within 15 days (4 sets)	
		Dimensional drawing Quality Assurance Plan Testing and Inspection Plan	
		After Inspection, for Despatch Clearance (4 Sets)	
		Inspection Report as per Clause 6.0 Inspection Release note	
		Alongwith Despatch (6 Sets)	
		Approved Drawing Packing List Inspection Report Inspection Release Note Operation and Maintenance instruction manual Guarantee Certificate	
9.0	Marking	All blanks shall be marked as follows: ASME B16.48 Nominal pipe size (NPS) ANSI class Material , specification, and grade Manufacturer's name or trademark	The marking shall be applied by steel stamping on the web (tie bar) or handle. Where space is limited, marking may be stamped on the blind portion of blanks (but not on the gasket seating surface) or on the circumference
10.0	Packing	In wooden crates suitable to weather handling and transportation Packing list to be enclosed Crate should have legible identification marking of contents.	All machined surface shall be coated with an easily removable rust preventive
11.0	Warranty	The spectacle blind flanges shall be guaranteed by the vendor for a period of one year of operation against defective materials, poor workmanship, improper design and failure of normal usage	



PIPELINES

IOCL-MECH-SB-127

Document No.: IOCL-CGD-STEEL PIPELINE-SPEC

Rev. No. 0.0





Date 03.02.2021



LAYING & CONSTRUCTION OF 3LPE COATED
CARBON STEEL PIPELINE AND ASSOCIATED WORKS
FOR CITY GAS DISTRIBUTION

इंडियन ऑयल कॉर्पोरेशन लिमिटेड
(पाईपलाइन प्रभाग) नोएडा

J. TECHNICAL SPECIFICATION FOR SEAMLESS PIPES

INDIAN OIL CORPORATION LIMITED PIPELINES DIVISION, NOIDA			
	SPECIFICATION FOR SEAMLESS LINE PIPES		
<p>STANDARD SPECIFICATIONS FOR SEAMLESS MAINLINE PIPE- API 5L (PSL 2)</p> <p>(ONSHORE APPLICATION)</p>			
IOCL-MECH- PIPE-SMLS- ML-021C			
	SPJM (MECH)	CPJM (MECH)	DGM(PJ-M)
	Prepared by	Reviewed by	Approved by
	Rev 01	Date	27.08.2016
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


SPECIFICATION FOR SEAMLESS LINE PIPES

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IOCL-MECH- PIPE-SMLS- ML-021C	<i>S. Gupta</i>	<i>CPJM</i>	<i>MV</i>
	SPJM (MECH)	CPJM (MECH)	DGM(PJ-M)
	Prepared by	Reviewed by	Approved by
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INDIAN OIL CORPORATION LIMITED PIPELINES DIVISION, NOIDA			
SPECIFICATION FOR SEAMLESS LINE PIPES			
<p align="center">SPECIFICATIONS FOR API 5L (PSL 2) MAINLINE PIPES (SEAMLESS)</p> <p>1.0 SCOPE OF THE SPECIFICATION:</p> <p>1.1 PURPOSE AND COVERAGE:</p> <p>1.1.1 This Specification defines the minimum technical requirements for the manufacture of Seamless steel line pipe (Pipes) of API-5L grade (PSL-2) in accordance with latest edition of API specification 5L. In the case of any details, which are not fully addressed, the latest API 5L Standard shall be applicable.</p> <p>1.1.2 Should there be any doubt or ambiguity, between the provisions of API 5L specifications and this specification, interpretation of this specification shall be final and abiding.</p> <p>1.1.3 In addition to this specification, wherever stringent, requirement/ provision/amendments of the latest edition of API 5L shall apply.</p> <p>1.1.4 The coverage by this specification is limited to line pipe to be used in onshore pipelines transporting non-sour hydrocarbons in liquid or gaseous phase.</p> <p>1.1.5 The manufacturer shall have a valid license to use API monogram in accordance with the requirements of specification 5L on line pipe as product specification level PSL 2.</p> <p>1.1.6 The line pipe surface shall be free from any contaminants that may interfere with the application and integrity of external corrosion protection coating.</p> <p>1.1.7 Line Pipe shall be suitable for bending using the induction bending process for Induction Bends.</p> <p>1.1.8 The specific requirements for the project for the line pipe under this specification are stated in the enclosure attached herewith.</p> <p>1.2. PRODUCT SPECIFICATION LEVEL:</p> <p>Line pipe supplied to this specification shall conform to Product Specification Level PSL2.</p> <p>1.3. GRADE:</p> <p>This specification is applicable to PSL-2 line pipes of grade B through X-70.</p> <p>1.4. DIMENSIONS:</p> <p>This specification shall be applied to line pipe of size 4.5" through 18" (Both sizes included).</p>			
IOCL-MECH- PIPE-SMLS- ML-021C			
	SPJM (MECH)	CPJM (MECH)	DGM (P.J-M)
	Prepared by	Reviewed by	Approved by
	Rev 01	Date	27.08.2016
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
SPECIFICATION FOR SEAMLESS LINE PIPES

2.0 CODES, STANDARDS AND SPECIFICATIONS:

Supplier shall provide Pipes in accordance with the Latest edition of the following Codes and Standards:

Code	Description
API 5L	Specification for Line pipe
API RP 5L1	Recommended Practice for Railroad Transportation of Line Pipe
API RP 5 LW	Recommended Practice for Transportation of Line Pipe on Barges and Marine Vessels
API RP 5LT	Recommended Practice for Truck Transportation of Line Pipe
API RP 5L3	Recommended Practice for conducting DWTT on Line Pipes
API BUL 5 T1	Bulletin on Non-Destructive Testing/Terminology
ASME Sect. V	Boiler and Pressure vessel code, Section V for NDE
ASME Sect. IX	Welding and Brazing Qualifications
ISO 9000	Quality Management and Assurance Standards
OISD 141	Oil Industry Safety Directorate Government of India Ministry of Petroleum Chemicals - Design and Construction Requirements for Cross Country Hydrocarbon Pipelines
ASTM E 112	Standard test Methods for Determining average grain size
ASNT-TC-1A	Personal Qualification and Certification in non-destructive Testing


IOCL-MECH- PIPE-SMLS- ML-621C

		
SPJM (MECH)	CPJM (MECH)	DGM (PJ-M)
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INDIAN OIL CORPORATION LIMITED PIPELINES DIVISION, NOIDA			
SPECIFICATION FOR SEAMLESS LINE PIPES			
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	3.1	PROCESS OF MANUFACTURE:	
		<p>a. The pipe manufactured to this specification shall not have any welding seam and to be manufactured by seamless process.</p> <p>b. Pipe without weld seam, produced by hot forming process, which can be followed by cold sizing and cold finishing in quenched condition to produce the desired shape, dimensions and properties.</p>	
	3.2	COLD EXPANSION:	
		Pipes furnished to this specification shall not be cold expanded.	
	3.3	MATERIAL:	
		<p>(i) Billet to be used for manufacturing of pipes shall be made of steel made in basic oxygen furnace or electric arc furnace.</p> <p>(ii) The steel shall be made by continuous casting only.</p> <p>(iii) The steel used for manufacture of pipe shall be vacuum degassed and shall be fully killed and fine grained with a grain size of ASTM 9 or finer as per ASTM E 112.</p> <p>(iv) The qualification criteria for approval of any steel mill for supply of billets have been indicated in Appendix-VI.</p> <p>(v) The qualification of steel billet manufacturer(s) shall be assessed prior to approval of the supplier. Bidder's offer shall be un-conditional irrespective of the finally qualified steel billet manufacturer(s). The owner reserves the right to accept/reject such inclusion for the subject tender.</p>	
	3.4	HEAT TREATMENT:	
		<p>The pipes shall be normalised or quenched and tempered. Other types of heat treatment shall not be acceptable. Pipe manufacturer shall submit the procedure of heat treatment for Owner's approval. The heat treatment shall be performed in accordance with the approved procedure.</p> <p>The plant shall be equipped with automatic control heat treatment temperature.</p> <p>Grain size of the post-heated microstructure shall be 9 (as per ASTM E 112) or finer.</p>	
	IOCL-MECH- PIPE-SMLS- ML-021C		<p>SPJM (MECH)</p> <p>Prepared by</p> <p>Rev 01</p> <p>Page No</p>
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Graphical and textual recording of heat treatment is mandatory and shall be produced for inspection at the end of each shift.




4.0 MATERIAL REQUIREMENTS:

4.1 CHEMICAL COMPOSITION:

The chemical composition of each heat of steel on product analysis shall conform to the chemical composition as specified below (on product analysis): Table 5 of API 5L is void.

Element	Chemical Requirements for Grade in (%)			
	X70	X55/X60	X56/X52/X46	X42 / Gr.B
C	0.120 max.	0.150 max.	0.180 max.	0.180 max.
Mn	0.80-1.50	0.80-1.50	0.80-1.50	0.80-1.30
Si	0.15-0.35	0.15-0.35	0.15-0.35	0.15-0.35
S	0.005 max.	0.005 max.	0.005 max.	0.005 max.
Ca	0.005 max.	0.005 max.	0.005 max.	0.005 max.
P	0.015 max.	0.015 max.	0.020 max.	0.020 max.
Al	0.040 max.	0.040 max.	0.050 max.	0.060 max.
Nb	0.050 max.	0.050 max.	0.050 max.	0.050 max.
V	0.080 max.	0.080 max.	0.080 max.	0.080 max.
Ti	0.020 max.	0.020 max.	0.040 max.	0.040 max.
Cr	0.300 max.	0.300 max.	0.300 max.	0.300 max.
Mo	0.250 max.	0.250 max.	0.250 max.	0.250 max.
Cu	0.300 max.	0.300 max.	0.350 max.	0.350 max.
Ni	0.300 max.	0.300 max.	0.300 max.	0.300 max.
N	0.010 max.	0.010 max.	0.012 max.	0.015 max.

IOCL-MECH- PIPE-SMLS- ML-021C

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Pipe Grade	Yield Strength MPA (psi)		Tensile Strength MPA (psi)	
	Minimum	Maximum	Minimum	Maximum
X42	315 (45730)	485 (71800)	430 (62420)	655 (95000)
X46	355 (51535)	525 (76100)	455 (66050)	655 (95000)
X52	385 (55890)	530 (76800)	485 (70410)	760 (110200)
X56	410 (59520)	545 (79000)	515 (74760)	760 (110200)
X60	445 (64600)	585 (81900)	530 (76840)	760 (110200)
X65	480 (69580)	600 (87000)	565 (82020)	760 (110200)
X70	510 (74040)	635 (92100)	595 (86390)	760 (110200)




The ratio of body YS AND body UTS on each tested pipe shall be less than or equal to 0.90.




The minimum elongation of base metal shall be determined in accordance with the formula given at foot note (f) of 'Table 7' (as per 45th edition) or corresponding table of latest edition and shall comply with minimum values of API spec. 5L. However, the elongation of the base material shall be at least 20 %.

4.2.2 FRACTURE TOUGHNESS TEST:
Charpy V Notch (CVN) test shall be conducted as per latest API 5L edition and as per Appendix-I of this specification


4.2.3 MICRO, MACROGRAPHIC AND HARDNESS TESTS:
A hardness survey, using a Vickers diamond pyramid hardness tester with a 10 kg load, shall be carried out on at least one pipe sample from each heat or a lot of 50 pipe whichever is less. The hardness survey shall consist of three traverses, 1 mm from the inside and outside surfaces and at mid thickness. Each traverse shall consist of a minimum of four indentations in each zone with a spacing between each hardness indent of 5 mm as indicated in Fig.1

No individual value shall exceed 248 HV10. The maximum hardness gradient shall not exceed 70 HV10. Modalities for retest shall be in accordance with API 5L.

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	5.1	<u>LENGTH:</u>		
	The pipes shall be supplied in double random lengths. No pipe shall be shorter than 10 meters or greater than 12.5 meters. Manufacturer shall specify guaranteed minimum average length in his offer.			
	5.2	<u>DIAMETER:</u>		
	The tolerances on the outside diameter at pipe body and ends shall be as per the requirements of API 5L.			
	5.3	<u>OUT OF ROUNDNESS:</u>		
	<u>FOR PIPE ENDS:</u>			
	The internal out-of-roundness within 100 mm of the pipe end shall not exceed the values indicated below:			
	For Diameter $\leq 10\frac{3}{4}$ - 2mm			
	For Diameter $\geq 12\frac{3}{4}$ - 3 mm			
Pipe end out of roundness is to be measured from ID using inside caliper.				
<u>FOR PIPE BODY:</u>				
The internal out-of-roundness of the pipe body shall not exceed the values indicated below:				
For Diameter $\leq 10\frac{3}{4}$ - 0.020 D or 4 mm which is less				
For Diameter $\geq 12\frac{3}{4}$ - 0.020 D or 5 mm which is less				
Out of roundness on pipe body is to be measured using outside caliper.				
5.4	<u>WALL THICKNESS:</u>			
Each length of pipe shall be measured for conformance to wall thickness requirements. Wall thickness measurements shall be made with a mechanical caliper or with a properly calibrated non-destructive inspection device of appropriate accuracy. The wall thickness at any place shall be within the tolerances as (+) 15% to (-)0%.				
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Element	Chemical Requirements for Grade in (%)			
	X70	X65/X60	X65/X62/X46	X42 / Gr.B
B	0.0005 max	0.0005 max	0.0005 max	0.0005 max
Al(soluble)	2 N min	2 N min	-	-
Nb + V	0.100 max	0.100 max	0.100 max	0.100 max
Cu+Cr+Ni+Mo	0.500 max	0.500 max	0.500 max	0.500 max
Nb+V+Ti	0.15 max	0.15 max	0.15 max	0.15 max
Ni + Cu	0.40 max	0.40 max	0.40 max	0.40 max
CE(Pcm)	0.20 max	-	-	-
CE(IIV)	-	0.38 max	0.43 max	0.43 max



Note:

- Intentional alloying additions other than Nb, V, Ti shall not be permitted without Owner's approval.
- Minimum of Si is not applicable for Al killed steel.
- For heat analysis and product analysis, all the elements listed in the above table shall be analysed and reported, even if those are not purposely added but are present as residuals only.
- Manufacturer shall state in the quotation, the nominal chemical composition and the steel making route of pipe.
- The steel shall be made by continuous casting process only.

4.2 MECHANICAL PROPERTIES:

4.2.1 TENSILE PROPERTIES:

The finished pipes, after all treatments and operations, shall conform to the requirements of API Specifications 5L (latest edition) except for minimum yield strength and minimum ultimate tensile strength of pipes which should be as per following table:

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LAYING & CONSTRUCTION OF 3LPE COATED
CARBON STEEL PIPELINE AND ASSOCIATED WORKS
FOR CITY GAS DISTRIBUTION

इंडियन ऑयल कॉर्पोरेशन लिमिटेड
(पाईपलाइन प्रभाग) नोएडा

INDIAN OIL CORPORATION LIMITED
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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.

5.5 STRAIGHTNESS:
The pipes shall be checked for straightness and the deviation from a straight line shall not exceed 1.0 mm per metre length of the pipe.
The local deviation from a straight line at each pipe end as specified in API clause 9.11.3.4 (b) shall not be allowed.

5.6 JOINTERS:
Joints on pipes are not permitted.

6.0 PIPE ENDS AND PROTECTORS





6.1 PIPE ENDS:
Pipes furnished to this specification shall be furnished with bevelled ends bevelled to an angle of 30 degrees ((+)-5 degrees, (-)-0 degrees) measured from a line drawn perpendicular to the axis of the pipe, with a root face of $1/16$ in. $\pm 1/32$ in (1.6 mm, ± 0.8 mm).


6.2 BEVEL PROTECTORS:
Both pipe ends of all pipes shall be provided with metallic or high impact plastic bevel protectors as per manufacturer's standard. The bevel protectors shall be of a design such that they can be re-used by coating applicator for providing ion externally coated pipes subsequent to the coating of pipes. The Manufacturer shall furnish detailed drawing of their standard metallic/plastic protector at the time of submission of bid.

7.0 INSPECTION AND TESTING:

7.1 HEAT ANALYSIS:
The manufacturer shall furnish report giving the heat analysis (Ladle analysis) of each heat of steel used in the manufacture of pipe and certify that the material furnished has been analysed and meet the chemical requirements stipulated by the Owner. All the elements listed in 4.1 shall be reported even if these elements are not purposely added but are present as residual only.

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<p>7.2 PRODUCT ANALYSIS:</p> <p>Product analysis report shall be furnished for finished pipes. Two pipes per heat of steel shall be analysed for all elements listed in Table 4.1. The percentage of alloying elements and impurities shall be determined and reported even if those are not purposely added but are present as residual only. Product analysis shall also meet the chemical requirements stipulated by the Owner as per clause 4.1.</p> <p>Where more than 50 pipes are manufactured from the heat, additional product analysis shall be carried out for one pipe out of every 50 pipes or less of the same heat. No other element other than specified in table 4.1 shall be added to the steel without prior permission of Owner.</p> <p>The product analysis shall also meet the requirements of carbon equivalent(CE) as specified in the Table at Cl. 4.1 of this specification based on the formula in the API 5L code.</p> <p>7.3 RECHECK ANALYSIS:</p> <p>If any part of the product analysis on any one of the fully analysed pipes fail to meet the requirements of 7.2 above, either the whole heat shall stand rejected or each individual pipe shall be fully analysed and all pipes failing to meet the requirements of 7.2 above shall stand rejected.</p> <p>7.4 MILL CONTROL CHEMICAL AND TENSILE TESTS:</p> <p>Mill Control chemical Analysis of two samples from two different billets shall be made by the manufacturer for each heat of steel used for the production of pipe under this specification at pipe mill. A record of each such analysis shall be made available to the Owner's Inspector.</p> <p>For each heat of steel (two samples from two different billet) used for pipe making, mechanical properties (YS, UTS and % elongation) shall be determined and furnished.</p> <p>Results of Mill Control Tests shall be reported to owner's representative. These tests shall not be counted against the tensile tests conducted for each heat of lot as applicable.</p>			
IOCL-MECH- PIPE-SMLS- ML-021C		 SPJM (MECH) Prepared by Rev 01	 CPJM (MECH) Reviewed by Date 27.08.2016
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8.0 MECHANICAL TESTS

8.1 TENSILE TESTS:

8.1.1 LONGITUDINAL TENSILE TEST
The longitudinal specimen (strip specimen with full thickness) shall be taken for tensile test as specified in API 5L code. Hot flattening, artificial ageing or heat treatment of tensile specimens is not permitted. Ring expansion test to determine the mechanical properties is also not permitted.

8.1.2 TRANSVERSE TENSILE TEST
The transverse specimen (Flattened rectangular specimen) shall be taken for tensile test as specified in API 5L code. Hot flattening, artificial ageing or heat treatment of tensile specimens is not permitted. Ring expansion test to determine the mechanical properties is also not permitted.




8.1.3 TEST FREQUENCY:
The API 5L clause for Test Frequency is replaced by the following:
Tensile tests shall be carried out on one pipe per each heat. In case more than 50 pipes produced from the same heat, one pipe from each lot of 50 pipes or part thereof shall be tested. For all other tests such as Charpy impact test, Micro/ Macro test etc., the test frequency will be same.

8.2 IMPACT TEST:
Charpy V Notch (CVN) test shall be conducted as per latest API 5L edition and as per Appendix-I of this specification
Re-Test: According to API 5L.


9.0 HYDROSTATIC TESTS:

9.1 MILL INSPECTION HYDROSTATIC TEST:
The test pressure shall be held for a minimum period of 15 seconds for all sizes and grades of pipe.
The pressure gauge used for hydrostatic testing shall be calibrated with a "dead weight tester" in the presence of Owner's Inspector. The calibration must be conducted at start of each shift and after a hydrostatic burst/leak failure.


IOCL-MECH- PIPE-SMLS- ML-021C

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<p>The pipes with leaking/bursting ends shall be rejected. They shall not be salvaged as API pipes after chopping of the leaky/burst end portions.</p> <p>The pipes produced from a billet preceding and succeeding a leaky/burst end pipe shall be rejected. If more than 25% of the pipes produced from a billet leak or burst either at the ends or in the middle, all the pipes produced from that billet shall be rejected.</p> <p>9.2 TEST PRESSURE:</p> <p>Test Pressure shall be equivalent to 95% of SMYS. The formula will be</p> $P = \frac{2 \times S \times 0.95 \times t}{D}$ <p>Where, P = Test Pressure S = Specified minimum yield strength t = Nominal wall thickness of pipe D = Nominal outside diameter of pipe</p> <p>Clause 10.2.6.6 can be applicable in case the bidder desired so but shall be indicated in bid specification.</p> <p>9.3 SPECIAL REQUIREMENTS OF HYDROTEST:</p> <ol style="list-style-type: none"> (1) Duly calibrated Pressure Gauge shall be installed both at the test bay as well as at the control cabin and graphical records w.r.t. both the pressure gauges shall be maintained for each pipe. (2) Both the pressure gauges shall be calibrated at the beginning of each shift with dead weight tester and the calibration record has to be appropriately maintained. (3) The Pressure Gauges used should have a minimum least count of 2 Kg/cm². Minimum 5" size pressure gauges should be used. (4) Any variation in the reading of two pressure gauges and chart recorder beyond 2 Kg/cm² is not permitted. (5) Variation in the reading of two pressure gauges beyond acceptable limits will warrant re-testing of all pipes since last calibration of the gauges. 	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; text-align: center; vertical-align: top;"> <p>IOCL-MECH- PIPE-SMLS- ML-021C</p> </td> <td style="width: 50%; text-align: center; vertical-align: top;"> <p><i>J. H. K.</i></p> <p>SPJM (MECH)</p> <p>Prepared by</p> <p>Rev 01</p> <p>Page No</p> </td> <td style="width: 50%; text-align: center; vertical-align: top;"> <p><i>[Signature]</i></p> <p>CPJM (MECH)</p> <p>Reviewed by</p> <p>Date</p> <p>13 of 32</p> </td> <td style="width: 50%; text-align: center; vertical-align: top;"> <p><i>[Signature]</i></p> <p>DGM(PJ-M)</p> <p>Approved by</p> <p>27.08.2016</p> </td> </tr> </table>	<p>IOCL-MECH- PIPE-SMLS- ML-021C</p>	<p><i>J. H. K.</i></p> <p>SPJM (MECH)</p> <p>Prepared by</p> <p>Rev 01</p> <p>Page No</p>	<p><i>[Signature]</i></p> <p>CPJM (MECH)</p> <p>Reviewed by</p> <p>Date</p> <p>13 of 32</p>	<p><i>[Signature]</i></p> <p>DGM(PJ-M)</p> <p>Approved by</p> <p>27.08.2016</p>
<p>IOCL-MECH- PIPE-SMLS- ML-021C</p>	<p><i>J. H. K.</i></p> <p>SPJM (MECH)</p> <p>Prepared by</p> <p>Rev 01</p> <p>Page No</p>	<p><i>[Signature]</i></p> <p>CPJM (MECH)</p> <p>Reviewed by</p> <p>Date</p> <p>13 of 32</p>	<p><i>[Signature]</i></p> <p>DGM(PJ-M)</p> <p>Approved by</p> <p>27.08.2016</p>		

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(5) Auto cut-off system from main hydraulic circuit must be there to isolate the pipe under hydro-test.




9.4 CYCLIC HYDRO-TEST:
This Cyclic Hydro-Test has to be carried out 1 in every 500 pipes which includes the pipe tested during PQT/First day production. This test has to be done in a separate test bench. The detailed procedure ~~is~~ as follows:



- (1) The pipe is to be pressurised upto 50 % of the Hydro-Test pressure. Hold the pressure for 1 hour.
- (2) Drop the pressure to static head + one bar.
- (3) Again pressurise to 75 % of the Hydro-test pressure. Hold the pressure for 1 hour.
- (4) Drop the pressure to static head + one bar.
- (5) Again pressurise to 100 % of the Hydro-test pressure. Hold the pressure for 6 hours.
- (6) A recorder shall be used to monitor time v/s pressure throughout these 6 hrs.











There should not be any leakage or bulging of the pipes or flaring up of the pipe ends.











10.0 NON-DESTRUCTIVE INSPECTION:

10.1 QUALIFICATION OF PERSONNEL:
Ultrasonic inspection shall be carried out by ASNT-TC-1A Level-II qualified operators. However, vendor shall have at least 1 (one) ASNT-TC-1A Level-III qualified operator among his UT inspection crew.
The proceedings for UT inspection shall be certified by an ASNT-TC-1A Level-III qualified UT operator. Also the entire UT testing shall be carried out under the overall supervision of a ASNT-TC-1A Level-III qualified operator.

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SPECIFICATION FOR SEAMLESS LINE PIPES			
<p>10.2 METHOD OF INSPECTION:</p> <p>10.2.1 PIPE BODY INSPECTION:</p> <p>10.2.1.1 LAMINAR IMPERFECTIONS IN THE PIPE BODY OF SMLS PIPES Ultrasonic inspection shall be used to verify that the pipe body is free of laminar imperfections. Inspection shall be performed in accordance with ISO 10893-8. The coverage of inspection shall be 100% of pipe body.</p> <p>10.2.1.2 THICKNESS MEASUREMENT FOR SMLS PIPES For SMLS pipe, ultrasonic thickness measurements shall be carried out as per ISO 10893-12. Coverage shall be at least 25% of pipe surface.</p> <p>10.2.1.3 LONGITUDINAL AND TRANSVERSE IMPERFECTIONS: All SMLS pipe shall be ultrasonically inspected for full length (100 %) for detection of longitudinal and transverse imperfections as per ISO 10893-10</p> <p>Pipe ends not covered by the automated inspection system shall be inspected for defects by the semi-automatic/manual ultrasonic angle beam method using the same inspection sensitivity and inspection parameters as automatic equipment. Otherwise such non-inspected pipe ends shall be cut off.</p> <p>N.D.T by Fluoroscopic equipment shall not be considered.</p> <p>10.2.2 REFERENCE /CALIBRATION PIPE: The reference standard (calibration pipe) shall have the same specified diameter and the wall thickness as the pipe being inspected and shall be of sufficient length to permit calibration of ultrasonic inspection equipment at the speed to be used in the normal production. The reference standard (calibration pipe) shall be of the same material, type and have the same surface finish and heat treatment as the pipe being inspected.</p>			
IOCL-MECH- PIPE-SMLS- ML-021C			
		SPJM (MECH)	CPJM (MECH)
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<p><u>Reference standard for detection of laminar imperfections</u></p> <p>The reference standard for pipe body UT shall contain reference standard as per ISO 10893-8 Clause 6.2. In addition to above, reference standard for pipe ends for detection of laminar imperfections shall have ¼ inch dia FBH x ¼ t depth, where 't' is the specified wall thickness.</p> <p><u>Reference standard for detection of longitudinal and transverse imperfections</u></p> <p>The reference standard for UT for detection of longitudinal and transverse imperfection shall contain machined notches/ holes as given below:</p> <ul style="list-style-type: none"> ➤ Longitudinal notches of type N 5 (at both OD and ID) ➤ Transverse notches of type N 5 (at both OD and ID). ➤ 3.2 mm radially drilled hole. ➤ Notch dimensions – Length - 50 mm max, width – 1mm max, depth -5% <p>Depth is expressed as a percentage of the specified wall thickness. It is not necessary for the depth to be less than 0.3 mm (0.012 in). The depth tolerance is ± 15 % of the specified notch depth or ± 0.05 mm (0.002 in), whichever is greater.</p> <p>10.3 ACCEPTANCE LIMITS:</p> <p>10.3.1 ACCEPTANCE LIMIT FOR LAMINAR IMPERFECTIONS:</p> <p>Acceptance Standard: 100% of Signal Height</p> <p>Maximum individual imperfection Area - 1000 mm²</p> <p>Minimum imperfection size considered is as follows:</p> <p>Area - 300 mm², Length -35 mm, Width – 6 mm</p> <p>Maximum population density i.e Number of imperfections smaller than the maximum and greater than the minimum imperfection size - 10 (per 1.0 m x 1.0 m square)</p> <p>Any lamination exceeding 100 mm in any direction is not acceptable.</p>																
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td colspan="2" style="text-align: center; vertical-align: middle;"> IOCL-MECH- PIPE-SMLS- ML-021C </td> <td style="width: 20%; text-align: center; vertical-align: middle;">  SPJM (MECH) Prepared by </td> <td style="width: 20%; text-align: center; vertical-align: middle;">  CPJM (MECH) Reviewed by </td> <td style="width: 20%; text-align: center; vertical-align: middle;">  DGM(PJ-M) Approved by </td> </tr> <tr> <td style="width: 10%; text-align: center;">Rev</td> <td style="width: 10%; text-align: center;">01</td> <td style="width: 10%; text-align: center;">Date</td> <td colspan="2" style="width: 60%; text-align: center;">27.08.2018</td> </tr> <tr> <td colspan="2" style="text-align: center;">Page No</td> <td colspan="3" style="text-align: center;">16 of 32</td> </tr> </table>		IOCL-MECH- PIPE-SMLS- ML-021C		 SPJM (MECH) Prepared by	 CPJM (MECH) Reviewed by	 DGM(PJ-M) Approved by	Rev	01	Date	27.08.2018		Page No		16 of 32		
IOCL-MECH- PIPE-SMLS- ML-021C		 SPJM (MECH) Prepared by	 CPJM (MECH) Reviewed by	 DGM(PJ-M) Approved by												
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<p>Clusters of small inclusions interfering with the ultrasonic inspection are not acceptable</p> <p>Locations showing indications above the allowable 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 owner's inspector to check questionable area.</p> <p>10.3.2. ACCEPTANCE LIMITS FOR LONGITUDINAL AND TRANSVERSE IMPERFECTIONS:</p> <table border="0"> <tr> <td>Reference Standard :</td> <td>N 6 Notch</td> </tr> <tr> <td>Test Speed :</td> <td>Permitted maximum test speed of inspection is 30mm/min</td> </tr> <tr> <td>Acceptance Limit :</td> <td>100%. Expressed as a percentage of the indication produced by the reference indicator.</td> </tr> <tr> <td>UT of Blind Zone :</td> <td>Minimum of 200 MM or untested portion from each end of the pipe shall be Scanned manually/semi-automatic UT.</td> </tr> </table> <p>Records: Graphical records with channel wise paper output indicating pipe number shall be provided and preserved for all pipes tested, including all the calibration charts for AUT. Protocol report with channel wise output for each pipe is also acceptable.</p> <p>10.4. ULTRASONIC EQUIPMENT</p> <p>10.4.1 The Ultrasonic equipment used for all inspections shall be capable of detecting artificial defects in compliance with API 5L and this specification for lamination, longitudinal and transverse defects as applicable. The equipment's speed and procedure shall meet prior approval of Owner's Inspector.</p> <p>The equipment shall be capable of continuous and uninterrupted inspection of the pipe.</p> <p>The equipment shall be checked for its effectiveness as specified during PQT and at regular intervals during production.</p> <p>10.4.2 A device which monitors the effectiveness of coupling with an audible warning system operating when the coupling is unsatisfactory.</p>		Reference Standard :	N 6 Notch	Test Speed :	Permitted maximum test speed of inspection is 30mm/min	Acceptance Limit :	100%. Expressed as a percentage of the indication produced by the reference indicator.	UT of Blind Zone :	Minimum of 200 MM or untested portion from each end of the pipe shall be Scanned manually/semi-automatic UT.							
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	SPJM (MECH)	CPJM (MECH)	DGM(PJ-M)													
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SPECIFICATION FOR SEAMLESS LINE PIPES														
10.4.3	An automatic device for making the location of defects, activated when signal exceeds the pre-set acceptable limits.													
10.4.4	An automatic guiding device for correct positioning of crystal probe.													
10.5	<p><u>CALIBRATION OF ULTRASONIC EQUIPMENT:</u></p> <p>The calibration of automatic ultrasonic equipment with the standard shall be carried out under the same inspection conditions of pipes under normal production.</p> <p>The calibration shall be performed at following intervals:</p> <ol style="list-style-type: none"> At the beginning of each normal inspection shift Every four hours to check its effectiveness. Every time the running of the system gives rise to doubt on its efficiency <p>If during the above calibration verification, it is found that the equipment has not functioned satisfactorily in the opinion of the Owner's Inspector, then all the pipes already inspected after the previous verification shall be inspected once again at Manufacture's cost.</p> <p>In case of continuous occurrence of signal outside the acceptance limits in area, where upon subsequent investigation, no defects are detected further investigations using other methods shall be executed to established the cause of these erratic signals.</p>													
10.6	<p><u>END INSPECTION:</u></p> <p>10.6.1 Ultrasonic inspection in accordance with the method described in ISO 10893-8 shall be used to verify that the 25 mm wide zone at each pipe end is free of laminar imperfections ≥ 6.4 mm in both axial and circumferential direction. The examination shall be carried out from the inside surface if the pipe is examined after bevel cutting. If examination is before bevel cutting, the examination may be undertaken from the outside surface.</p> <p>Pipe ends containing laminations or other discontinuities beyond acceptance limit shall be cut back until imperfections detectable by ultrasonic inspection have been removed.</p> <p>N.D.T by Fluoroscopic equipment shall not be considered.</p>													
<table border="1"> <tr> <td rowspan="4">IOCL-MECH- PIPE-SMLS- ML-021C</td> <td>SPJM (MECH)</td> <td>CPJM (MECH)</td> <td>DGM(PJM)</td> </tr> <tr> <td>Prepared by</td> <td>Reviewed by</td> <td>Approved by</td> </tr> <tr> <td>Rev 01</td> <td>Date</td> <td>27.08.2016</td> </tr> <tr> <td>Page No</td> <td colspan="2">18 of 32</td> </tr> </table>		IOCL-MECH- PIPE-SMLS- ML-021C	SPJM (MECH)	CPJM (MECH)	DGM(PJM)	Prepared by	Reviewed by	Approved by	Rev 01	Date	27.08.2016	Page No	18 of 32	
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INDIAN OIL CORPORATION LIMITED PIPELINES DIVISION, NOIDA			
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<p>10.6.2 BEVEL INSPECTION</p> <p>MAGNETIC PARTICLE INSPECTION: Bevel end of each pipe shall be tested with magnetic particle inspection (MPI) method. Any indication exceeding 3 mm in length detected on the bevel shall be cause of rebeveling. Imperfections shall not be repaired by welding. Pipe bevel containing indications or other discontinuities beyond acceptance limit shall be cut back until imperfections detectable by magnetic particle inspection have been removed.</p> <p>10.7 RESIDUAL MAGNETISM MEASUREMENT REQUIREMENTS</p> <p>The average of 4 readings shall not exceed 20 gauss and no single reading shall exceed 25 gauss when measured with Hall-effect gaussmeter. All measurements shall be recorded.</p> <p>11.0 WORKMANSHIP, INSPECTION AND REPAIR OF DEFECTS:</p> <p>11.1 INSPECTION:</p> <p>The Owner reserves the right to depute its representative (s) /third party inspection agency to perform inspection and witness tests in all phases of manufacturing and testing, starting from steel making to finished line pipe ready for transportation. Any action or omission on part of Owner's Representative shall not relieve the manufacturer of his responsibility and obligation of supply of material in strict accordance with this specification.</p> <p>11.2 REJECTION:</p> <p>If Owner's Inspector rejects pipes repeatedly for any reoccurring cause this shall be adequate reason to refuse final inspection of subsequent pipes until the cause has been corrected.</p> <p>11.3 COMPLIANCE:</p> <p>In the event that defective billets/pipes are detected during additional investigations by Owner's Inspector, Manufacturer and Owner shall mutually agree on additional inspection required, the cost of which shall be borne by the manufacturer. Under no circumstances shall any action or omission on part of Owner's Inspector shall relieve the manufacturer of his responsibility for compliance with this specification and the quality of finished pipes.</p>			
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SPECIFICATION FOR SEAMLESS LINE PIPES			
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LAYING & CONSTRUCTION OF 3LPE COATED
CARBON STEEL PIPELINE AND ASSOCIATED WORKS
FOR CITY GAS DISTRIBUTION

इंडियन ऑयल कॉर्पोरेशन लिमिटेड
(पाईपलाइन प्रभाग) नोएडा

INDIAN OIL CORPORATION LIMITED PIPELINES DIVISION, NOIDA			
SPECIFICATION FOR SEAMLESS LINE PIPES			
13.0 INSPECTION OF FIELD TEST AND WARRANTY:			
<p>Owner will be reimbursed by manufacturer, for pipe furnished on this order that fails under field hydrostatic test, if such failure is caused by manufacturing defect of pipe. The reimbursement cost shall include that of pipe, labour and equipment rental for finding, excavating, cutting out and installation of replaced pipe in position.</p>			
<p>The hydrostatic test pressure will not exceed that value which will cause a calculated hoop stress equivalent to 85% of specified minimum yield strength. Complete string of pipe lengths are subjected to field hydro test for a minimum period of 24 hours after sequence of cyclic load as per the guidelines given in API 1104 (latest edition).</p>			
<p>In case manufacturer so desires, he will be advised at least two weeks in advance so that his representative may witness the hydrostatic test in field. However, the testing and leak (if any), finding and repair operation shall not be postponed because of absence of the manufacturer's representative.</p>			
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**INDIAN OIL CORPORATION LIMITED
PIPELINES DIVISION, NOIDA**

SPECIFICATION FOR SEAMLESS LINE PIPES

Appendix-I

CHARPY V-NOTCH IMPACT TEST

- The specimen shall be full sized or largest obtainable sub sized in accordance with ASTM A370 and test shall be performed at 0°C unless otherwise specified separately in purchase order.
- Test temperature shall be -29°C if the service fluid is LPG.
- The specimen shall be taken as follows:
 - Three transverse specimen one length of pipe/heat/ lot of 50 pipes shall be taken. The specimens shall be oriented with the major axis transverse to the pipe axis and the 'V' notch perpendicular to wall thickness.
 - Flattened specimen shall not be used.
 - In case it is not possible to obtain transverse specimen, a longitudinal specimen may be taken upon approval from Owner.
- At the test temperature, the average impact value in joules for the full size specimens taken from one pipe length (per combination of pipe size and thickness) from each heat or from each lot of 50 pipes from the same heat in case more than 50 pipes are produced from one heat shall be as follows:
 - For all pipe sizes and specified wall thickness, fracture toughness requirements (full size absorbed energy value based on a set of 3 specimens) shall be as per API 5L Annexure-G Approach-4 or minimum 40 J whichever is higher for transverse body. The minimum impact value of one specimen of the three specimens analyzed shall not be less than 80% of the above specified average value.
 - For pipes of all sizes and wall thicknesses, the minimum shear fracture area for pipe body shall be at least 85% average and min.80% individual, based upon a test temperature of 0°C or as specified.
 - The average impact value for the sub sized specimens shall be as per API 5L Latest edition.





The retest and acceptance criteria shall be in a manner specified in API 5L Latest Edition

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LAYING & CONSTRUCTION OF 3LPE COATED
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


INDIAN OIL CORPORATION LIMITED PIPELINES DIVISION, NOIDA			
	SPECIFICATION FOR SEAMLESS LINE PIPES		
Appendix-II			
MANUFACTURING AND REPAIR PROCEDURE			
<p>1.0 The Manufacturer shall furnish a manufacturing and repair procedure document outlining the successive steps and associated inspection procedures from the production of steel to finished line pipe. The production shall only be started upon the specific approval by Owner. The approved procedure and agreed modifications there of shall be strictly followed in the production process.</p> <p>2.0 The manufacturing and repair procedure, shall include as minimum but not limited to the following:</p> <ol style="list-style-type: none">1. Manufacturer of steel, billet and their manufacturing location to be submitted for approval along with requisite documents mentioned in qualification criteria.2. Steel making process, chart and manufacturing procedure specification and process parameters with complete details of heat treatment and other refining processes.3. Billet rolling indicating number of passes, their temperature and thickness reduction in each pass required by "Controlled Procedure".4. Pipe manufacturing procedure specification with detailed description of each individual process from receipt of billets, its inspection, forming to despatch of pipes.5. Automatic ultrasonic testing procedure with details description on ultrasonic machine used, probe type and configurations, no. of probe, its coverage, calculation, overall coverage, paint spraying system/markings of defects, coupling loss signalling, calibration techniques and frequency, untested length, type of chart records and defect display etc6. Other Non destructive testing procedure for each technique viz. Manual Ultrasonic testing Dry penetrant test, magnetic particle testing7. Hydrostatics testing procedure.8. Quality assurance/control plan.9. Dimensional tolerance and control procedure.10. Testing procedure for all mechanical testing and chemical testing and details of testing equipments/instruments.			
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LAYING & CONSTRUCTION OF 3LPE COATED
CARBON STEEL PIPELINE AND ASSOCIATED WORKS
FOR CITY GAS DISTRIBUTION

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INDIAN OIL CORPORATION LIMITED PIPELINES DIVISION, NOIDA			
SPECIFICATION FOR SEAMLESS LINE PIPES			
<p>11. Sampling plan and sketch indicating location of test specimen, its size and dimensions, no of samples for both raw material and pipe as per this specification and API 5L.</p> <p>12. Marking and color coding.</p> <p>13. Field Weldability test procedure, sampling and testing as per API 1104.</p> <p>14. Pipe handling, storage and transportation procedure.</p>			
IOCL-MECH- PIPE-SMLS- ML-021C	S. Haldar		CPJM (MECH)
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	Rev	01	Date
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INDIAN OIL CORPORATION LIMITED PIPELINES DIVISION, NOIDA			
 SPECIFICATION FOR SEAMLESS LINE PIPES			
APPENDIX - III			
FIRST DAY PRODUCTION TESTS			
<ol style="list-style-type: none"> 1. Unless otherwise specified, PQT/First day production to be carried out for each grade of pipes and for each pipe size combination i.e for each diameter and thickness combination for length \geq 500m. Pipes produced (i.e for quantity less than 500m) shall be accepted based on regular production tests. 2. PQT/First day production to be carried out for all pipe size combination i.e for each diameter and thickness combination for line pipes used in HDD (Horizontal direction drilling) irrespective of length ordered. 3. These first days' production tests shall be repeated upon any change in the manufacturing procedures and whenever there is a change in mill setting/ parameters if deemed necessary by Owner's Inspector. 4. Out of the pipes produced during first day production, six lengths of completely finished pipes, three each from two different heats, shall be selected at random for testing to verify that the manufacturing procedure results in the quality of pipes which are in complete compliance of this specification. The pipes thus tested shall be considered to be the test pipes required per heat or per lot as required in this specification. 5. The Manufacturer shall submit to Owner a report giving the results of all tests mentioned below. The report shall be agreed and signed by Owner's inspector/Representative. The various tests to be conducted shall be as follows: <div style="margin-left: 20px;"> <ol style="list-style-type: none"> a) Visual Inspection All pipes shall be examined visually for dimensional tolerances and apparent surface defects in accordance with this specification. b) Ultrasonic Inspection </div> 			
IOCL-MECH- PIPE-SMLS- ML-021C		 SPJM (MECH)	 CPJM (MECH)
Prepared by		Reviewed by	 DGM(PJ-M)
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INDIAN OIL CORPORATION LIMITED PIPELINES DIVISION, NOIDA	
	SPECIFICATION FOR SEAMLESS LINE PIPES

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All pipes shall be examined ultrasonically by automatic ultrasonic equipment.




c) **Chemical and Physical Properties**
Heat analysis and Mill control tensile test to be carried out for selected heats of billets (2 samples /billet/heat). Product analysis shall be carried out for 1 sample/pipe. The physical properties of all PQT pipes shall be tested.
The physical properties of base metal (YS, UTS and elongation) shall be established in accordance with this specification for PQT selected pipes.
Impact Test shall be performed as per Appendix-I for PQT selected pipes.

d) **Micro/Macrographic and Hardness Inspection**
Micro/Macrographic and hardness inspection shall be performed in accordance with this specification. Macro/Micro inspection of base metal shall be performed and photographs of the same shall be submitted alongwith the report for PQT selected pipes.

e) **Field Weldability test:**
Field Weldability test shall be carried out as per Appendix-IV of the technical specifications for highest diameter, highest thickness pipe for each grade.

f) **Cyclic hydro test:**
Cyclic hydro test to be conducted in accordance with this specification. (One pipe from 1st day production). This test during 1st day production shall be considered in regular test frequency of one per 500 pipes.

6. If the above tests do not meet the requirements of this specification, owner shall have the right to reject PQT and re-PQT to be offered by manufacturer after corrective actions. Owner shall have right to intensify control during 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.

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SPECIFICATION FOR SEAMLESS LINE PIPES			
APPENDIX -IV			
FIELD WELDABILITY TEST			
<p>1.0 The manufacture shall propose a field Weldability test as per API 1104 which will establish that quality girth welding can be achieved within the allowable maximum hardness level under the simulated site conditions.</p> <p>2.0 In the proposal the manufacturer shall also give details of such procedure. All tests including micro and NDT examination shall be carried out for field weldability test as per API 1104. This procedure shall be subject to owner's approval before commencement of test.</p>			
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<div style="display: flex; align-items: center;"><div style="border: 1px solid black; border-radius: 50%; width: 40px; height: 40px; display: flex; align-items: center; justify-content: center; margin-right: 10px;">IOCL</div><div>SPECIFICATION FOR SEAMLESS LINE PIPES</div></div>			
APPENDIX - V			
DOCUMENTS TO BE SUBMITTED			
I) With Bid			
<div style="display: flex; align-items: flex-start;"><div style="width: 20px; text-align: right; padding-right: 10px;">1.</div><div>Validity of API Monogram (Copy of valid API Certificate)</div></div>			
<div style="display: flex; align-items: flex-start;"><div style="width: 20px; text-align: right; padding-right: 10px;">2.</div><div>Production capacity per Annum and per day for Seamless pipe production as per tender requirement for the offered mill.</div></div>			
<div style="display: flex; align-items: flex-start;"><div style="width: 20px; text-align: right; padding-right: 10px;">3.</div><div>Location of Plant.</div></div>			
<div style="display: flex; align-items: flex-start;"><div style="width: 20px; text-align: right; padding-right: 10px;">4.</div><div>List of supply records meeting the qualification criteria for pipes as per BQC requirement. Supply record shall consist of purchase order copy, inspection reports, documents proving completion of supply, duly certified documents from the respective embassies in case of foreign bidders.</div></div>			
<div style="display: flex; align-items: flex-start;"><div style="width: 20px; text-align: right; padding-right: 10px;">5.</div><div>Source and Details of billet manufacturer along with the documents as per Appendix VII</div></div>			
Note: Originals of the documents furnished in the bid shall have to be produced for verification, if required.			
II) After Placement of Purchase Order (Two sets) within 15 days			
<div style="display: flex; align-items: flex-start;"><div style="width: 20px; text-align: right; padding-right: 10px;">1.</div><div>Production and delivery plan</div></div>			
<div style="display: flex; align-items: flex-start;"><div style="width: 20px; text-align: right; padding-right: 10px;">2.</div><div>Documents as per Appendix-III</div></div>			
<div style="display: flex; align-items: flex-start;"><div style="width: 20px; text-align: right; padding-right: 10px;">3.</div><div>Details of Steel billet manufacturer along with the documents as per Appendix VII</div></div>			
III) Along with despatch			
<div style="display: flex; align-items: flex-start;"><div style="width: 20px; text-align: right; padding-right: 10px;">1.</div><div>Despatch Clearance by TPI/Owner</div></div>			
<div style="display: flex; align-items: flex-start;"><div style="width: 20px; text-align: right; padding-right: 10px;">2.</div><div>Pipe data sheet</div></div>			
<hr style="width: 10%; margin: 20px auto;"/>			
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SPECIFICATION FOR SEAMLESS LINE PIPES

APPENDIX-VI

A. QUALIFICATION CRITERIA STEEL BILLET MANUFACTURERS

Pipe manufacturer will choose his own supplier of the billet with the condition that every heat shall be tested by OWNER/ OWNER's representative for its physical (YS, UTS and elongation) properties by taking 1 sample per heat. These tests shall be in addition to mill control tests, finished pipe as well as during pipe forming process carried out in pipe mill.

Pipe manufacturer to produce the copy of technical delivery condition, QAP for procurement of billet from steel mill. Before despatch of billet, pipe manufacturer shall submit MTC of all heats.

In case of failure of the above mentioned sample, one more sample from the same billet shall be drawn and tested. In addition one more sample from a different billet of same heat shall also be tested.

Both the samples must meet the minimum requirement as stipulated in clause no. 5.1 of this specification. In case of failure of any of these samples, the entire heat shall be rejected.




Steel billet samples testing will be conducted at pipe mill or the lab approved by Engineer in charge.

Rejection Criteria:

The samples so selected as per above mentioned clauses, shall meet the requirements of Clause no. 5.1 of this specification. However, the responsibility of selection of billet properties would lie with the pipe manufacturer, so that the end product (i.e. pipes) also meet the requirements stipulated in Clause no. 5.1 of this specification.

Steel source of repute meeting qualification criteria

- Steel billet manufacturer(s) must have manufactured and supplied in a single order, the steel billet (as required under present tender) of not less than 4000 MT meant for the production of line pipes conforming to API 5L (PSL2) of the same or higher grade as required under the present bid in last five (5) years from the date of bid submission.
- A letter of commitment from proposed steel billet manufacturer for supply of steel billets required for manufacture of line pipes under present bid.

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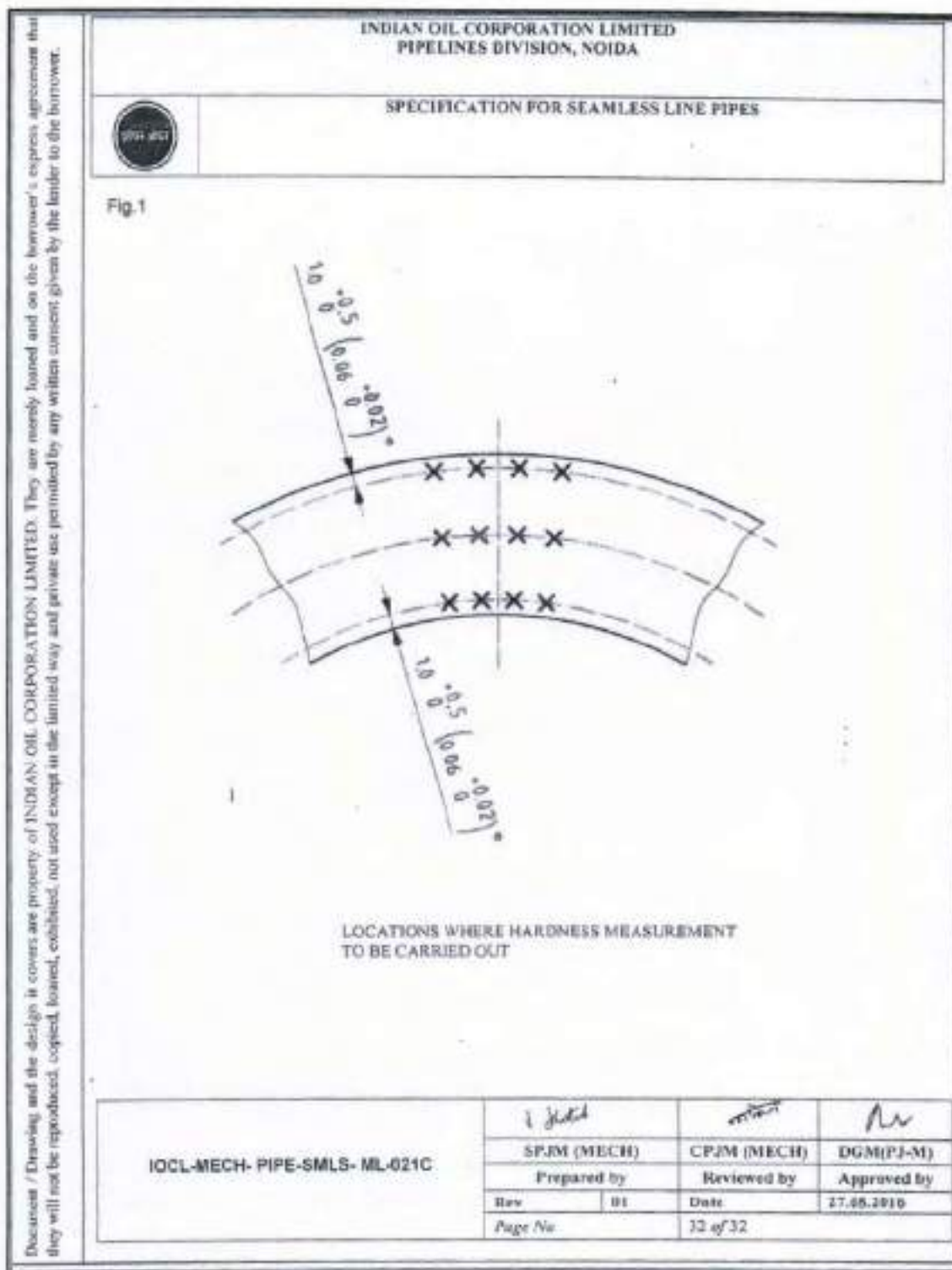
INDIAN OIL

SPECIFICATION FOR SEAMLESS LINE PIPES

- Bidder must submit the following documents for review/ approval for a proposed mill for supply of billets, failing which the name of the mill will not be considered forthrightly:
 - (i) Detailed Supply record
 - (ii) Process Flow Diagram of the Steel Mill
 - (iii) Plant Layout
 - (iv) Quality Assurance Plan and Quality Assurance Procedures.
 - (v) Manufacturing procedure

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K. SPECIFICATION FOR ASTM A333 Gr6 SEAMLESS STEEL PIPES

Clause	Area	Description		Requirements/ Remarks	
1.0	Scope	Supply of ASTM A 333 Gr 6 Seamless Steel Pipes		Rating and Quantity as per specific requirement of the project	
2.0	Service	Liquid Petroleum Gas/ Natural Gas			
3.0	Design and Codes	In accordance with ASTM A 333 Standard		For Grade 6	
4.0	Provisions	<u>Process of Manufacturing</u> - Seamless			
		<u>Tolerance</u> - As per ASTM A 333			
		<u>Length</u> - Single random length not less than 5 meters			
		<u>Ends</u> - Plain - ends beveled at 30 degree for pipes of size NPS 2 and larger			
		<u>Jointers</u> - Not Permitted			
		<u>Heat Treatment</u> : Mandatory – to be done as per ASTM A 333 (2015 edition) clause 4.3			
		Outside and inside diameters, wall thickness and test pressure of pipes – Appropriate sections of ASTM A 333			
6.0	Inspection & Test	Hydrostatic testing	100% Test Certificate 10% (random) IOCL/TPI	R W	As per ASTM A 333 for Gr 6. <i>All stage inspection shall be carried out by third party Inspection agency engaged by the vendor. However, final inspection shall be carried out by owner's designated third party inspection agency and/or IOCL as per approved QAP</i>
		Mechanical properties- tensile test and impact test	For each heat	R	
		Chemical properties	Two samples for each heat	R	
		Heat treatment chart	For each pipe	R	
		Dimensional inspection- Length, Thickness and diameter	100% checking by Vendor & 100% review of record 10% (random) by IOCL/TPI	R W	



IOCL- MECH - ASTM A333 – 033

Document No.: IOCL-CGD-STEEL PIPELINE-SPEC

Rev. No. 0.0

Date 03.02.2021

Clause	Area	Description	Requirements/ Remarks
		Visual inspection - Workmanship, Finish, and Appearance,	For all pipes (100%) W W: Witness R: Review
7.0	Painting	Brush Cleaning + Rust Preventive Coating	
8.0	Marking	All pipes marked to display the following Information: <ul style="list-style-type: none"> Size and Wall Thickness (sch) Weight per meter Grade Test pressure Length 	Marking on outside surface of the pipes starting approximately 12" from the end. Other marking requirement as specified in A333 (2015 edition) Clause 11 to be complied.
9.0	Documentation	i) With Bid (vendor as per approved list)	
		a) Process of manufacturing & Heat treatment.	
		b) Supply record as per BQC/Past supply record for same or higher size.	
		ii) After purchase order	
		a) Process of manufacturing & Heat treatment. b) Inspection plan/ITP/QAP.	
		ii) After Inspection for Dispatch clearance (in 4 sets) a) Inspection report b) Test certificates/report as per approved QAP.	
10.0	Packing & Despatch	All the pipes shall be given a mill coating on the entire length of the pipe to protect the pipe against rusting in transit.	
11.0	Warranty	The manufacturer shall warrant the pipes to be free of defects in mechanical design & workmanship within one year or 18 months from the date of supply and shall replace at his cost any defective pipe.	



IOCL- MECH - ASTM A333 – 033




Document No.: IOCL-CGD-STEEL PIPELINE-SPEC	Rev. No. 0.0	Date 03.02.2021
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L. TECHNICAL SPECIFICATION API6D VALVE

		FORMAT NO. QAF/MP/08	
		Rev: 00	
INDIAN OIL CORPORATION LIMITED		STANDARD SPECIFICATIONS	
API 6D BALL VALVES FOR GAS PIPELINE			
 IndianOil PIPELINES DIVISION TECHNICAL SPECIFICATIONS (API 6D BALL VALVES FOR GAS PIPELINE) Standard Specification No. : IOCL-MECH-BV-API 6D-046A			
 PIPELINES	IOCL-MECH-BV-API 6D-046A REV 00	Approved by	GM (PJ-M)
		Reviewed by	DGM (PJ-M)
		Checked by	CPJM (PJ-M)
		Prepared by	PJM (PJ-M)
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FORMAT NO. QAF/MP/08	
 INDIAN OIL CORPORATION LIMITED STANDARD SPECIFICATIONS API 6D BALL VALVES FOR GAS PIPELINE	Rev: 00

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 PIPELINES	IOCL-MECH-BV-API 6D-046A REV 00	Approved by	GM (PJ-M)	
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		Prepared by	PJM (PJ-M)	
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STANDARD SPECIFICATIONS		Rev: 00	
API 6D BALL VALVES FOR GAS PIPELINE			
ABBREVIATIONS			
ANSI	American National Standards Institute		
API	American Petroleum Institute		
ASME	American Society of Mechanical Engineers		
ASTM	American Society for Testing of Materials		
BQC	Bidder qualification criteria		
DFT	Dry film thickness		
ENP	Electroless Nickel plating		
HOA	Hydraulic Oil Actuators		
IEC	International Electrotechnical Commission		
IIP	Inspection and test plan		
LTCS	Low temperature carbon steel		
MSS	Manufacturers Standardization Society		
MTC	Material test certificate		
NACE	National Association of Corrosion Engineers		
NDE	Non destructive examination		
NPT	National Pipe Thread		
NPTF	National Pipe Thread Female		
NPTM	National Pipe Thread Male		
PESO	Petroleum and Explosives Safety Organization		
PMI	Positive material identification		
PQR	Procedure qualification record		
QA	Quality Assurance		
QAP	Quality Assurance Plan		
QC	Quality Certificate		
TPI	Third party inspector		
UT	Ultrasonic testing		
SS	Stainless Steel		
WPS	Welding procedure specification		
WQT	Welder qualification test		
W/W	Weld-weld ends		
 IOCL-MECH-BV-API 6D-046A REV 00		Approved by	GM (PJ-M)
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INDIAN OIL CORPORATION LIMITED		FORMAT NO. QAF/MP/08												
STANDARD SPECIFICATIONS		Rev: 00												
API 6D BALL VALVES FOR GAS PIPELINE														
TECHNICAL SPECIFICATION														
Clause	Area	Description												
1.0	General	Supply of API 6D Ball Valves Size, Pressure class rating and Quantity as per specific requirement. Actuator, Spares and tools as per specific requirement.												
2.0	Scope	The scope of this specification covers the design, manufacturing, inspection, testing and supply of carbon steel API 6D Ball valves of size 1" and above and ANSI class 150 to 900 for Natural gas pipeline. This specification covers the minimum requirements for design, manufacturing, inspection, testing and supply of fire safe and fire type tested, primary metal secondary soft or soft seated, high performance, zero leak tight shutOff, antistatic, anti-blowout stem arrangement, quarter turn Ball valve along with all accessories as specified.												
3.0	Service	1. Natural Gas (for both A/G and U/G installation as per Annexure I (Product characteristics)) 2. Unprotected outdoor service 3. Continuous service 4. Area classification : IEC Zone -I, Gas Group IIA and IIB Temp class T3												
4.0	Codes and Standard	1. API 6D: Specification for Pipeline and Piping Valves 2. API-6FA: Specification for Fire Test for Valves 3. API Standard 6DX: Standard for Actuator Sizing and Mounting Kits for Pipeline Valves 4. API 607: Fire Test for Quarter-turn Valves and Valves Equipped with Non-metallic Seats 5. API 1104-Welding Pipelines and Related Facilities. 6. API 5L-Specification for line pipe 7. ASME B1.1 -Unified inch screw threads 8. ASME B 1.20.1 -Pipe threads general purposes 9. ASME B 16.25: Butt welding ends 10. ASME B 16.47: Large Diameter Steel Flanges (Series-A: for sizes ranging from 26"-36"; Series B: For sizes above 36"). 11. ASME B16.5: Pipe Flanges and Flanged Fitting: NPS 1/2 through 24 except 22" 12. ASME B31.3: Process Piping. 13. ASME B31.4: Pipeline Transportation System for Hydrocarbons and Other Liquids. 14. ASME B31.8: Gas Transmission and Distribution Piping Systems. 15. ASME B16.34-Valves: Flanged, Threaded and Welding Ends. 16. ASME Sec II to IX - Boiler and Pressure Vessel Code 17. ASME B 36.10 -Welded and Seamless Wrought steel Pipe 18. ASTM A-370-Standard Test Methods and Definitions for Mechanical												
 PIPELINES		<table border="1"> <tr> <td>Approved by</td> <td>GM (PJ-M)</td> </tr> <tr> <td>Reviewed by</td> <td>DGM (PJ-M)</td> </tr> <tr> <td>Checked by</td> <td>CPJM (PJ-M)</td> </tr> <tr> <td>Prepared by</td> <td>PJM (PJ-M)</td> </tr> <tr> <td>Date</td> <td>21.06.2017</td> </tr> <tr> <td>Page No</td> <td>4 of 24</td> </tr> </table>	Approved by	GM (PJ-M)	Reviewed by	DGM (PJ-M)	Checked by	CPJM (PJ-M)	Prepared by	PJM (PJ-M)	Date	21.06.2017	Page No	4 of 24
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LAYING & CONSTRUCTION OF 3LPE COATED
CARBON STEEL PIPELINE AND ASSOCIATED WORKS
FOR CITY GAS DISTRIBUTION


इंडियन ऑयल कॉर्पोरेशन लिमिटेड
(पाईपलाइन प्रभाग) नोएडा

INDIAN OIL CORPORATION LIMITED		FORMAT NO. QAF/MP/08												
STANDARD SPECIFICATIONS		Rev: 00												
API 6D BALL VALVES FOR GAS PIPELINE														
Clause	Area	Description												
		Testing of Steel Products. 19. ASTM B 733-Auto catalytic Nickel Phosphorous Coating on Metals. 20. ASTM A333-Standard Specification for Seamless and Welded Steel Pipe for Low-Temperature Service and Other Applications with Required Notch Toughness 21. ASTM A 193/ 193M -Alloy steel and stainless steel bolting materials for high temperature service 22. ASTM A 194/194M - Carbon and alloy steel nuts for bolts for high temperatures service 23. ASTM A 320/320M -Alloy steel bolting materials for low temperature service 24. ASTM A 350/350M -Forgings, carbon and low alloy steel, requiring notch toughness testing for piping components 25. ASTM A 420/420M -Pipe fittings of wrought carbon steel and alloy steel for low temperature service 26. ASTM A352 / A352M-Standard Specification for Steel Castings, Ferritic and Martensitic, for Pressure-Containing Parts, Suitable for Low-Temperature Service 27. MSS-SP-6 -Standard Finishes for Contact Faces of Pipe Flanges and Connecting – end Flanges of Valves and Fittings 28. MSS SP-25 -Standard marking system for valves, fitting, flange union. 29. MSS-SP-44: Steel Pipeline Flanges (for sizes 12" and for sizes ranging from 26"-36") 30. MSS SP – 45 -Bypass and drain connection standard. 31. SSPC-VIS-1-Steel Structures Painting Council Visual Standard. Unless otherwise indicated, all latest codes and standards shall be followed.												
5.0	Design and Construction	1. Valve design shall meet the requirements of API 6D (latest edition) and other referred codes and shall be suitable for the service conditions indicated in the specifications. Allowable stress requirements shall comply with the provision of ASME Section VIII Div.1. 2. Corrosion allowance of 3 mm is to be considered. Minimum wall thickness shall not be less than minimum requirement of ASME B16.34 plus corrosion allowance. 3. Valve body design shall be <u>fully welded construction</u> for underground installation. 4. For above ground installation, the valves shall be fully welded or bolted (two/three piece) design as Specified in "Specific requirements of the Project". In case the offered valves are Top entry type, single piece construction is also acceptable for bolted valves. 5. Underground valves shall have Butt weld ends unless otherwise specified. Aboveground valves shall be Flanged type (if bolted construction) and Butt weld ended (if fully welded construction), unless otherwise specified.												
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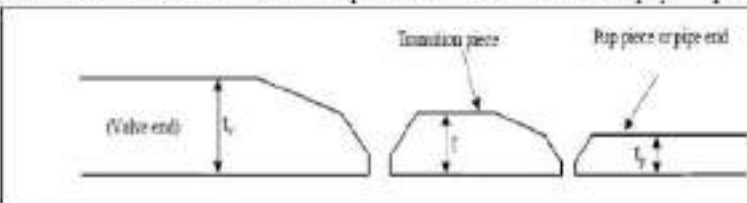

