SIPI-BENIN

Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.

RESONANCE ENERGY PVT LTD

VOLUME II OF II

TECHNICAL VOLUME

INTERNATIONAL COMPETITIVE BIDDING

0	03/08/2023	Issued for Bids	KM	VBS	AN
Rev	**Date**	**Description**	**Prepared by**	**Checked by**	**Approved by**

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SPECIFICATION

FOR

MAINLINE CONSTRUCTION (ONSHORE)

SPECIFICATION NO. SIPI/Steel/TS/01

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1. SCOPE

1.1 This specification covers the minimum requirements for the various activities to be carried out by CONTRACTOR for or about the construction of cross-country pipelines.

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

- Clearing, grubbing, and grading of Right-of-way
- Construction of all temporary facilities required in connection with the WORK.
- Staking of the pipeline route
- Handling, hauling, stringing, and storing of all materials.
- Trenching
- Field-bending of line pipe
- Lining-up
- Pipeline laying
- Backfilling
- Tying-in
- Installation of auxiliary facilities and appurtenances forming a part of pipeline installation
- Clean-up and restoration of Right-of-way
- Maintenance during defects liability period

1.3 This specification shall be read in conjunction with the conditions of all specifications and documents included in the CONTRACT between COMPANY and CONTRACTOR.

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

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

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

1.7 THE CONTRACTOR shall be deemed to have obtained all necessary information subject as mentioned above as to risks, contingencies and all other circumstances, which may influence the WORK.

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

2. REFERENCE CODES, STANDARDS AND SPECIFICATIONS

2. 1 Reference has been made in this specification to the latest edition 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 1104	-	Standard for Welding Pipelines and Related Facilities
d)	API 1105	-	Bulletin on Construction Practices for Oil and Products Pipelines
e)	Part 1992 Title 49	-	Transportation of Natural and Other Gas by Pipeline (US Department of Transportation - Pipeline Safety Standards)
f)	Part 195	-	Transportation of Liquids by Pipeline (US Department of Transportation – Pipeline Safety Standards)

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.

2. 2 For the purpose of this specification the following definitions shall hold:

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

3. REQUIREMENTS OF R.O.U. AND ACCESS THERE TO

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

CONTRACTOR shall notify COMPANY well in advance during work progress, the method of construction for crossing road, pipeline, cable, railway, river and other existing obstacles.

CONTRACTOR shall not commence work on such crossings before having obtained approval from the authorities and landowners concerned to the satisfaction of COMPANY. The crossings shall be installed to meet at all times the requirements and conditions of the permit issued by the authorities concerned. In the absence of any specific requirements by authorities, CONTRACTOR shall comply with COMPANY'S instructions. The right of ingress and egress to the ROW shall be limited to points where such ROW intersects public roads, Arrangements for other access required by the CONTRACTOR shall be made by him at his own cost and responsibility, and for such access, the conditions of this specifications shall also apply.

Where the ROW comes within 30 meters of an existing line or facility, CONTRACTOR shall propose and provide methods to safeguard the existing line or facility (e.g. a demarcation fence). No work is allowed in such area without COMPANY's prior approval.

3.1 Safety measures during construction of pipelines inside the area influenced by high Voltage lines

3.1.1 General

Pipelines which are constructed inside the area of high voltage lines may be electrically influenced by the high voltage lines. The voltage caused by the influence may at times be high enough to pose danger to personnel working on the pipeline. It is imperative therefore that the instructions given below should be strictly observed.

3.1.1.1 It is a necessity that all personnel working on the pipeline which is being laid in the area influenced by the high voltage systems, be given clear instructions on measures to be taken.

3.1.1.2 Vehicles and equipment must be earth-connected. This may be affected by attaching an uninsulated cable or chain (which touches the ground) of adequate length to the underside of the vehicle.

3.1.1.3 If it’s not impossible for plant and/ or materials to come within 50m of the centre of the high voltage systems, special measures must be taken to prevent any approach beyond that distance, unless article 3.1.2 is complied with.

3.1.1.4DURING THUNDERSTORMS OR WHEN DISCHARGES ARE OBSERVED ON INSULATORS ALL PERSONNEL MUST LEAVE THE AREA OF THE HIGH VOLTAGE LINE AND PIPELINE.

3.1.1.5 To prevent electrical voltage in a non-buried section of the pipeline from rising to dangerous levels, the length of the pipeline section which has been welded together before burial must not exceed the length at which the max. admissible voltage may be induced. This length may be calculated using an approved calculation method.

3.1.1.6 Before a pipeline section is lowered into the trench the structure's earth electrodes indicated in the drawings or determined with calculation method must have been installed and connected both to the pipeline section already buried and to the section which is about to be buried. The electrical connections which serve the purpose of preventing dangerous voltages must have a min. area of 35sqmm.Said connections must not be interrupted until after the permanent safety earth connections have been installed and connected to the entire uninterrupted pipeline.

3.1.1.7 The welded connection between the pipeline section and the section already buried must be installed at a distance of at least 50m from the nearest point of a pylon base.

3.1.1.8 Personnel doing work inside the area of influence of the high voltage system must wear electrically insulating footwear (e.g. rubber knee boots) and wear insulating rubber or plastic gloves.

3.1.2 Additional measures for work at less than 50m from the center of the high voltage system.

If work is done at less than 50m from the center of the high voltage system, the regulations below must be complied with in addition to the rules specified in clause 3.1.1.

3.1.2.1 The work must not be started until agreement has been reached with the authorities which controls the high voltage system, about the implementation of the safety measures specified in this section.

3.1.2.2 Measures must be taken to prevent excavating and hoisting equipment’s from approaching high voltage lines to within any of the following distances.
This distance depends on the voltage carried. For individual connections the distance must be :

0	-	50 KV	3m
40	-	200 KV	5m
200	-	380 KV	8m

The measures taken may be as follows:

1. Special selection of equipment, or limiting or blocking certain directions of movement, or limiting the operational area, thereby making it impossible for any work to be done at a distance from the high voltage line of less than the accepted minimum.

2. In case the measures recommended in 1. above are not feasible, installation of clearly visible markers of sufficient height or laying out a "no passage beyond this point" line of drums painted bright red and white must prevent any work being done inside the danger area. Further, an inspector must be prevented all the time.

3.1.2.3 In the event that a vehicle, crane etc. should accidently come into contact with a live cable of a high voltage system or flash-over of electrical charge occurs, the driver must not leave his vehicle because this will pose a serious threat to his life.

The vehicle or crane must break the contact WITHOUT ANY HELP FROM OUTSIDE.

The driver must not leave his vehicle until he has managed to leave "the dangerous area, or alternatively, when the Electricity Authorities have given notice that the cable(s) have been put out of circuit. In case a serious fire starts in the vehicle, he is permitted to jump from the vehicle, clearing it as far as possible, while the jump should possible be to a dry spot.

4.0 RIGHT-OF-WAY

The CONTRACTOR is required to perform his construction activities within the width of Right-of-way set aside for construction of pipeline, unless he has made other arrangements with the landowner and/ or tenant for using extra land. Variation in this width caused by local conditions or installation of associated pipeline facilities or existing pipelines will be identified in the field or instructed to the CONTRACTOR by COMPANY.

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

4.1 Staking

Prior to cleaning operations CONTRACTOR shall:

1) Install Benchmarks, Intersection Points and other required survey movements.

2) Stake markers in the centerline of the pipeline at distance of maximum 100 meters for straight line sections and maximum 10 meters for horizontal bends. Wherever ROW centerline has been staked on ground, CONTRACTOR shall exercise care in accurately staking the pipeline centerline, in consultation with COMPANY.
3) Stake two ROW markers at least at every 100 meters.
4) Set out a reference line with respect in pipeline centerline 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:

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 centerline 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 centerline markers.

Markers shall be of suitable material so as to serve their purpose and shall be colored 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.

4.2 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.

4.3 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 landowner 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 noninterference, especially in areas like grasing 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.

4.4 Row Clearing and Grading

4.4.1 All stumps shall be grubbed for a continuous strip, with a width equal to trench top width plus two meters on either side centered on the pipeline centerline. 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.

4.4.2 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, landowner 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.

4.4.3 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.

4.4.4 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.

4.4.5 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.

4.4.6 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.

4.4.7 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.

4.4.8 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 cross fall shall not exceed 10%.

4.4.9 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.

4.5 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 recognized such restrictive features of the Right-of-Way and shall provide the 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.

4.6 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 recognized 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 clause 6.3 of this Specification.

4.7 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.

5.0 HANDLING, HAULING, STRINGING AND STORING OF MATERIALS.

5.1 General

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 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.

5.1.1 "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.

5.2 Handling and Hauling of Line Pipe

5.2.1 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.

5.2.2 **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 equipment’s are 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. Use of round sectional slings is 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 remain free from any surface water. The pipes shall stacked at a slope so that driving rain does not collect inside the pipe.

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 beveled 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 protectors.
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 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 non-abrasive 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.

5.3 **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 CONTRACTOR's expense.

5.4 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.

5.5 Materials other than line pipe

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 did 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.

5.6 **Identification**

CONTRACTOR shall provide identification on 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 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.

6.0 TRENCHING

6.1 **Location**

CONTRACTOR shall, excavate and maintain the pipeline trench on the staked center line of the pipeline taking into account the curves of the pipeline.

6.2 **Excavation**

6.2.1 CONTRACTOR shall, by any method approved by COMPANY, dig the pipeline trench on the cleared and graded Right-of-Way. In cultivable land and other areas specifically designated by the COMPANY, top 60mm of the arable soil on the pipeline trench top and 500mm on either side shall be excavated and stored separately to be replaced in original position after backfilling and compacting rest of the trench.

Suitable crossing shall be provided and maintained over the open ROW where 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 excavated material shall never be deposited over or against the strung pipe.

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

6.2.3 On slopes where there is danger of landslide, the pipeline trench shall be maintained open only for the time strictly necessary. Forever, the COMPANY may require excavation of trench by hand, local route detours and limiting the period of execution of the works.

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

6.2.5 All sewers, drains ditches and other natural waterways involved in the execution of the works shall be maintained open and functional. The same applies to canals, irrigation canals, pipelines and buried facilities crossed by the ditch for which temporary pipeline shall be laid, if required, and proper temporary installations provided.

6.3 **Blasting**

Blasting for trenching and the related removal of scattered rock and debris caused by the blasting from the Right-of-Way and/or adjacent property, shall be performed by CONTRACTOR as part of his work.

Every possible precaution shall be taken to prevent injuries and damages to persons and properties during blasting operations, which shall be performed in accordance with Standard Rules for Blasting.

CONTRACTOR shall obtain necessary permits for storage and use of explosives and comply with the laws, rules and regulations of the respective Governmental agencies having jurisdiction thereof. No blasting will be allowed without prior and due notice given by CONTRACTOR to COMPANY, Government authorities, land-owners, property occupants, adjacent work crew, and other concerned parties.

CONTRACTOR shall employ only such workmen who are experienced in the type of work to be performed, to supervise, handle and use explosives.

6.3.1 Areas to be blasted are to be categorized as follows:

a) Where blasting is to be carried out beyond 50 meters away from any existing pipeline or structures (either above or below ground) the CONTRACTOR shall submit his proposed blasting procedure and perform a trial blast for COMPANY's approval.

b) Where blasting is to be carried out between 50 and 15 meters from any existing pipeline or structure (either above or below ground) the CONTRACTOR shall submit a procedure for controlled blasting e.g. break-holes, slit trench etc. which will also detail out safety precautions to safeguard the existing pipelines. This procedure will be approved by COMPANY prior to commencement and performing of trial blasting.

c) No blasting is allowed within 15 meters of any existing pipeline or structure (either above or below around).

6.3.2 All necessary precautions shall be taken to prevent stones from falling outside the Right-of-way and in cultivated areas and to avoid any damage to the installation and properties existing nearby.

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

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

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

6.4 **Normal Cover and Trench Dimensions**

The trench shall be excavated to a minimum so as to provide, on both sides of the installed pipeline, a clearance as indicated in the job standard/ 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 weight coating (as applicable) to the top of undisturbed surface of the soil or top of graded working strip or top of road or top of rail 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 COMPANY.

Sl. No.	**Location**	**Minimum Cover in meters**
a)	Industrial, Commercial & Residential Areas	1.0
b)	Minor Water Crossings/ Canals	1.5
c)	Drainage ditches at road and railroads	1.0
d)	Rocky area	1.0
e)	Uncased/ Cased Road Crossings	1.2
f)	Railroad Crossings	1.4
g)	Other Areas	1.0

For pipelines transporting High Vapour Pressure Hydrocarbons such as liquefied petroleum gas, butane, propane, etc., the minimum cover at locations `a' and `c' above shall be 1.2m.

6.5 **Cutting and Removal of Paving**

Whenever it is permitted by Authorities and / or COMPANY to open cut a paved road crossing, or where the line is routed within the road pavement, CONTRACTOR shall remove the paving in accordance with the restrictions and requirements of the authorities having jurisdiction thereof or as directed by COMPANY. The open cut for the road crossing shall be carried out only when the section of pipeline to be laid is complete. After laying the pipeline, backfilling

shall be immediately performed and all the area connected with the works shall be temporarily restored.

Throughout the period of execution of such works, 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 COMPANY.

For all roads, paths, walkway etc. which are open-cut, CONTRACTOR shall provide 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.

Groove cutting shall be done on road/road crossing as per instruction of concern authorities/EIC wherever required to minimize the damage to road at no extra cost to COMPANY

6.6 **Extra Depth and Clearance**

At points where the contour of the earth way requires extra depth to fit the minimum radius of the bend as specified 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, and the like, CONTRACTOR shall excavate such additional depth as may be necessary at no extra cost to the COMPANY.
CONTRACTOR shall excavate to additional depth where the pipeline approaches and crosses other pipelines, sewers, drain pipes, water mains, telephone, conduits, and other underground structures, so that the pipeline may be laid with at least 50 centimeters free clearance from the

obstacle or as specified in the drawings, or such greater minimum distances as may be required by authorities having jurisdiction.
Where the pipeline crosses areas, whose easements specifically require greater than normal depths of cover, the trench shall be excavated to extra depth in accordance with the Right-of-way Agreements or as required.

CONTRACTOR shall excavate all such additional depths as may be necessary at no extra cost to the COMPANY.

6.7 **Grades, Bends and Finish of Trench**

The trench is to 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. COMPANY 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. COMPANY desires to reduce to a minimum the required number of cold field 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 COMPANY.

COMPANY intends that there will be a minimum of hand grading of the trench bottom. However, to achieve this, CONTRACTOR will have to dig as square a bottom of the trench as

possible with his equipment. This in part can be obtained by adjusting and adopting the crumbling shoe and digging teeth of the trenching machines and by use of a drag behind the trenching machines or manually dressing-up the same. CONTRACTOR shall do such hand work in the trench as is necessary to free the bottom of the trench from loose rock and hard clods and to trim protruding roots from the bottom and side walls of the trench.

6.8 **Padding**

In all cases where rock or gravel or hard soil is encountered in the bottom of the trench, COMPANY will decide the exact extent of trench padding, that will be required. The thickness of the compacted padding shall not be less than 150mm. In those areas that are to be padded, the trench shall be at least 150mm deeper than otherwise required, and evenly and sufficiently padded to keep the pipe, when in place, at least 150mm above bottom of excavated trench. Acceptable padding shall be placed under the pipeline before its installation, and around after installation to establish at both sides and on top of the pipe a permanent layer of padding. The thickness of compacted padding on top of pipe corrosion coating shall be at least 150mm. Padding materials that are approved by COMPANY shall be graded soil/ sand and/ or other materials containing no gravel, rock, or lumps of hard soil. Sand used for padding shall pass through sieve size ASTM-10 or ISO-2.00.

When specified in the CONTRACT, rock shield may be used in place of or in addition to sand padding as indicated above. Such rock shield shall be in accordance with the specification issued for the purpose and shall be subject to COMPANY approval.

6.9 **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 COMPANY 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 in accordance with these specifications at no extra cost to COMPANY.

6.10 **Protection of Underground Utilities and Special Methods**

Details of some underground utilities, as far as acquired by COMPANY, shall be indicated in the Drawings. However, 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 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 specification at no extra cost.

Where the pipeline crosses other underground utilities/ structures, the CONTRACTOR shall first manually excavate to a depth and in such a manner that 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 the CONTRACTOR at his own cost and shall be of such design as to ensure against their possible failure.

Despite all precautions, should any damage to any structure/ utility etc., occur, the Owner/ Authority concerned shall be contacted by the CONTRACTOR and repair shall forthwith be carried out by the CONTRACTOR at his expense under the direction and to the satisfaction of COMPANY and the concerned Owner/ Authority. If CONTRACTOR fails to repair in reasonable time, COMPANY reserves the right to have the repair executed at the cost of the CONTRACTOR.

6.11 **Encroachments and Working near other utilities**

In locations, where pipeline has 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 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 methods in these areas, no extra compensation shall be paid. 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 Right-of-way, CONTRACTOR shall perform the work to the satisfaction of the Owner/ 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, underground structure/ utilities, as laid down in clause 6.10 of this specification.

6.12 **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 dewatering of trench or temporary filling of water into the line (in exceptional cases).

In the case of water on the ditch bottom when the pipeline is being laid, the ditch shall be drained to the extent and for the time required to make a visual inspection of the ditch bottom. After this inspection, the presence of water will be allowed provided its level does not cause sliding of the ditch sides and pipe floating before backfilling when no concrete weighting is provided.

The water pumped out of the ditch shall be discharged into a natural water course.

Wherever up-floating of the pipeline after backfilling is to be reckoned with, anti-buoyancy measures shall be provided by CONTRACTOR for areas indicated in the drawings or as may be encountered during construction, using one or a combination of the following methods:

- weighting by applying a continuous concrete coating around the pipe;
- weighting by installing saddle weights;
- installing metal anchors screwed into the subsoil in pairs;

- deeper burial of pipeline;
- Provision of select backfill material.

The above provisions shall be in accordance with the relevant specifications and/ or job standards/ drawings.

7.0 BENDING

CONTRACTOR shall preferably provide for changes of vertical and horizontal alignment by making elastic bends. CONTRACTOR may provide cold field bends, at its option for change of direction and change of slope. COMPANY at its option, may authorize fabricated bends for installation at points where in COMPANY's judgment the use of such bends is unavoidable.

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

7.1 Bends

Contractor Shall Use 3D/1.5D bends as per site requirement and as approved by EIC.

7.2 Miter and Unsatisfactory Bends

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

No miter bends shall be permitted in the construction of the pipe line. CONTRACTOR shall cut out and remove any bend or bends which do not meet the specifications and shall replace the same with satisfactory bends at no additional cost to the COMPANY. In the event the CONTRACT provides for supply of line pipe by COMPANY, the pipes required for replacement will be furnished by COMPANY, but the cost of replacement of such pipes shall be borne by CONTRACTOR.

Cutting of factory-made bends and cold field bends for any purpose are not permitted.

8.0 LINING UP

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

8.1 Pipe Defects and Repairs

It is CONTRACTOR's responsibility to repair all internal and/or external defects.

8.1.1 Acceptability of defects in the pipe detected during inspection at the work site shall be determined in accordance with latest edition of COMPANY's own material specification or CODE ANSI B31.8/B 31.4 whichever is more stringent.

8.1.2 The maximum permissible depth of dents in pipes upto and including 12 3/4" OD is 5mm and for pipes over 12 3/4" OD is 2% of the nominal pipe diameter.

8.1.3 Dents which contain a stress concentrator such as scratch, gauge, arc burn or groove, and dents located at the longitudinal, spiral or circumferential weld shall be removed by cutting out the damaged portion of pipe as a cylinder.

8.1.4 Repair on line pipe shall be executed as specified in COMPANY's material specification or Code ANSI B 31.8/B 31.4, whichever is more stringent. A record of all repairs is to be maintained by CONTRACTOR. This record, provided with the pipe identification number is to be submitted to the COMPANY.

8.1.5 If due to cutting or repairs, the pipe identification number is removed, it shall be reprinted immediately by CONTRACTOR in the presence of COMPANY. In the event, the CONTRACT provides for supply of line pipe by COMPANY, CONTRACTOR shall be charged for any pipe length due to loss of identification number. No pipe without identification number shall be transported and/or welded into the pipeline.

8.1.6 Repair of damaged pipe ends by hammering and/or heating is not allowed. If the dented area is minor and at least 200mm away from the pipe end, and the steel is not stretched, severed, or split in the COMPANY's opinion, the pipe may be straightened with a proper jack.

8.2 **Pipe Handling And Skid Spacing**

8.2.1 When lifting pipe, care must be taken not to kink or overstress it. Proper pipe slings approved by COMPANY shall be used. CONTRACTOR shall submit his method of skidding and skid spacing for COMPANY's approval. A strip of soft material shall be placed in between skid and pipe to protect the external coating of the pipe. The material shall be approved by the COMPANY.

8.2.2 The maximum skid spacing is not allowed before the stringer bead and the top and bottom reinforcements are completed, provided that the distance between the incomplete weld and the skid shall not exceed 9 (nine) percent of the skid spacing.

8.2.3 Skids shall be at least 1.20 meter long. For pipe with an O.D. of 12-3/4 inch and larger the skids in contact with the pipe shall have a width of at least 200mm. For pipe with an O.D. of less than 12 inch the skids in contact with the pipe shall have a width of at least 150mm. Pipe supports shall be stable, so that pipe movement will not cause the supports to move. Skids shall not be removed under a string before lowering in. The welded pipe shall be maintained on skids at the minimum distance of 500mm above ground. Crotches shall be installed at frequent intervals (at least every 10th support) with a greater number required at bends and undulation grounds.

8.3 **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 COMPANY so as to prevent the entry of dirt, 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.

8.4 **Temporary Caps**

Whenever the welded strings of pipes are left open at intervals to be tied in later after an appreciable time lag, under roads, railroads, rivers, marshy crossings, ets., temporary caps approved by COMPANY shall be welded to the ends of the pipe.

9.0 LAYING OF PIPE

9.1 **Lowering In Trench**

9.1.1 Lowering can start after removal from ditch bottom of all off cuts, pipe supports, stones, roots, debris, stakes, rock projections below underside of pipe and any other rigid materials which could lead to perforation or tearing of the coating. Sand padding and / or rock shield shall be provided as required in accordance with clause 6.8 of this specification.

9.1.2 Lowering shall follow as soon as possible, after the completion of the joint coating of the pipeline. In the case of parallel pipelines, laying shall be carried out by means of successive operations, if possible without interruption.

9.1.3 Before lowering in, a complete check by a full circle holiday detector for pipe coating and for field joint coating shall be carried out and all damages repaired at CONTRACTOR's cost. All points on the pipeline where the coating has been in contact with either the skids or with the lifting equipment during laying, shall be carefully repaired. If, after checking, it becomes necessary to place the pipeline again on supports at the bottom of the trench, these must be padded in such a way as to prevent damage to the coating, thus avoiding necessity for further repairs when the pipe is finally raised and laid. Before the last operation, a check must be made of the coating at points of contact with the supports.

9.1.4 Before lowering in, short completed sections of the pipeline shall be cleaned with compressed air in order to remove all dirt, etc. from the inside of pipe sections.

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

9.1.6 Wherever the pipeline is laid under tension, as a result of an assembly error (for example, incorrect positioning of bends, either horizontal or vertical), the trench shall be rectified or in exceptional cases a new assembly shall be carried out, to be approved by COMPANY, so that it fits the excavation and the laying bed.

9.1.7 Laying shall be carried out under safe conditions so as to avoid stresses and temporary deformations of the equipment’s which may cause damage to the pipeline itself and to the coating. In localized points where the right-of-way is restricted to the minimum necessary for the transit of Mechanical equipment, the laying shall be carried out using other suitable means.

The pipe shall be placed on the floor or the excavation, without jerking, falling, impact or other similar stresses. In particular, care must be taken that the deformation caused during the raising of the pipe work from the supports, does not exceed the values for the minimum allowable radius of elastic curvature, so as to keep the stresses on the steel and on the coating within safe limits. The portion of the pipeline between trench and bank shall be supported by as many side-booms as required and approved by COMPANY for holding the line in gentle S-curve maintaining minimum elastic bend radius as specified in job standard. Lowering in and back-filling shall preferably be carried out at the highest ambient temperature.

9.1.8 The pipeline must be laid without interruption for the whole or the length of section available. Where water is present, no laying shall be permitted until the ditch has been drained to the extent and for the time necessary to make visual inspection possible of the bed on which the pipe is to be laid. Following such inspections, the presence of water will be permitted, provided that it is not so high as to cause cave-in of the walls of the trench or floating of the pipeline before backfilling, when weighting is not provided for the pipe.

9.1.9 CONTRACTOR shall take precautions immediately after lowering in to prevent the movement of the pipe in trench.

9.1.10 In laying parallel pipelines in the same trench, the minimum distances between the pipeline indicated in the approved drawings shall be observed. Once the first pipeline has been positioned, it shall in no way be disturbed by laying of the subsequent pipeline.

At every seven meters along the trench sand/earth filled bags shall be placed between the parallel pipelines so as to ensure maintenance of the minimum stipulated distance between the parallel lines.

9.2 Overhead Sections and Sections in Tunnel

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

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

9.2.2 The erection of the supports shall be carried out taking care that the elevation and alignment is in accordance with the drawings.
In the case of metal work supports, prefabrication and/or assembly shall take into account the maximum allowed free span and the supports shall not interfere with the pipeline welds.

9.2.3 In case roller supports are used, the roller shall be lubricated, then checked for smooth rotation and, in case of seizure, the defect shall be repaired or roller shall be replaced. In the case of overhead section where the pipeline is slanting, the alignment of the end supports shall be made after placing the pipeline in position. Before installation of the pipe section, all the rollers shall be perfectly centered acting on the seat of the support plates.
The above alignment operations shall be carried out before connecting the overhead section with the ends of the buried section.

9.2.4 Lifting, moving and laying of the pipeline shall be carried out in accordance with the provisions of clause 9.1.5.

An insulation sheet shall be installed to isolate the pipe from the support or support from the earth.
The sheet shall be hard polyethylene at least 5mm thick.
It shall extend at least to 1cm outside the saddles or clamps.

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

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

a) Method of installation by lifting (as a preferred method).
b) Pulling method and related calculations, whenever lifting method cannot be used
c) Pulling device and its characteristics
d) Method of anchoring the pulling device
e) Characteristics of the pulling rope
f) Braking device, if any
g) Pipeline assembly systems.

10.0 BACK-FILLING

10.1 Backfilling shall not be done until the pipe and appurtenances have the proper fit 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. Before any such work is done, it shall be the CONTRACTOR's responsibility to first secure the approval of COMPANY. If any backfilling is done without COMPANY's approval, COMPANY will have the right to require removal of the backfill for examination, and the cost of such uncovering and refilling shall be borne by CONTRACTOR. Backfilling of trench in water courses shall be carried out as per the relevant specifications issued for the purpose.

10.2.1 Backfilling shall be carried out immediately after the pipeline has been laid in the trench, inspected and approved by the COMPANY, so as to provide a natural anchorage for the pipeline, thus avoiding long exposure of coating to high temperature, damaging actions of adverse weather conditions, sliding down of trench sides and pipe movement in the trench. If immediate back filling is not possible, a covering of at least 200mm of earth, free of rock and hard lumps shall be placed over and around the pipe and coating.
On no account the top soil from the ROW be used for this purpose. In general, the trench shall be dry during backfilling. Deviations thereof must have prior approval of the COMPANY. The backfill material shall contain no extraneous material and/or hard lumps of soil which could damage the pipe / coating or leave voids in the backfilled trench. After the initial backfill has been placed into the trench to a level slightly above the surrounding ground, CONTRACTOR shall compact the backfill material. The surplus material shall be neatly crowned directly over the trench and the adjacent excavated areas on both sides of the trench as per clause 6.2.1, to such a height which will, in COMPANY's opinion, provide adequately for future settlement of the trench backfill during the maintenance period and thereafter. The crown shall be high enough to prevent the formation of a 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 of to the satisfaction of land owner or authority having jurisdiction at no extra cost to the COMPANY.

For further requirements reference is made to Section of 14.0 "Clean-up and Restoration of Right-of-Way" of this specification.

10.3 Rock, gravel, lumps of hard soil or like materials shall not be backfilled directly onto the pipe unless 'padding' and/or rock shell has been provided as per Section 6.0 of this specification. When "Padding" as described in Section 6.0 of this specification is to be used, the following shall be applicable.

Where rock, gravel, lumps of hard soil or like materials are encountered at the time of trench excavation, sufficient earth, sand 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 to COMPANY shall be soil, sand, clay or other material containing no gravel, rock or lumps or hard soil. Whether such padding material would be taken from the adjacent spoil bank or imported from elsewhere shall be directed by COMPANY. All these works shall be carried out by CONTRACTOR at no extra cost to COMPANY. 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.

10.4 When the trench has been dug through drive ways or roads, all backfills shall be executed with sand or a suitable material as approved by COMPANY and shall be thoroughly compacted. In certain cases, special compaction methods, such as moistening or ramming of the backfill in layers may be required by COMPANY. COMPANY and any public or private authority having jurisdiction over a road, street or drive way may require that the surface of the backfill be graveled with crushed rock or some other purchased material and the road shall be repaved. In such instances, CONTRACTOR shall comply with said requirements at no extra cost to COMPANY.

10.5 Trenches excavated in dykes which are the property of railways or which are part 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. The materials required may include gravel, special stabilization materials or stabilized mixtures. However, special processing and/or compacting methods shall require the approval of COMPANY and/or competent authorities.

10.6 The trench in irrigated and paddy fields shall be backfilled to within 300mm of the top, then rammed and further backfilled until the trench is completely backfilled. Surplus material remaining after the operation shall be spread over the ROW as specified in Section 14.0 "Clean-up and Restoration of Right-of-Way", of this specification.

10.7 At the end of each day's work, backfilling shall not be more than 500 meters behind the head end of lowered-in pipe, which has been padded and approved for backfill. The backfill shall be maintained by CONTRACTOR against washouts etc., until the completion and final acceptance of the work by COMPANY.

10.8 CONTRACTOR shall furnish materials and install breakers in the trench in steep areas (slope generally 10% and more) for the purpose of preventing erosion of the backfill. The type of breakers installed shall be as per the approved drawings. Breakers shall be constructed of grout bags filled with a mixture of 4:1 Sand: Portland cement at COMPANY's direction.

CONTRACTOR may propose other methods such as foam dams etc. which shall be subject to approval by COMPANY. Such works shall be at no extra cost to COMPANY. CONTRACTOR shall pay attention to the direction of backfilling in such steep areas.

10.9 When backfilling the trenches in sloping terrains or steep areas, where in the opinion of the COMPANY, the backfill may be washed out of the trench, sheet piling or other effective water breakers across the trench shall be provided by CONTRACTOR. This is to divert the flow of water away from the trench into normal drainage followed before laying the line. In no case, the water is to be drained via the trench or via channels other than those followed before the line was laid.

10.10 CONTRACTOR shall leave the pipe uncovered at certain locations to allow COMPANY to survey the center line of the pipe and the level of the pipeline in the backfilled trench. Within 48 hours after backfilling, COMPANY shall have carried out such survey and informed CONTRACTOR of any realigning, if required. Thereafter CONTRACTOR shall compact the backfill.

The maximum allowable deviation from the centerline for land sections as staked out by COMPANY and as referenced by CONTRACTOR after backfilling is limited to:

Pipeline dia upto and including 24" : 200mm

10.11 Before backfilling of the trench, CONTRACTOR shall comply with the requirements of Clause 6.12 of this specification.

10.12 Stabilization of backfill shall be carried out by the CONTRACTOR in sandy areas and other such places to obtain consolidated cover as directed by the COMPANY. CONTRACTOR shall carry out the stabilization over the pipeline at no extra cost to COMPANY.

The backfill shall be stabilized preferably with 150mm layer of marl, mattresses of gatch other than straw or other stable materials. The width of stabilization shall be at least 5.0 meters on either side of the pipeline, plus one meter for every 10 meters height of dune (where the line passes through the dune areas).

10.13 Temporary workers shall be installed during backfilling and the survey as per clauses 10.10 to locate the pipeline axis. These markers shall then be replaced with permanent pipeline markers.

10.14 Backfilling shall be preferably carried out at the highest ambient temperature.

11.0 TIEING-IN

11.1 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 over lapping, 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.

11.2 Tie-in shall preferably be carried out at ambient temperatures corresponding to the average operating temperature in the case of a pipeline conveying fluids at normal temperatures and at

the maximum ambient temperature in the case where the pipeline is carrying fluids at high temperature.

11.3 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.

11.4 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.

11.5 If a pup end cannot be avoided for tie-in, the minimum length that shall be added is 1.0 meters and two or more such pups shall not be welded together. All cut-off lengths greater than 1.0 meters shall be moved ahead in order to be welded into the pipeline at a suitable location. Tie-in with two or more pups may be used provided that they each have minimum length of 1.0 meter and are separated by an entire length of pipe. In no case more than three (3) welds shall be permitted on a 10 meter length of pipeline.

11.6 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.

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

12.0 SPECIAL INSTALLATIONS ON THE PIPELINE.

12.1 General

12.1.1 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, pipework, 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 our and tested for full and correct operation in the presence of and to the satisfaction of COMPANY. All work shall be carried our 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.

Cold bending for the fitting of 1/2" and 1/4" pipes is allowed when special bending tools are used with guides to prevent flattening. The minimum radius allowed shall not be less than R = 10 D where D is the outside diameter of pipe.

The bending tool shall be subject to COMPANY's approval.

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 spatter, scale, or any potentially detachable matter prior to the tie-in or final bolting.

12.1.2 **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.

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

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

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

d) Rotation of flange bolt holes shall not exceed 1.6 mm.

12.1.3 **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 remover and discarded. It is mandatory that a torque wrench is used for bolt tightening.

12.1.4 **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.

12.1.5 **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.

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12.1.6 **Civil Work**

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

12.1.7 **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 end 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.

12.1.8 **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 approved quality of coal-tar epoxy or any other equivalent suitable COMPANY approved coating at no extra cost to the COMPANY. For buried pipes either heat shrink tapes conforming to COMPANY's specification or coal tar epoxy shall be 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.

12.1.9 **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.

12.2 Installation of Valves and Valve Stations

12.2.1 Block and sectionalising 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.

12.2.2 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 color code given by the COMPANY.

12.2.3 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, etc.

12.2.4 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.
Care shall be taken to avoid entry of sand particles etc. to valve body, seals etc. during transportation, storage, assembly and installation.

12.2.5 For valves and piping installed below ground and/or above ground, the anticorrosion 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.

12.2.6 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.

12.2.7 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.

12.2.8 All sectionalizing valve and any other inline assemblies shall be prefabricated and tested hydrostatically ex-situ as per applicable specification. 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 also 100% ultrasonically examined prior to backfilling. All works shall be executed in accordance with the relevant specifications issued for the purpose.

12.2.9 Isolation Valve testing (shell and seat test) shall be conducted as per API – 598, before installation at site.

12.3 Installation of Scraper Launchers and Receivers

12.3.1 Scraper stations shall be fabricated and installed as per the approved drawings and whenever applicable as per the requirements of clause 12.2 of this specification. It is CONTRACTOR's responsibility to have the units completely assembled, tested and made fully functional including all instruments & related piping.

12.3.2 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.

12.3.3 It shall be CONTRACTOR's 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.

12.3.4 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.

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

12.4 **Installation of Insulation Joints**

12.4.1.1 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.

12.4.2 Handing 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.

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

12.4.4 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.

12.4.5 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.

12.4.6 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.

13.0 WORKING SPREAD LIMITATIONS

N/A

14.0 CLEAN-UP AND RESTORATION OF RIGHT OF WAY

14.1 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.

14.2 **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.

All Pipe-ends shorter than 1.0m shall be returned to COMPANY being scrap, all pipes longer than 8.0m shall be reconditioned (bevels, coating, provided with pipe letter, number and length) and be returned to COMPANY's designated stockpile areas together with all undamaged, unused COMPANY supplied materials. All pieces between 1.0 and 8.0m shall be charged to the CONTRACTOR by COMPANY. CONTRACTOR shall record these returned materials in the Material account, to be prepared by him.

14.3 **Disposal**

14.3.1 All surplus and defective materials supplied by CONTRACTOR and all trash, refuse and spoiled materials shall be collected and disposed of by CONTRACTOR.

14.3.2 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, in an appropriate manner, but never be buried in the ROW.

14.3.3 Surplus soil can only be removed from the Owner's plot after authorization by COMPANY.

14.3.4 All dumping fees connected with the disposal of materials shall be to the account of CONTRACTOR.

14.3.5 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, ravel 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.

14.4 **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.

14.5 **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. 14.6 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.

14.7 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.

14.8 All cadastral or geodetric markers which may have been removed during the execution of the works shall be restored in their exact position.

14.9 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 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.

14.10 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.

14.11 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.

14.12 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.

14.13 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.

14.14 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.

14.15 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.

14.16 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 CONTRACTOR's 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:

- 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.

14.17 **Soil Surplus**

If on site, as a result of the work and after careful backfilling and compacting, a sub-soil surplus exists, this shall be worked up by grading and compacting below the sub-soil 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 sub-soil 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 subsoil 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 land-owner, land-user and COMPANY.

14.18 **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.

15.0 MAINTENANCE DURING DEFECTS LIABILITY PERIOD

Defects liability Period (defined as period of liability in the CONTRACT) means the period of 12 months calculated from the date certified in the Completion Certificate.

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.

Company reserves the right to have the required Computerized Potential Logging Test executed during the DEFECTS LIABILITY PERIOD and whenever conditions are more

favorable for this job. The work shall at or as soon as practicable after the expiration of the Defects Liability Period be delivered to COMPANY in the conditions required by the CONTRACT, fair wear and tear excepted, to the satisfaction of COMPANY. CONTRACTOR shall finish the work, if any outstanding, at the date of completion as soon as possible after such date and shall execute all such work.

16.0 DESCRIPTION OF SOR ITEMS

SOR ITEM NO. 1.0. : PIPELINE LAYING/ INSTALLTION
Laying/ installation of coated line pipe, associated fittings, INDUCTION / LONG RADIUS (R=3D) BENDS and accessories, etc. as per specifications, drawings, other provisions of Contract and instructions of Owner / Owner's representative, including but not limited to carrying out the following:
Earth in excavation and filling to the grades and levels shown in the approved drawings in all kinds of conditions including for Road embankments, using approved quality good earth from designated borrow area, for all heights and depths including clearing and stripping (min 150mm) of the area marked for filling, taking spot levels, consolidating the exposed natural soil surface, excavating the earth from borrow area loading, transporting & unloading, spreading in layers not exceeding 150mm thickness, breaking clods, watering (if reqd.), ramming and compacting by manual/ mechanical means to give minimum 92% of modified Proctor's density of earth, testing & dressing including disposal of all unserviceable material all complete as per specifications and directions of Engineer-in-charge. (Rate to include cost of all labour, tools, tackles, equipment, hire changes, cost of borrow earth by way of royalties, right of way, cess etc., as applicable with all bye works and sundry works.)
"Receiving and taking over" of "free issue" Line pipes from owner Dump /Storage Yard locations, handling, loading, transportation and unloading of Owner supplied externally corrosion coated and bare line pipes from designated place(s) of issue / dump site(s) to Contractor's own stockyard(s)/ workshop(s)/ worksite(s),
Arrangement of equipment for loading and trailer, carrying out inspection of Line pipes at the time of receiving and taking-over, recording of pipe & coating defects at the time of taking over in the presence of Company's representative, carrying out repair of coating defects & pipe defects attributable to Company; including supply of materials, consumables & equipment; handling, hauling and transportation from designated place of issue to Contractor Storage Yard;

Unloading and stacking of the line pipes at Contractor Storage Yard; including arranging all equipment, trailers, trucks & manpower; all works as per Scope of Work, drawings, PTS, GTS and other provisions of the Contract and instructions of OWNER / Owner's representative; all associated works not indicated herein but required to complete the work as per Scope of Work, Provision of Contract & instructions of OWNER / Owner's representative.
Preliminary activities, preparation of drawings, wherever required for crossing etc. including handling, stacking, stringing on the pipeline Right-of-Use/ pipeline route alignment, carrying out inspection of company supplied materials including line pipes at the time of taking over, laying/ installation of coated line pipes as per specification wherever required depending on site condition including execution of all works, "taking over", handling , including loading and unloading, transportation of Owner supplied materials other than line pipe from Owner's designated place (s) of issue to work site,
Arrangement of all additional land required for Contractor's storage, fabrication, access for construction (other than Owner provided ROU/ROW);
Carrying out all temporary, ancillary, auxiliary works, ready for commissioning of pipeline as per drawings, specifications, other provisions of Contract document and instructions of Engineer-in-charge, including but not limited to carrying out the following works:
Surveying of route and detours required at the time of execution including marking the same in topographical sheet, preparation of construction drawings showing survey details, and submit same to Owner for review / approval.
Revalidation of pipeline route based on alignment sheets and crossings drawings, supply of all materials (except Owner supplied materials), consumables, equipment, labour, etc.; Staking and installation of construction markers, clearing, grubbing, grading (as required) of Right of Use/ Right of Way;
Hard Barricading (touch to touch hard barricade shall be required during execution, no gap is envisaged along with no sperate payment for the same is envisaged) (the pipeline construction area prior to execution of the works as per drawings enclosed with tender document and to the entire satisfaction of Owner / Engineer-in-charge.
Counting the number and type of trees cut in presence of DFO/concerned authorities and keeping record thereof; Trenching to all depths and to a width to accommodate the pipeline as specified in scope document and as per the relevant standards, specifications, etc. by excavation in all types of soils (including soft/hard rock), including blasting, chiseling or otherwise cutting etc.; providing trench padding as required with sand/ graded earth approved by Owner / Owner's representative; Carrying out repairs of pipe defects/ replacement in case of irreparable defects and repairs of defects of pipe coating not attributable to Owner including defects/ damages occurring during transportation / handling not attributable to Owner (i.e. defects occurring after "taking over" of pipes from Owner); Thorough internal cleaning of all pipes by suitable methods to remove
Debris, shots, grits etc. to the satisfaction of Owner / Owner's representative; Stringing of line pipes along ROU/ROW including providing straw bags, soft padding/sand padding; Aligning, bending, cutting and beveling (as required) of pipes for welding and field adjustments, NDT of re- beveled area, welding, carrying out destructive/ non- destructive testing of welds as
Required including 100% radiography and providing all requisite equipment, labor, supervision, materials, films, consumables, all facilities and personnel to process, develop, examine and interpret radiographs and other tests, as required; carrying out repairs of weld joints found defective by Owner / Owner's representative, carrying out re-radiography and other non- destructive tests as required on repaired joints, etc.
Carrying out Installation of carrier pipe including concrete coated pipes (wherever required) at all crossings including Pipelines /roads/ canals/ nala/ water crossings etc. (except at major water and other crossings that are specifically covered separately in this document by HDD or boring method.
Carrying out installation of carrier pipe in the casing pipe at cased crossings (excluding supply and installation of casing pipes covered separately);
Coating of field weld joints, long radius bends (R=3D), elbows, buried fittings and valves etc. including supply of coating materials etc. (i.e., heat shrinkable sleeves and high build epoxy etc.) as per Technical Specification compatible with 3-layer PE coating material of the line pipe.
Supply & Installation of LR Bend (R = 3D) , as per specification wherever required depending on site condition. Supply of all fittings, elbow, etc. Is in Contractor's scope and shall be as per 3.2 certification
Installation / lowering the pipeline in trench to required depth as per Technical Specification & drawings including padding around pipeline with suitable soil duly approved by Owner’s representative including supply of padding material, backfilling and its compaction to the satisfaction of concerned authorities with excavated earth / borrowed select soil including supply of borrowed select soil duly approved by Owner’s representative before backfilling and make ready for restoration to be done by Owner / concerned authorities.

Supply and Installation of warning tape (1.0mm thick X 300mm wide) on the entire length of the pipeline as per specification. The material of warning tape shall be of high-density polyethylene and non-biodegradable type. It shall have non-toxic and anti-rodent properties.
Supply and installation of slope breaker as per specifications and drawings in steep slope areas wherever required or, as directed by Owner / Owner's representative
Crossing the all-foreign pipeline / HT line / cable / any other utilities etc. with necessary concrete / PVC protection including coordination with all agencies and obtaining NOC.
Supply and installation of bank protection along with backfill materials duly approved by Owner's representative for pipeline trench and banks falls under minor water body crossing as per technical specification & Std. Drag., wherever required or, as directed by Owner /Owner's representative
Training and diversions of streams in steep slope areas, wherever required.
Carrying out hydrostatic testing including air cleaning, pigging , cleaning, flushing, filling, pressurization of complete pipeline in various test sections as approved by Owner / Owner's representative to the specified test pressure indicated elsewhere and duration after stabilization as per specification, providing all equipment, pumps, fittings, instruments, dead weight tester, all types of pigs etc., and services, supervision, labour, consumables, water including supply of corrosion inhibitor, air, etc. as required, locating of leaks and rectification of defects attributable to Contractor, re- testing after rectification, successful completion of hydro- testing of pipeline including De-watering.
All tie-ins, including the tie-in(s) with the pipeline / piping installed by others including cutting of test header, re-beveling as required, radiography and other NDT examination, joint coating as per specification.
Carrying out all temporary, ancillary, auxiliary works and all incidental works required to make the pipeline ready for pre-commissioning; Repair of defects recorded during installation or otherwise including cutting, beveling, welding, radiography, field joint coating etc; as applicable,
Final clean-up and restoration of right of way/right of use or area disturbed by contractor including obtaining NOC from respective landowner and statutory authorities during their construction activities for laying of pipeline works and disposal of debris and returning all surplus material to designated disposal areas / storage yard as and backfilling of trench and compaction of the same as per satisfaction of Owner and / Or as directed by Owner / Owner's representative;
Restoration of land, facilities, and boundary wall etc. at associated facilities dismantled/damaged by the Contractor during construction;
Carrying out all temporary, ancillary, auxiliary works and all incidental works required to make the pipeline ready for pre-commissioning;
Obtaining work permits/ NOC from various statutory authorities having jurisdiction, before and after execution of the work, and complying with all stipulation/conditions/recommendation of the said authorities;
Preparation of as-built drawings, pipe-book, and other records. SOR shall be read in conjunction with scope of work, job specific requirements, specifications, standards, drawings and other provisions of contract document. All above works for buried pipeline as per Bid details.
Development & Maintenance of Contractor Storage Yard adequate to store the line pipes including arrangement of all Lifting & Handling equipment at Contractor's Storage Yard shall be done by the Contractor. Rate for the same shall be quoted in applicable items.
SWABBING, DRYING, HOOK UP WITH EXISTING PIPELINES WITH COLD TAPPING METHOD, PRE-COMMISSIONING, COMMISSIONING AND COMMISSIONING ASSISTANCE OF ENTIRE PIPELINE SYSTEM.
Swabbing, Drying, Hook up with existing pipelines with cold tapping method, Pre-commissioning activities and pre-commissioning checks to the specified acceptance criteria, making the entire pipeline system ready for commissioning, providing assistance during the complete duration of Drying, Pre Commissioning and commissioning including supply of all equipment, man- power, consumables (including pigs and required quantity of nitrogen for pipeline commissioning and valve operations) materials for all temporary works and performing all associated works, complete as per the relevant specifications, other provisions of Contract document and instructions of Owner / Owner's representative.
Overall commissioning including system checks, initiation and charging of entire pipeline system including stations and all associated facilities including but not limited to the following:
Notifying the Owner that the pipeline system is ready for commissioning; Review of status jointly with the Company and obtaining final clearance for start of commissioning; Development and submission of commissioning procedures including detailed calculations for lengths, obtaining Owner approval,

Carrying out overall commissioning of the total pipeline system including all facilities and all necessary co-ordination/ liaison with other Contractor(s) / OEM / Owner Project and O & M team / Owner's representative; Carrying out commissioning; Supply of all equipment like Nitrogen vaporizers/ CYLINDER, along with all piping and instruments, temporary venting/ flaring facilities, man- power, consumables including pigs and required quantity of Nitrogen; Performing all associated works, complete as per applicable specification, other provisions of Contract document and instructions of Owner / Owner's representative.
HOOK UP WITH EXISTING PIPELINES WITH COLD TAPPING METHOD Nitrogen purging in existing pipeline section for removal of Oxygen, Required ROU area cleaning, excavation to expose existing pipeline, Removal of coating on existing pipeline, cutting, grinding, fit-up/alignment (with 10" NB Equal Tee, 10" NB pup-piece, 10" x 12" NB Expander, 12" NB pup-piece(if required) with new pipeline), welding, NDT, coating, backfilling, restoration works etc.
PRESERVATION OF PIPELINE UP TO COMMISSIONING
Preservation of pipeline sections and associated facilities (in event of delay in ROU acquisition, commissioning, other unforeseen reasons) including supply of nitrogen and refilling up to desired pressure, monitoring, maintenance, all consumables, all equipment, manpower, etc. complete as per the requirements of specifications, other provisions of Contract document and instructions of OWNER / Owner's representative.
All the works shall be executed in accordance with the provision of contract including carrying out all temporary/ ancillary/ auxiliary works required for the performance of the works and all other acts, deeds, matters and things necessary to make the pipeline ready for pre-commissioning activities.
Any other activities 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 time schedule at no extra cost to owner. The pipeline laying shall be done as per specification, code & standard & guideline by Owner/ Owner’s Representative.
NOTES:
A. The proposed pipeline route is along State Highway etc. However, in case of non-availability of ROU along State Highway etc., the pipeline route may change as required / at suitable location on Pipeline which may cause increase / decrease in SOR quantities.
B. Rectification of defects in line pipe material not attributable to contractor shall be paid separately as per another item of schedule of rate.
C. Leak detection, its rectification and successfully re-hydrotesting shall be carried out by Contractor with a view that completion of all activity for successful hydrotesting is not inordinately extended, which will hamper the overall project schedule. Further, no extra payment claim shall be entertained for re-hydrotesting and leak detection if defects found attributable to Contractor.
D. Supply of all assorted CS pipes, Valves, IJs, flanges, fittings & Flow/ barred tees etc. shall be paid by separate item mentioned in SOR 23. Supply of LR Bend are included in above mentioned pipeline laying rate. No separate payment shall be paid.
E. In above item, backfilling of pipeline trench by borrowed select soil duly approved by Owner / Owner's representative shall be paid by separate item mentioned elsewhere in the SOR.
F. Contractor shall not perform any pipeline activities along ROU without specified barricading as per Std. Drg. and other safety measures.
G. The lengths of pipelines are tentative. Items except above are covered separately.
H. The above rate is excluding of crossings by HDD, Boring, moiling, open cut conventional Method mentioned under separate item for Pipeline laying and installation.
I. The rates shall be applicable for the work as specified in tender.
J. Contractor shall ensure that no tree/plant cutting shall be carried out during Pipeline Laying operations. Trenching shall be carried out manually, if need be, so as to ensure no damage to plant/tree/OFC /water pipeline /telephone line/sewage line/electric cable and other underground utilities.
K. U/G Piping or Pipe laying of 12" including valve chamber/ SV's/ TOP/ FT shall be paid under SOR item No.: 1.1

- **SOR ITEM NO. 2 : CASED CROSSING (BY HDD /Boring) INCLUDING SUPPLY OF CASING PIPE**

Complete work of cased crossing (between the limits as defined in approved drawings) including supply of casing pipe bare (for 12" NB Pipeline) including handling, loading, transportation, unloading to Contractor's own stock yard/ work site.
Installation of casing pipe by boring for rail, road or canal crossings wherever required in all types of soil and terrain including all other materials viz. casing insulators and casing end seals, materials for casing vent and drains, etc. including supply of all other materials equipment, consumables, manpower, welding including visual inspection of all weld joints, installation of casing insulators, end seals,
Pre-construction survey and making of crossing drawing based on site visit and getting their approval from concerned Authority/ Owner / Owner's representative prior to starting the execution of work.
Installation of casing pipe by jacking/ boring for cased crossings including open cut for adjacent service road, canal, minor nature of water channel, utility line crossing etc. (if any) wherever required for all depth in all type of soils and terrain for carrier pipe insertion. All other Contractor supplied materials like casing insulators and casing end seals as per enclosed specification/ drawings materials for casing vents and drain assembly etc.
Backfilling of the ditch/ trench including restoration and cleanup of area to the satisfaction of Owner / Owner's representative and/or as directed by concerned Authority.
vents and drain-off pipes, Bentonite filling, surface preparation and painting / Coating (External and Internal, if asked by Authorities) backfilling and restoration as original of the facility crossed and performing all works as per drawings, specifications and instructions of Owner / Owner's representative and provision of Contract document.
NOTES:
A. Actual length & cover from top of casing pipe string may vary depending upon site conditions, approved drawings, specification etc. and / or as decided by concerned Authority / Owner / Owner's representative.
B. Payment for the installation of carrier pipeline section inside bored/ HDD casing shall be paid under SOR item no. 1.1
C. Cased crossing of Railway is not envisaged for this project.
D. Supply, fabrication, Erection/Installation and painting & stenciling of pipeline marker for crossing will be paid separately as applicable.

- **SOR ITEM NO. 3. : PIPE LAYING/ INSTALLATION BY MOLLING METHOD**

Survey of underground utilities, execution of the work as per specification, including excavation of pits moiling with the hole size not exceeding 20% of the CARRIER pipe dia, jointing and insertion of carrier pipe, testing & commissioning and restoration of the pits to original condition, submission of As-Built Graph as per specifications and the instruction of Engineer-in-charge.
Installation of carrier pipe by boring for rail, road or canal crossings wherever required in all types of soil and terrain including supply of all other materials equipment, consumables, manpower, welding including visual inspection of all weld joints.
Pre-construction survey and making of crossing drawing based on site visit and getting their approval from concerned Authority/ Owner / Owner's representative prior to starting the execution of work.
Strings preparation of carrier pipes, welding, testing, 100 % radiography by X-ray, welding repair and retest, coating of field joints with Heat Shrink Sleeve or equivalent (including supply of coating material) and repair of pipeline coating with repair patch or equivalent material (including supply of repair patch) as per specification, pre-hydrotest of complete strings made for crossing etc.
Installation of carrier pipe by MANUAL/ MACHINE MOILING TECHNIQUE with adjacent service road, canal, minor nature of water channel, utility line crossing etc. (if any) wherever required for all depth in all type of soils and terrain for carrier pipe insertion. All other Contractor supplied materials shall be as per enclosed specification/ drawings.
Preparation of required length of carrier pipeline welded string including all other works as mentioned in SOR Sl. No. 1.1 above and as per specification/ drawings. insertion of carrier pipe after above ground pretesting at specified test pressure including backfilling and restoration as original of the facilities crossed.
Backfilling of the ditch/ trench including restoration and cleanup of area to the satisfaction of Owner / Owner's representative and/or as directed by concerned Authority.

Pigging, cleaning, Post installation hydrotest, dewatering and tie-in with pipeline, all other works including pigging, cleaning, final hydrotesting etc. along with mainline works (as mentioned in item no. 1.0 above) as per specification, approved procedure, drawing etc. and instruction of Owner / Owner's representative and provision of contract document, getting NOC from all concerned Authority of the facilities crossed.
Restoration of the pits to original condition, submission of As-Built Graph as per specifications and the instruction of Engineer-in-charge.
NOTES :
A. Actual length & cover from top of carrier pipe string may vary depending upon site conditions, approved drawings, specification etc. and / or as decided by concerned Authority / Owner / Owner's representative.
B. Payment for the length carrier pipeline string shall be bored length plus two meters. Payment for additional length of carrier pipeline string shall be paid under SOR item no. 1.1
C. Supply, fabrication, Erection/Installation and painting &stenciling of pipeline marker for crossing will be paid separately as applicable.
• **SOR ITEM NO. 4. : PIPELINE INSTALLATION BY HDD TECHNIQUE AT ANY OTHER LOCATION AS PER TENDER DRAWING OR AS INSTRUCTED BY OWNER / Owner's representative**
Complete work of any crossing (between the ROW limits as defined in Crossing Drawings enclosed with Bid Document) by HDD method including " Receiving and taking over" of owner supplied free issue 3 Layer PE / LPP coated line pipes of all sizes, type and wall thickness and API 5L Gr. X-60 grade from owner's designated point of issue and transportation to Contractor's stock yard/ work shop/ work site including all handling, loading, unloading, aligning etc. supply of all Contractor supplied material including consumables, manpower, equipment, other resources to work site(s) and acquiring the required land for storage., Execution of, but not limited to, following works in accordance with specifications and instruction of Engineer-in-charge and as per all provision of Contract Document.
Mobilization and demobilization at site(s), supply of all materials as per "Contractor's Scope of Supply, all consumables, equipment, manpower and other resources, and acquiring the required land for site preparations as per the provisions of the Contractor document.
Pre-construction survey, necessary cover required over the carrier pipeline from lowest bed level of the stipulated water crossing to be obtained from concerned authority, bed strata data including design & detail engineering and making of crossing drawing for getting their approval from concerned Authority/ Owner / Owner's representative, getting work permit/ NOC for crossings as well as utility crossings (if any) encountered during crossing prior to start the execution of work.
Obtaining historical data/ scour depth (for river) from concerned authority, if required, ascertaining under neath soil & strata, necessary cover required over the carrier pipeline from lowest bed level of the stipulated water crossing including design & calculation and detail engineering and making of crossing drawing for getting the approval from concerned Authority/ Owner / Owner's representative.
For road crossings, pre-construction survey based on site visit, collection of data (if required) from concerned Authority including design and detail engineering and making of crossing drawings for getting their approval from concerned Authority/ Engineer-in-charge, getting work permit/ NOC for the crossing as well as utility crossings (if any) encountered during crossing prior to start the execution of work.
Complete works for the major canal/NH/RLY by horizontal drilling method (HDD) including all additional drilled lengths necessitated by Contractor's design of water crossings, carrying out all topographical, hydrological and geo-technical surveys required for calculation of scour level for design and construction of crossing, preparation of all necessary design & construction drawings along with design document, procedure (i.e. scour level calculation & installation design) for Owner's / Consultant’s approval.
Preparation of detailed construction method/ statement and execution of, but not limited to, the following works in accordance with specifications, drawings and as per provisions of the Contract document and instructions of the Owner/Owner's representative;
Laying of the pipeline for crossing by the approved HDD method across the crossing including, strings preparation of pipes, welding, testing, 100% radiography by x-ray, welding repair and retest, coating of field joints with special type Dirax Heat Shrink Sleeve or equivalent (including supply of coating material) and repair of pipeline coating with special PERP-80 repair patch or equivalent material (including supply of repair patch) as per specification.
Pre and Post installation of hydrotest including leaks and repair of defects and resetting, etc. for defects attributed to Contractor's faulty work. Supply, fabrication and construction of protective fencing as required, Restoration and clean-up etc., Preparation of as built drawings and other records etc.;
Backfilling of the ditch/ trench including restoration and clean-up of area, disposal of drilling fluid & waste etc. to the satisfaction of Engineer-in-charge and /or as directed by Concerned Authority.

Pigging, Cleaning, Post installation hydrotest, dewatering and tie-in with pipeline at either bank etc. all other works including pigging, cleaning, final hydrotesting etc. along with mainline works (as mentioned in item no. 1.0 above) required as per specifications, codes, approved drawings, calculations, methods and as directed by Engineer-in-charge and provision of contract document; getting NOC from all concerned authority of the facilities crossed.

All other works not specifically listed herein, but required as per specifications, drawings, provision of contract document, calculations, and construction method statements , leading to successful completion of works.

In case of water body crossings

Drilling to the required depth on the banks and bed including maintenance of drill hole in all types of strata, all depth to accommodate the pipeline at all conditions of the waterbody crossings by HDD methods for providing with minimum cover either

(i) 2.5m below the scour level / profile, duly approved/ accepted by concerned authority (under whose jurisdictions the crossing lies)---- For rivers with rocky bed

or

(ii) 5.0 m below the scour level / profile, duly approved/ accepted by concerned authority (under whose jurisdictions the crossing lies)---- For major rivers.

or

(iii) 2.5 m below the bed level / profile, duly approved/ accepted by concerned authority (under whose jurisdictions the crossing lies)---- For minor waterbody crossings.

and

(iii) In addition to point (i) & (ii), In case of multiple combined X-ing i.e. river along with road/ drain, minimum cover requirement as per specification/ concerned authority for each type of x-ing has also to be fulfilled.

Crossings by HDD method other than water body

Drilling to the required depth below the surface/ Ground level including maintenance of drill hole in all types of strata, all depth to accommodate the pipeline at all conditions of the crossings by HDD methods for providing with minimum cover 1.5 mtr.

- **SOR ITEM NO. 4.2. : Major River Crossing By HDD method**

Complete work of any crossing (between the ROW limits as defined in Crossing Drawings enclosed with Bid Document) by HDD method including " Receiving and taking over" of owner supplied free issue 3 Layer PE / LPP coated line pipes of all sizes, type and wall thickness and API 5L Gr. X-60 grade from owner's designated point of issue and transportation to Contractor's stock yard/ work shop/ work site including all handling, loading, unloading, aligning etc. supply of all Contractor supplied material including consumables, manpower, equipment, other resources to work site(s) and acquiring the required land for storage., Execution of, but not limited to, following works in accordance with specifications and instruction of Engineer-in-charge and as per all provision of Contract Document.

NOTES:

A. Rates quoted shall be applicable for multiple crossings at different locations.

B. Contractor shall be paid based on distance between tie-in points at two ends of crossing and not between points at entry and exit of HDD

C. No separate payment shall be paid to the contractor for Receiving and taking over of owner supplied free issue 3 Layer PE / LPP coated line pipes of all sizes, type and wall thickness from owner's designated point of issue.

D. Contractor shall not be entitled for any extra payment for any extra depth beside the above necessitated due to location/ area constraint, capacity of rig etc.

E. No separate payment will be paid for length of HDD work in pipeline work of above Sr. 1.1 including stringing, welding, NDT, joint coating, cleaning, Pre, Post & mainline hydrotest, dewatering and other activities of pipeline. It is included in above mentioned quotes.

F. Supply, fabrication, Erection/Installation and painting &stenciling of pipeline marker for crossing will be paid separately as applicable.

- **SOR ITEM NO. 10.**

Including the scope of Issuing Material from SIPI (free issue Material), Transporting the Material to site, conducting WPS & PQR, welding work of station joints (pipe to pipe/fittings joints) with supply of consumables, 100% NDT (Radiography by Xray/Gamma Ray & UT) of weld joints, Erection of pipe sections on pipe supports, tightening of flange joints, skid connection setup, general restoration, above ground hydro static testing of piping and hook up of piping with existing Pipeline ,Painting by providing required Manpower, equipment, tools & tackles, as per required quality standard & follows the safety norms. Scope also includes hydrotest & pneumatic of piping & IV/FT

- **SOR ITEM NO. 11.**

INSTALLATION OF ALL FITTING & VALVES IN BYPASS LINE FOR ISOLATION VALVES.
• **SOR ITEM NO. 22.**
Complete work of fabrication, erection, painting, testing, and making ready for further commissioning / start-up the carbon steel piping system along with pipes, fittings, flanges valves etc. of all sizes and ratings/ thickness. including calibration and installation of pressure & temperature gauges (wherever required). Supply and installation of steel pipes (2"NB size & below), all Steel Ball Valves, Globe Valve (Buttweld/RF) ,Insulating Joint ,fittings like elbows, tees, reducers, swages, sockets, nipples, flanges, blind flanges, spectacle blind flanges, valves blind etc. of all ratings/ thickness and valves , including supply of all consumables, equipment, manpower and other resources and execution of but not limited to the following works in accordance with relevant specifications, scope of work and instruction of Company/ Engineer-in-Charge and as per all provisions of the contract document.

NOTE : List of machineries (if available) may be provided by SIPI-Benin on discounted rates prevailing the market rates.

- HYDRA (around 14 TON)
- JCB
- POWER GENERATOR – (Min. 63 KV)
- WELDING MACHINES
- TRACTORS
- DEWATERING PUMPS
- MUD-PUMP
- TRAILOR
- MOTHER OVEN
- AIR COMPRESSOR

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SPECIFICATION

FOR

WELDING OF ONSHORE GAS PIPELINES

SPECIFICATION NO. SIPI/Steel/TS/02

C O N T E N T S

01. SCOPE

This specification stipulates requirements for fabrication of all types of welded joints in carbon steel piping 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/ drain pipes and tappings for instrumentation.

Note: Any approval accorded to the Contractor shall not absolve him of his responsibilities and guarantees.

02. 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 :-

- Code for Gas Transmission and Distribution Piping System (ANSI B31.8).
- Standard for welding of Pipelines and Related Facilities (API 1104).
- Specification for welding Electrodes and Filler Materials (ASME Sec. II C).
- Non Destructive examination (ASME Sec. V).

03. MATERIAL SPECIFICATIONS

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

04. WELDING CONSUMABLES

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 welding electrodes/ filler wires supplied by the CONTRACTOR shall conform to the class specified in the welding specification chart. The materials shall be of the make approved by the 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.

Electrode Qualification test records shall be submitted as per Annexure-I with respect to the electrodes tested by the CONTRACTOR and submitted for approval of the COMPANY.

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

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.

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

04.01 **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.

a) argon complying with BS 4365

b) carbon dioxide complying with type 1 specified in BS 4105

c) 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% 02,5% CO_2 the variation of such addition shall not exceed ± 10% of that stated. Moisture content shall correspond to a dew point of - 30°C or lower.

05. EQUIPMENT & ACCESSORIES

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

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

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

06. WELDING PROCESSES

6.1 Welding of various materials under this specification shall be carried out using Shielded Metal Arc Welding process (SMAW) with the approval of the COMPANY.

6.2 The welding processes to be employed are given in the welding specification chart. Any deviation desired by the CONTRACTOR shall be obtained through the express consent of the COMPANY.

6.3 Automatic process shall be employed only with the express approval of the COMPANY. The welding procedure adopted and consumables used shall be specifically approved.

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

07. 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 beveled 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.

08. ALIGNMENT AND SPACING

Immediately prior to line-up CONTRACTOR shall inspect the pipe ends inside and outside for damage, dents, lamination's 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.

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 off-set 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 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.

09. 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.

10.0 WELDING

10.1 Root Pass

a) 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.

b) Position or roll welding may be permitted. Separate procedures shall be submitted and qualified for up hill, down hill, vertical down and roll welding. The vertical up method of welding shall be sued for the root pass of the tie-ins, special crossings, fittings and special parts, filled welds, repairs and when an external line up clamp is used. The down hill 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 3mm 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 chiseling.

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) 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. Atleast two passes shall be made on socket weld joints

i) Peening shall not be used.

10.2 Joint Completion

In case of manual welding, the first pass shall be carried out by a minimum of two welders, working simultaneously and so placed as to cause minimum distortion of the pipe.

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 speed shall be approximately same as that established in the qualified welding procedure specification.

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 8.0 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, normally not exceeding four minutes.

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 that 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.

Please Note- WPS will be in three parts:

WPS-01 - Mainline and Tie in welding
WPS -02 - Partial Repair
WPS-03 - Full through Repair

11.0 HEAT TREATMENT

11.1 Preheating

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

b) Preheating shall be performed using resistance or induction/ heating methods. Preheating by gas burners, utilising acetylene or propane gas may also be carried out. Oxypropane gas may be used with the permission of the COMPANY under careful supervision.

c) Preheating shall extend uniformly to atleast three times the thickness of the joint, but not less than 50mm, on both sides of the weld.

d) Preheating temperature shall be maintained over the whole length of the joint during welding. Temperature indicating crayons or other temperature indicating devices shall be provided by the CONTRACTOR to check the temperature.

11.2 Post weld Heat Treatment

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.

a) 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.

b) 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.

c) 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 rt wherer 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 along with the hardness test results on the weld joints (whenever required as per the welding specification chart) shall be submitted to COMPANY for its approval.

j) Each joint shall bear an identification number which shall be maintained in the piping sketch to be prepared by the CONTRACTOR. The joint identification number shall appear on the corresponding post weld heat 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/ Brinnel 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.

l) 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.

12.0 INSPECTION AND TESTING

12.1 **General**

a) The COMPANY's Inspector shall have free access to all concerned areas, where the actual work is being performed. The CONTRACTOR shall be 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 :-

I. To check the conformance to relevant standards/ specifications and suitability of various welding equipment and the welding performance.

II. To supervise the welding procedures qualification.

III. To supervise the welder's performance qualification.

IV. To carry out visual/NDT examination of the welding’s.

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.

12.2 **Welding Procedure Qualification**

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

b) 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-III (attached) shall be submitted to the COMPANY's Inspector for approval immediately after completing the procedure qualification test and atleast 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, charphy 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. The destructive testing of welded joints shall be as per Clause 14.0

12.3 **Welder's Qualification**

a) Welders shall be qualifed in accordance with the API 1104 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 specified in Clause 12.5 and 16.0 of this specification. The COMPANY's Inspector shall witness the test and certify the qualification of each welder separately. Only those welders who have been approved by the COMPANY's Inspector shall be employed for welding. CONTRACTOR shall submit the welder qualification test reports in the standard format as shown in Annexure-IV and obtain express approval, before commencement of the

work. It shall be the responsibility of CONTRACTOR to carry out qualification tests of welders.

b) The welders shall always have in their possession the identification card as shown in Annexure-V and shall produce it on demand by the COMPANY's Inspector. It shall be the responsibility of the CONTRACTOR to issue the identity cards after it has been duly certified by the COMPANY.

c) No welder shall be permitted to work without the possession of identity cards.

d) If a welder is found to perform a type of welding or in a position for which he is not qualified, he shall be debarred from doing any further work. All welds performed by an unqualified welder shall be cut and redone by a qualified welder at the expense of the CONTRACTOR

12.4 **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.

12.5 **Non Destructive Examination**

The non-destructive examination shall mainly consist of examination using x-ray/Gama ray radiography as detailed in Clause 16.0.

Radiographic examination of one hundred percent (100%) girth welds will be required by the COMPANY.

For 150# Rating Pipeline, welds shall meet the standards of acceptability as set forth in API 1104. However for higher class rating pipeline welds shall meet the standards of acceptability as set forth in API 1104 and as well as the requirements laid in subsequent paragraphs.

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

The COMPANY will review all the radiographs of welds and inform the CONTRACTOR regarding acceptable welds. The decision of the COMPANY shall be final and binding in the regard.

I. Any length of inadequate penetration of the root bead as defined by API-1104 is not acceptable except that root concavity is allowed as per API 1104.

II. Any amount of incomplete fusion at the root of the joint as detailed in API 1104 is considered unacceptable.

III. Unrepaired burn through areas are unacceptable.

All requirements mentioned in the specification shall be arranged and executed by the CONTRACTOR through his own resources. In addition, for pipes with wall thickness 9.5mm and above, ultrasonic inspection is required in the following cases as per clause 15.0 of this specification.

a) On the first 100 welded joints corresponding to each automatic (GTAW/GMAW) welding procedure used.

b) When 20mm or more are cut from the pipe end as supplied, the ends shall be ultrasonically inspected for an additional length of 20mm to assure no lamination exist.

c) When welds are repaired.

d) When in the opinion of COMPANY, ultrasonic inspection is required to confirm or clarify defects indicated by radiography

e) When automatic procedure is used at least 10 cm on each weld shall be ultrasonically inspected at COMPANY's discretion

In addition, ultrasonic inspection may be required for certain critical weldings of the pipeline (i.e. tie-ins, welding of valves, flanges) randomly selected at COMPANY's discretion. All fillet and groove welds other than those radiographed shall by subjected to dye penetrant/ MP inspection. The non-destructive test system used for inspecting welds must be approved by the COMPANY.

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 article shall be considered defective and shall so be marked with an identification paint marker.

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

1. Any length of inadequate penetration of the root bead as defined by API- 1104 is not acceptable except that root concavity is allowed as per API 1104.

2. Any amount of incomplete fusion at the root of the joint as detailed in API 1104 is considered unacceptable.

3. Unrepaired burn through areas are 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.

12.6 **Destructive Testing**

The COMPANY 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 14.0.

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

13.0 REPAIR OF WELDS

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

A separate welding procedure specification sheet shall be formulated and qualified by CONTRACTOR for repair welds simulating the proposed repair to be carried out. Separate procedures are required to be qualified for (a) thorough thickness repair (b) external repair and (c) internal repair. Welders shall be qualified in advance for repairs. The root pass, for repairs opening the root, shall be done by the vertical uphill technique. The procedure shall be proven by satisfactory procedure tests to API 1104 including the special requirement of the specification, and shall also be subject to metalographic examination, hardness surveys and Charpy tests to determine the effects of repair welding on the associated structure.

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

The repair shall be subjected, as a minimum requirement to the same testing and inspection requirements as the original weld. The re-radiography of repaired weld shall be limited to 6” weld length on either edge of the repaired area. Any repaired area that is wide, irregular or rough shall be rejected and a full cut out shall be done.

Repairs are limited to a maximum of 30% of the weld length. Welds not meeting the specification after one repair shall be cut out depending upon the extent of repair. A report of all repairs shall be maintained by CONTRACTOR.

13.2 **Limitations on Repairs**

Only one attempt at repair of any region is permitted. Repairs are limited to a maximum of 30% of the weld length measuring over cap. Welds containing cracks shall be cut out and rebevelled to make a joint.

13.3 **Weld Rejected by Accumulation of Defects**

Where a weld is rejected by the accumulation of defect clause, as defined by API 1104 and this specification, repairs within these limitations are permitted. Defects in the filling and capping passes shall be repaired preferentially.

14. DESTRUCTIVE TESTING OF WELDED JOINT - BUTT WELDS

14.1 **Preparation**

Having passed the visual and the non-destructive-inspection the test weld shall be subject to Mechanical test.

After satisfactory completion of all visual and non-destructive testing the test weld shall be set aside for a period not less than 24hours. No further work on the test weld and no cutting of test specimens from the weld shall be performed until a period of at least 24 hours has expired.
Weld specimens shall be taken from the positions indicated in Fig. 1 of this specification from areas as free from defects as possible; for this reason, it is necessary to take the previous non-destructive tests into account. The minimum number of tests to be carried out is given in Table-1 of this specification.

The tests shall be carried out in laboratories approved by the COMPANY. The specimens shall be prepared in accordance with the figures given in the paragraphs which refer to the individual tests.

14.2 **Tensile Strength**

Specimens shall be taken from the position indicated in Fig. 1 & 1A of this specification. Two ISO type specimens and two API - type specimens shall be taken.
The ISO test specimen are shown in Fig. 2 of this specification.

14.2.1 **Method**

The test shall be carried out in accordance with ISO:375.

Table-1
Type and Number of Test Specimens for
Procedure Qualification Test & Production Welds

Pipe Size, Out Side Diamter-Inches	Number of Specimens									
	Tensile API	Tensile ISO	Nick Break	Root Bend	Face Bend	Side Bend	Macro Bend	Hard Ness	Impact	Total
Wall Thickness - ½ inch (12.7mm) and Under										
Under 2-3/8	0	0	2	2	0	0	0	0	0	4
2-3/8 to 4- ½ incl.	0	0	2	2	0	0	0	0	0	4
Over 4-½ less than 12.75	2	0	2	2	2	2	0	2	12	24
12- 3/4 and Over	2	2	4	4	4	4	0	2	24	44
Wall Thickness - ½ inch (12.7mm)										
4-½ and smaller	0	2	0	0	0	2	0	0	0	4
Over 4-½ less than 12-3/4	2	0	2	2	2	0	2	2	12	24
12-3/4 and over	2	2	4	0	0	8	2	2	24	44

14.3 **Nick-Break Test**

14.3.1 **Preparation**

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

14.4 **Macroscopic Inspection**

14.4.1 **Preparation**

Specimens shall be taken from the positions indicated in Fig. 1 of this specification and shall be prepared in accordance with ASTM E2 and E3.

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

14.4.2 **Method**

Specimens shall be carefully examined under the microscope, with a magnification of atleast 25 times (25:1). The COMPANY may ask for a macrograph with 5 times (5:1) magnification for DOCUMENTATION purposes.

14.4.3 **Requirements**

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

14.5 **Hardness Test**

14.5.1 **Preparation**

The prepared macrosection is to be used for hardness testing using the Vickers method with 10 kg load Indentations are to be made along traverses each approximately 1mm below the surface on both sides of the weld.

In the weld metal a minimum of 6 indentations equally spaced along the traverses are to be made. The HAZ indentations are to be made along the traverses for approximately 0.5mm each into unaffected materials, and starting as close to the fusion line as possible.

One indentation on each side of the weld along each traverse is to be made on parent metal. Refer Fig.3. The indentations are to be made in the adjacent regions as well on the opposite sides of the macrosection along the specified traverses.

14.5.2 **Method**

The test shall be carried out in accordance with Recommendation ISO R81, Vickers hardness, using a laboratory type machine controlled as pre-recommendation ISO R146 and using a diamond pyramid penetrator set at 2.37 rad (136°) with a load of 10 kg.

14.5.3 **Requirements**

Hardness value shall not exceed the limit specified in welding Specification chart. In case of a single reading having a slightly (+10 HV) higher value than the specified limit, further indentations shall be made to check if the high value was an isolated case.

All the hardness values contained from the heat affected zone shall not exceed 100 HV with respect to the average hardness of the values obtained for the base metal. If these additional tests give a hardness within the specification limit the slightly higher value may be accepted.

14.6 **Charpy - V - Notch Impact Test**

14.6.1 Specimens shall be taken from the position indicated in Fig. 1 of this specification. The test specimens will be prepared in accordance with ISO R148. Charpy V-notch specimens shall have dimensions as given in Fig. 3 of this specification.

Three test specimens shall be taken from each sample and they shall be cut and worked so that their length is transverse and perpendicular to the weld bead with the notch position as shown in Fig. 4 of this specification. The notch shall be perpendicular to the roller surface. The test specimen width shall depend upon the pipe wall nominal thickness as following :

Sl. No.	**Nominal Wall Thickness in mm**	**Test Specimen width mm**
1.	Over 12	10
2.	Over 9.5 and upto 12	7.5
3.	From 7 upto 9.5	5
4.	Less than 7	2.5

14.6.2 **Test Method**

The test shall be carried out as indicated in ISO R148 "Beam impact test V notch".

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

14.6.3 **Requirements (Note-1)**
The impact energy shall be :

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

Note :

1) Only one value is permitted to be lower than average value upto the value specified.

2) These values are specified for resistance to brittle fracture only, here additional requirements are specified in project data sheet. (Ex. Pipeline materials with arrest properties i.e. a higher upper shelf Charpy V-energy for resistance against ropagating ductile fractures) the same shall be followed:

14.7 **Bend Test Requirements**

The Bend test Specimens shall be made and tested as per the requirements of API 1104 latest Edition except that the dimensions of the Jig for guided bend test shall be modified as follows:

Radius of the Plunger `A'	:	2 t
Radius of the die `B'	:	3 t + 1.6mm
Radius of the die `C'	:	50.8mm

The acceptance criterion on shall however be as per API 1104.

Note : t = thickness of specimen

15. ULTRASONIC INSPECTION

In addition to the radiographic inspection, ultrasonic inspection is required as per conditions listed in paragraph 12.5 of this specification. This section concerns manual ultrasonic inspection. However ultrasonic by automatic equipment may be used if approved by the COMPANY.

15.1 Equipment and Operators

The CONTRACTOR who carries out the ultrasonic inspection shall have sufficient qualified personnel equipment and instruments at his disposal to be able to effect the tests without hindering or delaying the pipeline assembly operations.

The operators shall be fully qualified as per a recognised standard (ASME Sec. V or equivalent) and they shall have as minimum level II. The operators shall be able to :

- calibrate the equipment;
- perform an operational test under production conditions;
- interpret the screen picture;
- evaluate the size and location of reflectors
  interpret the type of defects detected

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

The CONTRACTOR appointed to carry out ultrasonic inspection shall supply all the instruments necessary for their execution on site.

15.2 Specification for Ultrasonic Inspection Procedure Qualification

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.

15.3 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.

15.4 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 50mmwide 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
- 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:

a) that the required standards of the inspection procedure, as previously established and approved by the COMPANY, are satisfied.

b) 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'.

15.5 **Ultrasonic Instruments**

The Ultrasonic Instruments shall satisfy the following:

- be pulse 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 a 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 stabilizing device with a tolerance of ±2 Volts.

15.6 **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.

15.7 **Reference Sample Pieces**

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

For the calibration of runs and the regulation of detection sensitivity during the test, a calibration piece shall be used. This piece shall be taken from the production material, and will be at least 150mm long (measured in the direction of the axis), and at least 50mm wide (measured in the direction of the circumference) (see Fig. 5 of this specification).

In the middle of the inside and the outside surface of the calibration piece a groove shall be made. The groove will have a rectangular cross-section, a flat bottom and the following dimensions.

- depth: 1 ± 0.1mm
- breadth (measured parallel to the 150mm side): 1 ± 01mm
- Length (measured parallel to the 50mm side) not less than 30mm

In addition, the calibration piece shall have a hole, 2mm in diameter, passing through its thickness and positioned so that during calibration the echoes returning from the two grooves do not interfere with those returning from the hole.

15.8 **Calibration**

For a precise check of the sound paths necessary for a full inspection of the weld joint, the probe shall be moved (half skip and full skip distance) until internal and external notches on the test piece are detected (See Fig. 5 of this specification).

The relevant defect limits the path lengths on the time base. The calibration of reference sensitivity is obtained by utilizing the through - drilled test hole in the thickness of the reference block to draw the distance - amplitude correction curve relevant to the test probe.

Calibration shall be carried out according to the following procedure ; place its internal vertex until the maximum height of echo is displayed on the screen ; this echo is adjusted to 80% of full screen height by means of the sensitivity adjuster set in dB. Without varying the amplification, the probe placed at full skip distance from the hole is moved to detect the external vertex of the hole until the maximum height of echo is obtained. The straight line connecting the peaks of the two echoes obtained by the above procedure, represents 100% reference level, while the one connecting the two points at half height of the same echoes represents "50% reference level".

The two straight lines shall be marked on the screen with a pen. Calibration shall be repeated each time tests are re-started ; at intervals not longer than 30 minutes during normal operations; each time the conditions fixed in advance are altered. This calibration is applicable provided that the crystal of the probe is 8 x 9mm size. Should this size of the crystal be different, the

value of the sensitivity obtained from the calibration by a crystal of a different size shall be brought to the value of sensitivity obtained from the calibration by a 8 x 9mm crystal. The sensitivities of the two different size probes shall be compared through the echoes obtained on the notch of the test piece with the probe position at half skip of the distance.

15.9 **Regulation of Amplification During Production Testing**

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

15.10 **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.

15.11 **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 oved until maximum response is obtained, paying attention all the time of the probe-tube coupling.

If, under these conditions, the heights 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 unfavorably 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.

15.12 **Other Equipment**

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

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

16.0 RADIOGRAPHY

16.1 **Scope**

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

16.2 **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.

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.

16.3 **Procedure**

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

16.3.2 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.

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

16.3.4 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 eld, and the outline and holes of the penetrameter are clearly discernible.

16.3.5 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 alongwith the joint identification number shall be duly entered in a register and signed by the CONTRACTOR and submitted to the COMPANY for approval.

16.3.6 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.

16.3.7 Three copies of each acceptable radiographic procedure (as per Annexure-VI) 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.

16.3.8 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.

16.3.9 The CONTRACTOR shall, on a daily basis, record for each radiograph (1) radiograph's number, (2) welder's number (3) approximate chain age 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.

16.3.10 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.

16.3.11 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.

16.3.12 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.

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

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

16.4 **Radiation Source**

16.4.1 Radiographic examination shall be carried out using x-radiations/Gama ray. D4 AGFA film or equivalent is used and the required sensitivity obtained in case of Radiography by Gamma-Ray.

16.4.2 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.

16.5 **Level of Quality**

The quality level of Radiographic sensitivity required for radiographic inspection shall be at least equivalent to the values in Fig. 6

16.6 **Penetrameters**

The image quality indicator (abbreviation : IQI) shall be used for the qualification of the welding procedure and during normal line production. Radiographic sensitivity shall be measured with the wire image quality indicator (Penetrameter). The penetrameter shall be selected according to DIN54109 or ISO1027. For radiographs made with the source on the outside, a penetrameter shall be placed on each side of the film with the smaller wiere 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 demostrate that the minimum sensitivity level required is obtained. For this demostration, 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.

16.7 **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.

16.8 **Protection and care of film**

16.8.1 All unexposed films shall be protected and stored properly as per the requirements of API 1104 standard and ASTM E.94.

16.8.2 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.

16.9 **Re-radiography**

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

16.9.2 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.

16.9.3 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.

16.9.4 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.

16.10 **Qualification of Radiographers**

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

16.10.2 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 acquity eye test.

v. Date of qualification

16.10.3 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.

16.11 **Preservation of Radiographs**

16.11.1 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.

16.11.2 All radiographs shall become property of the COMPANY.

16.12 **Equipment and Accessories**

16.12.1 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.

16.12.2 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.

16.13 **Radiation Protection**

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

16.13.2 The protection and monitoring shall comply with local regulations.

16.13.3 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 Benin 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.

16.14 **Display of Safety Instructions**

16.14.1 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.

16.15 **Enforcement of Safety Regulations**

16.15.1 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.

16.16 **First Aid and Industrial Injuries**

16.16.1 CONTRACTOR shall maintain first aid facilities for its employees and subcontractors.

16.16.2 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.

16.16.3 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.

16.17 **No Exemption**

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

ANNEXURE-I
Sheet 1 of 3

ELECTRODE QUALIFICATION TEST RECORD

A. **Tested at (Site name)** Date:

Manufacturer's Name :

Brand Name :

Batch Number & Size Tested :

Classification & Code :

for Welding in Positions :

In combination with (if any) :

Code of Reference (used for testing) :

Special requirements :

B. **All Weld Tensile Test**

Base Material used :

Pre-heat temp. :

Postweld Heat Treatment Details :

Visual Examination :

Radiographic Examination Results :

Tensile Test Results :

Sl.No.	Identification No.	U.T.S.	Yield Point Elongation
1.			
2.			

ANNEXURE-I
Sheet 2 of 3

C. **Impact Test Results**

Test Temperature: Notch in:

Type of Specimens: (Charpy) Size of Specimens:

Sl.No.	Specimen No.	Impact Valve Average
1.		
2.		
3.		
4.		
5.		
6.		