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API 6D BALL VALVES FOR GAS PIPELINE		
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		<p>6. Valve shall be made of low temperature carbon steel for size 12" and below unless otherwise specified. All internals, O-rings, inserts, fasteners shall be suitable for low temperature service of up to (-) 46 °C</p> <p>7. Centre line of the bore to hand wheel, for underground valves shall be 2500 mm±100 mm.</p> <p>8. Vendor shall ensure sufficient gap between body/connector stud and connecting flange stud for smooth fitting and removal of stud and bolt in 2-piece/3-piece design bolted construction. Vendor shall provide the dimensional drawing for the same i.e individual flange to connector flange distance.</p> <p>9. Valve body with threaded joints are not permitted.</p> <p>10. Ball valves shall be with full bore/nominal bore, long pattern, fire safe and tested, double block and bleed features unless otherwise specified.</p> <p>11. Ball shall be of single piece, solid type construction.</p> <p>12. Valve ball mounting shall be trunion type as per API 6D. Valve design shall minimize the possibility of debris ingress into the trunion as far as possible.</p> <p>13. The end flanges shall be integral with body. End flanges shall be finished with raised face as per applicable standard. Dimensions and tolerances including drilling templates, flange facing, spot facing and back facing for flanges shall conform to applicable codes as mentioned above.</p> <p>14. Face to face dimension not specified in API 6D shall be as per Manufacturer standard and shall be subject to approval by owner.</p> <p>15. Flange dimension shall be as per ASME B 16.5 for size up to 24" (except 22"), ASME B16.47 Series A/MSS-SP-44 for size 22" and sizes ranging from 26"-36" and ASME B 16.47 Series B for sizes above 36".</p> <p>16. Seat design shall be Primary metal, secondary soft or soft seated with bubble tight upstream and downstream sealing.</p> <p>17. Fire safe tested valve shall be of same design, construction and material as offered valves as per API 6FA/API 607.</p> <p>18. All metallic parts, which usually include items such as gland, gland bushing, ball, bolts, nuts, seat rings, springs, body, internal keys, pins, screws, hinge pins, shafts, hand-wheels, gendrings motor drive attachment, etc. shall be of material suitable for desired service.</p> <p>19. Design shall be such, so as to avoid bimetallic corrosion between carbon steel and high alloy steel components. Suitable insulation shall be provided as required.</p> <p>20. All sliding, rotating, screwed components and plugs shall have adequate differential hardnesses and surface finishes ensuring prevention of galling.</p> <p>21. All non-metallic and metallic parts for valves under Fire safe type should be suitable for Fire safe service.</p> <p>22. All non-metallic parts and elements which usually include such items as packing.</p>
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		sealant material and lubricants for valves shall be suitable for the service.																							
23.		Manual Ball valves shall be provided with following operator:																							
		<table border="1"> <thead> <tr> <th>Rating</th> <th>Size</th> <th>Operator</th> </tr> </thead> <tbody> <tr> <td rowspan="2">150</td> <td>6" and larger</td> <td>Gear operator with hand wheel</td> </tr> <tr> <td>Less than 6"</td> <td>Level operator</td> </tr> <tr> <td rowspan="2">300</td> <td>6" and larger</td> <td>Gear operator with hand wheel</td> </tr> <tr> <td>Less than 6"</td> <td>Level operator</td> </tr> <tr> <td rowspan="2">600</td> <td>4" and larger</td> <td>Gear operator with hand wheel</td> </tr> <tr> <td>Less than 4"</td> <td>Level operator</td> </tr> <tr> <td rowspan="2">900</td> <td>3" and larger</td> <td>Gear operator with hand wheel</td> </tr> <tr> <td>Less than 3"</td> <td>Level operator</td> </tr> </tbody> </table>	Rating	Size	Operator	150	6" and larger	Gear operator with hand wheel	Less than 6"	Level operator	300	6" and larger	Gear operator with hand wheel	Less than 6"	Level operator	600	4" and larger	Gear operator with hand wheel	Less than 4"	Level operator	900	3" and larger	Gear operator with hand wheel	Less than 3"	Level operator
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	Less than 3"	Level operator																							
24.		Ball valves shall be provided with position indicator and stops of rugged construction at the fully open and closed positions.																							
25.		Drain/vent connections shall be provided with double isolation ball valves and plugged suitably. Sealant injection shall be provided with bonnet type needle valve and plugged suitably. All drain, vent and sealant pipes used shall be ASTM A333 Gr 6 with Sch. 160. Butt weld fittings (as per ASME B16.9) shall be ASTM 420 Gr.WPL6. Forged fittings (as per ASME B16.11) shall be ASTM A350 LF2 (6000#) and flanges (as per ASME B16.5) shall be ASTM A350 LF2. Ball valve and piping used for isolation of drain/vent shall be same or higher pressure class and with same or superior material as that of the main valve.																							
26.		For extended stem valves, vent and drain connections and sealant injection lines shall be terminated adjacent to the valve operator by means of suitable piping rigidly anchored to the valve body.																							
27.		Special tools, if any, for replacement of spare parts including removal of ball and seat shall be provided for each location.																							
28.		Body cavity over-pressure shall be prevented by self-relieving seat rings/assemblies. A pressure relief hole in the ball is not permitted. Self - relieving seat rings shall relieve the body cavity at a differential pressure not exceeding 50% of the valve class rating pressure.																							
29.		Valves should withstand sustained internal vacuum of at least 1(one) mill -bar in both open and closed positions.																							
30.		Valve shall be designed in such a way that repair or replacement of stem seal/packing shall be carried out under full line pressure.																							
31.		Butt weld end preparation of valve/transition piece/pup piece shall be as per ASME B31.8 Figure "I" as per specified connecting pipe thickness. The thickness of the pipe to which the valve has to be welded is indicated in the "Specific requirement of the project". Suitable transition/pup pieces shall be provided as																							
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		<p>applicable, to ensure that there is no weldability problem between valve butt weld end and connecting pipe weld end. The following conditions shall be satisfied for welding between valve and connecting pipe. A typical sketch as shown below shall be referred for requirement of transition/pup piece:</p> <div style="text-align: center;">  </div> <p>a. If the thickness of valve end ('t_v') is less than or equal to 1.5 times the thickness of pipe ('t_p'), then transition pieces /pup pieces are not necessary.</p> <p>b. If the thickness of valve end ('t_v') is more than 1.5 times thickness of connecting pipe ('t_p'), then following design conditions shall be satisfied for transition piece.</p> <ul style="list-style-type: none"> • Thickness of valve end, 't_v' ≤ 1.5 times of thickness of transition piece, 't' • Thickness of transition piece, t ≤ 1.5 thickness of pipe/pup piece, 't_p' <p>The material grade of the pup pieces must be the same as that of the adjacent connecting pipe. The thickness and material grade of the transition pieces must be selected to meet the criteria of ASME B31.8. (Thickness calculations based on applicable codes and the respective material grades).</p> <p>32. No repair is permitted on pup pieces. Pup piece/transition pieces shall be designed to withstand hydro test along with the valve at manufacturer's work. All testing of valve shall be carried out after transition/pup pieces are welded to the valve.</p> <p>33. For 6" and above, length of pup piece (if provided) shall be minimum 1D or 300 mm on both ends (whichever is more). For 4" and below valve size, pup piece of minimum 200 mm on both ends of butt weld valve is mandatory. Manufacturer shall ensure that there will be no danger to the seat inert/o-rings during welding of pup pieces.</p> <p>34. WPS/PQR/WQT as applicable for fully welded ball valve, transition piece and pup piece shall be provided by the vendor for owner's review and approval.</p> <p>35. The tolerance on internal diameter and out of roundness at the ends for weld end valves shall be as per applicable connected pipe specification as indicated in specific requirement.</p> <p>36. Valves shall have gas over oil actuator, manual hydraulic actuator, pneumatic actuator, and electric actuator, electro-hydraulic or manual operation as specified in specific requirement/actuator specification.</p> <p>37. Valve shall be provided with anti-static devices to ensure electrical continuity between stem/ball and valve body.</p>												
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		38. For the manual operator of all valves, the diameter of the hand wheel, the length of operating lever shall be such that under the maximum differential pressure, the total force required to operate the valve does not exceed 360N. Hand wheel diameter shall not exceed 1000mm. Spokes shall not extend beyond the perimeter of hand wheel.												
		39. Direction of operation of hand wheel shall be in clock-wise direction while closing the valve.												
		40. Manual gear operator Valves shall have locking devices to lock the valves either in full open (LO) or full close (LC) positions with locking devices permanently attached to the valve operator and shall be fully encased in water proof/splash proof enclosure, filled with suitable grease.												
		41. Stem extension and stem housing design shall be such that the complete assembly forms a rigid unit giving positive drive under all conditions with no possibility of free movement between valve body, stem extension and its operator. Valves provided with stem extension shall have waterproof outer casing. Stem shall be of single piece only.												
		42. For underground valves, outer casing of stem extension shall have 3/8" or 1/2" NPT plugs at the top and bottom, for filling and draining oil to prevent internal corrosion.												
		43. Repair by welding is not permitted for forged body valves, stem and trim components. Repair by welding as per ASME B16.34 is permitted for cast body valves and shall be permitted only after approval of owner. Defects higher than 10% of thickness in casting are not permitted for repair.												
		44. All repairs performed by means of welding shall be carried out by qualified welders, following the procedure required for the grade of the steel. The welder qualification WPS, PQR shall be submitted to Owner for approval. Welding shall be as per ASME B31.8 and ASME Section IX.												
		45. Design of weld end shall be such that during field welding operation, soft seals are not liable to damage.												
		46. Valve stem shall be capable of withstanding the maximum operating torque required to operate the valve against the maximum differential pressure corresponding to applicable class rating. The combined stress shall not exceed the maximum allowable stresses specified in ASME section VIII, Division 1. For power actuated valves, the valve stem shall be designed for maximum output torque of the selected power actuator (including gear box, if any) at valve stem. The design torque for the drive train calculation shall comply API 6D requirements for which calculation shall be furnished.												
		47. Ball valves of size, 8" and above shall be equipped with support foot and lifting lugs. Tapped holes and eyebolts are not to be used for lifting lugs.												
		48. 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												
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		<p>extrusion during opening or closing operation at maximum differential pressure. The seat rings shall be so designed as to ensure sealing at low as well as high differential pressure</p> <p>49. Ball valves of size, 8" and above shall have provision for secondary sealant injection under full line pressure for seat and stem seals and shall be designed accordingly. All sealant injection connection shall be provided with an internal non-return valve with sealing cap. Provision shall be made to replace the sealant injection fitting under full line pressure. Location and arrangement of sealant point shall be as per API 6D.</p> <p>50. Irrespective of size, sealant injection shall be provided for all mainline sectionalizing valves. (i.e for 4" and above)</p> <p>51. Vent and drain lines with double isolation ball valves shall be provided for size 4" and above. For valve size less than 4", only drain with plug shall be provided.</p> <p>52. The drain line in underground valves shall be protected by steel grating/enclosure/support foot so that they are not damaged during transportation or installation.</p>	
6.0	Materials	<p>1. Material for major components of the valve has been indicated in the valve data sheet-Annexure IA.</p> <p>2. Carbon steel used for the manufacture of valve shall be fully killed.</p>	
7.0	Inspection and testing	S.N o	<p>Description</p> <p>TPI/IOCL</p>
		1.	<p>Chemical and Mechanical testing of body and connectors for each heat.. pup/transition piece(if applicable)</p> <p>W-100%</p>
		2.	<p>Chemical and mechanical testing of pressure controlling parts viz. Ball and seat</p> <p>W-100%</p>
		3.	<p>Chemical and mechanical testing of stem</p> <p>W-100%</p>
		4.	<p>Charpy V-notch test to be carried out on each heat as follows:</p> <p>I. Pressure containing parts viz. body, connectors, end flanges, bolting material, pup/transition piece(if applicable)</p> <p>II. Pressure controlling parts viz. Ball and seat</p> <ul style="list-style-type: none"> • Test temperature: (-) 29°C. • Test procedure shall conform to ASTM A370. • The average absorbed impact energy value of three full-sized specimens shall be min 35/27J and the minimum impact energy value of any one specimen of the three specimens analyzed as above shall be min 28/22 J. <p>W-100%</p>
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		<p>• When Low Temperature Carbon Steel (LTCS) materials are indicated in specific requirement of the project provided by vendor, additional Charpy V-notch testing shall be carried out at (-)46°C and the impact energy shall be as per respective LTCS material specification.</p>	
		5.	<p>Hardness test shall be carried out on each heat of base material for all pressure containing parts and pressure controlling parts of the valve as defined above and pup/transition piece(if applicable). 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.</p> <p style="text-align: right;">W-100%</p>
		6.	<p>Visual Dimensional final check</p> <p style="text-align: right;">W-100%</p>
		7.	<p>Hydrostatic shell test shall be carried out as per Clause 9.3 of API 6D. Duration of test shall be twice that of value specified in Table 5 of API 6D. No leakage or pressure drop is allowed during the testing duration.</p> <p style="text-align: right;">W-100%</p>
		8.	<p>Hydrostatic seat test shall be carried out as per Clause 9.4 of API 6D. Duration of test shall be twice that of value specified in Table 6 of API 6D.</p> <p style="text-align: right;">W-100%</p>
		9.	<p>Double block and bleed test</p> <p style="text-align: right;">W-100%</p>
		10.	<p>High pressure gas shell testing as per Clause H.4.2 of API 6D-24th edition</p> <p>Appropriate safety precautions should be taken by the vendor for testing.</p> <p style="text-align: right;">W-100%</p>
		11.	<p>High pressure gas seat testing as per Clause H.4.3 of API 6D-24th edition</p> <p>Appropriate safety precautions should be taken by the vendor for testing.</p> <p style="text-align: right;">W-100%</p>
		12.	<p>Low pressure Pneumatic seat test</p> <p style="text-align: right;">W-100%</p>
		13.	<p>Operation Torque test as per Clause H.6 of API 6D-24th edition with all four conditions</p> <p style="text-align: right;">W-100%</p>
		14.	<p>Cavity relief testing</p> <p style="text-align: right;">One valve per size and per rating, (selected at random)</p>
		15.	<p>NDE as per Table-1</p> <p style="text-align: right;">W-100%</p>
		16.	<p>100% UT on pup pieces(if applicable)</p> <p style="text-align: right;">W-100%</p>
		17.	<p>Strip down test shall be carried out for 1 no. Valve</p> <p style="text-align: right;">W-100%</p>


 <p>PIPELINES</p>	<p>IOCL-MECH-BV-API 6D-046A</p> <p>REV 00</p>	Approved by	GM (PJ-M)	
		Reviewed by	DGM (PJ-M)	
		Checked by	CPJM (PJ-M)	
		Prepared by	PJM (PJ-M)	
		Date	21.06.2017	
		Page No	11 of 24	

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LAYING & CONSTRUCTION OF 3LPE COATED
CARBON STEEL PIPELINE AND ASSOCIATED WORKS
FOR CITY GAS DISTRIBUTION

इंडियन ऑयल कॉर्पोरेशन लिमिटेड
(पाईपलाइन प्रभाग) नोएडा


INDIAN OIL CORPORATION LIMITED		FORMAT NO. QAF/MP/08	
STANDARD SPECIFICATIONS		Rev: 00	
API 6D BALL VALVES FOR GAS PIPELINE			
Clause	Area	Description	
		(≤12") and 1 no. valve (>12") as applicable from random selection in entire purchase order. After strip down test, the valve to be hydro tested and seal tested.	
18.		Min. valve thickness of body, connector to be checked as per ASME B16.34 at the minimum thickness area of body and connector in the presence of TPI/IOCL.	W-10% for each size and rating
19.		PMI Check for fasteners – for each heat	W-100%
20.		Cyclic testing - for 1 no. Valve (≤12") and 1 no. valve (>12") as applicable from random selection in entire purchase order a) The valve shall be subjected to at least 100 Open-Close cycles with maximum differential pressure corresponding to the valve rating. b) Subsequent to the above, the valve shall subject to hydrostatic test and supplementary air seat test. 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.	Witness - 1 no. valve of total ordered quantity (Random selected)
21.		ENP thickness test certificate	R
22.		MTC of soft seal, gaskets, O ring, Studs and Nuts and other brought out items	R
23.		Spares inspection	R
24.		Painting inspection -1 no. for each valve size to be witnessed.	R / W
25.		Final documentation check	R
Notes			
1. Inspection shall be carried out by Owner and/or TPI (third party Inspection) at Vendor's/ Manufacturer's works.			
2. If new material is imported, then vendor shall engage TPI for testing of each			
 IOCL-MECH-BV-API 6D-046A REV 00		Approved by GM (P-J-M) Reviewed by DGM (P-J-M) Checked by CPJM (P-J-M) Prepared by PIM (P-J-M) Date 21.06.2017 Page No 12 of 24	
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API 6D BALL VALVES FOR GAS PIPELINE																										
																										
Clause	Area	Description																								
		<p>heat of raw material. Cost of TPI for such testing is under vendor's scope and the same to be included in total cost of valve.</p> <p>3. Bidders should give minimum 3 weeks advance notice for inspection.</p> <p>4. R- Review, W-Witness</p> <p>5. All testing shall be carried out with drain line, vent line, sealant line, extended stem and all other auxiliary lines installed.</p> <p>6. In no case shall any action of the owner or his inspector or inspection performed by the owner relieve the manufacturer from his responsibility for the material design quality inspection and operation of the valves.</p> <p>7. Owner reserves the right to do additional testing at any time to confirm or further investigate a fault to ensure that the valve is meeting the specification. The cost of any such testing shall be borne by the Vendor.</p> <p>8. Owner has the right to perform stage wise inspection and witness all requirement tests prior to shipment from manufacturers work.</p> <p>9. All test reports and certificates shall be valid only when signed by owner and/or inspector (TPI). Only those valves which are certified by company approved Inspectors shall be dispatched from Manufacturers works.</p>																								
		<p style="text-align: center;">Table 1 - NDE Requirement</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">Part</th> <th style="text-align: center;">Cast</th> <th style="text-align: center;">Forged/Bar</th> </tr> </thead> <tbody> <tr> <td>Body / closure / end connections / bonnet / cover / gland housing / Trunnion (if pressure containing)</td> <td>VT1, RT3 or (RT1+ UT1)</td> <td>VT2, UT2</td> </tr> <tr> <td>Welding of body with connectors -for fully welded ball valves/ Pressure containing welds/ Pipe pup to valve welds or pipe pups</td> <td colspan="2">VT3, RT2 or UT3</td> </tr> <tr> <td>Welding ends of valve, transition piece, pup piece (50mm from weld end on each side)</td> <td>VT1, RT3, UT4</td> <td>VT2, UT2</td> </tr> <tr> <td>Stem or Shaft</td> <td>N/A</td> <td>VT2, UT2</td> </tr> <tr> <td>Ball</td> <td>UT4</td> <td>UT2</td> </tr> <tr> <td colspan="3">Note 1: Refer Table J.2 of API 6D Latest edition for specification of the nomenclature and examination referred to in this table</td> </tr> <tr> <td colspan="3">Trunnion may be pressure containing or pressure controlling, depending on design type. If the trunnion is a pressure containing part, then requirements for body shall apply.</td> </tr> </tbody> </table>	Part	Cast	Forged/Bar	Body / closure / end connections / bonnet / cover / gland housing / Trunnion (if pressure containing)	VT1, RT3 or (RT1+ UT1)	VT2, UT2	Welding of body with connectors -for fully welded ball valves/ Pressure containing welds/ Pipe pup to valve welds or pipe pups	VT3, RT2 or UT3		Welding ends of valve, transition piece, pup piece (50mm from weld end on each side)	VT1, RT3, UT4	VT2, UT2	Stem or Shaft	N/A	VT2, UT2	Ball	UT4	UT2	Note 1: Refer Table J.2 of API 6D Latest edition for specification of the nomenclature and examination referred to in this table			Trunnion may be pressure containing or pressure controlling, depending on design type. If the trunnion is a pressure containing part, then requirements for body shall apply.		
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8.0	Marking	As per API 6D-24 th edition (Section - 11)																								
	<p>IOCL-MECH-BV-API 6D-046A</p> <p>REV 00</p>	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">Approved by</td> <td style="width: 30%;">GM (PJ-M)</td> <td style="width: 40%;"></td> </tr> <tr> <td>Reviewed by</td> <td>DGM (PJ-M)</td> <td></td> </tr> <tr> <td>Checked by</td> <td>CPJM (PJ-M)</td> <td></td> </tr> <tr> <td>Prepared by</td> <td>PJM (PJ-M)</td> <td></td> </tr> <tr> <td>Date</td> <td>21.06.2017</td> <td></td> </tr> <tr> <td>Page No</td> <td>13 of 24</td> <td></td> </tr> </table>	Approved by	GM (PJ-M)		Reviewed by	DGM (PJ-M)		Checked by	CPJM (PJ-M)		Prepared by	PJM (PJ-M)		Date	21.06.2017		Page No	13 of 24							
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STANDARD SPECIFICATIONS		Rev: 00	
API 6D BALL VALVES FOR GAS PIPELINE			
Clause	Area	Description	
9.0	Painting for valves and for Gearbox.	<p>1. Paint shall be applied only after all tests and examinations have been carried out by the Inspection Agency.</p> <p>2. The interior surfaces, the threaded parts, the bevelled or socket-welding ends, the flange contact faces, and the various valve-identifying markings shall not be painted.</p> <p>3. Shade of colour shall be off white unless otherwise stated in the specific requirement of the project.</p>	
		<p>Surface preparation by shot blasting as per grade SA 2 1/2, Swedish standard SIS-055-909</p> <p>1. Epoxy Zinc Silicate PRIMER- min. 60 MICRON</p> <p>2. High Build Epoxy (2 PACK) -min. 150 MICRON</p> <p>3. Two pack Polyurethane – 50 min. 60 MICRON</p> <p>TOTAL DFT – 270 min.</p> <p>For valves to be installed underground, the external surfaces of the buried portion of the valve shall be painted with three coats of suitable coal tar epoxy resin with min DFT of 300 micron.</p>	
10.0	Documentation	<p>i) With Bid</p> <p>a) General arrangement/ Cross-sectional drawing/Dimensional drawing of the valve and actuator drawing.</p> <p>b) Blow up view drawing of ball seat sealing arrangement.</p> <p>c) Blow up view drawing of stem sealing arrangement.</p> <p>d) Fully filled enclosed valve data sheet, Checklist (LA and IB) and Actuator specification datasheet</p> <p>e) Bill of Material and Material of conformity</p> <p>f) Supply record of API 6D ball valve as per bidder qualification criteria</p>	
 <p>PIPELINES</p>		<p>IOCL-MECH-BV-API 6D-046A</p> <p>REV 00</p>	
		Approved by	GM (P-J-M)
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API 6D BALL VALVES FOR GAS PIPELINE		
Clause	Area	Description
		<p>g) Reference list of similar ball valves manufactured and supplied in last seven years indicating all relevant details including project, year, client, location, size, rating, service, etc.</p> <p>h) Copy of valid API certificate for use of API monogram for 6D valves for the original manufacturing company.</p> <p>i) Certificate and report for successful fire type-tests for the offered valves in accordance with applicable standard as per API 6D shall be submitted along with tested valve drawing, tested valve datasheet and Material of construction. Also, fire-safe certificate shall not be older than 07 years. Fire safe tested valve to be of same design, construction and material as per offered valves as indicated in API 6FA/API 607.</p> <p>j) Bidder shall provide thrust and torque calculation of valve along with technical bid of valve for all sizes and rating along with the following:</p> <ul style="list-style-type: none"> Flow Coefficient (C_v) of valves for all sizes and rating. Breakaway torque for valve and maximum allowable stem torque on the valve The maximum allowable input torque to the gearbox (if applicable) Number of turns of hand wheel from full open to full close position, gear box details, mechanical advantage and gear ratio. <p>k) Indicative Quality Assurance Plan.</p> <p>ii) After Placement of Purchase Order within 15 days (4 sets)</p> <p>a) General arrangement/ Cross-sectional drawing and actuator drawing.</p> <p>b) Number of turns of hand wheel from full open to full close position, gear box details, mechanical advantage and gear ratio.</p> <p>c) Blow up view drawing of ball seat sealing arrangement.</p> <p>d) Blow up view drawing of stem sealing arrangement.</p> <p>e) Blow up view drawing of sealant injector.</p> <p>f) Drain, vent, sealant injection piping arrangement drawing for both above ground and underground valves.</p> <p>g) Painting procedure</p> <p>h) Welding, heat treatment and testing procedure</p> <p>i) Design calculation for pressure containing parts</p> <p>j) Bill of Material and Material of conformity</p> <p>k) Quality Assurance Plan</p> <p>l) Bidder to provide torque calculation of valve for all sizes and rating along with the following:</p> <ul style="list-style-type: none"> Flow Coefficient (C_v) of valves for all sizes and rating. Breakaway torque for valve and maximum allowable stem torque on the valve The maximum allowable input torque to the gearbox (if applicable) <p>m) Drawing indicating locations where radiography shall be carried out for cast body</p>

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STANDARD SPECIFICATIONS		Rev: 00
API 6D BALL VALVES FOR GAS PIPELINE		
Clause	Area	Description
		n) UT procedure for forged body valves o) Details of support foot, including dimensions and distance from valve centre line to bottom of support foot p) Duly filled enclosed data sheet q) Installation, operation, and maintenance instructions/manuals iii) After inspection, for Despatch Clearance (4 Sets) a) Inspection and Testing certificates and inspection release note. b) Packing List c) Heat-treatment records including time and temperature, e.g. charts d) Material test reports on all pressure-containing and pressure-controlling parts e) All documents as per approved QAP/TTP, approved drawings and technical specification. iv) Along with despatch (In 6 sets and CD/pen drive-3 nos.) a) All approved documents, drawings and procedures. b) Inspection and Testing certificates and inspection release note. c) Packing List d) Installation, operation, and maintenance instructions/manuals
11.0	Packing and shipment	a) In wooden crates, wrapped in 2-3 mm thick impervious (water proof) sheet, suitable to weather handling and transportation. b) Packing list to be enclosed. c) Crate shall have legible identification marking of contents Viz. Order Number, Manufacturer's Name, Valve size and rating, Tag Number, serial Number. d) Valve ends shall be suitably protected to avoid any damage during transit. e) End covers shall be provided at both ends of the valve. f) 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. g) All threaded and machined surfaces subject to corrosion shall be well protected by a coat of grease or other suitable material. h) All parts of the valves including drain, vent, and sealant injection port shall be carefully protected for prolonged storage period of at least 2 years. i) Vendor shall provide the storage and preventive maintenance procedure for valve during the prolong storage period of at least 2 years. j) It shall also meet the requirements of Section-12 of API 6D-24 th edition.
12.0	Warranty	The manufacturer shall warrant the Valve to be free of defects in mechanical design, material, manufacturing & workmanship. Any defect so detected in one year of operation or within 18 months from the date of supply shall be replaced free of cost by the supplier.

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API 6D BALL VALVES FOR GAS PIPELINE		

APPENDIX IC

ELECTROLESS NICKEL PLATING PROCEDURE

1.0 Surface preparation

The support surface shall be correctly prepared by abrasive blasting to SA 3.

2.0 Coating process

The ENP coatings shall be obtained by chemical reactions leading to a plating composed of 90% Nickel and 10% Phosphorus. This type of coating must comply with ASTM B 733, with the following classification of this standard: SC4, Type III, Class 2, and with the following particular or additional requirements:

3.0 Testing


3.1 Appearance

The ENP appearance shall be checked as specified in ASTM B 733, paragraph 7.2. Coating shall be smooth, adherent and free from visible blisters, pits, nodules, porosity and other defects. Slight discoloration resulting from heat treatment shall not be cause for rejection. 100% of the components shall be examined.

3.2 Other Tests

The following properties shall be tested according to ASTM B 733 in order to verify the quality of the deposits, and test certificates must be submitted to the TPI Owner for review:

- a) Hardness
- b) Thickness
- c) Alloy composition

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<div style="text-align: right;">FORMAT NO. QAF/MP/08</div>											
<div style="text-align: center;"> </div>											
<div style="text-align: center;">LIST OF STANDARD SPARES FOR API 6D BALL VALVE</div>											
S. NO.	VALVE DETAIL	PART NO. **	SPARE DESCRIPTION	UNIT	QTY PER SET **	NO. OF VALVES IN A LOCATION	REQUIRED QTY IN SET FOR EACH SIZE and RATING PER LOCATION	NO. OF LOCATIONS	TOTAL QUANTITY		
1	"SIZE" X "RATING", "END CONNECTION", "INSTALLATION"		SEAT INSERT	SET	1 TO 4 NOS.	1					
					5 TO 8 NOS.	2					
					9 TO 12 NOS.	3					
					13 and ABOVE	4					
			SEAT SPRINGS	SET	1 TO 8 NOS.	1					
					9 and ABOVE	2					
			BODY - SEAT SEAL O-RING and GASKET	SET	1 TO 4 NOS.	1					
					5 TO 8 NOS.	2					
					9 TO 12 NOS.	3					
					13 and ABOVE	4					
			STEM O-RING and PACKING	SET	1 TO 4 NOS.	1					
					5 TO 8 NOS.	2					
					9 TO 12 NOS.	3					
					13 and ABOVE	4					
			BODY - TAIL PIECE O-RING and GASKET	SET	1 TO 4 NOS.	1					
					5 TO 8 NOS.	2					
					9 TO 12 NOS.	3					
					13 and ABOVE	4					
			SPECIAL TOOLS and TACKLES (IF REQUIRED)	SET		1					
		2	SEALANT INJECTION KIT		SEALANT INJECTION KIT	NO.	FOR ALL	1			
							1 TO 9 NOS.	3			
							10 TO 18 NOS.	6			
							19 and ABOVE	9			
		** PART NO. AND QTY/SET ARE TO BE PROVIDED BY THE VENDOR DURING BID STAGE.									
		IOCL-MECH-BV-API 6D-046A REV 00		Approved by Reviewed by Checked by Prepared by Date Page No		GM (PJ-M) DGM (PJ-M) CPJM (PJ-M) PJM (PJ-M) 21.06.2017 24 of 24					
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VALVE DATA SHEET-1

1/2" Ball Valve -300# - WCB - BE & FE

1.0	Nominal size (inch, NB)	:	1/2"
2.0	Valve Type	:	Ball Valve, Floator
3.0	Standard	:	API 6D - 24th edition
4.0	Pressure class	:	ANSI 300#
5.0	Operating Pressure (bar)	:	49
6.0	Operating Temperature (deg C)	:	0 to 60
7.0	Service	:	Natural Gas
8.0	Location	:	
9.0	Corrosion allowance	:	1.6mm
10.0	Connecting pipe Specification for BE Valve		
	Material	:	ASTM A106 GRADE B
	Outside Diameter (mm)	:	21.34
	Wall Thickness (mm)	:	3.73mm (SCH 80)
11.0	Valve Construction Design		
	Bore	:	Full Bore
	End Connections	:	Butt End ASME B 16.25 OR Flanged End ASME B 16.5 as per requirement
	Valve Type	:	Floating
	Stem Design	:	Anti blow out type
	Stem Extension	:	NA
	Valve Operation	:	Lever
	Pup pipe material	:	ASTM A106 GRADE B for BE valves only
	Pup pipe length	:	150mm for BE valves only - 1/2" NB
	Pup pipe wall thickness	:	3.73mm (SCH 80) for BE valves only
	Fire Safe Design	:	Yes, API 6FA
	Anti Static	:	Yes
	Ball position indicator	:	Open/close indicator required
	Mechanical stops	:	Open/close limits required
	Secondary sealant injection point	:	NA
	Vent & Drain	:	as per technical specification/API 6D
12.0	Valve Material Specification		
	Valve Body	:	ASTM A216 Gr. WCB
	Ball	:	ASTM A351 Gr CF8M+ Minimum 80micron ENP coating
	Body Seat Rings	:	AISI 4140 + MINIMUM 80 MICRONS ENP COATING / AISI 410
	Seat Seal	:	VITON / DEVLON
	Stem	:	AISI 4140 + ENP coating/AISI 410 (No casting)
	Stem Seals	:	PTPF
	Primary Seat	:	Metal to Metal
	Secondary Seat	:	DEVLOON / RPTFE or Equivalent
	Flange	:	as per ASME B16.5
	Studs	:	ASTM A 193 Gr. B7 (HOT DIP GALVANIZED)
	Nuts	:	ASTM A 194 GR. 2H (HOT DIP GALVANIZED)
	Bonnet/Trunion Gasket	:	NYLON/PTEF/SS304



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	Body Gasket	:	Reinforced GRAFOIL
	Gland Packing	:	Reinforced GRAFOIL
	Drain Plug	:	ASTM A749 Gr. 316
	Seat Sealant Injection	:	ASTM A749 Gr. 316
	Gear Box	:	NA
13.0	Valve performance testing Requirement		
	Hydrostatic Test (Body)	:	75 bar - As per API 6D, Min. test period - 2 min with half valve open
	Hydrostatic Test (Seat)	:	55 bar, API 6D, Min. test period - 2 min
	Air Seat test	:	07 bar, API 6D, Min. test period - 15 min
	High Pre.Pneumatic(N2) Shell Test	:	55 bar, API 6D, Min. test period - 15 min
	High Pre.Pneumatic(N2) Seat Test	:	55 bar, API 6D, Min. test period - 15 min
	Double Block and Bleed for TMBV	:	API 6D
	Anti Static test	:	API 6D
	Operational Torque Test	:	API 6D
	Performance Test(open & Close)	:	API 6D, Min 10 cycles
	Other tests	:	As per specification/tender condition/QAP and API 6D
14.0	Painting		
	Surface Preparation	:	Shot Blasting as per grade SA 2 1/2, Swedish Standard SIS-055 909
	Primer	:	Primer coating (30 - 40 µm)
	Anti Corrosive Paint	:	Three coats of corrosion resistant high build epoxy paint shall be applied with minimum thickness of 300 micron. (Permissible thickness in each coat shall be within 80 to 120 micron)
	Color	:	Off White/Grey
15.0	Marking & Packing		
	Sealant lines	:	All sealant lines and other cavities of the valve shall be filled with sealant before shipment
	Packaging	:	As per API 6D
	Marking:		Order No., Manufacturere's Name, Manufacture year, Valve size & type, ANSI pressure rating, serial no. etc. shall be marked legibly



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VALVE DATA SHEET-2

3/4" Ball Valve -300# - WCB - BE & FE

1.0	Nominal size (inch, NB)	:	3/4"
2.0	Valve Type	:	Ball Valve, Floator
3.0	Standard	:	API 6D - 24th edition
4.0	Pressure class	:	ANSI 300#
5.0	Operating Pressure (bar)	:	49
6.0	Operating Temperature (deg C)	:	0 to 60
7.0	Service	:	Natural Gas
8.0	Location	:	
9.0	Corrosion allowance	:	1.6mm
10.0	Connecting pipe Specification for BE Valve		
	Material	:	ASTM A106 GRADE B
	Outside Diameter (mm)	:	26.67
	Wall Thickness (mm)	:	3.91mm (SCH 80)
11.0	Valve Construction Design		
	Bore	:	Full Bore
	End Connections	:	Butt End ASME B 16.25 OR Flanged End ASME B 16.5 as per requirement
	Valve Type	:	Floating
	Stem Design	:	Anti blow out type
	Stem Extension	:	NA
	Valve Operation	:	Lever
	Pup pipe material	:	ASTM A106 GRADE B for BE valves only
	Pup pipe length	:	150mm for BE valves only - 3/4" NB
	Pup pipe wall thickness	:	3.91mm (SCH 80) for BE valves only
	Fire Safe Design	:	Yes, API 6FA
	Anti Static	:	Yes
	Ball position indicator	:	Open/close indicator required
	Mechanical stops	:	Open/close limits required
	Secondary sealant injection point	:	NA
	Vent & Drain	:	as per technical specification
12.0	Valve Material Specification		
	Valve Body	:	ASTM A216 Gr. WCB
	Ball	:	ASTM A351 Gr CF8M+ Minimum 80micron ENP coating
	Body Seat Rings	:	AISI 4140 + MINIMUM 80 MICRONS ENP COATING / AISI 410
	Seat Seal	:	VITON / DEVLON
	Stem	:	AISI 4140 + ENP coating/AISI 410 (No casting)



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	Stem Seals	:	PTPF
	Primary Seat	:	Metal to Metal
	Secondary Seat	:	DEVLON / RPTFE or Equivalent
	Flange	:	as per ASME B16.5
	Studs	:	ASTM A 193 Gr. B7 (HOT DIP GALVANIZED)
	Nuts	:	ASTM A 194 GR. 2H (HOT DIP GALVANIZED)
	Bonnet/Trunion Gasket	:	NYLON/PTEF/SS304
	Body Gasket	:	Reinforced GRAFOIL
	Gland Packing	:	Reinforced GRAFOIL
	Drain Plug	:	ASTM A749 Gr. 316
	Seat Sealant Injection	:	ASTM A749 Gr. 316
	Gear Box	:	NA
13.0	Valve performance testing Requirement		
	Hydrostatic Test (Body)	:	75 bar - As per API 6D, Min. test period - 2 min with half valve open
	Hydrostatic Test (Seat)	:	55 bar, API 6D, Min. test period - 2 min
	Air Seat test	:	07 bar, API 6D, Min. test period - 15 min
	High Pre.Pneumatic(N2) Shell Test	:	55 bar, API 6D, Min. test period - 15 min
	High Pre.Pneumatic(N2) Seat Test	:	55 bar, API 6D, Min. test period - 15 min
	Double Block and Bleed for TMBV	:	API 6D
	Anti Static test	:	API 6D
	Operational Torque Test	:	API 6D
	Performance Test(open & Close)	:	API 6D, Min 10 cycles
	Other tests	:	As per specification/tender condition/QAP and API 6D
14.0	Painting		
	Surface Preparation	:	Shot Blasting as per grade SA 2 1/2, Swedish Standard SIS-055 909
	Primer	:	Primer coating (30 - 40 µm)
	Anti Corrosive Paint	:	Three coats of corrosion resistant high build epoxy paint shall be applied with minimum thickness of 300 micron. (Permissible thickness in each coat shall be within 80 to 120 micron)
	Color	:	Off White/Grey
15.0	Marking & Packing		
	Sealant lines	:	All sealant lines and other cavities of the valve shall be filled with sealant before shipment
	Packaging	:	As per API 6D
	Marking:		Order No., Manufacturere's Name, Manufacture year, Valve size & type, ANSI pressure rating, serial no. etc. shall be marked legibly



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VALVE DATA SHEET-3

1" Ball Valve -300# - WCB - BE & FE

1.0	Nominal size (inch, NB)	:	1"
2.0	Valve Type	:	Ball Valve, Floator
3.0	Standard	:	API 6D - 24th edition
4.0	Pressure class	:	ANSI 300#
5.0	Operating Pressure (bar)	:	49
6.0	Operating Temperature (deg C)	:	0 to 60
7.0	Service	:	Natural Gas
8.0	Location	:	
9.0	Corrosion allowance	:	1.6mm
10.0	Connecting pipe Specification for BE Valve		
	Material	:	ASTM A106 GRADE B
	Outside Diameter (mm)	:	33.4
	Wall Thickness (mm)	:	4.55mm (SCH 80)
11.0	Valve Construction Design		
	Bore	:	Full Bore
	End Connections	:	Butt End ASME B 16.25 OR Flanged End ASME B 16.5 as per requirement
	Valve Type	:	Floating
	Stem Design	:	Anti blow out type
	Stem Extension	:	NA
	Valve Operation	:	Lever
	Pup pipe material	:	ASTM A106 GRADE B for BE valves only
	Pup pipe length	:	150mm for BE valves only - 1" NB
	Pup pipe wall thickness	:	4.55mm (SCH 80) for BE valves only
	Fire Safe Design	:	Yes, API 6FA
	Anti Static	:	Yes
	Ball position indicator	:	Open/close indicator required
	Mechanical stops	:	Open/close limits required
	Secondary sealant injection point	:	NA
	Vent & Drain	:	as per technical specification
12.0	Valve Material Specification		
	Valve Body	:	ASTM A216 Gr. WCB
	Ball	:	ASTM A351 Gr CF8M+ Minimum 80micron ENP coating
	Body Seat Rings	:	AISI 4140 + MINIMUM 80 MICRONS ENP COATING / AISI 410
	Seat Seal	:	VITON / DEVLON
	Stem	:	AISI 4140 + ENP coating/AISI 410 (No casting)
	Stem Seals	:	PTPF



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	Primary Seat	:	Metal to Metal
	Secondary Seat	:	DEVLON / RPTFE or Equivalent
	Flange	:	as per ASME B16.5
	Studs	:	ASTM A 193 Gr. B7 (HOT DIP GALVANIZED)
	Nuts	:	ASTM A 194 GR. 2H (HOT DIP GALVANIZED)
	Bonnet/Trunion Gasket	:	NYLON/PTEF/SS304
	Body Gasket	:	Reinforced GRAFOIL
	Gland Packing	:	Reinforced GRAFOIL
	Drain Plug	:	ASTM A749 Gr. 316
	Seat Sealant Injection	:	ASTM A749 Gr. 316
	Gear Box	:	NA
13.0	Valve performance testing Requirement		
	Hydrostatic Test (Body)	:	75 bar - As per API 6D, Min. test period - 2 min with half valve open
	Hydrostatic Test (Seat)	:	55 bar, API 6D, Min. test period - 2 min
	Air Seat test	:	07 bar, API 6D, Min. test period - 15 min
	High Pre.Pneumatic(N2) Shell Test	:	55 bar, API 6D, Min. test period - 15 min
	High Pre.Pneumatic(N2) Seat Test	:	55 bar, API 6D, Min. test period - 15 min
	Double Block and Bleed for TMBV	:	API 6D
	Anti Static test	:	API 6D
	Operational Torque Test	:	API 6D
	Performance Test(open & Close)	:	API 6D, Min 10 cycles
	Other tests	:	As per specification/tender condition/QAP and API 6D
14.0	Painting		
	Surface Preparation	:	Shot Blasting as per grade SA 2 1/2, Swedish Standard SIS-055 909
	Primer	:	Primer coating (30 - 40 µm)
	Anti Corrosive Paint	:	Three coats of corrosion resistant high build epoxy paint shall be applied with minimum thickness of 300 micron. (Permissible thickness in each coat shall be within 80 to 120 micron)
	Color	:	Off White/Grey
15.0	Marking & Packing		
	Sealant lines	:	All sealant lines and other cavities of the valve shall be filled with sealant before shipment
	Packaging	:	As per API 6D
	Marking:		Order No., Manufacturere's Name, Manufacture year, Valve size & type, ANSI pressure rating, serial no. etc. shall be marked legibly



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VALVE DATA SHEET-4

2" Ball Valve -300# - WCB - BE & FE

1.0	Nominal size (inch, NB)	:	2"
2.0	Valve Type	:	Ball Valve, Floator
3.0	Standard	:	API 6D - 24th edition
4.0	Pressure class	:	ANSI 300#
5.0	Operating Pressure (bar)	:	49
6.0	Operating Temperature (deg C)	:	0 to 60
7.0	Service	:	Natural Gas
8.0	Location	:	
9.0	Corrosion allowance	:	1.6mm
10.0	Connecting pipe Specification for BE Valve		
	Material	:	ASTM A106 GRADE B
	Outside Diameter (mm)	:	60.33
	Wall Thickness (mm)	:	5.54mm (SCH 80)
11.0	Valve Construction Design		
	Bore	:	Full Bore
	End Connections	:	Butt End ASME B 16.25 OR Flanged End ASME B 16.5 as per requirement
	Valve Type	:	Floating
	Stem Design	:	Anti blow out type
	Stem Extension	:	NA
	Valve Operation	:	Lever
	Pup pipe material	:	ASTM A106 GRADE B for BE valves only - 2"NB
	Pup pipe length	:	200mm for BE valves only
	Pup pipe wall thickness	:	5.54mm (SCH 80) for BE valves only
	Fire Safe Design	:	Yes, API 6FA
	Anti Static	:	Yes
	Ball position indicator	:	Open/close indicator required
	Mechanical stops	:	Open/close limits required
	Secondary sealant injection point	:	NA
	Vent & Drain	:	as per technical specification
12.0	Valve Material Specification		
	Valve Body	:	ASTM A216 Gr. WCB
	Ball	:	ASTM A351 Gr CF8M+ Minimum 80micron ENP coating
	Body Seat Rings	:	AISI 4140 + MINIMUM 80 MICRONS ENP COATING / AISI 410
	Seat Seal	:	VITON / DEVLON
	Stem	:	AISI 4140 + ENP coating/AISI 410 (No casting)
	Stem Seals	:	PTPF
	Primary Seat	:	Metal to Metal
	Secondary Seat	:	DEVLOX / RPTFE or Equivalent
	Flange	:	as per ASME B16.5
	Studs	:	ASTM A 193 Gr. B7 (HOT DIP GALVANIZED)
	Nuts	:	ASTM A 194 GR. 2H (HOT DIP GALVANIZED)
	Bonnet/Trunion Gasket	:	NYLON/PTEF/SS304
	Body Gasket	:	Reinforced GRAFOIL



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	Gland Packing	:	Reinforced GRAFOIL
	Drain Plug	:	ASTM A749 Gr. 316
	Seat Sealant Injection	:	ASTM A749 Gr. 316
	Gear Box	:	NA
13.0	Valve performance testing Requirement		
	Hydrostatic Test (Body)	:	75 bar - As per API 6D, Min. test period - 2 min with half valve open
	Hydrostatic Test (Seat)	:	55 bar, API 6D, Min. test period - 2 min
	Air Seat test	:	07 bar, API 6D, Min. test period - 15 min
	High Pre.Pneumatic(N2) Shell Test	:	55 bar, API 6D, Min. test period - 15 min
	High Pre.Pneumatic(N2) Seat Test	:	55 bar, API 6D, Min. test period - 15 min
	Double Block and Bleed for TMBV	:	API 6D
	Anti Static test	:	API 6D
	Operational Torque Test	:	API 6D
	Performance Test(open & Close)	:	API 6D, Min 10 cycles
	Other tests	:	As per specification/tender condition/QAP and API 6D
14.0	Painting		
	Surface Preparation	:	Shot Blasting as per grade SA 2 1/2, Swedish Standard SIS-055 909
	Primer	:	Primer coating (30 - 40 µm)
	Anti Corrosive Paint	:	Three coats of corrosion resistant high build epoxy paint shall be applied with minimum thickness of 300 micron. (Permissible thickness in each coat shall be within 80 to 120 micron)
	Color	:	Off White/Grey
15.0	Marking & Packing		
	Sealant lines	:	All sealant lines and other cavities of the valve shall be filled with sealant before shipment
	Packaging	:	As per API 6D
	Marking:		Order No., Manufacturere's Name, Manufacture year, Valve size & type, ANSI pressure rating, serial no. etc. shall be marked legibly



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VALVE DATA SHEET-5

2" Ball Valve -300# - WCB - One end butt One end flanged

1.0	Nominal size (inch, NB)	:	2"
2.0	Valve Type	:	Ball Valve, Floator
3.0	Standard	:	API 6D - 24th edition
4.0	Pressure class	:	ANSI 300#
5.0	Operating Pressure (bar)	:	49
6.0	Operating Temperature (deg C)	:	0 to 60
7.0	Service	:	Natural Gas
8.0	Location	:	
9.0	Corrosion allowance	:	1.6mm
10.0	Connecting pipe Specification for BE Valve		
	Material	:	ASTM A106 GRADE B
	Outside Diameter (mm)	:	60.33
	Wall Thickness (mm)	:	5.54mm (SCH 80)
11.0	Valve Construction Design		
	Bore	:	Full Bore
	End Connections	:	Upstream - Butt End ASME B 16.25 AND Downstream-Flanged End ASME B 16.5
	Valve Type	:	Floating
	Stem Design	:	Anti blow out type
	Stem Extension	:	NA
	Valve Operation	:	Lever
	Pup pipe material	:	ASTM A106 GRADE B pipe on BE side
	Pup pipe length	:	200mm pipe of BE side
	Pup pipe wall thickness	:	5.54mm (SCH 80) on BE side
	Fire Safe Design	:	Yes, API 6FA
	Anti Static	:	Yes
	Ball position indicator	:	Open/close indicator required
	Mechanical stops	:	Open/close limits required
	Secondary sealant injection point	:	NA
	Vent & Drain	:	as per technical specification
12.0	Valve Material Specification		
	Valve Body	:	ASTM A216 Gr. WCB
	Ball	:	ASTM A351 Gr CF8M+ Minimum 80micron ENP coating
	Body Seat Rings	:	AISI 4140 + MINIMUM 80 MICRONS ENP COATING / AISI 410
	Seat Seal	:	VITON / DEVLON
	Stem	:	AISI 4140 + ENP coating/AISI 410 (No casting)
	Stem Seals	:	PTPF
	Primary Seat	:	Metal to Metal
	Secondary Seat	:	DEVLOX / RPTFE or Equivalent
	Flange	:	as per ASME B16.5
	Studs	:	ASTM A 193 Gr. B7 (HOT DIP GALVANIZED)



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	Nuts	:	ASTM A 194 GR. 2H (HOT DIP GALVANIZED)
	Bonnet/Trunion Gasket	:	NYLON/PTEF/SS304
	Body Gasket	:	Reinforced GRAFOIL
	Gland Packing	:	Reinforced GRAFOIL
	Drain Plug	:	ASTM A749 Gr. 316
	Seat Sealant Injection	:	ASTM A749 Gr. 316
	Gear Box	:	NA
13.0	Valve performance testing Requirement		
	Hydrostatic Test (Body)	:	75 bar - As per API 6D, Min. test period - 2 min with half valve open
	Hydrostatic Test (Seat)	:	55 bar, API 6D, Min. test period - 2 min
	Air Seat test	:	07 bar, API 6D, Min. test period - 15 min
	High Pre.Pneumatic(N2) Shell Test	:	55 bar, API 6D, Min. test period - 15 min
	High Pre.Pneumatic(N2) Seat Test	:	55 bar, API 6D, Min. test period - 15 min
	Double Block and Bleed for TMBV	:	API 6D
	Anti Static test	:	API 6D
	Operational Torque Test	:	API 6D
	Performance Test(open & Close)	:	API 6D, Min 10 cycles
	Other tests	:	As per specification/tender condition/QAP and API 6D
14.0	Painting		
	Surface Preparation	:	Shot Blasting as per grade SA 2 1/2, Swedish Standard SIS-055 909
	Primer	:	Primer coating (30 - 40 µm)
	Anti Corrosive Paint	:	Three coats of corrosion resistant high build epoxy paint shall be applied with minimum thickness of 300 micron. (Permissible thickness in each coat shall be within 80 to 120 micron)
	Color	:	Off White/Grey
15.0	Marking & Packing		
	Sealant lines	:	All sealant lines and other cavities of the valve shall be filled with sealant before shipment
	Packaging	:	As per API 6D
	Marking:		Order No., Manufacturere's Name, Manufacture year, Valve size & type, ANSI pressure rating, serial no. etc. shall be marked legibly



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DATA SHEET

2" Ball Valve - 300# - LCB - BE & FE

1.0	Nominal size (inch, NB)	:	2"
2.0	Valve Type	:	Ball Valve, Trunion mounted, double-block-and-bleed (DBB) valves
3.0	Standard	:	API 6D - 24th edition
4.0	Pressure class	:	ANSI 300#
5.0	Operating Pressure (bar)	:	49
6.0	Operating Temperature (deg C)	:	(-20) to 60
7.0	Service	:	Natural Gas
8.0	Location	:	Above Ground
9.0	Corrosion allowance	:	1.6mm
10.0	Connecting pipe Specification		
	Material	:	A333 Grade 6
	Outside Diameter (mm)	:	60.33
	Wall Thickness (mm)	:	5.54mm (SCH 80)
11.0	Valve Construction Design		
	Bore	:	Full Bore
	End Connections	:	Butt End ASME B 16.25 OR Flanged End ASME B 16.5 as per requirement
	Valve Type	:	Trunion Mounted
	Stem Design	:	Anti blow out type
	Stem Extension	:	Not Required
	Valve Operation	:	Lever
	Pup pipe material	:	A333 Grade-6 or equivalent - 2" NB
	Pup pipe length	:	200mm
	Pup pipe wall thickness	:	5.54mm (SCH 80)
	Fire Safe Design	:	Yes, API 6FA
	Anti Static	:	Yes
	Ball position indicator	:	Open/close indicator required
	Mechanical stops	:	Open/close limits required
	Secondary sealant injection point	:	NA
	Vent & Drain	:	as per technical specification
12.0	Valve Material Specification		
	Valve Body	:	A 352 Gr. LCB
	Ball	:	ASTM A351 Gr CF8M+ Minimum 80micron ENP coating
	Body Seat Rings	:	AISI 4140 + MINIMUM 80 MICRONS ENP COATING / AISI 410
	Seat Seal	:	VITON / DEVLON
	Stem	:	AISI 4140 + ENP coating/AISI 410 (No casting)
	Stem Seals	:	PTPF
	Primary Seat	:	Metal to Metal
	Secondary Seat	:	DEVLON / RPTFE or Equivalent
	Flange	:	as per ASME B16.5
	Studs	:	ASTM A 193 Gr. B7 (HOT DIP GALVANIZED)
	Nuts	:	ASTM A 194 GR. 2H (HOT DIP GALVANIZED)



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	Bonnet/Trunion Gasket	:	NYLON/PTEF/SS304
	Body Gasket	:	Reinforced GRAFOIL
	Gland Packing	:	Reinforced GRAFOIL
	Drain Plug	:	ASTM A749 Gr. 316
	Seat Sealant Injection	:	ASTM A749 Gr. 316
	Gear Box	:	NA
13.0	Valve performance testing Requirement		
	Hydrostatic Test (Body)	:	75 bar - As per API 6D, Min. test period - 2 min with half valve open
	Hydrostatic Test (Seat)	:	55 bar, API 6D, Min. test period - 2 min
	Air Seat test	:	07 bar, API 6D, Min. test period - 15 min
	High Pre.Pneumatic(N2) Shell Test	:	55 bar, API 6D, Min. test period - 15 min
	High Pre.Pneumatic(N2) Seat Test	:	55 bar, API 6D, Min. test period - 15 min
	Double Block and Bleed for TMBV	:	API 6D
	Anti Static test	:	API 6D
	Operational Torque Test	:	API 6D
	Performance Test(open & Close)	:	API 6D, Min 10 cycles
	Other tests	:	As per specification/tender condition/QAP and API 6D
14.0	Painting		
	Surface Preparation	:	Shot Blasting as per grade SA 2 1/2, Swedish Standard SIS-055 909
	Primer	:	Primer coating (30 - 40 µm)
	Anti Corrosive Paint	:	Three coats of corrosion resistant high build epoxy paint shall be applied with minimum thickness of 300 micron. (Permissible thickness in each coat shall be within 80 to 120 micron)
	Color	:	Off White/Grey
15.0	Marking & Packing		
	Sealant lines	:	All sealant lines and other cavities of the valve shall be filled with sealant before shipment
	Packaging	:	As per API 6D
	Marking:		Order No., Manufacturere's Name, Manufacture year, Valve size & type, ANSI pressure rating, serial no. etc. shall be marked legibly

M. SPECIFICATION FOR BS EN ISO 17292 BALL VALVE

Clause	Area	Description	Requirement / Remarks
1.0	Scope	Supply of Ball Valve Designed & Manufactured to BS EN ISO 17292 standard (latest edition)	Quantity as specified in Specific Requirement of the Project
2.0	Service	1. Natural Gas for both above and underground installation. 2. Unprotected outdoor service	i) Continuous service ii) Hazardous area, Class-I, Divn. -I & II, Group C&D gases as classified in API RP-500 C iii) Product / Crude/ LPG/ Natural Gas as Specified
3.0	Design/ Code	<ul style="list-style-type: none"> Designed/ fabrication code- As per BS EN ISO 17292 (Latest edition) End to End dimensions- As per ANSI B 16.10. 	Long pattern with anti static features. Fire tested design and with anti blow out stem.
4.0	Provision	<ul style="list-style-type: none"> Reduced Bore Bonnet shall be through bolted to body Seat ring shall be renewable type Indicator to show position of ball port. Stops for both fully open & fully closed position. 	<ul style="list-style-type: none"> Solid body Non-lubricating type. <u>For Natural Gas service, material for body, fastener shall be as per PMS (Piping Material Specification) enclosed along with the tender</u>
5.0	Material of Construction	1. Body	ASTM A216 Gr. WCB/ ASTM A105 (Normal temperature service) ASTM A352 LCB/ /ASTM A350 LF2 (for LTCS)
		2. Ball	SS-316 solid ball with mirror finished surface.
		3. Stem	SS-316
		4. Body Seat Ring	RPTFE/Devlon/ Nitrile/ Peek
		5. Back Seat Bush	ASTM A 276-410
		6. Valve body connector	Compatible for butt welding
6.0	Inspection & Test	i) Standard- BS 6755 Part-1 Latest edition	<i>All stage inspection shall be carried out by third party Inspection agency engaged by the vendor. However, final inspection shall be carried out by owner's designated third party inspection agency and/or IOCL as per approved QAP</i> All body tests to be done before painting. * Hydrotest & Air Seat test shall be taken for all the valves
		ii) Chemical Analysis and Mechanical Properties	R



IOCL-MECH-BV-BS 17292-047

N. SPECIFICATION OF GLOBE VALVES TO BS 1873 STANDARD

Clause	Area	Description	Requirement / Remark
1.0	Scope	Design, Manufacture, Testing, Inspection and Supply of Globe Valves as per BS 1873 Standard(latest edition)	Size, Rating, Quantity, end connection as per specific requirement of project. Applicable for size -4" and above.
2.0	Service	1. Petroleum Product / Crude/LPG for both above and underground installation. 2. Unprotected outdoor service	i) Continuous service ii) Hazardous area, Class-I, Divn. -I & II, Group C&D gases as classified in API RP-500 C iii) Product / Crude/ LPG/Natural gas as Specified
3.0	Specific Requirement	<ol style="list-style-type: none"> Straight pattern type Standard bore Direct hand wheel operated for following sizes Less than 12"-for 150# and 300# Less than 10" - for 600# Less than 6"- for 900# Gear operator for all other sizes. For gear operated valves, gear ratio shall be such that operating torque shall be less than 25 kg-m, with the differential pressure across the valve equal to design pressure. Rising stem with OS & Y Bolted bonnet <ul style="list-style-type: none"> For 600# & above pressure rating, all (100%) valves body castings shall be radiographed as per ASME B16.34 (Section 8.3). Acceptance criteria : ASME B16.34, Annex B. For other pressure ratings(150# & 300#), 10% of quantity ordered per size per heat to be radiographed as per ASME B 16.34. Ultrasonic examination may be carried out for body after approval where radiographic inspection is not feasible. 100% ultrasonic test/MPT to be carried out for weld ends for a distance of 50 mm from the ends. If Hand-wheel requires a torque of 271 NM or more to open or close against a maximum differential pressure, then that valve shall be supplied with a gear operator even 	<ul style="list-style-type: none"> Installation - Outdoor unprotected, aboveground/underground as per specific requirement of project. Suitable coating and extended stem to be provided for underground valve as per specific requirement of project. No shell tapping/drain provision shall be provided in the valve. End flanges shall be cast or forged integral with the body. Disc shall be loose plug type Stellite/Hard facing shall be minimum 1.6 mm. Pressure/temperature rating of valves shall be as per ASME B16.34 Stem shall be forged or machined from forged/rolled bar. No casting is permitted. Back seating arrangement to facilitate replacement of gland packing while in open position. Back seat bush shall be renewable. Rating 300# and above shall have gland stuffing boxes of sufficient depth to accommodate lantern rings in addition to gland packing. All globe valves shall be of solid fully guided disc design and suitable for installing in all positions like stem horizontal, vertical, etc. Disc shall be solid. Welded fabrication is not acceptable. A differential Hardness of at least 50 BHN is required to be maintained between mating surfaces. Valve design shall be carried out to avoid any bimetallic corrosion between carbon steel and high alloy steel components in



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Clause	Area	Description	Requirement / Remark		
		if not specified.	the assembly. Accordingly, suitable insulation shall be provided as required.		
4.0	Codes & Standards	Code of Conformity	BS 1873		
		Face to Face/End to End	ANSI B 16.10		
		End flange	ANSI B16.5, Raised Face to 125 AARH		
		Butt welding	ANSI B 16.25 Connecting pipe details as per specific requirement of project. Valve ends shall match thickness of the connecting pipe		
5.0	Materials of conformity	Body (Cast/Forged)	ASTM A 105/ASTM A216 or equivalent/superior		
		Bonnet (Bolted)	ASTM A 105/ASTM A216 or equivalent/superior		
		Stem (Rising)	SS316/Equivalent or superior (No casting)		
		Seat ring (Renewable)	STELLITED		
		Disc	STELLITED		
		Back Seat Bush	SS 316 or equivalent/superior		
		Hand Wheel (Rising)	Malleable Iron/Carbon steel/ductile iron		
		Bonnet Bolt	ASTM A193 Gr. B7/equivalent or superior		
		Bonnet Nuts	ASTM A194 Gr. 2H/equivalent or superior		
		Bonnet Gasket	Spiral wound SS316-GRAFOIL FILLER)		
		Gland Flange	ASTM A 105		
		Gland	SS 316 or equivalent/superior		
		Stem Packing	Corrosion inhibited die formed flexible graphite with braided anti extrusion rings		
6.0	Inspection & Test	Each valve shall be inspected and tested as per BS EN-12266 (Part-1 & 2)/ API 598		<i>All stage inspection shall be carried out by third party Inspection agency engaged by the vendor. However, final inspection shall be carried out by owner's designated third party inspection agency and/or IOCL as per approved QAP</i> <i>R - Review, W – Witness</i>	
		i)	Check of Chemical Analysis and Mechanical Properties. Identification of casting at foundry shop	R	Charpy V-notch test for body, plug, seat rings, stem, studs/nuts shall be conducted as per relevant material code.
		ii)	Hydrotest-Body & Seat	W-100%	
		iii)	Air Seat test	W-100%	
		iv)	Visual & Dimensional Final Check	W-100%	
		v)	Painting Inspection	R	
		vi)	Non-destructive test wherever applicable	R	



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Clause	Area	Description	Requirement / Remark
		Vii) Strip check-1 no. valve in a lot produced	W
		viii) Final documentation check	R
7.0	Documentation	i) With Bid (vendor as per approved list) a) General arrangement/ Cross-sectional drawing of globe valve/separate view of seat ring assembly/separate view of stem sealing arrangement. b) Bill of material and material of conformity	c) Supply record for similar valve along with copy of PO/Despatch documents/inspection reports/approved drawings/
		ii) After Placement of Purchase Order (4 sets)	
		a) General arrangement/ Cross-sectional drawing of globe valve/separate view of seat ring assembly/separate view of stem sealing arrangement. b) Bill of material and material of conformity	c) Quality Assurance Plan d) Testing and Inspection Plan
		iii) After Inspection, for Despatch Clearance (4 Sets)	
		a) Inspection Report as per Clause 6.0 b) Inspection Release note	
		iv) Along with Despatch (6 Sets)	
		1. Approved Drawing 2. Packing List 3. Inspection Report 4. Inspection Release Note	5. Operation and Maintenance instruction manual. 6. Guarantee Certificate.
8.0	Marking	Shall be in accordance with the requirements of ANSI B 16.34.	Shown details shall be stamped on a corrosion resistant plate
9.0	Painting	Shot Blasting +Zinc phosphate primer (50 micron) + Two coat synthetic enamel (40 micron each)	Total dry film thickness (DFT) minimum 130 Micron.
10.0	Packing	In wooden crates suitable to weather handling and transportation	<ul style="list-style-type: none"> Packing list to be enclosed Crate should have legible identification marking of contents.
11.0	Warranty	The Supplier shall warrant the globe valve and its component parts to be free from defects, Mechanical design and workmanship, during the first year of operation or 18 months from date of supply. All such defects, if any, shall be replaced at supplier's cost.	



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INDIAN OIL CORPORATION LIMITED PIPELINES DIVISION, NOIDA

O. SPECIFICATION OF GLOBE VALVES - BS EN ISO 15761 STANDARD

LOW TEMPERATURE SERVICE (CLASS D4A AND A4A OF PMS)

Clause	Area	Description	Requirement / Remark
1.0	Scope	Design, Manufacture, Testing, Inspection and Supply of Globe Valves as per BS EN ISO 15761 (latest edition) (Earlier version-BS 5352)	Size, Rating, Quantity, end connection as per specific requirement of project. Applicable for size - 1/2" through 4".
2.0	Service	1. Petroleum Product / Crude/LPG for above and underground installation. 2. Unprotected outdoor service	i) Continuous service ii) Hazardous area, Class-I, Divn. -I & II, Group C&D gases as classified in API RP-500 C iii) Product / Crude/LPG/Natural gas as Specified
3.0	Specific Requirement	1. Straight pattern type 2. Standard bore 3. Direct hand wheel operated 4. Rising stem with OS & Y 5. Bolted bonnet <ul style="list-style-type: none"> ▪ All globe valves shall be of solid fully guided disc design and suitable for installing in all positions like stem horizontal, vertical, etc. ▪ Disc shall be solid. Welded fabrication is not acceptable. ▪ A differential Hardness of at least 50 BHN is required to be maintained between mating surfaces. ▪ Valve design shall be carried out to avoid any bimetallic corrosion between carbon steel and high alloy steel components in the assembly. Accordingly, suitable insulation shall be provided as required. 	<ul style="list-style-type: none"> ▪ Installation - Outdoor unprotected, aboveground/underground as per specific requirement of project. ▪ Suitable coating and extended stem to be provided for underground valve as per specific requirement of project. ▪ No shell tapping/drain provision shall be provided in the valve. ▪ End flanges shall be cast or forged integral with the body. ▪ Disc shall be loose plug type ▪ Stellite/Hard facing shall be minimum 1.6 mm. ▪ Pressure/temperature rating of valves shall be as per ASME B16.34 ▪ Stem shall be forged or machined from forged/rolled bar. No casting is permitted. ▪ Back seating arrangement to facilitate replacement of gland packing while in open position. Back seat bush shall be renewable. <p>Rating 300# and above shall have gland stuffing boxes of sufficient depth to accommodate lantern rings in addition to gland packing.</p>
4.0	Codes & Standards	Code of Conformity	BS EN ISO 15761 Latest edition
		Face to Face/End to End	ANSI B 16.10
		End flange	ANSI B16.5, Raised Face to 125 AARH



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Clause	Area	Description	Requirement / Remark	
		Butt welding	ANSI B 16.25 Connecting pipe details as per specific requirement of project. Valve ends shall match thickness of the connecting pipe	
		Socket end	ASME B16.11- Only for Class 800- with 100mm pup pieces of A106 Gr. B Sch160 for all sizes. End to End dimension for socket welding end valves to be provided by the manufacturer during bid/approval.	
5.0	Materials of conformity	Body (Cast/Forged)	ASTM A352 GR. LCB/ASTM A 350 Gr.LF2 or equivalent/superior	
		Bonnet (Bolted)	ASTM A352 GR. LCB/ASTM A 350 Gr.LF2 or equivalent/superior	
		Stem (Rising)	SS316/Equivalent or superior	
		Seat ring (Renewable)	STELLITED	
		Disc	STELLITED	
		Back Seat Bush	SS 316 or equivalent/superior	
		Hand Wheel (Rising)	Malleable Iron/Carbon steel/ductile iron	
		Bonnet Bolt	ASTM A320 GR L7/equivalent or superior	
		Bonnet Nuts	ASTM A194 GR 4 / GR.7/equivalent or superior	
		Bonnet Gasket	Spiral wound SS316-GRAFOIL FILLER	
		Gland Flange	ASTM A352 LCB	
		Gland	SS 316 or equivalent/superior	
		Stem Packing(Renewable with valve open on stream)	Corrosion inhibited die formed flexible graphite with braided anti extrusion rings	
6.0	Inspection & Test	Each valve shall be inspected and tested as per BS EN-12266 (Part-1 & 2)/ API 598	<i>All stage inspection shall be carried out by third party Inspection agency engaged by the vendor. However, final inspection shall be carried out by owner's designated third party inspection agency and/or IOCL as per approved QAP</i> R - Review, W – Witness	
		i) Check of Chemical Analysis and Mechanical Properties. Identification of casting at foundry shop	R	Charpy V-notch test for body, plug, seat rings, stem, studs/nuts shall be conducted as per relevant



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Clause	Area	Description	Requirement / Remark
		ii) Hydrotest- body & seat	W-100% material code.
		iii) Air Seat test	W-100%
		iv) Visual & Dimensional Final Check	W-100%
		v) Painting Inspection	R
		vi) Final documentation check	R
		Vii) Strip check-1 no. valve in a lot produced	W
7.0	Documentation	i) With Bid a) General arrangement/ Cross-sectional drawing of globe valve/separate view of seat ring assembly/separate view of stem sealing arrangement. b) Bill of material and material of conformity ii) After Placement of Purchase Order (4 sets) a) General arrangement/ Cross-sectional drawing of globe valve/separate view of seat ring assembly/separate view of stem sealing arrangement. b) Bill of material and material of conformity iii) After Inspection, for Despatch Clearance (4 Sets) a) Inspection Report as per Clause 6.0 b) Inspection Release note iv) Along with Despatch (6 Sets) a) Approved Drawing b) Packing List c) Inspection Report d) Inspection Release Note e) Supply record for similar valve along with copy of PO/Despatch documents/inspection reports/approved drawings/ c) Quality Assurance Plan d) Testing and Inspection Plan e) Operation and Maintenance instruction manual. f) Guarantee Certificate.	
8.0	Marking	Shall be in accordance with the requirements of ANSI B 16.34.	Shown details shall be stamped on a corrosion resistant plate
9.0	Painting	Shot Blasting +Zinc phosphate primer (50 micron) + Two coat synthetic enamel (40 micron each)	Total dry film thickness (DFT) minimum 130 Micron.
10.0	Packing	In wooden crates suitable to weather handling and transportation	<ul style="list-style-type: none"> ▪ Packing list to be enclosed ▪ Crate should have legible identification marking of contents.
11.0	Warranty	The Supplier shall warrant the globe valve and its component parts to be free from defects, Mechanical design and workmanship, during the first year of operation or 18 months from date of supply. All such defects, if any, shall be replaced at supplier's cost.	