D. **Chemical Analysis Result**

Electrode Size used:

Batch No.:

%C	%S	%P	%SI	%Mn	%Cr	%Ni	%Mo	Other

E. **Fillet Weld Test Results**

Welding Positions:

Base Materials:

Size of Electrode used:

Visual Inspection Results: 1)
2)

Macro Test results: 3)

ANNEXURE-I
Sheet 3 of 3

Fracture Test Results:
Remarks:

F. **Other Test Results**

1. Transverse Tensile Test:

In combination with:

Base Material used:

Position of Welding:

Preheat Temperature:

Post Weld Heat Treatment:

Radiography:

Identification No. U.T.S. Fracture in Remarks

2. **Guided Bend Test**

Position	**ID No.**	**Root, Face or Side Bend**	**Remarks**
1.			
2.			
3.			
4.			
5.			

Any other Tests:

Conclusion:

ANNEXURE-II
Sheet 1 of 2
STRESS RELIEF HEAT TREATMENT PROCEDURE SPECIFICATION

Name of the Heat-Treater:

Name of the Project: Specification Reference No.:

1. **General Details**

Name of the Equipment:

Name of the Assembly/ Part:

Assembly/ Part Drawing No.:

Material:

2. **Furnace Details**

Type of Heating: Gas/ Oil/ Elec. Res./ Induction

Type of Heating: (Tick mark)

Capacity (Size):

Maximum Temp.(°C):

Method of Temp.:

Measurement

Atmosphere Control:

3. **Heat Treatment Cycle Details**

Changing Temp. °C:

Rate of Heating, °C/ Hr.:

ANNEXURE-II

Sheet 2 of 2

Soaking Temp. °C:

Soaking Time, Hrs.:

Rate of Cooling, °C/ Hr.:

Mode of Cooling:

4. Other Details, if any.

Notes :

The following documents shall be furnished along with the specifications:

i. Material Test Certificates

ii. Assembly/ Part Drawing.

ANNEXURE-III

Sheet 1 of 3

WELDING PROCEDURE QUALIFICATION TEST RECORD

Example of record form for welding procedure approval test:

Project/ Contract Pipe and Coating Material Process Outside Diameter Pipe Thickness Joint Design (Sketch Attached)		Contractor	
Make and type of filler metal	Diameter	Current	Volts
Root Second Run Other Runs Other Electrical Characteristics	A.c/d.c	Electrode +ve / -ve	
Shielding Gas : Type or mixture Flow Shielding Flux Position			
Direction of Welding: : Root : Second Run : Other Runs :		Vertical up/ Vertical down Vertical up/ Vertical down Vertical up/ Vertical down Vertical up/ Vertical down	
Number of Welders: Root Second Run Other Runs			

ANNEXURE-III
Sheet 2 of 3
Time lapse between commencement of root and commencement of second run

Time lapse between commencement of second run and commencement of other run

Minimum number of runs before joint allowed to cool

Maximum time between commencement and completion or weld

Type of line-up clamp

Removal of clamp after run :

Lowering off after run
Cleaning
Preheating
Minimum temperature °C Ambient Temperature °C

Type of heater to be used

Interpass temperature

Minimum °C Maximum °C

Post weld heat treatment

Speed of travel

Test Results

State acceptable non-acceptable (with reasons) or give numerical results

Non-destructive test :-

Visual
Radiograph

ANNEXURE-III

Sheet 3 of 3

Destructive Tests	1	2	3	4
Transverse tensile				
Tensile strength (with units)				
Fracture location				
Test temperature				
Macro-examination				
Fillet weld fracture				

Hardness Survey:-

Type	Load	Location of hardness measurement (Sketch)
Hardness rang:		
Parent metal		
Heat affected zone		
Weld		

Charpy V-notch impact tests

Specimen location and size

Notch location

Test temperature

Results (with units)

Additional test and tests and results e.g. chemical analysis, micro-examination, CTOD tests, bend tests etc.

The statements in this record are correct. The test joints were prepared, welded and tested in accordance with the requirements of this specification.

Inspector
Date:

ANNEXURE-IV
Sheet 1 of 1
Example of record form for welder approval test

Welder test certificate	Test No.	
Project/ Contract	Date	
Contractor	Inspector	
Welder s Name		
Address		
Pipe Material		
Pipe Thickness		
Pipe Outside Diameter		
Welding Process	Root	Fill and Cap
Electrode/ Wire		
Root	Current Voltage	
Second run	Current Voltage	
Full and cap	Current Voltage	
Direction of travel	Root: Vertical up/ Vertical down	Fill and cap: Vertical up/ Vertical down

Reason for failure
Visual
Non-destructive testing
Butt joint
Fillet weld
Number of attempts
Comments

ANNEXURE-V
Sheet 1 of 1
WELDERS IDENTIFICATION CARD

Name:

Identification: Photograph

Date of Testing:

Valid Until:

Approval of Welding:

Welding Position:

Material:

Diameter:

Wall Thickness:

Type of Welding:

Consumables

Approved by: Employer's Signature with seal

ANNEXURE-VI
Sheet 1 of 1
RADIOGRAPHIC PROCEDURE FOR PIPE WELDING

1. Location

2. Date of Testing

3. Name of Supervised Contractor

4. Material

5. Dia & Thickness

6. Type of Weld Joint

7. Radiation Source

8. Type of equipment (External/ Internal)

9. Intensifying Screens and Material

10. Filter Type and placement mask, Diaphragm Lead Screen etc. adjacent to Radiation Source or Specimen.

11. Geometric Relationship (Source local spot size, max and min source strength, object to film distance, radiation angle with respect to weld and film).

12. Limit of film coverage

13. Film type and make

14. Exposure Time

15. Processing (time temperature for development, stop bath or rinse, fixation, washing, drying etc.)

16. Density

17. Sensitivity

18. Type of penetrameter.

Approval of the COMPANY Signature of CONTRACTOR with Seal

SPECIFICATION

FOR

HYDROSTATIC TESTING OF ONSHORE PIPELINE

SPECIFICATION NO. SIPI/Steel/TS/03

CONTENTS

1.0 SCOPE

1.1 This specification covers the minimum requirements of supply, works and operations to be performed by CONTRACTOR for hydrostatic testing of steel pipelines transporting hydrocarbons in liquid or gaseous phase under high pressure. This specification does not cover the requirements of drying/pre-commissioning of the tested pipelines. This specification shall be read in conjunction with the conditions of all specifications and documents included in the CONTRACT between COMPANY and CONTRACTOR.

2.0 REFERENCE CODES, STANDARDS AND SPECIFICATIONS

2.1 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-1	Boiler & Pressure Vessel Code.
e) OISD 141	Design & construction requirements for cross-country hydrocarbon pipeline

2.2 In case of conflict between the requirements of this specification and that of the above referred coded, standards, and specifications, the requirements of this specifications shall govern.

2.3 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.

3.0 GENERAL

3.1 Hydrostatic test shall be performed on the entire length of the pipeline. Hydrostatic test shall be performed in accordance with approved Hydrostatic Test Diagrams for each test section. The maximum length of each test section shall not exceed 25 kms. The test section length up 250 m,dead weight tester is not required in hydrostatic testing.

3.2 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.

3.3 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.

3.4 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 141 as applicable, and requirements laid down in this specification.

4.0 HYDROSTATIC TEST PROCEDURE MANUAL

CONTRACTOR shall prepare for COMPANY's approval a hydrostatic test procedure manual. The 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 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) 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.

5.0 TEST DURATION AND PRESSURE

5.1 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.

5.2 Unless specified otherwise in the CONTRACT, the maximum base pressure shall not be higher than the one resulting in a hoop stress corresponding to 90% of SMYS of pipe material based on the minimum wall thickness in the test section and minimum test pressure shall not be lower than the one resulting in a hoop stress corresponding to 85% of SMYS of pipe material based on the minimum wall thickness in the test section.

6.0 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.

- Four cup batching pigs

- Caliper 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 : 400m3 min. ; 1000m3 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 callibration 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 atp 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.

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.

7.0 **PROCEDURES**

7.1 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.

7.2 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.

7.3 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.

7.4 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.

7.5 “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.
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 acceptance of gauging operation, air header shall be cut and removed. Pretested test headers loaded with three numbers of four cup batching pig shall be welded to test Section. Un-inhibited water equal to 10% of the volume of test section shall be introduced in front of the first pig. The first pig shall be launched by introducing about 1.5 km un-inhibited water. Then the second pig shall be launched by pumping the inhibited water till the second pig is received at the other end. The thermal stablisation and pressurisation can now the started”.

7.6 **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 4 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.

7.7 **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 0.2 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.
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.

7.8 Air Volume Calculation

In order to check the presence of air in the pipeline, two separate consecutive pressure lowering of 0.5 bar shall be carried out.

For calculation of air in the pipeline the second pressure lowering shall be used, and the relevant drained water shall be accurately measured (V_1). This amount measured shall be compared to the theoretical amount (V_p) corresponding to the pressure lowering that has been carried out, by using the procedure outlined in clause 12.1 of this specification.
If no air is present in the length under test:

$$\frac{V_1}{V_p} = 1$$

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_1 / 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.

7.9 **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 form dead weight testers.
- Every two-hours the ambient temperature and the pipe temperature at the thermocouples.

All data shall be recorded on appropriate forms attached to the hydrostatic test procedure manual. Care shall be taken that the maximum test pressures are not exceeded.
Bleed-off water shall be accurately measured and recorded.

8.0 **ACCEPTANCE**

8.1 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.

8.2 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.

8.3 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 form 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.

8.4 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.

9.0 TERMINATION

After the positive results of testing and collection of all data the test shall be terminated upon written approval given by the COMPANY.

9.1 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 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.

9.2 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.

9.3 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.

10.0 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.

11.0 MEASUREMENTS

11.1 Water Amount Measurement

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.

11.2 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 specifications:

Accuracy : ± 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.

11.3 **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 ±0.2°C.

b) 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 ± 1% of the scale range

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.

c) Ground temperature shall be taken by measuring pipe temperature at the thermocouple prior to starting the filling operation.

d) Environmental temperature shall be recorded from the beginning of pressurization to the end of the test by means of a recording thermometer featuring the following Characteristics:

Accuracy ± 1% of the scale range

Scale - 0° to + 60° C

Recording: Continuous on tape or disk, diagram width 100mm

Feed: 20mm/h for tape diagrams, 7.5°/h for disk diagrams.

12.0 CALCULATIONS

12.1 The theoretical water amount that is necessary for filling the section to be tested shall be obtained from the geometrical volume of the section considering the pipe tolerances.

The theoretical water amount that is necessary for pressurizing the section shall be calculated by means of the following formula:

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

Where:

Vp = computed water amount required to raise by P the pressure in the section to be tested (m^3).

Vt = geometrical volume of the section (m^3)

ΔP = 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}) x 10^6.

(Refer water compressibility factor vs pressure and temperature chart).
For temperature above 30°C the values may be extrapolated.

K = a dimensionless coefficient that is equal to a value of 1.02 for longitudinally welded pipe

12.2 The pressure change due to a water temperature change shall be calculated by the following formula:

$$\Delta P = \frac{B}{0.884\ r\ i/\ t + A}\ \Delta T$$

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 (°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 $(°C^{-1}) \times 10^6$

(Refer table – 1)

A = Isothermal compressibility value of water as estimated at the pressure and temperature values obtained at the end of test $(bar^{-1}) \times 10^6$ (Refer Figure 1)

r i = nominal inner radius of the pipe (mm).

t = nominal thickness of pipe (mm).

13.0 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:

13.1 Provision shall be made for the installation of no-admittance signs to unauthorized personnel from the roads to the R.O.W.

13.2 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.

13.3 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.

13.4 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.

13.5 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.

14.0 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.

TABLE – A

Sheet 1 of 4

0 C Bar	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

TABLE I: DIFFERENCE BETWEEN THE WATER THERMAL EXPANSION FACTOR AND THE STEEL THERMAL EXPANSION FACTOR (0 C -1) (10 -6)

TABLE - A

Sheet 2 of 4

0 C Bar	9	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

TABLE I: DIFFERENCE BETWEEN THE WATER THERMAL EXPANSION FACTOR AND THE STEEL THERMAL EXPANSION FACTOR (0 C -1) (10 -6)

TABLE - A

Sheet 3 of 4

0 C Bar	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

TABLE 1: DIFFERENCE BETWEEN THE WATER THERMAL EXPANSION FACTOR AND THE STEEL THERMAL EXPANSION FACTOR (0 C -1) (10 -6)

TABLE -A

Sheet 4 of 4

0 C Bar	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	+25618	+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

TABLE : DIFFERENCE BETWEEN THE WATER THERMAL EXPANSION FACTOR AND THE STEEL THERMAL EXPANSION FACTOR (0 C -1) (10 -6)

SPECIFICATION

FOR

MAJOR WATER CROSSINGS (CONVENTIONAL)

SPECIFICATION NO. SIPI/Steel/TS/04

C O N T E N T S

00 **DEFINITION**

A **major water crossing** shall be reckoned the one which will necessitate passing the gas pipeline across a water body such as perennial river, major irrigation canal, pond, lake, lagoon, creek etc. using special attention and means. The parameters required to classify a particular water body as a **major water crossing** shall comprise of size, hydrological data, authority/ownership, importance and other ecological/ environmental factors associated with it, and the authority to classify it such, shall rest with the COMPANY.

1.0 **SCOPE**

1.1 This specification covers the minimum requirements for the various activities to be performed by CONTRACTOR for the construction of pipeline major water crossings by conventional trenching method. Provisions of this specification are applicable only for "major water crossings" specifically named as such in the CONTRACT.

1.2 This specification shall be read in conjunction with the conditions of all specifications and documents included in the CONTRACT between COMPANY CONTRACTOR.

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

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

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

1.6 CONTRACTOR shall be deemed to have obtained all necessary information as to risks, contingencies and all other circumstances, which may influence the work w.r.t. the above.

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

1.8 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.

2.0 GENERAL

2.1 All works of the pipeline major water crossing shall be performed in accordance with the approved construction drawings, procedures, other applicable documents as per the CONTRACT, good pipeline practice and as directed by COMPANY.

2.2 Before start of the field construction, CONTRACTOR shall submit to COMPANY, for approval for each major water crossing a complete report containing at the minimum:-

i) Installation method

ii) Proposed time schedule indicating start and finish dates and detailed break-up of time period for all critical activities associated with the work.

iii) Required work area along with layout and location

iv) Equipment to be used (including number and capacity of equipment).

v) Manpower deployment during construction

vi) Proposed sub-contractors and/ or vendors along with their scope of work.

The description of the installation method as a minimum shall include the following:

a) Study of water currents in relation to the method of launching (on bottom and on surface).

b) Calculation for stability of pipeline during launching and final test.

c) Buoyancy studies

d) Preparation of fabrication yard and launching areas.

e) Pipeline construction details (handling, stringing, welding, concrete coating etc.)

f) Pre-test procedure including trial mix, design & tests for concrete coating.

g) Procedure for corrosion coating of field joint

h) Dredging, anchoring program, spoil-deposit and trench survey method including facilities for COMPANY.

i) Pulling or other installation method and related calculations.

j) Pulling arrangement including launchway and anchoring and breaking device.

k) Trench correction before launching.

l) Method of positioning and sinking of pipeline.

m) Method of rectification of damages to the pipeline, during launching.

n) Method of backfilling, bank protection and survey.

o) Final test procedure after backfilling.

p) Safety systems during launching, rope tests.

q) Communication.

r) Abandonment and recovery procedures concurred.

s) Necessary permission from concerned authorities for crossing.

COMPANY shall inform CONTRACTOR within 21 days if any objection against the document and procedure described requires resubmission by CONTRACTOR.

Approval by COMPANY of the methods used by CONTRACTOR shall in no way relieve CONTRACTOR from the sole responsibility for safe and satisfactory installation of the crossing.

2.3 CONTRACTOR shall comply with all the conditions and requirements issued by authorities having jurisdiction in the area where the work is to be performed. CONTRACTOR shall, at his own responsibility, obtain necessary permits from the authorities having jurisdiction, for performing his work.

If no public roads exist, CONTRACTOR shall arrange on his own for access to his work area at no extra cost to COMPANY.

2.4 **Pre-construction Surveys**

Prior to start of any work, CONTRACTOR shall carry out a survey of the major water crossings and acquaint himself with site conditions and to collect any data regarding the water velocity and the tidal variations in the flow pattern and shall verify the suitability of his equipment and the methods of construction.

3.0 TRENCHING

3.1 Dredging/ Excavating

3.1.1 CONTRACTOR shall dredge or excavate the trench for the water crossing in conformity with the approved drawings. Dredging of the trench shall be executed as accurately as possible.

3.1.2 The trench shall be excavated to such depth as required to provide the minimum cover and the pipeline configuration as specified. The pipeline profile of the crossings shall be followed as accurately as possible. Before laying, the trench shall be cleaned and levelled. The trench shall be subject to inspection by COMPANY prior to installation of the pipe.

3.1.3 Navigational traffic shall not be obstructed, unless permission has been given thereto. CONTRACTOR shall issue all necessary publications according to the local regulations.

Instructions given by authorities shall be followed accurately and immediately, so that there in no hindrance to traffic. For stoppage of navigational traffic public notification, PA system, signal/ sign etc. shall be provided. CONTRACTOR cannot request a compensation if his work is hampered or delayed due to weather conditions, any obstacles/ or by any traffic on the spot, where work is executed.

3.1.4 CONTRACTOR is fully responsible for the execution of the blasting (whenever permitted) the dredging and excavation work, hopping of the soil, transportation, dumping on land or in water, all to be executed in agreement with authorities, land owners and COMPANY.

3.1.5 CONTRACTOR may be obliged to dredge or excavate a trench deeper or wider than indicated in the drawings in order to properly lay the pipeline in unstable (underwater) areas, or near and adjacent to the banks of water courses. It shall be understood that CONTRACTOR is aware of such problems at the time of this bid and that, when such additional excavation is required, it shall be done by CONTRACTOR as part of the work and that he will install the necessary provision and/ or temporary works such as sheet-piling, special filling materials, etc. at no extra cost to COMPANY.

3.1.6 During, the execution of dredging work of CONTRACTOR, bearings, measurements and levels shall be taken by or on behalf of COMPANY. CONTRACTOR shall render assistance for this purpose and make available for COMPANY appropriate survey boats, fully manned and equipped before the start of excavation work of the water crossing trench. CONTRACTOR, if so desired by COMPANY, shall make cross profiles at intervals of not more than 10.0m of the bottom of the water-course along the surveyed center line of the water crossing. In such a case horizontal measurements shall be taken by triangulation or taping between known points and shall be made with such accuracy that the location of each vertical measurement is known within 1.0m. Vertical measurements shall be taken with a sonic recording device, or with line and rod, as directed by COMPANY and shall be taken with such accuracy that each depth is known within 0.2m. Vertical measurements shall be taken at points averaging not more than 5.0m apart and no two measurements shall be more than 7.0m apart. The cross profiles shall extend at least 10m on both sides of the top of the trench. All measurements shall be witnessed by COMPANY. The resulting profile, corrected to the elevation of the undisturbed water-course, shall then be the reference profile. Said profile shall be plotted on a 1:200 vertical and horizontal scale.

3.1.7 CONTRACTOR shall keep the trench in good condition until the pipe is laid, and no claim is to be made to the COMPANY by reason of its caving either before or after the pipe is laid. CONTRACTOR shall do whatever is required to excavate the trench, install the pipe in it and backfill the trench in accordance with these specifications at no extra cost to COMPANY.

3.1.8 Immediately before installation of the water crossing in the excavated trench, CONTRACTOR shall prepare a profile of the trench bottom along the surveyed center line of the water crossing for comparison with the reference profile. CONTRACTOR shall also make cross sections of the trench at intervals of not more than 100m. All profile and cross section measurements shall be taken as specified and shall be witnessed by COMPANY. These data shall be submitted to COMPANY for approval and COMPANY will approve or reject the trench excavation as completed within 24 hours after receipt of the profile and cross sections.

3.1.9 CONTRACTOR shall grade the trench in such a manner as to give the maximum amount of uniform support to the pipeline when it is lowered or pulled into place. The maximum unsupported span shall not exceed 10.0m.

3.1.10 In submerged sections, where rock or gravel is encountered in the bottom of the trench, padding is required. The thickness of the padding under the concrete coated pipe shall at least be 50 cm and after installation at least 50 cm around the pipe.

Blasting, if any, and padding shall be included in the work.

3.2 **Pumping Line**

In case CONTRACTOR uses pumping lines to discharge the spoil, he shall take care of the necessary permits.

Pumping lines, discharges and siphons shall be installed by CONTRACTOR and removed before the completion of the work. At crossings with existing roads, the pumping lines shall be led through a casing pipe bored/ jacked under the road or led through a porch over the road. A stress calculation must then be handed over to COMPANY. The necessary provisions to embank the dumping area and also the spoil basins shall be made by CONTRACTOR. CONTRACTOR is responsible for transportation of the soil and dumping on land and is liable for damage to works of third parties caused by leakage of pumping lines, etc. CONTRACTOR shall at all time prevent overflow of pumping water, spoil or sand over embankments, parcels or roads. Further more, CONTRACTOR shall safeguard COMPANY from claims of compensation by third parties due to encountered damage.

3.3 **Spoil**

Spoil which is not dumped on and including spoil acquired after cleaning the water crossing trench, shall be transported and dumped in places, designated thereto by agreement between CONTRACTOR and authorities and approved of by COMPANY. 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 COMPANY.

3.4 **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 ships, etc. cause no slides/ cave-ins of the dyke or dam.

4.0 **CONTINUOUS CONCRETE COATING**

CONTRACTOR shall provide concrete coating over the pipeline including the bends in accordance with the specification issued for the purpose (refer specification no. SIPI/S/05/11/03 and approved procedure. 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 pretest.

5.0 HYDROSTATIC PRE-TESTING

CONTRACTOR shall hydrostatically pre-test the pipe string of each water crossing before installation as per approved procedure.

Joint coating of the welds shall be done after this pre-test.

The section of the pipeline corresponding to the major water crossing shall, before installation, be subjected to hydrostatic pre-testing to a combined equivalent stress of 90% of the SMYS of the pipe material.

After the temperature has been stabilised, the pressure shall be maintained in the pipeline for at least twenty-four hours and recorded by Mano thermograph. 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 material supplied by COMPANY, the repairs shall be done free of cost, to the satisfaction of COMPANY.

6.0 INSTALLATION

6.1 CONTRACTOR shall submit a detailed scheme for the method he proposes to adopt for installing the pipeline to COMPANY for approval. CONTRACTOR shall calculate all stresses in the pipeline while laying and check whether the stresses remain within permissible limits. A set of all calculations shall be submitted to the COMPANY for approval.

6.2 CONTRACTOR shall perform all work required to install the water crossings, including the possible appurtenances indicated in the drawings. The water crossings shall be installed in such a manner as to comply with the requirements and conditions stated by the Authorities issuing the permits. CONTRACTOR shall pay special attention to minimize any damage to embankments and dykes in the vicinity of water crossings.

6.3 The equipment for launching shall be arranged in such a way that the pipeline is laid without impact or jerking and is not subjected to stresses of any type other than those which are allowable. Minimum allowed radius of curvature shall be followed, particularly at the end of the launching way towards the water in the freely suspended section.

6.4 After the water-crossing section has been installed in place, CONTRACTOR shall fill this section including the pertaining land sections with water for the final testing.

6.5 CONTRACTOR shall check if the position and depth of the water crossing are in accordance with the approved drawings, by means of a profile of the pipeline, before and after the water-crossing section is filled with water. CONTRACTOR shall lower each pipeline section which is not sufficiently deep by dredging or jetting the underlying ground.

6.6 The maximum allowed horizontal deviation from the required center line shall be limited to the following :-

For pipeline dia. upto and including 24" - 300 mm

For pipeline dia greater than 24" - 500 mm

6.7 Prior to backfill the pipeline shall, when laid in the trench, conform to the bottom contour of the trench grade, so that it will be firmly, uniformly and continuously supported. COMPANY may employ a diver or use other suitable methods to inspect the bottom of the trench and/ or after the pipe is installed prior to backfilling of the trench. CONTRACTOR shall facilitate the work of the diver and shall furnish the necessary equipment and helpers (other than actual diving equipment) necessary for the diver/ inspector to perform his work.

6.8 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 to the COMPANY.

6.9 **Installation of Parallel Pipelines**

When parallel pipelines are required to be installed for a major water crossing. CONTRACTOR shall further comply with the following requirements.

6.9.1 Depending on the diameters of the parallel pipelines, the characteristics of the crossing and the limitations of CONTRACTOR's equipment, CONTRACTOR may propose installation of the parallel pipelines either together in a combined operation or separately in a common trench.

6.9.2 If the pipelines are installed together, the minimum clear distance between the parallel pipelines (measured from the outside diameters of the concrete coated pipes) shall be 300mm. CONTRACTOR shall provide spacers at sufficient intervals along the length of the pipe section(s), securely fixed to the pipes, or shall propose other suitable alternative methods, so as to ensure that the stipulated minimum clear distance is maintained. The spacers may be removed before the trench is backfilled.

CONTRACTOR shall furnish detailed drawings for the pipe assembly showing the details of spacers/ other arrangements for COMPANY's approval before start of construction.

6.9.3 If the parallel pipelines are installed separately in a common trench, the minimum clear distance between the parallel pipelines in the trench shall be 5000mm. CONTRACTOR shall ensure that this minimum spacing be maintained till the time the trench is backfilled.

7.0 BACKFILLING AND BANK PROTECTION

7.1 Backfilling of the water-crossing section shall be performed as described in the following clauses.

7.1.1 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 COMPANY. In case material other than the original spoil is required, this shall be supplied and applied by CONTRACTOR.

Wherever boulders, rock, gravel and other hard object are encountered, they shall not be placed directly on the pipe. Sufficient earth, and 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 50 centimeters around the pipe before backfilling remainder of the trench with excavated or other material.

Wherever required by COMPANY, CONTRACTOR shall cover the (nearly) backfilled trench with a layer of rock boulders to be approved by COMPANY over a width equal to the width of the excavated trench with an extra of 5 m on either side at no extra cost to COMPANY.

7.1.2 Backfilling progress of the trench shall be checked continuously, and a daily progress report shall be made and handed over to COMPANY.

7.1.3 All embankments and/ or dykes, bed and banks shall be reinstated to their original state and levels, unless otherwise prescribed in the drawings or by the Competent authorities or COMPANY.

7.1.4 All remaining spoil-deposits shall be cleaned by CONTRACTOR to the satisfaction of COMPANY.

7.2 **Bank Protection**

7.2.1 Trenches in banks of major water crossings shall be backfilled with soil approved by COMPANY. The fill at the banks shall be tamped firmly and reinforced with sacked earth, rip-rap, or by other means as directed by COMPANY to the satisfaction of authorities having jurisdiction thereof. In areas where the backfilled soil is expected to be of loose type which is prone to flow, the trench shall be backfilled with boulder/ crushed rock of minimum 75mm thickness. The boulder/ crushed rock shall be derived from solid, stable, non-soluble and approved quality store approved by COMPANY and pipe shall be provided with adequate padding of soil of a quality approved by COMPANY. Wherever necessary the boulder/ crushed rock shall be held to the bed by use of 6.1 wire nets of minimum dia. Of 3.2mm, made from steel having tensile strength of 400 N/mm^2 and with a minimum elongation at failure of 12%. The minimum zinc coating of 275 gm^{-2} shall be applied on single/ double twisted wire. After the trench has been backfilled and during the clean up works, the water crossing shall be cleaned across the whole width of ROW. The existing bed profile shall be maintained after restorations.

7.2.2 Unless stipulated otherwise by the authorities or by COMPANY, CONTRACTOR shall protect the banks of the major water crossings by using gravel and boulders filled embankment mattresses of galvanized iron wire (of specification as in 7.2.1 above) to be laid over the backfilled, compacted and graded banks. In case slope of the banks is 1:1 or more, bank protection shall be carried out using gabions. Bank protection works shall be carried out by CONTRACTOR in accordance with the drawings included in the CONTRACT. All materials required for such works shall be supplied by CONTRACTOR

and all works carried out in accordance with specifications, approved drawings, instructions of COMPANY and to the complete satisfaction of authorities having jurisdiction at no extra cost to COMPANY.

The length of the above protection shall be equal to the actual bank excavation edge including damage and further extending 10 m on either sides, The width of the restoration on the slope shall be determined by the levels :

- 2m above Highest Water Level, (recordable) or upto the top of bank, whichever is higher.
- 5m below Low Water Level (recordable) or upto pipe trench level in the bed.

7.2.3 Before final hydrostatic testing, CONTRACTOR shall `prove' the diameter of the pipeline by passing a gauging (caliper) pig through the pipeline. The gauging pig shall have a diameter equal to 95% of the internal diameter of the pipe.

CONTRACTOR shall supply and install all temporary scraper, launchers. Receivers and other equipment, piping and materials and consumables for the purpose.

8.0 FINAL HYDROSTATIC TEST

The complete water crossing must be tested immediately after the approved backfilling of the trench. The test procedure shall result in a hoop stress in pipe corresponding to 90% SMYS of the pipe material. After temperature stabilization pressure shall be retained in the pipeline for a minimum of 4 hours and recorded by manothermograph. The hydrostatic testing shall be carried out in accordance with approved procedures.

9.0 POST-CONSTRUCTION SURVEY

After laying of the pipeline, CONTRACTOR shall carry out a post-construction survey jointly with COMPANY. Any defects brought to the notice of CONTRACTOR shall be promptly corrected by CONTRACTOR at his own expense to the complete satisfaction of COMPANY.

10.0 FINAL CLEAN-UP

After completion of construction, CONTRACTOR shall clear the site of all balance material and debris. All balance pipe lengths, in case supplied by COMPANY, shall be returned to COMPANY's designated stock yard(s). Site shall be cleared to the complete satisfaction of COMPANY and authorities having jurisdiction. All such works shall be done at no extra cost to COMPANY.

11.0 DOCUMENTATION

11.1 In addition to the documents specified elsewhere in this specification. CONTRACTOR shall submit to the COMPANY six copies of each of the following documents / records.

- Complete record of pipes `taken-over' from COMPANY, number of pipe lengths used, and record of return of balance pipe lengths to COMPANY's designated stock-yard(s).

- Copies of the permits obtained from authorities having jurisdiction for the various works.

- Records of Non-destructive testing of welds

- Clearance certificates from the land owners and authorities having jurisdiction regarding satisfactory clean-up and restoration of pipeline ROU and work areas.

11.2 After completion of construction CONTRACTOR shall prepare & furnish six sets of copies and two sets of reproducible of As-built drawing for the crossings.

As-built drawings shall be as a minimum, include the following information.

- True profile of the bed and banks of the water crossing along the pipeline after backfilling.

- True profile of the pipeline as installed and the top of cover to top of pipe at regular intervals.

- Location and angle of sag and over bends.

- Extent of backfill.

- Extent of bank protection.

11.3 All documents shall be in English Language

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SPECIFICATION

FOR

PIPELINES CROSSING ROADS, RAILROADS, MINOR WATER AND OTHER CROSSINGS

SPECIFICATION NO. SIPI/Steel/TS/05

CONTENT

1.0 SCOPE

1.1 This specification covers the minimum requirement for the various activities to be carried out by the CONTRACTOR for or about the installation of pipelines crossing roads, railroads, minor water courses and other services.

The provisions of this specification are not applicable for pipelines crossing water courses, which are specifically designated as "Major Water Courses" in the CONTRACT.

1.2 This specification shall be road in conjunction with the conditions of all specifications and documents included in the CONTRACT between COMPANY and CONTRACTOR.

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 recommended.

2.0 GENERAL

2.1 Crossing of roads, railroads, buried services, canals and minor water courses with equipment and/ or personnel is allowed only after acquiring approval from the authorities having jurisdiction and after making arrangements for safeguarding the roads, etc. and the buried services with appropriate provisions.

Highways, main-roads and railroads and their verges and banks of water crossings are not allowed to be used for loading, unloading or stacking of materials and/ or equipment. For secondary roads, such loading/ unloading is permitted only after prior approval from the concerned authorities CONTRACTOR is not allowed to close or divert roads or water courses without prior approval from the COMPANY and the concerned authorities. CONTRACTOR shall never unnecessarily hamper the users of the roads, railroads, buried services and/ or water courses. The water flow shall not be obstructed in any way.

2.2 COMPANY reserves the right to demand for individual crossings from the CONTRACTOR a separate detailed report for approval, containing:

• Time schedule

• Working method with equipment

• Test procedure

• Manpower deployment

• Calculations of temporary works

SIPI/Steel/TS/05

• Soil investigations, etc.

Such works shall be without any extra cost to COMPANY.

2.3 Pipeline crossings for road, railroad, canals and rivers etc., shall be hydrostatically pretested ex-situ, prior to joint coating, whenever,

- Crossing is executed by boring ;
- Crossing is installed in casing pipe;
- River crossing pipes which are to be continuously concrete weight coated (to be tested prior to concrete coating);
- Whenever, in COMPANY's opinion, the repair of pipeline at crossing, in case of a leak during final hydrostatic testing, would require inordinate amount of effort and/ or time;
- Whenever pretesting is insisted upon by the Authorities having jurisdiction over the utility crossed.

The section of the pipeline for the crossings shall be tested as a single string. Unless, specified otherwise in the CONTRACT, the test pressure shall be the one resulting in a hoop stress corresponding to 90% of SMYS of pipe material. Test pressure shall be retained in the pipeline for minimum period of 2 hours. Test section shall be visually examined for leaks/ defects, etc.

3.0 ROAD AND RAILROAD CROSSINGS

3.1 The work under crossings shall include necessary clearing, grading and trenching to required depths and widths, welding of casing (when required) and carrier pipes, coating, lowering-in, backfilling, clean-up, restoration to the original condition and further strengthening and protective works, testing, installation of assemblies, insulators and seals, and temporary works such as sheet pilling, bridges, etc.

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

Before the installation work of crossings is started, the CONTRACTOR shall provide suitable barricades, temporary bridge/ bypass work (especially where roads are open-cut) with railing, if required by COMPANY for safety of traffic. Adequate traffic warning signals and/ or traffic lights and suitable diversions shall be provided as directed by COMPANY/ Authority having jurisdiction over these areas. Such diversions shall not cross the pipeline where it has already been installed, unless proper safeguarding in COMPANY's opinion is ensured. Prior approval from the statutory authorities shall be obtained to lay the pipeline across highways/ roads either by boring or by open-cut method. Installation of the crossing shall be by the method (i.e., boring/ open-cut) approved by Authorities having jurisdiction. Railroad crossings shall always be bored/ jacked.

3.2 Boring/ jacking of carrier pipes for crossings is allowed only if the pipes for boring/ jacking are provided with a suitable corrosion coating and CONTRACTOR remains liable for the suitablity of the pipe and weld-coating of carrier pipes to be bored and for which coating and

method of application are anyhow to be authorized by COMPANY without prejudice to CONTRACTOR's liability. In all other cases the carrier pipes shall be cased.

Before start of the boring/ jacking CONTRACTOR shall execute a soil investigation and determine the ground water table. Based on these investigations CONTRACTOR shall prepare a construction drawing and submit to COMPANY for approval including time schedule and soil investigation report. The CONTRACTOR shall submit for approval of COMPANY the method of boring / trenchless to be carried out, depending on the nature of soil conditions, nature of crossing, local requirements etc.

During the execution of boring the ground water table over the length of the boring shall be lowered up to at least 0.50 M below bottom of the pipeline. This water table is to be regularly inspected and maintained by CONTRACTOR and reported to COMPANY. To safeguard the stability of the bore pit, CONTRACTOR shall, if necessary in COMPANY's opinion, use a closed sheet piling which shall extend at least over 50% of the length in undisturbed soil. The length of the boring shall be in accordance with the length of the ROW of the crossing (road, railroad, etc.) with minimum 0.6 m extra on either side.

If the soil conditions and groundwater for a particular boring give reasons for this, CONTRACTOR is entitled to suggest to COMPANY for a relaxation of one or more of the following requirements as defined hereforth :

- Soil investigation
- Lowering of groundwater table
- Sheet piling
- Length of boring etc.

In approaches to the crossing, CONTRACTOR shall eliminate unnecessary bending of pipe by conforming to the contour of the ground by gradually deepening the ditch at such approaches as directed by the COMPANY.

3.3 The bottom of the trench and/ or the pit for at least twelve (12) metres at theapproach to each end of a casing shall be graded and if necessary backfilled with clean sand and compacted upto atleast 95% Proctor density to an elevation that will provide sufficient and continuous support to the pipeline so that the pipeline remains correctly aligned at the casing ends during and after backfilling.

3.4 The diameter of the hole for a bored section shall have a hole diameter as close as practicable to the outside diameter of the carrier or casing pipe. If excessive void or too large hole results, or if it is necessary, in the opinion of COMPANY, 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 COMPANY and Authorities having jurisdication thereof at no extra cost to COMPANY. Equipment used for installation of casing pipe shall be of the type approved by COMPANY.

An installation consisting of hydraulic jacks shall be provided with easily readable pressure gauges (in bar) and sealable pressure limits. Their proper operation shall be demonstrated before the work is started. COMPANY can request that the maximum pressing force be limited.

At the front of the pipe there may be a cutting ring which may be 12mm larger than the outside diameter for the pipe or casing. A lubricating pipe can also be used in jacking, the nipples of which shall not protrude from the cutting edge. Said lubricating pipe shall not be fixed to the pipe casing. When jacking, only biologically degradable lubricants shall be used (e.g. WRC Medlube or an emulsion of bentonite).

Removal of soil from the pipeline during jacking shall be done Mechanically by means of a standard, locked auger, which has to be safeguarded against jacking ahead of the pipe.

During jacking the progress of the pipe to be jacked and the cutting capacity of the auger shall be mutually adjusted, by regulating the speed of the auger, to prevent the road from bulging (rpm too low) or cave-ins (rpm too high). In any case no more soil shall be removed than the volume of the pipe. The auger drive shall be provided with a clutch.

The progress in the work, the readings of the gauge pipes, the jacking pressures observed, etc., shall be recorded in a log book, to be shown to COMPANY upon request. All information shall be supplied to COMPANY on completion of the work.

If the jacking fails, the casing shall not be withdrawn. It shall be filled with sand and plugged at either end. The diameter of the casing pipe shall conform to API RP 1102 recommendations or as directed by the Engineer – in - charge.

COMPANY reserves the right to inspect certain lengths of pipes to assess damages, if any, to the corrosion coating of the carrier pipe used for boring. CONTRACTOR shall weld additional lengths of pipe and pull the required extra lengths of COMPANY's inspection. If during inspection any defects are noticed, CONTRACTOR, in consultation with COMPANY, shall carry out the remedial measures required.

3.5 While welding of the casing and vent/ drain pipes, internal high or low is not allowed. Welding of casing and vent/ drain pipes need not be radiographed, however, only normal visual checks shall be carried out. Before welding, the single length of pipe shall be inspected in order to check that there is no out of roundness and dents. When such defects are noticed, these must be completely removed before joining the pipes. If these defects cannot be repaired, the defective section shall be cut out.

3.6 In the case of crossing where excavation has been authorised, the welding for the casing pipe and for a continuous section of the pipeline corresponding to the expected length shall be carried out in the proximity of the crossing. Casing must be laid immediately after the trenching. Casing pipe must be laid with a single gradient in order to allow for an easy insertion and, if necessary at a future date, to allow for the removal or replacement of the pipeline, leaving the casing undisturbed.

3.7 The assembly of vent pipe units as approved by COMPANY 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.

3.8 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.

3.9 Insulators, as approved by COMPANY, shall be securely fastened to the pipe with all bolts and fixtures firmly tightened. The number of insulators and spacing shall be as shown in the drawings or at 2.5m intervals (whichever is more stringent). At the end of both sides of the casing, a double set of insulators shall be installed.

3.10 Care must be taken in pushing or pulling carrier pipe into the casing so that the pipe is aligned correctly in the casing and that the pushing or pulling force is evenly and constantly applied to avoid damages to the insulators. A nose piece having a diameter equal to that of the pipe shall be welded on the front and back end of the carrier pipe to facilitate installation of the carrier pipe properly in the casing and to keep it dry and clean.

3.11 After installation of the carrier pipe section, the casing and the appurtenances, but prior to making tie-in welds and backfilling, an electrical test shall be conducted by the CONTRACTOR in the presence of the COMPANY, 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 100 kohm/m^2. After backfilling and compaction, additional tests shall be conducted to determine if the casing is electrically shorted to the pipe. If the installation is found to be shorted, CONTRACTOR shall make the necessary corrections and repairs at his cost, until a test to the satisfaction of the COMPANY is obtained.

4.0 CROSSINGS OF BURIED SERVICES

4.1 The pipeline under construction may pass above or below the existing buried facilities such as pipelines, cables, etc. Type of crossing shall be such that a minimum depth of cover as required in the drawings and specifications are guaranteed. The minimum clearance required between pipeline and the existing facility shall be 500mm.

4.2 Whenever buried services in the ROW are to be crossed by CONTRACTOR, he shall safeguard the buried facilities and the required precautions shall be taken as approved by Owner of the buried services and by COMPANY.

4.3 For buried services to be crossed by boring/ jacking, the relevant provisions of Section 3.0 shall apply.

5.0 MINOR WATER COURSE CROSSINGS

5.1 Minor water crossings are crossings of ditches, canals, water courses, rivers, streams etc, whether the bed(s) contain(s) water or not, and not being specified as `Major Water Crossings' in the CONTRACT.

5.2 For minor water crossings a standard drawing or a separate detailed approved drawing for individual crossing shall be applicable, and all further specifications are applicable.

5.3 Whenever minor water crossings in the ROW are to be crossed, CONTRACTOR shall install/ temporary bridges to facilitate movement.

5.4 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 favourable period for executing the work.

5.5 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 the approved drawings shall be assembled and subsequently laid. Bends shall be of cold field type.

Whenever required by COMPANY, CONTRACTOR shall, before start of construction, execute a soil investigation. Based on this soil investigation he shall prepare construction drawings, work method and time schedule for approval of COMPANY as well as concerned local agencies.

The depth of the existing bottom of a minor water course crossing shall be determined in relation to the adjacent stable ground level by taking the average of four measurements. Measurement shall be taken with a gauge and with dimensions 60 x 60mm and having a flat bottom. The minimum force to be exerted shall be 360 N (36 kgf).

CONTRACTOR shall take special care to check with the responsible authorities for special conditions applying to working on, over, under or through minor water crossings and CONTRACTOR shall comply with any such conditions. Written arrangements with authorities shall be drawn up in cooperation with COMPANY.

5.7 For crossings beneath the bed of water courses, the pipe section shall be made in such a way that it conforms to the existing or future bed as indicated in the approved drawings. In crossings for which an individual drawing has not been prepared, the minimum cover of the pipeline shall not be less than that indicated in the standard drawings for a similar type of crossing.

5.8 Whenever the crossing requires a straight section of pipe between the lower bends coinciding with the river bed, this section shall be laid at a single horizontal level.

5.9 For crossings of ditches, canals, banked channels, etc. by boring, the pipe section shall be prepared, laid and tested in accordance with the applicable clauses of Section 3.0 of this specification.

5.10 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 COMPANY.

5.11 Banks and trenches of minor water crossings shall be backfilled with soil which is to be approved by COMPANY and shall be thoroughly compacted to prevent soil and bank erosion as per the drawings and standards to the satisfaction of authorities having jurisdiction thereof and the COMPANY. Whenever 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 30 centimeters around the pipe before backfilling remainder of the trench with excavated or other material as per approved drawings and standards.

After the trench has been backfilled and during the clean up works, the minor water crossing shall be cleaned at least across the whole of the ROW.

When directed by the COMPANY, CONTRACTOR shall stabilize and restore the bank of the water crossings with materials to be supplied by him as follows.

The excavation shall be trimmed in steps-and-berms backfilled with well compacted solid soil, followed by a minimum 0.25m thick layer of properly shaped boulders (75-150mm) encased in a net of galvanized iron wire of dia. 3mm spaced at a maximum distance of 50mm to be laid over the backfilled, compacted and
graded banks.

The GI wire shall be made from steel having tensile strength of 400 N/mm^2 and with a minimum elongation at failure of 10%. The minimum zinc coating of 200 gm^{-2} shall be applied on single/ double twisted wire.

The length of the above protection shall be equal to the actual bank excavation edge including damage and extending 2m on either sides. The width of this protection on the slope shall be determined by the following :

- 2m plus the highest water level (recoverable) or up to the top of bank whichever is higher.
- Up to the bottom of the crossing or 20m below the highest water level whichever is smaller.

Bank stabilization for certain minor water crossings shall be determined by COMPANY based on nature of crossing e.g., type of river, canal, major nallah, flood control banks and other water bodies; type of soil, regulations of local authorities; and any other socio-economic consideration evaluated by the COMPANY.

5.12 The crossing of any embankments shall be carried out strictly in accordance with approved drawings.

No drilling work on embankments shall be permitted without prior written approval from the competent authorities.

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SPECIFICATION

FOR

PIPING FABRICATION AND ERECTION

SPECIFICATION NO. SIPI/Steel/TS/06

C O N T E N T S

1.0 GENERAL

This specification covers the minimum technical requirements for the fabrication, erection and testing of piping systems in accordance with the requirements of this specification, approved drawings and as directed by COMPANY.

2.0 CODES OF PRACTICE

2.1 All phases of work pertaining to process lines handling Natural Gas shall be carried out in accordance with latest edition of ANSI B 31.8 "**GAS TRANSMISSION AND DISTRIBUTION PIPING SYSTEM**" with modifications and additions as specified in various sections of this specification.

2.2 All phases of work pertaining to utility lines shall be carried out in accordance with the latest edition of ANSI B 31.3 "**CODE FOR PRESSURE PIPING, PETROLEUM REFINERY PIPING**" CONTRACTOR shall bear the cost of repair, modifications and replacements, if any, becoming necessary due to noncompliance of codes, this specification or due to disregard of COMPANY's instructions.

3.0 FABRICATION

3.1 All fabrication shall be carried out in accordance with piping general arrangement drawings, (prepared by CONTRACTOR and approved by COMPANY) including this specification and codes as specified in section 2.0.

3.2 CONTRACTOR shall be responsible for working to the exact dimensions as per the approved drawings. Dimensional tolerances to be adopted during implementation of fabrication work shall be as per attached sketch "TOLERANCES FOR FABRICATION".

3.3 Flange bolt holes shall generally straddle the established center lines unless other orientation is required and as called out in approved drawings.

3.4 Threading shall be NPT to 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.

3.5 All threaded joints shall be aligned properly. The pipe entering unions shall be true to center lines 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.

3.6 Immediately before testing the piping, all threads of pipe and fittings shall be thoroughly cleared of 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.

3.7 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.

3.8 All threaded connections shall be protected from rusting by applying greases or oil when in operating condition.

3.9 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.

3.10 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.

3.11 **Laying, Cutting and Fitting up.**

Extensive use of templates, gauges, plumb lines shall be made for laying, cutting and fitting up of various piping components for fabrication.

3.12 Pipe joints shall be accomplished by butt welding for pipe sizes 2" and above and by screwed coupling for pipes 1½" and below with the exception for utilities piping which shall have socket weld coupling for size upto 1½".

3.13 Edge preparation for butt weld joints shall conform to ANSI B 16.25. Cutting of edges shall preferably be done by machine.

3.14 Pipe bends for piping system below 1½" NB shall be used when called for in approved arrangement drawings. Cold bending will be implemented with special bending tools with guides to avoid flattening. The minimum radius allowed shall not be less than five times the outside diameter of pipe. CONTRACTOR shall obtain COMPANY's approval of bending tool to be used.

3.15 All branch connection shall be joined to header with full penetration weld. Reinforcement pads where required shall be added only after external and internal visual inspection of the attachment. Re-inforcement pad shall be provided with ¼" tapped weep hole. Weep holes shall be plugged.

3.16 On completion of both shop and field fabrication, all sub-assemblies shall be cleaned from the inside and outside by suitable Mechanical means ensuring that they are free from all loose foreign materials such as scales, sand, weld spatters, oil, grease, cutting chips etc.

4.0 **WELDING**

Welding of pipelines shall be done as per applicable codes and Annexure-1

5.0 **ERECTION**

5.1 **Pre-fabrication and Field Assembly**

Extent of pre-fabrication shall be purely at the discretion of CONTRACTOR keeping in view the following:

5.1.1 Field joint shall be decided by CONTRACTOR keeping in view the transportation of pre-fabricated pieces to site.

5.1.2 There can be some variations in the dimensions and level appearing in the arrangement drawings and those actually occurring at site due to minor variations in the location of equipment’s, structures, cut out etc. Adequate field joints shall be provided, permitting assembly and erection of pipe work without major modification.

5.2 **Supporting**

Location and design of pipe supports shown in approved drawings and support drawings shall be strictly followed.

5.2.1 Supports shall be installed in such a way that they do not contribute to over stressing of a line.

5.2.2 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.

5.2.3 All temporary supports, elements required for alignment, erection and assembly shall be removed after completion of work.

5.3 **Equipment hook-up**

5.3.1 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.

6.0 **INSPECTION**

6.1 CONTRACTOR shall provide all facilities/ assistance to COMPANY for proper execution of their inspection without any extra charge.

6.2 All piping work shall be subjected to inspection by COMPANY at any time during fabrication. CONTRACTOR shall furnish to COMPANY detailed work programme sufficiently in advance, in order to enable COMPANY to arrange for inspection.

7.0 **PROTECTIVE COATING**

7.1 All above ground piping system shall be applied with protective coating in accordance with specification for shop & field painting.

7.2 All underground portion of piping system shall be coated with three layer P.E. coating. CONTRACTOR shall prepared 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.

7.3 Once the coating has been accepted by COMPANY, backfiling 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.

8.0 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 COMPANY. Flushing shall not be commenced without approval of flushing procedure.

8.1 CONTRACTOR shall perform all activities like dismantling and reinstalling of all strainers, in line instruments etc. before and after completion of flushing.

8.2 Flushing shall be considered as complete only after inspection and approval by COMPANY.

8.3 Disposal of muck and flushing media shall be arranged by CONTRACTOR as directed by COMPANY, in such a manner that it does not spoil the adjacent installation. CONTRACTOR shall obtain COMPANY approval regarding the place and method to be adopted for disposal of debris.

8.4 Record of flushing giving following details shall be submitted by CONTRACTOR to COMPANY for its approval and records:

a) Date of flushing

b) Identification of line: flushed-line number

9.0 HYDROSTATIC TESTING

9.1 Completed piping system as approved by COMPANY shall be hydrostatically tested in the presence of COMPANY. The general requirements of hydrostatic testing shall be in accordance with codes specified in section 2.0.

9.2 CONTRACTOR shall prepare hydrostatic test procedure based on specified codes. The hydrostatic test shall commence only after approval of procedure by COMPANY.

9.3 Piping system shall be hydrostatically tested to a pressure corresponding to 1.4 times the design pressure.

9.4 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 to added, the same shall be done after approval of COMPANY.

9.5 Lines repaired subsequent to hydrostatic test shall be retested using the same procedure as originally adopted. However, COMPANY may waive such retest in case of minor repairs by taking precautionary measures to ensure sound construction.

9.6 All equipment and instruments used for hydrostatic test shall be approved by COMPANY before start of tests.

9.7 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 pressurizing 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.

9.8 Orifice plates and restriction orifices shall not be installed until hydrostatic testing is completed. Temporary gaskets shall be used during testing.

9.9 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.

9.10 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.

9.11 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.

9.12 All welded and screwed joints shall be kept clean for detecting leaks during testing.

9.13 Test pressure shall be maintained long enough to facilitate complete inspection of the system. Minimum duration of test shall be 6 hours unless other wise specified. Pressurising equipment shall be isolated immediately after test pressure is attained.

9.14 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 by COMPANY.

9.15 **Test Records**

The records in duplicate shall be prepared and submitted by CONTRACTOR as below :

a) Date of test

b) Identification of pipe tested - line number

c) Test pressure

c) Test results

d) Signature of CONTRACTOR

e) Approval signature by

ANNEXURE-1
WELDING SPECIFICATION

10.0 **GENERAL**

This specification shall be followed for the fabrication of all types of welded joints of carbon steel above ground natural gas service piping systems.

The welded pipe joints shall include the following :

a) All line pipe joints of the longitudinal and circumferential butt welded.

b) Attachments of castings, forgings, flanges.

c) Welded manifold headers and other sub-assemblies

d) Welded branch connections with or without reinforcing pads.

e) Joints in welded/ fabrication piping components.

f) The attachments of smaller connections for vents drain drips and other instrument tappings.

Any approval granted by the Engineer-in-charge or owner's inspectors shall not relieve the contractor of his responsibilities & guarantees.

1.1 **Applicable Codes & Standards**

All welding work, equipments for welding, heat treatment, other auxiliary functions and the welding personnel shall be as per the requirements of the latest editions of the following approved standards and procedures :-

i) Code for gas transmission and distribution piping systems. ANSI B31.8.

ii) Code for petroleum refinery piping, ANSI B31.3.

In addition, the following codes/ specifications referred to in the relevant code of fabrication shall be followed for the welding/ brazing qualifications, consumable qualifications and non destructive test procedures.

I. Standard for welding of pipelines and related facilities API-1104.

II. Material Specifications - Welding rods, electrodes and filler materials - ASME Sec. - IIC.

III. Code for non destructive examination ASME Sec-V

IV. Qualification standard for welding and brazing procedure and welders, brazers, welding and brazing operators - ASME Sec-I

In the event of any difference due to the additional requirements mentioned in this specification, over and above those obligations as per codes, this specification shall be binding.

1.2 **Base Material**

a) In general carbon steel is used in this plant. The details of material specifications are given in the welding Specification Chart.

b) The contractor shall provide the Manufacturer's test certificates for every heat of the materials supplied by him.

1.3 **Filler Materials**

a) The Contractor shall provide all the necessary welding electrodes, filler materials, etc. required for the execution of the work.

b) The welding electrodes/ filler wires supplied by the Contractor shall conform to the class specified in the welding specification chart. The materials shall be of the make approved by the Engineer-in-charge.

c) The electrode shall be suitable for the welding process recommended and base metal used. Unless otherwise specified physical properties of the welds produced by a electrode recommended for the welding of a particular base metal shall not be lower than the minimum valves specified for the base metal 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 Engineer-in-charge.

d) Electrode qualification test records should be submitted as per the Exhibit- A (attached) in respect of the electrodes tested by the contractor, for obtaining the approval of the Engineer-in-charge.

e) The Contractor shall submit batch test certificate from the electrode Manufacturers giving details of physical and chemical tests carried out by them, for each batch of electrodes to be used.

f) All electrodes shall be purchased in sealed containers and stored properly to prevent deterioration. The electrodes removed from the containers shall be kept in holding ovens at temperature recommended by the electrode Manufacture. Out-of-the oven time of electrodes before they are consumed shall not exceed the limits recommended by the electrodes manufacturer. The electrodes shall be handled with care to avoid any damage to flux covering.

g) All low hydrogen type of electrodes shall be rebaked at 350°C for 1 hour minimum and stored in ovens kept at 80-100°C before use. Recommendations of the electrode Manufacturer shall be followed if available.

h) The electrodes, filler wires and flux used shall be free from rust, oil, greases, earth and other foreign matter which can affect the quality of welding.

1.4 **Welding Consumables**

The Contractor shall provide at this own expense all the welding consumables necessary for the execution of the job such as electrodes filler wires, oxygen, acetylene, etc. and these should bear the approval of the COMPANY.

1.5 **Equipment & Accessories**

1.5.1 The Contractor should have the arrangement of sufficient number of welding and cutting equipments, auxiliaries and accessories of sufficient capacities so as to meet the target schedule.

1.5.2 All the equipment for performing the heat treatment, including transformers, thermocouples, flow meters, automatic temperature recorders with suitable calibration arrangement etc. shall be provided by the Contractor, at his own expense and these should bear the approval of the COMPANY.

1.5.3 Contractor shall make necessary arrangements at his own expense for providing the radiographic equipment, radiographic films, and all the equipment/ materials required for carrying out the dye penetrant/ magnetic particle test for satisfactory and timely completion of the job.

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

1.6 **Welding Processes**

1.6.1 Welding of various materials under this specification shall be carried out using Shielded Metal Arc Welding (SMAW) Process with the approval of the Engineer-in- charge.

1.6.2 The welding processes to be employed are given in the welding specification chart. Any deviation desired by the Contractor shall be obtained through the express consent of the Engineer-in-charge.

1.6.3 Automatic and semi-automatic welding processes shall be employed only with the express approval of the Engineer-in-charge. The welding procedure adopted and consumables used shall be specifically approved.

1.6.4 A combination of different welding processes or a could be employed for a particular joint only after duly qualifying the welding procedure as per the requirements of code of fabrication to be adopted and obtaining the approval of the Engineer-in-charge.

1.7 **End Preparation**

1.7.1 **End Preparation**

The edges to be welded shall be prepared to meet the joint design requirements by gas cutting, machining or grinding method. After gas cutting, oxides shall be removed by chipping or grinding.

1.7.2 **Cleaning**

The ends to be welded shall be properly cleaned to remove paint, oil, greases, rust, oxides, sand, earth and other foreign matter. The ends shall be completely dry before the welding commences.

1.8 Alignment and Spacing

Prior to alignment, the contractor shall inspect the pipe ends inside and outside for amage, dents, laminations etc. Pipe for welding shall be set up correctly spaced. Temporary attachment of any kind shall not be welded. Every effort shall be made to reduce misalignment by the use of clamp and rotation of pipes to the best fit. For pipes of same nominal wall thickness, the off set should not exceed 1.6mm. Any branch connections sleeve shall be at least 150mm from any other weld. The welds for fitting hall be so located that top of the weld shall not come within 50mm of any other weld. The use of internal line up clamps is mandatory for diameters 10" and above. However, in case where it is impossible to use internal line up clamp, external line up clamp may be used.

1.9 Weather Conditions

1.9.1 The parts being welded and the welding personnel should be protected from rain and strong winds. In the absence of such a protection no welding shall be carried out.

1.10 Welding

1.10.1 Root Pass

a) Root pass shall be made with electrodes/ filler wires recommended in the welding specification chart. The preferable size of the electrode is 2.5mm diameter (12 SWG) but in no case greater than 3.25mm (10 SWG).

b) Uphill welding shall be adopted for welding pipes weld fixed with its axis horizontal. Downward technique of welding shall not be used for welding of pipes in horizontal position, unless specifically permitted by Engineer-incharge for a particular case.

c) The root pass of but joints should be executed properly so as to achieve full penetration with complete fusion of the root edges. Weld projection inside the pipe shall not exceed .4mm wherever not specified by the applicable code.

d) Any deviations desired from the recommended welding technique and electrodes indicated in the welding specification chart should be adopted only after obtaining express approval of the Engineer-in-charge.

e) Welding shall be continuous & 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 should be taken to avoid any kind of movement of components, to prevent occurrence of weld cracks.

h) Fillet welds shall be made by shielded metal arc/ GTAW welding process irrespective of the thickness and class of piping.

i) Peening shall not be used unless specified in the welding specification chart.

1.10.2 Joint Completion

a) Joint shall be completed using the class of filler wires/ electrodes, recommended in the welding specification chart.

b) Two weld beads shall not be started at the same point in different layers.

c) Butt joints shall be completed with a cover layer that would effect good cover at the joint edge and a gradual notch free surface.

d) Each weld joints should have a workman like finish.

e) Weld identification mark shall be stamped clearly at each joint, just adjacent to the weld. Metal stamping shall not be used on the thin wall pipe. Suitable paint shall be used on thin wall pipes for identification.

f) No painting shall be done until the weld joint has been hydrostatically tested.

1.11 Heat Treatment

1.11.1 Preheating

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

b) Preheating shall be performed using resistance or induction heating methods. Preheating by gas burners, utilising any acetylene or oxypropane gas mixtures, with neutral flame may also be carried out when permitted by the Engineer-in-charge.

c) Preheating shall extend uniformly to atleast three times the thickness of the joint, but not less than 100mm, on both sides of the weld.

d) Preheating temperature shall be maintained over the whole length of the joint during welding. Temperature indicating crayons or other temperature indicating devices shall be provided by the contractor to check the temperature.

1.11.2 Post weld Heat Treatment

a) Post weld heat treatment, wherever required for joints between pipes, pipes an fittings, pipe body and supports shall be carried out as per the relevant specifications, applicable standards and the instructions of the Engineer-in-charge.

b) The heat treatment of welded joints shall be carried out as per the requirements laid down in ANSI B31.8 and welding specification chart.

c) The contractor shall submit for the approval of the Engineer-in-charge, the details of the post weld heat treatment procedure, as per Exhibit `B' attached, that the propose to adopt for each of the materials/ assembly/ part involved, well before carrying out actual heat treatment.

d) Post weld heat treatment shall be done by using an electric resistance or induction heating equipment as decided by the Engineer-in-charge.

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 treated band over which specified post weld heat treatment is carried out, the temperature attained is atleast as that specified in the relevant applicable standards/ codes.

f) Throughout the cycle of heat treatment, the portion outside the heated band shall be suitably wrapped under insulation so as to avoid any harmful temperature gradient at the exposed surface of pipe. For this purpose temperature at the exposed surface of the pipes should 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 should be attached to the pipe directly at the equally spaced location along the periphery of the pipe joint. The minimum number of thermocouples attached per joint shall be 1 upto 6" dia, 2 upto 10" dia and 3 upto 12" and above. However the Engineer-in-charge can increase the required minimum number of thermocouples to be attached if found necessary.

h) Automatic temperature recorders which have been duly calibrated should be employed. The calibration chart of each recorder should be submitted to the Engineer-in-charge prior to starting the heat treatment operation and his approval should 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 Engineer-in-charge for his approval.

j) Each joint shall bear an identification number which shall be maintained in the piping sketch to be prepared by the contractor. The joint identification number should appear on the corresponding post weld heat treatment charts. The same identification numbers shall also be followed for identification for corresponding radiographic films. The chart containing the identification numbers and piping sketch shall be submitted to the Engineer-in-charge in suitable folders.

k) The hardness of the heat affected zone as well as of the weld metal, after heat treatment, shall be measured using suitable hardness tester and shall not exceed the maximum hardness specified in the welding specification chart. The weld joint shall be subjected to re-heat treatment when hardness measured exceeds the specified limit, at the contractor's own expenses.

l) The contractor shall arrange for the hardness testing and shall maintain the records of all joints tested. These records shall be checked by the plant Owner's inspector.

1.12 Cleaning of the Weld Joints

All weld joints shall be free from adherent weld spatter, slag, dirt or foreign matter. This can be achieved by brushing.

1.13 Inspection & Testing

1.13.1 General

a) The owner's inspector shall have free access to all concerned areas, where the actual work is being performed. The contractor shall also offer the Owner's inspector all means and facilities necessary for carrying out inspection.

b) The owner is entitled to depute his 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 :-

i. To check the conformance to relevant standards and suitability of various welding equipments and the welding performance.

ii. To supervise the welding procedure qualification.

iii. To supervise the welder performance qualifications.

c) Contractor shall intimate sufficiently in advance the commencement of qualification tests welding works and acceptance tests, to enable the plant owner's inspector to be present to supervise them.

1.13.2 Welding Procedure Qualifications

a) Welding Procedure Qualification shall be carried out in accordance with the relevant requirements of API 1104/ ASME Sec-IX or other applicable codes and other job requirements by the contractor at his expense. The contractor shall submit the welding procedure specifications in format as per Exhibit-C (attached) immediately after the receipt of the order.

b) 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 this own expense. A complete set of test results in format as per Exhibit-D (attached) shall be submitted to the COMPANY's inspector for approval immediately after completing the procedure qualification test and atleast 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 testers, 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. The destructive testing of welded joints shall be as per Annexure-2 and API 1104/ASME Sec-IX.

1.13.3 Welder's Qualification

a) Welders shall be qualified in accordance with the API 1104/ ASME IX and other applicable codes by the contractor at his expense. The butt weld test pieces of the qualification test shall meet the radiographic tests requirements as mentioned in this specification. The COMPANY's inspector shall witness the test and certify the qualification of each welder separately. Only those welders who have been approved by the COMPANY's inspector shall be employed for welding. Contractor shall submit the welder qualification test reports in the standard format and obtain express approval, before commencement of the work. It shall be the responsibility of contractor to carry out Qualification tests of welders.

b) The welders shall always have in their possession the identification card as shown in Exhibit-E and shall produce it on demand by the COMPANY's Inspector. It shall be the responsibility, of the Contractor to issue the identify cards after it has been duly certified by the COMPANY. If a welder is found to perform a type of welding for which he is not qualified, he shall be debarred from doing any further work. All welds performed by an unqualified welder shall be cut and redone by a qualified welder at the expense of the Contractor.

1.13.4 **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. Under-cutting adjacent to the completed weld shall not exceed the limits specified in the applicable standard/ code.

1.13.5 **Non-destructive Examination**

The non destructive examination shall mainly consist of examination using x-ray radiography as detailed in Annexure-4.
Radiographic examination of one hundred percent (100%) girth welds will be required by the COMPANY. Welds shall meet the standards of acceptability as set forth in API 1104 and as per the requirements laid in subsequent paragraphs.

The CONTRACTOR shall make all the arrangements for the radiographic examination of work covered by this specification at his expense.

The COMPANY will review all the radiographs of welds and inform the CONTRACTOR regarding unacceptable welds. The decision of the COMPANY shall be final and binding in this regard.
All requirements mentioned in the specification shall be arranged and executed by the CONTRACTOR through his own resources. In addition, for pipes with wall thickness 9.5mm and above, ultrasonic inspection is required in the following cases as per Annexure-3 of this specification.

a) On the first 100 welded joints corresponding to each automatic (GTAW/ GMAW) welding procedure used.

b) When 20mm or more are cut from the pipe end as supplied, the ends shall be ultrasonically inspected for an additional length of 20mm to ensure no lamination exist.

c) When welds are repaired.

d) When in the opinion of COMPANY, ultrasonic inspection is required to confirm or clarify defects indicated by radiography.

e) When automatic procedure is used at least 10cm on each weld shall be ultrasonically inspected at COMPANY's discretion.

In addition, ultrasonic inspection may be required for certain critical weldings of the pipeline (i.e. tie-ins, welding of valves, flanges) randomly selected at COMPANY's discretion. All fillet and groove welds other than that radiographed shall be subjected to dye pentrant/ MP inspection. The non destructive test system used for inspecting welds must be approved by the COMPANY.

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 article shall be considered defective and shall so be marked with an identification paint marker.

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

i. Any amount of inadequate penetration of the root bead as defined by API- 1104 is unacceptable.

ii. Any amount of incomplete fusion between the root and bevel as defined by API-1104 is unacceptable.

iii. Unrepaired burn through areas is unacceptable.

The contractor shall be responsible for carrying out radiography, rectification of defects and re radiography of weld rectified/ repaired.

- The extent of radiography shall be as per specifications to be supplied to the Contractor. For welds between dissimilar materials, the extent of radiographic examination shall be more stringent for the two recommended materials being welded.

- Radiographic examination shall be carried out using x-radiation. Gamma ray sources may be used in place of X-ray with the approval of the EIC in case of inaccessible joints.

- The contractor shall fulfill all the statutory safety requirements while handling x-ray and Gamma ray equipments.

- The Contractor shall furnish all films to the Owner's inspector immediately after processing. The details of the radiographs alongwith the joint identification number shall be duly entered in a register and signed by the Contractor and shall be submitted to the Owner's inspector for approval.

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

1.13.6 Magnetic Particle & Liquid Penetrant Examination

a) Whenever such tests are specified, the tests shall be carried out on joints chosen by the Owner's Inspector.

1.13.7 Hardness Test

Hardness requirement of welds shall be as per welding specification chart. Hardness testing may be carried out by Vickers, Brinell or Poldy Hardness tester as agreed by the Owner's Inspector.

1.13.8 Proof Tests

Hydrostatic and pneumatic tests shall be performed as per the requirements laid down in the respective flushing & testing specification/ applicable codes to demonstrate the soundness of the welds. The tests shall be conducted only after fulfilling the requirements of visual examination,

radiography etc. and after the entire work has been certified by the Owner's inspector, as fit for subjecting to such test.

1.14 Repairs of Welds

a) Defects ascertained, through the inspection methods, which are beyond acceptable limits shall be removed from the joint completely by the process of chipping and grinding.

b) When an entire joint is judged unacceptable, the welding shall be completely cut and the edges be suitably prepared as per required alignment tolerances. The welded joint shall again be examined following standard practices.

c) No repair shall be carried out without prior permission of the Owner's inspector.

d) Where random radiography is specified, the test welds of each welder shall be completely radiographed. In the case of pipes of sizes 6" and below, the first two welds shall be completely radiographed.

e) For each weld found unacceptable due to a welder's fault, two additional checks should be carried out on welds performed by the same welder. This operation is interactive and the procedure of radiographing two additional welds for each weld deemed

unsatisfactory shall be continued till such time that the two consecutive welds of satisfactory quality are found for every defective weld.

The contractor shall carry out these additional radiographic testing. To avoid the possibility of too many defective welds by a single welder remaining undetected for a long period of time, the Contractor shall promptly arrange for radiographic examination so that there is no
accumulation of defective joints.

1.15 **Limitations on Repairs**

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

1.16 **Weld Rejected by Accumulation of Defects**

Where a weld is rejected by the accumulation of defect clause, as defined by API-1104 and this specification, repairs within these limitations are permitted. Defects in the filling and capping passes shall be repaired preferentially.

1.17 **Documents to be submitted by the Contractor**

a) Welding procedure specifications as per Exhibit-C immediately after receipt of the order.

b) Welding procedure qualification records as per Exhibit-D.

c) Welder performance qualification records as per Exhibit-C&D immediately after conducting welder qualification tests.

d) Proposed heat treatment procedure as per Exhibit-B.

e) Heat treatment charts and records along with the hardness test results

ANNEXURE-A
Sheet 1 of 4
ELECTRODE QUALIFICATIONS TEST RECORD

A : Tested at (Site Name) Date :

Test Period :

Manufacturer's Name :

Brand Name :

Batch Number & size Tested :

Classification & Code :

Intended for Welding in positions :

In combination with (if any) :

Code of Reference (used for testing) :

Special requirements (if any) :

B : **All - Weld Tensile Test**

Base Material used :

Pre-heat temperature :

Postweld Heat Treatment Details :

Visual Examination :

Radiographic Examination Results :

Sheet 2 of 4

Tensile Test Results :

Sl. No.	Identification Number	U.T.S.	Yield Point	Elongation	Remarks

C: **Impact Test Results**

Test Temperature: Notch in :

Type of Specimens (Impd, Charpy: Size of Specimens :

Specimen No.	Impact Value	Average
1.		
2.		
3.		
4.		
5.		

D: **Chemical Analysis Result**

Electrode size used:

Batch No.

%C	%S	%P	%Si	%Mn	%Cr	%Ni	%Mo

E : **Fillet Weld Test Results**

Welding Positions :

Base Materials :

Size of electrode used :

Visual Inspection Results : 1)
2)
3)

Micro Test Results

Fracture Test Results :

Remarks :

F : **Other Test Results**

i) Transverse Tensile Test :

In Combination with :

Base Material used :

Position of Welding :

Preheat Temperature :

Postweld Heat Treatment :

Radiography :

Identification No.	U.T.S.	Fracture in	Remarks

2. **Guide Bend Test**

	Position	ID No.	Root, Face or Side Bend	Remarks
1				
2				
3				
4				
5				

3. **Any other tests**

Conclusions

Approved By :

EXHIBIT-B

Sheet 1 of 2

STRESS RELIEF HEAT TREATMENT PROCEDURE SPECIFICATION

Name of the Heat - Treatment :.....

Name of the Project :.....Specification Reference No. .....

1. **General Details**

Name of the Equipment : .....

Name of the Assembly/ Part : .....

Assembly/ Part Drawing No. : .....

Material : .....

2. **Furnace Details**

Type of Heating : Gas/ Oil/ Elec. Res./ Induction (Tick Mark)

Capacity (size) : .....

Maximum Temp. (°C)

Method of temp. measurement : .....

Atmosphere Control : .....

3. **Heat Treatment Cycle Details**

Charging Temp. °C : .....

Rate of Heating, °C/Hr : .....

Soaking Temp., °C : .....

Soaking Time, Hrs. : .....

Sheet 2 of 2

Rate of Cooling, °C/Hr : .....

Mode of Cooling : .....

4. Other Details, if any : .....

5. The following documents are to be furnished :
along with these specification :

i) Material Test Certificates

ii) Assembly/ Part Details

EXHIBIT-C
Sheet 1 of 2
STANDARD PROCEDURE SPECIFICATION NO.

for ..... Welding of ..... Pipe and Fittings

- Process & type ..... (Details of special machines).
- Material ..... (Pipes to which the procedure applied, grade of steel, type of pipe, Reference Specification).
- Diameter and wall thickness ..... (Series of dia and thickness to which procedure is applicable)
- Joint Design .....
- Filler Metal and Number of Beads .....
- Electrical or Flame Characteristics .....
- Position .....
- Direction of Weldings ..... (Uphill, Downhill, Mixed)
- Number of Welders .....
- Time Lapse between passes .....
- Type of Line-up Clamp .....
- Removal of Line-up Clamp ..... (Minimum percentage of welding carried out before removal of clamps)
- Cleaning .....
- Preheat, Stress Relief .....

Sheet 2 of 2

- Shielding Flux .....
- Speed of Travel .....

- Sketches and Tabulations (to be attached) .....
- Wire Speed (rate of wire speed and variation range) .....
- Minimum No. of passes which must be completed before discontinuing weld.
- Minimum No. of welders required for the first pass and second pass :

Tested : ..... Welder .....

Approved : ..... Welding Supt. .....

Accepted : ..... Chief Engineer .....

EXHIBIT-D
Sheet 1 of 2
COUPON TEST RECORD

Location .....
Date ..... State ..... Roll Weld ..... Fixed position
weld ..... welder ..... Mark
..... Welding Time ..... Time of day
..... M. Temperature ..... F. Weather Condition
..... Wing break used ..... Voltage
..... Amperage ..... Type of welding machine
..... Size ..... Filler Metal
..... Size of reinforcement
..... Pipe kind and Grade
..... Wall thickness
..... Dia O.D. .....

---

1 2 3 4 5 6 7

Bead No. ..... Size of electrode
..... No. of electrode
.....

---

1 2 3 4 5 6 7

Coupon Stenciled ..... Original
Dimension of Plate ..... Original area of plate
(inch$_2$) ..... Maximum Load
..... Tensile S/ in. plate area
..... Fracture Location
.....

Procedure Qualifying Test Qualified
Welder Line Test Disqualified

Sheet 2 of 2
Max. tensile strength ..... min. tensile strength .....

Avg. tensile strength ..... Remarks on tensile strength .....

1. .....

2. .....

3. .....

4. .....

Remarks on Bend Tests

1. .....

2. .....

3. .....

4. .....

Remarks on Nick Tests

1. .....

2. .....

3. .....

4. .....

Other Tests .....
(Use back for additional remarks)

EXHIBIT-E

WELDER's IDENTIFICATION CARD

Name :

Identification :

Date of Testing :

Valid Unit :

Approval of Welding :

Welding Position :

Material :

Diameter :

Wall Thickness :

Type of Welding Consumable :

Approved By :

Employer's Signature
with Seal

EXHIBIT-F

Sheet 1 of 2

RADIOGRAPHIC PROCEDURE FOR PIPE WELDING

1. Location
2. Date of Testing
3. Name of Supervised Contractor
4. Material

5. Dia. & Thickness
6. Type of Weld Joint
7. Radiation Source (X-ray, gamma ray)
8. Type of equipment (external/ internal)
9. Intensifying screens and material
10. Filter type and placement mask, diaphragm lead screen etc. adjacent to radiation sources or specimen.
11. Geometric relationship (source local spot size, max and min source strength, object to film distance, radiation angle with respect to weld and film).
12. Limit of film coverage
13. Film type and make
14. Exposure Time
15. Processing (time temperature for development stop bath or rinse, fixation, washing, drying etc.)
16. Density
17. Sensitivity
18. Type of penetrameter

Approval of the COMPANY Signature of CONTRACTOR

WELDING SPECIFICATION CHART
EXHIBIT-G
Sheet 1 of 2
Class :

Material Specification :

Pipes : API 5L Gr. X 52, API 5L Gr. X60, API 5L Gr. X 42

Fittings : A 105, A234 Gr. WPB. MSS-SP-75, Gr. WPHY42, MSS-S

Flanges : Alos, MSS-SP-44 Gr. F42, MSS-SP as Gr. WPH 60

Other : 44 Gr. F6C

Base Metal :

Welding Processes : Groove Joints : Butt

Root Pass **SMAW** Filler Pass **SMAW**

Fillet Joints/ Socket Joints : **SMAW**

Welding Materials : Groove Joints : Butt
Welding Electrodes :

For Mainline:
Root Pass E6010/ E7010 Filler Pass E7010/ E8010

For Above Ground Piping :
Root Pass E6010/ E7010 Filler Pass E7018/ E8018

Filler Joints/ Socket Joints : E7018/ E8018

Preheating : 10°C minimum for all welds.

Interpass Temperature : 150°C minimum for all welds

Post weld heat treatment : if required.
Holding temp. : 595-650 C Holding Time : 1 Hr. per inch thick.
Rate of heating : 200 C/hr max. Min holding time : 1 hr.
Method of cooling : Controlled Rate of cooling : 200°C/hr max.

Mechanical property requirements :

Charpy `V' notch impact test valve :
Normal : 22 J
Average : 27 J
At temperature : 0 °C
Hardness : 300 HV10 (for weld & HAZ)

Code of fabrication : ANSI B31.8; API 1104 and welding specifications.

TECHNICAL NOTES

1. Welding, heat treatment and non destructive testing shall be carried out in accordance with the requirement of ANSI B31.8/ API-1104 and additional requirement specified in the specification. In case of conflict between code and specification more stringent conditions shall be applicable.

2. No welding shall be carried out without preheating the joint to 10°C (50 °F) when the ambient temperature is below 10°C (50 °F).

3. Preheat shall be applied while welding the following material as detailed below :

API 5L Gr. X52	:	Thickness upto	100 °F min.
API 5L Gr. X52	:	and inclusive of 12mm	
A 105	:		
MSS-SP-44 Gr. F60	:	Thickness beyond	200 °F
A 234 GN WPB	:	12 mm	
MSS-SP-75-WPHY60			

4. For fillet welds complete welding may be carried out using the electrodes recommended for filler passes.

5. All weldments & HAZ shall meet the hardness requirements of 300 HV10 during procedure qualification. If the hardness exceeds 300 HV10 the joints shall be heat treated at temp. 1100-1250 °F for one hour. The heating and cooling rates shall be decided during procedure qualification subject to a maximum of 200 °C/Hr. Hardness testing shall be carried out by Vickers hardness tester during welding procedure qualification test only. No hardness test is required for production welds.

6. The electrodes used shall meet the following additional requirement :

Specification	UTS (Min.) (As welded)	Impact (As welded)
E7018-G	52.7 kg/mm2	20 ft. lb. at 0°C
E7018-I	52.7 kg/mm2	_
E6010	-	-
E6018	-	20 ft. lb. at 0°C

7. All the weldments & HAZ shall meet the impact test requirement of 20 ft. lb at 0°C.

ANNEXURE-2

1.0 DESTRUCTIVE TESTING OF WELDED JOINT - BUTT WELDS

1.1 Preparation

Having passed the visual and the non destructive inspection, the test weld shall be subjected to Mechanical test.

After satisfactory completion of all visual and non destructive testing the procedure test weld shall be set aside for a period not less than 24 hours. No further work on the test weld and no cutting of test specimens from the weld be performed till a period of at least 24 hours has expired.

Weld specimens, for pipe diameter greater than or equal to 12.3/4" shall be taken from the positions indicated in Fig. 1 of this specification from areas as free from defects as possible. For this reason it is necessary to take the previous non destructive tests into account. The minimum no. of tests to be carried out is given in Table-I of this specification.

The test shall be carried out at laboratories approved by COMPANY. The specimens shall be prepared in accordance with the figure given in the paragraphs which refer to the individual test.

Table-I

TYPE AND NUMBER OF TEST SPECIMENS FOR PROCEDURE QUALIFICATION TEST

Pipe Size, Out Side Diamter-Inches	Number of Specimens									
	Tensile API	Tensile ISO	Nick Break	Root Bend	Face Bend	Side Bend	Macro Bend	Hard ness	Impact	Total
Wall Thickness - ½ inch (12.7mm) and Under										
Under 2-3/8	0	0	2	2	0	0	0	0	0	4
2-3/8 to 4- ½ incl.	0	0	2	2	0	0	0	0	0	4
Over 4-½ less than 12.75	2	0	2	2	2	0	2	2	12	24
12- 3/4 and Over	2	2	4	4	4	0	2	2	24	44
Wall Thickness - ½ inch (12.7mm)										
4-½ and smaller	0	2	0	0	0	2	0	0	0	4
Over 4-½ less than 12-3/4	2	0	2	2	2	0	2	2	12	24
12-3/4 and over	2	2	4	0	0	8	2	2	24	44

1.2 **Tensile Strength**

Specimens for pipe diameter over 12 3/4" shall be taken from the position indicated in Fig. 1 of this specification. Two API type specimen shall be taken for pipe diameter greater than or equal to 12 3/4".

1.3 **Nick-Break Test**

1.3.1 **Preparation**

Specimens for nick-break test with notches thus worked can break in the base metal, instead of in the fusion zone; therefore an alternative test piece may be used after authorization by the

COMPANY with a notch cut in the reinforcement of outside weld bead to a maximum depth of 1.5mm measured from the surface of the weld bead.

1.4 Macroscopic Inspection

1.4.1 Preparation

Specimens shall be taken from the positions indicated in Fig. 1 of this specification and shall be prepared in accordance with ASTM E2 and E3.

The width of the macrosection has to be at least three times the width of the weld. The section is to be prepared by grinding or polishing and etching to clearly reveal the weld metal and heat effected zone.

1.4.2 Method

Specimens shall be carefully examined under the microscope with a magnification of at least 25 times. The COMPANY may ask for a macrograph with 5 times magnification for documentation purposes.

1.4.3 Requirements

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

1.5 Hardness Test

1.5.1 Preparation

The prepared macrosection is to be used for hardness testing using the Vickers method with 100 N (10 kg) load. Indentations are to be made along traverses each approximately 1mm below the surface at both side of the weld.

In the weld metal a minimum of 6 indentations equally spaced along the traverses are to be made. The HAZ indentations are to be made along the traverses for approximately 0.5mm each into unaffected material, and starting as close to the fusion line as possible.

One indentation at each side of the weld along each traverse has to be made on parent metal. Reference is made to fig. 3 of this specification. The indentation is to be made in the adjacent region as well as on the opposite side of the macrosection along the specified traverses.

1.5.2 Method

The test shall be carried out in accordance with Recommendation ISO R81, Vickers hardness, using laboratory type machine controlled as per recommendation of ISO R 146 and using a diamond pyramid penetrator set at 2.37 rad. (136) with a load of 100 N (10 kg).

1.5.3 **Requirements**

Hardness value shall not exceed 300 H VI0 . In case of a single reading slightly (+10 HV) higher than the specified limit, further indentations should be made to check if the high value was an isolated case.

All the hardness values obtained from the heat effected zone shall not exceed 100 HV with respect to the average hardness of the values obtained for the base metal.

If these additional tests mentioned above give a hardness within the specification limit, the slightly higher value may be accepted.

1.6 Charpy-V-notch Impact Test

1.6.1 Specimens shall be taken from the position indicated in Fig. 1 of this specification. The test specimens will be prepared in accordance with ISO R 148. Charpy Vnotch specimens shall have dimensions as given in Fig. 3 of the specification.

Three test specimens shall be taken from each sample and they shall be cut and worked so that their length is transversal and perpendicular to the weld bead with the notch position as shown in Fig. 4 of this specification. The notch shall be perpendicular to the roller surface. The test specimens width shall depend upon the pipe wall nominal thickness as following:

Nominal wall thickness in mm	Test Specimens width in mm
> 12	12
> 9.5 and ≤ 12	7.5
≥ 7 and ≤ 9.5	5
< 7	2.5

1.6.2 **Test Method**

The test shall be carried out as indicated in ISO R 148 "Beam Impact Test Vnotch. Test pieces shall be immersed in a thermostatic bath and maintained at the test temperature for at least 15 minutes. They shall than be placed in the testing machine and broken within 5 seconds of their removal from the batch.

1.6.3 **Requirements**

The impact energy shall be greater or equal to:

Test Specimens in mm	Average of Three specimens Joule (min) (Note-2)	Minimum Single Value Joules (Note 1)
10	27	22
7.5	21.5	17.5
5	18.5	15.0
2.5	10.0	8.0

Note:

1. Only one value is permitted to be lower than average upto the value specified.

1.7 **Bend Test Requirements**

The bend test specimens shall be made and tested as per the requirements of API-1104 except that the dimensions of Jig for guided bend test shall be modified as follows:

Radius of the plunger	°A'	=	2 t
Radius of the die	°B'	=	3 t + 1.6mm
Width of the die	°C'	=	50.8

The acceptance criteria shall however be as per para 2.643 and 2.653 of API-1104.

Note t = Thickness of Specimen (nominal)

ANNEXURE-3

1.0 ULTRASONIC INSPECTION

In addition to the radiographic inspection ultrasonic inspection is required as per conditions mentioned in Annexure-1 of this specification.
This section concerns manual ultrasonic inspection. However ultrasonic inspection by automatic equipment may be used if approved by the COMPANY.

1.1 **Equipment and Operators**

The CONTRACTOR who carries out the ultrasonic inspection shall have sufficient qualified personnel, equipment and instrument at his disposal to be able to effect the tests without hindering or delaying the pipeline assembly operations.

- Calibrate the equipment;
- Perform an operational test under production conditions;
- Interpret the screen picture;
- Evaluate the size and location of reflectors
- Interpret the type of defects detected.

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

The CONTRACTOR appointed to carry out UT inspection shall supply the instruments necessary for their execution on site.

1.2 **Specification for Ultrasonic Testing Procedure**

Qualification

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

This specification shall be 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.

1.3 **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, when there are typical defects the test intends to detect.

1.4 **Test Procedure**

Circumferential weld shall be inspected from both sides using angled. Probes.
The surface with which the probe 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 atleast 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
- Equipment for cleaning of surface to be examined.
- Rulers calibrated in centimeters for exact location of the position of defects.

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

a) that the required standards of the inspection procedure, as previously established and approved by the COMPANY, are satisfied.
b) 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 inspection 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 instrument and equipment necessary for carrying out ultrasonic inspection on site shall satisfy the requirements laid down by the public board of institutions which regulate "safety at work".

1.5 Ultrasonic Instruments

The ultrasonic instruments:

- Shall be each pulse 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 70 mm wide and at least 50 mm high.
- Shall have various amplification, with steps of 1 or 2 dB over a range of a 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 instrument 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 stabilizing device with a tolerance of 2 volts.