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P. SPECIFICATION FOR MDPE FITTINGS AND VALVES

For supply of MDPE fittings (PE-100) and valves (PE-100), specifications as mentioned in Petroleum and Natural Gas Regulatory Board (Technical Standards and Specifications including Safety Standards for City or Local Natural Gas Distribution Networks) Regulations, 2008 shall be followed.

 STANDARD QUALITY ASSURANCE PLAN Isolation Valves						QAP NO : IOCL/QAP/001			
SR. NO.	INSPECTION AND TESTING	QUANTUM OF CHECK / TEST	PROCEDURE	ACCEPTANCE CRITERIA AND CERTIFICATE	FORMAT OF RECORD	INSPECTION BY			REMARKS
						Manufacturer	TPIA	CA	
1.0	Raw Material								
1.1	Metallic Parts (Chemical / Physical Requirement)	One in each heat	As per ASTM B 283 (ALLOY UNS C37700) / EN 331	As per ASTM B 283 (ALLOY UNS C37700) / EN 331	MATERIAL TEST CERTIFICATE	P	R	R	
1.2	Seat & Stem Seal	One in each heat	As per EN 331	As per EN 331	MATERIAL TEST CERTIFICATE	P	R	R	
2.0	Final Product								
2.1	Gas Leak Tightness Test	100% by MFR. & 5% by TPJA	As per EN 331 /ASME B 16.33 Cl no. 4.2	As per EN 331 /ASME B 16.33 Cl no. 4.2	TEST REPORT	P	RW	R	
2.2	Twist (Torque) Test	1% by MFR. & TPJA	PTS	PTS	TEST REPORT	P	RW		
2.3	Bending Test	1% by MFR. & TPJA	As per EN 331 /ASME B 16.33 Cl no. 4.4.4	As per EN 331 /ASME B 16.33 Cl no. 4.4.4	TEST REPORT	P	RW	R	
2.4	Impact Test	One per heat per lot by TPJA	PTS	PTS	TEST REPORT	P	W		
2.5	Turning Torque Test	1% by MFR. & TPJA	As per EN 331 /ASME B 16.33 Cl no. 4.4.6	As per EN 331 /ASME B 16.33 Cl no. 4.4.6	TEST REPORT	P	RW	R	
2.6	Physical Test (Tensile test)	One per heat per lot by TPJA	As per ASME B 16.33 Cl no. 4.4.5 / PTS	As per ASME B 16.33 Cl no. 4.4.5 / PTS	TEST REPORT	P	W		
2.7	Temperature Resistance Test	1% by MFR. & TPJA	As per EN 331 /ASME B 16.33 Cl no. 4.3	As per EN 331 /ASME B 16.33 Cl no. 4.3	TEST REPORT	P	RW	R	
2.8	Flow Capacity Test	1% by MFR. & TPJA	As per EN 331 /ASME B 16.33 Cl no. 4.5	As per EN 331 /ASME B 16.33 Cl no. 4.5	TEST REPORT	P	RW	R	
3.0	Visual Inspection (Free from defects)	100% by MFR. & 5% by TPJA	As per EN 331 /ASME B 16.33	As per EN 331 /ASME B 16.33	INSPECTION REPORT	P	RW	R	
4.0	Dimension Tolerances (Min. length of engagement , OD , wall thk.)	100% by MFR. & 5% by TPJA	As per Approved Drawing	As per Approved Drawing	INSPECTION REPORT	P	RW	R	
5.0	Marking	100% by MFR. & 5% by TPJA	As per EN 331 / ASME B 16.33 Cl no. 2.4 / PTS	As per EN 331 / ASME B 16.33 Cl no. 2.4 / PTS	INSPECTION REPORT	P	RW	R	
6.0	Final Documentation		As per PTS	As per PTS	EN 10204 3.2 CERTIFICATE	P	H	R	
LEGEND: R - Review, W - Witness, H - Hold, P - Perform, TPJA - Third Party Inspection Agency, CA - Control Authority									
Notes: -									
1	If order quantity of a particular item is less than or equal to 100 nos. then vendor can go for TPJA inspection of buffer lot, which can be used further for different contractors but for same client.								
2	The above testing and acceptance criteria are minimum requirements; however, manufacturer shall ensure that the product shall also comply to the applicable codes.								
3	The TPJA shall use this QAP for inspection against subject tender and may consider this document as approved.								
4	Mechanical Testing shall be done in NABL Accredited Labs.								
5	Procedures have to be specially approved or only previously approved procedures have to be used, in case of conflict between specifications.								
6	Owner/ Owner's representative including TPJA will have the right to inspect any activity of manufacturing at any time.								
7	All reference Codes / Standards documents, P.O. Copies shall be arranged by vendor / supplier for reference of TPJA / IOCL at the time of inspection.								
8	At the time of delivery of material in stores, vendor will submit copy of all related document of inspection along with release note, dispatch clearance note & MTC.								
9	All Tests shall be carried out as per EN-331 (Latest Edition). However, other additional tests, which are not covered in EN-331, shall be carried out as per ASME B16.33.								

	STANDARD QUALITY ASSURANCE PLAN MDPE Ball Valve PE 100 (Without Stem)						QAP NO : IOCL/QAP/008		
SL No.	Test Description	Type Of Check	Quantum Of Check	Ref. Document	Acceptance Norms	Format of Records	Inspection		Remarks
							Vendor	TPIA	
1	Raw Materials	Test Certificate for Raw Materials	Each Batch	EN 1555-1/ PTS	EN 1555-1/PTS	MTR	P	R	
2	Test of raw material inspection	Raw material Characteristics check	Each Batch	Test Certificate for Raw Materials	As per material test cert.	MTR	P	R	
3	Hydrostatic Strength (PE100) (At 20 °c and 80 °c)	Strength Test	100%	EN 1555- 4 & ISO 1167- 1/4/PTS	As per EN 1555- 4 & ISO 1167- 1/4/PTS (No failure and no leak during test period of any test piece)	Hydrotest Report	P	W	
4	Leak Tightness test	Mechanical Characteristics	100%	EN 1555- 4/ PTS	As per Table-1, EN 1555-4/ PTS (No Leakage)	MTR	P	W	
5	Operating Torque	Mechanical Characteristics	100%	EN 1555- 4/ PTS	As per Table-1, EN 1555- 4/EN28233/ PTS	MTR	P	R	
6	Pressure Drop.	Mechanical Characteristics (Air flow rate)	100%	ISO 17778/ EN 1555-3/ PTS	ISO 17778/ EN 1555-3/ PTS	IR	P	R	
7	Oxidation Induction Time (Thermal Stability)	Physical Characteristics	Each Batch	EN 1555-3/ EN 728/ ISO 11357- 6/ PTS	As per EN 1555-3/ EN 728/ ISO 11357-6/ PTS	MTR	P	R	
8	Melt mass flow Rate	Physical Characteristics	Each Batch	EN 1553-3/ EN ISO 1133/ PTS	As per EN 1553-3/ EN ISO 1133/ PTS	MTR	P	R	
9	Dimensional Check	Dimensional	Each Batch	EN 1555-3/PTS	As per EN 1555-3/ PTS	IR	P	RW	Min. 10 % by TPIA
10	Density	Physical Characteristics	100%	ISO 1183/PTS	0.926 to 0.94 g/cm3	MTR	P	R	
11	Volatile Content	Physical Characteristics	Each Batch	EN 12099/PTS	≤350mg/Kg	MTR	P	R	
12	Content Carbon Black	Physical Characteristics	Each Batch	ISO 6964/PTS	2.50 ± 0.5%	MTR	P	R	
13	Appearance, Color	General Characteristics	100%	EN 1555- 4/PTS	EN 1555- 4/PTS	IR	P	R	
14	Marking	Physical Characteristics	100%	EN 1555- 3/ PTS	EN 1555- 3/ PTS	IR	P	RW	Min. 10 % by TPIA
15	Lot Release test	General Characteristics	Each Lot	EN 1555-7/PTS	EN 1555-7/PTS	IR	P	RW	

Legends:			
R Review	H Hold	TPIA Third Party Inspection Agency	PTS Particular Technical Specification
P Perform	W Witness	MTR Material Test Report	SS Standard Specification
Note:			
1. The above testing and acceptance criteria are minimum requirements; however, manufacturer shall ensure that the product shall also comply to the additional			
2. The TPIA shall use this QAP for inspection against subject tender and may consider this document as approved.			
3. Special manufacturing procedures have to be specially approved or only previously approved procedures have to be used, in case of conflict between specifications more			
4. Owner / Owner's representative including TPIA will have the right to inspect any activity of manufacturing at any time.			
5. All reference Codes/ Standards, Documents, P.O. Copies shall be arranged by vendor / supplier for reference of TPIA at the time of Inspection			
6. At the time of delivery of material in stores, vendor will submit copy of all related document of inspection along with release note & MTC.			



STANDARD QUALITY ASSURANCE PLAN
Electrofusion Fittings and Transition Fittings

QAP NO : IOCL/QAP/009

						INSPECTION BY			
Sr. No	Test Description	Type of Check	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	Format of Record	Manufacturer	TPIA	REMARKS
1	Raw Material	Review of test certificate	Each batch	EN 1555-1/ PTS	EN 1555-1/ PTS	MTR	P	R	
2	Hydrostatic Strength (PE100) (At 20 °c and 80 °c)	Strength Test	As per EN 1555-7	EN 1555-3 / ISO 1167 / PTS	As per EN 1555-3 / ISO 1167 / PTS (No failure and no leak during test period of any test piece)	Hydro test Report	P	W	
3	Decohesive resistance for Electrofusion Socket fittings	Length of initiation of rupture ≤ L2/3 in brittle failure	As per EN 1555-7	ISO 13954 / ISO 13955/ PTS	As per EN 1555-3	IR	P	R	
4	Decohesive Strength for Electrofusion Saddle fittings	Surface of rupture ≤ 25% brittle failure	As per EN 1555-7	ISO 13956 / PTS	As per EN 1555-3	IR	P	R	
5	Impact Resistance for Electrofusion Saddle fittings	Mechanical Properties	As per EN 1555-7	EN 1716/PTS	EN 1716/PTS	IR	P	R	
6	Tensile Strength for butt fusion	Mechanical Properties	As per EN 1555-7	ISO DS 13953 / PTS	ISO DS 13953 / PTS	IR	P	R	Applicable for spigot end fittings
7	Pressure Drop.	Mechanical Characteristics (Air flow rate)	As per EN 1555-7	ISO 17778 / EN 12117/ PTS	EN 12117/ EN 1555-3	IR	P	R	
8	Electrical Resistance Test	Electrical Characteristics	As per EN 1555-7	EN 1555-3	EN 1555-3	IR	P	R	
9	Oxidation Induction Time (Thermal Stability)	Physical Characteristics	As per EN 1555-7	EN 1555-3/ EN 728/ ISO 11357-6/ PTS	OIT > 20 Min./ 200°C	MTR	P	R	

10	Melt mass flow rate (MFR)	Physical Characteristics	As per EN 1555-7	EN 1553-3/ EN ISO 1133/ PTS	MFR 190°/5kg.0.20 – 1.20 gm./10 min. and after processing maximum deviation of ± 20% of the value measured on the batch used to manufacture the fitting	MTR	P	R	
11	Density	Physical Characteristics	1	ISO 1183	0.926 to 0.94 g/cm ³	MTR	P	R	
12	Dimensional check	Dimensions	1	As per EN 1555-3/PTS	As per EN 1555-3/PTS	IR	P	RW	Min. 10% by TPIA
13	Appearance, Color	Visual	1	EN 1555- 3/ PTS	EN 1555- 3/ PTS	MTR	P	R	
14	Marking	Physical Characteristics	1	EN 1555- 3/ PTS	EN 1555-3 / PTS	IR	P	RW	Min. 10% by TPIA
15	Documentation	All Inspection Reports and Certificates	-	EN 1555	All Inspection Reports and Certificates	IR	P	R	

Legends:			
R Review P Perform	H Hold W Witness	TPIA Third Party Inspection Agency MTR Material Test Report	PTS Particular Technical Specification SS Standard Specification
Note:			
1.The above testing and acceptance criteria are minimum requirements; however, manufacturer shall ensure that the product shall also comply to the additional requirements as per SS/ PTS along with applicable Codes & Standards.			
2. The TPIA shall use this QAP for inspection against subject tender and may consider this document as approved.			
3. Procedures have to be specially approved or only previously approved procedures have to be used, in case of conflict between specifications more stringent condition shall be applicable.			
4.Owner/ Owner's representative including TPIA will have the right to inspect any activity of manufacturing at any time.			
5.All reference Codes / Standards documents, P.O. Copies shall be arranged by vendor / supplier for reference of TPIA at the time of inspection.			
6. At the time of delivery of material in stores, vendor will submit copy of all related document of inspection along with release note, dispatch clearance note & MTC.			



P. TCP MATERIALS

REFER SECTION-VI OF DOCUMENT NO. IOCL-CGD-STEEL PIPELINE-SPEC

Q. HDPE DUCT AND OFC MATERIALS

REFER SECTION-III DOCUMENT NO. IOCL-CGD-STEEL PIPELINE-SPEC

R. ANY OTHER MATERIAL REQUIRED FOR COMPLETION OF WORK

ALL MATERIAL SUPPLIED BY CONTRACTOR SHALL BE AS PER RELEVANT CODES AND STANDARDS ACCEPTED BY IOCL.

CONTRACTOR SHALL SUBMIT DOCUMENTARY EVIDENCES, TEST CERTIFICATES ETC. AS REQUIRED BY IOCL.



LAYING & CONSTRUCTION OF 3LPE COATED
CARBON STEEL PIPELINE AND ASSOCIATED WORKS
FOR CITY GAS DISTRIBUTION

इंडियन ऑयल कॉर्पोरेशन लिमिटेड
(पाईपलाइन प्रभाग) नोएडा

SECTION-VIII

LIST OF APPROVED SUPPLIERS AND VENDORS



Indian Oil Corporation Limited

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SN.	ITEM	NAME OF VENDORS AND REMARKS					
1.	FLANGES (WNRF/ BLRF/ SORF/ SPECTACLE BLINDS) AND FORGED FITTINGS (WELD-O-LETS/ SOCK-O-LETS, ETC.)	SN.	NAME OF VENDORS	VALID FOR SIZE AND RATING UP TO			
				150#	300#	600#	900#
				48"	48"	30"	24"
		i.	C D ENGINEERING CO. GHAZIABAD	48"	48"	30"	24"
		ii.	CHW FORGE PVT LTD., GHAZIABAD	48"	48"	20"	20"
		iii.	SANGHVI FORGING & ENGINEERING, VADODARA	30"	24"	24"	24"
		iv.	GOOD LUCK ENGINEERING CO. / GOOD LUCK INDIA LTD., GHAZIABAD	48"	24"	24"	24"
		v.	UTSAH ENGINEERING PVT. LTD, GHAZIABAD	42"	42"	24"	18"
		vi.	FIT TECH INDUSTRIES PVT. LTD, THANE	36"	24"	24"	-
		vii.	JINDAL FORGINGS PVT LTD, KOLKATA	48"	24"	24"	20"
		viii.	TRIVENI REFRACTORIES PVT LTD, GHAZIABAD	48"	48"	30"	-
		ix.	SHAKTI FORGE INDUSTRIES, RAJKOT	48"	20"	20"	16"
		x.	A.M. ENGINEERS, MUMBAI	48"	24"	24"	20"
		xi.	KUNJ FORGING (P) LTD, GHAZIABAD	48"	30"	30"	20"
		xii.	JAV FORGING & ENGINEERING, FARIDABAD	36"	30"	30"	12"
		xiii.	N J ENGINEERS, VADODARA	24"	18"	12"	-
2.	PIPE FITTINGS (SEAMLESS/ WELDED TEES, BENDS, REDUCERS, ETC.)	SN.	NAME OF VENDORS	VALID FOR SIZE AND RATING UP TO			
				150#	300#	600#	900#
				48	48	36	24
		i.	SAWAN ENGINEERS PVT. LTD, VADODARA	48	48	36	24
		ii.	GUJARAT INFRA PIPES LTD. VADODARA	48	48	30	24
		iii.	A.M. ENGINEERS, MUMBAI	48	48	28	16
		iv.	TUBE PRODUCTS INCORPORATE, VADODARA	48	48	30	24
		v.	TEEKAY TUBES PVT LTD., MUMBAI	42	42	18	18
		vi.	TOPAZ PIPING INDUSTRIES, VADODARA	36	36	24	24
		vii.	PARAS FITTINGS PVT LTD, THANE	24	24	12	12
		viii.	DEE DEVELOPMENT ENGINEER (DEE PIPING SYSTEMS), PALWAL	24	24	-	
		ix.	JINDAL FORGINGS PVT LTD, KOLKATA	48	36	36	20
		x.	N J ENGINEERS, VADODARA	12"	12"	12"	12"
		xi.	P K TUBES & FITTINGS PVT. LTD., ALWAR	36"	30"	20"	-
3.	FASTENERS						
		i.	CONSOL ENGINEERING & FASTENERS INDUSTRIES, HOWRAH				
		ii.	PRECISION AUTO ENGINEERS, LUDHIANA				
		iii.	DEEPAK FASTENERS LIMITED. LUDHIANA				
		iv.	AEP COMPANY, ANAND				
		v.	HARDWIN FASTENERS PVT LTD., MUMBAI				
		vi.	PRESIDENT ENGINEERING WORKS, MUMBAI				
		vii.	SYNDICATE ENGINEERING INDUSTRIES, MUMBAI				
		viii.	PIONEER NUTS AND BOLTS PVT. LTD., LUDHIANA				
		ix.	HEM INDUSTRIES, MUMBAI				
		x.	FASTNERS & ALLIED PRODUCTS PVT. LTD., HUBLI				
		xi.	MULTI FASTNERS PVT LTD., VADODARA				
		xii.	MULTI THREAD FASTENERS, VADODARA				

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		xiii.	NEXO INDUSTRIES LIMITED, LUDHIANA
		xiv.	UDHERA FASTNERS LTD., LUDHIANA
		xv.	MEGA ENGINEERING PRIVATE LIMITED, KOLHAPUR
4.	GASKETS (SPIRAL WOUND METALLIC GASKETS)	i.	IGP ENGINEERS PRIVATE LTD., CHENNAI
		ii.	GOODRICH GASKETS PVT LTD., CHENNAI
		iii.	UNI KLINGER LIMITED, PUNE
		iv.	STARFLEX SEALING INDIA PVT. LTD., MUMBAI
		v.	MADRAS INDUSTRIAL PRODUCT, CHENNAI
5.	CARBON STEEL PIPE (ASTM A106 Gr. B & A333 Gr.6/ IS GRADE PIPES)	SN.	NAME OF VENDORS (MANUFACTURERS)
		i.	HEAVY METAL & TUBES LTD., MEHSANA
		ii.	ISMT LIMITED
		iii.	JINDAL SAW LTD.
		iv.	MAHALAXMI METAL CORPORATION
		v.	SAINEST TUBES PVT. LTD.
		vi.	RATNADEEP METAL & TUBES LTD.
		vii.	JCO GAS PIPE LTD, CHHINDWARA
		viii.	SHRI BAJRANG POWER AND ISPAT LIMITED, RAIPUR (up to 12.75" OD X 12.7 mm Thickness)
		NOTE:	
		1. TRADERS/ SUPPLIERS/ STOCKIST ARE ALSO ACCEPTABLE AND SHALL PROCURE THE PIPES FROM THE ABOVE LIST OF MANUFACTURES.	
		2. IS GRADE PIPES MAY ALSO BE PROCURED FROM VENDORS/ MANUFACTURERS LISTED AT SN.6 BELOW.	
6.	CARBON STEEL PIPES (API 5L GRADE)	i.	WELSPUN CORP LTD- FOR UP TO 16" ERW PIPES & SAW PIPES OF 16" & ABOVE.
		ii.	RATNAMANI METALS & TUBES LTD. - FOR UP TO 18" ERW PIPES & SAW PIPES OF 16" & ABOVE
		iii.	JINDAL INDIA LTD - FOR UP TO 18" ERW PIPES
		iv.	TATA BSL – FOR UP TO 18" ERW PIPES
		v.	JINDAL SAW – FOR 16" & ABOVE SAW PIPES
		vi.	SURYA ROSHINI LTD-- FOR UP TO 16" ERW PIPES & SAW PIPES OF 16" & ABOVE.
		vii.	MAN INDUSTRIES (INDIA) LTD – FOR 16" & ABOVE SAW PIPES
		viii.	ARCELOR MITTAL NIPPON STEEL INDIA LTD – FOR 16" & ABOVE SAW PIPES
7.	API 6D BALL VALVES (HOV) UP TO 4" 900#	i.	L&T VALVES LIMITED, COIMBATORE
		ii.	MICROFINISH VALVES LTD, DHARWAD
		iii.	FLOWCHEM INDUSTRIES, GANDHINAGAR
		iv.	STAR ENGINEERS, AHMEDABAD
		v.	OSWAL INDUSTRIES LTD, GANDHINAGAR
		vi.	EMERSON PROCESS MANAGEMENT INDIA PVT. LTD., PUNE
		vii.	STEEL STRONG VALVES, NAVI MUMBAI
		viii.	DEMBLA VALVES, THANE

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		NOTE: 1. VENDOR SHALL HAVE VALID API 6D BALL VALVE CERTIFICATE AND VALID API 6FA/ API 607 FIRE SAFE CERTIFICATE WHICH IS TO BE SUBMITTED TO IOCL BEFORE ORDER.	
8.	API 6D GATE VALVE (HOV) UP TO 4" 900#	i.	L&T VALVES LIMITED, COIMBATORE
		ii.	STEEL STRONG VALVES. NAVI MUMBAI
		iii.	HAWA VALVES (I) PVT. LTD., NAVI MUMBAI
		iv.	HAWA ENGINEERS LIMITED, AHMEDABAD
		v.	WEIR BDK (WEIR FLOW CONTROL INDIA), HUBLI
		vi.	FLOWCHEM INDUSTRIES, GANDHINAGAR
		vii.	FLOWERVE INDIA CONTROLS PRIVATE LIMITED, CHENNAI
		viii.	STAR ENGINEERS, AHMEDABAD
		NOTE: VENDOR SHALL SUBMIT VALID API 6D CERTIFICATE AND VALID API 6FA/ API 607 FIRE SAFE CERTIFICATE BEFORE ORDER.	
9.	BS 5351 / ISO 17292 BALL VALVES (FIRE SAFE) UP TO 4" 900#	i.	WEIR BDK (WEIR FLOW CONTROL INDIA), HUBLI
		ii.	BELGAUM AQUA VALVES PVT. LTD. (ONLY UPTO 4" 150#)
		iii.	NU-TECH CONTROLS, AHMEDABAD (ONLY UPTO 12" 150#)
		NOTE: VENDORS APPROVED FOR API 6D BALL VALVES AT SL NO. 7 ARE ALSO ACCEPTABLE FOR BS 5351 / ISO 17292 BALL VALVES AT SL NO 9.	
10.	API 600/602 GATE VALVE (HOV) UP TO 24" 150#	i.	NITON VALVE INDUSTRIES PVT LTD
		ii.	STEEL STRONG VALVES. NAVI MUMBAI
		iii.	LEADER VALVES LIMITED
		iv.	OCEAN VALVE MANUFACTURING CO.
		v.	HAWA VALVES (I) PVT. LTD., NAVI MUMBAI
		vi.	HAWA ENGINEERS LIMITED, AHMEDABAD
		vii.	SHALIMAR VALVES PVT. LTD
		viii.	LARSEN & TOUBRO LTD
		ix.	ZED VALVES CO. PVT. LTD.
		x.	MH VALVES LTD.
		xi.	NSSL PVT. LTD.
		xii.	NU-TECH CONTROLS, AHMEDABAD
		xiii.	JINDAL FORGING PVT. LTD., KOLKATA (UPTO 20" 150#)
		xiv.	OSWAL INDUSTRIES LTD, GANDHINAGAR
		xv.	FLOTEK INDUSTRIES, AHMEDABAD
		xvi.	STAR ENGINEERS, AHMEDABAD
11.	ISO 15761 GLOBE VALVE / API 623 GLOBE VALVE	i.	WEIR BDK (WEIR FLOW CONTROL INDIA), HUBLI
		ii.	LARSEN & TOUBRO LTD
		iii.	FLOWTECH INDUSTRIES
		iv.	MH VALVES PVT. LTD.
		v.	STEEL STRONG VALVES INDIA PVT LTD
		vi.	SHALIMAR VALVES PVT LTD

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		vii.	LEADER VALVES LTD
		viii.	NITON VALVE INDUSTRIES PRIVATE LTD.
		ix.	KSB VALVE
		x.	JINDAL FORGING PVT. LTD., KOLKATA (UPTO 12" 600#)
		xi.	STAR ENGINEERS, AHMEDABAD (UPTO 12" 150# & 6" 600#)
		xii.	FLOTEK INDUSTRIES, AHMEDABAD (UPTO 16" 900#)
12.	API 6D SWING CHECK VALVE	i.	L&T VALVES LIMITED, COIMBATORE
		ii.	STEEL STRONG VALVES, AHMEDABAD
		iii.	FLOWCHEM INDUSTRIES, GANDHINAGAR
		iv.	HAWA ENGINEERS LTD, AHMEDABAD (UPTO 4" 600#)
		v.	STAR ENGINEERS, AHMEDABAD (UPTO 16" 600#)
13.	DUAL PLATE CHECK VALVE	i.	FLUIDLINE VALVES COMPANY PVT.LTD
		ii.	FLOTEK INDUSTRIES
		iii.	EMRISE ENGINEERING PRIVATE LIMITED
		iv.	DINTECH VALVES PVT LTD
		v.	ADVANCE VALVES PVT. LTD
		vi.	WEIR BDK VALVES
		vii.	LEADER VALVES LTD
		viii.	NITON VALVE INDUSTRIES PRIVATE LTD.
		ix.	FLOVEL VALVES PVT.LTD.
		x.	NU-TECH CONTROLS, AHMEDABAD
		xi.	STAR ENGINEERS, AHMEDABAD (UPTO 16" 150#)
14.	API 6D PLUG VALVES	i.	L&T VALVES LIMITED, COIMBATORE
		ii.	GHATGE PATIL INDUSTRIES LTD., KOLHAPUR
15.	CI INJECTION PUMP SKID	i.	SWELORE ENGINEERING PVT. LTD., AHMEDABAD
		ii.	FLOW CONTROL PUMPS & SYSTEMS PRIVATE LIMITED, NASIK
		iii.	V K PUMP INDUSTRIES PRIVATE LIMITED, NASIK
16.	FRP TANK (UNDERGROUND SUMP TANK)	i.	CHEMICAL PROCESS EQUIPMENT LTD., MUMBAI
		ii.	RUIA CHEMICALS PVT. LTD., KOLKATA.
		iii.	STRATEGIC ENGG. (P) LTD., CHENNAI
		iv.	DAKLE INDUSTRIAL PLASTICS, VAPI
		v.	POLY PLAST CHEMI-PLANTS (I) PVT. LTD., MUMBAI
17.	STEEL SUMP TANK	i.	SUPER CHEM FAB ENGINEERS AND CONSULTANTS, DELHI
		ii.	GMP SYSTECH ENGINEERING PVT. LTD., AURANGABAD
		iii.	RAK DIN ENGINEERS, NEW DELHI
		iv.	MULTITEX FILTRATION ENGINEERES PVT. LTD., NEW DELHI
		v.	BRIDGE & ROOF COMPANY INDIA LIMITED, KOLKATA

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18.	OVERHEAD CRANE (ELECTRIC/ HAND OPERATED)	i.	GRIP ENGINEERS, FARIDABAD
		ii.	SAFEX INDUSTRIES LTD., AHMEDABAD
		iii.	EDDYCRANES ENGINEERS PVT. LTD, MUMBAI.
		iv.	ARMSEL MHE PVT. LTD, BENGALURU
		v.	MEEKA MACHINERY PVT LTD., AHMEDABAD
		vi.	SAFEX ELECTROMECH PVT. LTD., AHMEDABAD
19.	FIREFIGHTING PUMP	i.	KIRLOSKAR PUMPS, (KIRLOSKAR BROTHERS LIMITED, NEW DELHI)
		ii.	WILO MATHER AND PLATT PUMPS PVT LTD., NEW DELHI
		iii.	KIRLOSKAR EBARA PUMPS LIMITED, KIRLOSKARVADI
		iv.	KSB PUMPS LTD
		v.	WPIL LIMITED, GHAZIABAD
20.	ENGINE FOR FIREFIGHTING PUMP	i.	CUMMINS INDIA LTD.
		ii.	KIRLOSKAR OIL ENGINES LTD.
		iii.	KIRLOSKAR INDUSTRIES
21.	JOCKEY PUMPS (MOTOR DRIVEN)	i.	KIRLOSKAR PUMPS, (KIRLOSKAR BROTHERS LIMITED, NEW DELHI)
		ii.	KIRLOSKAR EBARA PUMPS LIMITED, KIRLOSKARVADI
		iii.	KSB PUMPS LTD, PUNE
		iv.	WILO MATHER AND PLATT PUMPS PVT LTD., NEW DELHI
		v.	FLOWMORE LIMITED, GURGOAN
		vi.	VARAT PUMP & MACHINERY PVT. LTD
		vii.	WPIL LIMITED, GHAZIABAD
22.	TOR FITTING/ COMPLETE CORROSION COUPONS ASSEMBLY	i.	NIRANJAN ENGINEERING WORKS, RAJKOT
		ii.	T D WILLIAMSON INDIA PRIVATE LIMITED, VADODARA
		iii.	ALLWYN INDUSTRIES, RAJKOT
		iv.	VEE KAY VIKRAM & CO. LLP., AHMEDABAD
23.	CORROSION COUPONS	i.	EMERSON PROCESS MANAGEMENT S.R.L.
		ii.	ATEL, ITALY
		iii.	CAPROCO, CANADA.
		iv.	MC MURRAY, USA
		v.	REHRABACK COSASCO, USA
		vi.	CASASCO DIVISION, USA
		vii.	NIRANJAN ENGINEERING WORKS, RAJKOT
		viii.	T D WILLIAMSON INDIA PRIVATE LIMITED, VADODARA
		ix.	ALLWYN INDUSTRIES, RAJKOT
24.	FIREFIGHTING HYDRANTS	i.	GHOSH ENGINEERING INDUSTRIES, HOOGHLY
		ii.	SHAH BHOGILAL JETHALAL AND BROS. GANDHINAGAR
		iii.	NEWAGE FIRE PROTECTION INDUSTRIES PVT LTD, MUMBAI
		iv.	NEWAGE FIREFIGHTING CO LTD, SURENDRANAGAR

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25.	HVLR WATER CUM FOAM MONITORS	i.	SHAH BHOGILAL JETHALAL AND BROS. GANDHINAGAR
		ii.	HD FIRE PROTECT PVT LTD, THANE
		iii.	VIMAL FIRE CONTROLS PVT. LTD., MUMBAI
		iv.	NEWAGE FIREFIGHTING CO LTD, SURENDRANAGAR
		v.	NEWAGE FIRE PROTECTION INDUSTRIES PVT LTD, MUMBAI
26.	RELIEF VALVES & SAFETY VALVES (TRV/ TSV/ PSV)	i.	TYCO SANMAR/ ANDERSON GREENWOOD CROSBY/ PENTAIR SANMAR/ EMERSON, TRICHY
		ii.	BLISS ANAND PVT. LTD., CHENNAI
		iii.	LESER GMBH & CO.
		iv.	WEIR BDK VALVES
		v.	UNI KLINGER LTD.
		vi.	NU-TECH CONTROLS, AHMEDABAD
		vii.	BRIGHTCH VALVES AND CONTROLS PVT LTD, AHMEDABAD
27.	STRAINER (BASKET/ 'Y'/ CONICAL TYPE)/ END FUNNEL	i.	GRAND PRIX (P) LTD., NEW DELHI
		ii.	MULTITEX FILTRATION ENGINEERS PVT. LTD., NEW DELHI
		iii.	RAK DIN ENGINEERS, NEW DELHI
		iv.	PETROMAR ENGINEERED SOLUTION PVT LTD
		v.	FILTER CONCEPT, AHMEDABAD
28.	WELDING ELECTRODES (FOR STATION PIPING)	i.	ESAB INDIA LTD.
		ii.	ADVANI ORLIKON
		iii.	D & H SECHRON ELECTRODES LTD.
		iv.	BOHLER
		v.	LINCOLN ELECTRIC
		vi.	HONAVAR ELECTRODES LTD.
		vii.	GEE LIMITED
		viii.	D & H WELDING
		ix.	MODI HITECH INDIA LIMITED
		x.	MAILAM INDIA LTD.
29.	PORTABLE FIRE FIGHTING EQUIPMENTS	i.	N K FIRE & SAFETY (A DIV. OF NEW AGE FIRE FIGHTING CO. LTD.), SURENDRANAGAR
		ii.	BRIJBASI HI-TECH UDYOG LTD. NEW DELHI
		iii.	JOSEPH LESLIE DRAGER MFG.PVT LTD, MUMBAI
		iv.	B L HEALTH & SAFETY PVT LTD., NEW DELHI
		v.	SHAH BHOGILAL JETHALAL & BROTHERS, AHMEDABAD
		vi.	INTEGRATED FIRE PROTECTION PVT LTD., KOLKATA
		vii.	ZENITH FIRE SERVICES (INDIA) PVT LTD, NAVI MUMBAI
		viii.	UNITED FIRE EQUIPMENTS PVT LTD, NEW DELHI
		ix.	HITECH SAFETY EQUIPMENT, DELHI
		x.	CHAWLA FIRE PROTECTION ENGINEERS, BAHADURGARH
		xi.	SAFEX FIRE SERVICES, THANE
		xii.	NITIN FIRE PROTECTION INDUSTRIES LTD., AHMEDNAGAR
		xiii.	NEW BHARAT FIRE PROTECTION SYSTEM (PVT.) LTD., THANE

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		xiv.	CO2 FYR FYTER CO., MUMBAI
30.	FLAME ARRESTOR/ BREATHING VALVES	i.	FORTUNE INFRATRADE PRIVATE LIMITED
		ii.	PROTEGO INDIA PRIVATE LIMITED
		iii.	KINGSLEY ENGINEERING SERVICES
		iv.	PENTA-TECH ENGG PVT. LTD.
		v.	GROTH CORPORATION
31.	EXTERNAL COATING MATERIAL FOR U/G PIPING (100% SOLIDS HB LIQUID EPOXY)	i.	3M (SCOTCHKOTE 162 HBL)
		ii.	SEAL FOR LIFE INDIA PVT LTD (POWERCRETE R-95)
32.	EXTERNAL COATING MATERIAL FOR U/G PIPING (100% SOLIDS POLYURETHANE)	i.	3M (SCOTCHKOTE URETHANE COATING 165 HBL/ 165 HBL BG)
		ii.	AMCHEM PRODUCTS PVT. LTD. (PURETHANE NXT/ PLX)
		iii.	TIB CHEMICALS (PROTEGOL UR – COATING 32-45 R)
		iv.	RHINO LININGS CORPORATION
		v.	CARBOLINE PAINTS (POLYCLAD-777)
33.	INTERNAL COATING MATERIAL FOR FIRE WATER PIPES/ FLANGES/ FITTINGS	i.	3M INDIA LTD.
		ii.	INTERNATIONAL (AKZONOBEL)
		iii.	HEMPEL PAINTS
		iv.	THE VALSPAR CORPORATION
		v.	DEMECH
		vi.	KIRLOSKAR CORROCOAT
		vii.	GRAUER & WEIL INDIA LTD
34.	RADIOGRAPHIC INSPECTION SERVICES BY X- RAY TECHNIQUE (For station mech. work)	i.	SIEVERT INDIA PVT LTD., MUMBAI
		ii.	INDUSTRIAL X-RAY & ALLIED RADIOGRAPHERS (I) PVT. LTD., MUMBAI (IXAAR)
		iii.	TCR ENGINEERING SERVICES PVT LTD, MUMBAI
		iv.	INSPECTION TECHNOLOGY (INTEC), MUMBAI
		v.	INSPECTION TECHNIC, MUMBAI
35.	RADIOGRAPHIC INSPECTION SERVICES BY GAMMA RAY TECHNIQUE (For station mech. work)	i.	ALL VENDORS LISTED ABOVE FOR RADIOGRAPHIC INSPECTION SERVICES BY X-RAY TECHNIQUE IN SN. 34
		ii.	OFFSHORE TESTING & INSPECTION SERVICES (I) PVT. LTD., NAVI MUMBAI
		iii.	SIGMA NDT SERVICES, MUMBAI
		iv.	CALCUTTA TEST HOUSE PVT. LTD., NEW DELHI
		v.	NDT SERVICES, AHMEDABAD
		vi.	GEECY APAVE PVT. LTD. MUMBAI
		vii.	INTER OCEAN SHIPPING CO., NEW DELHI
		viii.	X-TECH, VIZAG
		ix.	EMINENT NDT SERVICES PVT. LTD., CHENNAI (UPTO 18" OD SIZE)
		x.	LOKNATH NDT SERVICES, VADODARA

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36.	ELECTRO-FORGED GRATINGS	i.	BHOLA RAM STEELS PVT. LTD. PATNA
		ii.	GREATWELD STEEL GRATINGS PVT. LTD. PUNE
		iii.	INDIANA GRATINGS PVT. LTD. MUMBAI
		iv.	KANADE ANAND UDYOG PVT. LTD. MUMBAI
		v.	PINAX STEEL INDUSTRIES PVT. LTD. KOLKATA
		vi.	VINFAB GRATINGS MUMBAI
37.	OIL WATER SEPARATOR	i.	SUYASH EQUIPMENTS PRIVATE LIMITED
		ii.	PURE TECH INDIA
		iii.	VATECH WABAG LTD
		iv.	WTE INFRA PROJECT
		v.	ION EXCHANGE
38.	FLOW/ PRESSURE CONTROL VALVES	i.	FORBES MARSHALL
		ii.	ABB LTD.
		iii.	FISHER XOMOX/ EMERSON
		iv.	SEVERN GLOCON
		v.	INSTRUMENTATION LTD.
		vi.	MIL CONTROLS LTD.
		vii.	SAMSON CONTROL
		viii.	DRESSER
		ix.	KOSO
39.	FLOW TEE	i.	VEE KAY VIKRAM & CO. LLP., AHMEDABAD
		ii.	SAWAN ENGINEERS PVT. LTD, VADODARA
40.	INSULATING COUPLING	i.	VEE KAY VIKRAM & CO. LLP., AHMEDABAD
		ii.	IGP ENGINEERS PVT. LTD., CHENNAI
41.	MEDIUM VELOCITY WATER SPRINKLER SYSTEM (MVWSS)	i.	STERLING & WILSON PVT. LTD, MUMBAI
		ii.	TECHNOFIRE PROTECTION SERVICES PVT. LTD; MUMBAI
		iii.	RELIANCE FIRE PROTECTION SYSTEMS, MUMBAI
		iv.	DE'S TECHNICO LIMITED, KOLKATA
		v.	AGNICE FIRE PROTECTION PVT LTD, CHENNAI
		vi.	UKA CONSULTING & ENGINEERS PVT LTD; THANE
		vii.	CHETAN ENGINEERS, AHMEDABAD
		viii.	NEWAGE FIRE PROTECTION ENGINEERS PVT LTD, SION (EAST), MUMBAI
42.	PIPING STRESS ANALYSIS	i.	ENGINEERS INDIA LIMITED
		ii.	TECHNIP FMC
		iii.	PROJECTS & DEVELOPMENT INDIA LIMITED
		iv.	UPCEM ENGINEERING & CONSULTANCY PVT. LTD; NAVI MUMBAI
		v.	PROCON INDIA PVT LTD, DELHI
		vi.	SHIMI DESIGNS AND CONSULTING ENGINEERS PVT. LTD, CHENNAI
		vii.	GREENLEAF ENGINEERING LIMITED, NOIDA

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Checked by CPJM (Mech)

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List of Recommended Vendors

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SN.	ITEM	NAME OF VENDORS AND REMARKS		
43.	FIRE WATER NETWORK ANALYSIS	i.	ENGINEERS INDIA LIMITED	
		ii.	TECHNIP FMC	
		iii.	PROJECTS & DEVELOPMENT INDIA LIMITED	
		iv.	UPCEM ENGINEERING & CONSULTANCY PVT. LTD; NAVI MUMBAI	
		v.	GREENLEAF ENGINEERING LIMITED, NOIDA	
44.	FIRE WATER TANK CONSTRUCTION	SN	NAME OF VENDORS	VALID FOR CAPACITY
		i.	GOPAL TEKNOCON PRIVATE LTD, VISHAKHAPATNAM	13000 KL
		ii.	EXPO GAS CONTAINERS LIMITED, MUMBAI	10500 KL
		iii.	LARSEN AND TOUBRO HYDROCARBON ENGINEERING LTD, CHENNAI	7300 KL
		iv.	UNITED SYSTEM AND PROJECTS INDIA PVT. LTD, SECUNDRABAD	5800 KL
		v.	GAYATRI FABRICATOR, NOIDA	5000 KL
		vi.	MADRA CONSTRUCTION, BARDHAMAN	4000 KL
		vii.	NRP PROJECTS PVT LTD, CHENNAI	30000 KL
		viii.	BRIDGE & ROOF COMPANY INDIA LIMITED, KOLKATA	60000 KL
		ix.	HARJI ENGINEERING WORKS PVT LTD, NEW DELHI	10000 KL
		x.	FURNACE FABRICA (INDIA) LTD., MUMBAI	10000 KL
		xi.	NEWTON ENGINEERING AND CHEMICALS LTD, VADODARA	6700 KL
		xii.	SOPAN O&M COMPANY, PUNE	2000 KL
		xiii.	TUAMAN ENGINEERING LIMITED, KOLKATA	2300 KL
		xiv.	THERMOSYSTEMS PVT. LTD, NOIDA	5500 KL
		xv.	MOTIPRABHA INFRATECH PVT. LTD.	6900 KL
		xvi.	GREENLEAF ENGINEERING PVT. LTD (DESIGN ONLY)	12000 KL
45.	SS PIPES VENDORS	i.	RATNAMANI METALS AND TUBES, AHMEDABAD	
		ii.	JINDAL SAW LIMITED, NEW DELHI	
		iii.	BHANDARI FOILS AND TUBES, DEWAS, MADHYA PRADESH	
		iv.	JINDAL FORGING PVT LTD, KOLKATA	
46.	DUPLEX PIPES VENDORS	i.	RATNAMANI METALS AND TUBES, AHMEDABAD	
		ii.	JINDAL SAW LIMITED, NEW DELHI	
		iii.	BHANDARI FOILS AND TUBES, DEWAS, MADHYA PRADESH	
		iv.	JINDAL FORGING PVT LTD, KOLKATA	
47.	SS FLANGES & FITTINGS, SS HALF COUPLINGS, SS FASTENERS & ALL SS RELATED	i.	TEEKAY TUBES PVT.LTD, MUMBAI	
		ii.	GUJRAT INFRA PIPE PVT. LTD, BARODA	
		iii.	SIDDHARTH AND GAUTAM ENGINEERS, FARIDABAD	
		iv.	SUPER FORGE, MUMBAI	
		v.	BHANDARI FOILS AND TUBES, DEWAS, MADHYA PRADESH	
		vi.	SURAJ LIMITED AHMEDABAD	
		vii.	MAXELL FORGE INDUSTRIES, MUMBAI	
		viii.	JINDAL FORGING PVT LTD, KOLKATA	

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48.	DUPLEX FLANGES & FITTINGS, HALF COUPLINGS, FASTENERS, ETC.	i.	MAXELL FORGE INDUSTRIES, MUMBAI		
		ii.	BHANDARI FOILS AND TUBES, DEWAS, MADHYA PRADESH		
		iii.	JINDAL FORGING PVT LTD, KOLKATA		
49.	SPRAY NOZZLE	i.	HD FIRE PROTECT PVT LTD, THANE		
		ii.	UNIVERSAL AGENCIES, KOLKATA		
		iii.	UNIVERSAL FIRE SAFETY SERVICES, NAVI MUMBAI		
		iv.	FIRETECH EQUIPMENT & SYSTEM PRIVATE LIMITED, MUMBAI		
50.	FOAM MAKERS	i.	GALAXY ENGINEERING WORKS, HALDIA		
		ii.	NEWAGE INDUSTRIES, MUMBAI		
		iii.	ZENITH FIRE SERVICES, MUMBAI		
		iv.	NITIN FIRE PROTECTION, MUMBAI		
		v.	STEELAGE INDUSTRIES, NEW DELHI		
		vi.	HD FIRE PROTECT IND PVT LTD, THANE		
		vii.	FIRETECH EQUIPMENT & SYSTEM PRIVATE LIMITED, MUMBAI		
51.	HOT-PULLED PIGGABLE BENDS	SN.	NAME OF VENDOR	MAX. SIZE & WT	GRADE
		i.	WELSPUN CORP LTD, ANJAR, GUJARAT	4" - 36", 23.8 mm	API 5L X70
				38"-48", 28.58 mm	API 5L X 65
		ii.	JINDAL SAW LTD, MUNDRA, GUJARAT	4" - 36", 25.22 mm	API 5L X70
				38" - 48", 25.4 mm	API 5L X60
		iii.	RATNAMANI METAL & TUBES LTD., ANJAR, GUJARAT	3"-30", 20.62 mm	API 5L X 70
				32"-42", 17.5 mm	API 5L X 42
		iv.	PSL LIMITED, ANJAR, GUJARAT	4"- 30", 17.5 mm	API 5L X 70
				32"-42", 14.3 mm	API 5L X 52
		v.	LALIT ROHR FITTINGS PVT. LTD., VADODARA	6"-32", 19.1 mm	API 5L X70
52.	SPLIT TEE FITTINGS	SN.	NAME OF VENDOR	MAX. SIZE	
		i.	TDW INDIA LTD. VADODARA	42" 900#	
		ii.	CONMAT OIL & GAS PRIVATE LIMITED, VADODARA	42" 600#	
		iii.	PIPELINE SERVICES (UK) LTD, NOTTINGHAMSHIRE U.K.	ALL SIZES	
		iv.	UNIQUE HYGROGRAPHICS PVT LTD., VADODARA (LOR FLANGE FROM M/S UNIQUE WELLUBE FZC, SHARJAH)	24" 600#	
		v.	VEE KAY VIKRAM & CO LLP, VADODARA	26" 600#	
53.	HOT TAPPING WORKS	i.	TDW INDIA LTD. VADODARA	UPTO 42" 150#, 24" 600#	
		ii.	CONMAT OIL & GAS PRIVATE LIMITED, VADODARA	UPTO 42" 600#	
		iii.	PLANT TECH POWER TECHNICAL SERVICES PVT. LTD., NEW MANGALORE	UPTO 48" 150#, 30" 600#, 18" 900#	
		iv.	UNIQUE HYGROGRAPHICS PVT LTD., VADODARA	UP TO 18" 300#	
54.	EXTERNAL LEAK CLAMPS	i.	VEEKAY VIKRAM & CO LLP, AHMEDABAD	UPTO 48" 600#, 18" 900#	
		ii.	APSS TECHNOLOGIES PRIVATE LIMITED, SHAKARPUR, DELHI	UPTO 30" 600#, 16" 900#	

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	(FOR ONSHORE SERVICE)	iii.	YAMUNA ENGINEERING COMPANY, G.I.D.C. MAKARPURA, VADODARA	UPTO 48" 600#, 12" 900#
55.	MECHANICAL END CONNECTOR (WELD PLUS END)	iv.	THE PIPE LINE DEVELOPMENT COMPANY (PLIDCO), OHIO, USA	UPTO 30" 600#
		v.	VEEKAY VIKRAM & CO LLP, AHMEDABAD	UPTO 48" 600#
56.	BIDIRECTIONAL CLEANING PIG/ BATCHING PIG	i.	VEEKAY VIKRAM & CO LLP, AHMEDABAD	
		ii.	SRIRAM FOAMS (P) LTD., ANNA NAGAR (WEST), CHENNAI	
		iii.	TDW INDIA, SAVLI, VADODARA	
		iv.	VP ENGINEERS, THIRUVANMIYUR, CHENNAI	
		v.	VAM POLY PLAST PVT. LTD., HABSIGUDA, HYDERABAD	
57.	HD FOAM PIG	i.	VP ENGINEERS, THIRUVANMIYUR, CHENNAI	
		ii.	VEEKAY VIKRAM & CO LLP, AHMEDABAD	
		iii.	SRIRAM FOAMS (P) LTD., ANNA NAGAR (WEST), CHENNAI	
		iv.	TDW INDIA, SAVLI, VADODARA	
58.	RADIUM STICKERS	i.	3M INDIA	
		ii.	AVERY DENNISON	
		iii.	NIPPON CARBIDE	
		iv.	ATSM INC.	
		v.	ORAFOL INC	

59. LIST OF APPROVED PAINT MANUFACTURERS AND THEIR ACCEPTABLE BRANDS FOR ABOVE GROUND PIPING/ VESSELS/ VALVES/ EQUIPMENTS (NOT APPLICABLE FOR A/G STORAGE TANKS)

NAME OF PAINT	ETHYL ZINC SILICATE PRIMER	POLYAMIDE CURED HIGH BUILD EPOXY ZINC PHOSPHATE PRIMER	SELF PRIMING SURFACE TOLERANT EPOXY MASTIC PAINT	ALIPHATIC ISOCYANATE POLYURETHANE FINISH PAINT
BERGER PAINTS	ZINC ANODE 304 MZ	EPLIUX 13 HB PRIMER	VENDOR TO OFFER SUITABLE PAINT AS PER SPEC.	BERGERTHANE 41 S/G PU FINISH
ASIAN PAINTS	APCOSIL 605	APCODUR EHB ZINC PHOSPHATE PRIMER	VENDOR TO OFFER SUITABLE PAINT AS PER SPEC.	APCOTHANE HB PU FINISH/ APCOTHANE CF678
AKZO NOBEL PAINTS	INTERZINC 22	INTERGARD 251	INTERSEAL 670HS	INTERTHANE 990
SIGMA COATINGS (PPG INDIA)	SIGMAZINC 9/158	SIGMACOVER 256	SIGMACOVER 620	SIGMADUR 550H
AMERCOAT (PPG PMC), FORMELY AMERON	DIMETCOTE 9	AMERCOAT 68 HS	VENDOR TO OFFER SUITABLE PAINT AS PER SPEC.	AMERCOAT 450 HS
HEMPEL PAINTS	HEMPEL GALVOSIL 15700	HEMPADUR FAST DRY 15590	HEMPAPRIME MULTI 500/ HEMPADUR 45880	HEMPALIN 12050

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List of Recommended Vendors



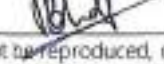
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NAME OF PAINT	ETHYL ZINC SILICATE PRIMER	POLYAMIDE CURED HIGH BUILD EPOXY ZINC PHOSPHATE PRIMER	SELF PRIMING SURFACE TOLERANT EPOXY MASTIC PAINT	ALIPHATIC ISOCYANATE POLYURETHANE FINISH PAINT
JOTUN PAINTS	RESIST 86	PENGUARD EXPRESS/ JOTAGUARD ZN PHOSPHATE	JOTAPRIME MASTIC 80/ JOTAMASTIC 87	HARDTOP XP
CARBOLINE PAINTS	CARBOZINC 11	CARBOGUARD 193 HB ZPP	CARBOMASTIC 615	CARBOTHANE 134 HG
GRAUER & WEIL (IND) LTD. (BOMBAY PAINTS)	ZONC-O-SIL 75	PENTADUR HB ZP 8531	VENDOR TO OFFER SUITABLE PAINT AS PER SPEC.	PENTATHANE HS 4510

Note: Refer Tank Construction Specification (IOCL-PL-PJ-MECH-TANK WORKS-204) for approved paints vendors for use in above ground crude oil/ petroleum products/ Firewater storage tanks):

GENERAL NOTE:

- APART FROM THE VENDORS DETAILED IN THIS DOCUMENT OR ITEMS WITH NO VENDOR LIST, THE CONTRACTOR MAY PROPOSE ANY VENDOR HAVING CREDENTIALS FOR THE RESPECTIVE ITEMS (FOR THE SAME OR HIGHER SIZE, PRESSURE RATING, SCHEDULE, CAPACITY, ETC AS APPLICABLE) IN THE LAST 7 YEARS IN OIL & GAS APPLICATIONS (EXCEPT FOR ITEMS MEANT FOR FIRE WATER SERVICE). IN SUCH CASES THE BIDDER SHALL PROVIDE SUPPLY RECORDS VIZ. COPY OF PO, INSPECTION REPORTS, INSPECTION RELEASE NOTE, PROVEN TRACK RECORD, EXPERIENCE DETAILS OR ANY OTHER DOCUMENTARY EVIDENCE TO ESTABLISH PAST SUPPLY, FOR OWNER'S REVIEW AND APPROVAL, AS APPLICABLE. **THE ACCEPTANCE OF THE SAME IS AT THE DISCRETION OF THE EIC**
- AT THE TIME OF P.O. PLACEMENT, PROPOSED VENDOR/ SUPPLIER SHALL NOT BE IN HOLIDAY LIST OF IOCL.

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2. List of vendors for CP materials

LIST OF APPROVED VENDOR		
The equipment offered by the Contractor should be of any of the following makes only:		
CP MATERIALS		
SR. NO.	EQUIPMENT	MANUFACTURER'S NAME/BRAND
1	Transformer Rectifier Unit (CPTRU)	1.M/s Raychem RPG Ltd. (Canara Electric), Mumbai/
		2.M/s Kristron Systems, Mumbai /
		3.M/s CATHODIC CONTROL CO PVT. LTD, India
		4. M/s Golconda Corrosion Control Pvt. Ltd., India
		5. M/s Hind Rectifiers Ltd., India
2	MMO Wire Anode	1.M/s Matcor, USA/
		2.M/s Covalence, USA/
		3.M/s Berry Plastics, USA /
		4.M/s Grouppo De nora, Goa/
		5.M/s Ceranoda Technologies, USA /
		6.M/s Telpro USA
3	MMO Tubular/Strip/Ribbon Anodes	1.M/s Grouppo De nora, Goa /
		2.M/s Oranzio De nora, Italy /
		3.M/s Magnetochemie, Holland /
		4.M/s Actel Ltd., UK /
		5.M/s Eltech systems Corporation, USA /
		6.M/s Ceranode Technologies, USA /
		7.M/s Matcor, USA /
		8.M/s CATHODIC CONTROL CO PVT. LTD, India/
		9.M/s ELECTRO PROTECTION SERVICES INDIA P LTD /
		10.M/s EMIRATES TECHNO CASTING, UAE /
		11. M/s Titanor Component Ltd., Goa, India
		12. M/s CORROSION MATTERS, HYDERABAD
4	Mg & Zn Anodes	1.M/s Scientific Metal, India /
		2.M/s Electro protection services, India /
		3.M/s Cathodic Control Company Pvt. Ltd., India /
		4.M/s PSL Holding Pvt. Ltd., Mumbai/
		5.M/s Nippon Corrosion, Japan /
		6.M/s AFIC, KSA/
		7.M/s Platt Bros. and Company, USA /
		8.M/s Impalloy International, UK /
		9.M/s Corpro International, Canada /
		10.M/s NAKABOHEC, Japan /
		11. M/s CORROSION MATTERS, HYDERABAD /
		12. M/s Metal Founder, Mumbai /
		13. M/s Shakti Enterprise, Ahmedabad /
		14. M/s Sargam Metals Pvt. Ltd., Chennai/
		15. M/s Vijay Corrosion Technology, Ahmedabad
5	CP Cables	1.M/s Victor cables, India /
		2.M/s Fort Gloster Cables, India /
		3.M/s Universal cables, India /
		4.M/s NETCO Cables, India /
		5.M/s Finolex cables, India /
		6.M/s Asian Cables, India /
		7.M/s Radiant Cables, India /
		8.M/s Cable Corporation of India, India /
		9.M/s Icon cables, India /
		10.M/s Gemscab, India /
		11.M/s KEI, India /
		12. M/s Torrent, India /
		13. M/s Polycab, India /
		14. M/s Nicco, India /
		15. M/s KEC International, India /
		16. M/s Uniflex, India /
		17. M/s Havells, India /
		18. M/s Crystal Cable Corporation, India /
		19. M/s Ravin, India/
		20. M/s Suyog Electricals Ltd., Vadodara



**LAYING & CONSTRUCTION OF 3LPE COATED
CARBON STEEL PIPELINE AND ASSOCIATED WORKS
FOR CITY GAS DISTRIBUTION**


**इंडियन ऑयल कॉर्पोरेशन लिमिटेड
(पाईपलाइन प्रभाग) नोएडा**

LIST OF APPROVED VENDOR		
The equipment offered by the Contractor should be of any of the following makes only:-		
CP MATERIALS		
SR. NO.	EQUIPMENT	MANUFACTURER'S NAME/BRAND
6	Flameproof Anode/ Cathode Junction boxes/TLP	1.M/s FCG Power Industries Pvt. Ltd., Vapi /
		2.M/s Baliga Lighting equipments (P)Limited,Chennai/
		3. M/s Flexpro electrical, Navsari /
		4.M/s Flame proof equipment Pvt. Ltd., Mumbai /
		5.M/s FCG flame proof control gears P. Ltd., Daman /
		6.M/s Pepperl & Fuchs manufacturing (I) Pvt. Ltd.,Kanchipuram /
		7.M/s Kaysons Techno equipments Pvt. Ltd., India /
		8. M/s R Stahl Pvt. Ltd. Kanchipuram/
		9. Sudhir Switchgears Pvt. Ltd., India
7	Permanent half cell	1.M/s Permacell Harco (USA) /
		2.M/s Borin Manufacturer, USA /
		3.M/s M.C Miller, USA /
		4.M/s Corrttech (Zulu), India /
		5. M/s Tinker Razor, USA /
		6.M/s Silvion, UK
8	Backfil material of anode bed	1.M/s Loresco,India /
		2.M/s GOA Carbon (Goa) /
		3.M/s India Carbon, Calcutta /
		4.M/s Petrocarbon & chemical company, Haldia
9	Thermit welding cartridge	1.M/s Erico, USA /
		2.M/s Thermoweld, USA /
		3.M/s Erico, Europe /
		4.M/s BAC, UK
10	Pin brazing equipment	1.M/s Safetrack, Sweden /
		2.M/s BAC, UK
11	Surge Diverter EXD	1.M/s Dehn Gmbh, Germany /
		2.M/s OBO, Bettermann, Germany
12	Solid state polarization Cell	1.M/s Dairyland Electrical Industries, USA /
		2.M/s Metricorr, Denmark /
		3.M/s Corpro system, India
		4. M/s Kristron, India
13	Heat shrink cap for anode to cable joint	1.M/s Raychem, USA /
		2.M/s Matcor, USA
14	Portable half cell	1.M/s Borin USA /
		2.M/s IARCO, USA /
		3.M/s M.C Miller, USA /
		4.M/s Electrochemical devices, USA
15	ER Probe	1.M/s Rose Corrosion Services UK /
		2. M/s Metal Samples, USA /
		3.M/s Roharbak Cosasco, USA /
		4.M/s Caproco, UK /
		5.M/s Korosi Specindo, Indonesia
16	GSM based Digital Data Logger	1.M/s Raychem, USA /
		2. M/s M C Miller, USA /
		3.M/s Kriston, Mumbai
17	Hand held Data Logger	1.M/s ECD, Mumbai /
		2. M/s M C Miller, USA /
		3.M/s Cath-tech
18	Multimeter	1.M/s Fluke /
		2. M/s Yokogawa
19	Pipeline Locator cum Mapper	1.M/s Radio Detection /
		2. M/s Vivax /
20	Four Pin Soil Resistivity Meter	1.M/s Tinkor & Razor /
		2. M/s Nillson /
		3. M/s Fluke
NOTE:		
1. In case bidder proposes any other makes of components, it is to be substantiated with the detailed credentials in terms of present commitments, orders executed with performance report from end user, in last three years of similar or higher rating of equipment along with copy of orders. In case of FLP, PESO certificate is mandatory to be submitted prior to approval.		
2. Owner reserves the right to accept or reject such proposals.		



3. List of Approved Sub-Contractors for TCP & PCP Works

1. Central Electronics Ltd., Shahibabad
 2. Corrttech International Pvt. Ltd., Ahmedabad
 3. Corrosion Control Services (B) Pvt. Ltd., Mumbai
 4. Mitcorr Cathodic Protection Pvt Ltd, Baroda
 5. Scientific Metal Engineers (P) Ltd., Karaikudi
 6. Underground Pipeline & NDTs (P) Ltd., Noida
 7. UNDTs Corrosion Services (P) Ltd., NOIDA
 8. SARK EPC Projects Pvt. Ltd., Ahmeadabad
 9. Corrosion Technology Services India (Pvt.) Limited (CTS), Mumbai
- Any other reputed Cathodic Protection contractor having carried out Cathodic Protection works on their own in last Seven years meeting required technical specifications mentioned elsewhere in the tender document. If Bidder is offering any other reputed Sub-contractor other than approved, then PO copies, performance certificates in detail, as per the tender document is to be submitted along with the offer for approval to EIC.
 - Above is only recommended vendor list for guidance to bidders. Bidder will be solely responsible for any material for quality and compliance to tender specification. Any vendor can be approved at latter stage also based on their PTR at the sole discretion of OWNER. In case of imported kits, foreign cables are acceptable.

	LAYING & CONSTRUCTION OF 3LPE COATED CARBON STEEL PIPELINE AND ASSOCIATED WORKS FOR CITY GAS DISTRIBUTION	इंडियन ऑयल कॉर्पोरेशन लिमिटेड (पाईपलाइन प्रभाग) नोएडा
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4. Vendor list for contractor supplied ofc works items

Sl. No.	Description	Vendor's Name
1.	HDPE conduit, end caps, couplers	Any TEC/TSEC approved make having valid TEC/TSEC approval
2.	MS Pipe	a. Welspun b. Maharastra Seamless c. Indian Seamless d. Tisco e. Jindal
3.	Jointing kit	a. 3M make, Model: 2179-CD/Equivalent b. Raychem make, FOSC Series/Equivalent
4.	Electronic Marker Locator & Electronic Marker	Electronic Marker Locator cum Cable/ Pipe Fault Locator:- 3M make, Model: 2273M-iD/Equivalent Electronic Marker:- 3M make, Full Range (8 feet) iD type Disk Marker suitable for Oil & Gas applications.