1.6 Probes

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

1.7 Reference Sample Pieces

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

For the calibration of runs and the regulation of detection sensitivity during the test, a calibration piece be used. This piece shall be taken from the production material, and will be at least 150mm long (measured in the direction of the axis), and at least 50mm wide (measured in the direction of the circumference), (see Fig. 4 of this specification).

In the middle of the inside and the outside surface of the calibration piece a groove shall be made. The groove will have a rectangular cross-section, a flat bottom and the following dimensions:

- Depth: 1 +/- 0.1mm
- Breadth (measured parallel to the 150mm side) : 1 +/- 0.1mm
- Length (measured parallel to the 50mm side) not less than 30mm.

In addition, the calibration piece shall have a hole, 2mm in diameter, passing through its thickness and positioned so that during calibration the echoes returning from the two grooves do not interfere with those returning from the hole.

1.8 Calibration

For a precise check of the sound paths necessary for a full inspection of the weld joint, the probe shall be moved (half skip and full skip distance) until internal and external notches on the test piece are detected (see Fig. 5 of this specification).

The relevant defect limits the path lengths on the time base. The calibration of reference sensitivity is obtained by utilising the through drilled test hole in the thickness of the reference block to draw the distance amplitude correction curve relevant to the test probe.

Calibration shall be carried out according to the following procedure : place its internal vertex until the maximum height of echo is displayed on the screen; this echo is adjusted to 80% of full screen height by means of the sensitivity adjuster set in dB. Without varying the amplification, the probe placed at full skip distance from the hole is moved to detect the external vertex the hole until the maximum height of echo is obtained. The straight line connecting the peaks of the two echoes obtained by the above procedure, represents the 100% reference level, while the one connecting the two points at half height of the same echoes represents "50% reference level".

The two straight lines shall be marked on the screen with a pen. Calibration shallbe repeated each time tests are re-started at intervals not longer than 30 minutes during normal operations; each time the conditions fixed in advance are altered. This calibration is applicable provided that the crystal of the probe is 8 x 9mm size. Should this size of the crystal be different, the value of the sensitivity obtained from the calibration by a crystal of a different size shall be brought to the value of sensitivity obtained from the calibration by a 8 x 9mm crystal. The sensitivities of the two different size probes shall be compared through the echoes obtained on the notch of the test piece with the probe position at half skip of the distance.

1.9 Regulation of Amplification during Production Testing

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

1.10 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.

1.11 **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 amplifications and the probe shall be moved until maximum respond is obtained paying attention all the time to the probetube coupling.

If, under these conditions, the height of the defer echo is equal to or greater than that of the reference echo, the defect shall be evaluated. 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 defects. Returns which are less than 50% of the reference echo, will not be considered. It returns are above 50% but lower than 100% of the reference echo, and if the operator has good reasons to suspect that the returns are caused by unfavorably oriented cracks, he shall inform the 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.

1.12 **Other Equipment**

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

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

ANNEXURE-4

RADIOGRAPHY

1.0 **SCOPE**

This annexure 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.

2.0 **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 System.

iv. ASTM E94, Recommended practice for Radiographic Testing.

v. ASTM, E 142, Standard Method for Controlling Quality of Radiographic Testing.

vi. The American Society for non-destructive Testing. Recommended Practice No. SNT-TC-1A Supplement-A.

3.0 **PROCEDURE**

3.1 The radiographic examination procedure to be adopted shall be submitted by the CONTRACTOR as per Exhibit-F.

3.2 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 in 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 through out 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.

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

3.4 The procedure of radiographic examination shall produce radiographs of sufficient density, clarity and contrast so that defects in the weld or in the pipe adjacent to the weld, and the outline and holes of the pentrameter are clearly discernible.

3.5 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 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.

3.6 When the radiation source and the film are both on the outside of the weld and located diametrically opposite each other, the maximum acceptable length of film for each

exposure shall not exceed the values given in API 1104. The minimum film overlap, in such cases, shall be 40mm. The ellipse exposure technique may be used on nominal pipe sizes of 2 inch and smaller provided that the source to film distance used is a minimum of 12 inches.

3.7 Three copies of each acceptable radiographic procedure (as outlined in Specification no. SIPI/S/O5/62/02) 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.

3.8 Three copies of the exposure charts relating to material thickness, kilo voltage, source to film distance and exposure time shall also be made available to COMPANY by the CONTRACTOR.

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

3.10 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.

3.11 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.

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

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

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

4.0 RADIATION SOURCE

4.1 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.

4.2 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°).

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.

5.0 LEVEL OF QUALITY

The quality level of radiographic sensitivity required for radiographic inspection shall be at least equivalent to the values in Figure-6.

6.0 PENETRAMETERS

6.1 The image quality indicator (abbreviation : IQI) shall be used for the qualification of the welding procedure and during normal line production. Radiographic sensitivity shall be measured with the wire image quality indicator (Penetrameter). The penetrameter shall be selected according to DIN 54109 or ISO 1027. 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 penetrameters 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 radiographs.

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.

7.0 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.

8.0 PROTECTION AND CARE OF FILM

8.1 All unexposed films shall protected and stored properly as per the requirements of API 1104 standard and ASTM E 94.

8.2 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.

9.0 RE-RADIOGRAPHY

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

9.2 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 area shall be identified with the original identification number plus the letter `R' to indicate the repair.

9.3 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.

9.4 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.

10.0 QUALIFICATION OF RADIOGRAPHERS

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

10.2 Certification of all the radiographers, qualified as per 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 acquity eye test.
v. Date of qualification.

10.3 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.

11.0 PRESERVATION OF RADIOGRAPHS

11.1 The radiographs shall be processed to allow storage of films without any discoloration for at least three years. All the radiographers shall be presented in suitable folders for preservation alongwith necessary documentation.

11.2 All radiographs shall become property of the COMPANY.

12.0 EQUIPMENT AND ACCESSORIES

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

12.2 For carrying out the mainline radiographic examination the CONTRACTOR shall be equipped with suitable mobile/ stationary type with 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 can be suitably controlled to allow viewing film densities upto 4.0 without damaging the film.

13.0 RADIATION PROTECTION

13.1 CONTRACTOR shall be responsible for the protection and personal monitoring of every man with or near radiation sources.

13.2 The protection and monitoring shall comply with local regulations.

13.3 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 agencies of Benin 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.

14.0 DISPLAY OF SAFETY INSTRUCTIONS

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

15.0 ENFORCEMENT FOR SAFETY REGULATIONS

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

16.0 FIRST AID INDUSTRIAL INJURIES

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

16.2 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.

16.3 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.

17.0 **NO EXEMPTION**

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

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SPECIFICATION

FOR

SHOP & FIELD PAINTING

SPECIFICATION NO. SIPI/Steel/TS/07

CONTENTS

1.0 GENERAL

1.1 These technical specifications shall be applicable for the work covered by the contract, and without prejudice to the various codes of practice, standard specifications etc. it is understood that contractor shall complete the work in all respects with the best quality of materials and workmanship and in accordance with the best engineering practice and instructions of Engineer-in-charge.

1.2 Wherever it is stated in the specification that a specific material is to be supplied or a specific work is to be done it shall be deemed that the same shall be supplied or carried out by the contractor.

Any deviation from this standard without within deviation permit from appropriate authority will result in rejection to job.

2.0 SCOPE

Scope of work covered in the specification shall include, but not limited to the following.

2.1 This specification defines the requirements for surface preparation, selection and application of paint on external surfaces of equipment, vessels, machinery, piping, ducts, steels structures, external & internal protection of storage tanks for all services RCC Chimney & MS Chimney with or without refractory lining and flare lines etc.

2.2 Extent of Works

2.2.1 The following surface and materials shall require shop, pre-erection and field painting.

a. All uninsulated C. S. & A.S. equipment like columns, vessels, drums, storage tanks, heat exchangers, pumps, compressors, electrical panels and motors etc.

b. All uninsulated carbon and low alloy piping fitting and valves (including painting of identification marks), furnace, ducts and stacks.

c. All items contained in a package unit as necessary.

d. All structural steel work, pipe, structural steel supports, walkways, handrails, ladders, platforms etc.

e. RCC/ MS chimneys with or without refractory lining & Flare lines.

f. Identification colour bands on all piping as required including insulated aluminium clad, galvanised, SS and non-ferrous piping.

g. Identification lettering/ numbering on all painted surface of equipment/ piping insulated aluminium clad, galvanised, SS and non-ferrous piping.

h. Marking/ identification signs on painted surfaces of equipment/ piping for hazardous service.

i. Supply of all primers, paints and all other materials required for painting other than owner's supply.

j. Over insulation surface of equipments and pipes wherever required.

k. Painting under insulation for carbon steel and stainless steel as specified.

l. Repair work of damaged/ preerection/ fabrication shop primer and weld joints at field.

2.2.2 The following surface and materials shall not be painted unless otherwise specified:

a. Uninsulated austentic stainless steel.

b. Plastic and/ or plastic coated materials.

c. Non-ferrous materials like aluminium, galvanized "piping", "gratings" and "handrails" etc. except G. I. Towers.

2.3 <u>Documents</u>

2.3.1 The contractor shall perform the work in accordance with the following documents issued to him for executions of work.

a. Bill of quantities for piping, equipment, machinery and structure etc.

b. Piping line list.

c. Painting specifications including special civil defence requirement.

2.4 Unless otherwise instructed final painting on pre-erection/ shop primed pipes and equipments shall be painted in the field, only after Mechanical completion and testing on system are completed as well as, after completion of steam purging wherever required.

2.5 Changes and deviations required for any specific job due to clients requirement or otherwise shall be referred to REPL for deviation permit.

3.0 CODES & STANDARDS

3.1 Without prejudice to the provision of clause 1.1 above and the detailed specifications of the contract, the following codes and standards shall be followed for the work covered by this contract.

IS:5	:	Colour coding
IS-101	:	Methods of test for ready mixed paint and enamels.
IS-2379:1990	:	Indian standard for pipe line Identification –Colour code.
ASTM	:	American standard test methods for Paints and coatings.

ASA A 13.1-1981 : Scheme for Identification of piping Systems : American National Standard Institution.

3.2 <u>Surface Preparation Standards:</u>

Following standards shall be followed for surface preparations:

3.2.1 Swedish Standard : SIS-05 5900-1967/ ISO-8501-1-1998 (Surface preparation standards for painting steel surfaces). This standard contains photographs of the various standards on four different degrees of rusted steel and as such is preferable for inspection purpose by the Engineer-in-Charge.

3.2.2 Steel structure painting Council, U.S.A (surface preparations specifications (SSPC-SP).

3.2.3 British standard (surface finish or Blast-cleaned for painting) BS:4232

3.2.4 National Associations of Corrosion Engineers, U.S.A. (NACE)

3.2.5 Various International Standards equivalent to swedish Standard for surface preparation are given in Table-I.

3.3 The contractor shall arrange, at his own cost, to keep a set of latest edition of any one of the above standards and codes at site.

3.4 The paint manufacturer’s instructions shall be followed as far as practicable at all times. Particular attention shall be paid to the following:

a. Instructions for storage to avoid exposure as well as extremes of temperature.

b. Surface preparations prior to painting.
c. Mixing and thinning.

d. Application of paints and the recommended limit on time intervals between coats.

4.0 EQUIPMENT

4.1 All tools, brushes, rollers, spray guns, abrasive materials hand/ power tools for leaning and all equipments, scaffolding materials, shot/ wet abrassive blasting, water blasting equipments & air compressors etc. required to be used shall be suitable for the work and all in good order and shall be arranged by the contractor at site and in sufficient quantity. Mechanical mixing shall be used for paint mixing operations in case Sf two pack systems except that the Engineer-in-Charge may allow the hand mixing of small quantities at his discretion.

5.0 SURFACE PREPARATION, SHOP COAT, COATING APPLICATION & REPAIR AND DOCUMENTATION

5.1 General

5.1.1 In order to achive the maximum durability, one or more of following methods of surface preparation shall be followed, depending on condition of steel surface and as instructed by Engineer-in-Charge. Adhesion of the paint film to surface depends largely on the degree of cleanliness of the metal surface. Proper surface preparation contributes more to the success of the paint protective system:

a. Manual or hand tools cleaning.
b. Mechanical or power tool cleaning.
c. Blast cleaning.

5.1.2 Mill scale, rust, rust scale and foreign matter shall be removed fully to ensure that a clean and dry surface is obtained. The minimum acceptable standard in case of manual or hand tool cleaning shall be St. 2 or equivalent, in case of Mechanical or power tool cleaning it shall be St. 3 or equivalent, in case of blast cleaning it shall be Sa 2½ or equivalent as per Swedish Standard SIS-055900-1967/ ISO-8501-1-1988. Where highly corrosive condition exits, then blast cleaning shall be Sa3 as per Swedish Standard.

Remove all other contaminants, oil, grease etc. by use of an aromatic solvent prior to surface cleaning.

5.1.3 Blast cleaning shall not be performed where dust can contaminate surfaces undergoing such cleaning or during humid weather conditions having humidity exceeding 85%.

5.1.4 Irrespective of the method of surface preparation, the first coat of primer must be applied on dry surface. This should be done immediately and in any case within 4 hours of cleaning of surface. However, at times of unfavourable weather conditions, the Engineer-in-Charge shall have the liberty to control the time period, at his sole discretion and / or to insist on recleaning, as may be required, before primer application is taken up. In general, during unfavourable weather conditions, blasting and painting shall be avoided as far as practicable.

5.1.5 The external surface of R.C.C. chimney to be painted be dry and clean. Any loose particle of stand, cement, aggregate etc. shall be removed by rubbing with soft wire brush if necessary, acid etching with 10-15% HCL solution about 15 minutes shall be carried out and surface must be thorought washed with water to remove acid & loose particles then dry completely before application of paint.

5.2 Procedure of Surface Preparation.

5.2.1 Blast Cleaning

5.2.1.1 Air Blast Cleaning

The surface shall be blast cleaned using one of the abrasives: AL_2O_2 particles chilled casts iron or malleable iron and steel at pressure of 7kg. Cm_2 at appropriate distance and angle depending on nozzle size maintaining constant velocity and pressure. Chilled cast iron, malleable iron and steel shall be in the form of shot or grit of size not greater than 0.055”

maximum in case of steel and malleable iron and 0.04” maximum in case of chilled iron. Compressed air shall be free form moisture and oil.

The blasting nozzles should be venturei style with tungsten carbide or boron carbide as the material for liners. Nozzles orifice may vary from 3/16” to ¾”. On completion of blasting operation, the blasted surface shall be clean and free from any scale or rust and must show a grey white metallic lusture. Primer or first coat of paint shall be applied within 4 hours of surface preparation. Blast cleaning shall bot be done outdoors in bad weather without adequate protection or when there is dew on the metal which is to be cleaned, surface profile shall be uniform to provide good key to the paint adhesion (i.e.35to 50µ). If possible vacuum collector shall be installed for collecting the abrasive and recycling.

5.2.1.2Water Blast cleaning

Environmental, health and safety problems associated with abrasive blast cleaning limit the application of air blast cleaning in many installations. In such case water blast cleaning is resorted to. Water blast cleaning can be applied with or without abrassive and highpressure water blasting. The water used shall be inhibited with sodium chromate/ phosphate. The blast cleaned surface shall be washed thoroughly with detergents and wiped solvent and dried with compressed Air. For effective cleaning abrassives are used. The most commonly used pressure for high pressure water blast cleaning for maintenance surface preparation is 3000 to 6000 psi at 35-45 liters/ minute water volume and pressure upto 10000 psi and water volume of 45 liters/ minute provide maximum cleaning.

The wate blast cleaned surface shall be comparable to SSPC-SP-12/ NACE No. 5. The operation shall be carried out as per SSPC guidelines for water blast cleaning. The indicative values for sand injection is

Air	:	300 to 400 Cu.ft/ min.
Water	:	5-10 liter/ min. with corrosion inhibitor
Sand	:	200-400 lbs/ hr.
Nozzle	:	0.5 to 1” dia

Special equipments for water blast cleaning with abrasives now available shall be used.

5.2.2 Mechanical of Power tool cleaning

Power tool cleaning shall be done Mechanical striking tools, chipping hammers, griding wheels or roating steels wire-brushes. Excessive burnish of surface shall be avoided as it can reduce paint adhesion. On completion of cleaning, the detached rust mill scale etc. shall be removed by clean rags and/ or washed by water or stream and thoroughly dried with compressed air jet before application of paint.

5.2.3 Maual or hand tool cleaning

Manual or hand tool cleaning is used only where safety problems limit the application of other surface preparation procedure and hence dones not appear in the specifications of paint systems.

Hand tool cleaning normally consists of the following:

a. Hand descaling and/ or hammering
b. Hand scraping
c. Hand wire brushing

Rust, mill scale spatters, old coating and other foreign matter, shall be removed by hammering, scrapping tools, emery paper cleaning, wire brushing or combination of the above methods. On completion of cleaning, loose materials shall be removed from the surface by clean rags and the surface shall be brushed, swept, deducted and blown off with compressed air/ steam to remove all loose matter. Finally the surface may be washed with water and dried for effective cleaning.

5.3 **Non compatible shop coat primer**

The compatibility of finishing coat should be confirmed from the paint manufacturer. In the event of use of primer such as zinc rich epoxy, inorganic zinc silicate etc. as shop coat the pant system shall depend on condition of shop coat, if shop coat is in satisfactory condition showing no major defects, the shop coat shall not be removed. The touch up primer and finishing coat(s) shall be identified for application by Engineer-in- Charge.

5.4 Shop coated (coated with primer & finishing coat) equipment should not be repainted unless paint is damaged.

5.5 Shop primed equipment and surface will only be ‘spot cleaned’ in damaged areas by means of power tool brush cleaning and then spot primed before applying one coat of filed primer unless otherwise specified. If shop primer is not compatible with field primer then shop coated primer should be completely removed before applications of selected paints system for particular environment.

5.6 For packaged units/ equipment, shop primer should be as per the paint system given in this specification. However, manufacturer’s standard can be followed after review.

5.7 **Coating Procedure and Application:**

5.7.1 Surface shall not be coated in rain, wind or in environment where injurious airbone elements exists, when the steel surface temperature is less than 5° F above dew point when the relative humidity is greater then 85% or when the temperature is below 40° F.

5.7.2 Blast cleaned surface shall be coated with one complete application of primer as soon as practicable but in no case later than 4 hrs. the same day.

5.7.3 To the maximum extent practicable, each coat of material shall be applied as a continuous film uniform thickness free of probes. Any spots or areas missed in application shall be

recoated and permitted to dry before the next coat is applied. Applied paint should have the desired wet film thickness.

5.7.4 Each coat shall be proper state of cure or dryness before the application of succeeding coat. Material shall be considered dry for recoating when an additional coat can applied without the development of any detrimental film irregularities such as lifting or loose of adhesion of the under coat. Manufacturer instruction shall be followed for intercoat interval.

5.7.5 When the successive coat of the same colour have been specified, alternate coat shall be tinted, when practical, sufficiently to produce enough contrast to indicate complete coverage of the surface. The tinting material shall be compatible with the material and not detrimental to its service life.

5.7.6 Air spray application shall be in accordance with the following:

a. The equipment used shall be suitable for the intended purpose, shall be capable of properly atomizing the paint to be applied, and shall be equipped with suitable pressure regulators and gauges. The air caps, nozzles, and needles shall be those recommended by the manufacturer of the equipment for the material beign sprayed. The equipment shall be kept in satisfactory condition to permit proper paint application.

b. Traps or separators shall be provided to remove oil and condensed water from the air. These traps or separators must be of adequate size and must be drained periodically during operations. The air from the spray gun impinging against the surface shall show condensed water or oil.

c. Ingredients shall be kept properly mixed in the spray pots or containers during application by continuous Mechanical agitation.

d. The pressure on the material in the pot and of the air at the gun shall be adjusted for optimum spraying effectiveness. The pressure on the material in the pot shall be adjusted when necessary for change in elevation of the gun above the pot. The atomizing air pressure at the gun shall be high enough to properly atomize the paint but not so high as to cause excessive fogging of paint, excessive evaporation of solvent, or less by overspray.

e. Spray equipment shall be kept sufficiently clean so that dirt, dried paint, and other foreign materials are not deposited in the paint film. Any solvents left in the equipment shall be completely removed before applying paint to the surface begin painted.

f. Paint shall be applied in a uniform layer, with overlapping at the edge of the spray pattern. The spray patterns shall be adjusted so that the paint is deposited uniformly. During application the gun shall be held perpendicular to the surface and at a distance which will ensure that a wet layer of paint is deposited on the surface. The trigger of the gun should be released at the end of each stroke.

g. All runs and sags shall be brushed out immediately or the paint shall be removed and the surface repainted.

h. Areas inaccessible to the spray gun shall be painted by brush: if not accessible by brush, daubers or sheepking shall be used.

i. All nameplates, manufacturer’s identification tags, machined surface instrument glass, finished flange faces, control valve items and similar items shall be masked to prohibit coating disposition. If these surface are coated, the component shall be cleaned and restored to its original condition.

j. Edges of structural shapes and irregular coated surface shall be coated first and an extra pass made later.

k. If spray gun shown choking, immediately dechoking procedure shall be followed.

5.7.7 Airless spray application shall be in accordance with the following procedure: as per steel structure paint manual vol. 1 & vol. 2. By SSPC, U.S.A., Air less spray relies on hydraulic pressure rather than air atomization to produce the desired spray. An air compressor or electric motor is used to operate a pump to produce pressures of 1,000 to 6.000 psi. Paint is delivered to the spray gun at this pressure through a single hose within the gun, a single paint stream is divided into separate streams, which are forced through a small orifice resulting in atomization of paint without the use of air. This result in more repaid coverage with less overspray. Airless spray usually is faster, cleaner, more economical and easier to use than conventional airspray.

Airless spray equipment is mounted on wheels, and paint is aspirated in a hose that sucks paint from any container, including drums. The unit shall have in built agitator that keep the paint uniformly mixed during the spraying. The unit shall consists of in built strainer. Usually very small quantities of thinning is required before spray. Incase of High Build epoxy coating (two pack), 30:1 pump ratios and 0.020-0.023” tip size will provide a good spray pattern. Ideally fluid hoses should no be less than 3/8” ID and not longer than 50ft to obtain optimum results.

In case of gun choking, decoking steps shall be followed immediately.

5.7.8 Brush application of paint shall be in accordance with the following:

a. Brushes shall be of a style and quality that will enable proper application of paint

b. Round or oval brushes are most suitable for rivets, bolts, irregular surfaces and rough or pitted steel. Wide flat brushes are suitable for large flat areas, but they shall not have width over five inches.

c. Paints shal be applied into all corners.

d. Any runs or sags shall be brushed out.

e. There shall be minimum of brush marks left in the applied paint

f. Surface not accessible to brushes shall be painted by spray, duubers, or sheepkin

5.7.9 Manual application by sling (where 6 O' clock position of pipe is not approachable)

A canvas strip (alternatively a tinplate strip) about 450mm wide and 1.5m longs is hold under the pipe by two men. Liquid coating poured on the sling at each side of the pipe. The men holding this sling move it up and down and walk slowly forward while fresh coating is poured on the pipe and they manipulate the sling so that an even coating is ontained all round the bottom. This work shall be done vey carefully and by experienced personnel. There shall bot be any formation of "Whiskers" and holes in the coating. The coating film shall be inspected by mirror.

5.7.10 For each coat the painter should know the WFT corresponding to the specified DFT and standardize the paint application technique to achieve the desired WFT. This is to be ensured in the qualification trial.

5.8 Drying of Coated Surface

5.8.1 No coat shall be applied unit the preceding coat has dried. The material shall be considered dry for re-coating when another coat can be applied without the development of any film irregularities such as lifting or loss of adhesion of undercoats. Drying time of the applied coat should not exceed maximum specified for it as a first coat; if it exceeds the paint material has possible deteriorated or mixing is faulty.

5.8.2 No paint shall be force dried under condition which will cause checking, wrinkling blistering formation of pores, or detrimentally after the condition of the paint.

No drier shall be added to a paint on the job unless specifically called for in the manufacturer's specification for the paint.
Paint shall be protected from rain, condensation, contamination snow and freezing until dry to the fullest extent practicable.

5.9 Repair of damaged paint surface.

5.9.1. Where paint has been damaged in handling and in transportation, the repair of damaged coating of pre-creation/ fabrication shall be as given below.

5.9.2. Repair of damaged inorganic zinc silicate primer after erection/ welding: Quickly remove the primer from damaged area by Mechanical scraping and emery paper to expose the white metal. Blasts clean the surfaces possible. Feather the primer over the intact adjacent surface surrounding the damaged area by emery paper.

5.9.3 Repair of damaged pre-erection and shop priming in the design temperature of 90° C to 500° C.

- Surface preparation shall be done as per procedure 5.9.2 Page 12 of 49
- One coat of F-9 shall be applied wherever damaged was observed on pre-erection/ pre-fabrication/ shop primer of inorganic zinc silicate coating (F-9) shall not be applied if damaged area is not more than 5 x 5 cm.

5.10 PAINT APPLICATION

5.10.1 Shop priming/ pre-erection priming with F9 of F12 shall be done only on blasted surface.

5.10.2 Shop priming/ pre-erection priming with F-9 or F-12 shall be done only with airless spray.

5.10.3 For large flat surface field painting shall be done by airless spray otherwise brush can be used.

5.11 Documentation.

1. A written quality plan with procedure for qualification trials and for the actual work.
2. Daily progress report with dedtails of weather condition, particular of application no of coats and type of materials applied, anomolies, progress of work versus programme.
3. Result of measurement of temperature relative humidity, surface profile, film thickness, holiday detection, adhesion tests with signature of appropriate authority.
4. Particular of surface preparation and paint application during trials and during the work.
5. Details of non-compliance, rejects and repairs.
6. Type of testing equipments and calibration.
7. Code and batch numbers of paint material used.

TABLE-I (for clause 5.0)
SURFACE PREPARATION STANDARDS

S. No.	DESCRIPTION	VARIOUS INTERNATIONAL STANDARDS (EQUIVALENT)				REMARK
		SWEDISH STANDARD SIS-05-5900 1967	SSPC-SP USA	NACE USA	BRITISH STANDARD BS-4232: 1967	
1.	MANUAL OR HAND TOOL CLEANING REMOVAL OF LOOSE RUST LOOSE MILL SCALE AND LOOSE PAINT, CHIPPING, SCRAPING, SANDING AND WIRE BRUSHING, SURFACE SHOULD HAVE A FAINT METALLIC SHEEN.	ST.2	SSPC-SP-2	-	-	THIS METHOD IS APPLIED WHEN THE SURFACE IS EXPOSED TO NORMAL ATMOSPHERIC CONDITION WHEN OTHER METHODS CANNOT BE ADOPTED AND ALSO FOR SPOT CLEANING DURING MAINTENANCE PAINTING.
2.	MECHANICAL OR OWER TOOL CLEANING REMOVAL OF LOOSE RUST, LOOSE MILL SCALE AND LOOSE PAINT TO DEGREE SPECIFIED BY POWER TOOL CHIPPING, DESCALING, SANDING, WIRE BRUSHING AND	ST.3	SSPC-SP- 3	-	-	**-DO-**

	GRINDIN, AFTER REMOVAL OF DUST, SURFACE SHOULD HAVE A PRONOUNCED METALLIC SHEEN.					

TABLE-I (for clause 5.0)
SURFACE PREPARATION STANDARDS

S. No.	DESCRIPTION	VARIOUS INTERNATIONAL STANDARDS (EQUIVALENT)				REMARK
		SWEDISH STANDARD SIS-05-5900 1967	SSPC-SP USA	NACE USA	BRITISH STANDARD BS-4232: 1967	
3	BLAST CLEANING (AIR & WATER) THERE ARE FOUR COMMON GRADES OF BLAST CLEANING					
3.1	WHITE METAL BLAST CLEANING TO WHITE METAL CLEANLINESS REMOVAL OF ALL VISIBLE RUST, MILL SCALE PAINT & FOREIGN MATTER 100% CLEANLINESS WITH DESIRED SURFACE PROFILE.	SA-3	SSPC-SP-5	NACE#1	FIRST QUALITY	WHERE EXTREMELY CLEAN SURFACE CAN BE EXPECTED FOR PROLONG LIFE OF PAINT SYSTEMS.
3.2	NEAR WHITE METAL BLAST CLEANING TO NEAR WHITE METAL CLEANLINESS, UNIT AT LEAST 95% OF EACH ELEMENTS OF SURFACE AREA IS FREE OF ALL VISIBLE RESIDUES WITH DESIRED SURFACE PROFILE.	SA 2 ½	SSPC-SP-10	NACE #2	SECOND QUALITY	THE MINIMUM REQUIREMENT FOR CHEMICALLY RESISTANT PAINT SYSTEM SUCH AS EPOXY, VINYL, POLYURETHANE BASED AND INORGANIC ZINC SILICATE PAINTS, ALSO FOR CONVENTIONAL PAINT SYSTEM USED UNDER FAIRLY CORROSIVE CONDITIONS TO OBTAIN DESIRED LIFE OF PAINT SYSTEM

TABLE-I (for clause 5.0)
SURFACE PREPARATION STANDARDS

S. No.	DESCRIPTION	VARIOUS INTERNATIONAL STANDARDS (EQUIVALENT)				REMARK
		SWEDISH STANDARD SIS-05-	SSPC-SP USA	NACE USA	BRITISH STANDARD BS-4232: 1967	

		5900 1967				
3.3	COMMERCIAL BLAST BLAST CLEANING UNIT AT LEAST TWO—THIRD OF EACH ELEMENT OF SURFACE AREA IS FREE OF ALL VISIBLE RESIDUES WITH DESIRED SURFACE PROFILE.	SA-2	SSPC-SP- 6	No. 3	THIRD QUALITY	FOR STEEL REQUIRED TO BE PAINTED WITH CONVENTIONAL PAINTS FOR EXPOSURE TO MILDLY CORROSIVE ATMOSPHERE FOR LONGER LIFE OF THE PAINT SYSTEMS.
3.4	BRUSH-OFF BLAST BLAST CLEANING TO WHITE METAL CLEANLINESS, REMOVAL OF ALL VISIBLE RUST, MILL SCALE , PAINT & FOREIGN MATTER, SURFACE PROFILE IS NOT SO IMPORTANT.	SA-1	SSPC-SP-7	No. 4		

6.0 PAINT MATERIALS

Paint manufacturers shall furnish all the characteristics of paint material on printed literature, alongwith the test certificate for all the specified characteristics given in this specifications. All the paint materials shall be of first quality and conform to the following general characteristics as per the table 6.1, 6.2 and 6.3.

PAINT MATERIALS

TABLE NO.: 6.1 PRIMERS

S. No	DESCRIPTION	P-2	P-4	P-6
1.	Technical Name	Chlorinated rubber Zinc Phosphpate primer	Etch primer/ wash primer	Epoxy zinc phosphate primer
2.	Type and composition	Single pack, air drying chlorinated rubber based medium	Two pack polyvinyl butyral resin medium cured with phosphoric acid solution pogmented	Tow component

		plasticised with unsaponlfiable plasticizer, plgmented with Zic phosphate	with zic tetroxy choromate.	polyamide cured epoxy resin medium, pigmented with zinc phosphate.
3.	Volume solids (approx)	40%	7-8%	40%
4.	DFT (Dry dilm thickness) per coat (approx)	40-50µ	8-10µ	40-50µ
5.	Theoretical covering capacity in M2/ coat/ litre (approx)	8-10	8-10	8-10
6.	Welght per litre in kgs/ litre (approx)	1.3	1.2	1.4
7.	Touch dry at 30° C (approx)	30 minutes	2 hrs.	After 30 mins.
8.	Hard dry at 30° C (approx)	Min.: 8 hrs. Max.: no limitation	Min.: 2 hrs. Max.: 24 hrs.	Min.: 8 hrs. Max.:3-6 months
9.	Over Coating Interval (approx.)	Min : 8 hrs Max : No limitation	Min : 4.6 hrs Max : 24 hrs	Min : 8 hrs Max : 3-6 months
10.	Pot life (approx) at 30° C for two component paints (approx).	Not applicable	Not applicable	8 hrs.

PAINT MATERIALS
TABLE NO.: 6.2 FINISH PAINT

S. No	DESCRIPTION	F-2	F-3	F-6	F-7
1.	Technical Name	Acrylic polyurethane finish paint	Chlorinated rubber based finish paint	Epoxy-High build finish paint	High build coaltar epoxy coating.
2.	Type and composition	Two-pack aliphatic isocynate cured acrylic finish paint	Single pack plasticised chlorinated rubber based medium with chemical and weather resistant pigments.	Tow- pack polyamide/ ploymine cured epoxy resin medium suitable pigmented.	Tow pack polyamide cured epoxy resin blended with coal/ tar medium, suitably pigmented.
3.	Volume solids (approx)	40%	40%	62%	65%
4.	DFT (Dry dilm thickness) per coat (approx)	30-40µ	40-50µ	100-125µ	100-125µ
5.	Theoretical covering capacity in M2/ coat/ litre (approx)	10-13	8-10	5-6	5-2-6.5
6.	Welght per litre in kgs/ litre (approx)	1.3	1.2	1.4	1.5
7.	Touch dry at 30° C (approx)	1 hrs.	30 minutes	3 hrs.	4 hrs.

8.	Hard dry at 30° C (approx)	Overnight	8 hrs.	Overnight	48 hrs.
9.	Over Coating Interval (approx.)	Min.: Overnight (12) hrs. Max.: Unlimited	Min.: Overnight Max.: Unlimited	Min.: Overnight Max.: 5 day	Min.: 24 hrs. Max.: 5 day
10.	Pot life (approx) at 30° C for two component paints (approx).	6-8 hrs.	Not applicable	4-6 hrs.	4-6 hrs.

PAINT MATERIALS
TABLE NO.: 6.3 FINISH PAINTS

S. No	DESCRIPTION	F-8	F-9	F-11	F-12
1.	Technical Name	Self priming type surface tolerant high build epoxy coating (Complete rust control coating)	Inorganic Zinc Slicate coating	Heat resistant synthetic medium based two pack aluminum paint suitable upto 250°C dry temperature	Heat resistant silicone aluminum paint suitable upto 500° C temperature
2.	Type and composition	Two-pack epoxy resin based suitable pigmented and capable pigmented and capable of adhering to manually prepared surface and old coating	A two-pack air drying self-curing solvent based inorganic inc silicate coating.	Heat resistant synthetic medium based two pack aluminum paint suitable upto 250°C	Single pack silicone resin based medium with aluminum flakes.
3.	Volume solids (approx)	72%	60%	25%	20%
4.	DFT (Dry dilm thickness) per coat (approx)	100-125µ	65-75µ	20-25µ	20-25µ
5.	Theoretical covering capacity in M2/coat/ litre (approx)	6.0-7.2	8-9	10-12	8-10
6.	Welght per litre in kgs/ litre (approx)	1.4	2.3	1.2	1.1
7.	Touch dry at 30° C (approx)	3 hrs.	30 min.	3 hrs.	30 min.
8.	Hard dry at 30° C (approx)	24 hrs.	12 hrs.	12 hrs.	24 hrs.
9.	Over Coating Interval (approx.)	Min.: 10 hrs. Max.: 6 months	Min.: 8 hrs. at 20°C and 50% RH. Max.: Unlimited	Min.: 16 hrs. Max.: Unlimited	Min.: 16 hrs. Max.: Unlimited
10.	Pot life (approx) at 30° C for two component paints (approx).	90 min.	4-6 hrs.	Not applicable	Not applicable
11.	Temperature resitance	-	-	250° C	500° C

F-14: Specially for mutated polyamine cured coal tal epoxy suitable for-45°C to 125°C for application under insulation
F-15: Two pack cold curved epoxy phenolic coating suitable for 45°C to 125°C for application under insulation
F-16: Epoxy siloxane anser coat 738

Notes:

1. Covering capacity and DFT depends on method of application. Covering capacity specified above are theoretical. Allowing the loose during the application, minimum specified DFT should be maintained.

2. All primers and finish coats should be cold cured and air drying unless otherwise specified.

3. All paints shall be applied in accordance with manufacturer’s instruction for surface preparation, intervals, curing and application. The surface preparation, quality and workmanship should be ensured.

4. Technical data sheets for all paints shall be supplied at the time of submission of quotations.

6.4 List of recommended manufacturers

The paint shall conform to the specifications given above and the best quality in their products range of the manufacturers listed in Annexure-I.

7.0 PAINT SYSTEM

The paint system should vary with type of environment envisaged in and around the plants. Three types of environment as given below are considered for selection of paint system. The paint system is also given for specific requirements.

Primers & finish coats covered in table nos. 7.0 to 15.0

PRIMERS

P-2	:	Chlorinated Rubber Zinc Phosphate Primer
P-4	:	Etch Primer/ Wash Primer
P-6	:	Epoxy Zic Phosphate Primer

FINISH COATS/ PAINTS

F-2	:	Acrylic- Polyurethane finish paint
F-3	:	Chlorinated Rubber Finish Paint
F-6	:	High Build Epoxy finish coating
F-7	:	High Build Coal Tar epoxy coating
F-8	:	Self-priming surface tolerant high build epoxy coating
F-9	:	Inorganic Zinc Silicate Coating.
F-11	:	Heat resistant Synthetic medium based Aluminum paint.

F-12	:	Heat resistant Silicone Aluminum paint.
F-14	:	Specially formulated polyamine-cured coal for Epoxy coating
F-15	:	Epoxy phenolic coating
F-16	:	Epoxy Siloxane Coating : Amercoat 738

TABLE 7.1: PRE-ERECTION/ PRE-FABRICATION AND SHOP PRIMING FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL, STEEL STRUCTURE, PIPING AND EQUIPMENT ETC.

S. No.	DESIGN TEMPERATURE IN °C	SURFACE PREPARATION	PAINT SYSTEM	TOTAL DFT IN MICRONS (MIN.)	REMARKS
7.1.1	-90 TO 4000	SSPC-SP-10	1 COAT OF F-9	65-75	No overcoating is to be done
7.1.2	401 To 500	SSPC-SP-10	1 COAT OF F-12	40-50	FINISH COAT AT SITE

TABLE 7.2: REPAIR OF PRE-ERECTION/ PRE- FABRICATION AND SHOP PRIMING AFTER ERECTION/ WELDING FOR CARBON STEEL LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL, ITEMS IN ALL ENVIRONMENT.

S. No.	DESIGN TEMPERATURE IN °C	SURFACE PREPARATION	PAINT SYSTEM	TOTAL DFT IN MICRONS (MIN.)	REMARKS
7.2.1	-90 TO 400	SSPC-SP-3 (FOR REPAIR ONLY) SSPC-SP-10	1 COAT OF F-9	65-75	FOR DAMAGED AREA OF MORE THAN 5X5 CM.
7.2.2	40 TO 500	SSPC-SP-3 (FOR REPAIR ONLY) SSPC-SP-10	2 COATS OF F-12	40-50	FOR DAMAGED AREA OF MORE THAN 5X5 CM.

TABLE 8.0: FIELD PAINT SYSTEM FOR NORMAL CORROSIVE ENVIRONMENT (FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL)

ALL NORMAL CORROSIVE AREAS SUCH AS OFF SITES EXTERNAL SURFACE OF UNINSULATED COLUMNS, VESSELS, HEAT EXCHANGERS, BLOWERS, PIPING, PUMPS, TOWERS, COMPRESSORS, STRUCTURAL STEEL WORKS, RCC CHIMNEY WITH OR WITHOUT REFRACTORY LINE INSIDE CHIMNEY (ALL ENVIRONMENTS), EXCLUDING TANK TOPS, FLARE LINES, D.M. PLANTS, INTERIOR OF TANKS ETC. FLARE LINES FOR NORMAL CORROSIVE ENVIRONMENT ALSO TO NE PAINTED AS PER TABLE 9.0

S. No.	DESIGN TEMPERATURE IN °C	SURFACE PREPARATION	PAINT SYSTEM		TOTAL DFT IN MICRONS (MIN.)	REMARKS
			FIELD PRIMER	FINISH PAINT		
8.1	-90 TO –15	SSPC-SP-10	REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @65-75µ DFT/ COAT	NONE	65-75	No over coating to be done follow repair procedure only on damaged areas of preerection/ pre-fabrication primer/ coating F-9
8.2	-14 TO 60	SSPC-SP-10	REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75µ DFT/ COAT + 2 COATS OF P-2 @ 40µ DFT/ COAT 2 X 40 = 80	2 COATS OF F-3 @ 40 µ DFT/ COAT 2 X 40 = 80	225	
8.3	61 TO 80	SSPC-SP-10	REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75µ DFT/ COAT + 2 COATS OF P-6 @ 40µ DFT/ COAT 2 X 40 = 80	1 COATS OF F-6 @ 100 µ DFT/ COAT	245	
8.4	81 TO 250	SSPC-SP-10	REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75µ DFT/ COAT	3 COATS OF F-11 @ 20 µ DFT/ COAT 3 X 20 = 60	125	
8.5	251 TO 400	SSPC-SP-10	REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75µ DFT/ COAT	2 COATS OF F-12 @ 20 µ DFT/ COAT 2 X 20 = 40	105	
8.6	401 TO 500	SSPC-SP-10	REPAIR AS PER 7.2.2	2 COATS OF F-12 @ 20 µ DFT/ COAT 2 X 20 = 40	80	

NOTE 1 : FOR MS CHIMNEY OR WITHOUT REFRACTORY LINING 8.3, 8.4 AND 8.5 SHALL BE FOLOWED.

NOTE 2 : FOR EXTENAL SURFACE OF RCC CHMNEY: 2 COATS OF F-6 @ 100 µ DFT/ COAT TO OBBTAIN 2 X 100=200µ SHALL BE APPLIED AFTER MAKING SURFACE PREPARATION AS PER GUIDELINES IN 1.5

NOTE 3 : WHEREVER REQUIRED S.NO. 8.3 SHALL BE USED FOR 14°C TO 80°C AND S.NO. 8.2 WILL BE DELETED.

TABLE 9.0: FIELD PAINT SYSTEM FOR CORROSIVE ENVIRONMENT (FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL)

FOR ALL CORROSIVE AREAS ABOVE GROUND WHERE H_2S, SO_2 FUMES OR SPILLAGE'S OF ACID/ ALKALI/ SALT ARE LIKELY TO COME IN CONTACT WITH SURFACE SUCH AS EXTERNAL SURFACE OF UNINSULATED COLUMNS, VESSELS,HEAT EXCHANGERS, BLOWERS, PIPING, PUMPS, TOWERS, COMPRESSORS, FLARE LINES, STRUCTURAL STEEL ETC.

S. No.	DESIGN TEMPERATURE IN °C	SURFACE PREPARATION	PAINT SYSTEM		TOTAL DFT IN MICRONS (MIN.)	REMARKS
			FIELD PRIMER	FINISH PAINT		
9.1	-90 TO –15	SSPC-SP-10	REPAIR OF PRE-FABRICATIONNPRIMER 1 COAT OF F-9 @ 65-75µ DFT/ COAT	NONE	65-75	Repair of preerection/ pre fabrication primer shall be done wherever damage is observed.
9.2	-14 TO 80	SSPC-SP-10	REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75µ DFT/ COAT + 1 COATS OF P-6 @40 µ DFT/ COAT	1 COATS OF F-6 @ 100µ DFT/ COAT + 1 COAT OF F-2 @ 40µ DFT/ COAT	225	Surface preparation is required only for repairing of damaged preerection/ fabrication primer
9.3	81 TO 400	SSPC-SP-10	REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75µ DFT/ COAT	2 COATS OF F-12 @ 20 µ DFT/ COAT 2 X 20 = 40	105	
9.4	401 TO 500	SSPC-SP-10	REPAIR 2S PER 7.2.2	2 COATS OF F-12 @ 20 µ DFT/ COAT	80	

TABLE 10.0: FIELD PAINT SYSTEM FOR HIGHLY CORROSIVE (FOR CARBON STEEL, LOW TEMPERATURE CARBON STEEL & LOW ALLOY STEEL) EXTERNAL SURFACES OF UNINSULATED COLUMNS, VESSELS, HEAT EXCHANGERS, BLOWERS, PIPING PUMPS, TOWERS, COMPRESSORS, FLARE LINES, STRUCTURE STEEL ETC.

EXPOSED TO SPILLAGE OR FUMES OF HCL H_2S0_4, SALTY WATER IMPINGEMENT, CHLORIDE ETC.

S. No.	DESIGN TEMPERATURE IN °C	SURFACE PREPARATION	PAINT SYSTEM		TOTAL DFT IN MICRONS (MIN.)	REMARKS
			FIELD PRIMER	FINISH PAINT		
10.1	-90 TO –15	SSPC-SP-10	REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 65-75µ DFT/ COAT	NONE	65-75	Repair of pre-erection/ fabrication primer shall be followed. No over coating is allowed
10.2	-14 TO 80	SSPC-SP-10	REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75µ DFT/ COAT + 1 COATS OF P-6 @40 µ DFT/ COAT	2 COATS OF F-6 @ 100µ DFT/ COAT = 2 X 100= 200 + 1 COAT OF F-2 @ 40µ DFT/ COAT	345	Surface preparation is required only for repairing of damaged pre-erection/ fabrication primer.
10.3	81 TO 400	SSPC-SP-10	REPAIR OF PRE-FABRICATION PRIMER 1 COAT OF F-9 @ 65-75µ DFT/ COAT	2 COATS OF F-12 @ 20 µ DFT/ COAT 2 X 20 = 40	105	
10.4	401 TO 500	SSPC-SP-10	REPAIR AS PER 7.2.	2 3 COATS OF F-12 @ 20 µ DFT/ COAT 2 X 20 = 40	80	

TABLE 11.0: FIELD PAINT SYSTEM FOR CARBON STEEL STORAGE TANKS (EXTERNAL) FOR ALL ENVIRONMENTS.

S. No.	DESIGN TEMPERATURE IN °C	SURFACE PREPARATION	PAINT SYSTEM		TOTAL DFT IN MICRONS (MIN.)	REMARKS
			FIELD PRIMER	FINISH PAINT		
1.1 EXTERNAL SHELL. WIND GIRDERS APPARATUSES, ROOF TOPS OF ALL GROUND TANK INCLUDING TOP SIDE OF FLOATING ROOF OF OPEN TANK AS WELL AS COVERED FLOATING ROOF AND ASSOCIATED STRUCTURAL WORK ROLLING AND STATIONARY LADDERS, SPIRAL STAIRWAYS, HAND TAILS FOR ALL ENVIRONMENTS FOR GRUDE OIL, LDO, HSD, ATF KEROSENE, GASOLINE, MOTOR SPIRIT, DM WATER, FIREWATER, RAW WATER, POTABLE WATER, ACIDS, ALKALIS SOLVENTS AND CHEMICALS ETC.						
11.1.1	-14 TO 80	SSPC-SP-10	1 COAT OF F-9 @ 65-75µ DFT/ COAT + 1 COATS OF P-6 @40 µ DFT/ COAT 65 X 40 = 105	1 COATS OF F-6 @ 100µ DFT/ COAT + 2 COATS OF F-2 @ 40µ DFT/ COAT 2 X 40 = 80	285	F-6 should be suitable for occasional water immersion
11.1.2	81 TO 500	SSPC-SP-10	1 COAT OF F-9 @ 65-75µ DFT/ COAT	2 COATS OF F-12 @ 20 µ DFT/ COAT 2 X 20 = 40	105	
11.2 EXTERNAL SURFACE OF BOTTOM PLATE (SOIL SIDE) FOR ALL STORAGE TANKS.						
	-14 TO 80	SSPC-SP-10	1 COAT OF F-9 @ 65-75µ DFT/ COAT	3 COATS OF F - 7 @ 100 µ DFT/ COAT 3 X 100 = 300	365	F7 should be suitable for immersion service of the products given.

TABLE 12.0: FIELD PAINT SYSTEM FOR CARBON STEEL AND ALLOY STORAGE TANK: (INTERNAL)

S. No.	DESIGN TEMPERATURE IN °C	SURFACE PREPARATION	PAINT SYSTEM		TOTAL DFT IN MICRONS (MIN.)	REMARKS
			FIELD PRIMER	FINISH PAINT		
INTERNAL SURFACE OF UNDERSIDE OF FLOATING ROOF, INTERNAL STRUCTURAL OF CONE ROOF, BOTTOM PLATE, ROOF STRUCTURE, STEEL, LADDERS SUPPORTS FOR STORING GRUIDE OIL, LDO AND HSD (EXCLUDING WHITE OIL PRODUCTS)						

12.1	-14 TO 80	SSPC-SP-10	1 COAT OF F-9 @ 65-75µ DFT/ COAT	3 COATS OF F-7 @ 100µ DFT/ COAT 3 X 100 = 300	365	F7 should be suitable for immersion service of the products given.
12.2 BARE SHEEL OF INSIDE FLOATING ROOF TANK AND CONE ROOF TANK FOR PRODUCTS MENTIONED IN 12.1						
12.2.1	-14 TO 80	SSPC-SP-10	PHOSPHATING TREATMENT WITH PHOSPHATING CHEMICALS (2 COATS)	2 COATS OF @10 µ 2 X 10 = 20	20	
12.3 FLOATING CONE ROOF TANKS FOR PETROLEUM PRODUCTS SUCH AS ATF, GASOLINE, NAPHTHA, KEROSENE, MOTOR SPIRIT, INSIDE OF BOTTOM PLATE, UNDERSIDE OF FLOATING ROOF AND SHELL ABOVE MAXIMUM LIQUID LEVEL AND STRUCTURAL STEEL , LADDERS ETC.						
12.3.1	-14 TO 80	SSPC-SP-10	1 COAT OF F-9 @ 65-75µ DFT/ COAT	3 COATS OF F-6 @ 100µ DFT/ COAT 3 X 100 = 300	365	F-6 should be suitable for immersion service of petroleum produce like ATF, Kerosene, petrol etc.
12.4 BARE SHELL OF INSIDE OF FLOATING CONE ROOF TANKS FOR PRODUCTS MENTIONED IN 12.3						
12.4.1	-14 TO 80	SSPC-SP-10	1 COAT OF F-9 @ 65-75µ DFT/ COAT	NONE	65-75	No over coating is allowed same as per pre-erection primer, if any
12.5 INTERNAL PROTECTION IF FIXED ROOF TYPE STORAGE TANKS FOR POTABLE WATER: INSIDE OF SHELL, UNDER SIDE OF ROOF AND ROOF STRUCTURE INSIDE SURFACE BOTTOM PLATE AND STRURAL STEEL WORKS, LADDERS, WALKWAYS, PLATFORMS ETC.						
12.5.1	-14 TO 80	SSPC-SP-10	2 COAT OF F-6 @ 40µ DFT/ COAT 2 X 40 = 80	2 COATS OF F-6 @ 100µ DFT/ COAT 2 X 100 = 200	280	F-6 shall be suitable for immersion service.
12.6 D. M. (DEMINERALISED WATER) AND HYDROCHLORIC ACID (HCL): INTERNAL SHELL, BOTTOM PLATE AND ALL ACCESSORIES						
12.6	1 -14 TO 80	SSPC-SP-10	EBONITE RUBBER LINING AS PER SMMS SPECIFICATION 6-06-204			
12.7 EG TANKS (INTERNAL SHELL, BOTTOM PLATE ROOF AND ALL ACCESSORIES)						
12.7.1	ALL	SSPC-SP-10	3 COATS VINYL CHLORIDE CO-POLYMER AMERCOAT 23 @ 75µ / COAT	225		
12.8 INSIDE PONTOON AND INSIDE OF DOUBLE DECK OF ALL FLOATING ROOFS.						
12.8.1	-14 TO 80	SSPC-SP-3	1 COAT OF F-8 @ 100µ DFT/ COAT	1 COATS OF F-6 @ 100µ DFT/ COAT 1 X 100 = 100	200	
12.9 INTERNAL SURFACE OF AMINE & SOUR WATER STORAGE TANKS						
12.9.1	-14 TO 80	SSPC-SP-10	1 COAT OF F-9 @ 65-75µ DFT/ COAT 2 X 40 = 80	2 COATS OF F-15 @ 75µ DFT/ COAT 2 X 75 = 150	215-225	

TABLE 13.0: COATING SYSTEM FOR EXTERNAL SIDE OF UNDERGROUND CARBON STEEL PLANT PIPING AND TANKS

S. No.	DESIGN TEMPERATURE IN °C	SURFACE PREPARATION	PAINT SYSTEM		TOTAL DFT IN MICRONS (MIN.)	REMARKS
			FIELD PRIMER	FINISH PAINT		
13.1 CARBON STEEL PLANT PIPING (UNDERGROUND)						
13.1.1 YARD COATING						

13.1.1.1	25 TO 60	SSPC-SP-10	1 COAT OF SYNTHETIC FAST DRYING PRIMER TYPE-B AS PER AWWA-C-203 (1991)	4mm THICK COALTAR COATING WRAPPING AS PER AWWA-C-203 IN 2 LAYER OF EACH 2mm THICKNESS	4mm	CTE coating shall confirm to 120/ 5 as per BS: 4164
13.1.2 OVER THE DITCH COATING						
13.1.2.1	25 Tto 60	SSPC-SP-10	1 COAT OF SYNTHETIC FAST DRYING PRIMERTYPE-B AS PER AWWA-C-203 (1991)	2 LAYERS OF COALTAR BASED TAPE COATING AS PER AWWA-C-203	4 mm	
13.2 CARBON STEEL PLANT PIPING (UNDERGROUND)						
13.2.1	61 TO 400	SSPC-SP-10	1 COAT OF F-9 @ 65-75µ DFT/ COAT	NONE	65-75	
13.3 EXTERNAL SIDE OF UNINSULATED UNDERGROUND STORAGE TANKS:						
13.3.1	40 TO 80	SSPC-SP-10	1 COAT OF F-9 @ 65-75µ DFT/ COAT	3 COATS OF F-7 @ 100µ DFT/ COAT 3 X 100 = 300	365	
13.3.2	-90 TO –41 81 TO 400° c	SSPC-SP-10	1 COAT OF F-9 @ 65-75µ DFT/ COAT 1 COAT OF AMERCOAT 738 @ 250µ DFT/ COAT	NONE NONE	65-75 250	

TABLE 14.0 :PAINTING UNDER INSULATION FOR INSULATED (HOT COLD SAFETY CARBON STEEL, LOW ALLOY STEEL, LOW TEMPERATURE CARBON STEEL & STAINLESS STEEL PIPING, STORAGE TANKS EQUIPMENTS IN ALL ENVIRONMENT

S. No.	DESIGN TEMPERATURE IN °C	SURFACE PREPARATION	PAINT SYSTEM		TOTAL DFT IN MICRONS (MIN.)	REMARKS
			FIELD PRIMER	FINISH PAINT		
14.1 INSULATED CARBON STEEL, LOW ALLOY STEEL AND LTCS PIPING AND EQUIPMENT & TANKS						
14.1.1	-4 TO 125	SSPC-SP-10	REPAIR OF PREFABRICATION PRIMER F-9 @ 65- 75µ DFT	2 COATS OF F-14 @ 125µ DFT/ COAT 2 X 125 = 250 OR 3 COATS OF F-15= 3 X 80=240	315	For other temperature ranges no painting is required under insulation.
14.1.2	OPERATING TEMPERATURE –45 TO 125° C BUT DESIGN TEMPERATURE 126-400° C	SSPC-SP-10	REPAIR OF PREFABRICATION PRIMER F-9 @ 65- 75µ DFT	3 COATS OF F-12 @ 20µ DFT/ COAT 3 X 20 = 60	105-115	
14.2 INSULATED STAINLESS STEEL INCLUDING ALLOY-20- PIPING						
14.2.1	BELOW 0° C TO ALL MINUS TEMPRATURE	ALUMINUM SHEETING WITH ALUMINUM FOIL AND CHLORIDE FREE MINERAL SEALANT CONTAINING BARIUM CHROMATE SHALL BE APPLIED				
14.2.2	0 TO 120	SSPC-SP-10 (15-25µ SURFACE PROFILE)	NONE	2 COATS OF F-14 @ 125µ DFT/ COAT 2 X 125 = 250 OR 3 COATS OF F-15= 3 X 80 = 240	250	If the piping & equipments are already erected then surface shall be prepared by cleaning with emery paper and wash/ flush with chloride free DM water followed by wiping with organic solvent
14.2.3	121 TO 500	SSPC-SP-10	NONE	3 COATS OF F-12 @ 20µ DFT/ COAT 3 X 20 = 60	60	No pre erection primer to be applied
14.2.4	501 TO 1000	SSPC-SP-10	NONE	1 COAT OF AMERCOAT 738 @ 150µ DFT/ COAT	150	Only Amorcoat 738 from Amoron is available for this temperature range.

S. No.	DESIGN TEMPERATURE IN °C	SURFACE PREPARATION	PAINT SYSTEM		TOTAL DFT IN MICRONS (MIN.)	REMARKS
			FIELD PRIMER	FINISH PAINT		
14.2.5	CYCLIC SERVICE-196 TO	SSPC-SP-10	NONE	1 COAT OF AMERCOAT 738 @	150	

	480 EXCEPTING –45 TO 120			150µ DFT/ COAT		
14.3 NO PAINTING REQUIRED FOR INSULATED MONEL, IN COLOY AND NICKEL LINES						

TABLE 15.0: INTERNAL PROTECTION OF CARBON STEEL WATER BOXES AND TUBE SHEETS OF COOLERS/ CONDENSERS WATER BOXES, CHANNELS, PARTITION PLATES, END COVERS AND TUBE SHEETS ETC.

S. No.	DESIGN TEMPERATURE IN °C	SURFACE PREPARATION	PAINT SYSTEM		TOTAL DFT IN MICRONS (MIN.)	REMARKS
			FIELD PRIMER	FINISH PAINT		
15.1	Upto 65	SSPC-SP-10	1 COATS OF F-6 @ 40µ DFT/ COAT	2 COATS OF F-7 @ 125µ DFT/ COAT 2 x 125 = 250	290	For C. S.
15.2	Upto 65 NON FERROUS AND BRASS TUBE SHEETS	SSPC-SP-10	1 COATS OF P-4 @ 8µ DFT/ COAT 1 COATS OF P-6 @ 40µ DFT/ COAT	2 COATS OF F-7 @ 125µ DFT/ COAT 2 x 125 = 250	300	FOR NON FERROUS SURFACE

TABLE 16.0 FIELD PAINTING SYSTEM FOR GI TOWERS/ NON-FERROUS TUBE SHEET

S. No.	DESIGN TEMPERATURE IN °C	SURFACE PREPARATION	PAINT SYSTEM		TOTAL DFT IN MICRONS (MIN.)	REMARKS
			FIELD PRIMER	FINISH PAINT		
16.1	Upto 65	SSPC-SP-10	1 COATS OF P-4 @ 8-10µ DFT/ COAT + 1 COAT OF P-6 @ 4µ DFT/ COAT	2 COATS OF F-2 @ 40µ DFT/ COAT 2 x 40 = 250	130	SHADE AS PER DEFENCE REQUIREMENTS
16.2	Upto 65 NON FERROUS AND BRASS TUBE SHEETS	SSPC-SP-10	1 COATS OF P-4 @ 8µ DFT/ COAT 1 COATS OF P-6 @ 40µ DFT/ COAT	2 COATS OF F-7 @ 125µ DFT/ COAT 2 x 125 = 250	300	

17.0 STORAGE

17.1 All paints and painting materials shall be stored only in rooms to be arranged by contractor and approved by Engineer-in-Charge for the purpose. All necessary precautions shall be taken to prevent fire. The storage building shall preferably be separate from adjacent building. A signboard bearing the words "PAINT STORAGE NO NAKED LIGHTHIGHLY INFLAMMABLE" shall be clearly displayed outside.

18.0 COLOUR CODE FOR PIPING

For identification of pipeline, the colour code as per Table 18.1 shall be used. Paint material for color-coding shall be as specified in this standard in clause- 6.0.

18.1 Colour coding scheme for pipe, equipment, machinery & structure:

SR. NO.	DESCRIPTION	GROUND COLOUR	FIRST COLOUR BAND	SECOND COLOUR BAND
18.1.1	ALL KINDS OF WATER			
	DRINKING WATER	Sea Gree	French Blue	Signal Red
	DE-MINERALISED WATER	-do-	Gulf Red	-
	COOLING WATER	-do-	French Blue	-
	BOILER FEED WATER	-do-	Gulf Red	-
	CONDENSATE	-do-	Light Brown	Signal Red
	QUENCH WATER	-do-	Dark Grey	-
	WASH WATER	-do-	Ganary Yellow	-
	PROCESS WATER	-do-	Oxide Red	-
	PROCESS WATER	-do-	Crimson Red	-
	FIRE WATER	Fire red	White	-
	SEA WATER	Sea Green		-
18.1.2	STEAM			
	VERY HIGH PRESSURE STEAM (VHP)	Aluminium to IS2339	Signal Red	-
	HIGH PRESSURE STEAM (SH)	-do-	French Blue	-
	MEDIUM PRESSURE STEAM (SH)	-do-	Gulf Red	
	LOW PRESSURE STEAM (SL)	-do-	Canary Yellow	Canary Yellow
	DILUTION STEAM/ PURGE STEAM	-do-	Grey	
18.1.3	COMPRESSED AIR	Sky Blue	Signal Red	-
	PLANT AIR	-do-	Silver Grey	-
	INSTRUMENT AIR	-do-	French Blue	-
	NITROGEN	Canary Yellow	Black	-
	OXYGEN	-do-	White	-
	CO_2	-do-	Light Grey	-

SR. NO.	DESCRIPTION	GROUND COLOUR	FIRST COLOUR BAND	SECOND COLOUR BAND
18.1.4	GASES			
	FUEL GAS AND SOUR GAS	Canary Yellow	Grey	Dark Violet
	CHARGE GAS	-do-	Signal Red	French Blue
	RESIDUE GAS, LPG	-do-	Oxide Red	White

	ACETYLENE	-do-	Service Brown	-
	SWEET GAS	-do-	Grey	-
18.1.5	ACIDS AND CHEMICALS			
	SULFURIC ACID	DARK Violet	Briliant Green	Light Orange
	NITRIC ACID	-do-	French Blue	-do-
	HYDROCHLORIC ACID	-do-	Signal Red	-do-
	ACETIC ACID	-do smoke	Silver Grey	-do-
	CAUSTIC	Grey	Light Orange	-
	CHLORINE	Canary Yellow	Dark Violet	-do-
18.1.6	HYDRO CARBONS			
	NAPTHAS	Dark Admiralty Grey	Brilliant Green	Black
	PROPYLENE	-do-	-do-	Smoke Grey
	PROPYLENE C.G. (LIQ)	-do-	-do-	Gulf Red
	ETHYLENE GLYCOL	-do-	-do-	-
	ETHYLENE DICHLORIDE	-do-	Gulf Red	-
	BENZENE	-do-	Canary Yellow	-
	BUTADIENE	-do-	Black	
	ETHANE(LIQ)	Dark Admiralty Grey	Light Grey	French Blue
	PROPYLENE(LIQ)	-do-	Signal Red	Black
	ETHYLENE(LIQ)	-do-	Light Grey	Black
	TAR	-do-	Signal Grey	Brilliant Green
	AROMATIC GASOLINE	-do-	Brilliant Green	Canary Yellow
	METHANOL (LIQ)	-do-	White	Gulf Red
	PYROLYSIS GASOLINE	-do-	Brilliant Green	Black
	MIXED C4(LIQ)	-do-	Signal Green	Light Brown
	LPG(LIQ)	-do-	Brilliant Gren	Dark Violet
	KEROSENE	Light Brown	-do-	-
	DIESEL OIL (WHITE)	-do-	-do-	-
	DIESEL OIL (BLACK)	-do-	-	

18.2 The colour code scheme is intended for identification of the individual group of the pipeline. The system of colour coding of a ground colour and colour bands superimposed on it.

18.3 Ground colours as given in Table 18.1 shall be applied throughout the entire length for uninsulated pipes, on the metal cladding & on surfaces covered by Clause 2.2.2, ground colour coating of minimum 2m length or of adequate length not to be mistaken as colour band shall be applied at places requiring colour bands. Colour band(s) shall be applied at the following location.

a. At battery limit points
b. Intersection points & change of direction points in piping ways.

c. Other points, such as midway of each piping way, near valves, junction joints of services appliances, walls, on either side of pipe culverts.

d. For zong stretch/ xard piping at 50M interval.

e. At start and terminating points.

18.4 **Identification Sign**

18.4.1 Flow direction shall be indicated by an arrow in the location stated in Para a,b,c & d and as directed by Engineer-in-charge.

18.4.2 Colours of arrows shall be black or white and in contrast to the colour on which they are superimposed.

18.4.3 Product names shall be marked at pump inlet, outlet and battery limit in a suitable size as approved by Engineer-in-charge.

18.4.4 Size of arrow shall be either of those given in 18.5.

18.5 **Colour Bands**

18.5.1 As a rule minimum width of colour band shall conform to the following table:

Nominal Pipe Size	Width : L(mm)
3” NB and below	25mm
Above 3” NB upto 6” NB	50mm
Above 8” NB upto 12” OD	75mm
Above 12” OD	100mm

Note: For insulated pipes, nominal pipe size means the outside diameter of insulation. Nominal pipe size figures are to be inches.

18.5.2 Colour band(s) shall be arranged in the sequence shown in Table 18.1 and the sequence follows the direction of flow. The relative proportional width of the first colour band to the subsequent bands shall be 4:1, minimum width of any band shall be as per Clause 18.5.1.

18.5.3 Whenever it is required by the Engineer-in-charge to indicate that a pipeline carries a hazardous material, a hazard marking of diagonal strips of black and golden yellow as epr IS:2379 shall be painted on the ground colour.

18.6 Wherever it is required by the Engineer-in-charge to indicate that a pipeline carries a hazardous material, a hazard marking of diagonal strips of black and golden yellow as per IS:2379 shall be painted on the ground colour.

19.0 **IDENTIFICATION OF VESSELS, PIPING ETC.**

19.1 Equipment number shall be stencilled in black or white on each vessel, column, equipment & machinery (insulated or uninsulated) after painting. Line number n black or white shall be stencilled on all the pipelines of more than one location as directed by Engineer-in-charge, size of letters printed shall be as below :

Column & Vessels	-	150mm(high)
Pump, Compressor and other machinery	-	50mm (high)
Piping	-	40-150mm

20.0 **PAINTING FOR CIVIL DEFENCE REQUIREMENTS**

20.1 Following items shall be painted for camouflaging if required by the client.

a. All columns

b. All tanks in offsites

c. Large vessels

d. Spheres

20.2 Two coats of selected finishing paint as per defence requirement shall be applied in a particular pattern as per 20.3 and as per the instructions of Engineer-in-charge.

20.3 **Method of Camouflaging**

20.3.1 Disruptive painting for camouflaging shall be done in three colours in the ratio of 5:3:2 (all matt finish).

Dark Green	Light Green	Dark Medium Brown
5:	3:	2

20.3.2 The patches should be asymmetrical and irregular.

20.3.3 The patches should be inclined at 30 degree to 60 degree to the horizontal.

20.3.4 The patches should be continuous where two surfaces meet at an angle.

20.3.5 The patches should not coincide with corners.

20.3.6 Slits and holes shall be painted and dark shades.

20.3.7 Width of patches should be 1 to 2 meters.

21.0 INSPECTION AND TESTING

21.1 All painting materials including primers and thinners brought to site by contractor for application shall be procured directly from manufacturers as per specifications and shall be accompanied by manufacturer's test certificates. Paint formulations without certificates are not acceptable.

21.2 Engineer-in-Charge at his discretion, may call for tests for paint formulations. Contractor shall arrange to have such tests performed including batchwise test of wet paints for physical & chemical analysis. All costs there shall be borne by the contractor.

21.3 The painting work shall be subject to inspection by Engineer-in-Charge at all times. In particular, following stagewise inspection will be performed and contractor shall offer the work for inspection and approval of every stage before proceeding with the next stage. The record of inspection shall be maintained in the registers. Stages of inspection are as follows:

a. Surface preparation
b. Primer application
c. Each coat of paint

In addition to above, record should include type of shop primer already applied on equipment e. g. Redd oxide zinc chromate or zinc chromate or Red lead primer etc.

Any defect noticed during the various stages of inspection shall be rectified by the contractor to the entire satisfaction of Engineer-in-Charge before proceeding further. Irrespective of the inspection, repair and approval at intermediate stages of work. Contractor shall be responsible for making good any defects found during final inspection/ guarantee period/ defect liability period as defined in general condition of contract. Dry film thickness (DFT) shall be checked and recorded after application of each coat and extra coat of paint should be applied to make-up the DFT specified without any extra cost to owner, the extra cost should have prior approval of Engineer-in-Charge.

21.4 **Primer Application**

After surface preparation the primer should be applied to cover the crevices, corners, sharp edges etc. in the presence of inspector nominated by Engineer-in-Charge.

21.5 The shades of successive coats should be slightly different in colour in order to ensure application of individual coats, the thickness of each coat and complete coverage should be checked as per provision of this specification. This should be approved by Engineer-in-Charge before application of successive coats.

21.6 The contractor shall provide standard thickness measurement instrument with appropriate ranges(s) for measuring. Dry film thickness of each coat, surface profile guage for checking of surface profile in case of blast cleaning. Holiday directors and pinhole detector and positector whenever required for checking in case of immersion conditions.

21.7 Prior to application of paints on surface of chimneys the thickness of the individual coat shall be checked by application of each coat of same paint on M. S test panel. The thickness of paint on test panel shall be determined by using guage such as 'Elkomere'. This thickness of each coat shall be checked as per provision of this specification. This shall be approved by Engineer-in-Charge before application of paints on surface of chimney.

21.8 At the discretion of Engineer-in-Charge, the paint manufacturer must provide the expert technical service at site as and when required. This service should be free of cost and without any obligation to the owner, as it would be in the interest of the manufacturer to ensure that both surface preparation and application are carried out as per their recommendations.

21.9 Final inspection shall include measurement of paint dry film thickness. Adhesion Holiday detection check of finish and workmanship. The thickness should be measured at as many points/ locations as decided by Engineer-in-Charge and shall be within + 10% of the dry thickness, specified in the specifications.

21.10 The contractor shall arrange for spot checking of paint materials for Sp. Gr., flow time (ford cup) and spreading rate.

22.0 **GUARANTEE**

22.1 The contractor shall guarantee that the chemical and physical properties of paint materials used are in accordance with the specifications contained herein/ to be provided during execution of work.

22.2 The contractor shall produce test report from manufacturer regarding the quality of the particular batch of paint supplied. The Engineer-in-Charge shall have the right the test wet samples of paint at random, for quality of same as stipulated in clause 11 above. Batch test report of manufacturer's for each batch paint supplied shall be made available by the contractor.

23.0 **QUALIFICATION CRITERIA OF PAINTING CONTRACTOR**

Painting contractor who is awarded the job under this standard must have necessary equipment's, machinery, tool and tackles for surface preparation, paint application and inspection. The contractor must have qualified trained and experienced surface preparation, paint applicator, inspector, and supervisors. The contractor supervisor, inspector surface perpetrator and paint applicator must be conversant with the standards referred in this specification the contractor's capacity, capability and competency requirements for the job shall be quantified in the tender document and shall be assessed by an REPL team before awarding any job.

24.0 **PROCEDURE FOR APPROVAL OF NEW COATING MATERIALS AND MANUFACTURER'S**

Following procedure is recommended to be followed for approval of new manufacturers.

24.1 The manufacturer should arrange testing of the inorganic zinc silicate coating materials as per the list of tests given in para 24.5 below from one of the reputed Government laboratories.

24.2 Samples of coating should be submitted to the Govt. laboratory in sealed containers with batch no. and test certificate on regular format of manufacturer's testing laboratory. The sampling shall be certificate and sealed by a citifying agency.

24.3 All test panels should be prepared by govt. testing agency coloured photographs of test panels should be taken before and after the test should be enclosed along with test report.

Sample batch. No. and manufacturer's test certificate should be enclosed along with the report. Test reports contain details of observation and rusting if any, as per the testing code.

24.4 Manufacturers should intimate the company, details of sample submitted for testing name of Govt. testing agency, date, contact personnel of the Govt. testing agency. At the end of the test the manufacturer should submit the test report to the company for approval. The manufacturer(s) shall be qualified based on the result of these tests and other assessment and the Company's decision in this regard shall be final and binding on the manufacturer.

24.5 Tests required for evaluation of acceptance of coating materials for offshore application.

Test	ASTM Test Method
Density	D 1475
Dipping properties	D 823
Film Characteristics	
Drying time	D 1640
Flexibility	D 1737/ D 522
Hardness	D 3363
Adhesion	D 2197
Abrasion resistance	D 968/ D 1044
DFT/ Coat AS PER SSPC GUIDELINES	
Storage Stability	D 1849
Resistance to	
Humidity for 2000 hrs.	D 2247
Salt Spray for 2000 hrs.	B 117
Accelerated Weathering	D 822
% Zn in DFT G 53	

24.6 Coating system for panel test shall be decided after discussion with SIPI.

ANNEXURE-I
LIST OF RECOMMENDED MANUFACTURERS

1.0 Asian Paints(I) Ltd.
2.0 Berger Paints Ltd.
3.0 Goodlass Nerlolac Paints Ltd.
4.0 Jenson And Nicholson Paint Ltd & chokuGu Jenson & Nicholson Ltd.
5.0 CDC Carboline Ltd.
6.0 Premier Products Ltd.
7.0 Grand Polycoats
8.0 VCM Polyurethane Paint (for polyurethane Paint only)
9.0 Sigma Coating, Singapore
10.0 Ameron, USA
11.0 Kansai Paint, Japan
12.0 Hempel Paint, USA
13.0 Valspar Corporation, USA
14.0 Courtaulds Coating, UK.

Note: This list subjected to revision based fresh approval which will be intimated to PDD/ Vendor Cell.

ANNEXURE-II
LIST OF RECOMMENDED MANUFACTURER'S PRODUCTS

S. No	MANUFACTURER NAME	P2 CHLORINATED RUBBER Zp PRIMER	P4 ETCH PRIMER/ WASH PRIMER	P6 EPOXY ZINC PH. PRIMER	F9 INORGANIC ZINC SILICATE PRIMER/ COATING
1.	ASIAN PAINTS (I) LTD.	ASIOCHL OR HB. ZN.PH PRIMER RO PC 168	APCONYL WP 636 (PC 335)	APCODUR HB. RO.ZP-PC433	APCOCIL 605
2.	BARGER PAINT LTD.	LINSOL HIGH BUILD ZP PRIMER	BISON WASH PRIMER	EPILUX 610	ZINC ANODE 304
3.	AMERON/GODDLASS NEROLAC PAINTS LTD.	-	AMERCOAT 187	AMERCOAT 71	DIMET COTE-9
4.	JENSON & NICHOSON PAINTS LTD. AND CHOKUGU JENSON NICHOLSON	JENSOLAC CHLORINATED RUBBER HB ZN.PH. PRIMER	J & N ETCH PRIMER	EPILAC ZINC PHOSPHATE PRIMER	-
5.	SHALIMAR PAINTS LTD.	CHIOROKOTE ZINC PHOSPHATE PRIMER GREY	TUFFKOTE ETC PRIMER	EPIGUARD 4 ZINC PHOSPHATE PRIMER GREY	TUFFKOTE ZILICATE TL
6.	SIGMA COATING	SIGMA NUCOL UNICOAT 7321	SIGMA COVER PRIMER (7413)	COLTURE CM PRIMER 7412	SIGMASIL MC (7568)
7.	CDC CARBOLINE LTD.	-	-	CARBOLINE 893	CARBOZINC 11
8.	PRIMER PRODUCTS LTD.	-	-	P-15/3A U-16/92	U17/ 92 ETHYL SILICATE INORGANIC ZINC
9.	CORAMANDEL PAINTS CHEMICALS LTD.	COROCLORE CR HB. ZN. PH. PRIMER	CPC WASH PRIMER	COROPEX EPOXY ZH. PH. HIGH BILD PRIMER	-
10.	ANUPAM ENTERPRISES	ANUCHLOR ZP PRIMER	ANUPRIME 291	ANUPAM ANILICOR A-EZP-500	-

LIST OF RECOMMENDED MANUFACTURER'S PRODUCTS (Contd…)

S. No	MANUFACTURER NAME	P2	P4	P6	F9
11.	GRAND POLYCOATS	GP CHILOROPRIME 601	GP PPRIME 401	-	-
12.	BOMBAY PAINTS LTD. THEMPEL MAKINE PAINTS	HEMPA TEX HIGHBUILD 4633	PENTOLITE WASH PRIMER 8520	HEMPEL'S SHOP PRIMER E-1530	GALVASOL 1570
13.	VANAPRABHA ESTERS & GLYCERIDES	VEGCHLOR HB PRIMER 1143	VEG WASH PRIMER 1181	VEGPOX 1241 Z/ P	-
14.	SUNIL PAINTS AND VARNISHED PVT. LTD.	SUNCHLOR HB ZINC PHOSPHATE PRIMER	SUN WASH	SUNPOXY ZINC PHOSPHATE PRIMER	-
15.	COURTAULDS COATING LTD.	-	-	INTERGARD 251	INTERZINC
16.	MARK-CHEM INCOPORATED, (FOR PHOSPHATING CHEMICAL ONLY)	RUST PREVENTIVE LIQUID DRSAIO			
17.	VCM POLYURETHANE PAINTS (FOR POLY EURETHANE PAINTS ONLY)				
18.	JOTUN PAINTS			EPOXY CQ SPECIAL ZINC PHOSPHATE PRIMER	JOTACOTE – 2
19.	KCC PRODUCTS (KOREA)				EZ 180(N)

LIST OF RECOMMENDED MANUFACTURER'S PRODUCTS (Contd….)

S. No	MANUFACTURER NAME	F2 ACRYLIC-POLY YURETHANE FINISH PAINT	F3 CHLORINATED RUBBER FINISH PAINT	F6 HIGH BUILD FINISH PAINT	F7 HIGH BUILD COAL TAR EPOXY COATING
1.	ASIAN PAINTS (I) LTD.	APCOTHANE CF76 (PC1109)	ASIOCHLOR CF 621 (PC 161)	APCODUR HB COATING 9466	APCODUR CF 300
2.	BARGER PAINT LTD.	BARGER THANE ENAMEL (81)	LINOSOL CHLORINATED RUBBER HB	EPILUX 04 AND 78 HB EPOXY	EPILUX 555

			COATING	COATING	
3.	AMERON/GODDLASS NEROLAC PAINTS LTD.	AMERCOAT 450GL	AMERCOAT 515	AMER COAT 383 HS	AMERCOAT 78 HB
4.	JENSON & NICHOSON PAINTS LTD. AND CHOKUGU JENSON NICHOLSON	J & N 993 HB POLYURETHANE FINISH PAINT.	JENSON HB CHLORINATED RUBBER FINISH PAINT	EPILAC 981 ENAMEL	EPILAC SOLVENTLESS COAT TAR EPOXY COATING
5.	SHALIMAR PAINTS LTD.	SHALITHANE FINISH	CHLORKOTE FINISH	EPIGARD KL FINISH	BIPIGARD'S BLACK HB COAL TAR EPOXY COATING
6.	SIGMA COATING	SIGMADOUR HS SEMIGLOSS 7530	SIGMA NUCOL FINISH 7308	SIGMA COVER CM 7456	COLTURIET TCN 300
7.	CDC CARBOLINE LTD.	CARBOLINE 132	-	CARBOLINE 191	CARBOMASTIC-14
8.	PRIMER PRODUCTS LTD.	U3/ 92 POLYURETHANE	CR-71 FINISH PAINT	42B/ 4A HIGH BUILD EPOXY	350B/ 3A, COAL TAR EPOXY COATING
9.	CORAMANDEL PAINTS CHEMICALS LTD.	-	COROCLORE CR FINISHING	COROPEX EPOXY HB COATING	COROPEX EPOXY COAL TAR COATING
10.	ANUPAM ENTERPRISES	ANUTHANE ENAMEL	ANUCHLOR HB ENAMEL	DURACOAT-6000	COROGUARD
11.	GRAND POLYCOATS	GP COAT 131, 132 GP BOND 141	GP CHILOROGAURD 631	GP GUARD HP 234	POLYGUARD GE

LIST OF RECOMMENDED MANUFACTURER'S PRODUCTS

S. No	**MANUFACTURER NAME**	**F2 ACRYLIC-POLY YURETHANE FINISH PAINT**	**F3 CHLORINATED RUBBER FINISH PAINT**	**F6 HIGH BUILD FINISH PAINT**	**F7 HIGH BUILD COAL TAR EPOXY COATING**
12.	BOMBAY PAINTS LTD. THEMPEL MAKINE PAINTS	PENTATHANE FP 4510	HEMPATEX HIBUILD 4633	HEMPADUR HIGH BUILD 5520	HEMPADUR 1510
13.	VANAPRABHA ESTERS & GLYCERIDES	VEGTHANE FP 3641	VEGCHLOR FP 3140	VEGPOX- 3265 VEGPOX 3562	VEGPOX 4265
14.	SUNIL PAINTS AND VARNISHED PVT. LTD.	SUNTHANE (ALIPHATIC)	SUNCHLOR HB CR COATING	LPOXY HB 'PS 901'	LPOXY BLACK P. S. 551
15.	COURTAULDS COATING LTD.	INTERTHANE	-	INTEGARD EM SERIES	INTERTUF JXA 006/ 007/ 010

16.	MARK-CHEM INCOPORATED, (FOR PHOSPHATING CHEMICAL ONLY)				
17.	VCM POLYURETHANE PAINTS (FOR POLY EURETHANE PAINTS ONLY)	PIPCOTHANE ALIPHATIC POLYURETHANE FINISH PAINT			
18.	JOTUN PAINTS	HARDTOP AS		PENGUARD	JOTAGUARD 85
19.	KCC PRODUCTS (KOREA)			KOPOX TOPCOAT HB ET 5740	EH 173

LIST OF RECOMMENDED MANUFACTURER'S PRODUCTS

S. No	**MANUFACTURER NAME**	**F-8 EPOXY MASTIC COATING SURFACE TOLERANT**	**F-11 HEAT RESISTANCE SYNTHETIC MEDIUM ALUMINUM PAINT**	**F-12 HEAT RESISTANCE SILICON AL. PAINT**
1.	ASIAN PAINTS (I) LTD.	APCODOR CF 640	ASIAN HR ALUMINUM PAINT (PC 300)	HR SILICON ALUMINUM PAINT (PC 189)
2.	BARGER PAINT LTD.	PROTECTOMASTIC	FERROLOT HR ALUMINUM PANT	BARGER HEAT RISISTANT SILICON ALUMINUM PAINT
3.	AMERON/GODDLASS NEROLAC PAINTS LTD.	AMERLOCK 400		AMERCOAT 878
4.	JENSON & NICHOSON PAINTS LTD. AND CHOKUGU JENSON NICHOLSON	-	FERROTECT SYNTHETIC RUBBER H/R ALUMINUM PAINT 4000	FERRLOTECT SILICON HEAT RESISTANCE 1000
5.	SHALIMAR PAINTS LTD.	EPIPLUS 56	HEAT RESISTING LUSTROL ALUMINUM	LUSTOTHERM HIGH TEMP ALUMINUM PAINT
6.	SIGMA COATING	SIGMA ETPC ALUMINUM	HIGH TEMPERATURE RESISTANT EPOXY SUSTEM UPTO 200° C 4062	AROSTA FINISH HR
7.	CDC CARBOLINE LTD.	CARBOMASTIC-15	CARBOLINE 1248	CARBOLINE 4674
8.	PRIMER PRODUCTS LTD.	HB EPOXY MATIC 150B/ 150A		

9.	CORAMANDEL PAINTS CHEMICALS LTD.	-	SILVOTOL HR ALUMINUM PAINT	CPC SILICONE HR ALUMINUM PAINT
10.	ANUPAM ENTERPRISES	ANUMASTIC-102	-	ANUPAM HEAT GUARD

LIST OF RECOMMENDED MANUFACTURER’S PRODUCTS

S. No	**MANUFACTURER NAME**	**F-8**	**F-11**	**F-12**
11.	GRAND POLYCOATS	GP PRIME GUARD 235		-
12.	BOMBAY PAINTS LTD. THEMPEL MAKINE PAINTS	HEMPADUR 1708	KANGAROO HHR ALUMINUM 4950	HEMPADUR HIGH BUILD 5520
13.	VANAPRABHA ESTERS & GLYCERIDES	VEGEPOX MASTIC 2255	VEG HR AL PAINT TO IS211339	VEG HHR AL PAINT TO 600°C
14.	SUNIL PAINTS AND VARNISHED PVT. LTD.	LPOXY HIGHBUILD P.S.901	-	-
15.	COURTAULDS COATING LTD.	INTERPLUX	-	INTERTHERM 50
16.	MARK-CHEM INCOPORATED, (FOR PHOSPHATING CHEMICAL ONLY)			
17.	VCM POLYURETHANE PAINTS (FOR POLY EURETHANE PAINTS ONLY)	-		
18.	JOTUN PAINTS	JOTUMATIC 87		SOLVELITT HEAT RESISTANT SILICON PAINT
19.	KCC PRODUCTS (KOREA)	EH 4158H		QT 606

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SPECIFICATION

FOR

REPAIR OF PIPELINE CORROSION COATING

SPECIFICATION NO. SIPI/Steel/TS/08

C O N T E N T S

1.0 **SCOPE** :

This specification covers the minimum requirement of material and equipment, installation procedure and inspection of repair of damaged polyethylene coatings on steel pipes.

1.1 The repair shall be carried out using repair patch made of radiation cross linked Polyolefin backing, coated on the inside with semi-crystalline thermoplastic Adhesive and filler mastic

2.0 MATERIAL AND EQUIPMENT

2.1 CONTRACTOR shall supply all equipment and manpower required for a skillful and adequate application in the field in accordance with the specification.

2.2 The repair material shall be :

- Repair patch shall be cross linked polyolefin with semi-crystalline thermoplastic adhesive (PERP patch make of RAYCHEM or equivalent).
- Filler mastic : PERPFILLER make of RAYCHEM or equivalent.

2.3 The material shall not be older than their period of validity at the time of Application by CONTRACTOR. Deteriorated/decomposed materials shall not be used.

2.4 Material shall be stored in sheltered storages in the manufacturer's original packing and away from direct sunlight and in accordance with manufacturer's recommendations.

3.0 **APPLICATION PROCEDURE**

Application procedure shall be as per manufacturer's recommendations and as per the following guidelines (ref. Fig: 1)

Preparation : Remove coating from damaged area with knife, scraper or power brush. Scrap off the damaged area and adjacent coating to remove oil, grease, ruse dirt and moisture.