PE(Fitting/Valves/Transition Fittings)	Tega Muhendislik
	Georg Fischer Piping System
	Kimplas piping Systems
	Glynwed pipe systems
	RMG Autometers gas technologies

Approved list of vendors/sub-contractors

Casing Insulators	Casing End -Seal	Joint Coating Materials - for Mainline (3LPE coating)	Joint Coating Materials – for HDD (3LPE coating)	Warning Mats/ Mesh	Temporary Cathodic Protection works	Calliper Survey Works
PVC insulator of M/s Mideast Pipeline Products, Calcutta	'CASEAL' of M/s Seal for Life India Pvt. Ltd., Corrosion Protection Group, USA/ India	HTLP - 80 of M/s Seal for Life India Pvt. Ltd., Corrosion Protection Group, USA/ India	'DIRAX' of M/s Seal for Life India Pvt. Ltd., Corrosion Protection Group, USA/ India (for HDD)	M/s Sparco Multiplast Pvt. Ltd., Ahmedabad	M/s Corrosion Control Services (B) Pvt Ltd., Mumbai	M/s TDW India Ltd., Vadodara
PVC insulator of M/s MNC Industrial Corporation, Delhi	Casing end-seals of RACI (Ricerche Applicazioni Chimiche Industriali S.r.l, Italy)	Wrapid sleeve / GTS-80 of M/s Canusa	'DDX™ Directional Drilling Kit' of M/s Canusa (for HDD)	M/s Raychem RPG Ltd., Mumbai	M/s Corrtch International Pvt. Ltd., Ahmedabad	M/s Graffin Technologies, Ahmedabad
HDPE Casing Insulators of M/s Raychem RPG Ltd.	---	FRDP-80 heat shrink sleeve of M/s CYG Changtong New Material Company Ltd., China	FRDK Sleeves (Fiberglass Reinforced Heat Shrinkable Sleeves) of M/s CYG Changtong New Material Company Ltd., China	M/s Singhal Industries Pvt. Ltd., Khatraj, Kalol Road, Gujarat	M/s Central Electronic Ltd., Shahibabad	M/s Bhotika Pipeline Services (In technical collaboration with Analytic Pipe, Germany)
PVC insulator of M/s Vee Kay Vikram & Co, Ahmedabad	---		---	---	M/s Mitcorr Cathodic Protection Pvt. Ltd., Baroda	M/s Envirocal, Vadodara
HDPE Casing Spacers of RACI (Ricerche Applicazioni Chimiche Industriali Srl, Italy)	---	---	---	---	M/s Underground Pipeline & NDTs (P) Limited	M/s Athena Powertech LLP, Vadodara
---	---	---	---	---	M/s Scientific Metal Engineers (P) Ltd., Karaikudi	M/s Veekey Vikram
---	---	---	---	---	M/s UNDTs Corrosion Services (P) Ltd., Noida	M/s Transpipe Integrity Solutions Pvt. Ltd., Mumbai (upto 60 Km pipeline length in single stretch)
					M/s SARK EPC Projects Pvt. Ltd., Ahmedabad	
					M/s Corrosion Technology Services India (Pvt.) Limited (CTS), Mumbai	

(Signature of the Tenderer)

T#6(A)
Approved list of vendors/sub-contractors

Welding & Radiographic Inspection Works (max pipeline size – 30" OD)	Rock Shield Materials
M/s Sievert India Ltd., Mumbai	'Petroshield' of M/s Tuflex India, Vadodara
M/s Industrial X-Ray & Allied Radiographers (I) Pvt. Ltd., Mumbai (IXAAR)	Rockshield of M/s Raychem RPG Ltd.
M/s TCR Engineering Services Pvt. Ltd., Mumbai	M/s Indonet Plastic Industries
M/s Inspection Technology (INTEC), Mumbai	Protecta-Mesh of M/s Seal for Life
M/s Inspection Technic, Mumbai	Warshield of M/s Sparco Multiplast Pvt. Ltd., Ahmedabad

Note:

1) The utilization of materials in IOCL project is subject to meeting guidelines issued by Govt of India related to restrictions under rule 144 (XI) of the General Financial Rules (GFRS) 2017 vide OM No F NO 6/18/2019-PPD dated 23 7 2020 and its subsequent amendments

(Signature of the Tenderer)

Approved list of vendors/sub-contractors

Welding and Radiographic Inspection
works for CGD Upto 12" OD Dia

M/s Sri Shanmuka NDT & Inspection services

M/s A star Testing and Inspection Pvt Ltd

M/s Matrix Inspection and Engineering services
pvt ltd

M/s Eminent NDT services Pvt Ltd

Approved list of vendors/sub-contractors**Updated list of materials of approved brand and/ or manufacturer to be used in Civil works:-**

Sl. No.	Description of Material	Brand/ Manufacturer
1	Cement	ACC, Ultratech, JK Lakshmi, Vikram, Ambuja, RAMCO
2	White Cement	J.K., Birla or equivalent
3	Steel	TATA, SAIL, RINL, JSPL
4	Anodised Aluminium Sections	Jindal, Indalco, Hindalco, Ajit India
5	Aluminium Fittings	Garnish, Adarsh, Everite
6	Automatic door closer	Everite or equivalent
7	Tiles (Vitrified/ Ceramic/ Porcelain)	Somany, Kajaria, Johnson, NITCO
8	Tiles (Terrazzo)	NITCO, DECO
9	P.V.C. Flooring	LG floor tiles or equivalent
10	Plastic door	Sintex or equivalent
11	Sanitary Fixtures	Hindustan, Cera, Parry, Neycer, Jaquar
12	C.P. Brass fittings for water supply	Jaquar, Parko, Marc
13	Submersible Pump	Wasp, Kirloskar
14	Water Pump Sets	Wasp, Crompton, Kirloskar
15	Overhead Tank	Sintex or equivalent
16	C.I. Sluice Valves	Kirloskar, Upadhyay
17	Gun Metal Valves, Ball Valves	Leader or equivalent
18	G.I. Pipe(s)	Tata, Jindal, Prakash- Surya, GST
19	G.I. Pipe Fittings	"R" Brand (ISI marked) or equivalent
20	Chlorinated Polyvinyl Chloride (CPVC) Pipes & fittings	Astral, Ashirvad, Finolex, Prince, Supreme
21	Sand Cast Iron (SCI) Soil/ Waste pipes	SRIF, RIF
22	Manhole Cover	RIF, BC, Kajeco
23	R.C.C. Hume Pipe (Non- pressure)	Indian Hume Pipe, Pragati, Spun line
24	Stainless Steel Sink	Jayna or equivalent
25	Water proofing compound, admixtures	ACCO, CICO, PUDLO, STP, PIDILITE
26	Water proofing Polymeric Membrane	Pd-lite, STP, Fosroc, Sikka

(Signature of the Tenderer)

Approved list of vendors/sub-contractors

27	Paint (Synthetic Enamel/ Epoxy/ Textured Emulsion/ Acrylic Distemper/ Acrylic Emulsion)	Berger, Asian, ICI, Nerolac
28	Waterproof Cement Paint	Super Snowcem or equivalent
29	Glass for Panelling, Mirror	Modiguard, Asahi, Pilkington
30	Sun Control Film	Garware or equivalent
31	False Ceiling	India Gypsum, Hunter Douglas
32	Prelaminated Particle Board	Novapan, Bakelite Hylam, Kitply, Anchor, Bhutan Board, Dura
33	G.I. Sheet 22 Gauge (Corrugated & Plain)	Tata, Necon
34	Geo-Textile Fabric	Gayatri Polymers & Geo-Synthetics, Tuflex India, Garware-Wall Ropes, Jeevan Products, KT Exports (I)

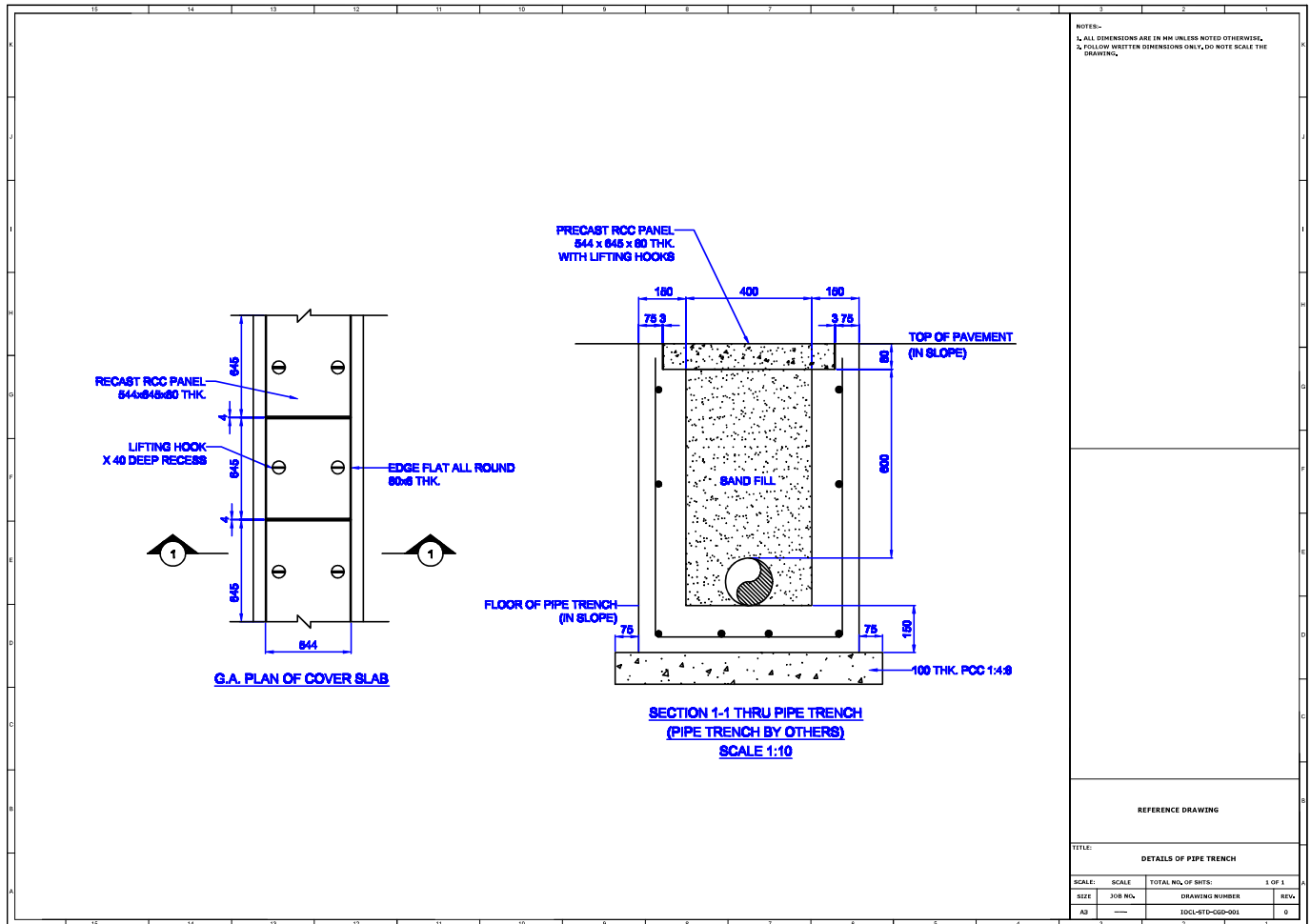


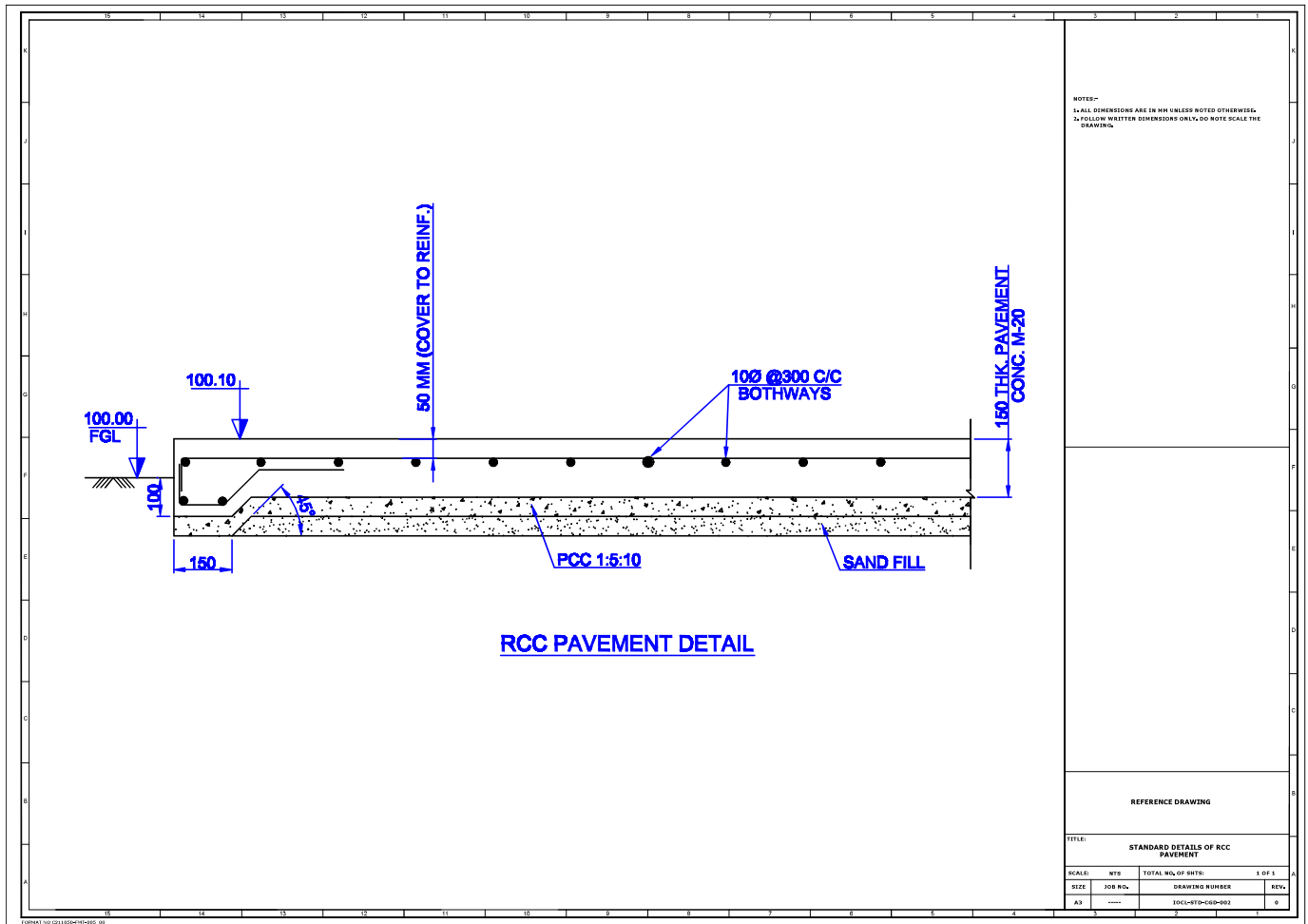
LAYING & CONSTRUCTION OF 3LPE COATED
CARBON STEEL PIPELINE AND ASSOCIATED WORKS
FOR CITY GAS DISTRIBUTION

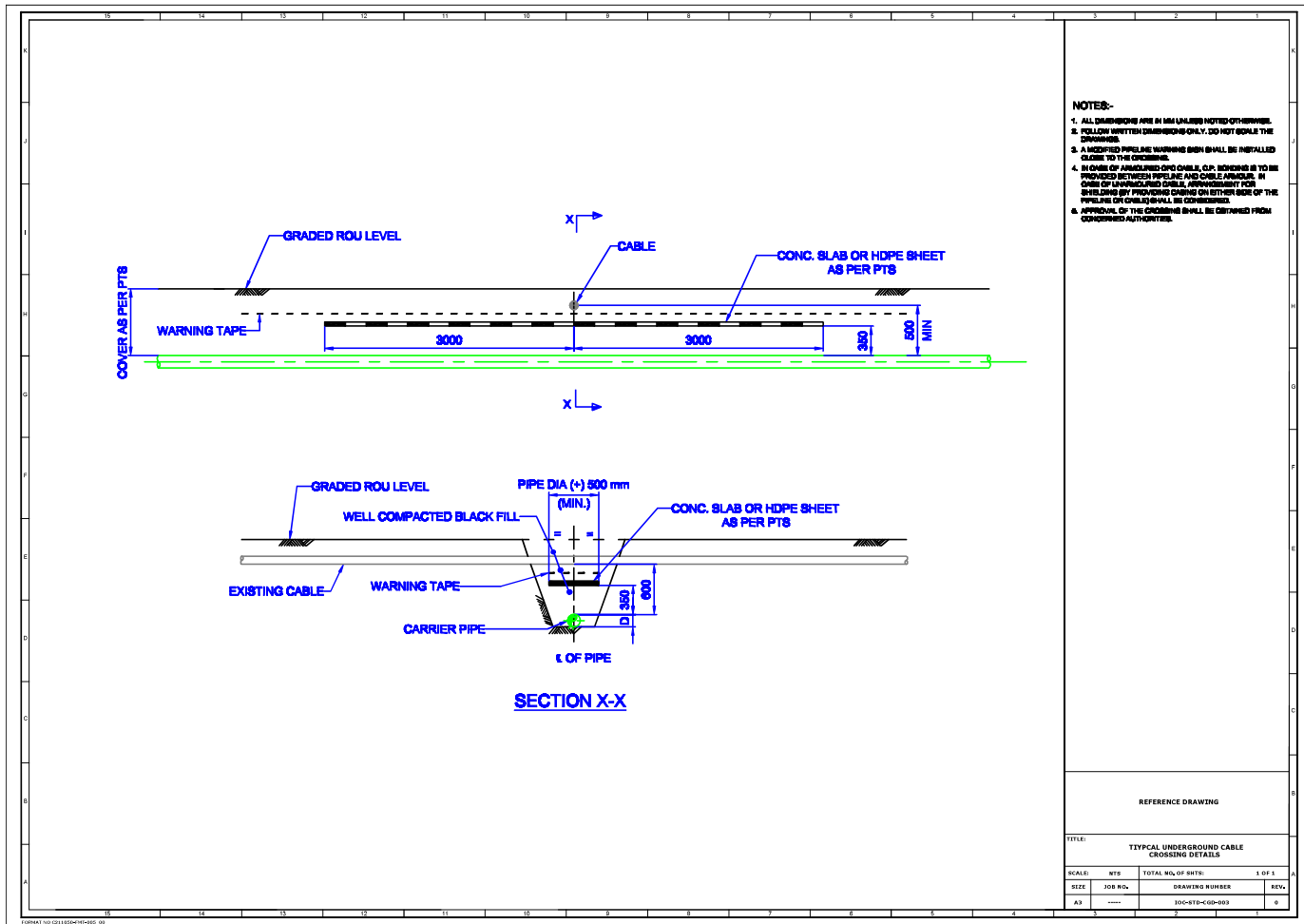
इंडियन ऑयल कॉर्पोरेशन लिमिटेड
(पाईपलाइन प्रभाग) नोएडा

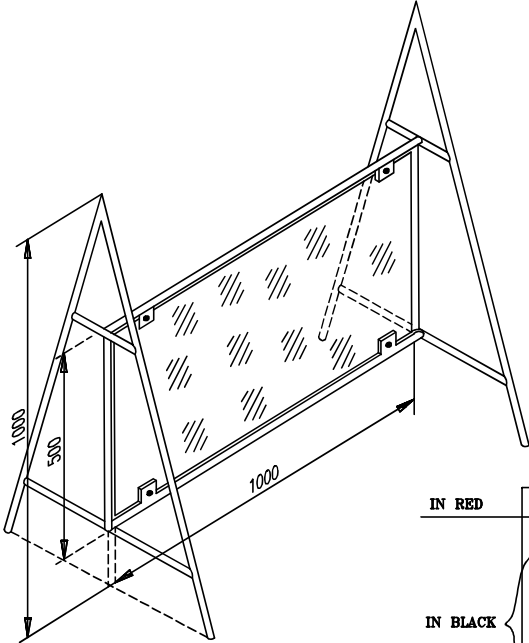
SECTION-IX

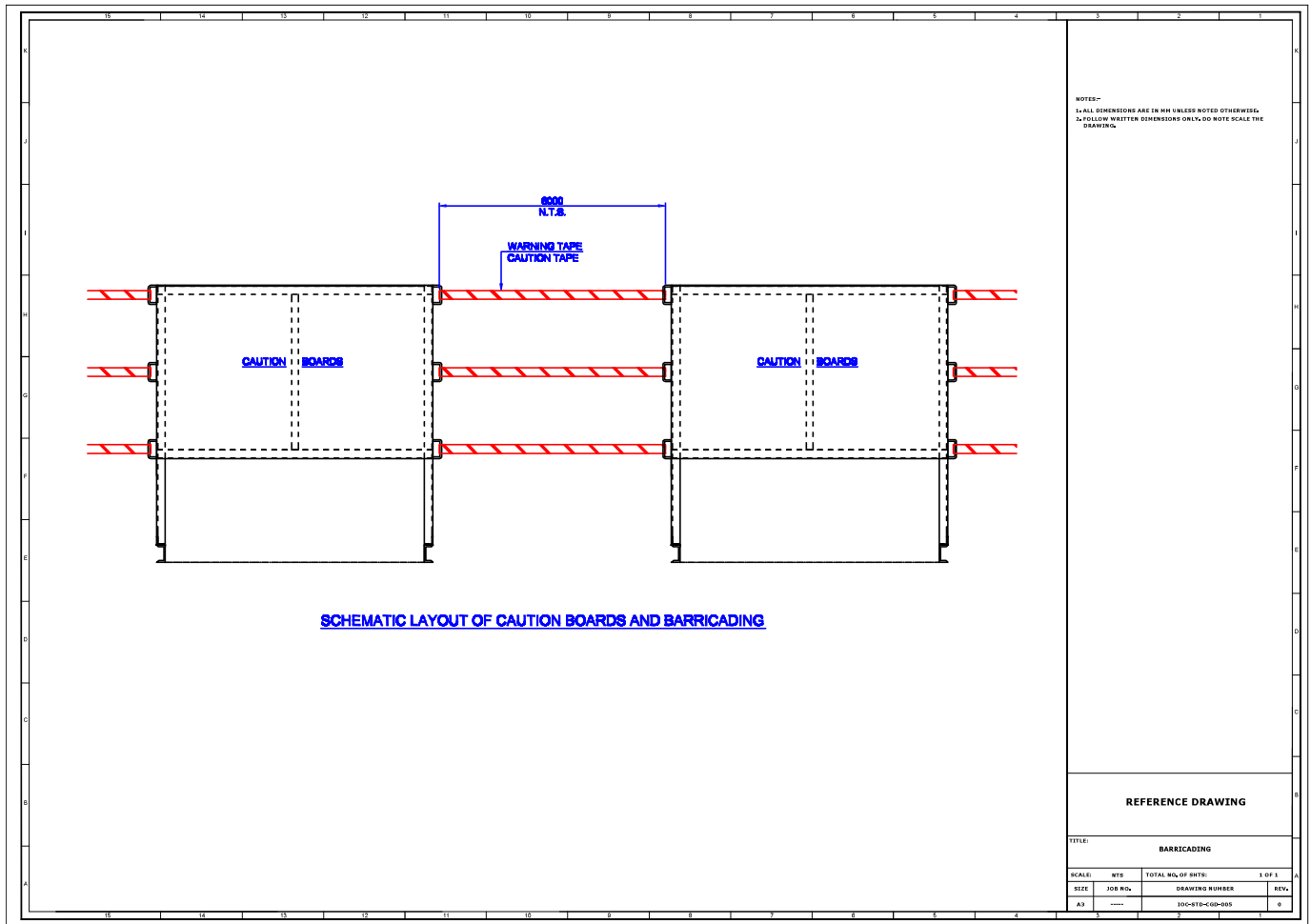
STANDARD DRAWINGS

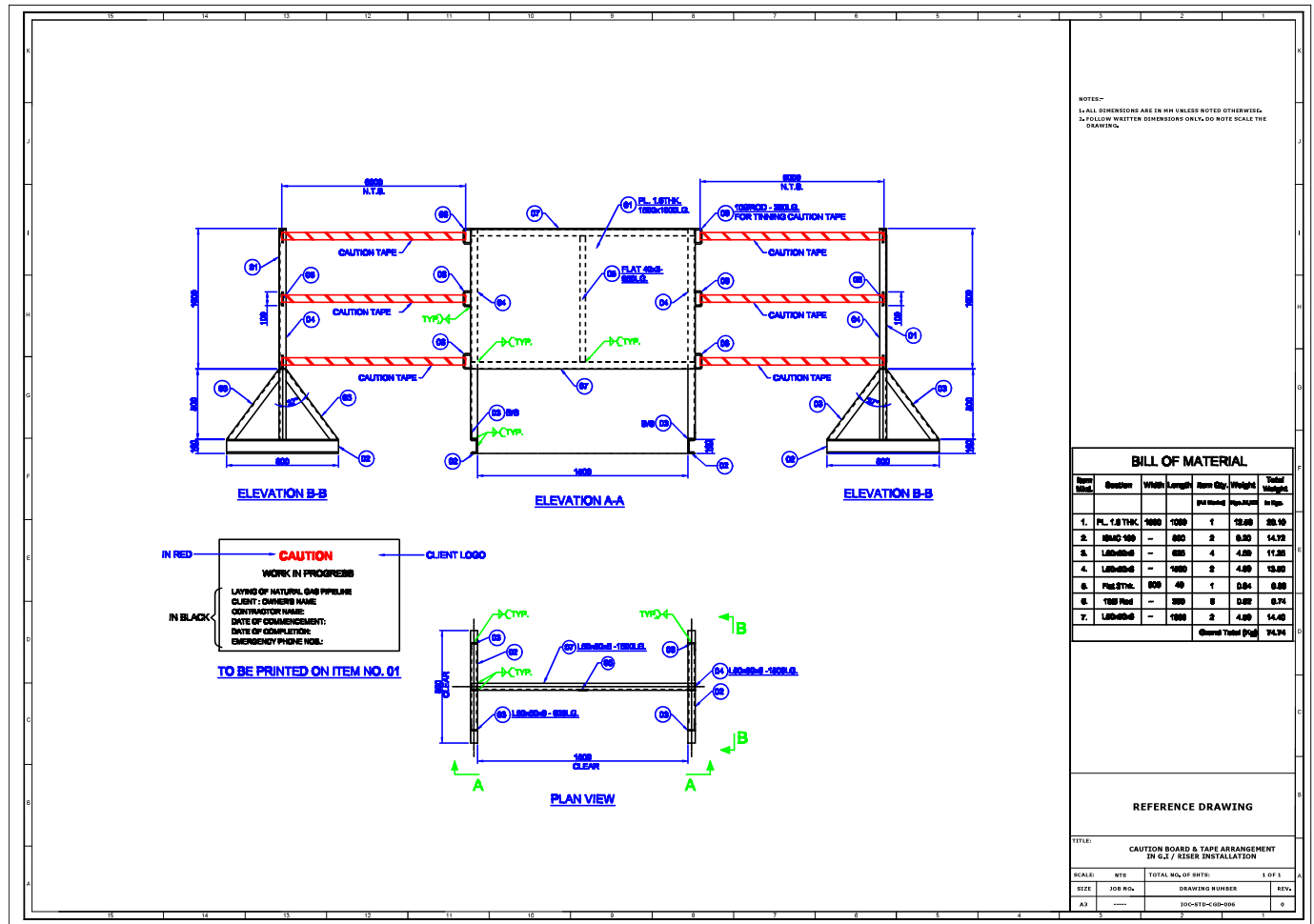


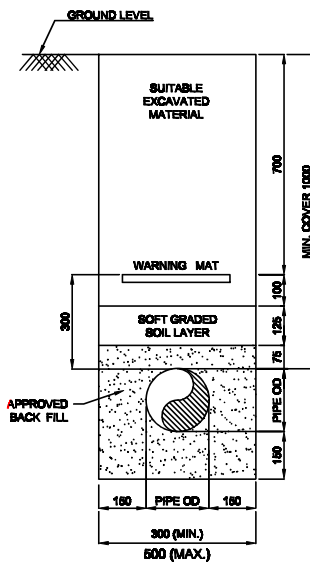




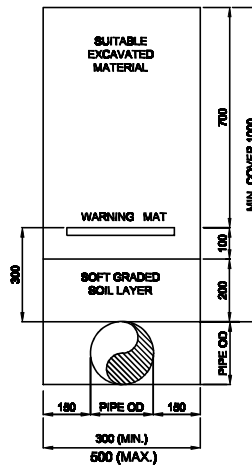
	12	11	10	9	8	7	6	5	4	3	2	1	
H											NOTES:- 1. ALL DIMENSIONS ARE IN MM. UNLESS NOTED OTHERWISE.		H
G													G
F													F
E													E
D													D
C													C
B											<div style="display: flex; justify-content: space-between; align-items: center;"> IN RED → <div style="border: 1px solid black; padding: 5px; text-align: center;"> CAUTION WORK IN PROGRESS LAYING OF NATURAL GAS PIPELINE CLIENT : OWNER'S NAME CONTRACTOR NAME : DATE OF COMMENCEMENT : DATE OF COMPLETION : EMERGENCY PHONE NOS: </div> ← CLIENT'S LOGO </div>		B
A											REFERENCE DRAWING		A
F											CAUTION BOARD FOR BARRICADING		
	NTS		TOTAL NO. OF SHTS:						1 OF 1				
	JOB NO.		DRAWING NUMBER						REV.				
			IOC-STD-CGD-004						0				
	12	11	10	9	8	7	6	5	4	3	2	1	



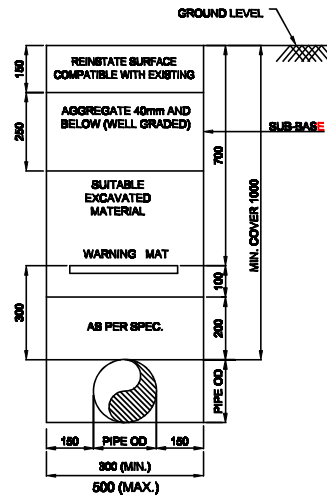




**TRENCH IN ROCKY STRATA
TYPICAL SECTION**



**TRENCH IN NORMAL SOIL
TYPICAL SECTION**



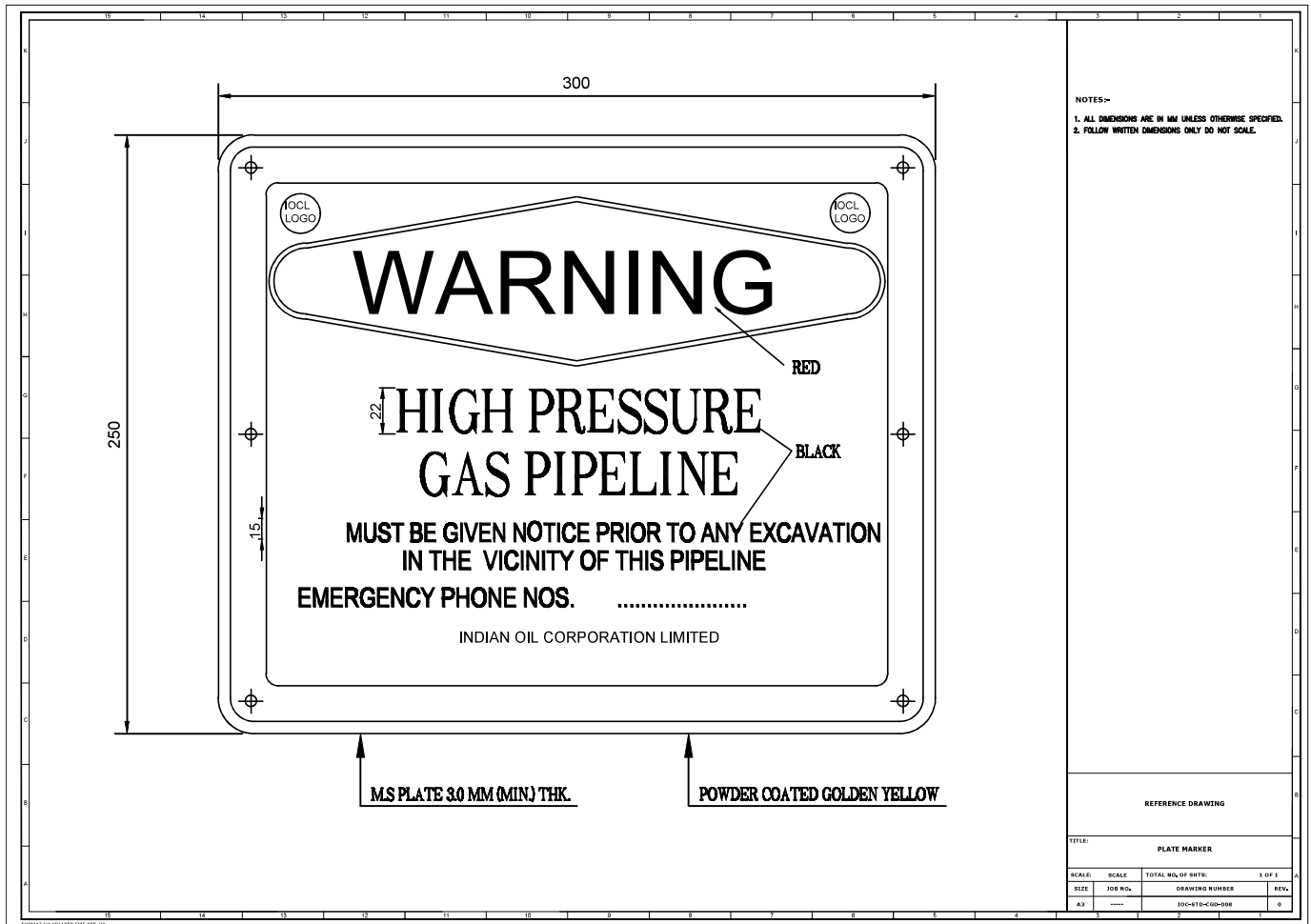
**TRENCH RESTORATION DETAIL
TYPICAL SECTION**

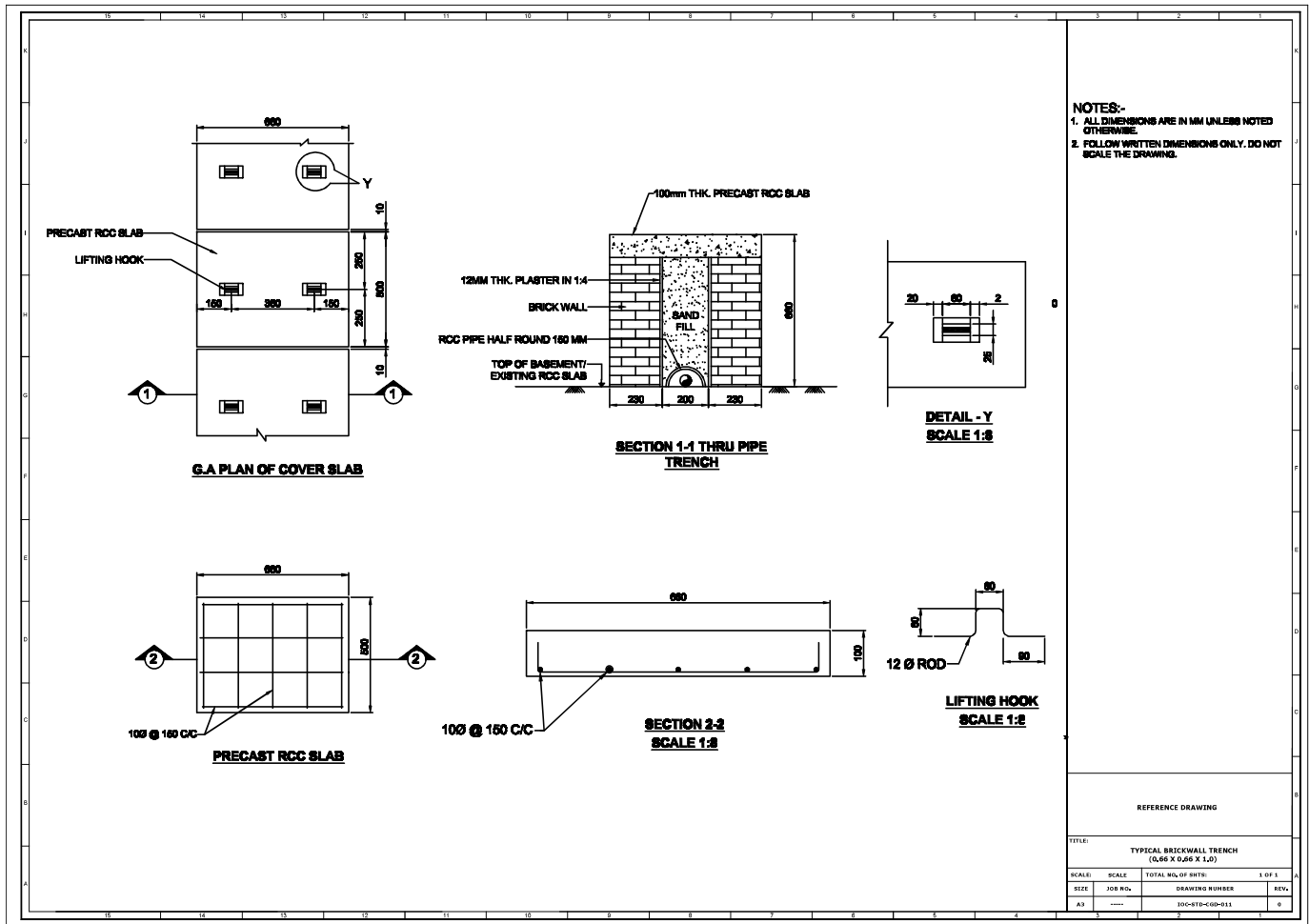
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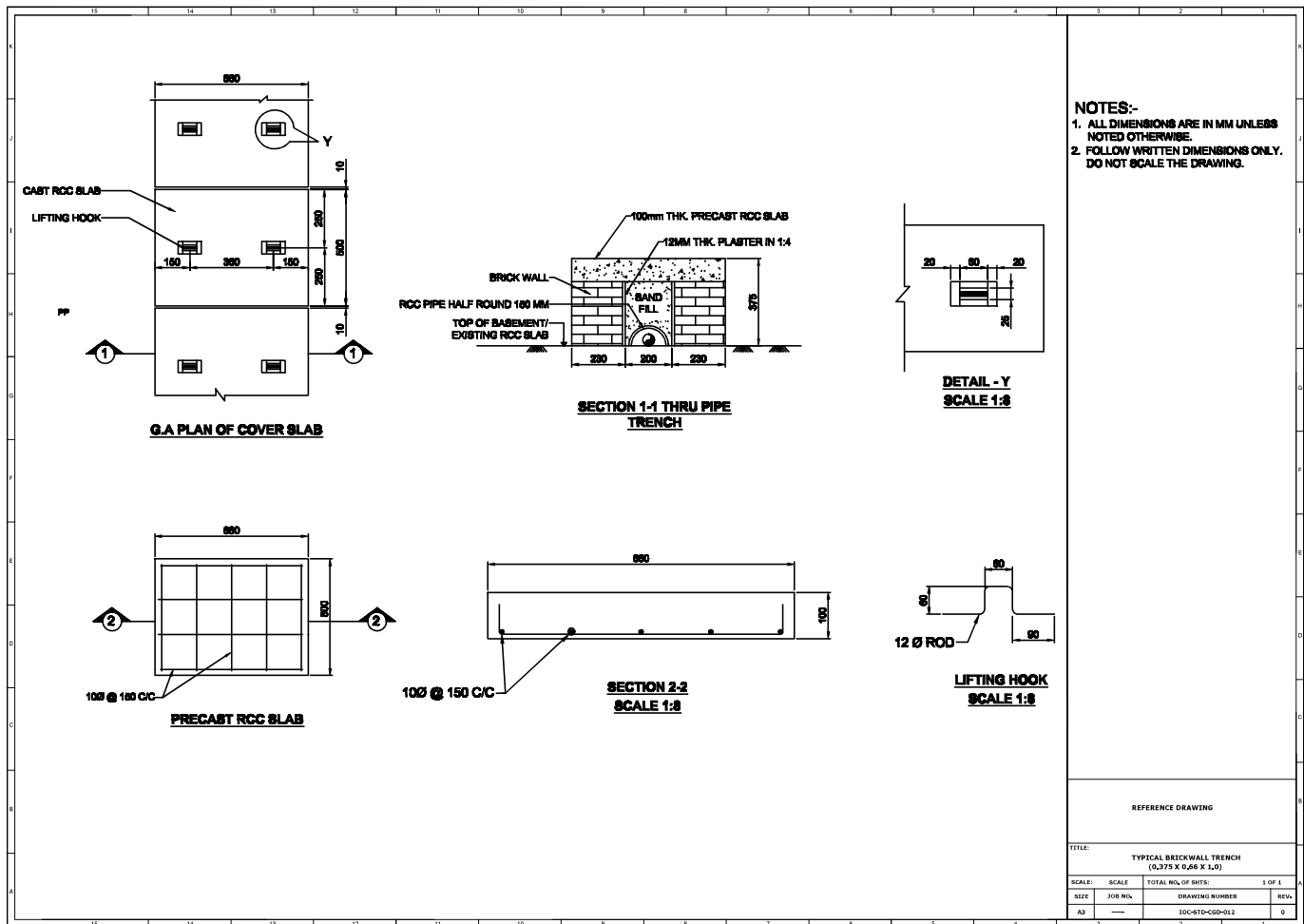
1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. FOLLOW WRITTEN DIMENSIONS ONLY. DO NOT SCALE THE DRAWING.
3. FOR ALL PIPELINE TO BE CONSTRUCTED IN THE LAND UNDER JURISDICTION OF GOVT. OF INDIA, THE MIN. COVER TO BE ADOPTED SHALL BE 1000MM IN ACCORDANCE WITH GOVT. OF INDIA PETROLEUM PIPELINE (ACQUISITION OF RIGHT OF LINE IN LAND) ACT NO. 18, 1986 AND AMENDMENT ACT NO. 13 OF 1997. ANY EXTRA COVER REQUIREMENT SHALL BE IN ACCORDANCE WITH SPECIFICATIONS.
4. MIN. COVER REQUIREMENT SHALL BE SUBJECT TO APPROVAL OF CONCERNED AUTHORITIES WHEREVER NECESSARY.
5. EXTRA COVER REQUIREMENT SHALL BE ESTABLISHED AT ALL OVER BE NOS AND HORIZONTAL BE NOS WHEREVER NECESSARY.
6. FOR MINIMUM COVER REQUIREMENT AT PIPELINE CROSSING RIVERS, RAILWAY TRACKS, RIVER MARGINS AREAS, ETC., REFER RELEVANT STANDARDS.

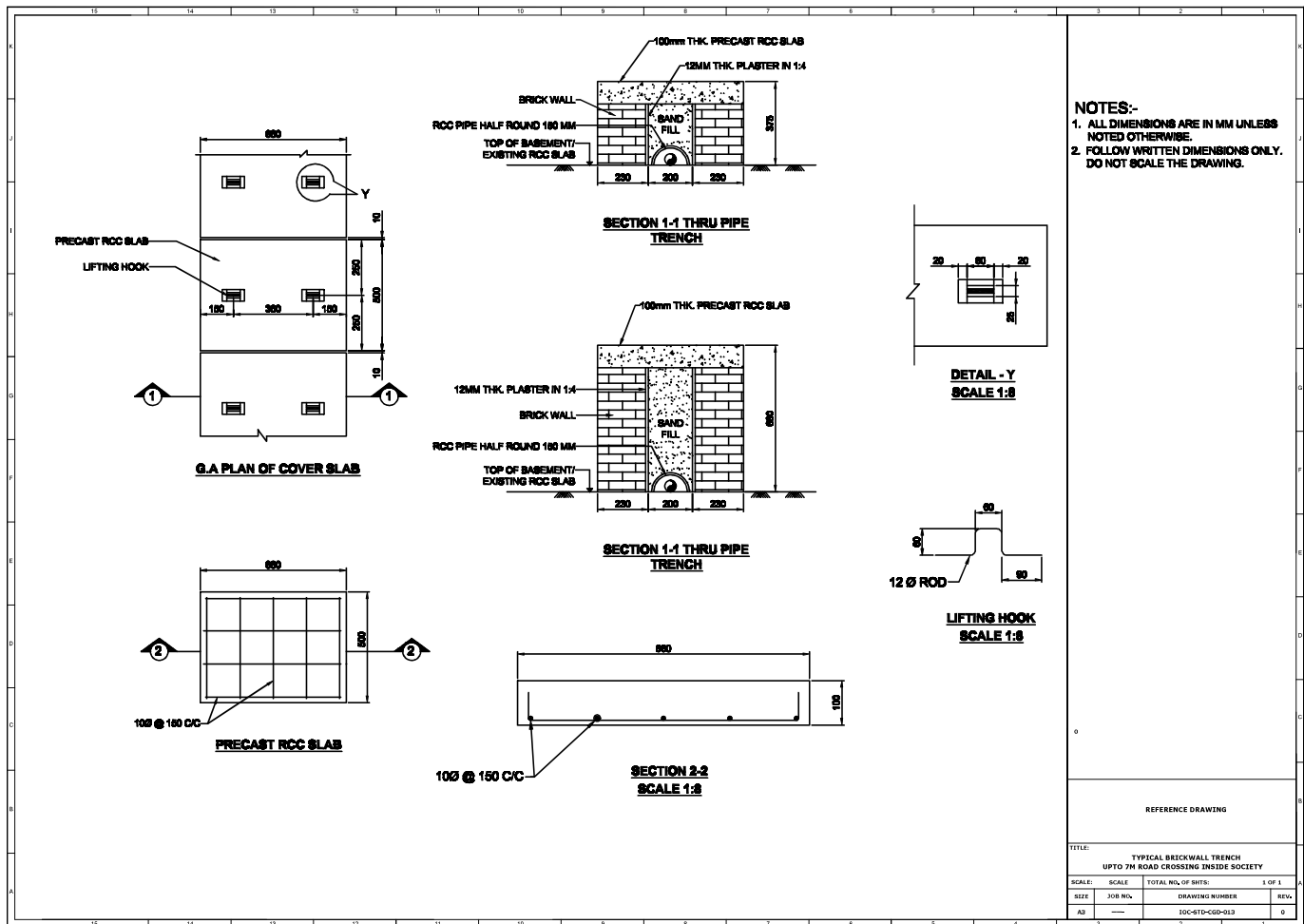
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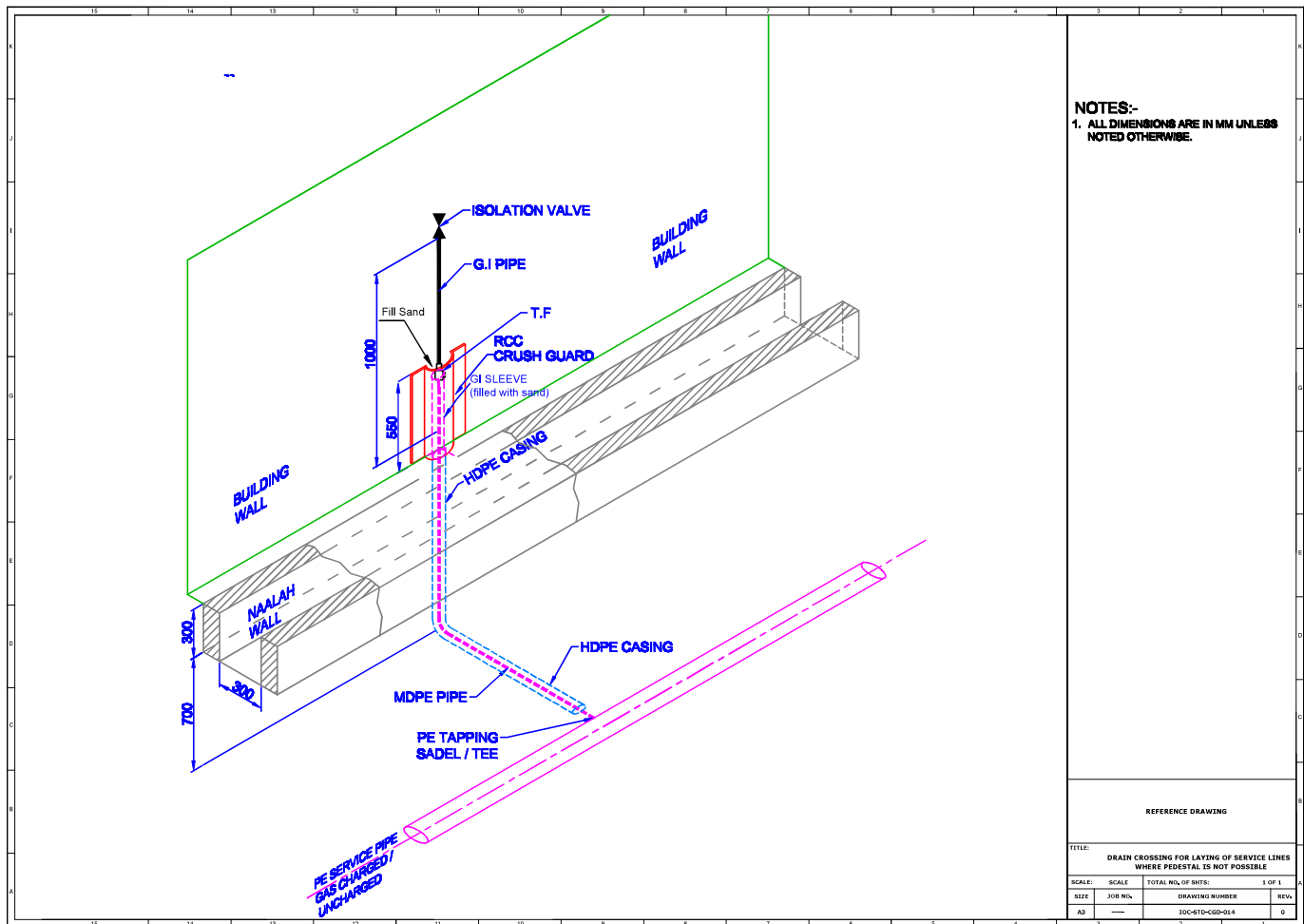
TITLE: TYPICAL TRENCH DIMENSIONS FOR PIPELINE				
SCALE:	NTS	TOTAL NO. OF SHEETS:	1 OF 1	
SHEET	JOB NO.	DRAWING NUMBER	REV.	
A3	----	DD-STD-C-00-007	0	

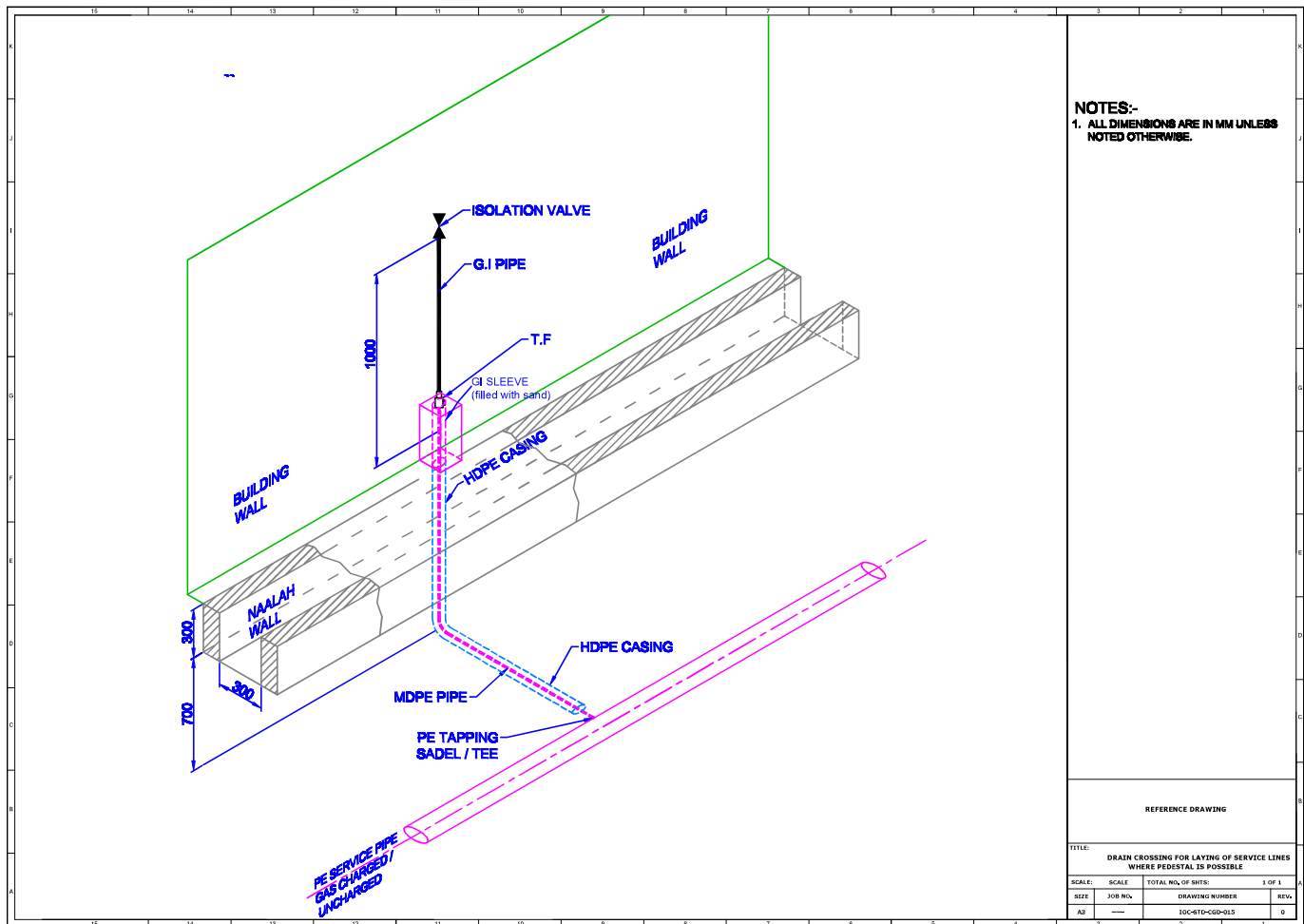


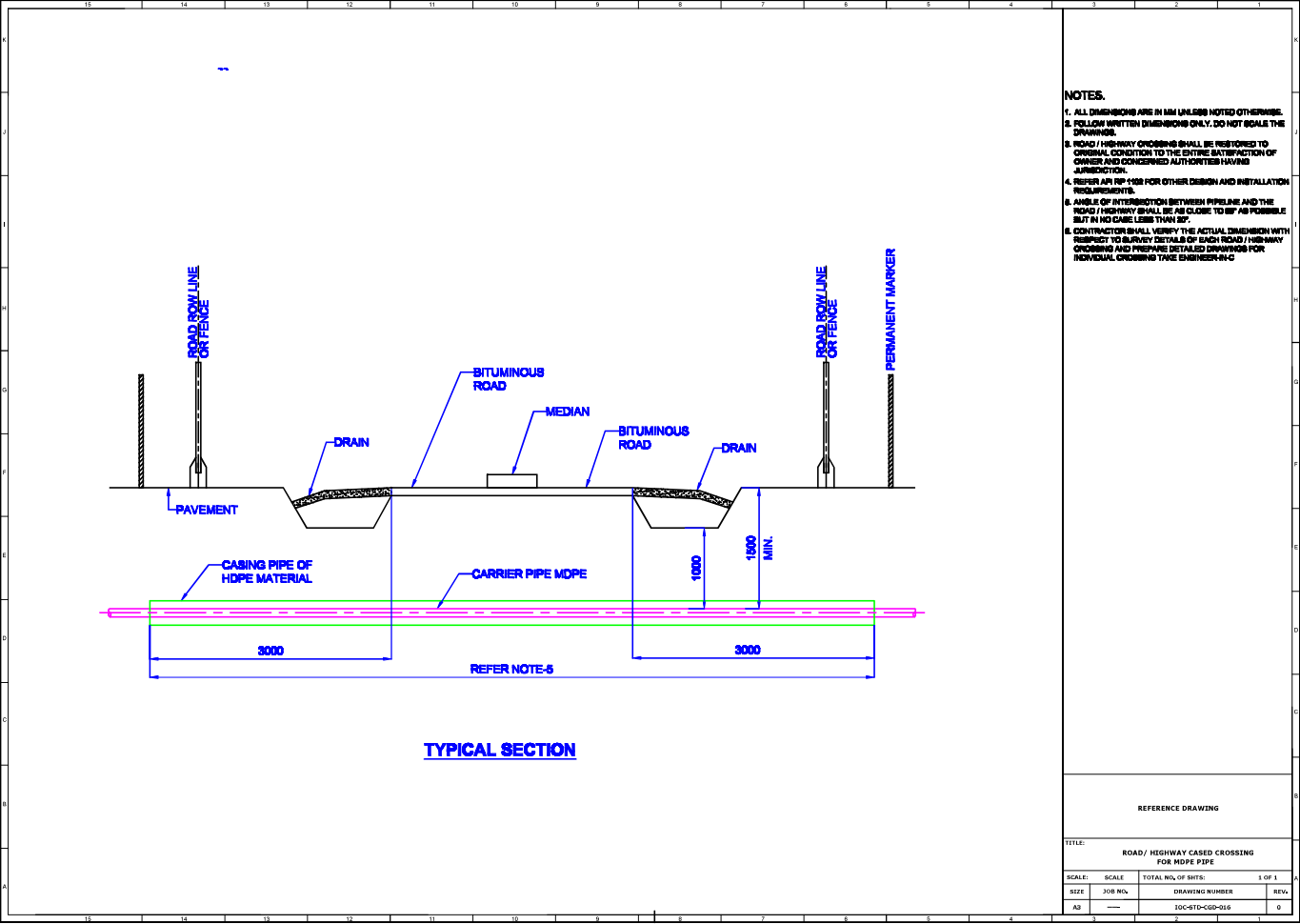


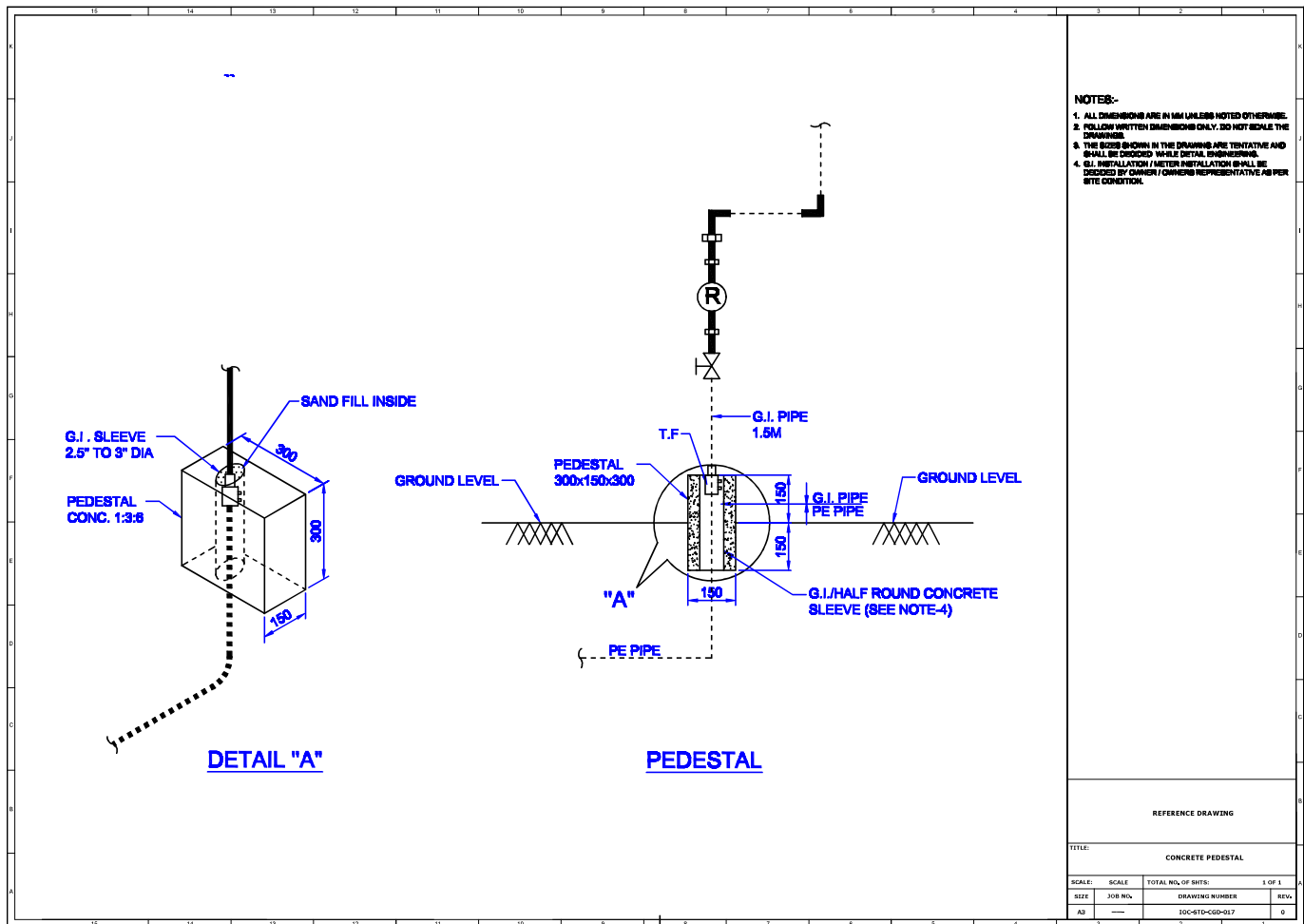


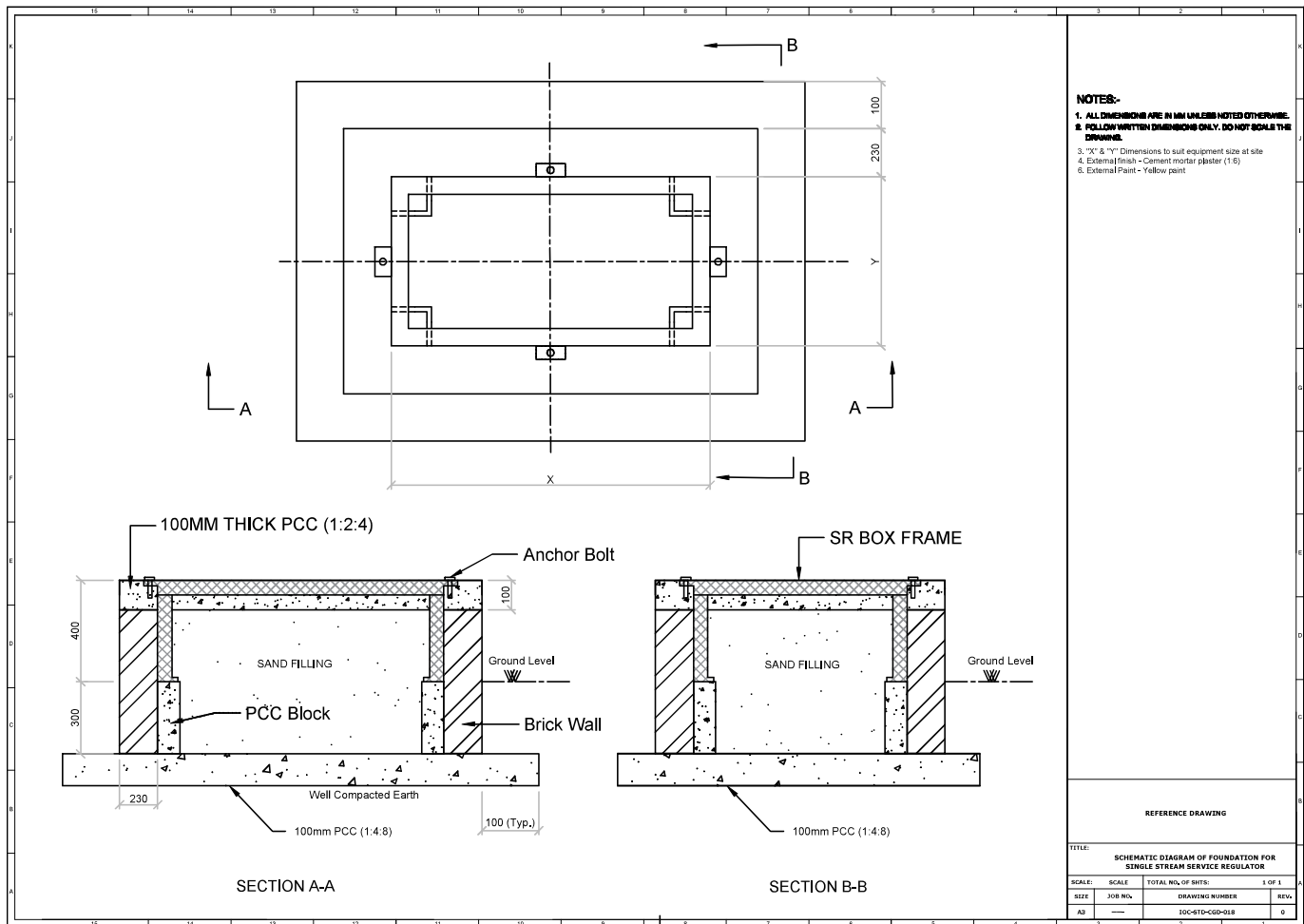


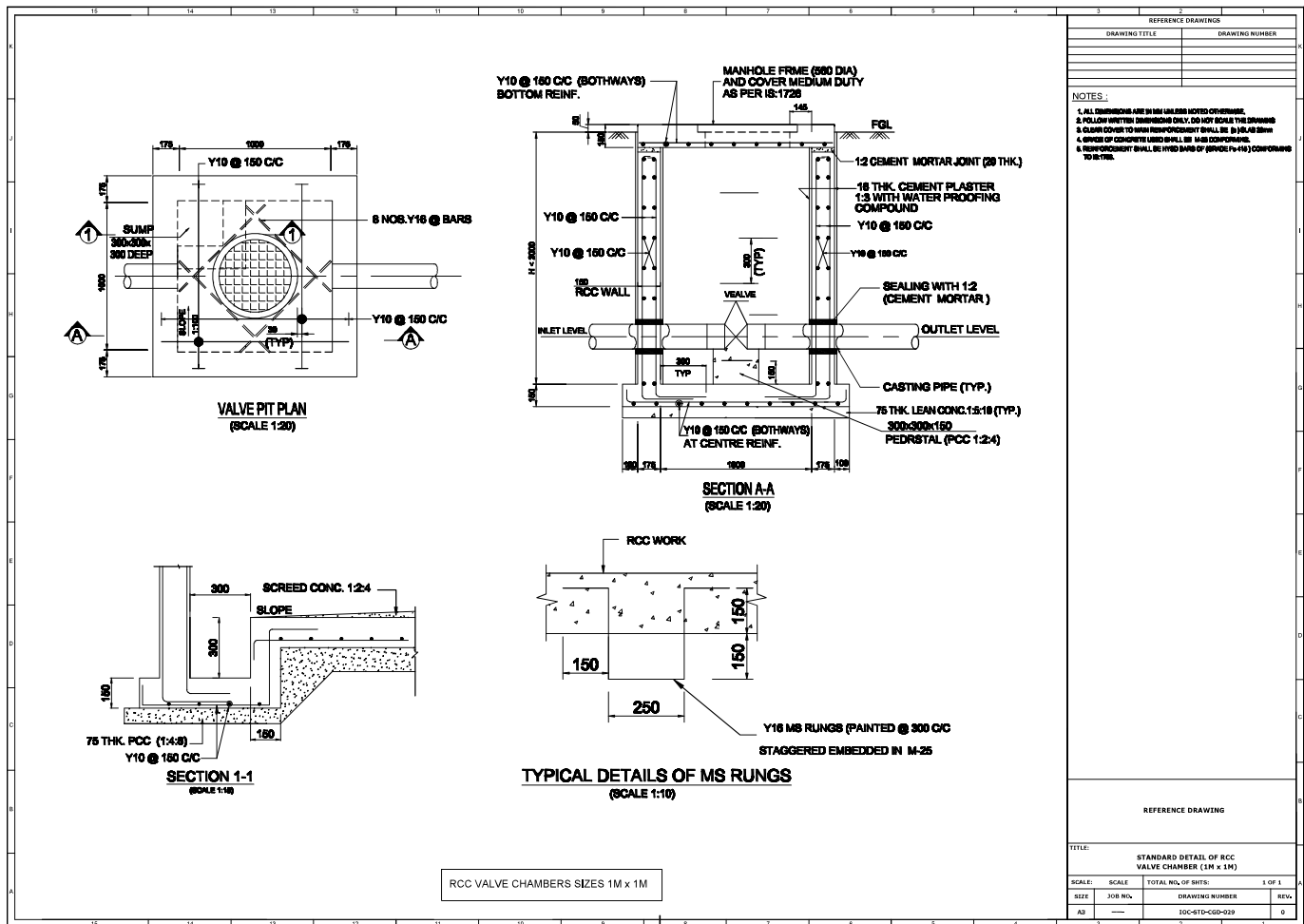


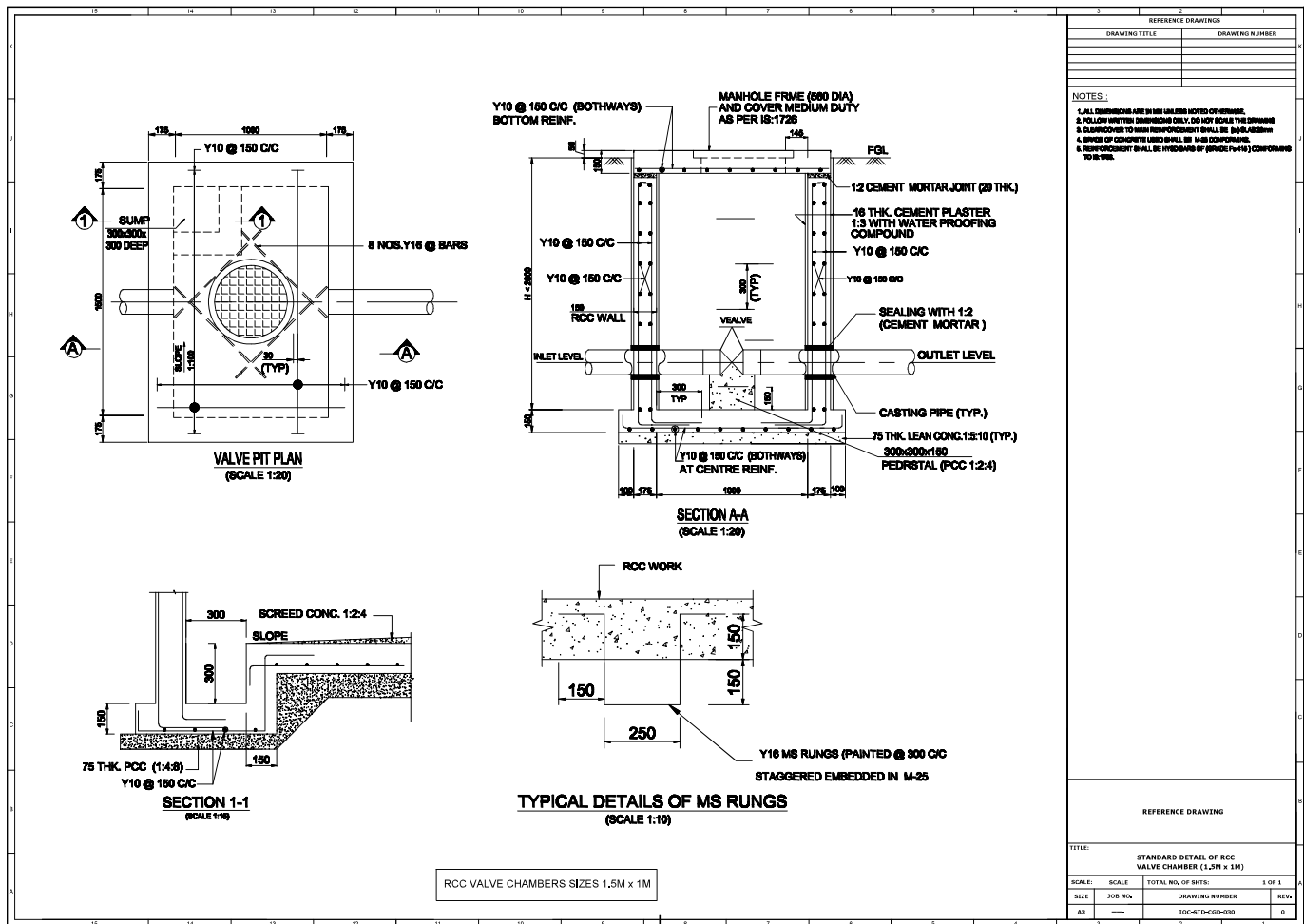


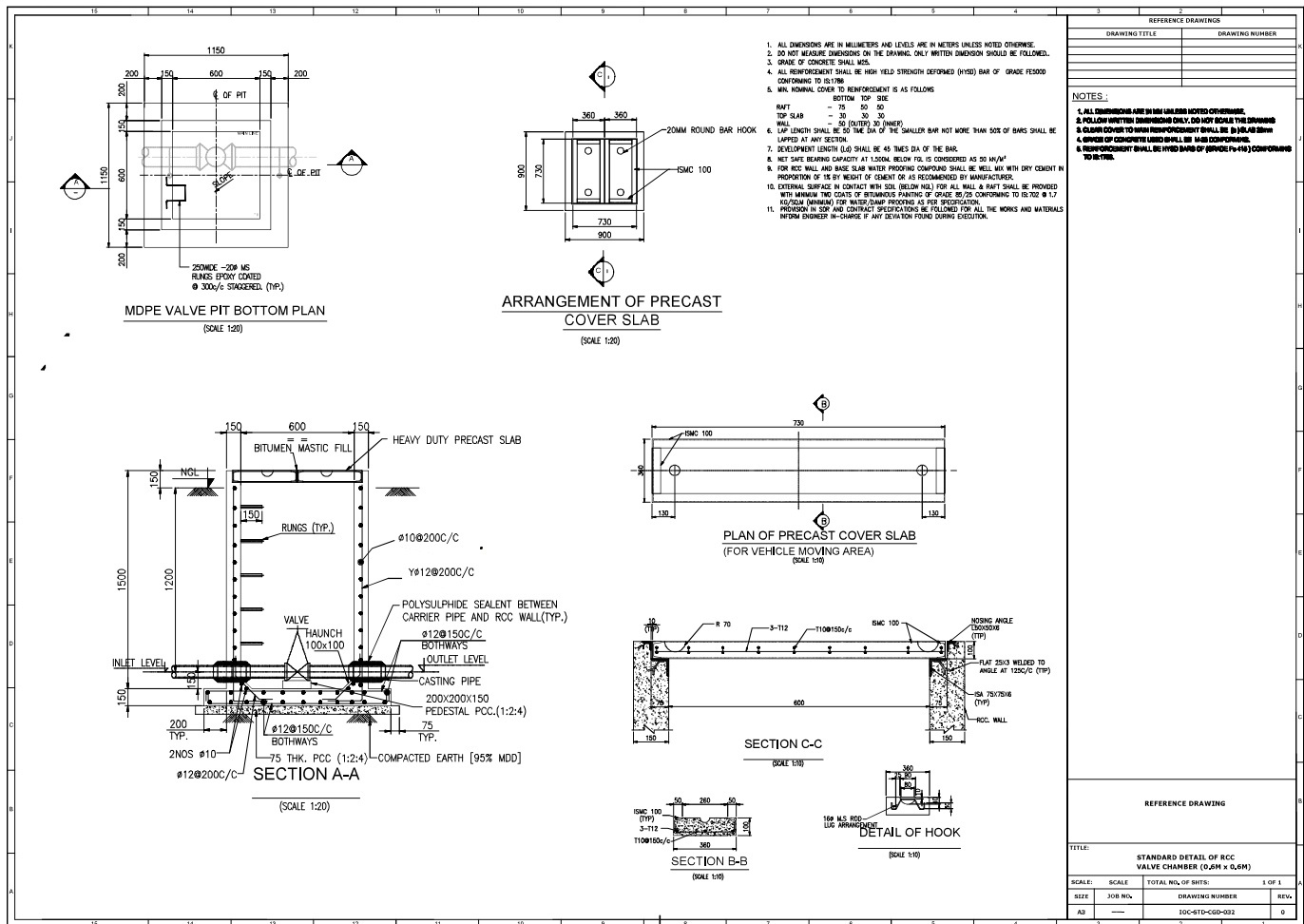


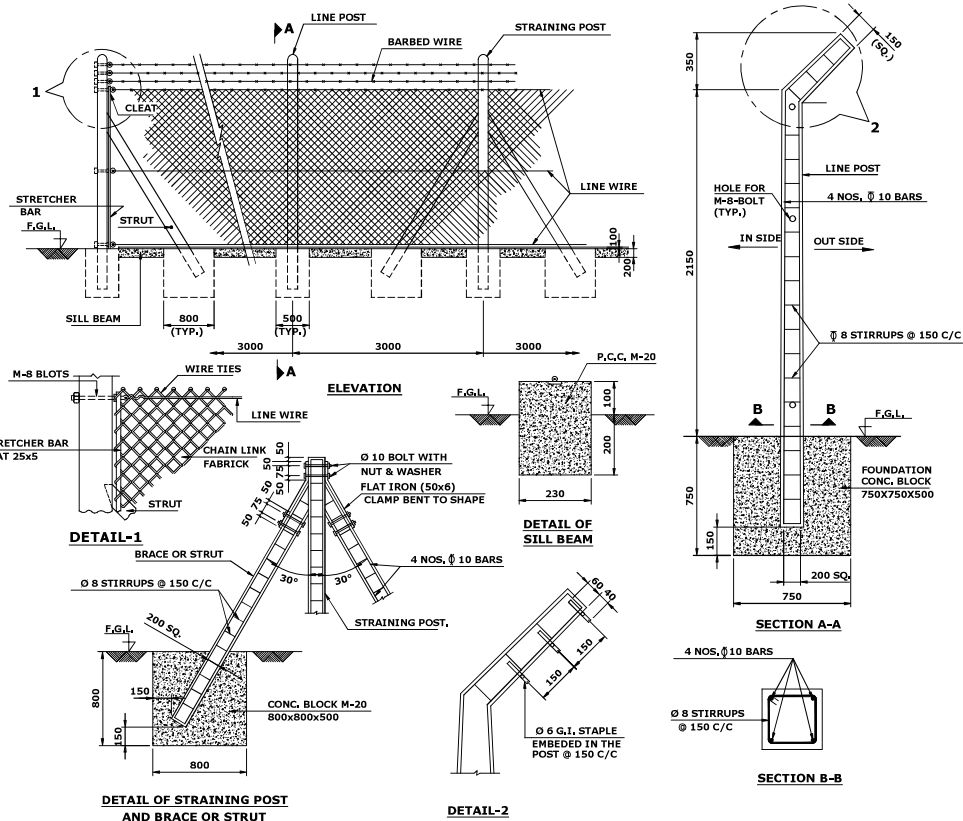












NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. THE GALVANISED STEEL BARBED WIRE A1 TO IS:278 SHALL HAVE LINE WIRE OF Ø 2.5 MM POINT WIRE OF Ø 2.0 MM & MINIMUM WEIGHT OF COMPLETE BARBED WIRE SHALL BE 108gm/m WITH 75 MM DISTANCE BETWEEN TWO BARS.
3. LINE POST SHALL BE PLACED AT 3.0 M C/C.
4. STRUT SHALL BE PROVIDED AT EVERY 15 TH. POST LAST BUT ONE END POST & CORNER POST ON BOTH SIDE & END POST ON ONE SIDE ONLY.
5. REINF. STEEL SHOWN THUS (SHALL CONFORM TO IS:1786 LATEST & REINF. STEEL SHOWN THUS Ø SHALL CONFORM TO GRADE Fe 415 (MIN.) LATEST.
6. STRAINING BOLTS SHALL BE PROVIDED AT THE END POST & AT PLACES AS DIRECTED BY ENGINEER INCHARGE.
7. SIZE OF STRAINING POST SHALL BE SAME AS THAT OF LINE POST.
8. GRADE OF CONC. SHALL BE AS FOLLOWS:
MODERATE SOIL SEVRE/
AGGRASSIVE SOIL
i) LINE & STRAINING POSTS RCC M25 RCC M30
ii) FOUNDATION BLOCKS PCC M20 PCC M20
iii) SILL BEAM PCC M20 PCC M20
iv) BRACE OR STRUT RCC M25 RCC M30
9. MANUFACTURE OF CONC. POSTS SHALL CONFORM TO IS:4996.
10. THE CHIAN LINK FABRIC SHALL CONFORM TO IS:2721.
11. STRETCHER BAR SHALL BE HOT DIP GALVANISED.
12. SUITABLE INSERTS SHALL BE PROVIDED ON THE TOP OF THE SILL BEAM TO TIE THE BOTTOM LINE WIRE WITH THE SILL BEAM.

TYPE-I



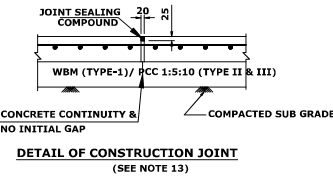
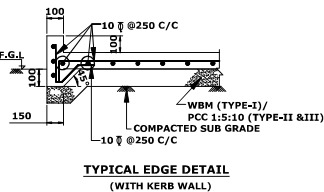
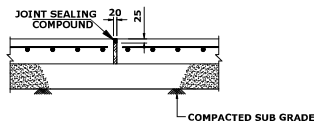
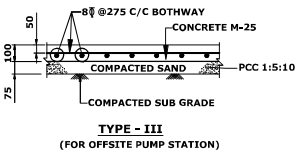
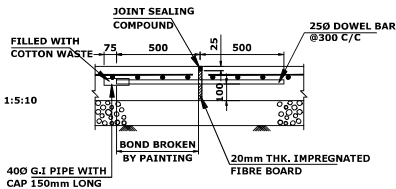
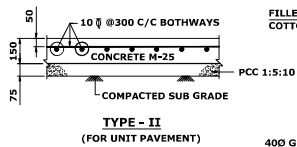
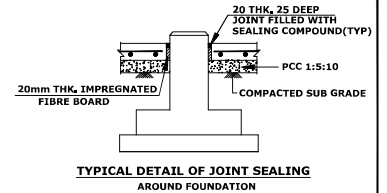
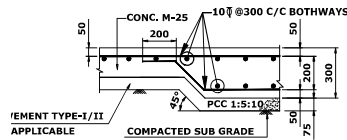
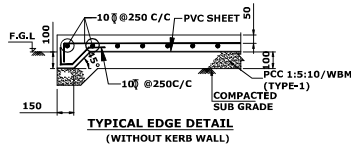
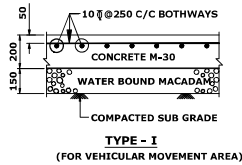
1. ALL DIMENSIONS AND LEVELS ARE IN mm (UNLESS MENTIONED OTHERWISE)
2. ONLY FIGURED DIMENSIONS ARE TO BE FOLLOWED.
3. ALL STRUCTURAL STEEL SHALL CONFORM TO IS: 2002-2011 GRADE-A.
4. FABRICATION SHALL BE DONE IN ACCORDANCE TO IS: 800-2007
5. ALL SHOP SHALL BE 6MM FILLET WELD UNLESS OTHERWISE STATED.
6. ALL SHOP JOINTS SHALL BE COMPLETELY WELDED WITH CONTINUOUS FILLET WELD FOR CONTACT LENGTH.
7. FABRICATION OF ALL MEMBERS TO BE DONE AFTER FULL SCALE SHOP LAYOUT BEFORE CUTTING MEMBERS.
8. FOR ACTUAL LAYOUT AND LOCATION OF CHAIN LINK FENCING AND GATE REFER PLOT PLAN.



FENCING & GATE (WITH STEEL POSTS)



TYPE-II

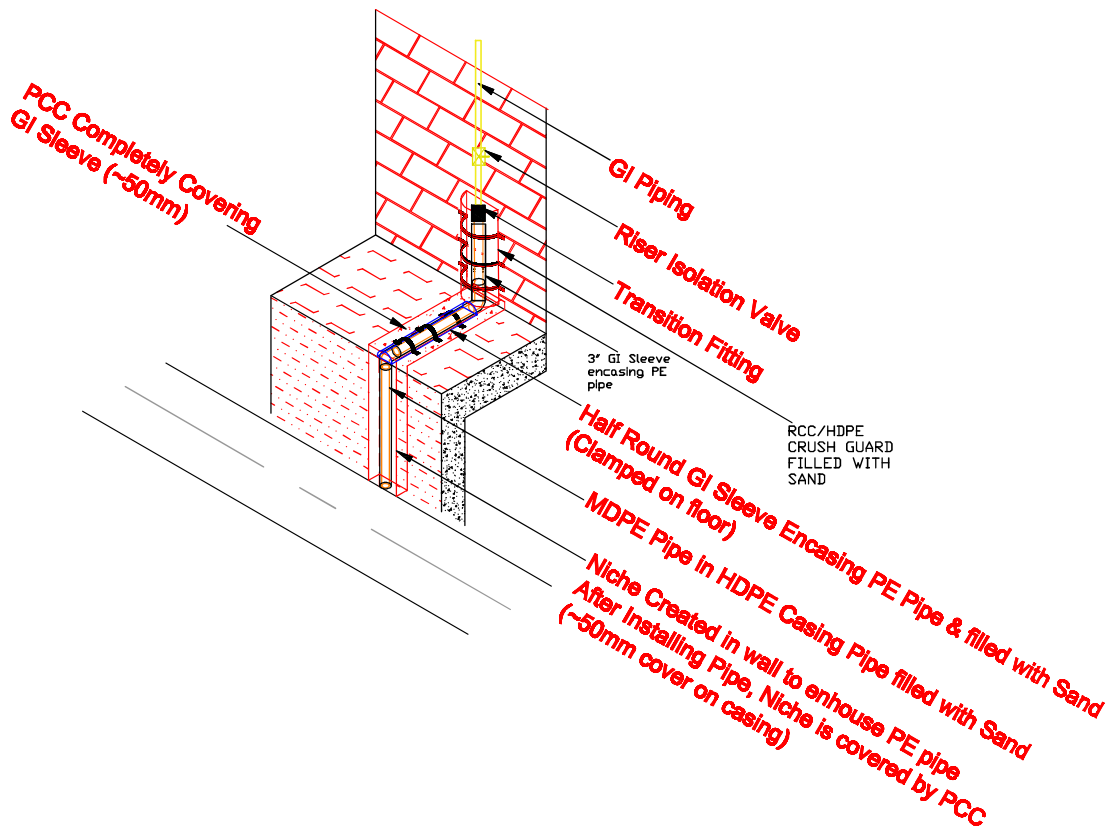


NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SPECIFIED.
2. CONCRETE SHALL BE CONFIRM TO IS:456.
3. Φ DENOTED HIGH YIELD DEFORMED BARS OF GRADE Fe415 (MIN.) CONFIRMING TO IS:1786, UNLESS OTHERWISE SPECIFIED,
4. JOINT SEALING COMPOUND IN PAVING AND AROUND EQUIPMENT FOUNDATIONS SHALL CONFIRM TO IS:1834 TYPE-B.
5. EXPANSION AND SEALING JOINT FILLER MATERIAL SHALL BE FILLERS OF BITUMEN PREFORMED FIBRES IMPREGNATED FIBRE, CONFIRMING TO IS:1838, PART-1.
6. CONCRETE PAVING SHALL BE SLOPED STEEPEST TO 1:100 UNLESS OTHERWISE SHOWN IN DETAIL ENGINEERING DRAWING, SLOPE OF THE SUB GRADE SHALL BE PREPARED TO MATCH WITH SLOPE OF PAVEMENT,
7. SUB GRADE BELOW PAVEMENT SHALL BE THOROUGHLY COMPACTED TO 95% OF LAB DRY DENSITY AS PER IS:2720, PART VIII.
8. CAST IN-SITU CONCRETE FOR PAVEMENT SHALL BE LAID IN ALTERNATE PANELS OF SIZES AS DEFINED IN THIS STANDARD DRAWING HOWEVER, THE PANEL SIZE SHALL BE ADJUSTED AROUND COLUMNS & FOUNDATION
9. EXPANSION JOINTS SHALL BE SPACED AT 14.0M (MAX.) FOR TYPE-I PAVEMENT & 13M C/C (MAX.) FOR TYPE-II PAVEMENTS,
10. EXPANSION JOINTS SHALL BE SPACED AT 15 M C/C & CONSTRUCTION JOINS SHALL BE SPACED AT 7.5M C/C (MAXIMUM) FOR TYPE-III PAVEMENTS,
11. THIS STANDARD NOT VALID FOR CAUSTIC HANDLING AREAS.
12. LIMITATION OF SINGLE AXLE LOAD ON RCC PAVEMENT:
FOR TYPE-I PAVEMENT : MAX, UPTO 12.0 TONNE
FOR TYPE-II PAVEMENT : MAX, UPTO 6.0 TONNE
(FOR SMALL VEHICLES LIKE FORK LIFT)
13. CONSTRUCTION JOINTS MAY BE PROVIDED IN CASE PANEL SIZE IS LESS THAN THE REQUIREMENT OF EXPANSION SUIT SITE REQUIREMENTS,
14. FOR PIPE SUPPORT DETAILS COMING IN THICKENED PAVEMENT AREA REFER RELEVANT PIPING GAD / PIPING STANDARDS,

FOR PAVEMENT DETAILS

GEOTECHNICAL RECOMMENDATION SHALL BE FOLLOWED FOR SUBGRADE TREATMENT FOR PAVEMENTS IN BLACK COTTON SOIL AREAS/ JOB SPECIFIC REQUIREMENT



Note:

1. Concealing of GI Pipe Should not be Done
2. MDPE pipe in Niche should be covered by atleast 50mm PCC
3. All Hollow spaces should be filled by fine sand (compact)
4. Clamping of GI sleeve should be firm. Suitable no. of clamps to be provided.

Indian Oil Corporation Limited

Veranda Crossing for PNG
(D) Connection

1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. RUNNING TEXT AND MARKER SIZES ARE INDICATIVE AND ARE SUBJECT TO THE APPROVAL BY OWNER (CONTRACT REPRESENTATIVE) BEFORE FABRICATION.
3. SCHEME FOR POWDER COATING AND COLORING: ONE COAT OF PRIMER + TWO COATS OF SPECIFIED PAINTS. ALL LETTERS EXCEPT NUMBERS TO BE PAINTED BLACK.
4. APPROVAL OF MARKING MARKER DESIGN SHALL BE OBTAINED BEFORE THE COMMENCEMENT OF WORK.

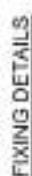
1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. WARNING TEXT AND MARKER SIZES ARE INDICATIVE AND ARE SUBJECT TO THE APPROVAL BY OWNER / OWNER'S REPRESENTATIVE BEFORE FABRICATION.

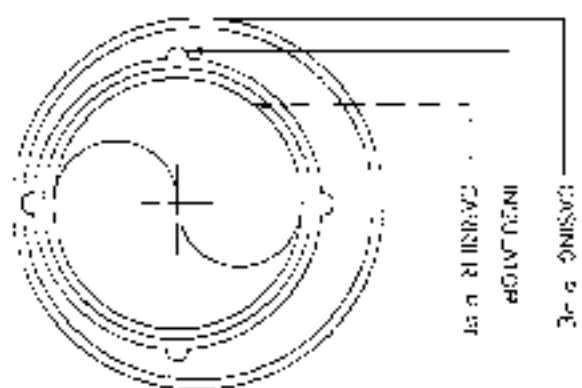
3. SCHEME FOR POWDER COATING AND COLORING: ONE COAT OF PRIMER & TWO COATS OF SPECIFIED PAINTS. ALL LETTERS EXCEPT 'BURNING' TO BE PAINTED BLACK.

4. APPROVAL OF TURNING MARKER DESIGN SHALL BE OBTAINED BEFORE THE COMMENCEMENT OF WORK.

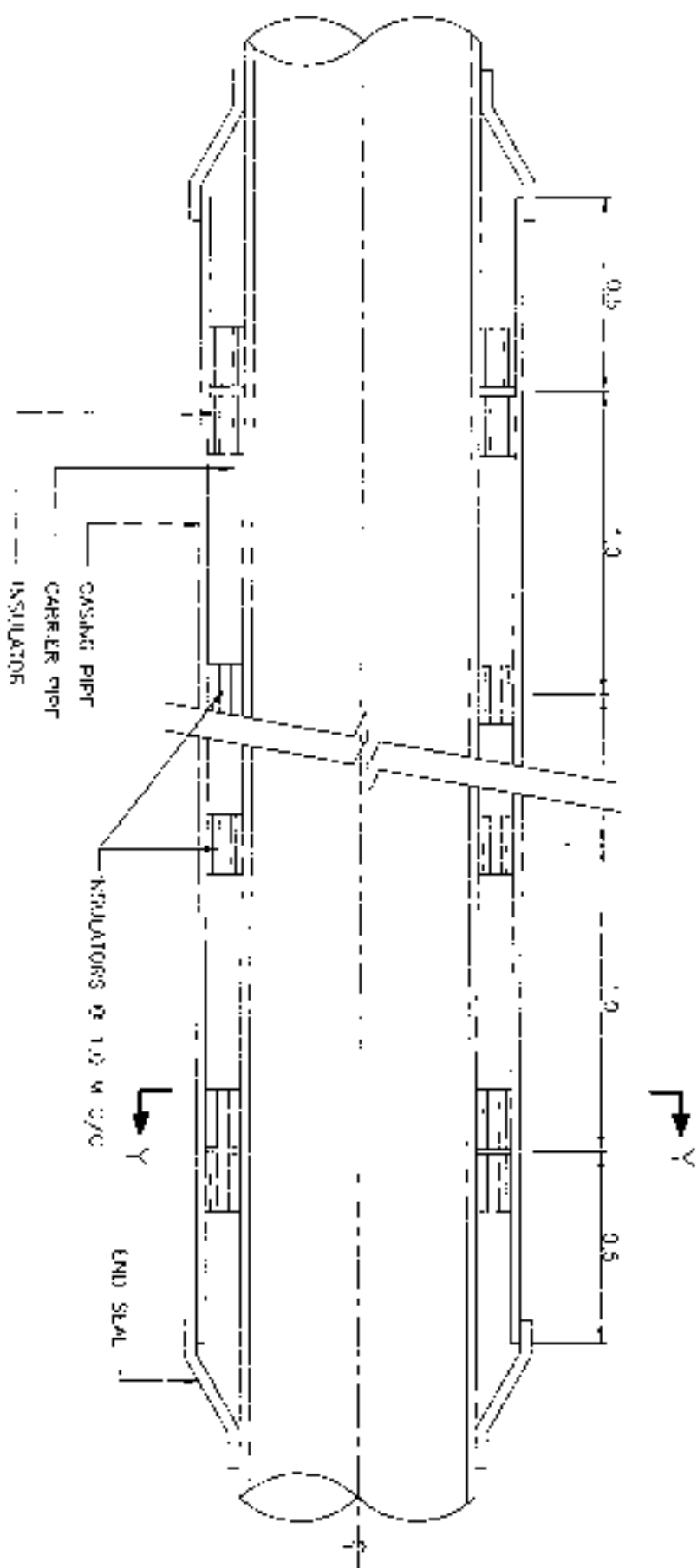
PROJECT: LAYING OF 3 LIFE COATED CARBON STEEL PIPELINES

TITLE: POLE MARKER WITH FOUNDATION





SECTION Y-Y



CASING PIPE DETAILS

NOTES:-

1. ALL DIMENSIONS UNLESS OTHERWISE SPECIFIED ARE IN METRES
2. CARRIER PIPE WITHIN CASING SHALL BE COATED WITH ANTI CORROSION COATING (3 LAYER POLYETHYLENE 3.0% COATING)
3. THE FIRST & LAST INSULATORS (DOUBLE SEAL) SHOULD BE PLACED AT A DISTANCE OF 0.5M (MAX) FROM CASING ENDS.
4. THE SPACING OF INTERMEDIATE INSULATORS SHALL BE 1.0 M C/C (MAX)
5. CASING PIPE TO BE PAINTED WITH TWO COATS OF ANTI CORROSION EPOXY PAINT OVER A COAT OF PRIMER PRIOR TO INSTALLATION INSIDE RICH.
6. THE SIZE OF CASING PIPE SHALL BE AS FOLLOWS:

CARRIER PIPE	RAILWAY	1-3-1WAY
5.0 < 7.75	3 PIPE SIZE HIGHER THAN OR HIGHER THAN C/C OF CARRIER PIPE IF CARRIER PIPE	2 PIPE SIZE HIGHER THAN C/C OF CARRIER PIPE
0.75 > 12.75	3 PIPE SIZE HIGHER THAN C/C OF CARRIER PIPE	3 PIPE SIZE HIGHER THAN C/C OF CARRIER PIPE

7. THICKNESS OF CASING PIPE SHALL BE AS PER IS 1102

CASING DETAILS SHOWING:	SID/MIL/EXT/7710
INSULATOR	
S.N.C.	C/D REFERENCE DRAWING
	DWG NO.

PURPOSE	APPROVED FOR CONSTRUCTION
---------	---------------------------

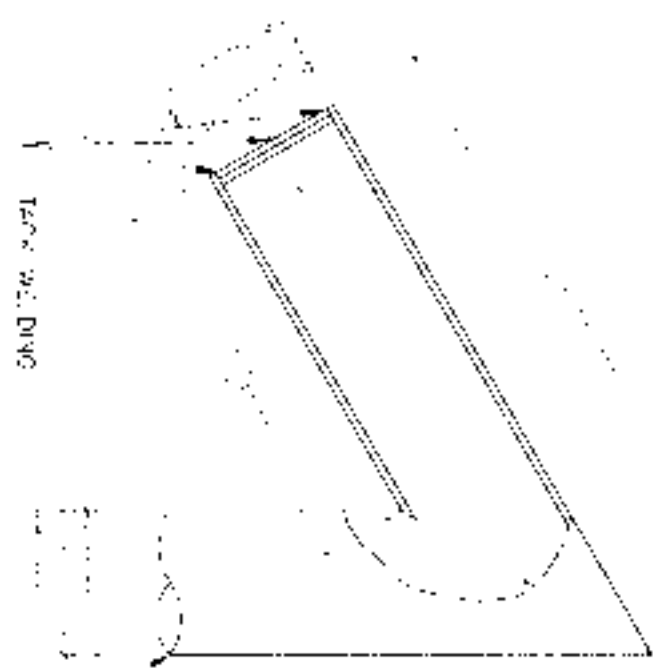
DESIGNING	IN CHARGE	DATE
CHECKED	BY	DATE
APPROVED	BY	DATE

भारतीय तेल कॉर्पोरेशन लिमिटेड - पाइपलाइन्स
INDIAN OIL CORPORATION LIMITED (PIPELINES)

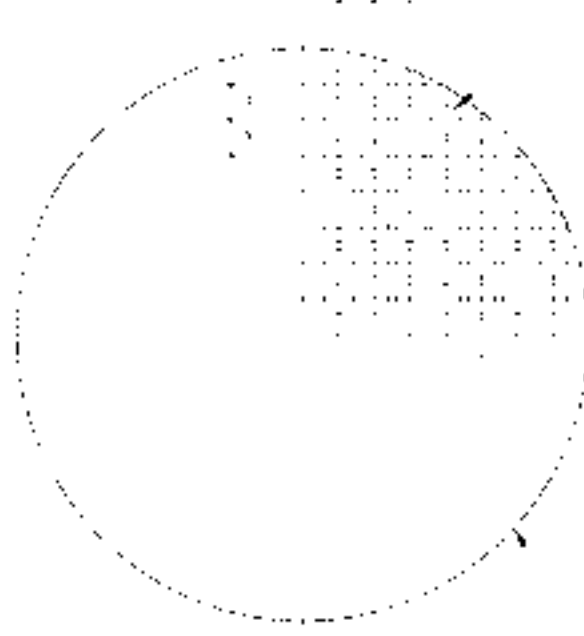
STANDARD MAINLINE DRAWING

CASING PIPE DETAILS SHOWING INSULATORS

CAD DWT NO.	DWG NO.	SCALE	SHEET
INDO-100010200-09200-001	560-00	AS	1 OF 1



Case - CLE

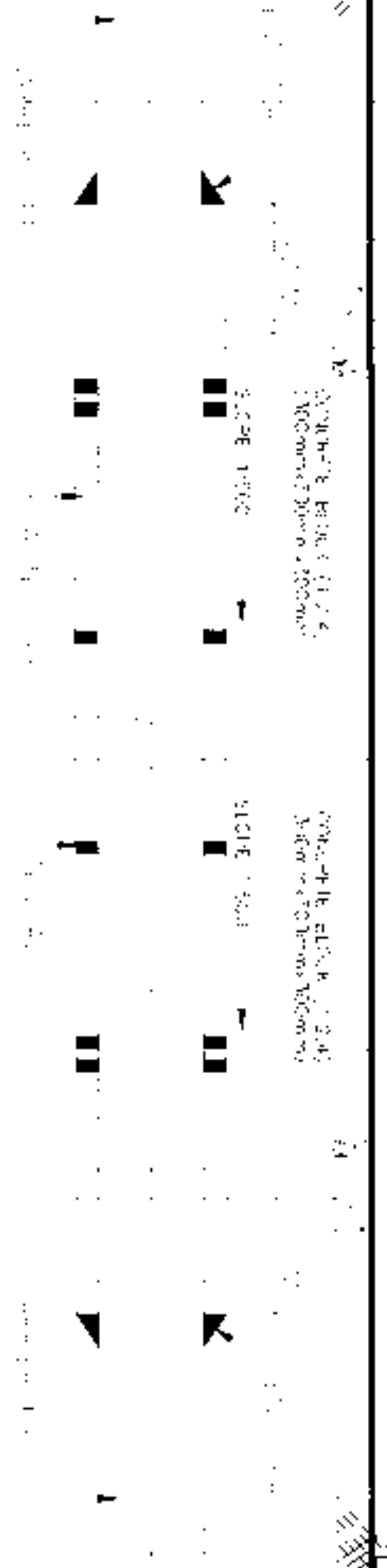


Filter Detail

VENT END DETAILS

FILTER DETAILS

TYPICAL CASED CROSSING



NOTES:
1. All dimensions are in feet and inches.

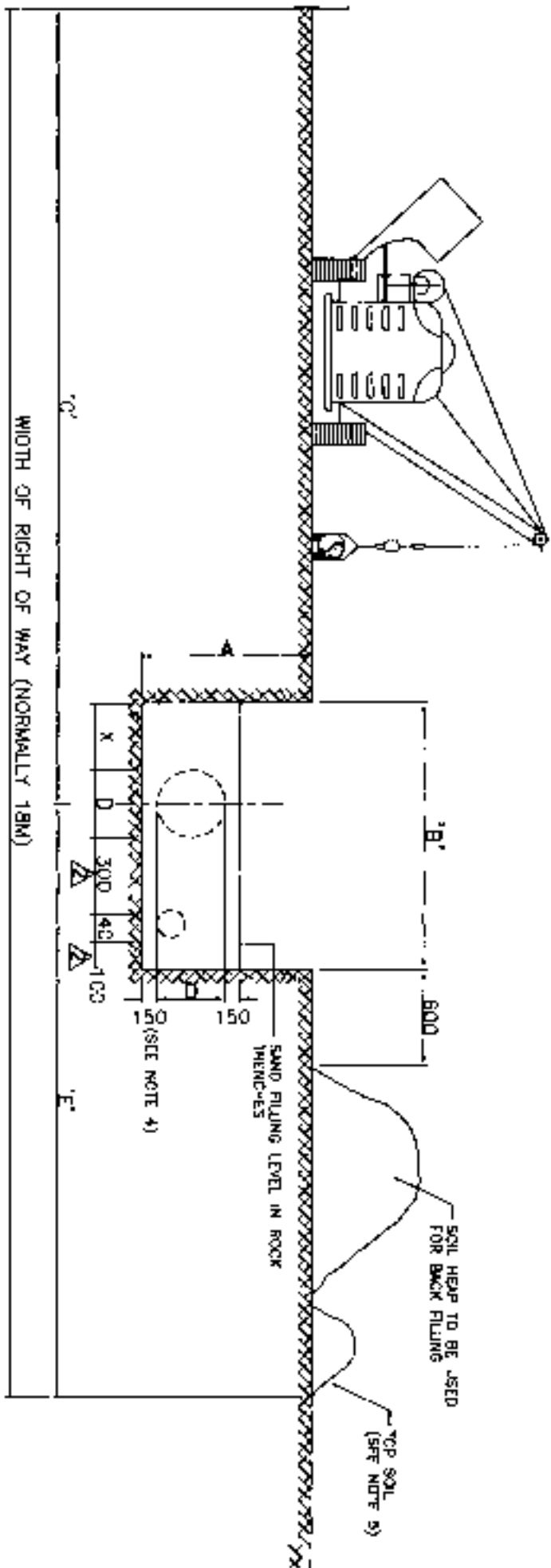
NO.	DESCRIPTION	DATE
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2	REVISION	10/10/10
3	REVISION	10/10/10
4	REVISION	10/10/10
5	REVISION	10/10/10
6	REVISION	10/10/10
7	REVISION	10/10/10
8	REVISION	10/10/10
9	REVISION	10/10/10
10	REVISION	10/10/10

APPROVED FOR CONSTRUCTION

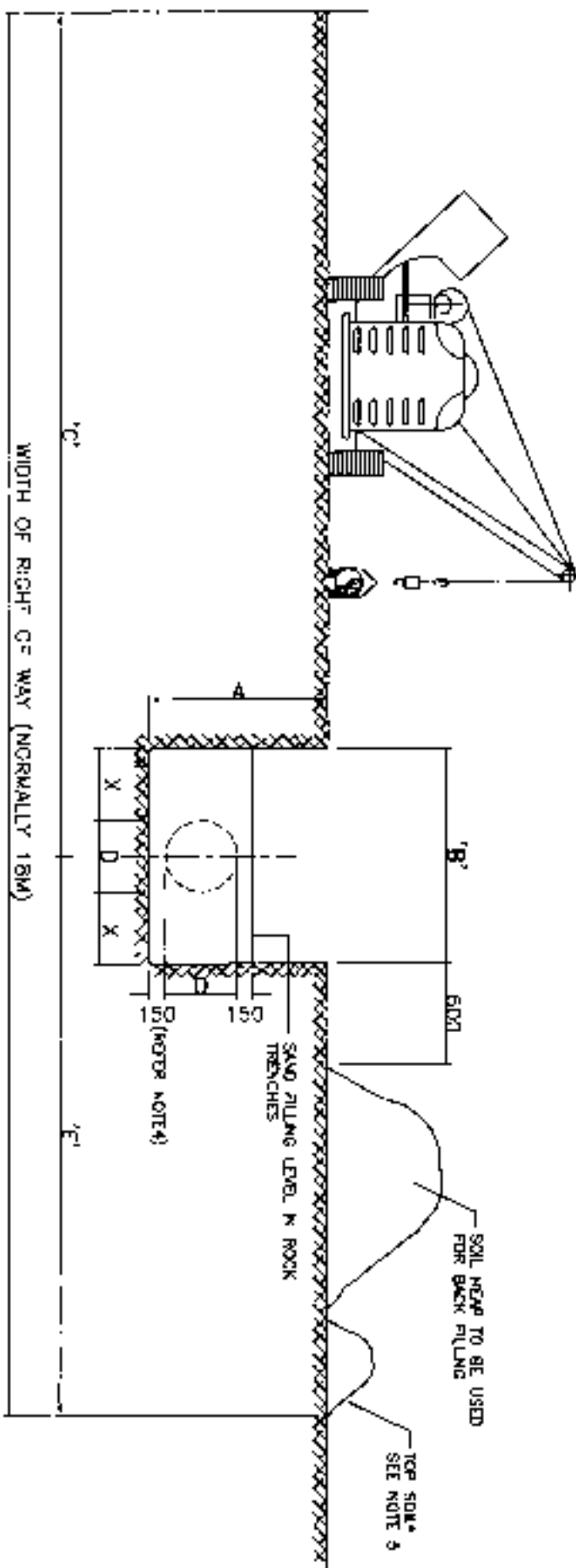
INDIAN OIL CORPORATION LIMITED (IOL)

CASING PIPE VENT END DETAILS

Scale: 1/4" = 1'-0"



STANDARD DITCH DIMENSIONS (WITH OFC)



STANDARD DITCH DIMENSIONS (WITHOUT OFC)

TABLE A

O.D. OF PIPE	DIMENSION 'A' IN NORMAL SOIL (MM)	DIMENSION 'A' IN ROCK (MM)	DIMENSION 'X' (ALL PIPELINES)	DIMENSION 'B' (ALL PIPELINES)
PRODUCT/CRUDE/NATURAL GAS PIPELINE	PRODUCT/CRUDE/NATURAL GAS PIPELINE	PRODUCT/CRUDE/NATURAL GAS PIPELINE	IN NORMAL SOIL (MM)	IN ROCK (MM)
WITHOUT OFC	D + 1200	D + 1500	200	300
WITH OFC	D + 1200	D + 1500	200	300

NOTES:-

- ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE NOTED.
- DITCH DIMENSIONS TO CONFORM TO TABLE GIVEN HEREIN.
- DIMENSION 'E' SHALL BE 5.0M IN NORMAL CASES FOR LAYING FIRST LINE IN NEW ROW, HOWEVER 'C' & 'E' WILL VARY ON CASE TO CASE BASIS TO SUIT SITE CONDITIONS AND AVAILABILITY OF WIDTH OF ROW.
- REQUIRED DEPTH OF COMPACTED SOFT SOIL OR SAND PADDING AT THE BOTTOM OF ROCK TRENCH TO BE PROVIDED BY THE CONTRACTOR BEFORE LOWERING THE PIPE.
- IN CULTIVABLE LAND AND OTHER AREAS SPECIALLY DESIGNATED BY THE OWNER, THE CONTRACTOR SHALL STRIP TOP-SOIL TO A DEPTH OF 100mm TO THE FULL ANTICIPATED WIDTH OF THE DITCH AND STORE THIS MATERIAL SEPARATELY ALONG THE ROW TO ALLOW RE-FILLING OF THIS MATERIAL ON TOP OF THE BACKFILLED DITCH.

6. IN CASE OF MOORUM, EXTRA DEPTH OF 150mm EXCAVATION SHALL BE CARRIED OUT TO ACCOMMODATE SAND PADDING AT BOTTOM OF TRENCH AS PER DECISION OF OWNER-IN-CHARGE.

S.NO.	OLD REFERENCE DRAWINGS	DWG. NO.
1.	STANDARD DITCH DIMENSIONS	STD/ML/ENR/7/15

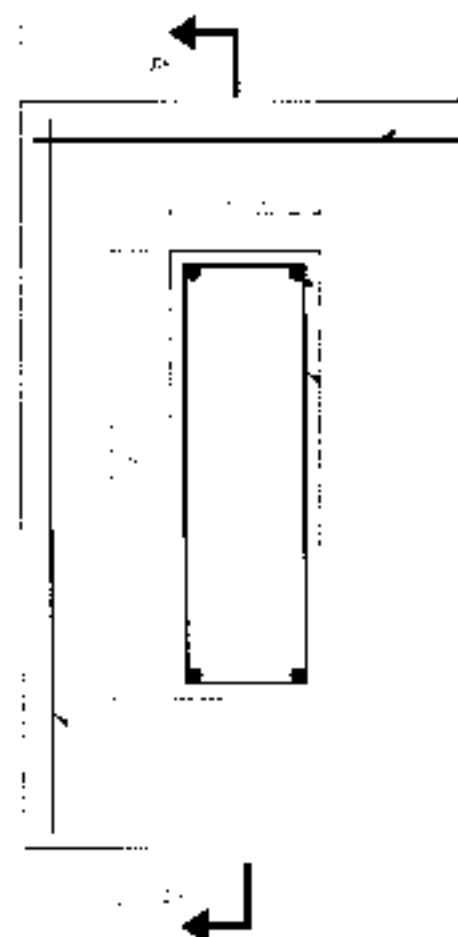
PURPOSE	APPROVED FOR CONSTRUCTION
DESIGN	DESIGNED
CHECKED	CHECKED
APPROVED	APPROVED

STANDARD MAINLINE DRAWING

STANDARD DITCH DIMENSIONS FOR MAINLINE

CAD FILE NO.	DWG. NO.	SCALE	SHEET
STD-470-05	9200-99900-401-565-05	N/A	1 OF 1

4. 100% MIN.
4.1. STIPES 100% MIN. 100% MIN.



FOUNDATION PLAN OF BOUNDARY PILLAR

31



ELEVATION OF BOUNDARY PILLAR

31



FOUNDATION PLAN
SURVEYED BY
AND SIGNED BY

NOTES:-

1. LATEST VERSIONS ARE IN USE UNLESS OTHERWISE SPECIFIED.
2. DRAWING SHALL BE IN FULLY SIGNED AND STAMPED TO BE VALID FOR CONSTRUCTION OF BOUNDARY PILLAR.

1.	STANDARD BOUNDARY PILLAR	STD/ML/EXBT/7717
2.	TO BE USED FOR CONSTRUCTION	100% MIN.

PURPOSE APPROVED FOR CONSTRUCTION

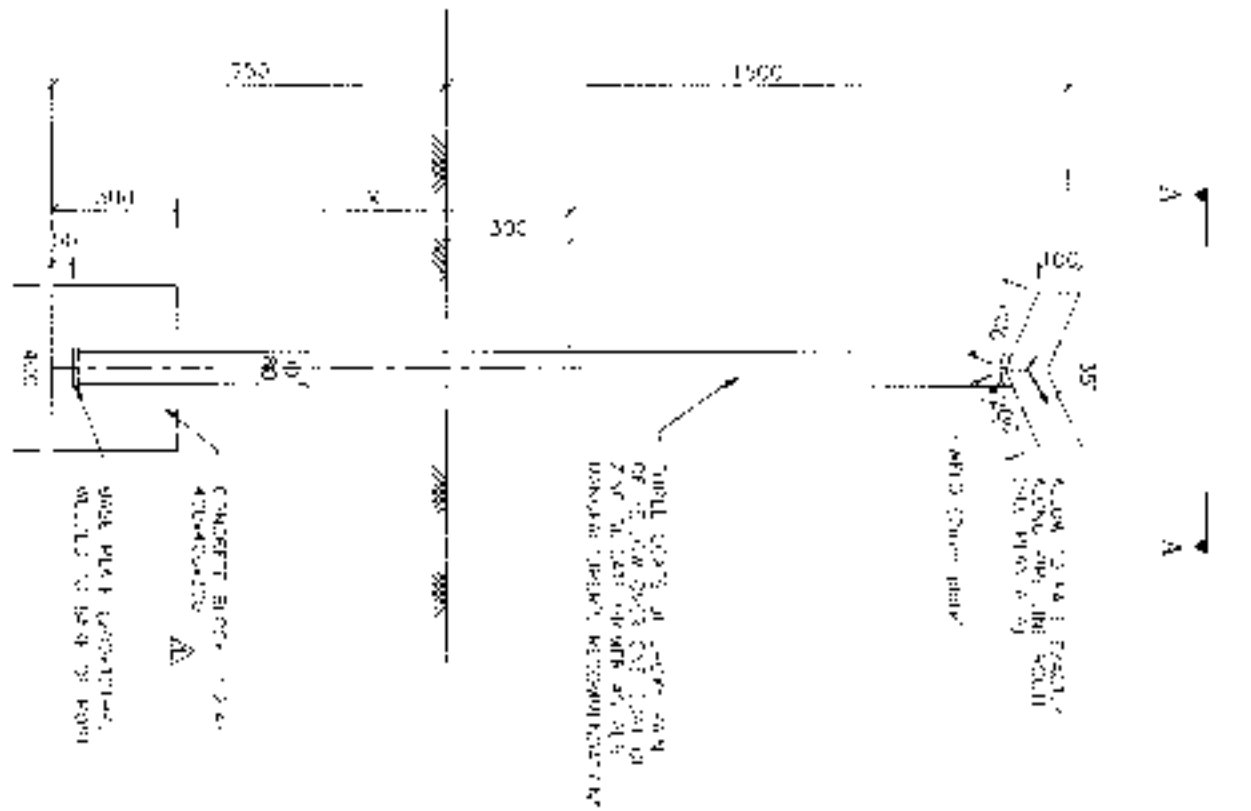
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PROJECT	10/10/2020	BY	10/10/2020
REVISION	10/10/2020	BY	10/10/2020
REVISION	10/10/2020	BY	10/10/2020
REVISION	10/10/2020	BY	10/10/2020

STANDARD BOUNDARY PILLAR

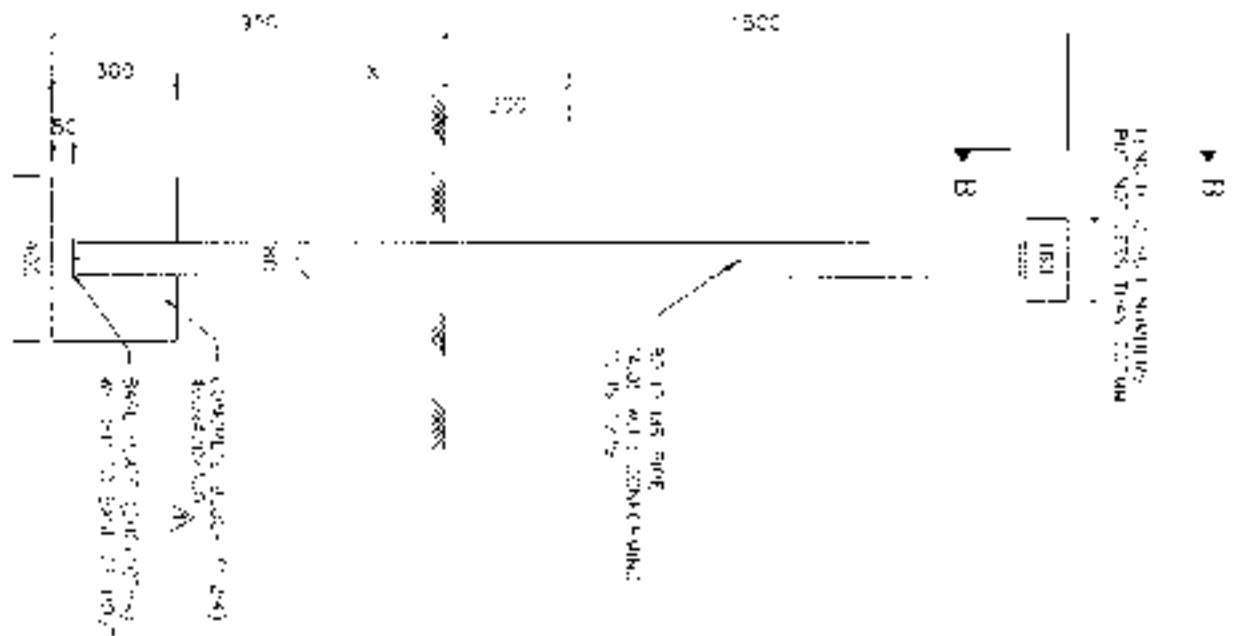
DATE	10/10/2020	BY	10/10/2020
PROJECT	10/10/2020	BY	10/10/2020
REVISION	10/10/2020	BY	10/10/2020
REVISION	10/10/2020	BY	10/10/2020
REVISION	10/10/2020	BY	10/10/2020

NOTES:-

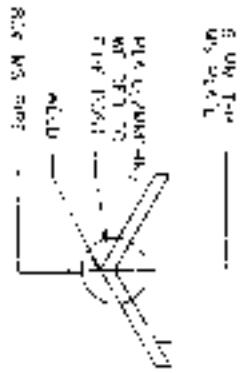
1. DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED
2. FOR CONSTRUCTION AND TACK COATS OF BLACK COAT, 200 PROTECT SHALL BE PROVIDED ON PIPE SURFACE TOP & BOTTOM MARKED 'Y'
3. ALL PAINT & POWDER SHALL BE AS PER TENDER SPECIFICATION
4. PIPELINE MARKING & COAT SHALL BE LOCATED AT 1200 MM HIGHER CENTERLINE OF MAINLINE PIPE IN VERTICAL POSITION ROAD



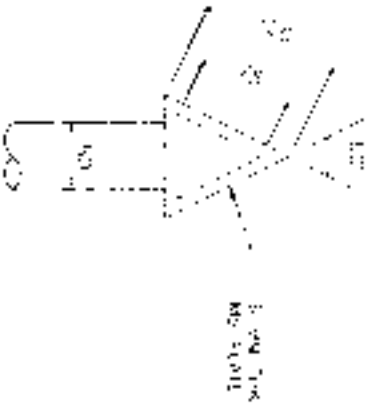
DETAIL OF PIPELINE MARKER



DETAIL OF INSTALLED K.M. POST



PLAN A-A



VIEW B-B

PURPOSE APPROVED FOR CONSTRUCTION

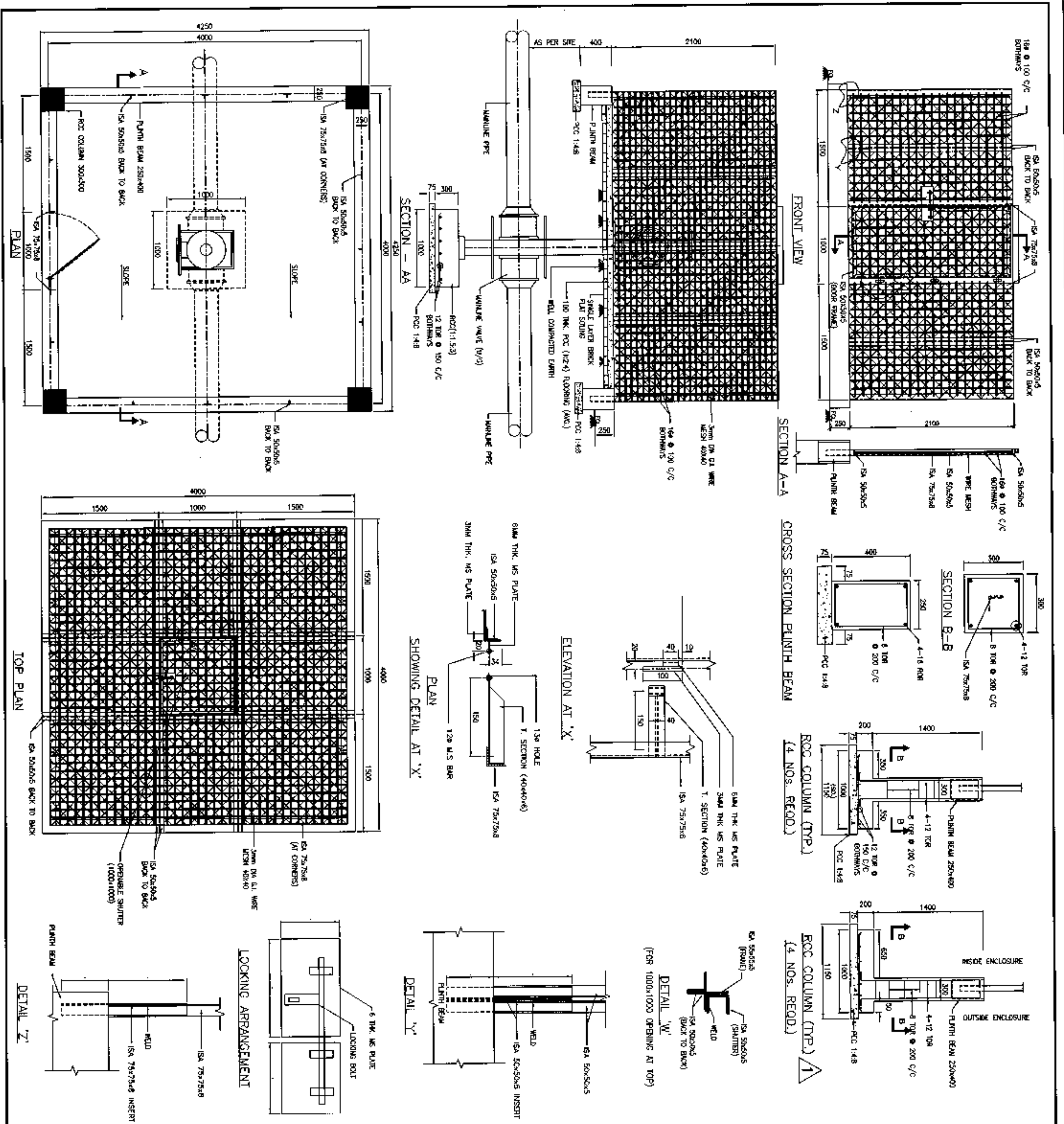
STANDARD PIPELINE MARKER	STANDARD PIPELINE MARKER
TYPE	TYPE
SIZE	SIZE
DATE	DATE

REVISION	DATE	BY	REVISION
1	10/10/2018	10/10/2018	10/10/2018
2	10/10/2018	10/10/2018	10/10/2018
3	10/10/2018	10/10/2018	10/10/2018

INDIAN OIL CORPORATION LIMITED (PIPELINES)

STANDARD PIPELINE MARKER

Sheet No.	Dwg. No.	Scale	Size	Sheet
10/10/2018	10/10/2018	10/10/2018	10/10/2018	10/10/2018



NOTES:-									
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE MENTIONED.									
2. CONC. MIX USED SHALL BE AS FOLLOWS:-									
i) STRUCTURAL CONC. - 1:1.5:3 NOMINAL MIX WITH 20 MM DN. AGG.									
ii) PCC - 1:2:4 NOMINAL MIX WITH 20 MM DN. AGG.									
iii) LEAN CONC. - 1:4:8 NOMINAL MIX WITH 40 MM DN. AGG.									
3. REINFORCING BARS USED SHALL BE TMT AND CONFORM TO IS-1786 (Fe 415).									
4. ALL JUNCTIONS OF BARS SHALL BE TIED PROPERLY WITH 18 SWG WIRES.									
5. CLEAR COVER TO MAIN REINFORCEMENT SHALL BE AS FOLLOWS:									
i) COLUMN :- 40 MM									
ii) BEAM :- 40 MM									
iii) FOUNDATION :- 50 MM									
6. COVER BLOCKS M.S. CHAIRS SHALL BE PROVIDED TO KEEP THE BARS IN POSITION.									
7. ALL HOOKS, BENDS, JUGGLING, CURTAILMENT ETC SHALL BE AS PER I.S.-456 & OTHER APPLICABLE CODES.									
- BOTTOM REINFORCEMENT OF BEAMS SHALL NOT BE SPLICED AT MID SPAN.									
- TOP REINFORCEMENT OF BEAMS SHALL NOT BE SPLICED NEAR SUPPORTS.									
- COLUMN REINFORCEMENT SHALL NOT BE SPLICED AT JOINTS.									
- REINFORCEMENT BARS AT JUNCTIONS SHALL BE SUITABLY ANCHORED IN CONNECTING MEMBER.									
8. FOR BEAMS/ COLUMNS LAP LENGTH SHALL BE MIN. 57 TIMES THE HIGHER DIA OF LAPPING BARS UNLESS STATED									
9. ALL WELDS SHALL CONFORM TO IS - 816.									
10. ALL STRUCTURAL STEEL & PLATES SECTIONS SHALL CONFORM TO I.S. - 2062 SPECIFICATIONS.									
11. ALL STRUCTURAL STEEL SHALL BE PAINTED WITH 2 COATS OF EPOXY PAINT OVER A COAT OF PRIMER AS PER MANUFACTURER'S RECOMMENDATION & DIRECTIONS OF EIC.									
12. UNDER GROUND PORTION OF VALVE SHALL BE BITUMEN FLOOD COATED.									
13. DIRECTION OF SLOPE OF FLOORING SHALL BE AS PER SITE CONDITIONS.									
14. THIS DRAWING SHALL BE USED WHERE SPACE CONSTRAINED FOR ENCLOSURE COLUMNS. OTHER WISE UNREVERSED DRAWING VIDE CAD REF NO. STD-475 (9200-99900-401-570-01) SHALL BE USED.									

S.NO.	REFERENCE DRAWING	DWG. NO.

PURPOSE		APPROVED FOR CONSTRUCTION	

REVISION	DATE	BY	CHKD	DESIGNED	CHECKED	APPROVED	SUBJECT OF REVISION
01	20/11/17	UCC	UCC	UCC	UCC	UCC	REMOVED AS MARKED (ECCENTRIC FOOTING PROVIDED WHERE SPACE CONSTRAINED)
02	23/10/20	PM	SR	SR	SR	SR	APPROVED

STANDARD MAINLINE DRAWING			
CAD FILE NO.	DWG. NO.	SCALE	SHEET
STD-475-01	9200-99900-401-570-01	NIS	A2 1 OF 1

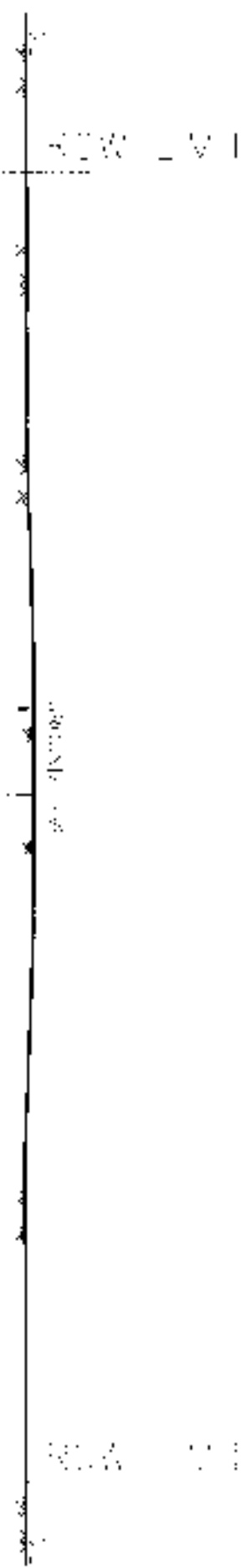
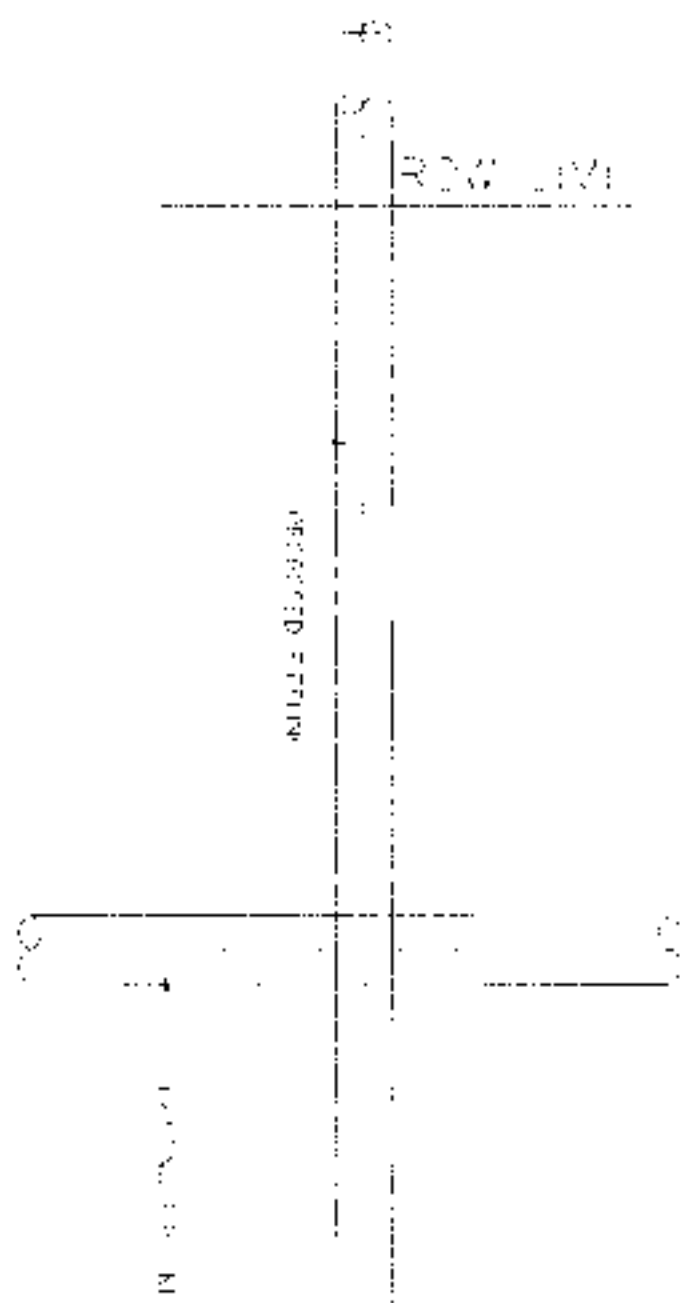


Fig. 21. Proposed Pipeline



ALL MEASUREMENTS ARE IN METERS
 1. DISTANCE FROM ROAD TO PIPELINE
 2. DISTANCE FROM PIPELINE TO ROAD
 3. DISTANCE FROM PIPELINE TO ROAD
 4. DISTANCE FROM PIPELINE TO ROAD

1. DISTANCE FROM ROAD TO PIPELINE
 2. DISTANCE FROM PIPELINE TO ROAD
 3. DISTANCE FROM PIPELINE TO ROAD
 4. DISTANCE FROM PIPELINE TO ROAD

NO.	DESCRIPTION	DATE
1	PROPOSED PIPELINE	20/10/2020
2	PROPOSED PIPELINE	20/10/2020
3	PROPOSED PIPELINE	20/10/2020
4	PROPOSED PIPELINE	20/10/2020

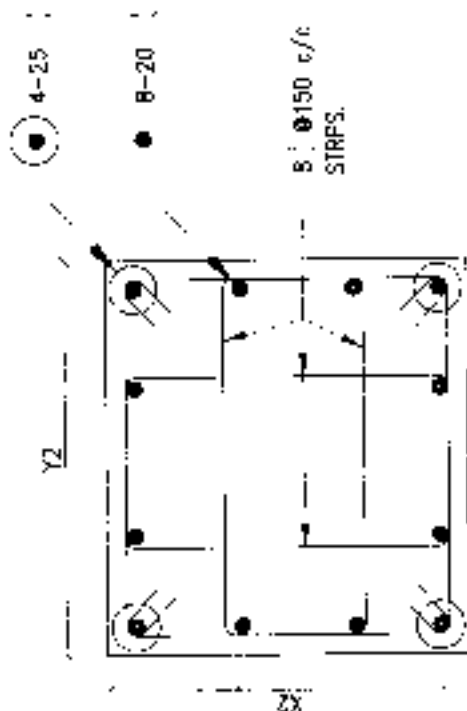
PROPOSED PIPELINE CROSSING

INDIAN OIL CORPORATION LIMITED (IOCL)
 STANDARD PIPELINE CROSSING
 BELOW EXISTING PIPELINE

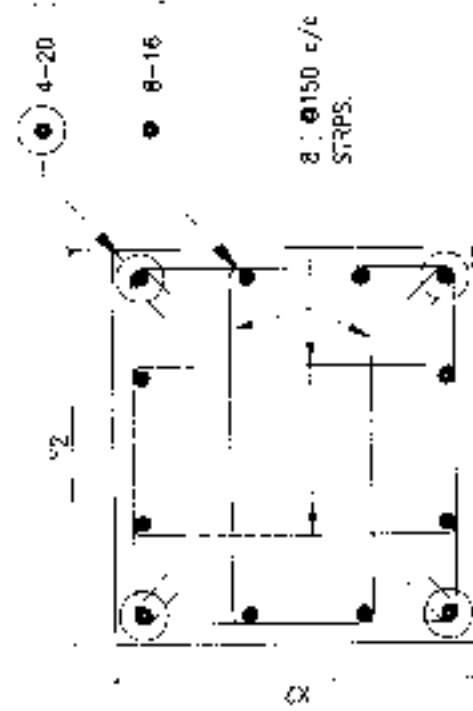
NO.	DESCRIPTION	DATE
1	PROPOSED PIPELINE	20/10/2020
2	PROPOSED PIPELINE	20/10/2020
3	PROPOSED PIPELINE	20/10/2020
4	PROPOSED PIPELINE	20/10/2020

NOTES

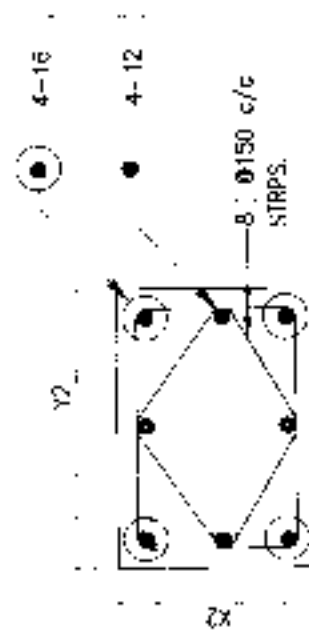
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE MENTIONED.
2. CONC. MIX USED SHALL BE AS PER IS-455.
3. STRUCTURAL CONC. - 1:1.5:3 NOMINAL MIX WITH 20 MM DIA. AGG.
4. LEAN CONC. - 1:4:6 NOMINAL MIX WITH 40 MM DIA. AGG.
5. REINFORCING BAR SHALL BE TMT (Fe-415) 500/AS PER IS:5950 CONFORMING TO 1:1.5:3 & OTHER APPLICABLE CODES (LATEST).
6. CLEAR COVER TO MAIN REINFORCEMENT SHALL BE AS FOLLOWS:
 - a) PIER: 40
 - b) FOOTING: 50
7. ALL HOOKS/BENDES/USELESS CANTING ETC. SHALL BE AS PER IS-456, 1953 & OTHER APPLICABLE CODES (LATEST).
8. LAP LENGTH SHALL BE MAX. 30 CM. THREE TIMES THE MINOR DIA. OF BAR. BUT NOT LESS THAN 30 CM. FOR 500/Fe-415 REINFORCEMENT.
9. ALL JOINTS OF BARS SHALL BE 10% PROHIBIT WITH IN 500 MM.
10. COVER BARS AND U.S. C-450 SHALL BE PROVIDED TO KEEP THE BARS IN POSITION.
11. SHALL BE AS PER ASSEMBLY DRAWING AND WITH 4 NO. 20 C/C LOCATION & ELEVATION OF PIPE AND PIPE SUPPORT.
12. CONTRACTOR SHALL CHECK THE DRAWING BEFORE EXECUTION.
13. SOIL BEARING CAPACITY DETERMINED FOR THE DESIGN IS 10 T/SSM.
14. FGL - FINISH GRADE LEVEL.