Preheating : Preheat the exposed bare metal surface to about 60°C and adjacent pipe coating to about 47°C with a torch moved back and forth over the surface.

Application of the Filler : Plastic filler shall be applied to all exposed metal surface. The mastic is heated and smoothed down with a paint scraper to cover all bare metal in a manner such that all entrapped air is removed.

Application of repair tape : Cut a patch from the tape in a manner such that it extends 50 mm beyond the damaged area, position it over the damaged area, heat until the temperature sensitive

paint on the outside of the patch changes colour. It shall be smoothed down to confirm with the contour of lap, and shall be freed of any air bubbles or wrinkles.

For cosmetic type of defects such as minor gauging tearing, scratches which do not indicate holiday during holiday inspection, following procedure shall be adopted :

The defect area shall be roughened to remove loose polyethylene coating, oil grease, dirt etc.

This shall be followed by application of repair patch as described above.

4.0 INSPECTION, TEST

A visual inspection shall be carried out for the following:

- Mastic extrusion on ends of the patch shall be examined.
- There shall be no sign of punctures or pin holes or bend failure. The external appearance of the patch shall be smooth, free from dimples, air entrapment or void formation.
- The entire repair patch shall have changed colour uniformly.

5.0 HOLIDAY INSPECTION

The holiday detector used shall be checked and calibrated easily with an accurate D.C. Voltmeter. The detector electrode shall be in direct contact with the surface of coating to be inspected.

The entire surface of the repaired 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 repaired patch shall be conducted only after it has cooled below 50°C.

No repaired point shall be covered or lowered in the trench until it has been approved by the COMPANY.

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SPECIFICATION

FOR

PIPELINE MARKERS

SPECIFICATION NO. SIPI/Steel/TS/09

C O N T E N T S

1.0 SCOPE

1.1 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 cross-country pipeline.

1.2 This specification shall be read in conjunction with the conditions of all specifications and documents included in the CONTRACT between COMPANY and CONTRACTOR.

2.0 REFERENCE CODES

Reference has been made in this specification to the latest revision of the following code :

API RP 1109 : Recommended practice for marking liquid petroleum pipeline facilities.

3.0 GENERAL

3.1 CONTRACTOR shall supply, fabricate and install the pipeline markers along the pipeline route. The locations of markers as indicated in the approved drawings shall be treated for guidance purposes only and the exact location of the markers shall be based on AS BUILT drainage and as directed by COMPANY.

3.2 The pipeline markers shall be fabricated and installed in accordance with the SIPI 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.

3.3 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.

4.0 AERIAL MARKERS

Aerial markers shall in general in installed along the pipeline at every five (5) kilometres intervals and at places specified by COMPANY. Refer SIPI Standard Drawing for details.

5.0 KILOMETRE MARKERS

Kilometre markers shall in general be installed along the pipeline between the aerial markers 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 SIPI Standard Drawing for details.

6.0 PIPELINE WARNING SIGN

Pipeline Warning Sign shall in general be installed at

- National and State Highway Crossings (2 Nos.)
- Other Road Crossings (1 No.)
- Railway Crossings (2 Nos.)
- 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.

7.0 ROW BOUNDARY MARKERS

Right-of-Way boundary markers shall be fabricated and installed as per the drawings at every 250 metres interval along the entire pipeline route. These shall be installed on either side of the pipeline alignment to define the ROW boundary limits. These shall also be installed at pipeline turning points to maintain the continuity of the ROW limits.

8.0 DIRECTION MARKERS

Direction markers as shown in SIPI Standard Drawing No. shall be installed to identify the significant turning points of the pipeline during aerial traverse. One direction marker shall be installed at each turning point, in addition, two more direction markers shall be installed along the pipeline alignment, one on either side of the turning point at 200m from the turning point.

9.0 NAVIGABLE WATERWAY PIPELINE CROSSING WARNING SIGN

The Navigable Waterway Pipeline Crossing Warning Sign shall be fabricated in accordance with SIPI Standard Drawing No. Such Warning Sign shall be installed one on each bank of navigable water courses at the pipeline crossing location, in lieu of the Pipeline Warning Sign described in clause 6.0 of this specification

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SPECIFICATION

FOR

FLUSHING AND TESTING

SPECIFICATION NO. SIPI/Steel/TS/10

C O N T E N T S

1.0 SCOPE

This specification covers the general requirements for Inspection, flushing and testing of piping systems.

Flushing and testing of all piping system shall be witnessed by the Engineer-in- Charge.

2.0 Inspection

During various stage and after completion fabrication and erection, the piping system shall be inspected by the Engineer- in - Charge to ensure that :

- Proper piping material has been used.
- Piping has been erected as per drawings and the instruction of the engineer- in charge.
- All supports have been installed correctly.
- Test preparations mentioned in this specification have been carried out.

3.0 Flushing

Flushing of all lines shall be done before pressure testing. Flushing shall be done by fresh potable water or dry compressed air, wherever water flushing is not desirable, to clean the pipe of all dirt, debris or loose foreign materials.

Required pressure of water, flushing shall meet the fire hydrant pressure or utility water pressure. For air flushing the line, system will be pressurised by compressed air at the required pressure which shall be 50 psi maximum. The pressure shall then be released by quick opening of a valve, already in the line for this purpose. This procedure shall be repeated as many times as required till the inside of the pipe is fully cleaned.

In line instruments like control valves, orifice plates, rotameters, safety valves and other instruments like thermowells which may interfere with flushing shall not be included i m the flushing circuit.

From all permanent strainers the screens/meshes shall be removed before flushing. Screens/meshes shall be re- installed after flushing but before testing. In case an equipment such as column, vessel, exchanger etc. forms part of a piping circuit during flushing, this shall be done with the approval of Engineer- in - Charge. However equipment thus included in the circuit, shall be completely cleaned and dried with comprssed air, after flushing is completed. During flushing discharged water/air shall be drained at the place directed the Engineer- in - Charge. If necessary, proper temporary drainage shall be provided by the contractor.
Care shall be taken during flushing so as not to damage/spoil work of other agencies. Precautions shall also be taken to prevent entry of water/foreign matter into equipment, electric motors, instruments, electrical installations etc. in the vicinity of lines being flushed.

The contractor shall carry out all the activities required before, during and after the flushing operation, arising because of flushing requirements, such as but not limited to the following.

Dropping of valves, specials, distance pieces, online instruments and any other piping part before flushing. The flanges to disengaged for this purpose shall be envisaged by the contractor and approved by the Engineer-in-Charge. These flanges shall be provided with temporary gaskets at the time of flushing.

After flushing is completed and approved, the valve, distance pieces, piping specials etc. shall be re-installed by the contractor with permanent gaskets. However, flanges of equipment nozzles and other places where isolation is required during testing, only temporary gaskets shall be provided.

Records in triplicate shall be prepared and submitted by the Contractor for each piping system for the flushing done.

4.0 Testing

4.1 Extent of testing

With the exclusion of instrumentation. piping system fabricated or assembled in the field shall be tested irrespective of whether or not they have been pressure tested prior to site welding of fabrication.

To facilitate the testing of piping systems, vessels and other equipments may be included in the system with the prior approval of Engineer-in-charge, if the test pressure specified is equal to or less than that for the vessels and other equipments.

Pumps, compressors and other votary equipments shall not be subjected to field test pressures.

Lines which are directly open to atmosphere such as vents, drains, safety valves, discharge need not be tested, but all joints shall be visually inspected wherever necessary such lines shall be tested by continuous flow of fluid to eliminate the possibility of blockage. However, such lines if provided with block valve shall be pressure tested upto the first block valve.

Seats of all vales shall not be subjected to a pressure in excess of the maximum cold welding pressure of the valve. Test pressure applied to vales shall not be grater than the manufacturer is recommendation nor less than that required by the applicable code. Where desirable set pressure is less than test pressure, test shall be made through an open valve.

Instruments in the system to be tested, shall be excluded from the test by isolation or removal, unless approved otherwise by the Engineer-in-charge. Restrictions which interfere with filling, venting and drawing such as orifice plates etc. shall not be installed unless testing is complete.

Control valves shall not be included in the test system. Where by-passes are provided test shall be performed through the by-pass end/or necessary spool shall be used in place of the control valve.

Pressure gauges which are part of the finished system, but cannot withstand test pressure shall not be installed until the system has been tested. Where piping systems to be tested are directly connected at the battery limits to piping for which the responsibility tests with other agencies, the piping to be tested shall be isolated from such piping by physical disconnection such as valves or blinds.

4.2 General Requirement/Test preparation for Testing

Test shall be carried out with permanent gaskets installed unless specified otherwise or instructed by the Engineer-in- charge.

No pressure test shall be carried out against close valve unless approved by the Engineer-in-charge.

The Engineer-in-charge shall be notified in advance by the contractor, of the testing sequence and programme, to enable him to be present for witnessing the test. The contractor shall be fully responsible for making arrangements with the local boiler inspector to witness the tests for steam lines falling under IBR. IBR certificates for these tests shall be obtained in the relevant IBR forms and furnished to the Engineer-in-charge. Before testing, all piping shall be cleaned by flushing to make it free from dist loose scale, debris and other loose foreign materials.

All piping systems to be hydrostatically tested shall be vented at the high points and the systems purged of air before the test pressure is applied.

Wherever in the line any void is existing due to any reasons, for absence of control valve, safety valve, check valves etc. it shall be filled with temporary spools.

All joints welded, screwed or flanged shall be left exposed for examination during the test. Before pressuring the lines, each weld joint shall be cleaned by wire brush to free it from rest and any other foreign matter.

Where a system is to be isolated of a pair of companion flanges, a blank shall be inserted between the companion flanges. Minimum thickness of the blank shall be designed in accordance with applicable design code.

Open ends of piping system where blanks cannot be used, such as pumps, compressors, turbines or wherever equipment or pipe spool have been receivered or disconnected prior to hydrostatic testing, shall be blinded – off by using standard blind flanges of same rating as the piping system being tested.

Pressure gauges used in testing shall be installed as close as possible to the lowest point in the piping system to be tested, to avoid overstressing of any of the lower portion of the system. For longer lines and vertical lines, two or more pressure gauges shall be installed at locations selected by the Engineer-in-charge. For lines containing check valves any of

the following alternatives shall be adopted for pressure testing. Wherever possible pressurize up-stream side of valve.

Replace the valve by a temporary spool and re-install the valve after testing.

Provide blind on valve flanges and test the upstream and downstream of the line separately and remove the blind after testing. All these flanges, temporary gaskets shall be provided during testing and shall be replaced by permanent gaskets subsequently. For check valves in lines 1-1/2" and below, flapper or seat shall be removed during testing (if possible). After completion of testing the flopper/ seat shall be refitted.

Gas lines when hydrostatically tested shall be provided with additional temporary supports during testing as directed by Engineer-in-charge.

Piping which is spring or counter – weight supported shall be temporarily supported, where the weight of the fluid would overload the support. Retaining pins for spring supports shall be removed only after testing is completed and test fluid is completely drained.

When testing any piping system, air or steam of approximately 2 kg/cm$_2$ (g) may be used as preliminary test to detect missing gaskets etc. as this avoids the necessity of purging the gas to make repairs. However, this method may not be used for this purpose, if the steam temperature is more than the design temp. of the line.

For jacketed pipes testing of core pipes shall be done on individual pieces where the pipe is continuously packed, before it is jacketed. The outer jacket shall be tested separately as a system for piping with discontinuous jacketing, the eore pipe and the jacket shall be tested as separate system.

4.3 Testing Modes, Test pressure and Test Pressure Gauges

4.3.1 Testing Modes

In general all pressure test shall be hydrostatic using iron free water, which is clean and free of silt. Maximum clorine content in water for hydrostatic testing for MS piping shall be 15-20 ppm. Air shall be used for testing only if water would cause corrosion of the system or overloading of supports etc. in special cases as directed by Engineer-in-charge. Where air/water tests are undesirable substitute fluid such as gas, oil, methanol etc. shall be used as the testing medium, with due consideration to the hazards involved. These test fluids shall be specified in the line list given to the contractor.

4.3.2 Test Pressure

The hydrostatic/pneumatic test pressure shall be as indicated in the line list or as per the instruction of Engineer-in-charge.

The selection of the piping system for one individual test shall be based on the following:-

Test pressure required as per line list.

Maximum allowable pressure for the material of construction of piping depending upon the above requirements and based on construction progress, maximum length of piping shall be included in each test.

4.3.3 Test Pressure Gauge

All gauge used for field testing shall have suitable range so that the test pressure of the various system falls in 40% to 60% of gauge scale range. Gauge shall be of a good quality and in first class working condition.

Prior to the start of any test or periodically during the field test programmes, all test gauges shall be calibrated using a standard dead weight gauge tester or other suitable approved testing apparatus. Any gauge having an incorrect zero reading or error of more than ± 2% of full scale range shall be discarded. The Engineer-in-charge shall check the accuracy of master pressure gauge used for calibration.

4.4 Testing Pressure

4.4.1 Hydrostatic Test

All vents and other connections used as vents shall be kept open while filling the line with test fluid for complete removal of air. For pressurizing and depressurizing the system, temporary isolating valves shall be provided if valves, vents, drains do not exist in the system.

Pressure shall be applied only after the system/line is ready and approved by the Engineer-in-charge.

Pressure shall be applied by means of a suitable test pump or other pressure source which shall be isolated from the system as the desired test pressure is reached and stabilized in the system.

A pressure gauge shall be provided at the pump discharge for guiding the system to the required pressure.

The pump shall be attended constantly during the test by an authorized person. The pump shall be isolated from the system wherever the pump is to be left unattended.

Test pressure shall be maintained for a sufficient length of time to permit through inspection of all joints for leakage or signs of failure. Any joint found leaking during a pressure test, shall be re-tested to the specified pressure after repair. Test period shall be maintained for a minimum of three hours. The pump and the piping system to be tested are to be provided with separate pressure indicating test gauges. There gauges are to be checked by the standard test gauge before each pressure test.

Care shall be taken to avoid increase in the pressure due to atmospheric variation during the test.

4.4.2 Air Test

When testing with air, pressure shall be supplied by means of a compressor. The compressor shall be portable type with a receiver after cooler & oil separator.

Piping to be tested by air shall have joints covered with a soap and water solution so that the joints can be examined for leaks.

All other activities shall be same as per hydrotesting procedure (specified above).

4.5 Completion of Testing

After the hydrostatic test has been completed, pressure shall be released in a manner and at a rate so as not to endanger personnel or damage equipments.

All vents and drains shall be opened before the system is to be drained and shall remain open till all draining is complete, so as to prevent formation of vacuum in the system. After draining lines/systems shall be dried by air.

After testing is completed the test blinds shall be removed and equipment/piping isolated during testing shall be connected using the specified gaskets, bolts and nuts. These connections shall be checked for tightness in subsequent pneumatic tests to be carried out by the contractor for complete loop/circuit including equipments (except rotary equipments).

Pressure tests shall be considered complete only after approved by the Engineer-in-charge. Defects, if any, noticed during testing shall be rectified immediately and retesting of the system/line shall be done by the contractor at his cost.

4.6 Test Records

Records in triplicate shall be prepared and submitted by the contractor for each piping system, for the pressure test done in the proforma as given in Exhibit `F'.

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SPECIFICATION

FOR

CASING INSULATORS AND END SEALS

SPECIFICATION NO. SIPI/Steel/TS/11

C O N T E N T S

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

2 Manufacturer shall obtain prior approval from COMPANY on casing insulators drawings/designs.

4.0 MATERIAL

Casing insulators shall be made of injection molded 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
Compresssive strength	3200 psi	D-695i
Tensile strength	3100-5000	D-638, D-651
Impact strength	4.Oft. 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.

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-seal shall be made of head shrink high density radiation crosslinked 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:

Property		Minimum Value	Test Method
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 Poin	90°C	ASTM E-28
	Lap Shear	60°C - 25 psi 23°C - 250 psi (2 inch/min)	ASTM D-1002
c)	System (as applied)		
	Peel strength (To casing and carrier pipe and closure patch)	5 pli (10 inch/min.)	ASTM 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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SPECIFICATION

FOR

FIELD JOINT COATING
(ON-SHORE PIPELINE)

SPECIFICATION NO. SIPI/Steel/TS/12

CONTENTS

1.0 SCOPE

This specification covers the minimum requirements of materials, equipment and installation of field joint anti-corrosion coating of buried onshore pipelines factory coated with either three layer polyethylene or fusion bonded epoxy coating, by heat shrink wraparound sleeves or by cold applied tapes 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 section of this specification shall apply to all specifications referred in this specification.

2.0 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 Stubstrates 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 calibation 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.

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.

3.0 MATERIALS AND EQUIPMENT

3.1 Field Joint Corrosion Coating Material

Field joint anti-corrosion coating material shall be either heat shrinkable wraparound sleeve or cold applied tape suitable for a maximum operating temperature of (+) 60°C (T_{max}) and shall conform to designation EN 12068 – C HT 60 UV. In addition the field joint anti-corrosion coating shall comply the requirements specified in para 3.2 of this specification.

3.1.1 Heat Shrinkable Wraparound Sleeve

Heat shrinkable wraparound 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 thermochrome paint which will change colour when the desired heat during shrinking is 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		
	Average	**Min.**	**On Weld Bead(Min.)**
Upto 10¾” (273.1mm)	2.0	1.8	1.6
Over 10¾” (273.1mm) to below 20” (508.0mm)			

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.

3.1.2 Cold Applied Tapes

Cold applied tapes 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. 1.0mm. 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 2.5mm on the weld.

The Contractor shall propose only those cold applied tape coating systems that have been previously used in pipelines of similar size and operating conditions.

3.2 Functional Requirements of Field Joint Coating

3.2.1 Properties of the PE backing shall be as follows:

Sl. No	Property	Unit	Requirement	Test Method
a)	Tensile Strength at @+25°C	N/mm2	≥12	EN 12068
b)	Ultimate Elongation @+ 25°C	%	≥250	EN 12068
c)	Dielectric withstand with 1000 Volts/sec	kv	≥30	ASTM D 149
d)	Water absorption @+ 25°C for 24 hours	%	≤0.05	ASTM D 570
e)	Volume Resistivity @+25°C	Ohm-cm	≥10^15	ASTM D 257

3.2.2 Functional Properties of Joint Coating System (As applied)

As applied field joint coating system shall comply the requirements of EN 12068. Table 1 and 2 corresponding to designation EN 12068 – C HT 60 UV, except as modified below:

1.1 Cathodic Disbondment Resistance at Tmax i.e. 60°Cshall be 20mm when tested as per Annexure K of EN 12068. Test shall be carried out at (+) 60°C.

a. Peel Strength shall be as follows:

Peel Strength		Unit	Requirement for SIPI Resistance Class C (Minimum)	Test Method as per EN 12068
Inner to Inner + Outer to Inner	@23°C	N/mm	1.5	
	@T_{max}	N/mm	0.3	
Outer to Outer	@23°C	N/mm	1.5	
	@T_{max}	N/mm	0.3	
To Pipe Surface	@23°C	N/mm	3.5	
	@T_{max}	N/mm	0.3	
To Factory Coating	@23°C	N/mm	3.5	
	@T_{max}	N/mm	0.3	

(T_{max} shall be (+) 60°C)

Contractor shall obtain prior approval from Company regarding the manufacturer of the joint coating material. Complete technical details along with test certificates complying with the requirements of clause 3.2.1 and 3.2.2 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.

3.3 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.

3.4 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 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.

3.5 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.

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

3.7 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.

d) Roughness profile measuring (Stylus) instrument.

4.0 APPLICATION PROCEDURE

4.1 General

4.1.1 The application procedure shall be in accordance with manufacturer's instruction and the minimum requirements specified below whichever are 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.

4.1.2 Operators for coating application shall be given necessary instructions and training before start of work, by the CONTRACTOR. To verify and qualify the application procedures, all coating applied during the qualification test, shall be removed for destructive testing as detailed subsequently in this specification. Contractor shall only utilize those operators who have been approved/ prequalified by the field joint coating manufacturer.

4.1.3 Oil, grease, 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-SP 1 shall be followed.

4.1.4 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. During blast cleaning the pipe surface temperature shall be simultaneously more than 5° and more than 3°C above 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 2½ in accordance with Swedish Standard SIS-055900 with a roughness profile of 50-70 microns. Surface roughness profile shall be measured using an approved profile comparator in accordance with ISO 8503-1 and shall be calibrated prior to the start of the work in accordance with ISO:8503-3 or ISO:8503-4. The blast cleanliness shall be checked on every joint and the roughness profile shall be checked 1 every 10 joints.

Dust girt 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.

4.1.5 The field joint surface shall be inspected immediately after blast cleaning and any feature of the steel surface such as weld spatter, scabs, laminations, or other imperfections considered injurious to the coating integrity made visible during blast cleaning shall be reported to the 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.

4.1.6 The ends of existing pipe protective coating shall be inspected and chamfered. Unbounded portions of the coating shall be removed and then suitably trimmed. Portions where parent coating is removed shall be thoroughly cleaned as specified. The adjacent chamfered areas of the line pipe coating shall be cleaned and abraded, to expose a clean uniform fresh surface of uncontaminated factory applied coating.

4.1.7 All steel joint surfaces shall be thoroughly examined before the application of the coating in order to ensure the surfaces are free of oil, grease, rust, mud, earth or any other foreign matter. All these substances shall be removed before coating, to the procedures herein described.

4.1.8 Protection coating shall be applied on the joints immediately after the completion of cleaning operation.

4.2 Application of Heat Shrink Wraparound / Sleeves

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

4.2.1 The wrap around sleeve shall be of a size such that a minimum overlap of 50mm before applying is ensured (after shrinking) on both sides of the yard applied corrosion coating of pipes.

In the cases where carrier pipe is installed by direct boring/ jacking, the overlap on the mill coating for the leading edges of the joints shall be minimum 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.

4.2.2 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. Temperature indicating crayons shall not be used Pre-heat temperature shall be checked on every joint. Care shall be taken to ensure that the entire circumference of the pipe is heated evenly. Temperature measuring instruments shall be calibrated immediately before the start of the works and thereafter at intervals recommended by the manufacturer of the instrument.

4.2.3 Upon pre-heating the pipe surface shall be applied with two pack epoxy primer of wet film thickness 100 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 or every joint with a wet film thickness gauge prior to installation of sleeve. Thickness gauge shall be calibrated once per shift.

4.2.4 Immediately after application of epoxy primer, the wraparound sleeve shall be entirely wrapped around the pipe within the stipulated time recommended by the manufacturer. Sleeve shall be positioned such that the closure patch is located to one side of the pipe in 10 or 2 O'clock position, with the edge of the undergoing layer facing upward and an overlap of min. 50mm. Gently heat by appropriate torch the backing and the adhesive of the closure and press it firmly into place.

4.2.5 A heat shrinking procedure shall be applied to shrink the sleeve in such a manner to start shrinkage of the sleeve beginning from the 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 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.

4.3 Application Procedure for Corrosion Protection Tapes

4.3.1 Cold applied joint protection tapes shall be of the type which can be applied by spirally wrapping on the pipe.

4.3.2 Immediately after the completion of surface preparation the approved primer of wet film thickness 100 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.

4.3.3 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. Sufficient tension shall be applied to ensure good conformity, avoiding air pockets and also continuously smooth out as the wrapping proceeds. The wrapping shall start and finish to give a minimum of 50mm overlap on to the adjoining yard applied coating. Outer wrap shall be applied in similar method.

4.4 **Pre-Qualification of Field Joint Coating System**

The field joint coating system materials and the procedures proposed by the Contractor shall be pre-qualified during the sleeve installation start-up phase. Five joints (5) shall be coated with the requirements of this specification and then inspected and tested in accordance with the requirements of this specification with respect to the following:

- Surface preparation cleanliness, roughness profile and dust contamination
- Pre-heat temperature (as applicable)
- Primer thickness
- As applied coating thickness
- Holiday detection
- Peel test at (+) 23°C & (+) 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. Peel test will be at 10 joints and per day team production.
- Visual appearance and void after installation on the body, area adjoining the weld and area adjoining the factory applied coating. (To establish voids adjoining the weld and factory coating a strip of 50mm wide and 200mm long shall be stripped and examined).

Company Representative shall witness the tests and inspection. Regular application of field joint coating shall commence only upon successful completion of the prequalification testing.

After successful completion of the pre-qualification testing as above, the entire field joint coating shall be removed, the pipe surface re-blasted and field joint coating re-applied as per the requirements of this specification.

5.0 **INSPECTION & TESTING**

5.1 Visual Inspection

Visual inspection of the as applied coating shall be carried out on every joint, for the following:

- Mastic extrusion on either ends of the sleeve shall be examined.

- There shall be no sign of punctures or pinholes or bend failure. The external appearance of the sleeve shall be smooth, free of dimples, air entrapment or void formation. All sleeves shall be tested for the presence of voids by knocking on the sleeves. A hollow sound compared to the remainder of the sleeve may indicate the presence of voids under the sleeve. Such sleeve shall be tested for adhesion at the discretion of the Company Representative.

- Weld bead profile shall be visible through the sleeve.
- Visual indicator provided on the backing and the closure patch showing desired heat is achieved.

5.2 Holiday Inspection

The 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 applicable as per the requirements of factory applied mainline coating specification of Company. Inspection of the sleeves shall be conducted only after the joint has cooled below 50°C. The holiday detector used shall be checked and calibrated daily with an accurate DC voltmeter. The detector electrode shall be in direct contact with the surface of coating to be inspected.

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

5.3 As-applied Coating Thickness

Coating thickness shall be checked by non-destructed methods for each field joint. 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 sides of the girth weld at 3, 6, 9, & 12 O'clock positions. To establish the minimum thickness on the girth weld, four measurement 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.

5.4 Peel Strength Testing

5.4.1 One out of every 50 joint coatings or one joint coating out of every day's production whichever is stringent shall be tested to establish the peel strength on steel and factory applied coating. Contractor shall carry out such testing in the presence of Company Representative.

5.4.2 From each test sleeve selected as above, one or more strips of size 25mm x 200mm shall be cut perpendicular to the pipe axis and slowly peeled off.

The required peel strength shall meet the requirements of this specification as applicable for(+) 23°C or (+) 60°C whichever is feasible. This test shall be conducted between wrapping & metal and mill coating & between layers at overlap with joint coating (wherever applicable). After removal of strip, the bulk of adhesive shall remain adhered to the pipe showing no bare metal, otherwise, test shall be considered failed. The adhesive layer that remains on the pipe surface shall generally be free of voids resulting from air or gas inclusion. In case the peel strength test at a different temperature than that specified 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.

5.4.3 If the sleeve does not meet the requirements of clause 5.4.2 the adjacent two sleeves shall also be tested. If the adjacent two sleeves are acceptable the test rate shall be increased to one sleeve every twenty five until Company's Representative is satisfied. The test rate can then be reduced as per clause 5.4.1. If either or both of the adjacent two sleeves do not meet the requirements of clause 5.4.2, the field joint shall be stopped.

5.4.4 Company Representative reserve the right of 100% removal of sleeves if he is not convinced that the requirements of clause 5.4.2 are achieved.

6.0 REPAIRS

6.1 If a field joint is detected to be unacceptable after testing as per section 5.0 of this specification the Contractor shall, at his own cost :

- Determine the cause of the faulty results of the field coating.
- Mobilize the expert of manufacturer, if required.
- Test to be 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.

6.2 CONTRACTOR shall replace all joint found or expected to be unacceptable as per section 5.0 of this specification.

6.3 CONTRACTOR shall, at his own cost repair all areas where the coating has been removed for testing by COMPANY.

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

6.5 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 the Coating defects are

established, the Contractor shall be responsible for excavations at such points repair the coating, spark testing and back filling the excavations without extra charge.

7.0 DOCUMENTATION

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

i. Complete information as per clause 5.2, DIN EN 12068 alongwith descriptive technical catalogues.

ii. Test certificates and results of previously conducted tests, for all properties listed in clause 3.2 of this specification.

iii. Reference list of previous supplies, in last 5 years, of the similar material indicating the project details such as diameter, quantity, operating temperature, year of supply, project name, contact person and feed back on performance.

Once the Company’s approval has been given, any change in material or Manufacturer shall be notified to Company, whose approval in writing of all changes shall be obtained before the materials are manufactured.

7.2 Prior to shipment of materials from the Manufacturer’s works. Contractor shall furnish the following documents:

i. Test certificates/ results as per Manufacturer’s Quality Control Procedure for each batch of materials.

ii. Specific application instructions with pictorial illustrations.

iii. Specific storage and handling instructions.

7.3 All documents shall be in English language only.

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SPECIFICATION

FOR

TRANSPORTATION OF GOODS INDEGENOUSLY

SPECIFICATION NO. : SIPI/Steel/TS/14

C O N T E N T S

1.0 SPECIFICATIONS FOR GOODS BEING TRANSPORTED INDIGENOUSLY

1.1 General

This specification establishes the requirements of the handling, packaging, of transportation of goods indigenously.

1.2 Packing

1.2.1 The packing specifications incorporated herein are supplementary to the internal and external packing methods and standards. All packaging shall be done in such a manner as to reduce volume as much as possible. Fragile articles should be packed with special packing materials depending on the type of materials.

1.2.2 Items transported in bundles must be securely tied with steel wire or strapping. Steel reinforcing rods, bars, pipes, structural members etc. shall be bundled in uniform lengths and the weight shall be within the breaking strength of the securing wire or strapping.

1.2.3 All delicate surface on equipments/materials should be carefully protected and painted with protective paint/compound and wrapped to prevent rusting and damage.

1.2.4 All Mechanical and electrical equipment and other heavy articles shall be securely fastened to the case bottom and shall be blocked and braced to avoid any displacement/shifting during transit.

1.2.5 Attachments and spare parts of equipment and all small pieces shall be packed separately in wooden cases with adequate protection inside the case and wherever possible should be sent along with the main equipment. Each item shall be suitably tagged with identification of main equipment, item denomination and reference number of respective assembly drawing. Each item of steel structure and furnaces shall be identified with two erection markings with minimum lettering height of 15 mm. Such markings will be followed by the connection number in indelible ink/ paint. A copy of the packing list shall accompany the material in each package.

1.2.6 All protrusions shall be suitably protected by providing a cover comprising of a tightly bolted wooden disc on the flanges.

1.2.7 Wherever required, equipment/materials/instruments shall be enveloped in polythene bags containing silica gel or similar dehydrating compound.

1.2.8 All pipes and tubes of stainless steel, copper, etc., shall be packed in wooden case or crates irrespective of their size.

1.2.9 Pipes with threaded or flanged ends shall be protected with suitable caps/covers, before packing.

1.2.10 Pipes shall be packed as under:

a) Upto 50 mm NB in Wooden cases/crates.

b) Above 50 mm NB and upto 100 mm NB in Bundles and the bundles should be strapped at minimum three places.

c) Above 100 mm NB in loose

1.2.11 All packages requiring, handling by crane should have sufficient space at appropriate place to put sling of suitable Dia (strength). Iron/Steel angle should be provided at the places where sling markings are made to avoid damage to package/equipment while lifting.

1.2.12 Detailed packing list in waterproof envelope shall be inserted in the package together with equipment/material. One copy of the detailed packing list shall be fastened outside of the package in waterproof envelope and covered by metal cover. In case of bigger Dia pipes and large equipments, documents contained in the envelope shall be fastened inside a shell connection with an identifying arrow sign "Documents" applied with indelible paint.

1.2.13 The contractor shall be held liable for all damages or breakages to the goods due to the defective or insufficient packing as well as for corrosion due to insufficient protection.

1.2.14 Packaged equipment or material showing damage, defects or shortages resulting from improper packaging material or packing procedures or having concealed damage or shortages, at the time of unpacking, shall be to the contractor's account.

1.3 **Marking**

1.3.1 Each package shall be marked on three sides with proper paints/indelible waterproof ink as follows:

(OWNER)
(PROJECT)
(DESTINATION)

Work order No. _____
Net Wt._____ Kgs. Gross Wt. _____ Kgs.
Dimensions_____X_____X_____CMS.
Package No. (S. No. of total Packages)_____
Contractor's name_____

1.3.2 Additional marking such as 'HANDLE WITH CARE' 'THIS SIDE UP' 'FRAGILE' or any other additional indications for protection and safe handling shall be added depending on the type of material.

1.3.3 Specific marking with white paint for 'SLINGING' and 'CENTRE OF GRAVITY' should be provided for all heavy lifts weighing 5 Tonnes and above.

1.3.4 In case of bundles/bags or other packages, wherever marking cannot be stenciled, the same shall be embossed on metal or similar tag and wired securely at two convenient points.

1.3.5 Fragile articles should be adequately packed with special packing materials depending on type of materials.

1.4 Dispatch

1.4.1 Dispatch of materials shall be made in accordance with the relevant terms of the CONTRACT FORM. Any change in mode of transport shall be resorted to only after prior approval in writing. Contractor shall ensure dispatch of GOODS immediately after they are inspected and released and shall intimate status of despatch by fax to: -

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SPECIFICATION

FOR

TEMPORARY CATHODIC PROTECTION SYSTEM

SPECIFICATION NO.: SIPI/Steel/TS/15

C O N T E N T S

1.0 SCOPE

1.1 This specification defines the requirements of design, engineering supply of materials, installation, testing and commissioning of temporary cathodic protection system of external surface of cross country underground pipeline/structure including supplementing of corrosion survey, investigation for interference/ interaction problems and mitigation of the same. Unless otherwise specified monitoring of the temporary cathodic protection system till the commissioning of permanent C.P. System shall be carried out by temporary C.P. contractor.

This specification defines the basic guidelines to develop a suitable temporary cathodic protection system for the structure required to be protected. All data required in this regard shall be taken into consideration to develop an acceptable design and for proper engineering of the system.

1.2 Compliance with these specifications and/ or approval of any of the contractor's documents shall in no case relieve the contractual obligations.

1.3 In case where temporary and permanent cathodic protection works are being executed by the same agency, activities of permanent CP system which are common to temporary CP system shall be completed as part of temporary CP system. In cases where temporary and permanent cathodic protection works are being executed by different agencies, the contractual scope of work shall be referred for further details.

1.4 All work to be performed and supplies to be effected as a part of contract shall require specific approval of owner or his authorised representative. Major activities requiring approval shall include but not be limited to the following :-

- Corrosion survey data interpretation report and design basis for CP system.
- CP system design package
- Purchase requisitions for major equipment and vendor approval
- Detailed engineering package
- Field testing and commissioning procedure
- Procedures for interference testing and mitigation
- CPL survey and system monitoring procedures

2.0 CODES AND STANDARDS

The system design, performance and materials to be supplied shall unless otherwise specified, conform to the requirements of latest relevant applicable standards of:-

BIS specifications
BS specifications and codes of practice
ANSI specifications
NFPA publications
NACE publications
IEC publications
DNV publications
IEEE publications
DIN publications
ASTM publications

In case of conflicting requirements amongst any of the above standards the publication having most stringent requirement shall be governing.

3.0 CORROSION DATA

3.1 The corrosion survey including soil resistivity data along ROW and other data required for CP design is attached with this document. However, verification of its veracity and adequacy shall be the entire responsibility of the contractor. In addition, contractor shall have to generate/ collect additional data as required for completeness of the job. Contractor shall also carry out soil resistivity survey at temporary mode ground bed locations for proper design of ground beds. Wenner's 4-pin method or approved equal shall be used for such measurements. Survey instruments shall have maximum AC and DC ground current rejection feature.

3.2 Additional data to be collected

The following data shall be collected to generate design data for evaluation of interaction/ interference possibilities due to presence of other services in ROW/ in vicinity.

i. Route and types of foreign service/pipeline in and around or crossing the right of way (including those existing and those which are likely to come up during contract execution or any abandoned pipelines.

i. Diameter, wall thickness, pressure, pipeline coating against corrosion, soil cover used in case of pipelines.

ii. Detail of the existing cathodic protection system protecting the services i.e. location, rating, type of protection, anode beds, test station locations and their connection schemes.

iii. Graphical representation of existing structure/ pipe-to soil potential records. T/R unit current/ voltage readings.

iv. Remedial measures existing on foreign pipeline/services to prevent interaction.

v. Possibility of intergration/isolation of CP system, Which may involve negotiations with owners of other services.

vi. Crossing and parallel running of electrified and non-electrified traction (along with information regarding operating voltage, type AC/DC etc.) as well as abandoned tracks near ROW having electrical continuity with the tracks in use.

vii. Crossing and parallel running of any HT/AC/DC overhead line (existing/proposed) along with details of voltage, type AC/DC etc.

viii. Voltage rating, number of cores and sheathing details of under ground power cables, along ROW or in its vicinity.

ix. Information on existing and proposed DC/AC power sources and system having earth as return path, in the vicinity of the entire pipeline, route such as HV/DC sub stations, fabrication yards with electric welding etc.

x. Any other relevant information that may be needed in designing and implementing proper protection scheme for the proposed pipeline. Unless otherwise mentioned, Contractor shall conduct necessary potential gradient survey for any existing anode ground bed that may interfere with the CP system of the pipeline covered under this project.

xi. Any masonry work for other concrete or non conductive constructions in the ROW which may block the CP current or cause interference to the pipeline.

xii. Any underground cable running in parallel or crossing the ROW.

3.3 Report

On completion of all field work a report incorporating all the results generated from surveys and details of additional data collected shall be furnished. The report shall also contain detailed interpretation of survey results and resistivity data enclosed, probable interference prone areas etc. to form design basis for the scheme of cathodic protection. This report shall be plotted on semi-log graph sheets.

4.0 CATHODIC PROTECTION DESIGN PARAMETERS

Unless otherwise specified in the project specifications, following parameters shall be used for design of temporary cathodic protection system. Those parts of sacrificial anode cathodic protection system which will be integrated with permanent CP system shall be designed based on permanent CP parameters.

4.1 Protection current density

(i) Pipe lines having polyethylene coatings

Pipeline surrounding	Protection current density*	
	Temporary CP (µA/m²)	Permanent CP (MA/m²)
Normal soil	50	0.120
Marshy area/ buried in sea water/ HDD crossing	100	0.120
High resistivity area (more than 100Ω m)	25	100

(ii) Pipe lines having FBE Coatings

Pipeline surrounding	Protection current density*	
	Temporary CP (µA/m²)	Permanent CP (MA/m²)
Normal soil	200	0.300
Marshy area/ buried in sea water/ HDD crossing	300	0.500
High resistivity area (more than 100Ω m)	150	0.250

Pipe to soil "ON" potential shall not be more negative than (-) 1.5V.

* Actual current density to be adopted shall be decided based upon soil and other environmental conditions, proximity of foreign pipelines and structures affecting interference. Where considered necessary for satisfactory protection of pipeline the current density shall be suitably increased by contractor.

4.2 Safety factor for current density : 1.3

4.3 Anode utilization factor : 0.65 for Mg. Anode
0.80 for Zn Anode

4.4 Pipeline natural potential : (-) 0.45 V

4.5 Unless otherwise specified in project specification the design life of temporary CP shall be one year and that of permanent CP shall be 30 years.

5.0 CATHODIC PROTECTION DESIGN CRITERIA

5.1 Cathodic protection system shall be designed to meet the following criteria:

a. The pipe-to-electrolyte potential measurement shall be – 950 MV or more negative as measured between pipe surface and saturated Cu-CuS04, reference electrode containing electrolyte when cathodic protection is applied but on potential measurement shall not go more negative than (-) 1500 MV.

b. The pipeline shall be considered protected when a minimum of (-) 300 millivolt potential shift has been achieved from the initial native potential to the CP `ON' potential.

c. In rare circumstances a minimum polarisation shift of (-) 100 millivolts shall indicate adequate levels of cathodic protection for the pipeline. The formation of decay of this polarisation shall be used in the criteria. Discretion to use any of the criteria listed above shall solely rest with the Owner/ Owner's representative.

5.2 A positive potential swing of 50-100 mV shall be considered the criteria for presence of an interference situation requiring investigation and incorporation of mitigation measures by the CONTRACTOR.

6.0 SYSTEM DETAILS

The system shall include the following major equipment/sub-systems unless otherwise specified:

- Sacrificial anodes and anode ground beds
- Test stations
- Surge diverter/grounding cell
- Polarisation cells
- Interconnecting cables
- Cable to pipe connections
- Spark Gap Arrester

All equipment shall be new and supplied by approved reputed manufacturers. Equipment offered shall be field proven. Equipment requiring specialised maintenance or operation shall be avoided as far as possible and prototype equipment shall not be accepted. Make and construction of all material shall be subject to owner's approval. The detailed specification of each system and equipment shall be furnished by the contractor. However, certain minimum requirements for the major equipment are highlighted in this document.

As far as possible equipment including test stations, anode lead junction boxes, etc., shall be located in safe area. All equipment located in hazardous areas shall be of flame proof type as per IS:2148 for gas groups IIA & IIB and temp. class T3.

6.1 Anode Ground Beds

6.1.1 The pipeline shall be protected by prepacked zinc/ magnesium anodes.

6.1.2 Anodes shall be installed along the pipeline at suitable intervals as per pipeline protection voltage attenuation calculations and ground bed resistance/ current output of anode installations. Minimum one anode installation shall be provided for every one km. of the pipeline. In congested area, minimum one anode installation shall be provided for every 250 meter of pipeline length.

6.1.3 Each electrically continuous section of pipeline shall preferably be protected totally by one type (material) of anodes to avoid inter-anode circulation currents.

6.1.4 The anodes shall be installed at sufficient depth to reach moist soil and shall be separated from the pipe line by at least 5m and 2m for magnesium and zinc anodes respectively. The anode connections to pipeline shall be routed through test stations.

6.1.5 At the temporary cathodic protection anode ground bed, the leads of all the anodes shall be joined together in a junction box filled with epoxy and buried. A single cable shall be routed from the junction box to the test station. At permanent CP anode ground bed (i.e. at cased crossing), the leads of all the anodes shall be brought up to the test station and shall be terminated individually.

6.1.6 For sacrificial anode ground bed which shall be integrated with permanent CP System the leads of all the anodes shall be brought up to the test station and shall be terminated individually.

6.1.7 The number of anodes at each ground bed shall be sufficient for providing the specified pipe protection current density taking into consideration the ground bed resistance, pipe coating resistance, cable resistance, etc. Contractor shall prepare a table for number of anodes required at different soil resistivities to produce the specified protection current.

6.2.1 Magnesium anode

The anode shall be of high manganese, magnesium alloy packed with special back fill. The metallurgical composition, potential and consumption rate of anode shall be as below:

(i) Composition:

Element	Weight
Manganese	0.5 – 1.3%
Copper	0.02% max.
Silicon	0.05% max.
Zinc	0.05% max.
Aluminum	0.01% max.
Iron	0.03% max.
Nickel	0.001% max.
Other metallic elements	
- Each	0.05% max.
- Total	0.3%
Magnesium Balance	
(ii) Anode closed circuit potential	1.5 volts
(iii) Anode consumption rate	7.9 kg/(A yr)

6.2.2 Zinc Anode

The anode shall confirm to the requirements of ASTM – 418 standard. The anode (other than ribbon anode) shall be packaged with special back fill. The metallurgical composition of anode, potential and consumption rate shall be as below:

(i) Composition:

Element	Weight
Aluminium	0.005%
Cadmium	0.0035%
Copper	0.002% max.
Iron	0.0014% max.
Lead	0.0035% max.
Zinc	Remainder

(ii) Anode closed circuit potential	1.1 volts
(iii) Anode consumption rate	11.24 kg/(A yr)

6.2.3 Contractor shall furnish spectrographic analysis from each heat both for zinc and magnesium anodes along with electrochemical test results.