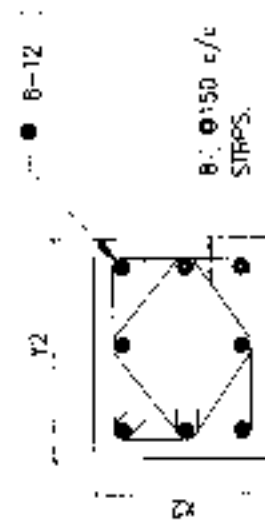
SECTION C-C
(FOR 42" & 36" DIA VALVE)



SECTION C-C
(FOR 30" & 28" DIA VALVE)



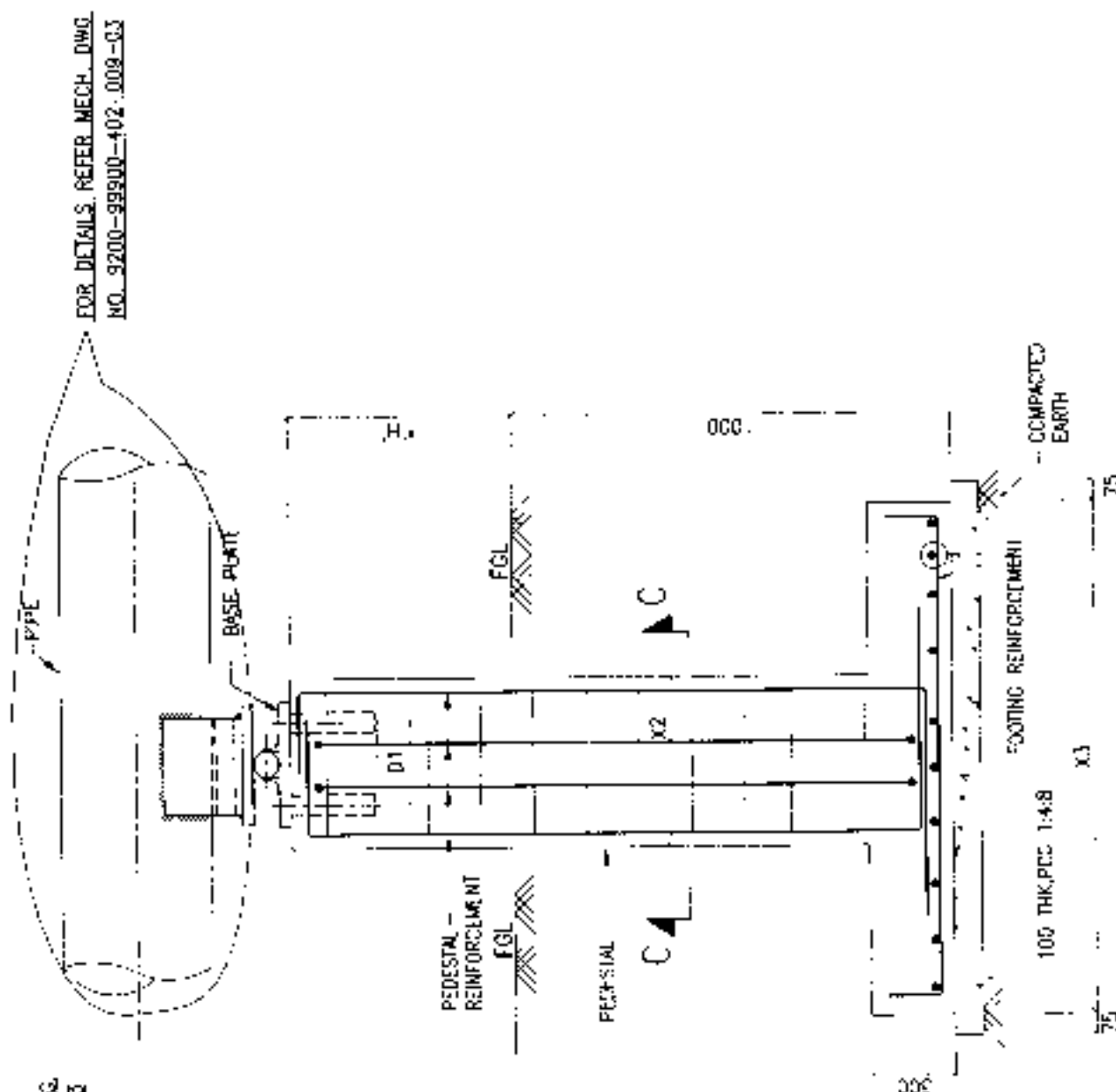
SECTION C-C
(FOR 24", 20" & 18" DIA PIPE)



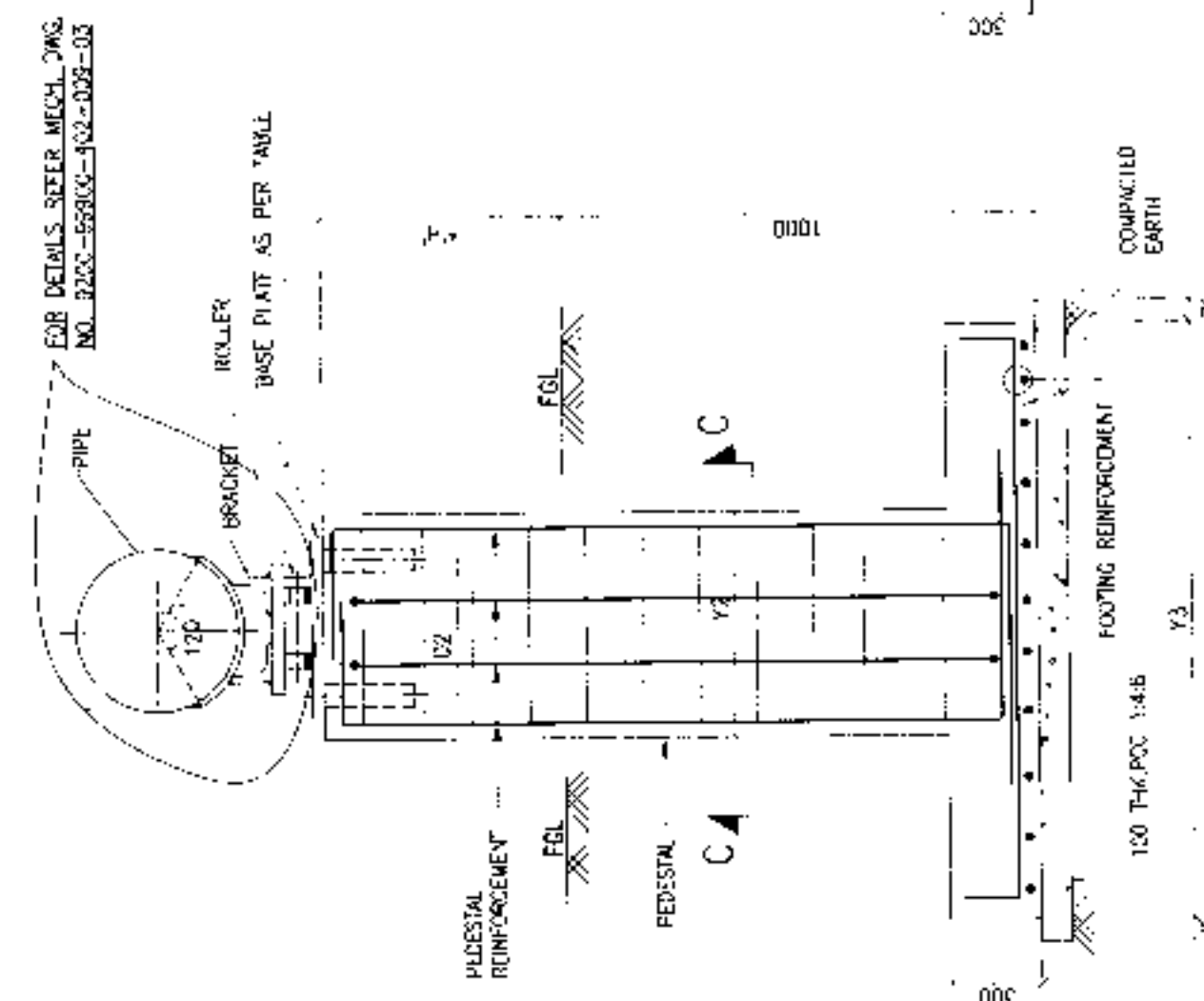
SECTION C-C
(FOR 18" & 14" DIA PIPE)



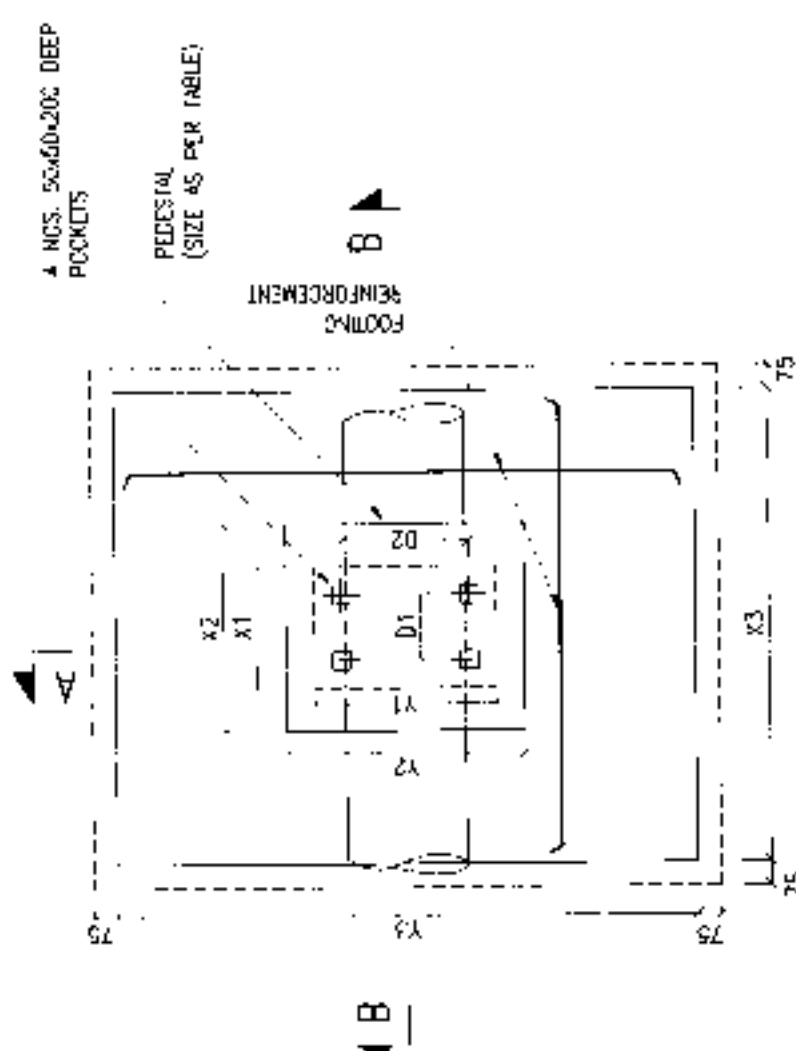
SECTION C-C
(FOR 17", 10", 8" & 6" DIA PIPE)



SECTION B-B



SECTION A-A



FOUNDATION PLAN

TABLE:-

PIPE SIZE DIA	N	BOIT HOLE LOCATION	BASE PL. SFT	PEDESTAL SIZE	FOOTING SIZE	FOOTING REINFORCEMENT (BOTHWAYS)
6"	200	D1 300, D2 300, D3 300	400	400	500	10 TOR @ 200 C/C
8"	200	D1 300, D2 300, D3 300	400	400	500	10 TOR @ 200 C/C
10"	200	D1 300, D2 300, D3 300	400	400	500	10 TOR @ 200 C/C
12"	200	D1 300, D2 300, D3 300	400	400	500	10 TOR @ 200 C/C
14"	200	D1 300, D2 300, D3 300	400	400	500	10 TOR @ 200 C/C
16"	200	D1 300, D2 300, D3 300	400	400	500	10 TOR @ 200 C/C
18"	200	D1 300, D2 300, D3 300	400	400	500	10 TOR @ 200 C/C
20"	200	D1 300, D2 300, D3 300	400	400	500	10 TOR @ 200 C/C
24"	200	D1 300, D2 300, D3 300	400	400	500	10 TOR @ 200 C/C
28"	200	D1 300, D2 300, D3 300	400	400	500	10 TOR @ 200 C/C
30"	200	D1 300, D2 300, D3 300	400	400	500	10 TOR @ 200 C/C
36"	200	D1 300, D2 300, D3 300	400	400	500	10 TOR @ 200 C/C
42"	200	D1 300, D2 300, D3 300	400	400	500	10 TOR @ 200 C/C

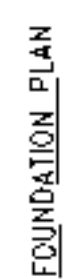
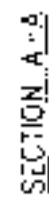
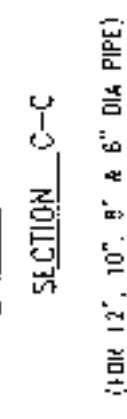
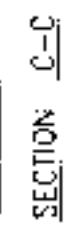
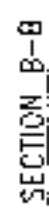
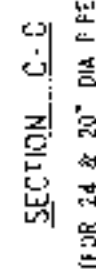
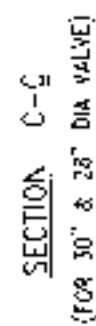
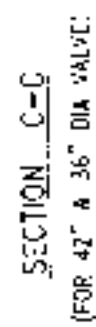
INDIAN OIL CORPORATION LIMITED (PHELINES)

STANDARD CIVIL DRAWING

TYPICAL FOUNDATION DETAILS FOR PIPE SUPPORT
(6" TO 42") WITHOUT GUIDE

STD. FILE NO. 9200-99800-403-021-00
SCALE: 1/4" = 1'-0"
DATE: 10/10/2020
DWG. NO. 9200-99800-403-021-00
N/S
AT 1 OF 2


1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE NOTED.
2. CONC. MIX. USED SHALL BE AS PER IS-465
a) STRENGTH CONC. - 15.43 MPa NOMINAL MIX WITH 20 MM
b) FILL CONC. - 14.8 MPa NOMINAL MIX WITH 40 MM AGG.
3. REINFORCING BAR USED SHALL BE IS-415/500/550/575/600/625/650/685/725/760/785/825/855/885/925/955/985/1000/1050/1100/1150/1200/1250/1300/1350/1400/1450/1500/1550/1600/1650/1700/1750/1800/1850/1900/1950/2000/2050/2100/2150/2200/2250/2300/2350/2400/2450/2500/2550/2600/2650/2700/2750/2800/2850/2900/2950/3000/3050/3100/3150/3200/3250/3300/3350/3400/3450/3500/3550/3600/3650/3700/3750/3800/3850/3900/3950/4000/4050/4100/4150/4200/4250/4300/4350/4400/4450/4500/4550/4600/4650/4700/4750/4800/4850/4900/4950/5000/5050/5100/5150/5200/5250/5300/5350/5400/5450/5500/5550/5600/5650/5700/5750/5800/5850/5900/5950/6000/6050/6100/6150/6200/6250/6300/6350/6400/6450/6500/6550/6600/6650/6700/6750/6800/6850/6900/6950/7000/7050/7100/7150/7200/7250/7300/7350/7400/7450/7500/7550/7600/7650/7700/7750/7800/7850/7900/7950/8000/8050/8100/8150/8200/8250/8300/8350/8400/8450/8500/8550/8600/8650/8700/8750/8800/8850/8900/8950/9000/9050/9100/9150/9200/9250/9300/9350/9400/9450/9500/9550/9600/9650/9700/9750/9800/9850/9900/9950/10000/10050/10100/10150/10200/10250/10300/10350/10400/10450/10500/10550/10600/10650/10700/10750/10800/10850/10900/10950/11000/11050/11100/11150/11200/11250/11300/11350/11400/11450/11500/11550/11600/11650/11700/11750/11800/11850/11900/11950/12000/12050/12100/12150/12200/12250/12300/12350/12400/12450/12500/12550/12600/12650/12700/12750/12800/12850/12900/12950/13000/13050/13100/13150/13200/13250/13300/13350/13400/13450/13500/13550/13600/13650/13700/13750/13800/13850/13900/13950/14000/14050/14100/14150/14200/14250/14300/14350/14400/14450/14500/14550/14600/14650/14700/14750/14800/14850/14900/14950/15000/15050/15100/15150/15200/15250/15300/15350/15400/15450/15500/15550/15600/15650/15700/15750/15800/15850/15900/15950/16000/16050/16100/16150/16200/16250/16300/16350/16400/16450/16500/16550/16600/16650/16700/16750/16800/16850/16900/16950/17000/17050/17100/17150/17200/17250/17300/17350/17400/17450/17500/17550/17600/17650/17700/17750/17800/17850/17900/17950/18000/18050/18100/18150/18200/18250/18300/18350/18400/18450/18500/18550/18600/18650/18700/18750/18800/18850/18900/18950/19000/19050/19100/19150/19200/19250/19300/19350/19400/19450/19500/19550/19600/19650/19700/19750/19800/19850/19900/19950/20000/20050/20100/20150/20200/20250/20300/20350/20400/20450/20500/20550/20600/20650/20700/20750/20800/20850/20900/20950/21000/21050/21100/21150/21200/21250/21300/21350/21400/21450/21500/21550/21600/21650/21700/21750/21800/21850/21900/21950/22000/22050/22100/22150/22200/22250/22300/22350/22400/22450/22500/22550/22600/22650/22700/22750/22800/22850/22900/22950/23000/23050/23100/23150/23200/23250/23300/23350/23400/23450/23500/23550/23600/23650/23700/23750/23800/23850/23900/23950/24000/24050/24100/24150/24200/24250/24300/24350/24400/24450/24500/24550/24600/24650/24700/24750/24800/24850/24900/24950/25000/25050/25100/25150/25200/25250/25300/25350/25400/25450/25500/25550/25600/25650/25700/25750/25800/25850/25900/25950/26000/26050/26100/26150/26200/26250/26300/26350/26400/26450/26500/26550/26600/26650/26700/26750/26800/26850/26900/26950/27000/27050/27100/27150/27200/27250/27300/27350/27400/27450/27500/27550/27600/27650/27700/27750/27800/27850/27900/27950/28000/28050/28100/28150/28200/28250/28300/28350/28400/28450/28500/28550/28600/28650/28700/28750/28800/28850/28900/28950/29000/29050/29100/29150/29200/29250/29300/29350/29400/29450/29500/29550/29600/29650/29700/29750/29800/29850/29900/29950/30000/30050/30100/30150/30200/30250/30300/30350/30400/30450/30500/30550/30600/30650/30700/30750/30800/30850/30900/30950/31000/31050/31100/31150/31200/31250/31300/31350/31400/31450/31500/31550/31600/31650/31700/31750/31800/31850/31900/31950/32000/32050/32100/32150/32200/32250/32300/32350/32400/32450/32500/32550/32600/32650/32700/32750/32800/32850/32900/32950/33000/33050/33100/33150/33200/33250/33300/33350/33400/33450/33500/33550/33600/33650/33700/33750/33800/33850/33900/33950/34000/34050/34100/34150/34200/34250/34300/34350/34400/34450/34500/34550/34600/34650/34700/34750/34800/34850/34900/34950/35000/350



PIPE SIZE IN DIA	BOLT HOLE LOCATION		BASE PL. SIZE		PEDESTAL SIZE			FOOTING SIZE			FOOTING REINFORCEMENT (BOTHWAYS)
	D1	D2	X1	Y1	X2	X3	Y3	X3	Y3		
6"	200	450	350	590	400	700	600	900	10 TOR @ 200 C/C		
	200	450	350	590	400	700	600	900	10 TOR @ 200 C/C		
	200	450	350	590	400	700	600	900	10 TOR @ 200 C/C		
8"	200	450	300	590	400	700	600	900	10 TOR @ 200 C/C		
	200	450	300	590	400	700	600	900	10 TOR @ 200 C/C		
	200	450	300	590	400	700	600	900	10 TOR @ 200 C/C		
12"	200	450	300	580	400	600	600	900	10 TOR @ 200 C/C		
	250	450	400	590	500	700	700	900	10 TOR @ 200 C/C		
	250	450	400	590	500	700	700	900	10 TOR @ 200 C/C		
16"	250	450	400	590	500	700	700	900	10 TOR @ 200 C/C		
	250	450	400	590	500	700	700	900	10 TOR @ 200 C/C		
	250	450	400	590	500	700	700	900	10 TOR @ 200 C/C		
24"	250	450	400	590	500	800	800	1100	1200	10 TOR @ 200 C/C	
	250	450	400	590	500	800	800	1100	1200	10 TOR @ 200 C/C	
	250	450	400	590	500	800	800	1100	1200	10 TOR @ 200 C/C	
28"	500	600	550	700	600	1000	1300	1400	12 TOR @ 150 C/C		
	500	600	550	700	600	1000	1300	1400	12 TOR @ 150 C/C		
	500	600	550	700	600	1000	1300	1400	12 TOR @ 150 C/C		
36"	550	650	700	800	700	1100	1500	1600	12 TOR @ 150 C/C		
	550	650	700	800	700	1100	1500	1600	12 TOR @ 150 C/C		
	550	650	700	800	700	1100	1500	1600	12 TOR @ 150 C/C		
42"	650	750	800	900	800	1200	1600	1700	12 TOR @ 150 C/C		
	650	750	800	900	800	1200	1600	1700	12 TOR @ 150 C/C		
	650	750	800	900	800	1200	1600	1700	12 TOR @ 150 C/C		

PURPOSE | APPROVED FOR CONSTRUCTION

[illegible]


इंडियन ऑयल कॉर्पोरेशन लिमिटेड (प्रा.ता.अ.म.)
INDIAN OIL CORPORATION LIMITED (P.O.E.L.I.S.)
 STANDARD CIVIL DRAWING

TYPICAL FOUNDATION DETAILS FOR PIPE SUPPORT
(6" TO 42") WITH GUIDE

CAD FILE NO.	DWG. NO.	SCALE	SHEET
STD-539	9200-99900-403-021-00	NTS	A1 2 OF 2

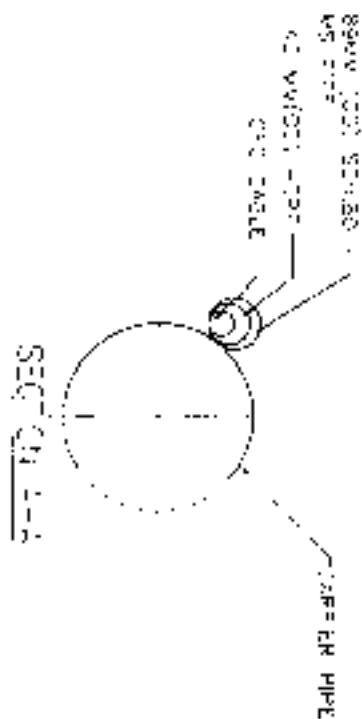
Q OF ROAD CROSSING



TYPICAL CROSS SECTION

MAIN LINE COVER

PIPELINE CATEGORY	D' (MIN) IN METRE	D' (MIN) IN METRE	X' (MIN) IN METRE
PETROLEUM PRODUCT / CRUDE PIPELINE	1.20 M	1.50 M	5.00 M
LPG / R-LNG PIPELINE	1.50 M	1.50 M	5.00 M



NOTES.

1. ALL DIMENSIONS AND MATERIALS UNLESS OTHERWISE SPECIFIED.
2. INSTALLATION OF CARRIER PIPE & CONDUIT FOR OPT SHALL BE DONE TOGETHER BY A SINGLE HORIZONTAL DIRECTIONAL DRILLING (HDD) OPERATION.
3. PIPE LINE SLOTTON INSTALLED BY HDD TECHNIQUE TO BE CUT AND HOOKED UP WITH THE MAINLINE SECTION ON BOTH SIDES OF THE CROSSING.
4. DEPTH OF MAINLINE COVER AT POINT HOOK-UP SHALL BE GRADUALLY BROUGHT TO NORMAL COVER AS PER DRAWING.
5. TRANSITION PIPE AS PER DIA SHALL BE PROVIDED WHEREVER REQUIRED.

PURPOSE TENDER

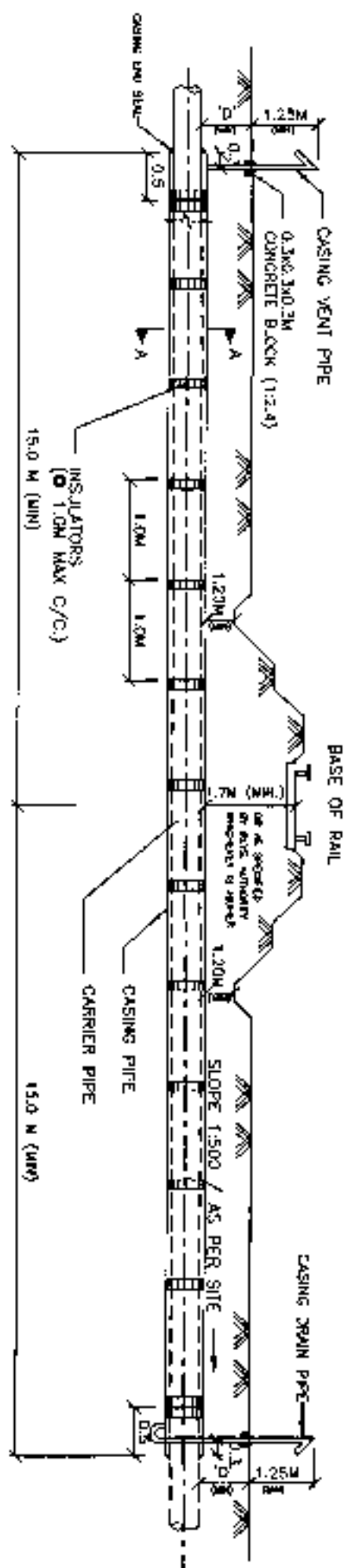
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INDIAN OIL CORPORATION LIMITED (PIPELINES)

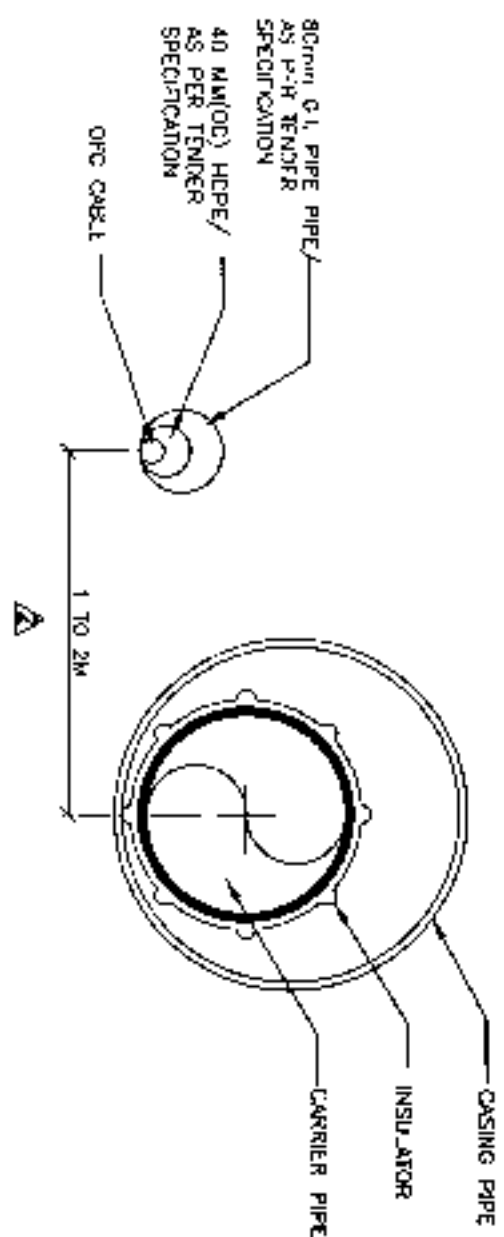
STANDARD MAINLINE DRAWING

STANDARD SHALLOW ROAD CROSSING WITH OPTICAL FIBRE CABLE

DATE FILE NO.	DATE NO.	SCALE	SHEET	SHEET
10/10/2020	10/10/2020	1:1	1	1



STANDARD CASED RAILWAY CROSSING



MAIN LINE COVER	
PIPELINE CATEGORY	TO (MM)
PETROLEUM PRODUCT / CRUDE / LPG / GAS PIPELINE	1.20 M

NOTES :

1. ALL DIMENSIONS WHEREVER NOT INDICATED ARE IN METRES
2. CARRIER PIPE WITHIN CASING SHALL BE COATED WITH ANTI CORROSION COATING (3 LAYER POLYETHYLENE 3LPE).
3. COLD FIELD BENDS (SAG/RISE) TO BE AVOIDED FOR HOOKING UP OF THE Cased Crossing Section WITH MAINLINE PIPE ON EITHER SIDE OF THE CROSSING. GRADUAL SLOPE TO BE PROVIDED TO TRENCH BOTTOM FOR WATCHING THE ALUMINUM MAINLINE PROFILE AND MAINTAINING SPECIFIED COVER.
4. CASING PIPE SHALL BE MIN. THREE MINIMUM PIPE SIZES LARGER THAN CARRIER PIPE. THICKNESS OF CASING PIPE SHALL BE AS PER LATEST RAILWAY GUIDELINES.
5. CASING PIPE SHALL EXTEND TO A DISTANCE OF 15 M BEYOND THE CENTRE LINE OF THE OUTERMOST RAILWAY TRACKS ON EITHER SIDE OF THE "BACKS OF" TO A DISTANCE OF 0.6M BEYOND THE RIGHT OR LEFT LIMITS OF RAILWAY APPROXIMATELY ON EITHER SIDE, WHICHEVER IS MORE.
6. THE FIRST & LAST INSULATORS (DOUBLE SET) SHOULD BE PLACED AT A DISTANCE OF 15M (MAX) FROM CASING ENDS.
7. APPROVED TYPE OF CASING END SEAL SHALL BE PROVIDED TAKING CARE OF PROPER SEALING OF BOTH CARRIER & HOPE PIPE AT ENTRY AND EXIT TO CASING PIPE.
8. THE BACK FILL UNDER CARRIER PIPE AT ENTRY & EXIT PIT (BORING PITS) SHALL BE PROPERLY COMPACTED AND STRENGTHENED WITH SAND BAGS TO PREVENT SETTLEMENT OF CARRIER PIPE AND DAMAGE TO INSULATORS.
9. CASING PIPE TO BE PAINTED WITH ATLEAST TWO COATS OF ANTI CORROSIONE BITUMASTING PAINT OVER A COAT OF PRIMER PRIOR TO INSERTION INSIDE BORE.
10. IN CASE OF VENT PIPE FAILING IN BORROW PIT/VALU/ DRAIN CASING PIPE TO BE SATISFACTORILY EXTENDED.
11. HOPE PIPE SHALL BE SATISFACTORILY PLACED IN THE ANNULUS BETWEEN CASING & CARRIER PIPE.

1	STANDARD CASED RAILWAY CROSSING STD/MI/EXHT/701	DATE	REVISED
2	STANDARD CASED RAILWAY CROSSING STD/MI/EXHT/701	DATE	REVISED
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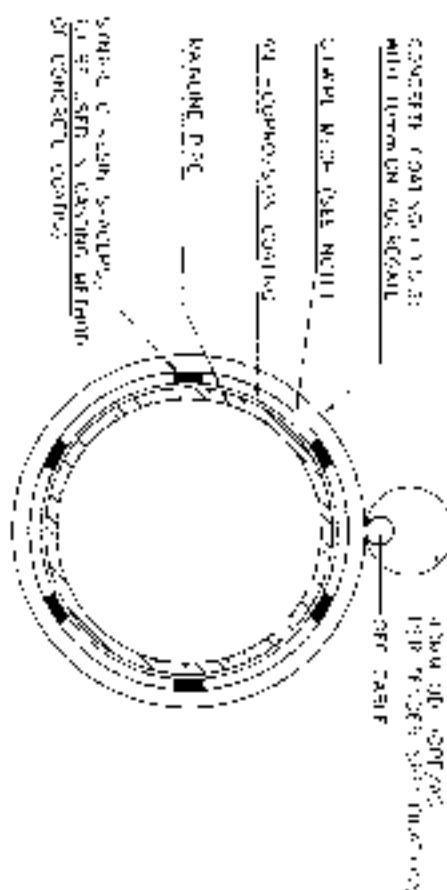
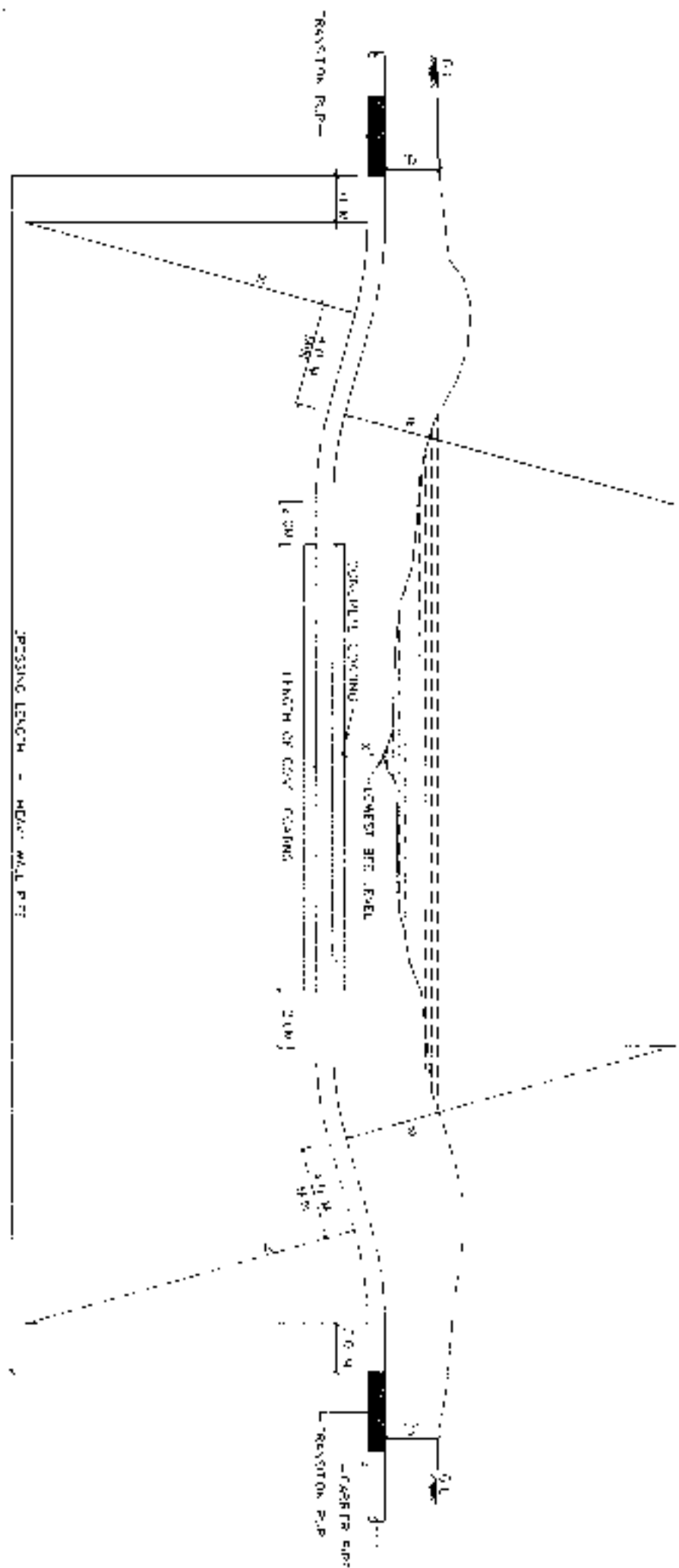
इंडियन ऑयल कॉर्पोरेशन लिमिटेड - भारतीय तेल
INDIAN OIL CORPORATION LIMITED (PUBLISHED)

STANDARD MAINLINE DRAWING

STANDARD CASED RAILWAY CROSSING WITH

OPTICAL FIBRE CABLE

STD FILE NO.	DATE	NO.	SCALE	SIZE	SHEET
STD-444-01	9200-39900-401	551-02	1/8"	43	1 OF 1



CROSS SECTION OF CONCRETE COATED PIPE

PIPELINE CATEGORY	TO MIN. IN METRE	TO MIN. IN METRE
TO MIN. IN METRE	1.00 M	2.00 M
TO MIN. IN METRE	1.00 M	2.00 M

NOTES

1. ALL LINE WORKS WITHIN 4 METRES OF THE PIPE SHALL BE DONE WITHIN 4 METRES OF THE PIPE.
2. THE VALUE OF α (RADIUS OF CURVE) SHALL NOT BE LESS THAN 400 FOR PIPE DIA 1600 AND NOT LESS THAN 100 FOR PIPE DIA 1200. (SEE NOTE 10 OF SPECIFICATION).
3. THE DEPTH OF THE RIVER SHALL BE AS PER THE SURVEY REPORT AND BUREAU RECORDS.
4. PROPER BANK PROTECTION MEASURE TO BE TAKEN AT CROSSING LOCATION AS PER SPECIFICATION/DESIGN OF LOCAL ADOPTED STRAIGHT.
5. ALL WORK SHALL BE DONE WITHIN 4 METRES OF THE PIPE.
6. THE PIPE SHALL BE LAYED AT A DEPTH OF 1.00 M BELOW THE LOWEST LEVEL OF THE RIVER.
7. THE PIPE SHALL BE LAYED AT A DEPTH OF 1.00 M BELOW THE LOWEST LEVEL OF THE RIVER.
8. THE PIPE SHALL BE LAYED AT A DEPTH OF 1.00 M BELOW THE LOWEST LEVEL OF THE RIVER.
9. THE PIPE SHALL BE LAYED AT A DEPTH OF 1.00 M BELOW THE LOWEST LEVEL OF THE RIVER.
10. THE PIPE SHALL BE LAYED AT A DEPTH OF 1.00 M BELOW THE LOWEST LEVEL OF THE RIVER.

ITEM NO.	DESCRIPTION	UNIT	QTY
1	STANDARD SUBMERGED CROSSING WITH CONCRETE COATING	SQ. M	1.00
2	CONCRETE COATING	SQ. M	1.00

REFERENCE MATERIAL FOR CONSTRUCTION

1	INDIAN OIL CORPORATION LIMITED (IOL)
2	INDIAN OIL CORPORATION LIMITED (IOL)
3	INDIAN OIL CORPORATION LIMITED (IOL)
4	INDIAN OIL CORPORATION LIMITED (IOL)
5	INDIAN OIL CORPORATION LIMITED (IOL)
6	INDIAN OIL CORPORATION LIMITED (IOL)
7	INDIAN OIL CORPORATION LIMITED (IOL)
8	INDIAN OIL CORPORATION LIMITED (IOL)
9	INDIAN OIL CORPORATION LIMITED (IOL)
10	INDIAN OIL CORPORATION LIMITED (IOL)

ITEM NO.	DESCRIPTION	UNIT	QTY
1	STANDARD SUBMERGED CROSSING WITH CONCRETE COATING & OPTICAL FIBRE CABLE	SQ. M	1.00
2	CONCRETE COATING	SQ. M	1.00
3	OPTICAL FIBRE CABLE	M	1.00

CONCLUSION

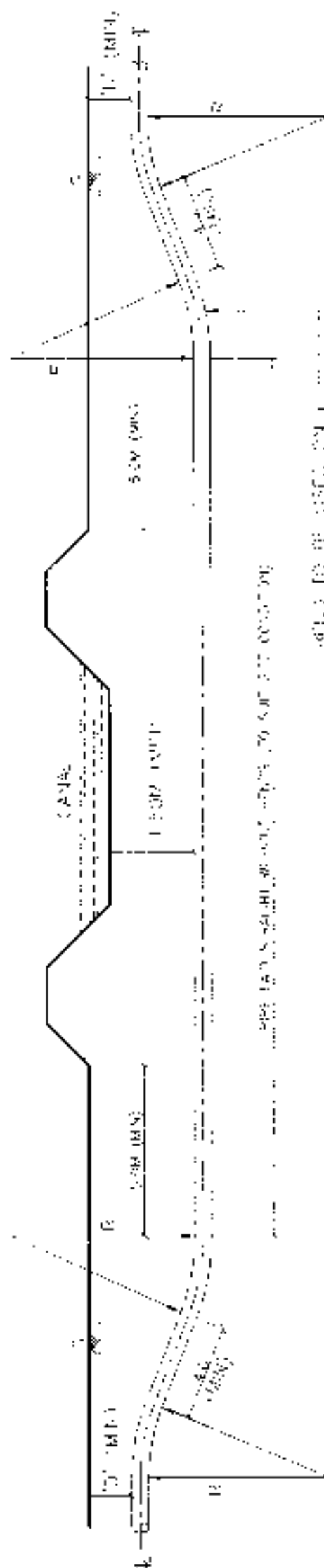
ALL CITIZENS ARE INVITED TO ATTEND

[illegible]

GROUPS TAKEN PROTECTION MEASURES TO BE TAKEN AT CROSSING POINTS OF THE SPECIFIC ROUTES.

(A) EFFECTS OF LOCAL COMMUNITIES

REMOVAL FROM FILED BY THE FBI IN CHARGE
OF RECORDS IS CONSIDERABLE

[illegible]

WILL TO BE USED ONLY IN THE
 PRESENCE OF OFFICER IS
 CONSIDERABLE BUREAU
 OF COURTESY BUREAU

11/5/00 14:45:00

PRO	CONCEPTUAL DESIGN	SYSTEM DEVELOPMENT
	CONCEPTUAL DESIGN	SYSTEM DEVELOPMENT

2000

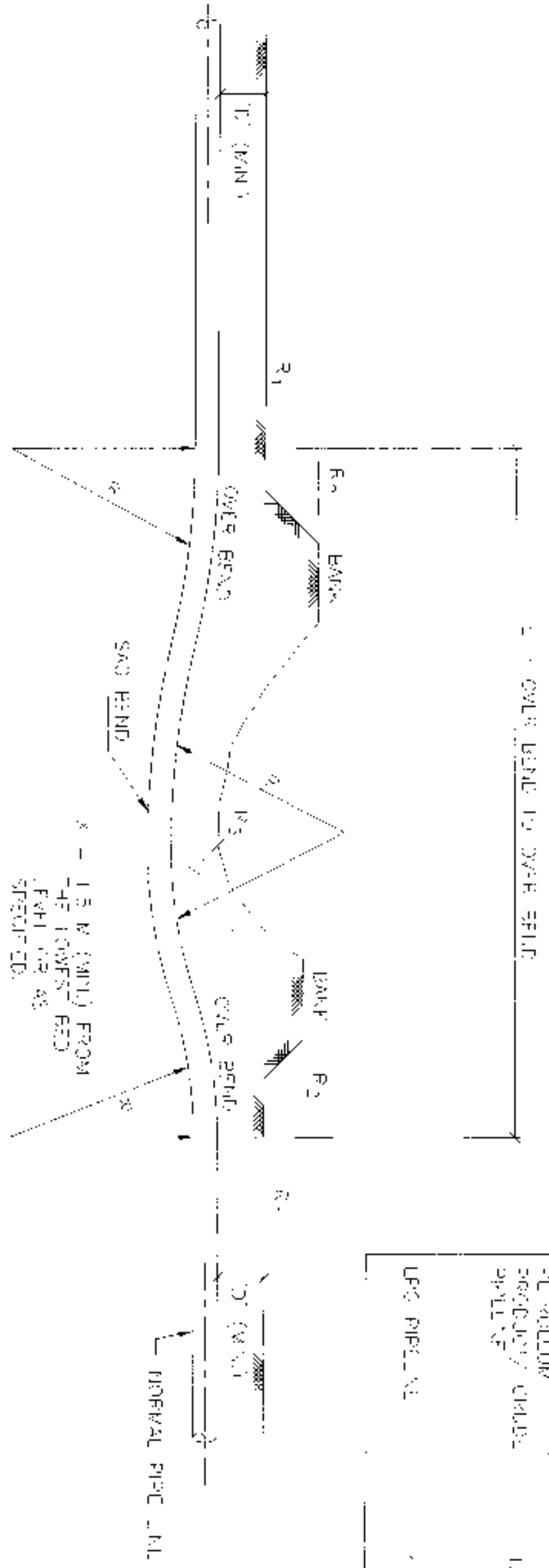
PIPELINE CATEGORY	'D' (MIN) IN METRE
PETROLEUM PRODUCT LIQUID FUELS	150 MM
CO ₂ TRANSPORT	150 MM

[illegible]

इंडियन ऑयल कॉर्पोरेशन लिमिटेड - पाइपलाइन्स
INDIAN OIL CORPORATION LIMITED (PIPELINES)
STATION ROAD, KANPUR - 208 002

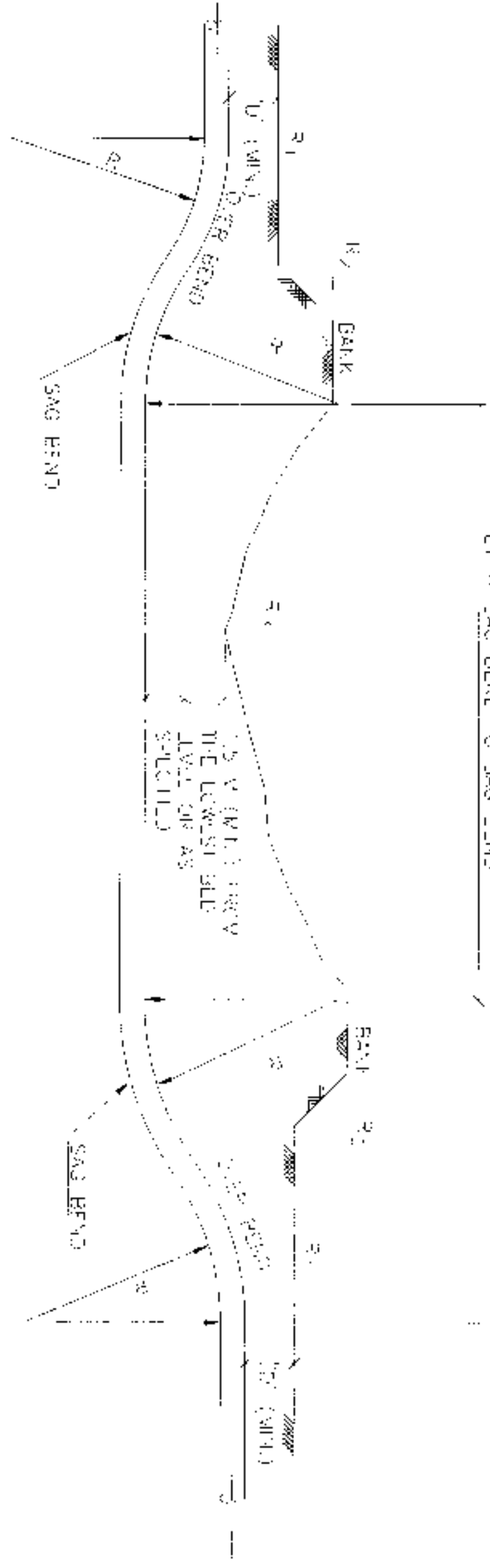
STANDARD CANAL CROSSING
(OPEN CUT)

DATE	TIME	WIND	WAVE	SEA	STATE
10/10/10	10:00	10	10	10	10



TYPICAL CROSSING USING SINGLE SAG BEND

= OVER BEND TO OVER BEND
 U = SAG BEND TO SAG BEND



TYPICAL CROSSING USING DOUBLE SAG BEND

MAIN LINE COVER	
PIPELINE CATEGORY	D (MIN) IN METRE
STANDARD CATEGORY / OTHER	1.00 W
UPG PIPELINE	1.50 W

- NOTES:
1. ALL DIMENSIONS WHEREVER NOT MENTIONED ARE IN METERS.
 2. R1 AVERAGE R.L. AT HIGHER SIDE OF APPROACH.
 3. R2 AVERAGE BANK TOP.
 4. R3 R.L. OF THE LOWEST POINT ON THE BED.
 5. R4 AVERAGE ROAD LOWEST BED LEVEL TO THE TOP OF THE PIPE IN BEND.
 6. NORMAL PIPE AS IN MAIN LINE SHALL BE USED.
 7. PIPE SHALL BE COVERED WITH ANT-CORROSION COATING.
 8. BEND (COLD FEED) SHALL BE USED ONLY IF CHANNEL OF CHANNEL IS CONSIDERABLE.
 9. PROTECT BANK PROTECTION MEASURE TO BE TAKEN AT CROSSING LOCATION AS PER SPECIFICATIONS / GUIDELINES OF LOCAL ADMINISTRATION.
 10. THE VALUE OF R (RADIUS OF BEND) SHALL NOT BE LESS THAN 400 FOR PIPE UP TO 1200 AND NOT LESS THAN 600 FOR PIPES ABOVE 1200. (D = 100 OF PIPE).
 11. GFC SHALL BE AD IN THE SAME TRENCH AS PER DRAWING FOR STANDARD DIT - DIVISIONS FOR NORMAL TRENCH (DWG. NO. 9200-99900-401 950 01)

STANDARD WATER COURSE CROSSING	STD/WL/VEH/10/1
STD	STD
STD	STD

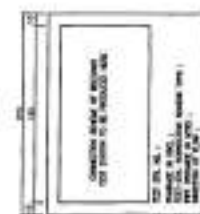
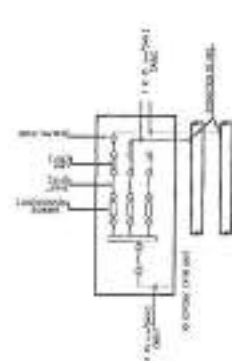
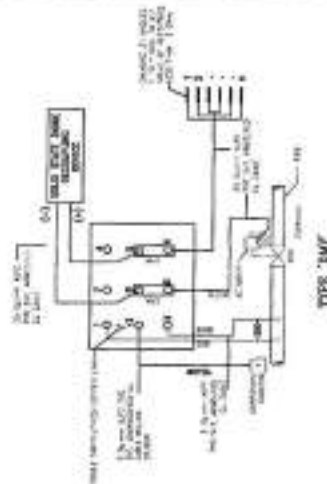
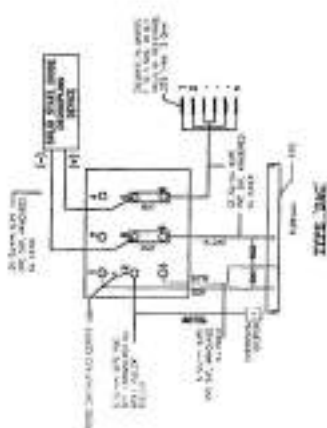
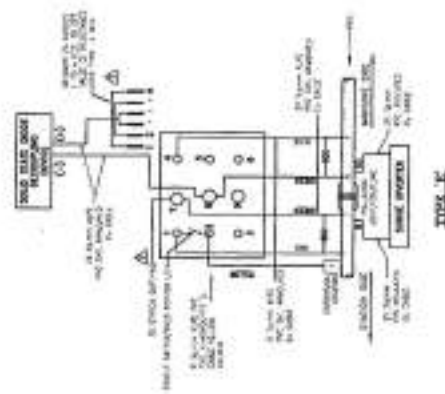
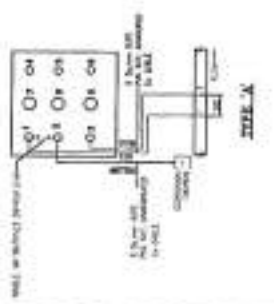
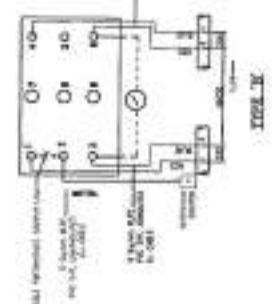
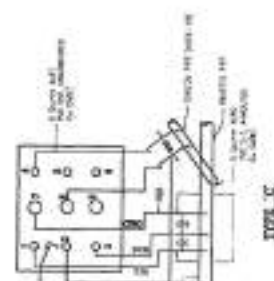
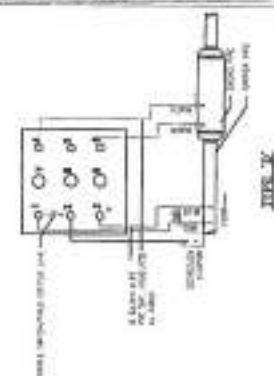
DURGAST APPROVED FOR CONSTRUCTION

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इंडियन ऑयल कॉर्पोरेशन लिमिटेड - पाइपलाइन
 INDIAN OIL CORPORATION LIMITED (PIPELINES)

STANDARD WATER COURSE CROSSING

DWG. NO.	SCALE	SHEET
9200-99900-401 950 01	1/10	1/1



ATOMIC FUNCTION FOR THE POLYMER

THE DISCONTINUOUS PARTIAL

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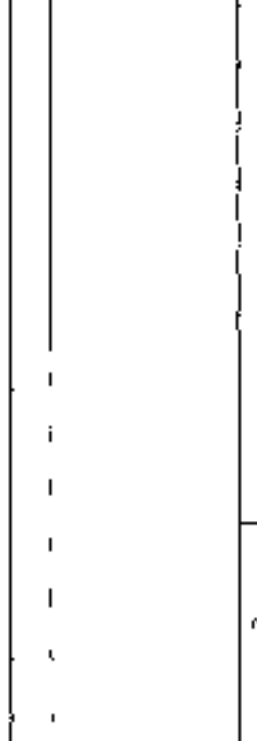
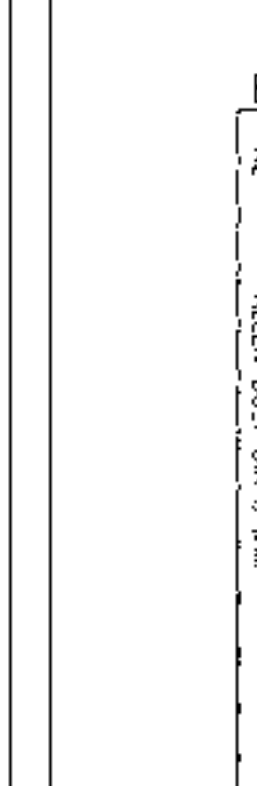
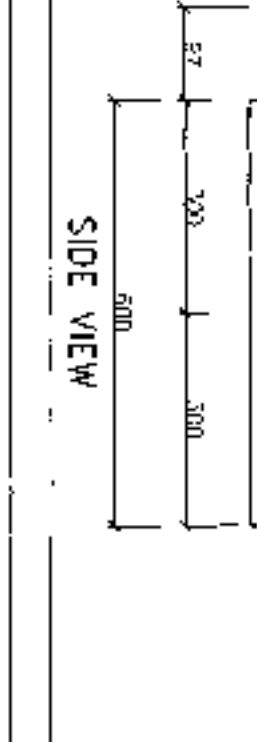
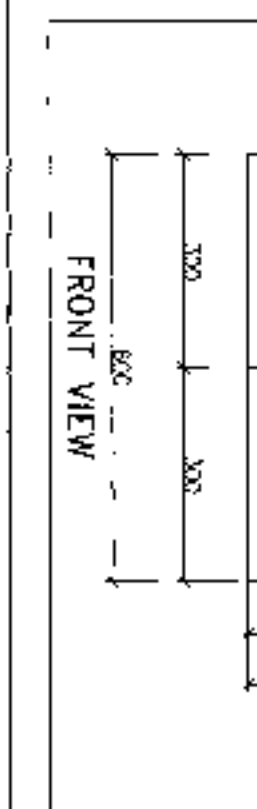
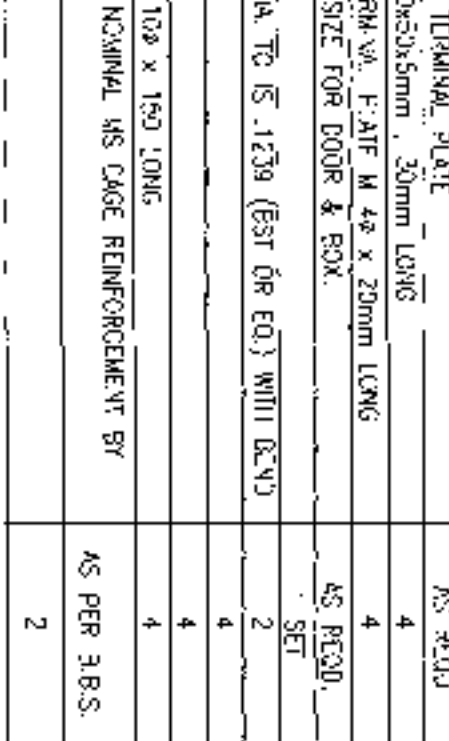
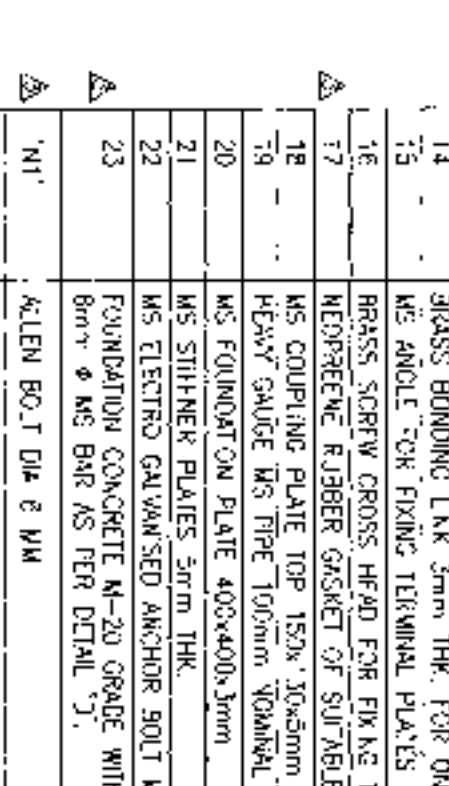
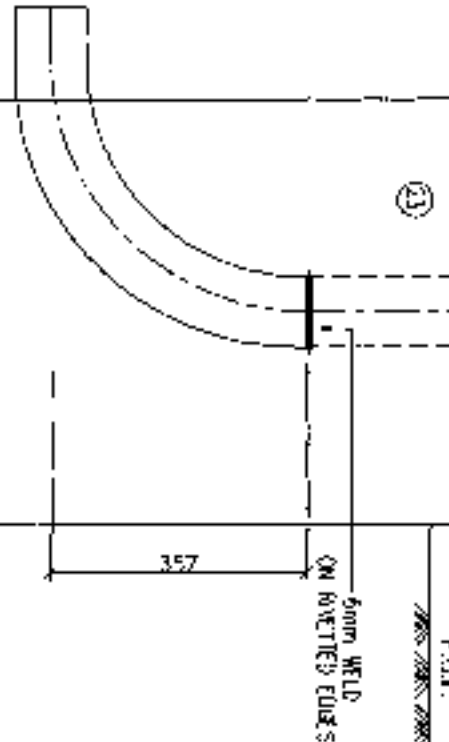
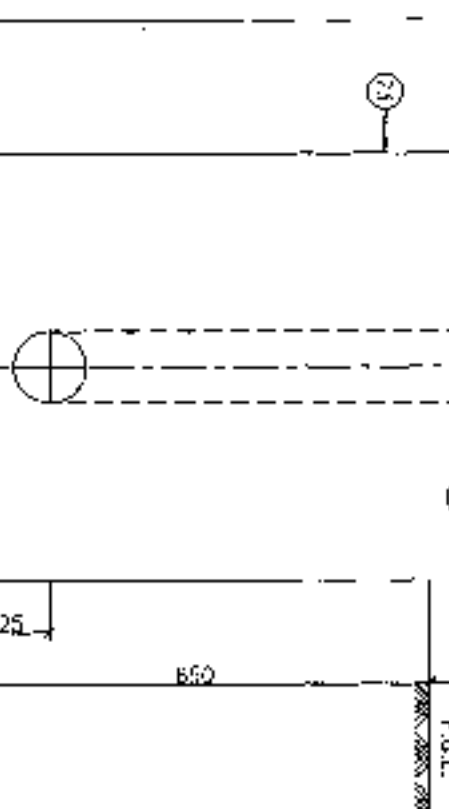
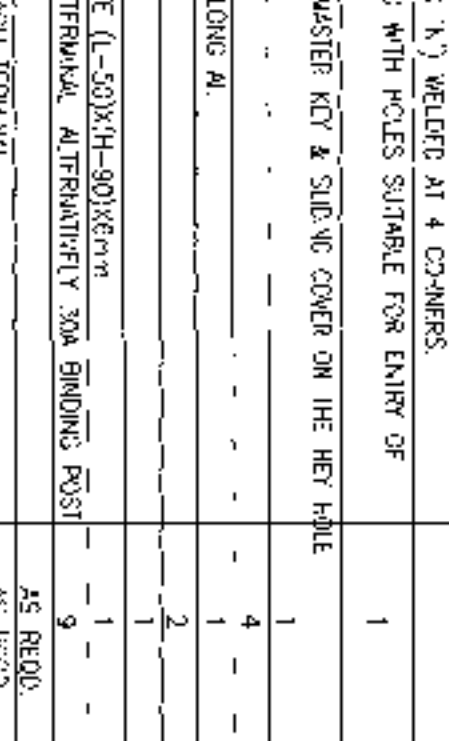
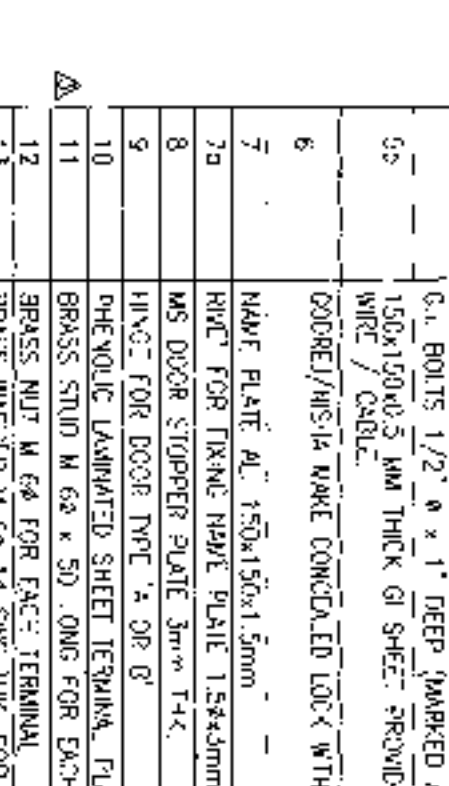
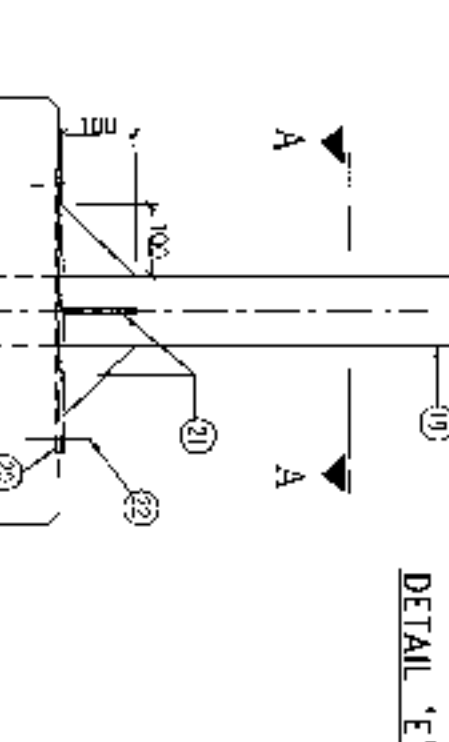
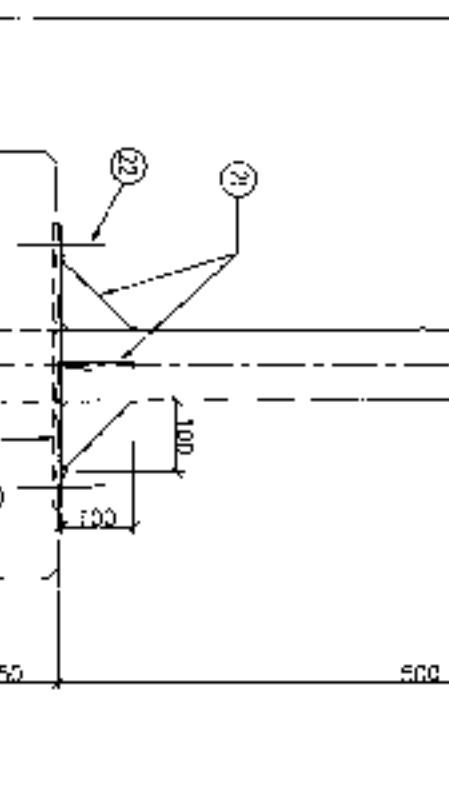
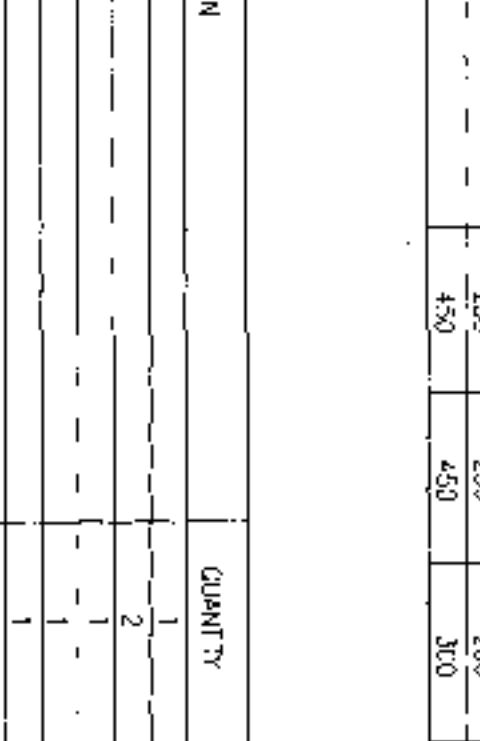
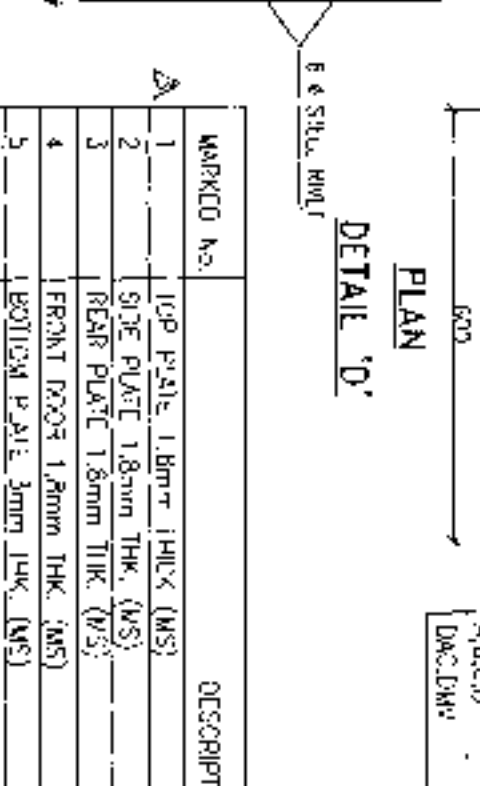
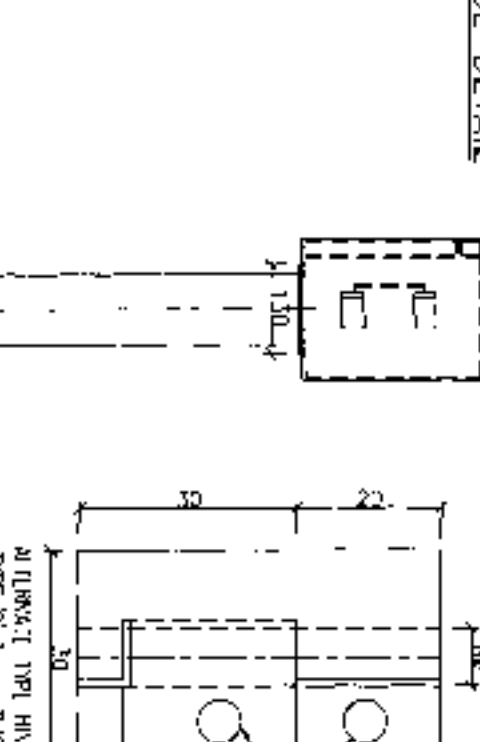
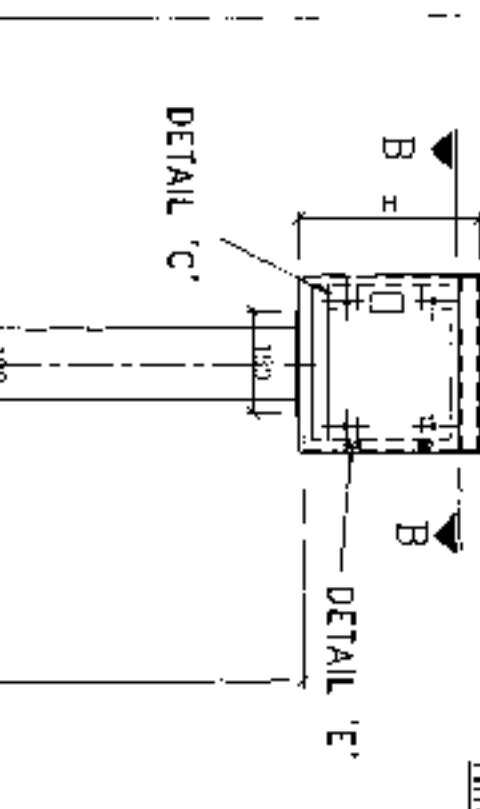
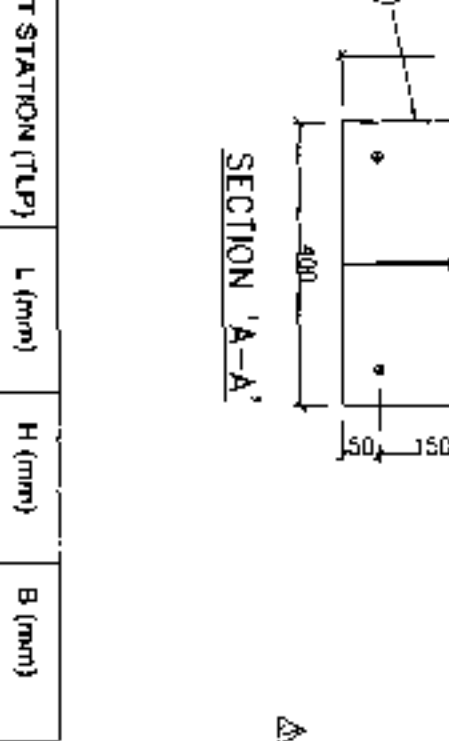
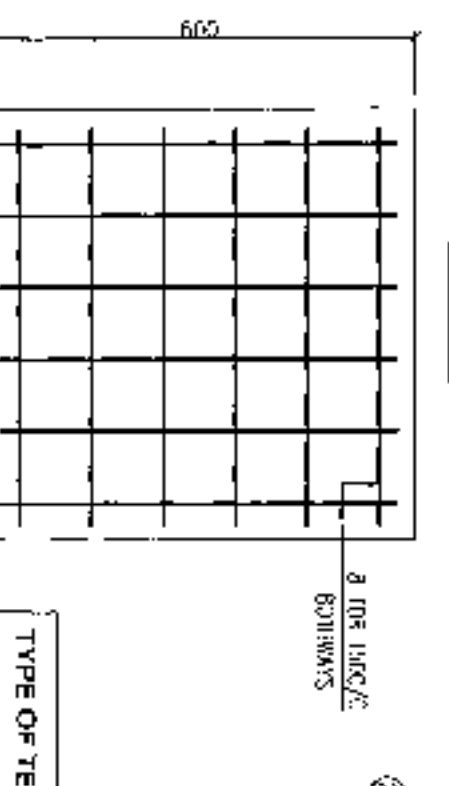
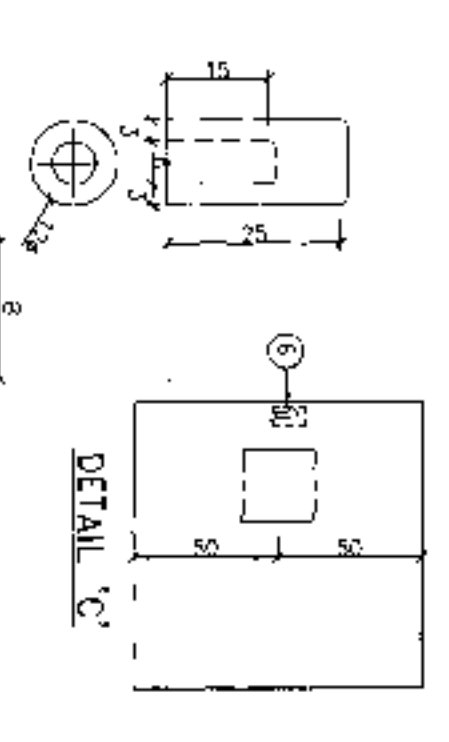
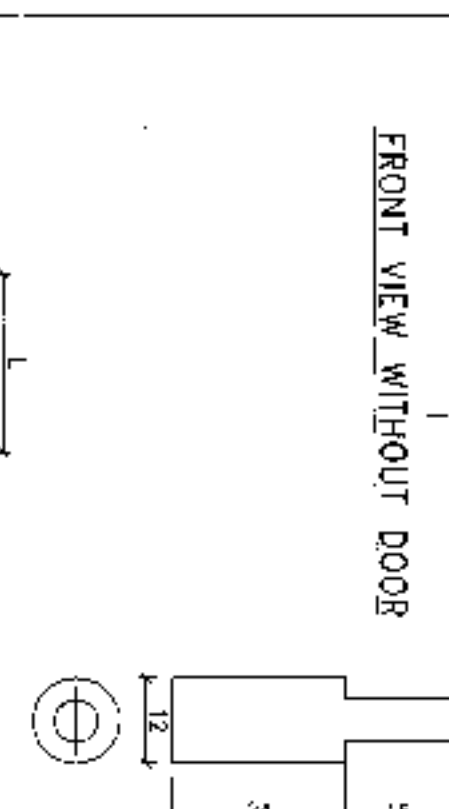
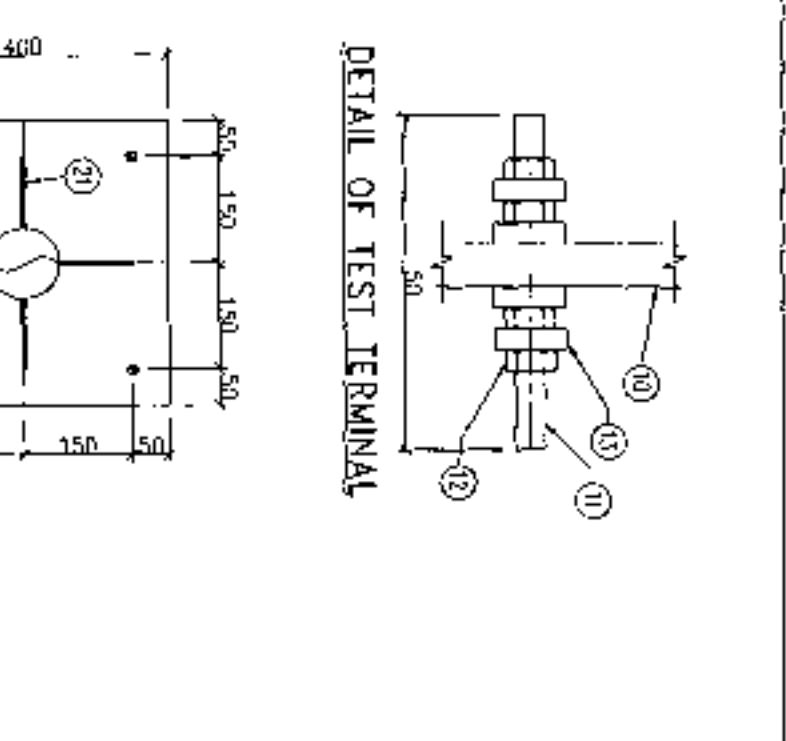
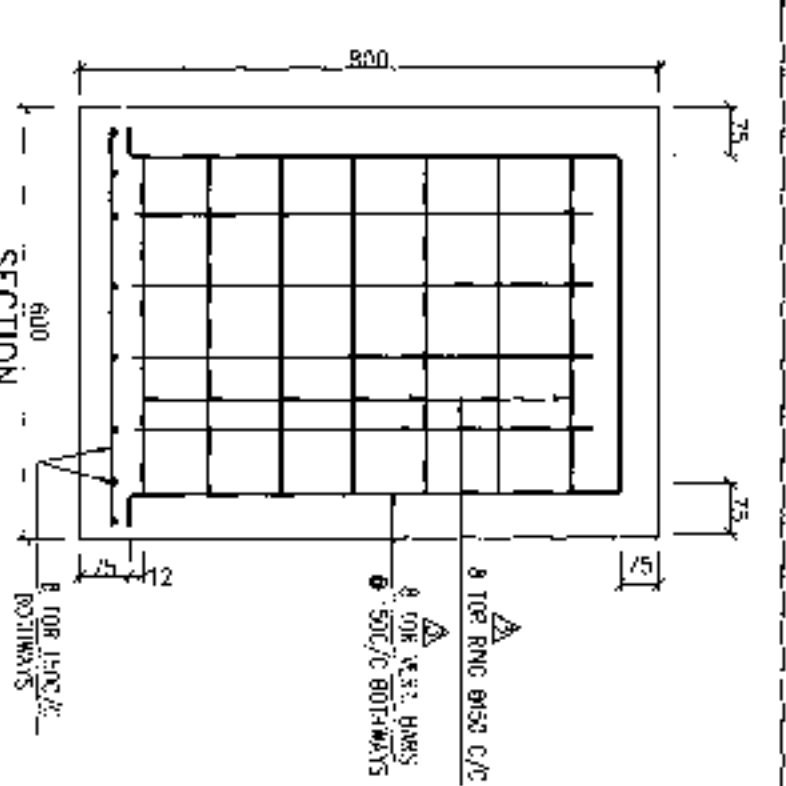
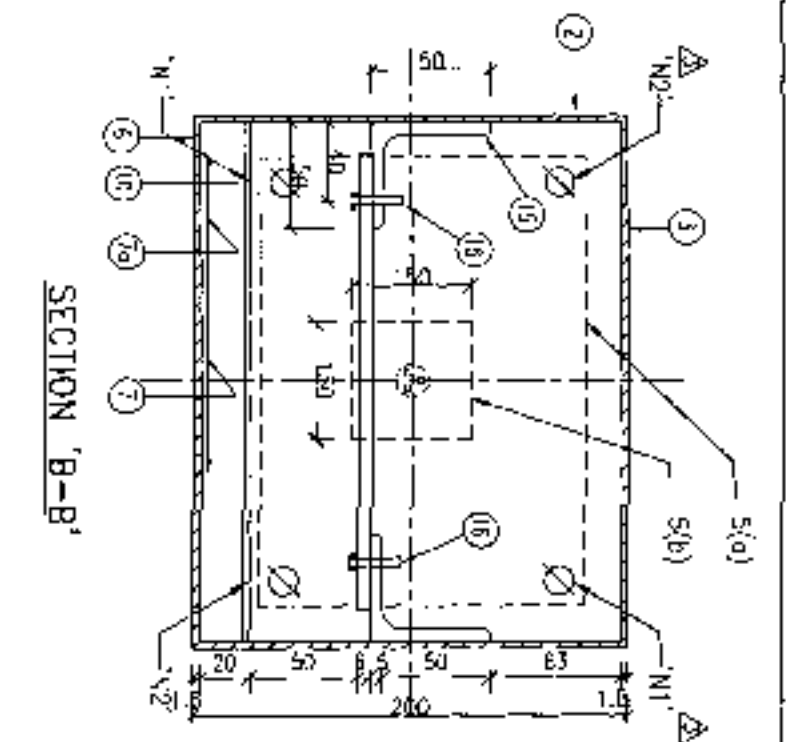
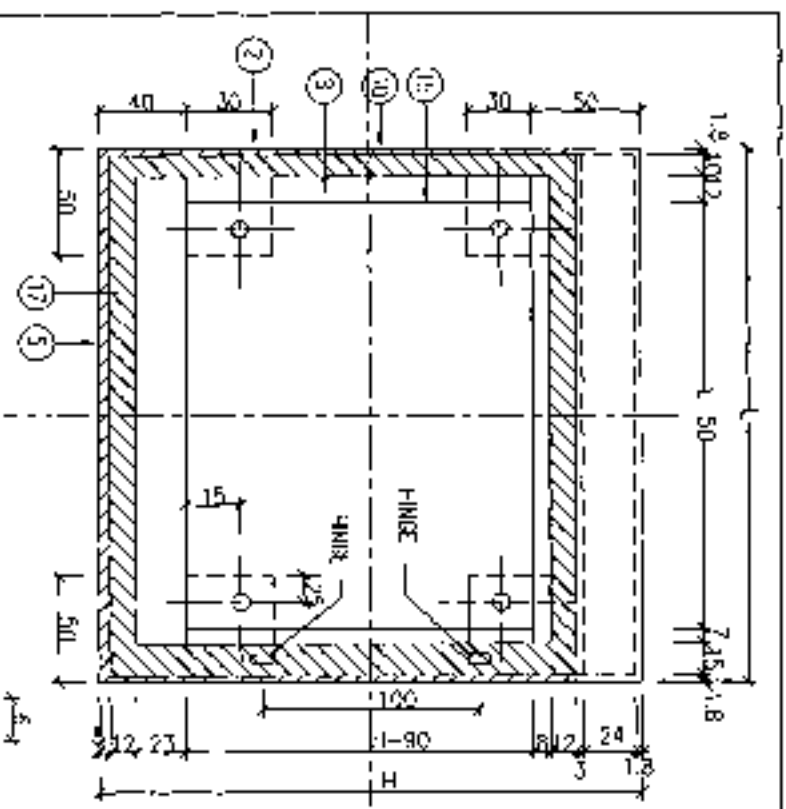
इविमानियल सर्विसिजन् लिमिटेड - पञ्जाब
THE EVIMANIAL SERVICES LIMITED PUNJAB
STANDARD ELECTRICAL DRAWING

TYPICAL TEST STATION SCHEMES

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
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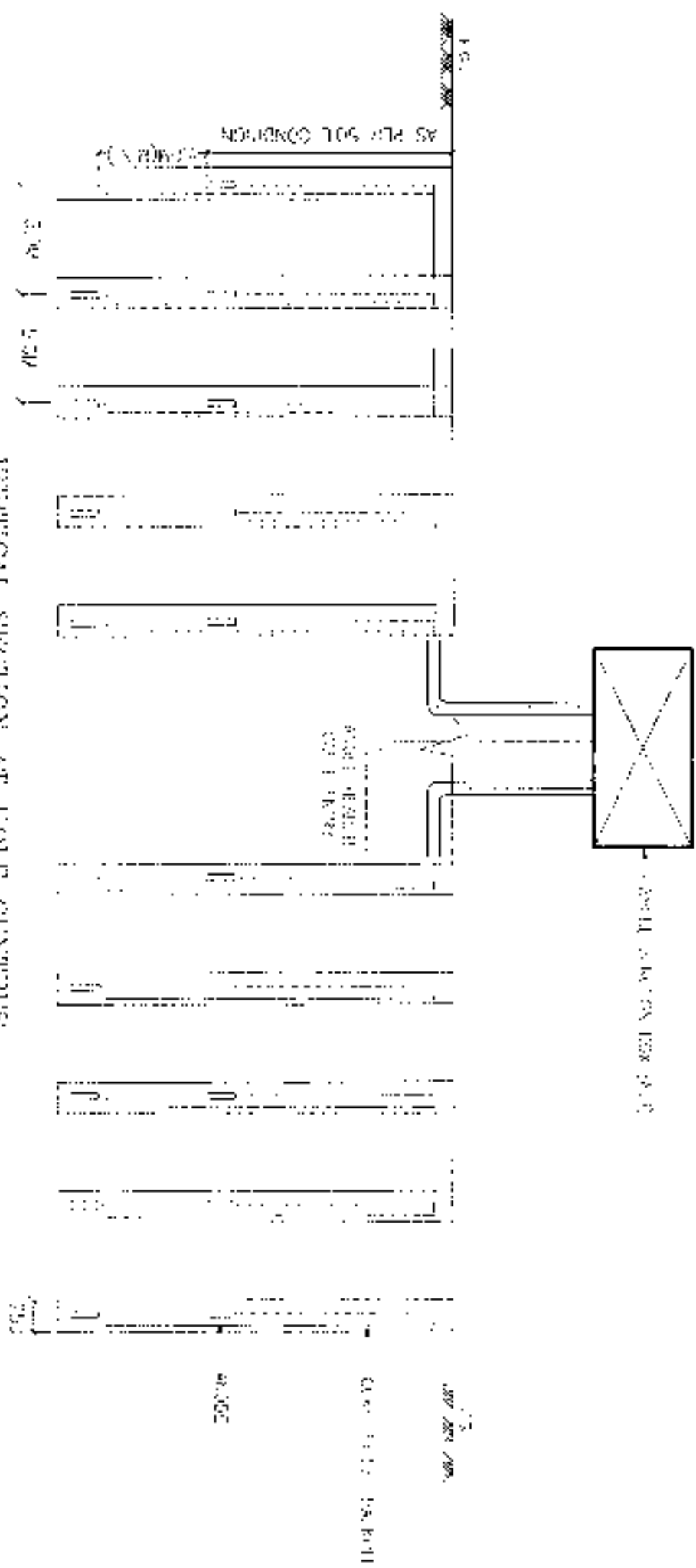


TYPE OF TEST STATION (TUP)	L (mm)	H (mm)	B (mm)
A, B, C, D	250	250	200
E, F, G, H	450	450	300

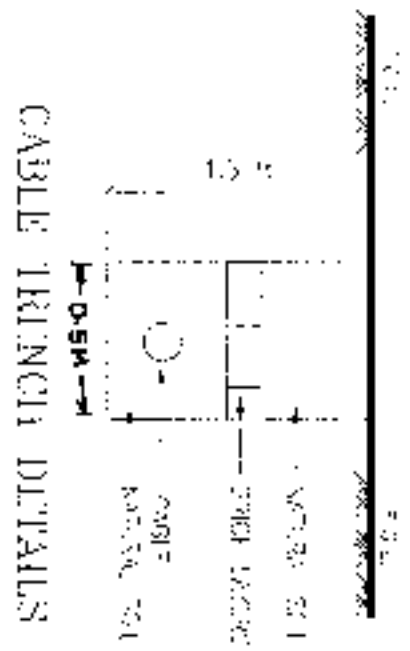
MARKED NO.	DESCRIPTION	QUANTITY
1	TOP PLATE 1.8mm THK (MS)	1
2	SIDE PLATE 1.8mm THK (MS)	2
3	REAR PLATE 1.8mm THK (MS)	1
4	FRONT DOOR 1.8mm THK (MS)	1
5	1 BOTTOM PLATE 3mm THK (MS)	1
6	ADDITIONAL BOTTOM PLATE 3mm THK (MS)	1
7	ALL BOLTS 1/2" x 1" DEEP (MARKED AS 'N') WELDED AT 4 CORNERS.	1
8	150x150x5 MM THICK GI SHEET PROVIDED WITH POLES SUITABLE FOR ENTRY OF WIRE / CABLE.	1
9	DOOR/HINGE/SLIDE LOCK WITH MASTER KEY & SLIDING COVER ON THE HINGE HOLE	1
10	NAME PLATE AT 150x150x1.5mm	1
11	NAME FOR TYPING NAME PLATE 1.5x4mm LONG AL	1
12	MS DOOR STOPPER PLATE 3mm THK	2
13	HINGE FOR DOOR TYPE 'A' OR 'B'	1
14	PHENOLIC LAMINATED SHEET TERMINAL PLATE (L=50xH=80xTH=3mm)	1
15	BRASS STUD M 6x x 50 LONG FOR EACH TERMINAL ALTERNATIVELY FOR BONDING POST	9
16	BRASS NUT M 6x FOR EACH TERMINAL	AS REQD.
17	BRASS WASHER M 6x 14 SWG THK FOR EACH TERMINAL	AS REQD.
18	BRASS BONDING LINK 3mm THK FOR ONE TERMINAL PLATE	AS REQD.
19	MS ANGLE FOR FIXING TERMINAL PLATE 30mm LONG	4
20	BRASS SCREW CROSS HEAD FOR FIXING TERMINAL PLATE M 4x x 20mm LONG	4
21	NEOPRENE RUBBER GASKET OF SUITABLE SIZE FOR DOOR & BOX	AS REQD.
22	MS COUPLING PLATE TOP 150x 30x5mm	SET
23	HEAVY GAUGE MS TIE TOP/MS TIE BOTTOM DIA. TO IS 1239 (EST OR EQ.) WITH 6x10	4
24	MS FOUNDATION PLATE 400x400x3mm	4
25	MS STIFFER PLATES 3mm THK	4
26	MS ELECTRO GALVANIZED ANCHOR BOLT M 10x x 150 LONG	4
27	FOUNDATION CONCRETE M-20 GRADE WITH NOMINAL MS CAGE REINFORCEMENT BY 8mm x MS BAR AS PER DETAIL 'J'.	AS PER S.B.S.
28	ALLEN BOLT DIA 8 MM	2
29	ALLEN BOLT DIA 5 MM	2

S.NO.	REFERENCE DRAWING	DWG. NO.
1.	TYPICAL FABRICATION AND INSTALLATION DETAILS OF TEST STATION FOR COMMON USE	STD/ELEC/4884

PURPOSE	APPROVED FOR CONSTRUCTION
INDIAN OIL CORPORATION LIMITED (PIPELINES)	STANDARD ELECTRICAL DRAWING
TYPICAL FABRICATION AND INSTALLATION	DETAILS OF TEST STATION FOR COMMON USE
CAD FILE NO.	DWG. NO.
STD-488-03	9200-99900-404-603-03
SCALE	SIZE
1:1	A2
SHEET	1 OF 1



VERTICAL SECTION AT HOLE CENTERS



CABLE TRENCH DETAILS

NOTES:

1. ANODES FOR THE VERTICAL ANODE BED.
2. ANODES TO BE USED IN THE CASE.
3. ANODES ARE NOT TO BE USED FOR HANDLING THE ANODES.
4. VERTICAL HOLE OF 2.5m or more DIA. TO BE DRILLED WITH A LUGS TO BE USED.
5. ANODES ARE TO BE USED AND SUPPLY WITH WATER AND FLOWING INTO THE HOLE TO BE USED.
6. ANODES ARE TO BE USED AND SUPPLY WITH WATER AND FLOWING INTO THE HOLE TO BE USED.
7. ANODES ARE TO BE USED AND SUPPLY WITH WATER AND FLOWING INTO THE HOLE TO BE USED.
8. ANODES ARE TO BE USED AND SUPPLY WITH WATER AND FLOWING INTO THE HOLE TO BE USED.
9. ANODES ARE TO BE USED AND SUPPLY WITH WATER AND FLOWING INTO THE HOLE TO BE USED.
10. ANODES ARE TO BE USED AND SUPPLY WITH WATER AND FLOWING INTO THE HOLE TO BE USED.

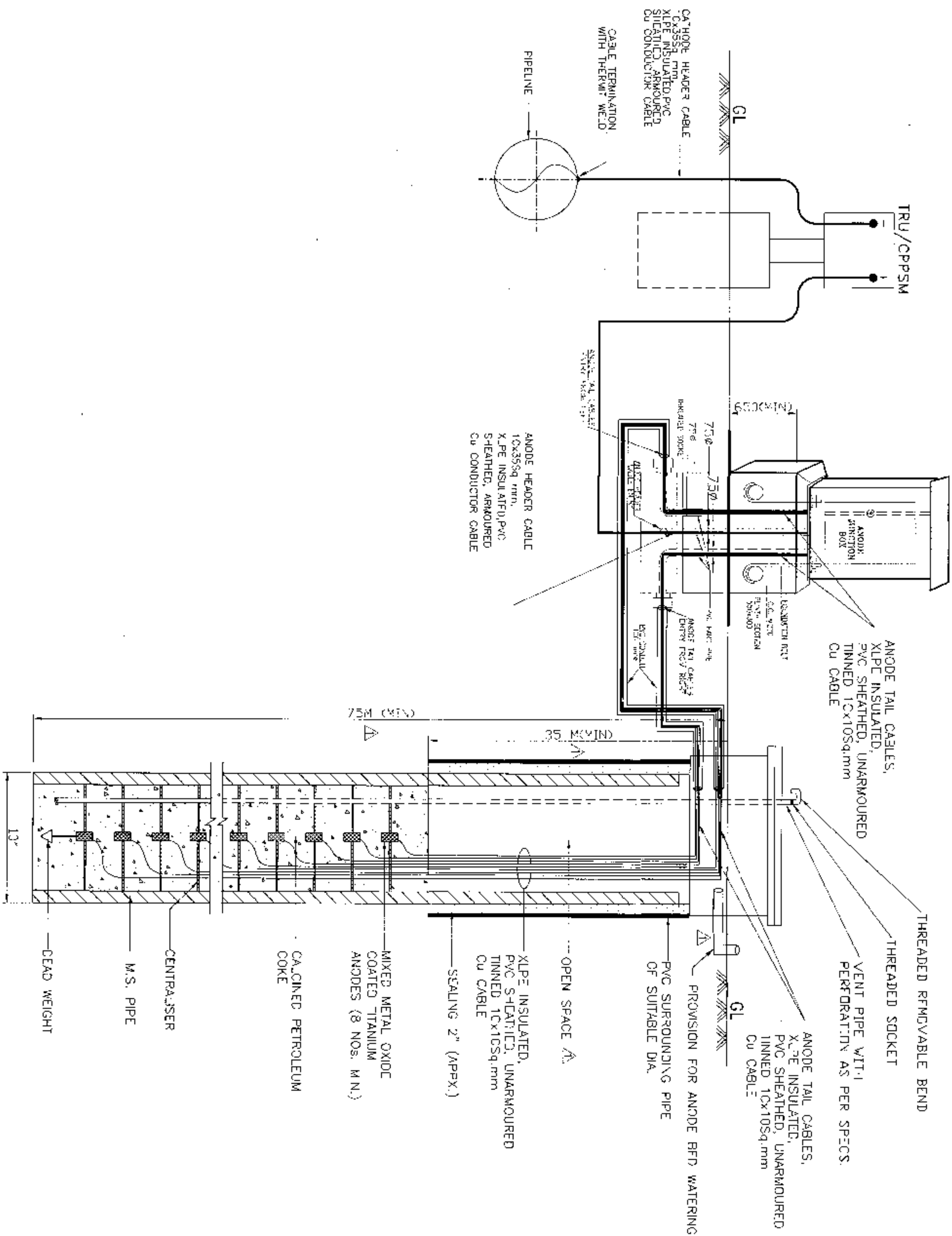
NO.	DATE	REVISION	REMARKS
1	01/01/2020	1	AS PER SOIL CONDITION

PURPOSE APPROVED FOR CONSTRUCTION

इंडियन ऑयल कॉर्पोरेशन लिमिटेड - पश्चिमोत्तर
INDIAN OIL CORPORATION LIMITED (IOCL)
 CHANDIGARH, PUNJAB, INDIA

INDICATIVE ANODE BED CONSTRUCTION DETAILS (VERTICAL TYPE)

ANODE NO.	ANODE NO.	ANODE NO.	ANODE NO.
1	2	3	4



- NOTE:**
1. DETAILS ARE INDICATIVE AND DIMENSIONS MAY VARY AS PER SITE CONDITIONS.
 2. PROVISION FOR ANODE BED WATERING THROUGH PVC PIPE MAY BE PROVIDED SUITABLY.
 3. INSULATING PVC PIPE OF 35MM (MIN) UP TO 40 TO BE INSTALLED WITHOUT FALL.
 4. PIPELINE TO ANODE BED DISTANCE SHOULD BE MAXIMUM WITHIN THE AVAILABLE AREA.

LEGEND :

AJB	ANODE JUNCTION BOX
TRU	TRANSFORMER RECTIFIER UNIT
CPSPM	CATHODIC PROTECTION POWER SUPPLY MODULE

UT	SCHEMATIC OF ANODE JUNCTION BOX (20-200-40-100 TO)
S.NO.	REFERENCE DRAWING
	DWG NO.

PURPOSE	APPROVED FOR CONSTRUCTION
DESIGNED BY	REVIEWED BY
CHECKED BY	APPROVED BY
DATE	DATE

STAN OIL INDIA LTD. (INDIA)
INDIAN OIL CORPORATION LIMITED (INDIA)
STANDARD ELECTRICAL DRAWING

DEEP WELL ANODE BED CONSTRUCTION DETAILS
STD-490-01 9200-99900-404-610-01

2 QUANTITY OF BENEFIT WITHIN SPILL BE MINIMUM 100g

SLNO.	DESCRIPTION	QUANTITY
1	1000	1000
2	2000	2000
3	3000	3000
4	4000	4000
5	5000	5000
6	6000	6000
7	7000	7000
8	8000	8000
9	9000	9000
10	10000	10000

1	200' ELEC'D OC 450V-115000V WOOD CR EACH 20' Hg.	2	300'
3	POUGHES STONES 50.5"x2.0mm		1 yd
3	CRYSALITE, BENJONITE(OC) AND SILLIM SILLIMANITE(50')		50' each
4	100' group		10' group
5	CUTTING 600' 2000' x 2000' 1200'		1 yd
6	CASE 25 50' mm		40' 2000'
7	SP. OF HILL AND MOUNTAIN		1 yd

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	

DESCRIPTION OF LOT	45 x 35 x 350 m.
REF. NUMBER	67, 80
AREA OF ACQUISITION	70, 80
PREPARED BY	110, 80
OPEN TO THE PUBLIC	- 105, 10 - 110, 80 - 100, 80 - 100, 80 -
USE OF THE LOT	15 x 6 m. m. 7.14
TO BE USED	110, 80 x 7.14, 110, 80 x 5.2, 110, 80 x 5.2
CONTRACT NUMBER	720 and 110, 80
DATE OF ACQUISITION	11.2.1980


Aluminate (%)	0.0035 wt%
Calcium (%)	0.0015 wt%

NAME	DATE
JOHN DOE	10/25/2023
JANE SMITH	11/05/2023
BOB JONES	11/15/2023
ALICE BROWN	11/20/2023
CHARLIE WHITE	12/01/2023
DAVID GREEN	12/10/2023
EMILY BLACK	12/20/2023
FRED BROWN	12/30/2023
GRACE WILSON	01/05/2024
HELEN DAVIS	01/15/2024
IRVING MILLER	01/25/2024
JACK HARRIS	02/05/2024
JANET LEE	02/15/2024
JOHN WALKER	02/25/2024
JUDITH KING	03/05/2024
KAREN WOOD	03/15/2024
KEVIN BAKER	03/25/2024
KIMMY SCOTT	04/05/2024
LEONARD ADAMS	04/15/2024
LUCAS NELSON	04/25/2024
LUCY HILL	05/05/2024
MARIA PEREZ	05/15/2024
MATTHEW ROSS	05/25/2024
MELBA ROY	06/05/2024
MICHAEL STEVENSON	06/15/2024
MILAN TORRES	06/25/2024
MIRIAM PETERSON	07/05/2024
MORTIMER COOPER	07/15/2024
MURIEL HENRY	07/25/2024
NATHAN KYLE	08/05/2024
NELSON BARNES	08/15/2024
NORMA FOSTER	08/25/2024
OLIVER GIBSON	09/05/2024
OLIVIA HUGHES	09/15/2024
OSCAR FLEMING	09/25/2024
OSCAR WATSON	10/05/2024
PATRICIA BRYAN	10/15/2024
PATRICK GRIFFIN	10/25/2024
PEGGY BELL	11/05/2024
PETER JONES	11/15/2024
PETERSON WALKER	11/25/2024
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PURPOSE	APPROVED FOR CONSTRUCTION
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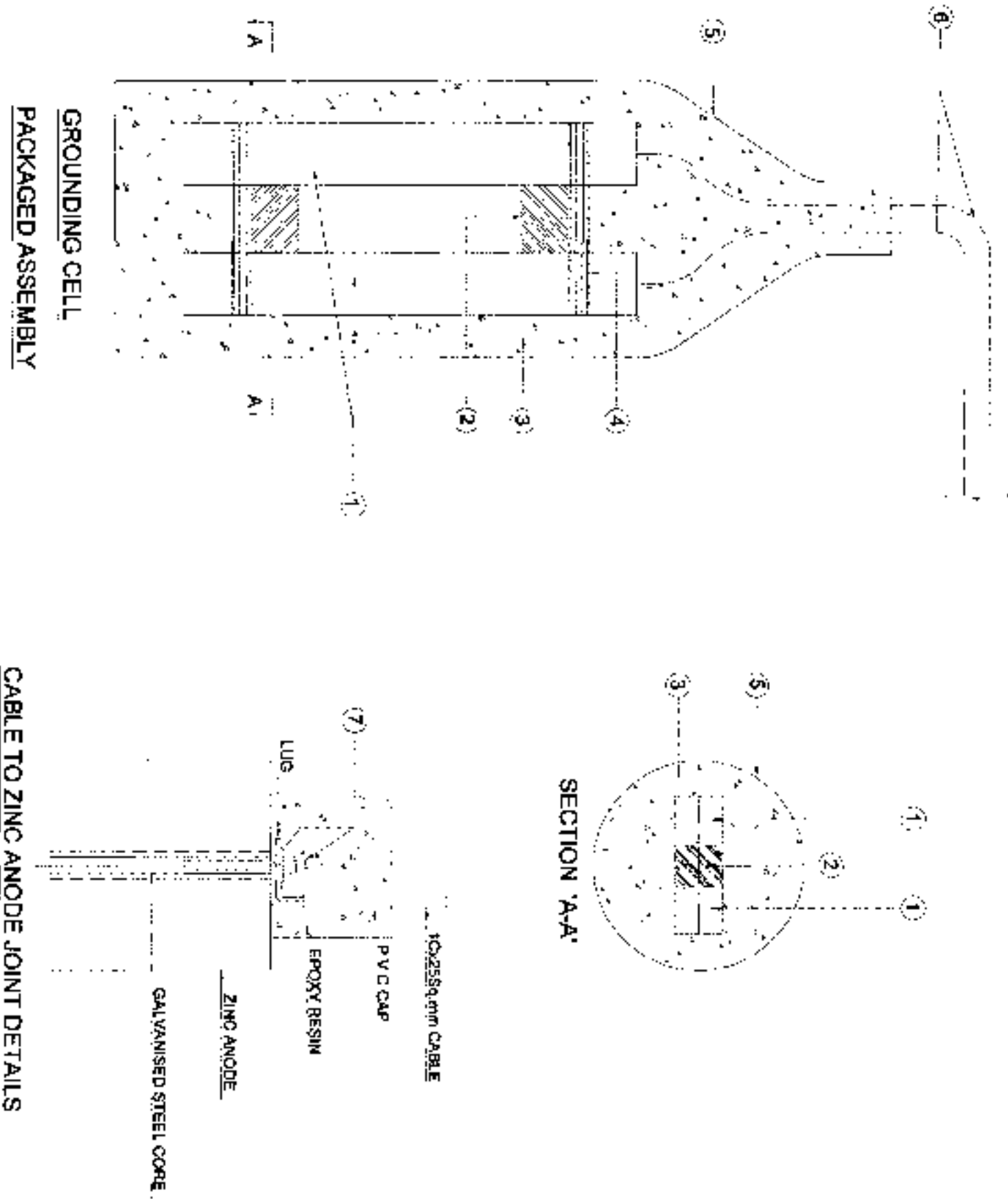
DATE	TIME	BY	REASON	CHECKED	APPROVED	REMARKS
10/2/04	08:00	W. J. J.	REASON	CHECKED	APPROVED	REMARKS

 इंडियन ऑइल कॉर्पोरेशन लिमिटेड (प्राधान्यक्रम)
INDIAN OIL CORPORATION LIMITED (PRIORITY)

STANDARD - 5TH GRADE

STANDARD DRAWING FOR ZINC GROUNDING CELL

DATE REC'D	ENG. NO.	SCALE	SHEET
SEP-20-01	9223-95900-404-61-01	AS	1 OF 1



NOTE:

- 1. The length of the anode shall be as per the weight of the cable.
- 2. The anode shall be of the type as specified in the specification.
- 3. The anode shall be of the type as specified in the specification.
- 4. The anode shall be of the type as specified in the specification.

STANDARD ALLOY CHEMICAL COMPOSITION

Element	Symbol	Unit	Min.	Max.
Aluminum	Al	%	92.0	98.0
Iron	Fe	%	0.05	0.10
Silicon	Si	%	0.05	0.10
Manganese	Mn	%	0.05	0.10
Chromium	Cr	%	0.05	0.10
Nickel	Ni	%	0.05	0.10
Copper	Cu	%	0.05	0.10
Zinc	Zn	%	0.05	0.10
Lead	Pb	%	0.05	0.10
Antimony	Sb	%	0.05	0.10
Strontium	Sr	%	0.05	0.10
Barium	Ba	%	0.05	0.10
Calcium	Ca	%	0.05	0.10
Sulfur	S	%	0.05	0.10
Phosphorus	P	%	0.05	0.10
Chlorine	Cl	%	0.05	0.10
Fluorine	F	%	0.05	0.10
Bromine	Br	%	0.05	0.10
Iodine	I	%	0.05	0.10
Hydrogen	H	%	0.05	0.10
Oxygen	O	%	0.05	0.10

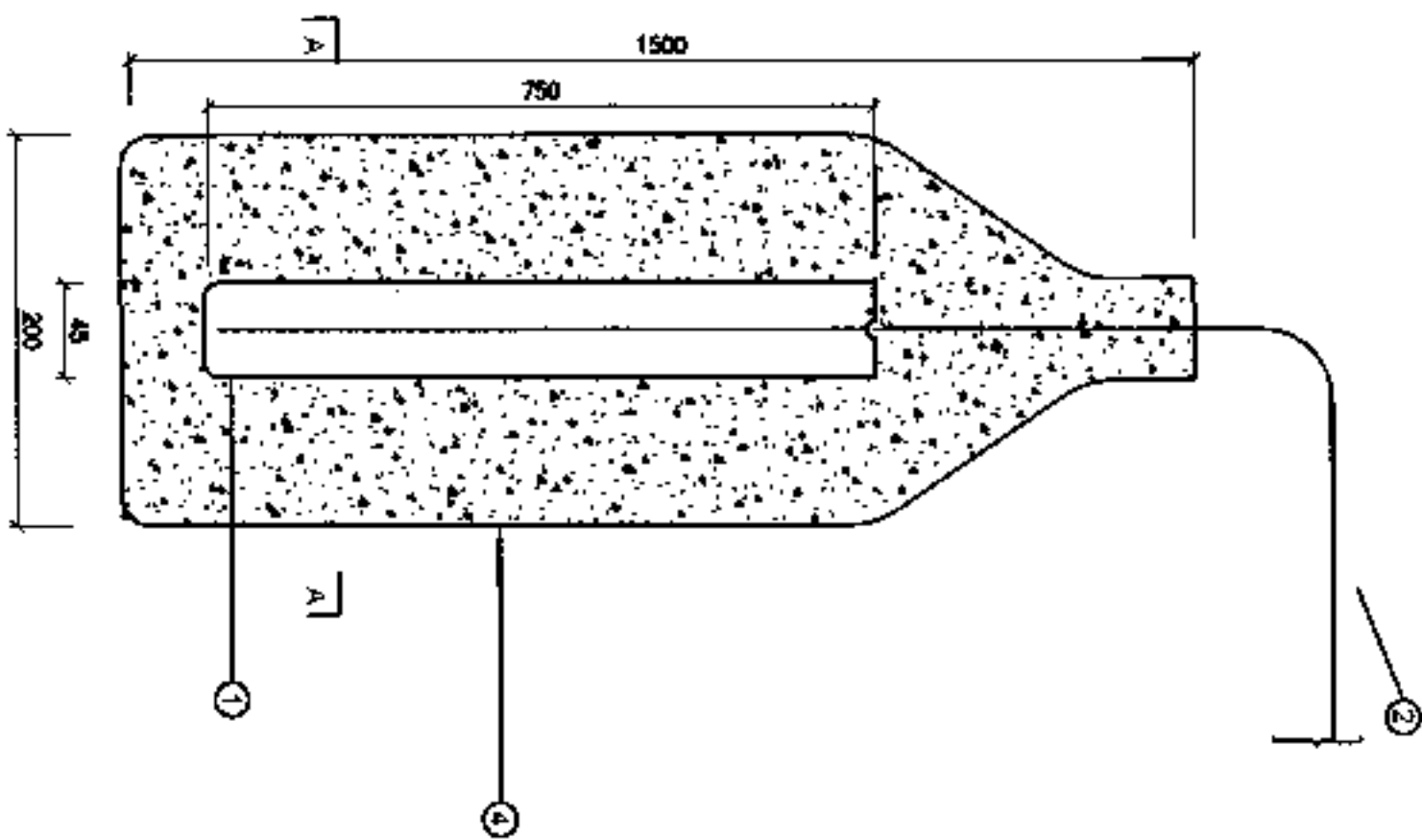
1. The length of the anode shall be as per the weight of the cable.
2. The anode shall be of the type as specified in the specification.
3. The anode shall be of the type as specified in the specification.
4. The anode shall be of the type as specified in the specification.

6. The length of the anode shall be as per the weight of the cable.
7. The anode shall be of the type as specified in the specification.
8. The anode shall be of the type as specified in the specification.
9. The anode shall be of the type as specified in the specification.

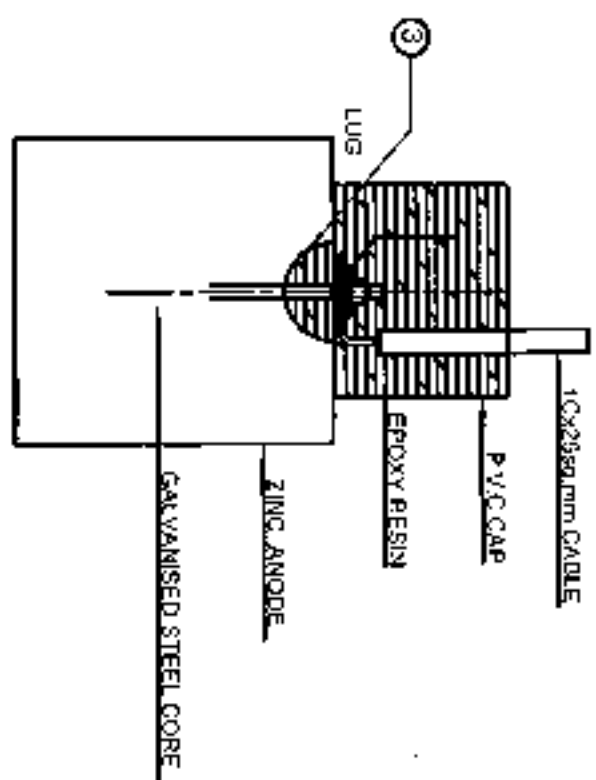
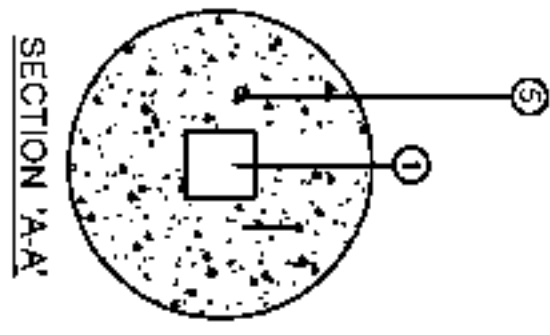
10. The length of the anode shall be as per the weight of the cable.
11. The anode shall be of the type as specified in the specification.
12. The anode shall be of the type as specified in the specification.
13. The anode shall be of the type as specified in the specification.

14. The length of the anode shall be as per the weight of the cable.
15. The anode shall be of the type as specified in the specification.
16. The anode shall be of the type as specified in the specification.
17. The anode shall be of the type as specified in the specification.

18. The length of the anode shall be as per the weight of the cable.
19. The anode shall be of the type as specified in the specification.
20. The anode shall be of the type as specified in the specification.
21. The anode shall be of the type as specified in the specification.



PACKAGED ASSEMBLY



CABLE TO ZINC ANODE JOINT DETAILS

NOTE

1. ZINC ANODE SHOULD BE PREPARED BEFORE USING IN A COTTON BAG USING DEFICIENT, SODIUM SULPHATE & CRYSTAL AS BACKFILL.
2. THE BACKFILL IN THE COTTON BAG MAY BE MODIFIED FOR APPLICATION IN COMPARATIVELY HIGHER SOIL RESISTIVITY AREA, SO THAT THE PRODUCED ANODE BAG IS 300mm dia. IN PLACE OF 200mm dia.

TYPICAL CHEMICAL COMPOSITION

Element	Weight Content %
Al	4.00%
Ca	4.00 MAX.
Pb	4.00% MAX.
Fe	0.0014 MAX.
Zn	Purest

DETAILS OF PACKAGED Zn- ANODE

1. ZINC ANODE WEIGHT 10 kg
2. TAIL CABLE : QUANTITY 10 M LENGTH.
3. SEALING COMPOUND.
4. COTTON BAG.
5. SPECIAL BACK FILL COMPOSITION
OPSLM : 75%
BEROMITE : 20%
SODIUM SULPHATE : 5%

S.NO.	REFERENCE DRAWING	DWG. NO.
01.		

PURPOSE APPROVED FOR CONSTRUCTION

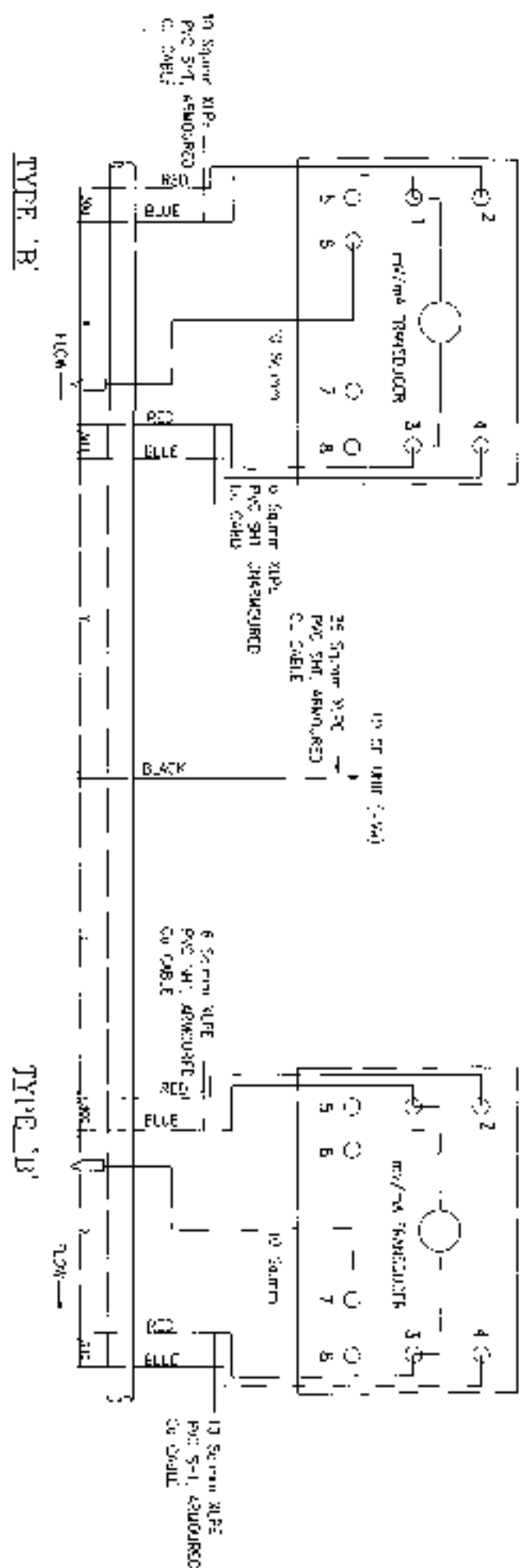
DESIGN	DESIGNED	CHECKED	APPROVED	SUBJECT OF REVISION

श्रीराम जॉयन्त कॉर्पोरेशन लिमिटेड (प्रा.स.जी.सी.)
INDIAN OIL CORPORATION LIMITED (P.O.P.I. I.N.F.S.I.)

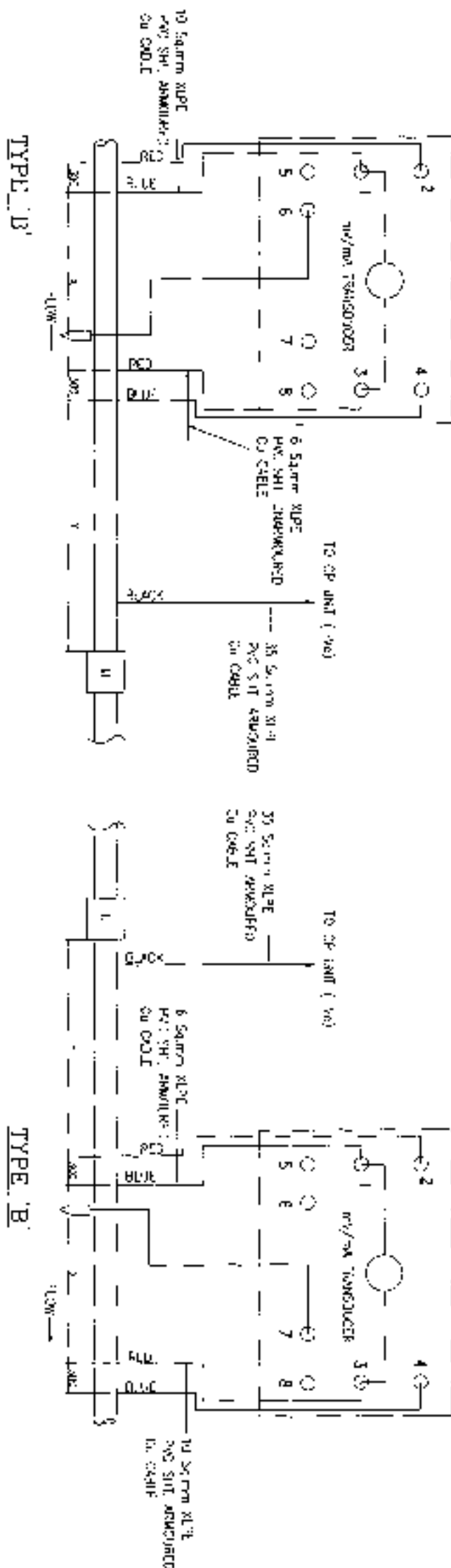
STANDARD INSTRUMENT

STANDARD DRAWING FOR ZINC ANODE

QAO FILE NO.	DWG. NO.	SCALE	SHEET
STD-785-04	9200-99900-40402-200-01	MKS	A1 1 OF 1



CATHODE AND I/P CONNECTION AT INTERMEDIATE CP



CATHODE AND I/P CONNECTION AT INTERMEDIATE STATION

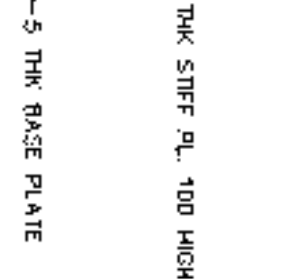
- NOTES:
1. THE DRAWING IS TO BE USED FOR THE CONNECTION AND DESIGN OF THE CATHODE AND I/P CONNECTION AT INTERMEDIATE STATION.
 2. THE DRAWING IS TO BE USED FOR THE CONNECTION AND DESIGN OF THE CATHODE AND I/P CONNECTION AT INTERMEDIATE STATION.
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INDIAN OIL CORPORATION LIMITED (PUNE)

INDICATIVE SCHEME FOR CATHODE AND I/P CONNECTION AT CP STATION

NO.	REVISION	DATE	BY
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EQD FILE NO	DWG NO	SQARE	SIZE	SHEET
STD-784-00	9200-99900-40402-291-QD	SMS	AL	1 OF 1

- NOTE:**
1. DETAILS ARE INDICATIVE AND DIMENSIONS MAY VARY AS PER SITE CONDITIONS.
 2. PROVISION FOR ANODE BED WATERING THROUGH PVC PIPE MAY BE PROVIDED SUITABLY.
 3. INSULATING PVC PIPE OF 35(MIN) UP TO 40 TO BE INSTALLED WITHOUT FAIL.
 4. PIPELINE TO ANODE BED DISTANCE SHOULD BE MAXIMUM WITHIN THE AVAILABLE AREA.
 5. THE ANODE CABLE SHALL BE DOUBLE FEED

LEGEND :

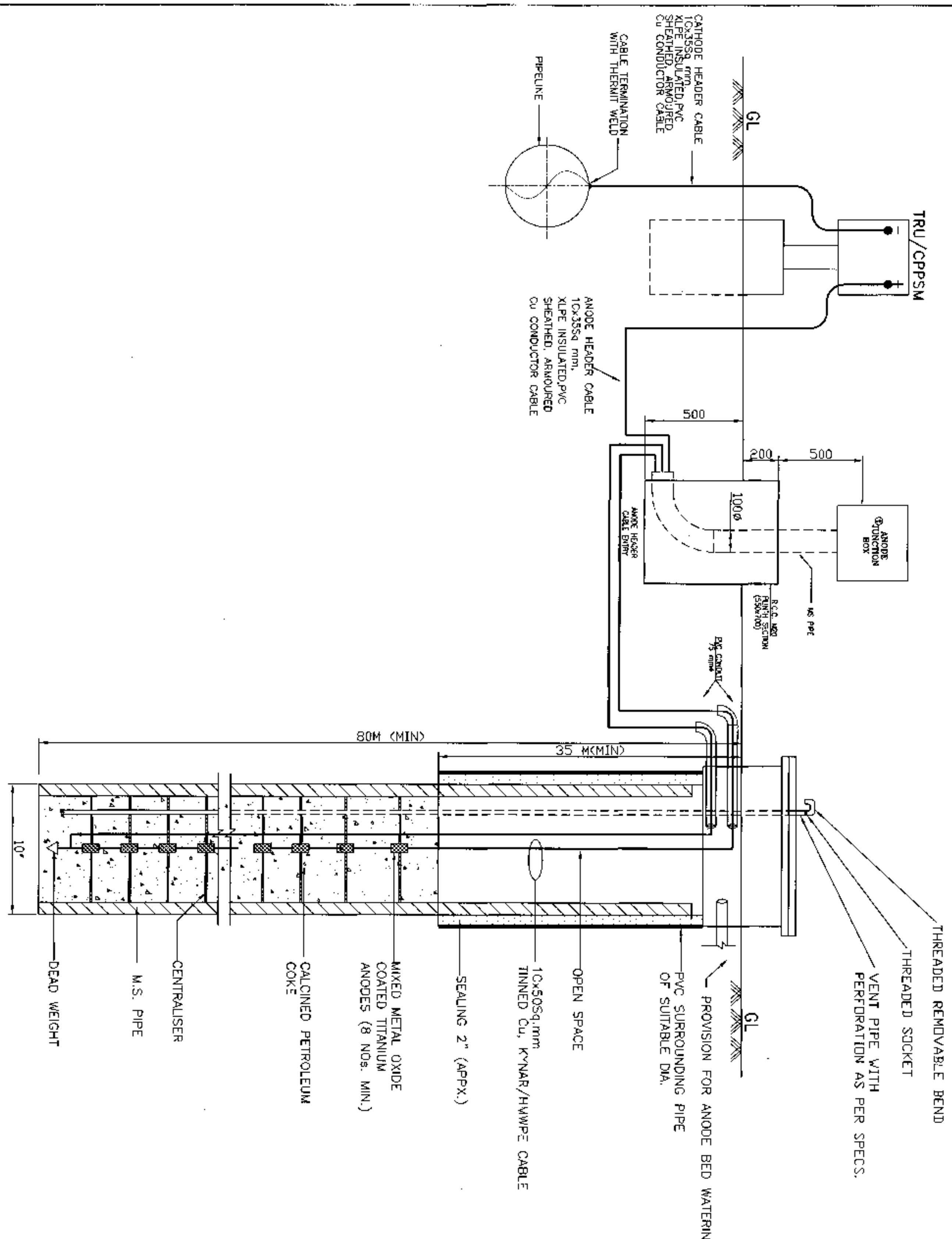
AJB	ANODE JUNCTION BOX
TRU	TRANSFORMER RECTIFIER UNIT
CPSM	CATHODIC PROTECTION POWER SUPPLY MODULE

Q1	SCHEDULE OF ANODE JUNCTION BOX (200-9900-40-00-00)	
S.NO.	REFERENCE DRAWING	DWG. NO.

PURPOSE	APPROVED FOR CONSTRUCTION
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REVISION	NO.	DATE	BY	REASON	SUBJECT OF REVISION
DESIGNED	1	01/01/2018
CHECKED	2	01/01/2018
APPROVED	3	01/01/2018

STANDARD ELECTRICAL DRAWING			
DEEP WELL ANODE BED WITH STRING ANODE CONSTRUCTION DETAILS			
DWG. FILE NO.	DWG. NO.	SCALE	SHEET
STD-790-00	9200-9900-4000-292-00	1:1	1 OF 1



Scanned on 21.11.18, 8-29879

NOTES:-

1. The work shall be done in accordance with the specifications of the Indian Standards Institution (ISI) and the Bureau of Indian Standards (BIS).

2. The work shall be done in accordance with the specifications of the Indian Standards Institution (ISI) and the Bureau of Indian Standards (BIS).

3. The work shall be done in accordance with the specifications of the Indian Standards Institution (ISI) and the Bureau of Indian Standards (BIS).

4. The work shall be done in accordance with the specifications of the Indian Standards Institution (ISI) and the Bureau of Indian Standards (BIS).

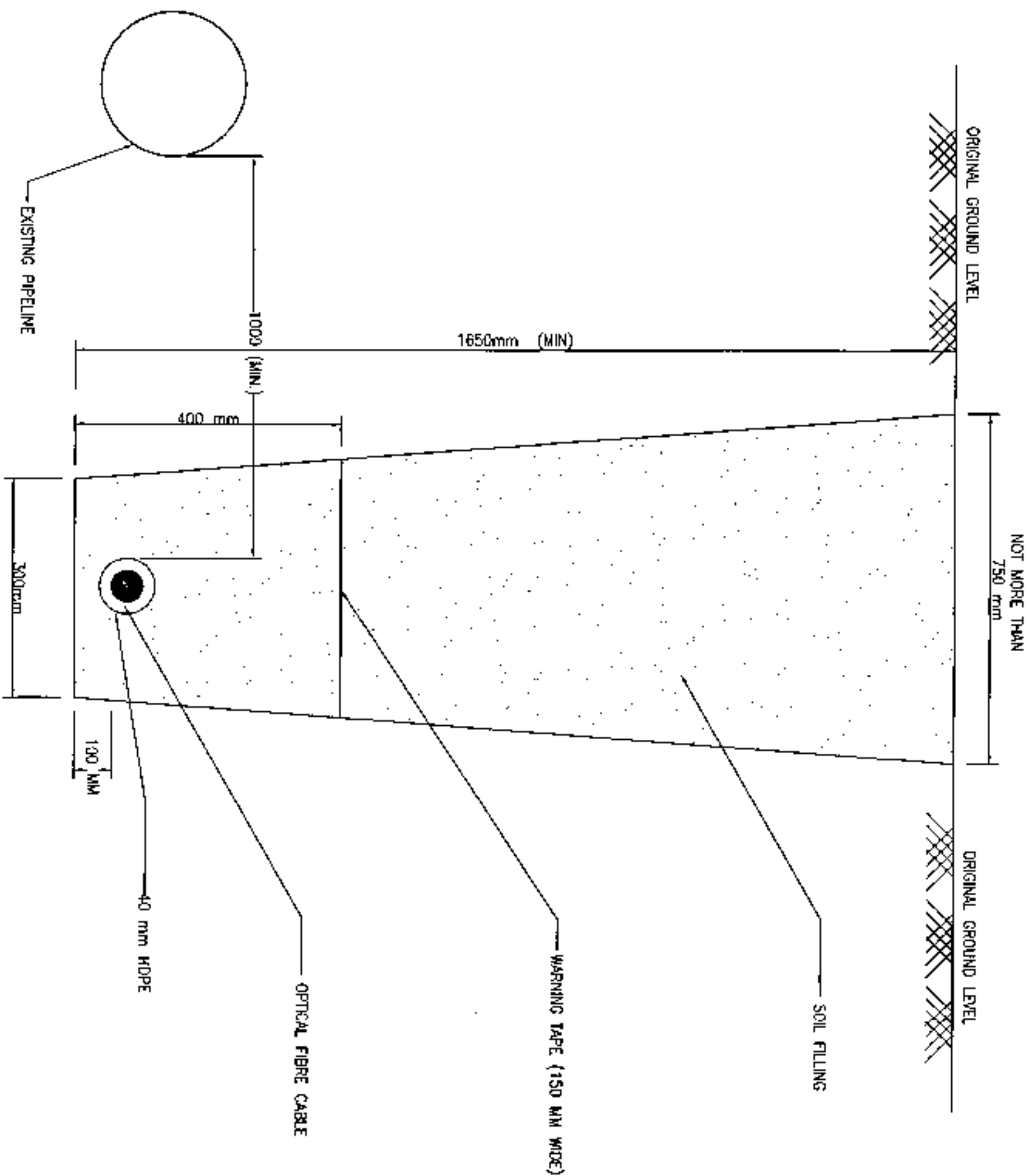
5. The work shall be done in accordance with the specifications of the Indian Standards Institution (ISI) and the Bureau of Indian Standards (BIS).

PURPOSE: APPROVED FOR CONSTRUCTION

6. The work shall be done in accordance with the specifications of the Indian Standards Institution (ISI) and the Bureau of Indian Standards (BIS).

7. The work shall be done in accordance with the specifications of the Indian Standards Institution (ISI) and the Bureau of Indian Standards (BIS).

8. The work shall be done in accordance with the specifications of the Indian Standards Institution (ISI) and the Bureau of Indian Standards (BIS).



NOTES:-

1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. CONTRACTOR SHALL SUPPLY & PUT SUITABLE SIZE END CAPS AT BOTH THE ENDS OF EACH HDPE SECTION TO SEAL EACH HDPE DUCT SECTION AFTER LAYING TO PREVENT INGRESS OF SILT, WATER, LITTER, DUST ETC., PRIOR TO BACKFILLING. AT THE END OF EACH DAY'S WORK, THE OPEN ENDS OF THE HDPE PIPE SECTION SHALL BE TIGHTLY CLOSED WITH END CAPS TO PREVENT THE ENTRY OF DIRT/MUD, WATER OR ANY FOREIGN MATTER INTO HDPE PIPES UNTIL THE WORK IS RESUMED.
3. 100 MM SOFT SOIL PADDING SHALL BE DONE AT BOTTOM OF THE TRENCH PRIOR TO LAYING HDPE PIPE.
4. CABLE SEALING PLUG SHALL BE USED TO SEAL THE ENDS OF THE DUCT PERFECTLY AFTER THE CABLE IS LAYED IN THE DUCT IN ORDER TO PREVENT THE ENTRY OF DIRT, WATER, MOISTURE, INSECTS, RODENTS ETC. THIS IS REQUIRED TO BE INSTALLED AT ALL THE PLACES WHERE CABLE HAS COME OUT OF THE DUCT EITHER FOR JOINTING OR ENTRY INTO THE BUILDING AS REQUIRED.
5. AFTER 40 CM OF BACK FILLING A WARNING TAPE OF 150 MM WIDE MARKED AS "WARNING-LOCL OPTICAL FIBRE CABLE BELOW" IN ENGLISH, HINDI AND LOCAL LANGUAGE SHALL BE PROVIDED THROUGH OUT THE LENGTH OF HDPE PIPE.

S.NO.	REFERENCE	DRAWING	DWG. NO.

PURPOSE	APPROVED FOR CONSTRUCTION

NO.	DATE	DESIGNED	CHECKED	APPROVED	SUBJECT OF REVISION
01	18.5.17	IN. SQ.	IN. SQ.	IN. SQ.	
02	07.7.17	IN. SQ.	IN. SQ.	IN. SQ.	

श्रीधर अय्यन कोर्पोरेट लिमिटेड (मिशनरिस)
INDIAN OIL CORPORATION LIMITED (PIPELINES)

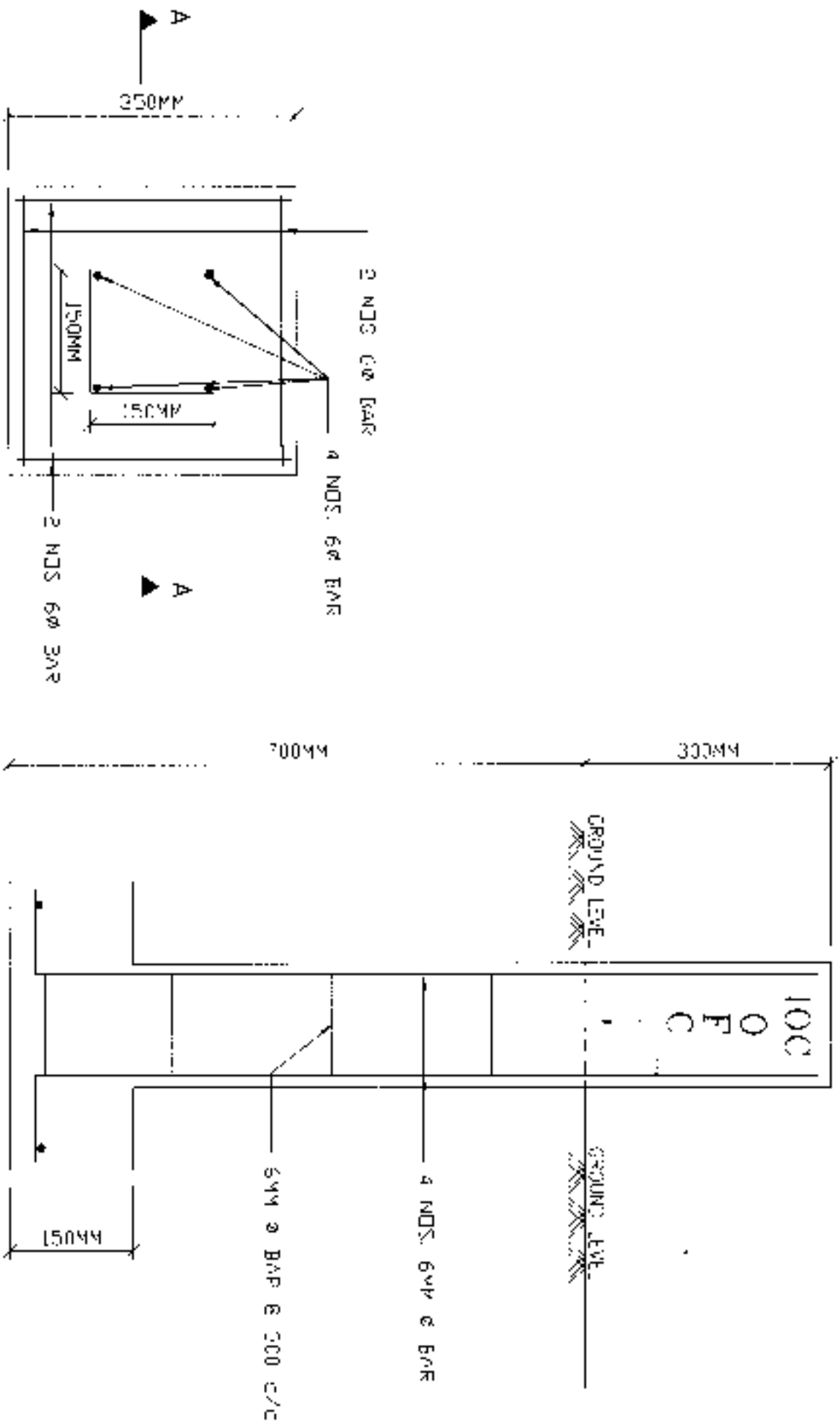
STANDARD TELECOM. DRAWING

OFC CABLE LAYING IN PLAIN AREA IN A SEPARATE TRENCH

CAD FILE NO.	DWG. NO.	SCALE	SIZE	SHEET
STD-316-01	9200-99900-406-255-01	N.T.S	A3	1 OF 1


NOTES :-

- 1 ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
- 2 ALL CONCRETE 1:2:4 MIX.
- 3 ALL REINFORCEMENT PLAN ALL ROUNDS / BAR.
- 4 ALL EXPOSED METAL AND FITTINGS SHALL BE GALVANIZED.
- 5 EXPOSED FILLER COLOUR - YELLOW
LETTERS - LEAD WH- RED/ BLACK
- 6 LETTERS 10 MM HEIGHTS (CHPL - 3 MM WIDTH 10 MM)



PLAN

SECTION A-A


इंडियन ऑयल कॉर्पोरेशन लिमिटेड (गोपनीय)
INDIAN OIL CORPORATION LIMITED (PIPE LINES)
 STANDARD TELECOM. DRAWING

HDPF & OFC MARKER

C&D FILE NO. DWG. NO. SCALE SIZE SHEET
 510-307 9200-99900-406-257-00 N:1.5 A1 1 OF 1

IC L A-2 450 x 297

[illegible]

7M VERTICAL RAISE, 80°M



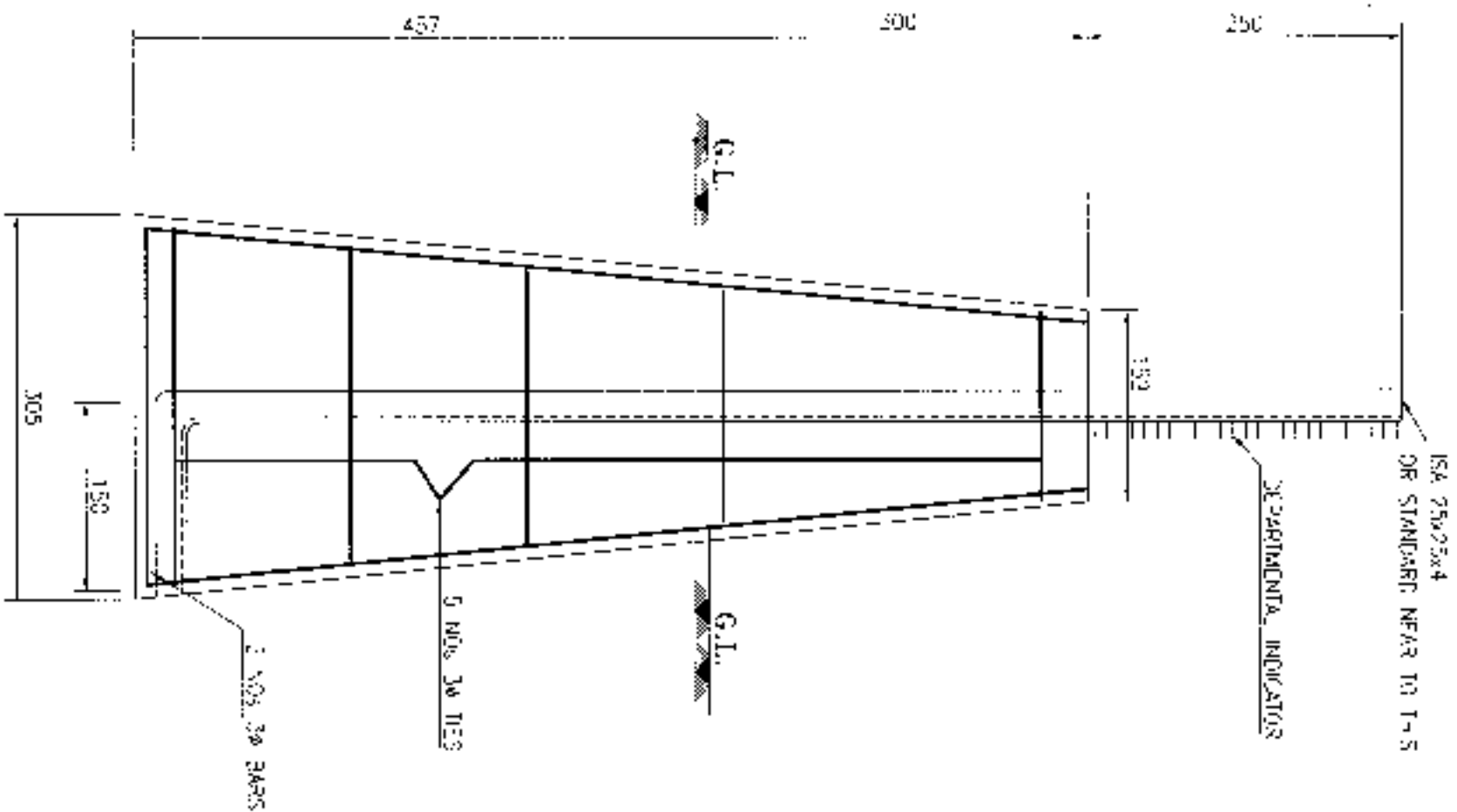
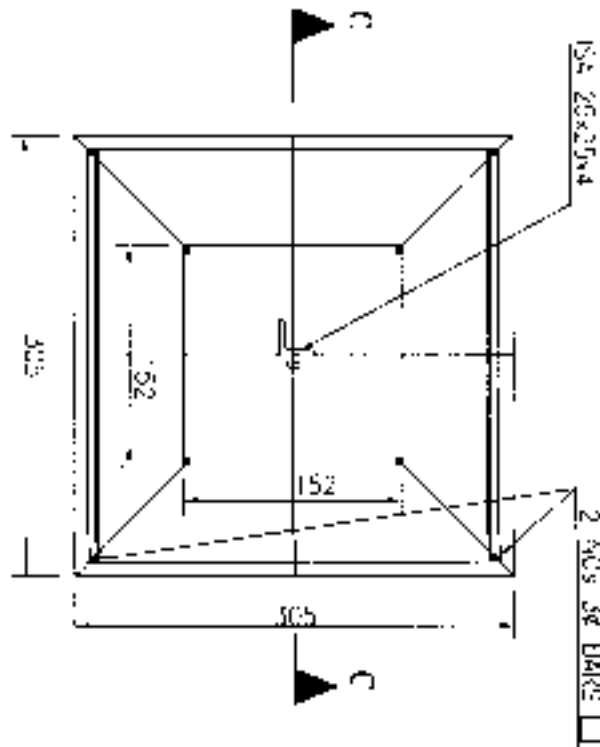
PURPOSE: APPROVED FOR CONSTRUCTION

STATION 4100 0000 0000 0000
INDIAN OIL CORPORATION LIMITED - 000000
STATION 4100 0000 0000 0000

DUCT LAYOUT - OR BLOWING TEST

STATION 4100 0000 0000 0000

STATION 4100 0000 0000 0000



SECTION C-C

NOTES:-

1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. ALL CONCRETE 1:2:4 MIX.
3. ALL REINFORCEMENT PLAIN B.S. ROUNDS/SMALL.
4. ALL EXPOSED METAL AND FITTINGS SHALL BE GALVANIZED.
5. THE OFC MARKER PLATE SHALL BE OF MS OF 4 MM THICKNESS THE MARKING ON THE PLATE SHALL BE ACHIEVED THROUGH CUT OUT.
6. COLOUR OF INDICATOR PLATE TO BE DARK ORANGE.
7. DEPARTMENTAL INDICATOR PLATE AND MOUNTING ANGLE TO BE WELDED.

STNO	REFERENCE DRAWING	DWG NO

PURPOSE ☐ APPROVED FOR CONSTRUCTION

REVISED DRAWN	DESIGNED	CHECKED	APPROVED	SUBMITTED	REVISION
01/10/2018	SSR	SSR	SSR	SSR	
02/10/2018	SSR	SSR	SSR	SSR	
03/10/2018	SSR	SSR	SSR	SSR	
04/10/2018	SSR	SSR	SSR	SSR	
05/10/2018	SSR	SSR	SSR	SSR	
06/10/2018	SSR	SSR	SSR	SSR	
07/10/2018	SSR	SSR	SSR	SSR	
08/10/2018	SSR	SSR	SSR	SSR	
09/10/2018	SSR	SSR	SSR	SSR	
10/10/2018	SSR	SSR	SSR	SSR	
11/10/2018	SSR	SSR	SSR	SSR	
12/10/2018	SSR	SSR	SSR	SSR	
13/10/2018	SSR	SSR	SSR	SSR	
14/10/2018	SSR	SSR	SSR	SSR	
15/10/2018	SSR	SSR	SSR	SSR	
16/10/2018	SSR	SSR	SSR	SSR	
17/10/2018	SSR	SSR	SSR	SSR	
18/10/2018	SSR	SSR	SSR	SSR	
19/10/2018	SSR	SSR	SSR	SSR	
20/10/2018	SSR	SSR	SSR	SSR	
21/10/2018	SSR	SSR	SSR	SSR	
22/10/2018	SSR	SSR	SSR	SSR	
23/10/2018	SSR	SSR	SSR	SSR	
24/10/2018	SSR	SSR	SSR	SSR	
25/10/2018	SSR	SSR	SSR	SSR	
26/10/2018	SSR	SSR	SSR	SSR	
27/10/2018	SSR	SSR	SSR	SSR	
28/10/2018	SSR	SSR	SSR	SSR	
29/10/2018	SSR	SSR	SSR	SSR	
30/10/2018	SSR	SSR	SSR	SSR	
31/10/2018	SSR	SSR	SSR	SSR	
01/11/2018	SSR	SSR	SSR	SSR	
02/11/2018	SSR	SSR	SSR	SSR	
03/11/2018	SSR	SSR	SSR	SSR	
04/11/2018	SSR	SSR	SSR	SSR	
05/11/2018	SSR	SSR	SSR	SSR	
06/11/2018	SSR	SSR	SSR	SSR	
07/11/2018	SSR	SSR	SSR	SSR	
08/11/2018	SSR	SSR	SSR	SSR	
09/11/2018	SSR	SSR	SSR	SSR	
10/11/2018	SSR	SSR	SSR	SSR	
11/11/2018	SSR	SSR	SSR	SSR	
12/11/2018	SSR	SSR	SSR	SSR	
13/11/2018	SSR	SSR	SSR	SSR	
14/11/2018	SSR	SSR	SSR	SSR	
15/11/2018	SSR	SSR	SSR	SSR	
16/11/2018	SSR	SSR	SSR	SSR	
17/11/2018	SSR	SSR	SSR	SSR	
18/11/2018	SSR	SSR	SSR	SSR	
19/11/2018	SSR	SSR	SSR	SSR	
20/11/2018	SSR	SSR	SSR	SSR	
21/11/2018	SSR	SSR	SSR	SSR	
22/11/2018	SSR	SSR	SSR	SSR	
23/11/2018	SSR	SSR	SSR	SSR	
24/11/2018	SSR	SSR	SSR	SSR	
25/11/2018	SSR	SSR	SSR	SSR	
26/11/2018	SSR	SSR	SSR	SSR	
27/11/2018	SSR	SSR	SSR	SSR	
28/11/2018	SSR	SSR	SSR	SSR	
29/11/2018	SSR	SSR	SSR	SSR	
30/11/2018	SSR	SSR	SSR	SSR	
01/12/2018	SSR	SSR	SSR	SSR	
02/12/2018	SSR	SSR	SSR	SSR	
03/12/2018	SSR	SSR	SSR	SSR	
04/12/2018	SSR	SSR	SSR	SSR	
05/12/2018	SSR	SSR	SSR	SSR	
06/12/2018	SSR	SSR	SSR	SSR	
07/12/2018	SSR	SSR	SSR	SSR	
08/12/2018	SSR	SSR	SSR	SSR	
09/12/2018	SSR	SSR	SSR	SSR	
10/12/2018	SSR	SSR	SSR	SSR	
11/12/2018	SSR	SSR	SSR	SSR	
12/12/2018	SSR	SSR	SSR	SSR	
13/12/2018	SSR	SSR	SSR	SSR	
14/12/2018	SSR	SSR	SSR	SSR	
15/12/2018	SSR	SSR	SSR	SSR	
16/12/2018	SSR	SSR	SSR	SSR	
17/12/2018	SSR	SSR	SSR	SSR	
18/12/2018	SSR	SSR	SSR	SSR	
19/12/2018	SSR	SSR	SSR	SSR	
20/12/2018	SSR	SSR	SSR	SSR	
21/12/2018	SSR	SSR	SSR	SSR	
22/12/2018	SSR	SSR	SSR	SSR	
23/12/2018	SSR	SSR	SSR	SSR	
24/12/2018	SSR	SSR	SSR	SSR	
25/12/2018	SSR	SSR	SSR	SSR	
26/12/2018	SSR	SSR	SSR	SSR	
27/12/2018	SSR	SSR	SSR	SSR	
28/12/2018	SSR	SSR	SSR	SSR	
29/12/2018	SSR	SSR	SSR	SSR	
30/12/2018	SSR	SSR	SSR	SSR	
31/12/2018	SSR	SSR	SSR	SSR	

INDIAN OIL CORPORATION LIMITED (पेट्रोलियम)
STANDARD TELECOM DRAWING

PIT MARKER

DWG. L. NO.	DWG. NO.	SCALE	S. CL.	S. ILL.
STD 201	4225 406 25' 00'	N.T.S.	A5	1 OF 1

OFC A-3 422 X 297

NOTES:-

1. The above schedule is for the purpose of reference only and is not to be taken as a final schedule.

1.0 KM

1.0 KM

1.0 KM

DATE

NO. OF SHEETS

SHEET NO.

PURPOSE APPROVED FOR CONSTRUCTION

1.0 KM

INDIAN OIL CORPORATION LIMITED

SKETCH OF PIPELINE ALONG WITH
HDPE (OVERLAPPING)

STD-1200 3200-00000-400 255-01

2.0 KM

**APPROVED FORMAT FOR
RECORD OF INSTALLATION OF JOINT PIT**



STANDARD FORMAT NO. : IOCL-PL-TC-FORM-03-REV000

PROJECT:

SHEET 1 of 1

SECTION :

DATE:

[illegible]

REMARKS:

Contractor
Signature :
Name :
Designation :

For and on behalf of Owner/Owner's Consultant

Signature :
Name :
Designation :

**APPROVED FORMAT FOR
RECORD OF CABLE BLOWING AT HDD CROSSINGS
(ROAD/ DRAIN)**



STANDARD FORMAT NO.: IOCL-PL-TC-FORM-04-REV00

PROJECT:

SHEET 1 of 1

SHEET 1 of 1

SECTION :

DATE:

[illegible]

REMARKS:

NOTE:-

a) THE OFC BLOWING ACROSS THE HDD CROSSING (ROAD/ DRAIN) SHALL BE DONE ALONG WITH THE OFC BLOWING IN THE RESPECTIVE MAINLINE SECTION

b) ANY JOINT LOCATION OF OFC [IN VICINITY OF HDD CROSSING (ROAD/ DRAIN), IF ANY] SHALL BE MINIMUM 30 MTRS AWAY FROM HDD CROSSING ENDS AT BOTH SIDES.

c) ALSO, 30 MTRS ON EITHER SIDE ACROSS THE HDD CROSSING (ROAD/ DRAIN), THE HDPE CONDUIT SHALL BE OF SINGLE PIECE AND IN NO CASE JOINING OF HDPE CONDUIT SHALL BE ALLOWED.

Contractor

Signature :
Name :
Designation :

For and on behalf of Owner/Owner's Consultant

Signature :
Name :
Designation :

**APPROVED FORMAT FOR TEMPLATE OF
RFID MARKERS**



**STANDARD FORMAT NO. : IOCL-PL-TC-
FORM-05-REV00**

PROJECT:

SHEET 1 of 1

TEMPLATE FOR RFID MARKERS

LABEL	DESCRIPTION
1. COMPANY	INDIAN OIL
2. DESCRPTN	24F(18+6) OFC KGPL
3. JOINT NO	_____
4. CHAINAGE	_____ KM
5. JT_DATE	DD/MM/YYYY
6. JT_TYPE	ORIGINAL / REPAIR/ JUNCTION

NOTE:- LABEL = 8 CHARACTERS, DESCRIPTION = 14 CHARACTERS , TOTAL 6 LINES

- 10 digit unique ID number of Electronic Marker - PRESET
- User defined data - 6 lines
- 8 character label per line
- 14 character description per line



INDIAN OIL CORPORATION LIMITED
PIPELINES DIVISION
FORMAT FOR PRE-LAYING & POST-LAYING OPTICAL LOSS

IOCL-PL-TC-FORM-06-00

Issue date: 27.12.2019

Revision No.: 00

Revision date: --

Section _____

Date _____

Cable drum no. _____

FIBRE NO.	FIBRE COLOR	FIBER TUBE COLOR	Pre-laying optical loss		Post laying optical loss		Variation in loss should not be more than 0.1 db/Km* (YES/NO)
			Optical distance	Optical loss in dB/Km	Optical distance	Optical loss in dB/Km	
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							
13.							
14.							
15.							
16.							
17.							
18.							
19.							
20.							
21.							
22.							
23.							
24.							

*** While calculation of variation in Attenuation (Db/Km) , we have to exclude splice losses (if any) post laying of OFC.**

Signatures:

Executed by: _____

Reviewed by: _____

APPROVED FORMAT FOR SPLICE/ FIBRE LOSS MEASUREMENT								STANDARD FORMAT NO. : IOCL-PL-TC-FORM-01-REV00					
PROJECT:						SHEET 1 of 2							
SECTION :						DATE :							
TOTAL NUMBER OF JOINTS IN THE SECTION :						Nos		TOTAL CABLE LENGTH IN THE SECTION :				KMS	
TESTING EQUIPMENT(OTDR) : Make -						Model -		Sr. No. -					
WAVELENGTH :													
FIBRE NO.	JOINT NO. -			JOINT NO. -			JOINT NO. -			TOTAL SECTION LOSS			
	Distance from Station 'A' :	Mtrs		Distance from Station 'A' :	Mtrs		Distance from Station 'A' :	Mtrs					
	Distance from Station 'B' :Mtrs			Distance from Station 'B' :Mtrs			Distance from Station 'B' :Mtrs						
	SPLICE LOSS (db)			SPLICE LOSS (db)			SPLICE LOSS (db)			SPLICE LOSS (db)			
	Station 'A'	Station 'B'	Average	Station 'A'	Station 'B'	Average	Station 'A'	Station 'B'	Average	Station 'A'	Station 'B'		
1.													
2.													
3.													
4.													
5.													
6.													
7.													
8.													
9.													
10.													
11.													
12.													

REMARKS :

NOTE : 1) Wherever, the splice loss is (-), same to be considered Zero for calculating the average loss.

2) Splice Loss is to be measured at all the cable joints from both directions.

3) Average Splice loss should be less than 0.10 db/splice.

Contractor

Signature : _____

Name : _____

Designation : _____

For and on behalf of Owner/Owner's Consultant

Signature : _____

Name : _____

Designation : _____

APPROVED FORMAT FOR SPLICE/ FIBRE LOSS MEASUREMENT



STANDARD FORMAT NO. : IOCL-PL-TC-FORM-01-REV00
PROJECT:
SHEET 2 of 2

SECTION :

DATE :

TOTAL NUMBER OF JOINTS IN THE SECTION :

Nos

TOTAL CABLE LENGTH IN THE SECTION :

KMS

TESTING EQUIPMENT(OTDR) : Make -

Model -

Sr. No. -

WAVELENGTH :

FIBRE NO.	JOINT NO. -			JOINT NO. -			JOINT NO. -			TOTAL SECTION LOSS	
	Distance from Station 'A' :Mtrs			Distance from Station 'A' :Mtrs			Distance from Station 'A' :Mtrs				
	Distance from Station 'B' :Mtrs			Distance from Station 'B' :Mtrs			Distance from Station 'B' :Mtrs				
	SPLICE LOSS (db)			SPLICE LOSS (db)			SPLICE LOSS (db)				
	Station 'A'	Station 'B'	Average	Station 'A'	Station 'B'	Average	Station 'A'	Station 'B'	Average	Station 'A'	Station 'B'
13.											
14.											
15.											
16.											
17.											
18.											
19.											
20.											
21.											
22.											
23.											
24.											

REMARKS :

- NOTE : 1) Wherever, the splice loss is (-), same to be considered Zero for calculating the average loss.
2) Splice Loss is to be measured at all the cable joints from both directions.
3) Average Splice loss should be less than 0.10 db/splice.

Contractor
Signature :
Name :
Designation :

For and on behalf of Owner/Owner's Consultant
Signature :
Name :
Designation :

**APPROVED FORMAT FOR
RECORD OF CABLE BLOWING DURING THE DAY**



STANDARD FORMAT NO. : IOCL-PL-TC-FORM-02-REV000

PROJECT: **SHEET 1 of 1**

SECTION :

DATE:

[illegible]

REMARKS:

Contractor
Signature :
Name :
Designation :

For and on behalf of Owner/Owner's Consultant
Signature :
Name :
Designation :

Section X

PIPING MATERIAL SPECIFICATION (PMS)

1 Coding of Piping Classes

Each class is named by a code consisting of four parts:

First part

A figure designating the rating and the code:

- 1 = 150 lbs ANSI
- 3 = 300 lbs ANSI
- 6 = 600 lbs ANSI
- 9 = 900 lbs ANSI

Second part

A letter designating the material:

- A = Alloy steel
- C = Carbon steel
- F = Fiberglass reinforced plastic/epoxy (FRP)
- G = Galvanized
- P = Plastic (PEHD, ...)
- S = Stainless steel
- V = PVC

Third part

A sequential number to differentiate two or more piping classes of the same rating and same material but presenting some differences related to the handled fluid.

Fourth part

A letter designating the underground:

- U = Underground

1.2. Wall Thickness

The wall thickness of pipe shall be as follows:

Wall thickness of pipe shall be calculated as specified in the applicable sections of:

- ANSI B 31.8 for classes covering the main process and auxiliary gas lines.
- ANSI B 31.3 for classes covering utilities lines.

1.3. Corrosion Allowance

The minimum corrosion allowance used to calculate wall thickness as follows:

- Carbon steel and ferritic alloys in classes calculated following ANSI B 31.8 : 1.6 mm
- Carbon steel and ferritic alloys in classes calculated following ANSI B 31.3 : 1.6 mm
- Stainless steel : 0 mm
- Plastic and FRP pipes: 0 mm.

1.4. Wall Thickness Calculation

- a) Pipes for gas application have to comply with ASME/ANSI B 31.8 code. Pipe wall thickness will be calculated as follows :


$$t = \frac{PD}{2 S F E T} + c \quad (1)$$


- t = nominal wall thickness (mm)
P = design pressure (MPa)
S = minimum yield strength (MPa)
D = nominal outside diameter (mm)
F = design factor = 0.4
E = longitudinal joint factor
= 1.0 for API 5LX 52 (Seamless or HFW)
T = temperature derating factor = 1.0
C = corrosion allowance (mm)


- b) Pipes for utilities lines have a wall thickness complying with ASME/ANSI B 31.3 code :


$$t = \frac{PD}{2 (SE + PY)} + c \quad (1+a)$$

- t = nominal wall thickness (mm)
S = allowable stress (MPa)
P = design pressure (MPa)
E = longitudinal joint factor
Y = coefficient as per table 304.1.1
C = corrosion allowance (mm)
a = negative fabrication tolerance (%)

		PIPING SPECIFICATION		P.020486 G 11076 M701 (3C1)	
				SHEET 1 OF 6	
BASIC PIPING SPECIFICATION DATAS		MAXIMUM DESIGN CONDITIONS			
		TEMPERATURE ° C		PRESSURE bar g	
PRIMARY FLANGE RATING	300#-RF	CARBON STEEL	- 20 to 65	NG	49.00
				AG	49.00
BASIC MATERIAL	CARBON STEEL				
CORROSION ALLOWACE	1.6 mm				
X-RAYS	100%				
SIZE RANGE	1/2"-16"				
CODE	ANSI B 31.8				
FLUIDS					
0	ISSUE FOR WORK	06.11.2023	NK	RG	PG
REV	DESCRIPTION	DATE	PREPARED BY	CHECKED BY	APPROVED BY

			PIPING SPECIFICATIONS				SPECIFICATION NO P.020486 G 11076 M701 (3C1)
							SHEET 2 OF 6
ITEM	SHORT CODE	SIZE FROM-THRU	END CONNECTION	RATING AND/OR SCHED.	DIMENSION STANDARD	MATERIAL	REMARKS
PIPES	P	1/2" - 1 1/2"	PE-SEAMLESS	SCH 80	ANSI B36.10	ASTM A 106 Gr. B	SEAMLESS
		2" - 3"	BE-ANSI B16.25	SCH 80	ANSI B36.10	ASTM A 106 Gr. B	SEAMLESS
		4" - 8"	BE-ANSI B16.25	6.4 mm	API 5L	API 5L X 52	HFW / SMLS
		10" - 12"	BE-ANSI B16.25	6.4 mm	API 5L	API 5L X 56	HFW / SMLS/ LSAW
		16"	BE-ANSI B16.25	7.1 mm	API 5L	API 5L X 56	HFW / SMLS/ LSAW
ELBOWS 90 LR	E	1/2" - 1 1/2"	SW	CLASS 3000	ASME B16.11	ASTM A105	SEAMLESS
		2"-3"	BE-ASME B16.25	SCH 80	ASME B16.9	ASTM A234 Gr. WPB	SEAMLESS
		4" - 8"	BW - ANSI B16.25	SEE PIPE	ANSI B16.9	API 5L X 52 or ASTM A860 WPHY 52	
		10" - 16"				API 5L X 56 or ASTM A860 WPHY 60	
ELBOWS 45 LR	E45	1/2" - 1 1/2"	SW - ASME B16.25	CLASS 3000	ASME B16.11	ASTM A105	SEAMLESS
		2"-3"	BE-ASME B16.25	SCH 80	ASME B16.9	ASTM A234 Gr. WPB	SEAMLESS
		4" - 8"	BW - ANSI B16.25	SEE PIPE	ANSI B16.9	API 5L X 52 or ASTM A860 WPHY 52	
		10" - 16"				API 5L X 56 or ASTM A860 WPHY 60	
REDUCERS CONCENTRIC	RCO	1/2" - 1 1/2"	SW - ASME B16.25	CLASS 3000	ASME B16.11	ASTM A105	SEAMLESS
		2"-3"	BE-ASME B16.25	SCH 80	ASME B16.9	ASTM A234 Gr. WPB	SEAMLESS
		4" - 8"	BW - ANSI B16.25	SEE PIPE	ANSI B16.9	API 5L X 52 or ASTM A860 WPHY 52	
		10" - 16"				API 5L X 56 or ASTM A860 WPHY 60	
REDUCERS ECCENTRIC	REC	1/2" - 1 1/2"	SW - ASME B16.25	CLASS 3000	ASME B16.11	ASTM A105	SEAMLESS
		2"-3"	BE-ASME B16.25	SCH 80	ASME B16.9	ASTM A234 Gr. WPB	SEAMLESS
		4" - 8"	BW - ANSI B16.25	SEE PIPE	ANSI B16.9	API 5L X 52 or ASTM A860 WPHY 52	
		10" - 16"				API 5L X 56 or ASTM A860 WPHY 60	
TEES EQUAL	T	1/2" - 1 1/2"	SW - ASME B16.25	CLASS 3000	ASME B16.11	ASTM A105	SEAMLESS
		2"-3"	BE-ASME B16.25	SCH 80	ASME B16.9	ASTM A234 Gr. WPB	SEAMLESS
		4" - 8"	BW - ANSI B16.25	SEE PIPE	ANSI B16.9	API 5L X 52 or ASTM A860 WPHY 52	
		10" - 16"				API 5L X 56 or ASTM A860 WPHY 60	
TEES RED	TR	1/2" - 1 1/2"	SW - ASME B16.25	CLASS 3000	ASME B16.11	ASTM A105	SEAMLESS
		2"-3"	BE-ASME B16.25	SCH 80	ASME B16.9	ASTM A234 Gr. WPB	For Branch Size, Please refer to the Chart given in Sheet 6 of this Document.
		4" - 8"	BW - ANSI B16.25	SEE PIPE	ANSI B16.9	API 5L X 52 or ASTM A860 WPHY 52	
		10" - 16"				API 5L X 56 or ASTM A860 WPHY 60	
SOCKOLETS	SOL	1/2" - 1 1/2"	SW - ANSI B16.25	CLASS 3000	MSS-SP-97	ASTM A 105	
THREDOLETS	TOL	1/2" - 1 1/2"	THREADED AS PER ASME B 1.1	CLASS 3000	MSS-SP-97	ASTM A 105	Thredolet shall only be used for Temperature measuring equipments
WELDOLETS	WEL	2"-8"	BW - ANSI B16.25	STD	MSS-SP-97	ASTM A 105	
CAPS	CAP	1/2"- 1 1/2"	SW	SEE PIPE	ANSI B16.9	ASTM A 105	SEAMLESS
		2"	BE-ASME B16.25	SCH 80	ASME B16.9	ASTM A234 Gr. WPB	
		4" - 8"	BW - ANSI B16.25	SEE PIPE	ANSI B16.9	API 5L X 52 or ASTM A860 WPHY 52	
		10" - 18"				API 5L X 56 or ASTM A860 WPHY 60	
NIPPLES	NBEP NOET NBET	1/2" - 1.1/2"	BOTH ENDS PLAIN	80	ANSI B36.10	ASTM A 106 Gr. B	SEAMLESS-LG=100mm
		1/2" - 1.1/2"	ONE END THRD-MNPT	80	ANSI B36.10	ASTM A 106 Gr. B	SEAMLESS-LG=100mm
		1/2" - 1.1/2"	BOTH ENDS THRD-MNPT	80	ANSI B36.10	ASTM A 106 Gr. B	SEAMLESS-LG=100mm
FULL COUPLINGS THRD	CF	1/2" - 1.1/2"	FNPT ANSI B1-20-1	3000#	ANSI B16.11	ASTM A 105	SEAMLESS
CAPS THRD	C2	1/2" - 1.1/2"	FNPT ANSI B1-20-1	3000#	ANSI B16.11	ASTM A 105	SEAMLESS
PLUGS THRD	PL	1/2" - 1.1/2"	MNPT ANSI B1-20-1	3000#	ANSI B16.11	ASTM A 105	SEAMLESS

			PIPING SPECIFICATIONS				SPECIFICATION NO P.020486 G 11076 M701 (3C1)
							SHEET 3 OF 6
ITEM	SHORT CODE	SIZE FROM- THRU	END CONNECTION	RATING AND/OR SCHED.	DIMENSION STANDARD	MATERIAL	REMARKS
WN FLANGES	FLG	1/2" - 1 1/2"	SW	300# SWRF, TO MATCH SCH 80 PIPE	ASME B16.5	ASTM A105	SERRATED FINISH
		2"	BW - ASME B16.25	300# WNRF, TO MATCH SCH STD PIPE	ASME B16.5	ASTM A105	
		4" - 8"	BW - ASME B16.25	300# WNRF, TO MATCH SCH STD PIPE	ASME B16.5	ASTM A 694 F 52	
		10" - 16"	BW - ASME B16.25	300# WNRF, TO MATCH SCH STD PIPE	ASME B16.5	ASTM A 694 F 60	
ORIFICE FLANGES	FRO	1/2" - 1 1/2"	SW	300# SWRF, TO MATCH SCH 80 PIPE	ASME B16.36	ASTM A105	SERRATED FINISH
		2"	BW - ASME B16.25	300# WNRF, TO MATCH SCH STD PIPE	ASME B16.36	ASTM A105	
		4" - 8"	BW - ASME B16.25	300# WNRF, TO MATCH SCH STD PIPE	ASME B16.36	ASTM A 694 F 52	
		10" - 16"	BW - ASME B16.25	300# WNRF, TO MATCH SCH STD PIPE	ASME B16.36	ASTM A 694 F 60	
BLIND FLANGE	FBL	1" - 16"	FLGD	300# RF	ANSI B16.5	ASTM A 105	SERRATED FINISH
SPECTACLE BLINDS	SPB	1" - 16"		300# RF	ASME B16.48	ASTM A 105	
RESTRICTION ORIFICES	ROF	All Size		300# RF	ASME B16.36	ASTM A 105	
BOLT	BOL	All Sizes	-	-	ASME / B16.5 / ASME B 18.2.1	ASTM A193 Gr. B7 (HOT DIP GALVANISED, 80 - 100 MICRON)	THREADS AS PER ASME B1.1
NUT	NUT	All Sizes	-	-	ASME B 18.2.2	ASTM A194 GR 2H (HOT DIP GALVANISED, 80 - 100 MICRON)	THREADS AS PER ASME B1.1
GASKET SPIRAL WOUND	GSK	All Sizes	-	300# RF	ASME B 16.20	3.2MM Thick Spiral Wound 316L with CS Outer ring and 316L inner ring and graphite filler.	

			PIPING SPECIFICATIONS				SPECIFICATION NO P.020486 G 11076 M701 (3C1) SHEET 4 OF 6
ITEM	SHORT CODE	SIZE FROM- THRU	END CONNECTION	RATING AND/OR SCHED.	DIMENSION STANDARD	MATERIAL	REMARKS
BALL VALVE (See Note 4)	VBA	1/2" - 1 1/2"	SW	800#	ASME B16.10	BODY : ASTM A105	WRENCH OPERATED.
					ISO EN 17292	BALL : ASTM A182 GR.F316 SEAT : RPTFE	ANTI-STATIC FIRE SAFE
		2" - 4"	FLGD RF:ASME B16.5 or BW :ASME B16.25	300 #	ASME B16.10	BODY : ASTM A216 GR WCB	WRENCH OPERATED.
					API-6D	BALL : ASTM A182 Gr. F316 SEAT : AISI4140+ 75 microns ENP / AIS410	ANTI-STATIC FIRE SAFE
		6" - 16"	FLGD RF:ASME B16.5 or BW :ASME B16.25	300#	ASME B16.10	BODY : ASTM A216 GR WCB	ANTI-STATIC
					API-6D	BALL : ASTM A182 Gr. F316 SEAT : AISI4140+ 75 microns ENP / AIS410	FIRE SAFE GEAR OPERATED - MANUAL / ACTUATED - AS INDICATED IN DATA SHEET
GLOBE VALVE	VGL	1/2" - 1 1/2"	SW: ASME B16.25	800#	ASME B16.10	BODY : ASTM A 105	HANDWHEEL
					ISO 15761	DISC / RING : 13% CR. / SS304L	
						STEM : 13% CR. STEEL (NO CASTING)	
		2" - 4"	FLGD RF:ASME B16.5 or BW: ASME B16.25	300#	ASME B16.10	BODY : ASTM A216 GR WCB	HANDWHEEL
					BS 1873	DISC / RING : 13% CR. / SS304L	
						STEM : 13% CR. STEEL (NO CASTING)	
SWING CHECK VALVE	VCH	1/2" - 1 1/2"	SW: ASME B16.25	800#	ASME B16.10	BODY : ASTM A 105	
						DISC / RING : 13% CR. / SS304L	
						HINGE PIN : 13% CR. STEEL (NO CASTING)	
		2 1/2" - 16"	FLGD RF:ASME B16.5 or BW: ASME B16.25	300#	ASME B16.10	BODY : ASTM A216 GR WCB	
					API-6D	DISC / RING : 13% CR. / SS304L	
						HINGE PIN : 13% CR. STEEL (NO CASTING)	



PIPING SPECIFICATIONS

SPECIFICATION NO
P.020486 G 11076 M701
(3C1)

SHEET 5 OF 6

REDUCERS CHART

SMALL SIZE

	1/2"	3/4"	1"	1.1/2"	2"	3"	4"	6"	8"	10"	12"	14"	16"	18"	20"
1/2"															
3/4"	X														
1"	X	X													
1.1/2"	X	X	X												
2"		X	X	X											
3"				X	X										
4"				X	X	X									
6"						X	X								
8"							X	X							
10"							X	X	X						
12"								X	X	X					
14"								X	X	X	X				
16"									X	X	X	X			
18"										X	X	X	X		
20"											X	X	X	X	

LEGEND

X : CONCENTRIC AND ECCENTRIC REDUCERS- BW



PIPING SPECIFICATIONS

SPECIFICATION NO
P.020486 G 11076 M701
(3C1)
SHEET 6 OF 6


BRANCH CHART


BRANCH SIZE


	1/2"	3/4"	1"	1.1/2"	2"	2.1/2"	3"	4"	6"	8"	10"	12"	14"	16"	18"	20"
1/2"	T															
3/4"	TR	T														
1"	TR	TR	T													
1.1/2"	TR	TR	TR	T												
2"	SOL	TR	TR	TR	T											
2.1/2"	SOL	SOL	TR	TR	TR	T										
3"	SOL	SOL	SOL	TR	TR	TR	T									
4"	SOL	SOL	SOL	TR	TR	TR	TR	T								
6"	SOL	SOL	SOL	SOL	WOL	TR	TR	TR	T							
8"	SOL	SOL	SOL	SOL	WOL	WOL	WOL	TR	TR	T						
10"	SOL	SOL	SOL	SOL	WOL	WOL	WOL	TR	TR	TR	T					
12"	SOL	SOL	SOL	SOL	WOL	WOL	WOL	WOL	TR	TR	TR	T				
14"	SOL	SOL	SOL	SOL	WOL	WOL	WOL	WOL	TR	TR	TR	TR	T			
16"	SOL	SOL	SOL	SOL	WOL	WOL	WOL	WOL	TR	TR	TR	TR	TR	T		
18"	SOL	SOL	SOL	SOL	WOL	WOL	WOL	WOL	WOL	TR	TR	TR	TR	TR	T	
20"	SOL	SOL	SOL	SOL	WOL	WOL	WOL	WOL	WOL	TR	TR	TR	TR	TR	TR	T


LEGEND

T : TEE EQUAL-BW
TR : REDUCING TEE-BW
WOL : WELDOLET- BW
SOL : SOCKOLET-SW

		PIPING SPECIFICATIONS				SPECIFICATION NO. P.020486 G 11076 M702 (3C1U)
						SHEET 1 OF 6
		BASIC PIPING SPECIFICATION DATAS		MAXIMUM DESIGN CONDITIONS		
		TEMPERATURE ° C		PRESSURE bar g		
PRIMARY FLANGE RATING	300#-RF	NG	0 to 45	NG	49.00	
		AG	60	AG	49.00	
BASIC MATERIAL	CARBON STEEL					
CORROSION ALLOWACE	1.6 mm					
X-RAYS	100%					
SIZE RANGE	1/2"-18"					
CODE	ANSI B 31.8					
FLUIDS						
NG : NATURAL GAS						
AG : ACTUATING GAS						
0	ISSUED FOR TENDER	06.11.2023	NK	RG	PG	
REV	DESCRIPTION	DATE	PREPARED BY	CHECKED BY	APPROVED BY	

			PIPING SPECIFICATIONS				SPECIFICATION NO. P.020486 G 11076 M702 (3CIU)
							SHEET 2 OF 6
ITEM	SHORT CODE	SIZE FROM-THRU	END CONNECTION	RATING AND/OR SCHED.	DIMENSION STANDARD	MATERIAL	REMARKS
PIPES	P	1/2" - 2"	BE-ANSI B16.25	80	ANSI B36-10	ASTM A 106 Gr. B	SEAMLESS
		4"	BE-ANSI B16.25	6.4 mm	API 5L	API 5L X 52	ERW / SMLS
		6"	BE-ANSI B16.25	6.4 mm	API 5L	API 5L X 52	ERW / SMLS
		8"	BE-ANSI B16.25	6.4 mm	API 5L	API 5L X 52	ERW / SMLS
		10"	BE-ANSI B16.25	6.4 mm	API 5L	API 5L X 52	ERW / SMLS
		12"	BE-ANSI B16.25	7.2 mm	API 5L	API 5L X 52	ERW / SMLS
		16"	BE-ANSI B16.25	8.7 mm	API 5L	API 5L X 52	ERW / SMLS
		18"	BE-ANSI B16.25	9.5 mm	API 5L	API 5L X 52	ERW / SMLS
ELBOWS 90 LR	E	1/2" - 2"	BW - ANSI B16.25	SEE PIPE	ANSI B16.9	ASTM A 234 WPB	SEAMLESS
		4" - 18"	BW - ANSI B16.25	SEE PIPE	ANSI B16.9	API 5L X 52 or ASTM A860 WPHY 52	
ELBOWS 45 LR	E45	1/2" - 2"	BW - ANSI B16.25	SEE PIPE	ANSI B16.9	ASTM A 234 WPB	SEAMLESS
		4" - 18"	BW - ANSI B16.25	SEE PIPE	ANSI B16.9	API 5L X 52 or ASTM A860 WPHY 52	
ELBOWS 30 LR	E30	1/2" - 2"	BW - ANSI B16.25	SEE PIPE	ANSI B16.9	ASTM A 234 WPB	SEAMLESS
		4" - 18"	BW - ANSI B16.25	SEE PIPE	ANSI B16.9	API 5L X 52 or ASTM A860 WPHY 52	
ELBOWS 22.5 LR	E22.5	1/2" - 2"	BW - ANSI B16.25	SEE PIPE	ANSI B16.9	ASTM A 234 WPB	SEAMLESS
		4" - 18"	BW - ANSI B16.25	SEE PIPE	ANSI B16.9	API 5L X 52 or ASTM A860 WPHY 52	
ELBOWS 15 LR	E15	1/2" - 2"	BW - ANSI B16.25	SEE PIPE	ANSI B16.9	ASTM A 234 WPB	SEAMLESS
		4" - 18"	BW - ANSI B16.25	SEE PIPE	ANSI B16.9	API 5L X 52 or ASTM A860 WPHY 52	
REDUCERS CONCENTRIC	RC	1/2" - 2"	BW - ANSI B16.25	SEE PIPE	ANSI B16.9	ASTM A 234 WPB	SEAMLESS
		4" - 18"	BW - ANSI B16.25	SEE PIPE	ANSI B16.9	API 5L X 52 or ASTM A860 WPHY 52	
REDUCERS ECCENTRIC	RE	1/2" - 2"	BW - ANSI B16.25	SEE PIPE	ANSI B16.9	ASTM A 234 WPB	SEAMLESS
		4" - 18"	BW - ANSI B16.25	SEE PIPE	ANSI B16.9	API 5L X 52 or ASTM A860 WPHY 52	
TEES EQUAL	T	1/2" - 2"	BW - ANSI B16.25	SEE PIPE	ANSI B16.9	ASTM A 234 WPB	SEAMLESS
		4" - 18"	BW - ANSI B16.25	SEE PIPE	ANSI B16.9	API 5L X 52 or ASTM A860 WPHY 52	
TEES RED	TR	1/2" - 2"	BW - ANSI B16.25	SEE PIPE	ANSI B16.9	ASTM A 234 WPB	SEAMLESS
		4" - 18"	BW - ANSI B16.25	SEE PIPE	ANSI B16.9	API 5L X 52 or ASTM A860 WPHY 52	
WELDOLETS	WEL	3/4"-18"	BW - ANSI B16.25	SEE PIPE	MANUFACTURER	ASTM A 105	SEAMLESS
CAPS	C	1/2" - 2"	BW - ANSI B16.25	SEE PIPE	ANSI B16.9	ASTM A 234 WPB	SEAMLESS
		4" - 18"	BW - ANSI B16.25	SEE PIPE	ANSI B16.9	API 5L X 52 or ASTM A860 WPHY 52	
NIPPLES	NBEP NOET NBET	1/2" - 1.1/2"	BOTH ENDS PLAIN	80	ANSI B36-10	ASTM A 106 Gr. B	SEAMLESS-LG=100mm
		1/2" - 1.1/2"	ONE END THRD-MNPT	80	ANSI B36-10	ASTM A 106 Gr. B	SEAMLESS-LG=100mm
		1/2" - 1.1/2"	OTH ENDS THRD-MNPT	80	ANSI B36-10	ASTM A 106 Gr. B	SEAMLESS-LG=100mm
FULL COUPLINGS THRD	CF	1/2" - 1.1/2"	FNPT ANSI B1-20-1	3000#	ANSI B16.11	ASTM A 105	SEAMLESS
CAPS THRD	C2	1/2" - 1.1/2"	FNPT ANSI B1-20-1	3000#	ANSI B16.11	ASTM A 105	SEAMLESS
PLUGS THRD	PL	1/2" - 1.1/2"	MNPT ANSI B1-20-1	3000#	ANSI B16.11	ASTM A 105	SEAMLESS

<div></div>			PIPING SPECIFICATIONS				SPECIFICATION NO. P.020486 G 11076 M702 (3C1U)
							SHEET 3 OF 6
ITEM	SHORT CODE	SIZE FROM- THRU	END CONNECTION	RATING AND/OR SCHED.	DIMENSION STANDARD	MATERIAL	REMARKS
WN FLANGES	F	1/2"- 2"		300# RF	ANSI B16.5	ASTM A 105	
		4" - 18"			ANSI B16.5	ASTM A 694 F 52	Always to be welded on 3C1 pipe
ORIFICE FLANGES	FO	1/2"- 2"		300# RF	ANSI B16.36	ASTM A 105	COMPLETE WITH GASKET BOLTS, NUTS JACK-SCREWS AND PLUGS
		4" - 18"			ANSI B16.36	ASTM A 694 F 52	
BLIND FLANGES	FB	1/2"- 2"		300# RF	ANSI B16.5	ASTM A 105	
		4" - 18"			ANSI B16.5	ASTM A 694 F 52	
DRIP RINGS	DR	1/2"- 2"		300# RF	ANSI B16.36	ASTM A 105	3/4" FNPT OUTLET CONNECTION
		4" - 18"			ANSI B16.36	ASTM A 694 F 52	
SPECTACLE BLINDS	SB	1/2"- 2"		300# RF	ANSI B16.5	ASTM A 515 GR 70	
		4" - 18"			ANSI B16.5	ASTM A 694 F 52	
RESTRICTION ORIFICES	RO	1/2"- 2"		300# RF	ANSI B16.5	ASTM A240 GR 304	
		4" - 18"			ANSI B16.5	ASTM A 694 F 52	
MONOLITHIC	IJ	2"-8"	BW - ANSI B16-25	300#	ANSI B16.5	PIPE PUPS: Same as pipe Material Forged Ring - ASTM A 105	REFER DATA SHEET
INSULATING		4" - 18"	BW - ANSI B16-25	300#	API 5L	PIPE PUPS:API 5L X 52 Forged Ring - ASTM A 694 F52	REFER DATA SHEET
			BW - ANSI B16-25	300#	API 5L	PIPE PUPS:API 5L X 52 Forged Ring - ASTM A 694 F52	REFER DATA SHEET
			BW - ANSI B16-25	300#	API 5L	PIPE PUPS:API 5L X 52 Forged Ring - ASTM A 694 F52	REFER DATA SHEET
JOINTS			BW - ANSI B16-25	300#	API 5L		REFER DATA SHEET
STUD BOLTS	B	1/2" - 18"		300# RF	ANSI B18.2.1 ANSI B18.2.2	ASTM A 193 B 7 HEXAGONAL NUTS ASTM A194 GR 2H	
GASKETS SPIRAL WOUND	G	1/2"-18"		300# RF	API 601 MSS SP 44	WINDING ANSI 304 FILLING PURE GRAPHITE CENTERING RING CS	4.5 mm THK

			PIPING SPECIFICATIONS				SPECIFICATION NO. P.020486 G 11076 M702 (3CIU)
							SHEET 4 OF 6
ITEM	SHORT CODE	SIZE FROM-THRU	END CONNECTION	RATING AND/OR SCHED.	DIMENSION STANDARD	MATERIAL	REMARKS
BALL VALVES	VBA	1/2" - 1 1/2"	FLGD RF:ANSI B16-5	600#	ANSI B16-10	BODY: ASTM A 105 BALL: SS 316	FULL BORE WRENCH OPERATED. FIRE SAFE
		2" - 4"	FLGD RF:ANSI B16-5 or BW :ANSI B16.25	300#	ANSI B16-10	BODY: ASTM A 216 WCB/A234 WPB BALL: (ASTM A 216 WCB / A 234 WPB) with ENP (75 microns)	FULL BORE / REDUCED BORE AS INDICATED IN DATA SHEET DOUBLE BLOCK & BLEED WRENCH OPERATED. FIRE SAFE
		6" - 18"	FLGD RF:ANSI B16-5 or BW :ANSI B16.25	300#	ANSI B16-10	BODY: ASTM A 216 WCB/A234 WPB BALL: (ASTM A 216 WCB / A 234 WPB) with ENP (75 microns)	FULL BORE / REDUCED BORE AS INDICATED DATA SHEET DOUBLE BLOCK & BLEED GEAR OPERATED./ACTUATED (AS PER MR) FIRE SAFE
GLOBE VALVES	VGL	1/2"-1 1/2"	FLGD RF:ANSI B16-5	600#	ANSI B16-10	BODY: ASTM A 105 TRIM: ASTM A182 F6	HANDWHEEL FIRE SAFE
		2" - 18"	FLGD RF:ANSI B16-5	300#	ANSI B16-10	BODY: ASTM A 216 WCB/A234 WPB TRIM: ASTM A182 F6	HANDWHEEL FIRE SAFE
SWING CHECK VALVES	VCH	1/2" - 1 1/2"	FLGD RF:ANSI B16-5	600#	ANSI B16-10	BODY: ASTM A 105 TRIM: ASTM A182 F6	HORIZONTAL INSTALLATION VERTICAL INSTALLATION FLOW UPWARDS
		2"-18"	FLGD RF:ANSI B16-5	300#	ANSI B16-10	BODY: ASTM A 216 WCB TRIM: ASTM A 216 WCB	HORIZONTAL INSTALLATION VERTICAL INSTALLATION FLOW UPWARDS



PIPING SPECIFICATIONS

SPECIFICATION NO.
P.020486 G 11076 M702
(3C1U)

SHEET 5 OF 6

REDUCERS CHART

SMALL SIZE

L
A
R
G
E

S
I
Z
E

	1/2"	3/4"	1"	1.1/2"	2"	3"	4"	6"	8"	10"	12"	14"	16"	18"	20"	24"	28"	30"	32"	36"
1/2"																				
3/4"	X																			
1"	X	X																		
1.1/2"	X	X	X																	
2"		X	X	X																
3"				X	X															
4"				X	X	X														
6"						X	X													
8"							X	X												
10"							X	X	X											
12"								X	X	X										
14"								X	X	X	X									
16"									X	X	X	X								
18"										X	X	X	X							
20"																				
28"																				
30"																				
32"																				
36"																				
42"																				

LEGEND

X :CONCENTRIC AND ECCENTRIC REDUCERS-BW



PIPING SPECIFICATIONS

SPECIFICATION NO.
P.020486 G 11076 M702
(3CIU)

SHEET 6 OF 6

BRANCH CHART

BRANCH SIZE

H
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A
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S
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Z
E

	1/2"	3/4"	1"	1.1/2"	2"	3"	4"	6"	8"	10"	12"	14"	16"	18"	20"	24"	28"	30"	32"	36"
1/2"	T																			
3/4"	TR	T																		
1"	TR	TR	T																	
1.1/2"	W	TR	TR	T																
2"	W	W	TR	TR	T															
3"	W	W	W	TR	TR	T														
4"	W	W	W	W	TR	TR	T													
6"	W	W	W	W	W	TR	TR	T												
8"	W	W	W	W	W	BW	TR	TR	T											
10"	W	W	W	W	W	BW	BW	TR	TR	T										
12"	W	W	W	W	W	BW	BW	BW	TR	TR	T									
14"	W	W	W	W	W	BW	BW	BW	BW	TR	TR	T								
16"	W	W	W	W	W	BW	BW	BW	BW	BW	TR	TR	T							
18"	W	W	W	W	W	BW	BW	BW	BW	BW	TR	TR	T							
24"																				
28"																				
30"																				
32"																				
36"																				

LEGEND

T : TEE EQUAL-BW

TR : REDUCING TEE-BW

W : WELDOLET- BW

BW : BRANCH WELD-CHECK IF REINFORCING PLATE IS NECESSARY ACCORDING ASME B 31.8



PIPING SPECIFICATIONS

SPECIFICATION NO.
P.020486 G 11076 M702
(3CIU)

SHEET 6 OF 6

BRANCH CHART

BRANCH SIZE

	1/2"	3/4"	1"	1.1/2"	2"	3"	4"	6"	8"	10"	12"	14"	16"	18"	20"	24"	28"	30"	32"	36"
1/2"	T																			
3/4"	TR	T																		
1"	TR	TR	T																	
1.1/2"	W	TR	TR	T																
2"	W	W	TR	TR	T															
3"	W	W	W	TR	TR	T														
4"	W	W	W	W	TR	TR	T													
6"	W	W	W	W	W	TR	TR	T												
8"	W	W	W	W	W	BW	TR	TR	T											
10"	W	W	W	W	W	BW	BW	TR	TR	T										
12"	W	W	W	W	W	BW	BW	BW	TR	TR	T									
14"	W	W	W	W	W	BW	BW	BW	BW	TR	TR	T								
16"	W	W	W	W	W	BW	BW	BW	BW	BW	TR	TR	T							
18"	W	W	W	W	W	BW	BW	BW	BW	BW	TR	TR	T							
24"																				
28"																				
30"																				
32"																				
36"																				

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LEGEND

T : TEE EQUAL-BW

TR : REDUCING TEE-BW

W : WELDOLET- BW

BW : BRANCH WELD-CHECK IF REINFORCING PLATE IS NECESSARY ACCORDING ASME B 31.8

Proforma of Indemnity Bond for Work Orders
(Raw Materials)

IndianOil Corporation Ltd.

Dear Sirs,

WHEREAS :

(i) (Indian Oil Corporation (Pipelines Division)_____ (hereinafter called "the Corporation" which expression shall include its successors and assigns) has awarded to _____(Name) (Constitution) (Address)

(hereinafter called "the Contractor" which expression shall include *its/*his/*their successors and assigns/*executors, administrators, representatives and assigns) a contract for the fabrication of _____on terms and conditions set out, interalia, in the Corporation's Letter No. _____ dated _____to the Contractor and the General Conditions of Contract of the Corporation (hereinafter collectively referred to as "the said Contract" which expression shall include any formal contract entered into subsequent thereto and/or in supersession thereof and all amendments, modifications and/or variations thereto, in or of) ;

(ii) The Corporation has agreed to supply to the Contractor raw materials/components for incorporation in fabrication by the Contractor as aforesaid (the components/raw materials to be supplied by the Corporation to the Contractor for the said fabrication hereinafter for the sake of brevity referred to as 'the said material which expression shall include any item, thing or component that the same is fabricated into and any semifabricated material and material in the course of fabrication), upon the condition, interalia that pending fabrication and delivery at job-site of the completed fabricated work(s) incorporating the said material, the said material shall be under the custody and charge of the Contractor and shall be kept, stored, altered, worked upon and/or fabricated at the sole risk and expense of the Contractor ;

(iii) As a pre-condition to the supply of the said material by the Corporation to the Contractor, the Corporation has required the Contractor to furnish to the Corporation an indemnity and undertaking in the manner and upon terms and conditions hereinafter indicated;

NOW, THEREFORE, in consideration of the premises aforesaid the Contractor and I/We _____Son _____ of _____resident of _____etc. (hereinafter collectively with the Contractor called "Indemnifiers" which expression shall include *its successors and assigns/*their respective heirs, executors, representatives and assigns) hereby irrevocable and unconditionally, jointly and severally undertake to indemnify and keep indemnified the Corporation from/against all loss, damage and destruction (inclusive but not limited to any or all loss or damage or destruction to or of the said material or any item or part or component thereof by theft, chemical or physical action or reaction, bending, warping, exposure, rusting, faulty workmanship, faulty fabrication or faulty method of technique of fabrication, riot, civil commotion, strike or lockout or other action of omission or commission whatsoever within or beyond the control of the Contractor), misuse and

misappropriation by the Contractor and the Contractor's servants and/or agents whatsoever to, of or in the said material or any part or item thereof between the date that the same or relative part or item thereof was supplied to the Contractor upto and until the date of return to the Corporation of the said material or relative part of item or component thereof or completed fabricated work (s) incorporating the said material AND

jointly and severally undertake to pay to the Corporation at _____
forthwith

on first demand in writing without protest or demur or proof or satisfaction the value of the said material or item or part thereof lost, damaged, destroyed misused and/or misappropriated, as the case may be, inclusive of the costs, charges and expenses (including but not Limited to handling, transportation, cartage, insurance, freight, packing and inspection costs and/or expenses) incurred by the Corporation as specified in the said demand.

AND the Indemnifiers hereby agrees with the Corporation that :-

(i) This Indemnity/Undertaking shall remain valid and irrevocable until the settlement of all claims of the Corporation arising hereunder.

(ii) This Indemnity/Undertaking shall be in addition to any other indemnity, guarantee or security whatsoever

that the Corporation may now or at any time anywise have in relation to the Corporation's obligations / liabilities under and/ or in connection with the said contract inclusive for the said materials and Corporation shall have full authority to take recourse to or enforce this security in preference to the other security(ies) at its sole discretion, and no failure on the part of the Corporation in enforcing or requiring enforcement of any other security shall have the effect of releasing the Indemnifiers from their full liability hereunder.

(iii) The Corporation shall be at liberty without reference to the Indemnifiers and without affecting the full liability of the Indemnifiers hereunder to take any other indemnity or guarantee of security in respect of the

Contractors obligations and/or liabilities under or in connection with the said contract inclusive of the said

material and to vary the terms vis-a-vis the Contractor of the said Contract or to grant time and/or indulgence to the Contractor or to reduce or to increase or otherwise vary the prices or the total contract value or the quantity, quality, description or value of the said material or to release or to forebear from enforcement of all or any of the rights of the Corporation or obligations of the Contractor under the said contract (inclusive in respect of said material) and/or the remedies of the Corporation under any other indemnify or guarantee or security(ies) now or hereafter held by the Corporation and no such dealing(s), variation(s), reduction(s), Increase (s), other indulgence (s) or arrangement(s) with the Contractor or release or forbearance whatsoever shall have the effect of releasing the Indemnifiers from their full liability to the Corporation hereunder or of anywise prejudicing rights of the Corporation against the Indemnifiers and the Indemnifiers hereby waive all rights, if any, at any time inconsistent with the terms of this Indemnity/Undertaking.

(iv) This Indemnity/Undertaking shall not be determined or affected by the liquidation or winding up,

dissolution, or change of Constitution or insolvency of the Contractor and the obligations of the Indemnifiers in terms hereof shall not be anywise affected or suspended by reason of any dispute or disputes having been raised by the Contractor (whether or not pending before any arbitrator, officer, Tribunal or Court) or any denial

of liability by the Contractor or any other order or communication whatsoever by the Contractor stopping or preventing or purporting to stop or prevent any payment by the Indemnifiers to the Corporation in terms hereof.

(v) The mere statement or allegation made by or on behalf of the Corporation in any notice or demand or other writing addressed to the Indemnifiers or any of them as to any of the said material or item or part thereof

supplied to the Contractor having been lost, damaged, destroyed, misused, or misappropriated while in the

custody of the Contractor and/or prior to completion of the Completed fabricated work(s) incorporating the said material and delivery to job site thereof shall as between the Indemnifiers and the Corporation be conclusive of the factum of the said material or item or part thereof having been supplied to the Contractor and/or the loss, damage, destruction, misuse or misappropriation thereof, as the case may be, while in the custody of the Contractor and/or prior to the completion of the completed fabricated work(s) and delivery to job site thereof without necessity on the part of the Corporation to produce any documentary proof or other evidence whatsoever in support or proof thereof.

(vi) The amount stated in any notice of demand addressed by the Corporation to the Indemnifiers or any of them as the value of any of the said material lost, damaged, destroyed or misused or misappropriated, or of the costs, charges and/or expenses incurred by the Corporation in connection therewith shall as between the Indemnifiers and the Corporation be conclusive of the value of such said material and the said costs and expenses as also of the amount liable to be paid by the indemnifiers to the Corporation in terms and for the purpose hereof, without necessity for the Corporation to produce any voucher bill or other documentation or evidence whatsoever in support or proof thereof.

(vii) Shri _____ who has signed this undertaking is duly authorised to sign this undertaking and to confer the authorities herein conferred for and on behalf of the Contractor.

Yours faithfully,

For _____

Place :

Date :

Note :

(i) This undertaking is to be stamped for the aggregate value of stamp duty payable on an agreement and on a general power of attorney in the State in which it is executed.

(ii) This undertaking is to be signed on behalf of the Contractor by a Director or other officer either authorized by the Board to execute this undertaking or generally authorized to execute contracts and powers of attorney on behalf of the Contractor.

(iii) The signature of this Undertaking is to be Notarially Attested.