6.2.4 Special Backfill

The composition of special back fill for anodes shall be as below:

Gypsum	75%
Bentonite	20%
Sodium Sulphate	5%

6.2.5 The anodes shall be provided with cable tail of sufficient length to reach junction box test station as applicable without tension.

6.2.6 Tolerance in fabrication of anodes

The anode surface shall be free from cracks which may reduce the performance of the anode.

Any cracks which follow the longitudinal direction of elongated anodes shall not be acceptable.

Small cracks in the transverse direction of elongated anodes and in anodes of other shapes may be accepted provided the cracks would not cause any Mechanical failure during service of the anode considering that the combination of cracks and lack of bond to the anode core is detrimental.

For transverse cracks the acceptable limits shall be furnished by the bidders along with the offer.

The anode shall be free from excessive shrinkages. The following limits shall be used:

- Maximum 10% of the depth of anode or 50% of the depth of the anode core whichever is less. The depression may be measured from the edged of one side.

The surface of the anodes shall be free from coatings and slag/dross inclusions etc.

The maximum deviation from straightness shall not exceed 2%.

The weight tolerance on individual anodes may be taken as ± 5%. The total weight of the anodes shall not have negative tolerance.

Recommended dimensional tolerance shall be as follows:

Length	± 2.5%
Width/thickness	± 5%

6.3 Test Stations

6.3.1 Test stations shall be provided along the pipeline ROW for monitoring the performance of the Cathodic Protection system at intervals not exceeding 1000 meters in uncongested & 250 meters in congested area unless otherwise specified. In addition to above, test stations shall also be provided at the following locations:

a. At both sides of major road crossings

b. At all insulating joints

c. At vulnerable locations with drastic changes in soil resistivity

d. At connections of surge diverters, grounding cells and polarisation cells

e. At HT AC/DC overhead line crossings and selected locations where HT overhead line is in the vicinity of the pipeline.

f. At both sides of railway line crossings and running parallel to the pipeline.

g. At both sides of major river crossings.

h. At high voltage cable crossings or along routes where HV cables are running in parallel.

i. In the vicinity of DC networks or grounding system where interference problems are suspected.

j. At crossings/parallel running of other pipeline structures

k. At both sides of cased crossings

l. At any other locations considered vulnerable locations where interference is expected

m. At any other locations considered necessary by owner/owner's representative

6.3.2 Bond stations shall be provided at required locations as a means to monitor and control current flow between the pipeline and foreign pipelines / structures / electrified railway tracks etc. that crossing and running parallel to the pipeline in common ROW or within 25 metre from the pipeline.

6.3.3 Test stations used for sacrificial anodes shall have shunt for measurement of anode current, and provision for resistance insertion to limit the anode current output.

6.3.4 Test station with current measuring facility shall be provided at each intermediate CP station drainage point (to measure pipeline from drainage point), at interference prone areas, on both sides of major river crossings and at least at two additional locations along the pipeline ROW between two CP stations.

6.3.5 All test stations shall have weather proof enclosure, having degree of protection IP 55 with hinged lockable shutter. Enclosure shall be made of sheet steel of at least 3 mm thickness and shall be suitable

for M.S. post mounting. The test stations shall be designed with terminals required for both temporary and permanent CP system and shall be suitable for total life of permanent CP system.

6.3.6 The test stations shall be installed with the front of the test station facing the pipeline.

The name plate of test stations shall in minimum carry following information.

- Test station number
- Chainage in km
- Test station connection scheme type
- Distance from pipeline in meters
- Direction of product flow

6.3.7 Terminal blocks and different scheme of wiring as required shall be provided in the test station as per the test station connection scheme sketch.

6.3.8 The location of all the test stations shall be marked with their connection schemes and other relevant information's on alignment sheets. A detailed test station schedule shall be prepared.

6.4 Surge diverter, grounding cell and polarisation cell

6.4.1 Where high voltage (66 KV and above) transmission line runs in parallel or crosses the pipeline, the pipeline shall be grounded through polarisation cells & zinc anodes of minimum 20 kg net each. Alternatively, grounding could be done directly with zinc galvanic anodes of minimum 20 kg net each at the discretion of owner. Grounding shall be done at regular intervals where transmission lines run parallel
within 25 meter of the pipeline to ground any surges on the pipeline that would appear in case of transmission line faults.

6.4.2 In case of continuous induction of voltage on the pipeline beyond safe limits is expected or observed during commissioning due to HV Line or other of any rating., the pipeline shall be grounded to the earth system of nearest HV transmission tower of the transmisison line causing the voltage induction through polarisation cell or the pipeline shall be grounded to a separate earthing system of zinc galvanic anodes through polarisation cell. Alternatively, the pipeline shall be directly grounded with zinc galvanic anodes of minimum 20 kg net each at the discretion of the owner. The polarisation cell shall be installed in test station.

6.4.3 Spark gap arrestor shall be connected across each insulating joint to protect in from high voltage surges.

6.4.4 Alternatively, zinc grounding cell may be provided across insulating joints along ROW where the pipeline on both the sides of the insulating joint are cathodically protected and difference of protection voltage is not more then 0.4 volts.
Alternatively, owner on its own discretion may permit use of Magnesium / Zinc galvanic anodes for protection of insulating joints. Choice between Magnesium or zinc anodes shall depend upon the potential valves on either side of the insulating joint. These anodes shall be sized for the specified design life of permanent cathodic protection system.

6.4.5 The total system including cables, cable termination, anodes/ surge divertors shall be suitable for the anticipated fault current at the location of installation.

6.4.6 Unless otherwise specified on data sheet, the minimum rating of grounding cells, polarisation cells and surge diverters shall be as below:

(i) Grounding Cell

- Type : Zinc, 2 or 4 plate type
- Current rating : Suitable to pass more than 10kA surge

(ii) Polarisation cell

- Type : Solid state or Electrolytic multiple pairs S.S plats type ground
- Rating : Suitable to pass 5KA or more surge

(iii) Spark Gap Arrester

- Type : Spark gap
- Current, 8/20 wave : 100 kA
- Spark over AC voltage:
- 50 Hz : 1 kV
- Impulse (1.2/50) micro sec) : 2.2 kV

6.4.7 The grounding cell, spark gap arresters, and polarisation cell system shall be sized for the design life of permanent CP system. The zinc or magnesium anodes meant for pipeline grounding shall also be sized for the life of the permanent CP system taking into account the current discharge from the anodes. The grounding system shall have minimum resistance to earth to restrict the pipeline voltage as per NACE criteria.

6.4.8 In case of HT transmission overhead lines of voltage below 66KV also requisite mitigation measures should be provided to take care of continuous induction of voltage interface due to presence of transmission line in close proximity.

6.5 CP at Cased Crossing

At cased crossings where casing is coated, the casing shall be protected by sacrificial anode installations. The sacrificial anode installations shall be provided at both ends of casing. The anode installation shall be sized based on permanent C.P. design parameters specified for the main pipeline.

The carrier pipe inside the casing shall be protected by zinc ribbon anodes well connected to the outer surface of bottom of carrier pipe extending upto hour hand positions of 4 and 8 o'clock. The anodes shall be placed at close intervals as per design parameters calculations and sized based on the permanent CP design parameters.

6.6 Painting

The sheet steel used for fabrication shall be thoroughly cleaned and degreased to remove mill scale, rust, grease and dirt. Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The under surfaces shall be prepared by applying a coat of phosphate paint and a coat of yellow zinc chromate primer. The under surfaces shall be free from all imperfections before undertaking the finished coat. After preparation of the under surface, spray painting with two coats of final paint shall be done. The finished panel shall be dried in oven in dust free atmosphere. Panel finish shall be free from imperfections like pin holes, orange peels, run off paint, etc. All unpainted steel parts shall be cadmium plated to prevent rust information.

6.7 2 Cables

Cables shall be annealed high conductivity, tinned, stranded copper conductor, XLPE insulated 650/1100 V grade, armoured, PVC sheathed. The size of the copper conductor shall be 6 sq mm for anode cable from anode to buried junction box, 10 sq mm from junction box to test station, 10mm² from test station to pipeline. The size of the conductor shall be 6 sq mm for potential measurement, 10 sq.mm for current measurement and 25mm² for bonding, polarisation cell/grounding cell and surge diverter connection purpose. The anode cable from anode to junction box (buried) shall be unarmoured. The length of anode tail cable shall be sufficient enough to reach junction box (buried) in case of temporary CP anodes and up to test station in case of permanent CP sacrificial anodes. PE Sleeves shall be provided for unarmoured cables.

7.0 INSTALLATION

7.1 Cable Laying

7.1.1 Cables shall be laid in accordance with approved layout drawings to be prepared by the contractor. No straight through joint shall be permitted in a single run of cable. Cable route shall be carefully measured and cables cut to required length.

7.1.2 All cables inside station/plant area shall be laid at a depth of 0.75 M. Cables outside station/plant area shall be laid at a depth of 1.5m. Cables shall be laid in sand under brick cover back filled with normal soil. Outside the station/plant area the routes shall be marked with Polyethylene cable warning mats placed at a depth of 0.9m from the finished grade.

7.1.3 All underground unarmoured cables forming part of permanent CP system shall run through PE sleeves. Cables along the pipeline shall be carried along the top of the pipe by securely strapping it with adhesive tape or equivalent as required.

7.1.4 RCC or GI pipes of proper size shall be provided for all underground cables for road crossings.

7.1.5 Cables shall be neatly arranged in trenches in such a manner that criss-crossing is avoided and final take off to equipment is facilitated.

7.2 Cable to Pipe Connections

All the cable connections to the pipeline including charged foreign pipeline shall be made using an approved exothermic process. A suitable water proof sealing system of the cable connections shall be made which will be compatible with parent coating system of the pipeline after exnothernice process.

For charged pipeline pin-brazing shall be used. Eutectic solder shall not be acceptable for charged or non-charged pipeline.

8.0 CIVIL WORKS

All civil works associated with the complete cathodic protection work shall be included in the scope of contractor. This shall include providing cable trenches, foundation for equipment and all test stations, etc.

9.0 TESTING AND INSPECTION AT WORKS

9.1 OWNER/OWNER's representative shall visit the works during manufacture of various equipment to assess the progress of work as well as to ascertain that only quality raw material is used for the same. All necessary assistance during such inspections shall be provided.

9.2 The minimum testing, inspection requirements for all components/ equipments shall confirm to the requirements as defined in the relevant codes and standards. Detailed inspection and testing procedures along with the acceptance criteria shall be prepared by CONTRACTOR for OWNER's approval.

9.3 Test certificates including test records, performance curves etc., shall be furnished. All test certificates shall be endorsed with sufficient information to identify equipment to which the certificate refers to and must carry project title, owner's name and purchase order details etc.

9.4 Owner reserves the right to ask for inspection of all or any item under the contract and witness all tests and carry out inspection or authorise his representative to witness test and carry out inspection. CONTRACTOR shall notify the OWNER or OWNER's representative at least 20 days in advance giving exact details of tests, dates and addresses of locations where the tests would be carried out.

10.01 PACKING AND TRANSPORT

All equipment/material shall be protected for inland/marine transport, carraige at site and outdoor storage during transit and at site. All packages shall be clearly, legibly and durably marked with uniform block letters giving the relevant equipment/material details. each package shall contain a packing list in a water proof envelope. Copies of the packing list in triplicate, shall be forwarded to owner prior to despatch. All items of material shall be clearly marked for easy identification against the packing list.

11.0 SYSTEM TESTING, COMMISSIONING AND INTERFERENCE MITIGATION

11.1 System testing at site

11.1.1 Contractor shall furnish the detailed field testing and commissioning procedure for approval. Field tests as per the approved procedures shall be carried out on the equipment/systems before being put into service. the acceptance of the complete installation shall be contingent upon inspection and field test results.

11.1.2 Before the CP facilities are placed in operation all necessary tests shall be carried out to establish that all equipment, devices, wiring and connection, etc., have been correctly installed, connected and are in good working condition as required for intended operation.

11.1.3 Owner/owner's representative may witness all the tests. At least one week's notice shall be given before commencing the tests.

11.1.4 All tools, equipments and instruments required for testing shall be provided by CONTRACTOR.

11.1.5 Generally following tests shall be carried out and recorded in proforma given in subsequent clauses:

Checking	:	Visual inspection, comparison with drawings and specifications.
Inspection	:	Detailed physical inspection
Testing	:	Simulation tests of equipment to determine its operational fitness.

(i) Cables

- Cable no.
- Voltage grade
- Conductor cross-section
- Continuity check
- Voltage test

- Insulation resistance values between core and earth
- All cables shall be tested by 500 V megger

(ii) Insulating joint

Checking of insulating joint for leakage, before and after energisation of C.P. by means of insulating joint tester. Structure to electrolyte potential of both protected and non-protected sides of insulating joint shall be checked before and after energistaion of CP system.

(iii) Polarisation cell

- Location/identification number
- Rating
- Check for electrolyte
- Check for wiring
- Check for standby current drain with CP energisation (current drain with respect to voltage across the cell shall be recorded)

(iv) Grounding cell

- Location
- Type (no. of anodes)
- Ratings

(v) Surge diverter

- Location/identification no.
- Ratings
- Check for healthiness

(vi) Anode ground beds

- Location/test station number
- Current output of the ground bed

(vii) Spark Gap Arrester

- Location/ identification No
- Ratings
- Check for healthiness

11.2 Commissioning

11.2.1 Natural pipe to soil potential shall be measured at each test station location prior to connecting anodes to pipeline. The pipe to soil potential observation shall be repeated after connecting the anodes and allowing sufficient time for polarisation. The current output of the anode installation shall also be measured to ensure that it does not exceed the output current capacity of the anodes. In case the anode output current exceeds the rated capacity it shall be controlled by insertion of resistance element in the anode circuit inside test station and the pipe to soil potential shall be rechecked for adequacy of protection. Additional anodes shall be provided where required to achieve desired level of protection.

Each anode installation shall become individually operational as above.

11.2.2 After connecting all the anode ground beds to pipeline, measurement of pipe to soil potentials shall be taken at each test station to ensure conformity to protection criteria.

11.2.3 In case of insufficient protection as per the CP design criteria on any portion of the pipeline, CONTRACTOR shall carry out necessary additions modification to the provided protection in consultation with the ENGINEER.

11.3 Interference Mitigation

Investigation shall be made for stray current electrolysis of the pipeline, AC induction on pipeline due to overhead high voltage line, interference due to high voltage DC lines, electric traction, etc.

Measurements including pipe to soil potential and pipeline current etc., on the pipeline/structure being CP protected shall be made to investigate the current discharge and collection locations.

In case of fluctuating stray currents investigation shall be made continuously over a period of time and if required simultaneously at different locations to find out the stray current source. For long time measurements, recorders shall preferably be used.

Where foreign pipeline (unprotected or protected by independent CP system) runs in parallel to the pipeline in same trench or very near to the pipeline, and is not bonded to the pipeline then investigation shall be made for current discharge points on both the pipelines.

Mitigation measured shall be provided depending on type of interference. These shall include installation of bond with variable resistor and diodes, installation of galvanic anodes for auxiliary drainage of current, adjustment/relocation (if possible) of offending interference source, provision of electric shield etc., depending on the type of interference.

Bonding with foreign pipeline/structure as a mitigation measure shall be provided where the owner of the pipeline/structure has no objection, otherwise, alternative mitigation measure shall be provided. Where bonding is provided for mitigation the bonding resistor shall be adjusted for optimum value for minimum/no interference. Galvanic anodes installed as a mitigation measure shall be sized for the life specified for permanent CP.

12.0 SYSTEM MONITORING

The temporary CP system provided shall be monitored at all the test stations once in a month for healthiness/adequacy of protection till commissioning of permanent CP or for design life of temporary CP specified, whichever is less. During this period if any deficiency/interference in protection system is noticed the same shall be rectified/augmented by additional anodes as required. The monitoring report shall be submitted regularly to owner for his review/information.

13.0 DRAWINGS AND DOCUMENTS

13.1 General

13.1.1 Within three weeks from the date of issue of PURCHASE ORDER, CONTRACTOR shall submit four copies of the list of all drawings/ data/ manuals/ procedures for approval, identifying each by a number and descriptive title and giving the schedule date. This list shall be revised and extended, as necessary, during the progress of work

13.1.2 All drawings and documents shall be in English and shall follow metric system. Number of copies of each submission shall be as follows unless otherwise specified.

Submission	No. of Copies
a. For review/approval	6
b. Drawings issued for execution construction	6
c. Final / As built drawings execution/construction	6
d. Operation/Maintenance manual, vendor data	6

13.2 Contract drawings and documents

13.2.1 As a part of the contract, drawings and documents shall be furnished which shall include but not be limited to the following:

a. Report on corrosion survey

b. Basis of system design calculations, equipment selection criteria and sizing calculations.

c. Bill of material, material requisitions, purchase requisitions

13.2.2 Detailed construction drawings (including as built drawings)

a. Sacrificial anode fabrication drawings

b. Typical layout drawing for anode ground bed installation and connection

c. Equipment layout, cable layout and schedules

d. Fabrication, installation and connection scheme drawing for different types of test stations.

e. Fabrication and installation details of surge diverter, grounding cell and polarisation cell with its enclosure and housing

f. Cable-to-pipe joint details for charged and non-charged pipelines.

g. Incorporation of anode beds, polarisation cell, surge diverters, test stations, etc., and other relevant features of CP system design in Pipeline alignment sheet and other related drawings

h. Identification of section of pipeline affected by interference, source of interference and details of interference mitigation arrangements provided. various measurement data at all relevant test stations with and without mitigation measures provided.

i. Detailed commissioning report including various measurement data at all test stations, etc.

j. Vendor drawings and catalogues, test certificates

k. Operation and maintenance manual

l. Miscellaneous
- Equipment inspection and testing procedure
- Construction, installation procedures
- Field testing and commissioning procedures
- Procedure for monitoring of cathodic protection after commissioning
- Quality control procedures

14.0 INSTRUMENT, TOOLS AND SPARES

14.1 CONTRACTOR shall supply all instruments, tools and tackles necessary for proper operation and maintenance of complete cathodic protection system and associated equipment.

14.2 CONTRACTOR shall provide a list of spares and consumables required for proper operation and maintenance of part of cathodic protection system to be integrated with permanent CP system designed on the basis of permanent CP design parameters and associated equipment, for two years operation of the system.

15.0 INFORMATION REQUIRED WITH THE BID

Bidders are advised in their own interest to provide the following information along with the bid without which the bids are liable for summary rejection.

a. Basis and calculations for preliminary system design for cathodic protection system.

b. List of formulas to be used for detailed system design calculations.

c. Basis of system design, design calculations, equipment selection criteria, sizing calculations along with characteristics curves for various equipments.

d. Preliminary bill of material for major equipment.

e. Details of the equipment/material offered along with technical leaflets/related literatures/catalogues, make, rating, type test certificates.

f. Dimensions, weight and general arrangement drawings for each offered equipment.

g. List of instruments, tools and tackles offered for maintenance and operation.

h. List of recommended maintenance/operation spares.

I Clause-wise deviations, if any, to the specifications along with justifications

SPECIFICATION

FOR

CORROSION SURVEY

SPECIFICATION NO.: SIPI/Steel/TS/16

C O N T E N T S

1.0 SCOPE

The specification covers the corrosion survey including measurement of soil resistivity, chemical analysis of soil/ water and other cathodic protection related data collection along right of way of the pipelines.

2.0 CODES AND STANDARDS

Equipment and measurement techniques shall unless otherwise specified, conform to the requirement of following latest applicable standards:-

BIS Specifications

BS Specifications and Codes of Practice

NACE Publications

3.0 GENERAL

This specification defines the basic guidelines for carrying out the corrosion survey. Contractor shall be responsible for providing necessary data interpretation based on corrosion survey measurement which is intended to form a basis for design of cathodic protection system for the pipeline to be burried along ROW.

4.0 SOIL RESISTIVITY SURVEY

4.1 Unless otherwise specified the soil resistivity measurements shall be carried out at intervals of approximately 500 mtr. along the ROW. Where soil resistivity is less than 100 ohm mtr and two successive readings differ by more than 2:1 then additional soil resistivity readings in between the two locations shall be taken.

4.2 To carryout the soil resistivity measurement Wenner's 4 pin method or approved equal shall be used. The depth of resistivity measurement shall be around the burial depth of the pipeline or 1.5 mtr approximately. At locations where multi-layer soil with large variation in resistivity/ corrosiveness is expected and/ or locations specifically advised by Owner or his representative resistivity measurements at additional depth of upto 2.5 mtr (approx.) or more shall be taken. In general the resistivity of soil which shall be surrounding the pipe shall be measured. Hence the depth of measurement/ electrode spacings may vary depen ding on totography and strata at the area.

In general, electrode spacing, shall be approximately equal to 1.5 times the depth of the pipelines.

4.3 At places where Right-of-way has not yet been cleared measurement shall eb made right over the centre line of pipeline route surveyed accounting for the cuttings/ fillings also.

4.4 Observations shall be made enclosing the soils adjoining the trench wherever pipeline trenching has already been done.

4.5 The observations shall be made enclosing the soil immediately surrounding the pipeline route where right of way has been cleared but trenching has not been done.

4.6 All measurement shall be taken at right angles to the right of way unless otherwise asked by Owner or his representative at site.

4.7 At places in right of way where other pipelines are already existing care shall be taken to precisely locate such pipes line and take such precautions that observations are not adversely affected by presence of such pipelines.

4.8 Care shall also be taken that the observations are not influenced by presence of other earth currents in the area especially in the vicinity of HT lines and plants using earth return in their source of power etc.

4.9 Wherever possible/ advised by Owner or his representative depth of water table shall be determined by resistivity observations.

4.10 All measurements shall be made and recorded in metric units. While recording the data reference to the nearest point shall be made. The provide visual representation of variations in the resistivities along right of way, values shall be plotted on semilog graph sheets. The resistivity graph shall also indicate the resistivities at additional depths measured at various locations and depth of water table.

5.0 TESTS ON SOIL SAMPLES

Soil/ water samples shall be collected along the right of way for analysis. Samples shall be collected on an average at one location per every 10 km along right of way with minimum at two locations. Exact locations shall be decided at site depending on the type of soil, soil resistivity and in consultation with Owner or his representative. The soil samples shall be collected at 1 mtr and 2 mtr depth at each location.

The collected soil/ water samples shall be analysed to determine presence and percentage of corrosive compounds including moisture content, oxygen activity and pH value.

6.0 ADDITIONAL DATA COLLECTION

The following data shall be collected with a view to generate design data of evaluation of cathodic protection interaction possibilities due to presence of other services in right of way and its vicinity.

6.1 Route and types of foreign service/ pipelines in and around or crossing the right of way.

6.2 Diameter, wall thickness, pressure, soil cover etc. of the foreign pipeline.

6.3 Voltage rating, phases and sheathing details of parallel running or crossing cables with ROW.

6.4 Foreign pipeline coating details.

6.5 Details of exiting cathodic protection systems protecting the services including rating and location of grounds bed test station locations and connections schemes etc. Where pipeline is likely to pass close to any existing ground bed, necessary anode-bed potential gradient survey shall be carried out.

6.6 Interference remedial measures existing on foreign pipelines/ services/ shall be collected from the owner of the foreign pipeline/ services.

6.7 Graphical representation of existing structure/ pipe to soil potential records, Transformer Rectifier Unit/ CP Power source voltage/ current readings.

6.8 Possibilities of integration/ isolation of the pipeline CP System with foreign pipeline/ structure CP System, which may involved negotiation with Owner's of foreign services.

6.9 Information on existing and proposed DC/ AC power sources and system in the vicinity of the entire right of way.

6.10 Crossing and parallel running of electrified and non-electrified railway tracks alongwith details of operating voltage and type (AC/ DC).

6.11 Crossings or parallel running of any H.T. AC/ DC overhead line with in approximately 25 mtr from ROW alongwith details of voltage rating, fault level etc.

6.12 Any other relevant information that may be needed in designing and implementing of proper cathodic protection scheme for the proposed pipeline.

7.0 REPORT

On completion of all the field and laboratory work an interim report incorporating results generated from surveys, additional data collected, results of test carried out, etc. shall be submitted for comments/ approval. The final report incorporating comments/ missing data shall be furnished for records. The report alongwith various drawings, graphs etc. prepared in connection with the work shall be submitted alongwith six prints by the contractor.

8.0 INFORMATION REQUIRED WITH BID

Bidder shall provided following information alongwith the bid without which the bids are liable for summary rejection.

8.1 Instruments that will be used for carrying out soil resistivity survey.

8.2 Measures that will be taken to avoid foreign pipelines/ HT lines etc. affecting the soil resistivity observations.

8.3 Measurement location identification procedure.

8.4 Procedure for collection of soil samples.

8.5 Description of soil test procedure.

8.6 Specification of soil testing instruments.

8.7 Formats for presentation of results.

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SPECIFICATION

FOR

GASKET, BOLT & NUTS

SPECIFICATION NO.: SIPI/Steel/TS/17

C O N T E N T S

TECHNICAL NOTES FOR GASKETS

1. Materials for gaskets shall conform to the codes/ standards and specifications given in the Piping Material Specification.

2. Asbestos filler for spiral wound gaskets shall not have any colour or dye.

3. Each size of gaskets shall be supplied in bundles labelled with size, rating and material specifications.

4. All gaskets shall be inspected as follows :-

   a. Visual Inspection
   b. Dimensional Check

5. Material test certificates for all mandatory tests as per the relevant material specifications and other inspection reports shall be furnished before despatch of material.

6. All items shall be inspected and approved (Stagewise) by Purchaser's Representative.

TECHNICAL NOTES FOR BOLTS & NUTS

1. Materials for stud bolts, M/C bolts, jack screws and nuts shall conform to the codes/ standards and specifications given in the Pipeline Material Specification No. 2784-00-71- S-109.

2. Test reports shall be supplied for all mandatory tests as per the relevant material specifications.

3. All bolting shall be as per ANSI B18.2.1 for studs, M/C Bolts and Jack screws and ANSI B18.2.2 for nuts.

4. Threads shall be unified (UNC for = 1" dia and BUN for C1" dia) as per ANSI B1.1 with class 2A fit for studs, M/C bolts and jack screws and class 2B fit for nuts.

5. Stud bolts shall be fully threaded as specified in the standards, codes.

6. The nuts shall be double chamfered, heavy hexagonal type.

7. Heads of jack screws and M/C bolts by heavy hexagonal type. Jack screw end shall be rounded.

8. Each size of studs & M/C bolts with nuts and jack screws shall be supplied in separate bags marked with size and material specifications.

9. All items shall be inspected and approval (Stagewise) by Purchaser's Representative.

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SPECIFICATION

FOR

PIPING MATERIAL SPECIFICATION

SPECIFICATION NO.: SIPI/Steel/TS/18

C O N T E N T S

AMENDMENT STATUS

Sl. No.	Clause / Paragraph / Annexure / Exhibit / Drawing Amended	Page No.	Status of Revision and Date			
			Rev-1	Rev-2	Rev-3	Rev-4

1.0 SCOPE

This specification covers the requirements of various piping materials used in piping/ pipeline system handling natural gas and associated utilities in the pipeline.

2.0 CODES AND STANDARDS

2.1 Pipeline and terminal facilities envisaged as a part of this project shall be designed and Engineered primarily in accordance with the provision of ASME B 31.8- Gas Transmission and Distribution piping system Latest edition.

2.2 All codes standards and specifications referred herein shall be the latest edition of such documents.

2.3 For sake of brevity, the initials of the society to which the codes are referred are omitted in the specification, for example, B16.5 is a code referring to ANSI/ ASME, A 105 is a code referring to ASTM.

2.4 In addition, SIPI specifications for various piping and pipeline materials shall also be applicable.

3.0 MATERIAL SPECIFICATION

Piping material specifications are classified for the general purpose of selection of material for the class of services. The maximum design pressure and design temperature together with the fluid in line governs the selection of material specifications. Deviation of materials from class specifications may occur due to specific design condition. These deviations are permissible if they are equal or better than the individual class requirements.

4.0 CLASS DESIGNATION CODE

The piping class designation consist of three digits numbering system made up of letter, number and letter e. g. A1A, B1A, D1A, etc as follows:

First letter indicates ANSI class rating e. g.

A-Class 150
B-Class 300
D-Class 600

The middle number indicates differences in the specification within the same rating and material.

The last letter indicates type of material e. g.

A-Carbon Steel

5.0 PIPELINE

The material for linepipe shall be as per the requirements of specification as indicated in table-I.

6.0 PIPING

6.1 Carbon steel pipe shall be made by open hearth, electric furnace or basic oxygen process only. The steel used shall be fully killed and made with fine grain structure. The grade and wall thickness of various sizes of pipes shall be as per piping material specification for the applicable class.

6.2 Pipe dimension shall be in accordance with ANSI B 36.10 for carbon steel pipes and ANSI B 36.19 for stainless steel pipes.

6.3 All pipe threads shall conform to American Standard taper as per ANSI B 1.20.1 NPT, unless otherwise specified.

6.4 For butt weld end, bevel shall be in accordance to ANSI B 16.25/ API 5L as applicable.

7.0 **FITTINGS**

7.1 Fully killed carbon steel shall be used in the manufacture of fittings.

7.2 Threaded joints, if used shall conform to American Standard taper as per ANSI 1.20.1 NPT.

7.3 Dimension of socket weld/ screwed fittings shall conform to ASME B 16.11

7.4 Bore of socket welded fittings shall suit O. D. of pipe and its thickness.

7.5 Dimensions of butt welded carbon steel fittings upto size 18” NB shall conform to ASME B 16.9/ MSS-SP-75 as applicable.

7.6 Butt welding ends shall conform to ANSI B 16.25/ API 5L. in case of difference in thickness of matching ends, requirements of ASME B 31.8 shall apply.

7.7 Integrally reinforced forged branch fittings such as sockolet, threadolet, weldolet, nippolet etc. shall be as per MSS-SP-97. Fittings not covered in ASME B 16.9 and MSS-SP-97, shall conform to manufacturer’s standard.

8.0 **BENDS**

8.1 Contractor shall use elbow of radius 3D/1.5D. No cutting is allowed from elbows in any case.

9.0 **FLANGES**

9.1 Flange rating shall be same as ANSI class rating unless otherwise specified.

9.2 Dimensions pf flanges shall be in accordance with ANSI B 16.5 for sizes up to 18” NB.

9.3 Neck of Weld Neck (WN) flanges to suit pipe bore and thickness.

9.4 Bore of Socket Welded (SW) flanges shall suit pipe O.D. and its thickness.

9.5 Threads for screwed flanges if used shall conform to American Standard taper as per ANSI B 1.20 1 NPT.

9.6 Sizes for blind flanges shall be indicated by nominal pipe sizes.

9.7 Carbon steel flanges faces shall have serrated finish or smooth finish as indicated in the material specification. Flanges faces shall have serrated finish to 250-500 microinches AARH as per ANSI B 16.5 for ANSI class 150# and smooth finish to 125-200 microinches AARH as per MSS-SP-6 for ANSI class 300# & 600#.

9.8 Butt welding ends of WN flanges shall conform to ANSI B 16.25.

9.9 Spectacle blind/ spacer & blinds for sizes upto and including sizes 18" NB shall be in accordance with API standard 590/ SIPI standard. Spectacle blind shall be used for sizes upto 8" NB and for 10" & above spacer & blind shall be used.

9.10 Two jack screws 180° apart shall be provided for all spectacle blind assemblies. The jack screws shall be as per SIPI's standard, attached with this specification.

10.0 GASKETS

10.1 Spiral wound metallic gaskets shall conform to B 16.20 and shall be provided with compressed asbestos filler. All spiral wound gaskets shall be provided with carbon steel centering ring. Gasket thickness shall be as indicated in piping material specification for the applicable piping class.

10.2 Non-metallic compressed asbestos gaskets for flanged pipe joints shall conform to B16.21. Unless specified otherwise, asbestos material shall conform to IS 2712 Gr. O/1. Gasket thickness shall be as indicated in piping material specification for the applicable piping class.

11.0 BOLTING

11.1 Nuts for stud bolts shall be American Standard Hexagonal Heavy series and double chamfered.

11.2 Dimension and tolerances for stud bolts and nuts shall be as per ANSI B 18.2.1 and 18.2.2 with full threading to ANSI B 1.1 Class 2A thread for bolts and Class 2B for nuts. Diameter and length of stud bolts shall be as per ANSI B 16.5 with full threading.

11.3 Threads for nuts shall as per ANSI B 1.1, as follows:

Nuts for stud dia ¼" to 1"	:	UNC-2B
Nuts for stud bolts dia 1 1/8" to 3 ¼"	:	8UN-2B

11.4 Threads for stud bolts shall be as per ANSI B 1.1, as follows.

Studs bolts dia ¼" to 1"	:	UNC-2A
Stud bolts dia 1 1/8" to 3 ¼"	:	8UN-2A

11.5 Heads of jack screws shall be heavy hexagonal type. Jack screw end shall be rounded. Stud bolts shall be fully threaded with two hexagonal nuts.

12.0 THREAD SEALANT

12.1 Threaded joints shall be made with 1" wide PTFE Jointing tape.

13.0 VALVES

13.1 All valves installed above ground within the terminal of sizes 2" and above shall have flanged ends. Valves of size less than 2" shall have socket welded ends except for ball valves.

13.2 Flange dimensions and face finish of flanged end valves shall confirm to clause 9.0 of this specification.

13.3 Butt welding ends of Butt Welded valves shall confirm to ANSI B 16.25.

13.4 Face to face and end to end dimensions shall confirm to applicable standards.

13.5 Buried valves on mainline shall be provided with stem extension, sealant, vent/drain & shall have butt welded ends.

13.6 Sectionalizing Valves (Block valves) installed on the main pipeline shall have butt welded ends and shall be full bore to allow smooth passage of cleaning pigs as well as intelligent pigs.

13.7 Unless specified otherwise. Valves shall confirm to the following standards:

Screwed / Socket welded / Flanged end valves (1 ½" and below)

Ball Valves	-	BS 5351
Plug Valves	-	BS 5353
Check Valves	-	BS 5352
Globe Valves	-	BS 5352
Gate Valves -		API 602

Flanged / Butt weld end Valves (2" and above)

Ball Valves	-	API 6D
Plug Valves	-	API 6D
Check Valves	-	API 6D / BS 1868
Globe Valves	-	BS 1873
Gate Valves	-	API 600

13.8 Valve operators shall be as indicated below, unless specified otherwise in the P&ID.

a) Gate and Globe Valves

i) For ANSI class 150&300 - Hand Wheel operated for size <12"NB.
Gear operated for size >14" NB.

ii) For ANSI class 600 - Hand Wheel operated for size <10"NB.
Gear operated for size >12" NB.

b) Ball and Plug Valves

i) For ANSI class 150, 300, 600 – Wrench operated for size <4" NB.

Gear operated for size >6" NB.

14.0 QUICK OPENING END CLOSURE

Quick opening end closure to be installed on scraper traps shall be equipped with safety locking devices in compliance with section VIII, division 1, UG-35 (b) of ASME Boiler and Pressure Vessel code.

15.0 HYDRO TESTING VENTS AND DRAINS

High point vents and low point drains required for the purpose of hydro testing shall be of size 0.75" and consist of sockolet, gate valve, flange & blind flange.

TABLE-1

MAIN LINE PIPE MATERIAL

Line Pipe Material and thickness shall be indicated in Mainline SOR.

TABLE-2

INDEX OF PIPING MATERIAL SPECIFICATIONS

Piping Class	Service	Design pressure Kg/ cm2	Design Temp. °c	C .A. in mm	Basic Material	Design Code	Attachment Status
AIA (150#)	NATURAL GAS	19	65	1.5	API 5L	ASME B 31.8	**Yes (As Annexure-I)**
BIA (300#)	NATURAL GAS	49	65	1.5	API 5L	ASME B 31.8	--
DIA (600#)	NATURAL GAS	92	65	1.5	API 5L	ASME B 31.8	--

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SPECIFICATION

FOR

ASSORTED PIPES

SPECIFICATION NO. : SIPI/Steel/TS/20

C O N T E N T S

1.0 **GENERAL**

1.1 All pipes and their dimensions, tolerances, chemical composition, physical properties, heat treatment, hydrotest and other testing and marking requirements shall conform to the latest codes and standards specified in the Material Requisition (MR). Deviation(s), if any, shall be clearly highlighted in the offer.

1.2 **Testing**

1.2.1 Test reports shall be supplied for all mandatory tests as per the applicable material specifications. Test reports shall also be furnished for any supplementary tests as specified in MR & Clauses 1.10 & 1.11.

1.2.2 Material test certificates (physical property, chemical composition & treatment report) shall also be furnished for the pipes supplied.

1.3 **Manufacturing Processes**

1.3.1 Steel made by Acid Bessemer Process shall not be acceptable.

1.3.2 All longitudinally welded pipes other than IS:3589 should employ automatic welding.

1.4 Pipe shall be supplied in single or double random lengths of 4 to 7 and 7 to 14 meters, respectively.

1.5

a. Seamless and E.R.W. pipes shall not have any circumferential seam joint in a random length. However, in case of E.FS.W. pipe, in one random length one welded circumferential seam of same quality as longitudinal weld is permitted. This weld shall be at least 2.5 m from either end. The longitudinal seams of the two portions shall be staggered by 90°. Single random length in such cases shall be 5 to 7m.

b. Unless otherwise mentioned in the respective material code, E.FS.W. pipes < 36" shall not have more than one longitudinal seam joint and E.FS.W. pipes ≥ 36" shall not have more than two longitudinal seam joints.

1.6 Pipe with screwed ends shall have NPT external taper pipe threads conforming to ASME/ ANSI B1.20.1 upto 1.5" NB & IS:554 for 2" to 6" NB.

1.7 Pipe with bevelled ends shall be in accordance with ASME B16.25. Weld contours shall be as follows:

Material	Wall Thickness	Weld Contour
Carbon Steel (Except Low Temp. Carbon Steel)	Upto 22mm	Figure 2 Type A
	> 22mm	Figure 3 Type A

3.0 **HYDROSTATIC TEST**

Refer Annexure – I.

4.0 **MARKING AND DESPATCH**

4.1 All pipes shall be marked in accordance with the applicable codes, standards and specifications. In addition, the purchase order number, the item code & special conditions like "IBR", " CRYO", "NACE", etc., shall also be marked.

4.2 Pipes under "IBR", "CRYO", & "NACE" shall be painted in red stripes, light purple brown stripes & canary yellow stripes, respectively, longitudinally throughout the length for easy identification.

4.3 Paint or ink for marking shall not contain any harmful metal or metallic salts such as zinc, lead or copper which cause corrosive attack on heating.

4.4 Pipes shall be dry, clen and free from from moisture, dirt and loose foreign materials of any kind.

4.5 Pipes shall be protected from rust, corrosion and Mechanical damage during transportation, shipment and storage.

4.6 Rust preventive used on machined surfaces to be welded shall be easily removable with a petroleum solvent and the same shall not be harmful to welding.

4.7 Both ends of the pipe shall be protected with the following material:

Plain end	: Plastic cap
Bevel end	: Wood, Metal or Plastic cover
Threaded end	: Metal or Plastic threaded cap

4.8 End protectors to be used on bevelled ends shall be securely and tightly attached with belt or wire.

4.9 Steel end protectors to be used on galvanized pipes shall be galvanized.

ANNEXURE–I

3.0 **HYDROSTATIC TEST**

3.1 All pipes shall be hydrostatically tested.

3.2 The mill test pressure shall be as follows:

3.2.1 **Seamless, E.R.W. & Spiral Welded**

a) Carbon Steel

Material Standard	Test Pressure Standard
ASTM A 106 Gr. X52	ASTM A 530
API 5L Gr. X52, Seamless	API 5L
API 5L, E.R.W.	API 5L
API 5L, Spiral	API 5L
ASTM A333 Gr.3 & 6, Seamless	ASTM A 530
ASTM A 333 Gr. 3 & 6, E.R.W.	ASTM A 530

3.2.2 **Electric Fusion Welded**

a) Carbon Steel & Alloy Steel E.FS.W. (16” & above)

Material Standard	Test Pressure Standard
API 5L Gr. X 52 ASTM A 671 Gr.CC65, 70 (Cl.32) ASTM A 672 Gr.C60, 65, 70 (Cl.12,22) ASTM A 671 Gr.CF60, 65, 66, 70 (Cl.32) ASTM A 691 Gr. ½ Cr, 1Cr, 1 ¼Cr, 2 ¼Cr, 5Cr, 9Cr (Cl.42)	P=2ST/ D S=90% of SMYS (except for API 5L X 52) S=85% of SMYS for API 5L Gr. X 52 T=Nominal Wall Thickness D=O.D. of Pipe

b)

3.2.3 **Carbon Steel Pipes to IS Standards**

Material Standard	Test Pressure Standard
IS :1239	IS :1239
IS :3589	IS :3589

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SPECIFICATION

FOR

PIPELINE PRE-COMMISSIONING AND COMMISSIONING OF PIPELINE PROJECT

SPECIFICATION NO. SIPI/Steel/TS/21

CONTENTS

1.0 INTRODUCTION

This specification covers the minimum technical requirements for precommissioning and commissioning of gas pipeline, including precommissioning activities such as pre-commissioning checks, flushing of terminal piping, dewatering, swabbing and nitrogen purging.

2.0 GENERAL

The scope of work for testing and commissioning including pre-commissioning activities shall include, but not limited to the manpower, machinery & equipment, detailed procedures, materials and consumables, communications etc. to perform the work satisfactorily.

Contractor shall prepare detailed procedures for flushing of terminal piping, dewatering, swabbing
, inertisation and commissioning 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 i.e. flushing of terminal piping, dewatering, swabbing, inertisation and commissioning of the pipeline. 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.

3.0 THE WORK

The work to be performed by the Contractor shall consist of the following activities:

Pre-commissioning	:	Entire pipeline project shall be checked with respect to latest P&ID's and other design specification.
Dewatering	:	Removal of hydrotest water from the entire pipeline network system.
Swabbing	:	Reducing the amount of remaining water in the main pipeline system which is left behind after completion of the dewatering operations to make the pipeline free of water
Inertisation	:	Inertising the entire pipeline with nitrogen
Commissioning	:	Charging the entire pipeline network with the product and achieving normal operating conditions of the pipeline

4.0 PRE-COMMISSIONING CHECKS

4.1 The pre-commissioning checks shall be carried out for the pipeline to ascertain that the pipeline system has been Mechanically completed in all respects. These checks shall cover the main pipeline including distribution network system and sectionalising valve stations. The pre-commissioning checks shall include the following:

i) System Checks

The entire facilities shall be checked against the latest P&ID's and other design specification codes.

ii) Checking of Field Instruments

All the field instruments like control valves, sectionalising valves, transmitters, solenoid valves, shut down switches, alarms etc. shall be checked physically and also for their intended application by simulating the operating conditions. It will also include checking of different meters, gauges action of shutdown valves etc. as applicable.

iii) Survey of the Pipelines

This shall be performed to confirm that proper fittings/ supports, route markets, fencing around SV Stations etc. have been intalled along the pipeline.

iv) Checking of Communications System

This is to check that there is proper communication with adequate back-up power to ensure uninterrupted communication.

v) Checking of Electrical Distribution System

This is to ensure safety and also to ensure an uninterrupted power supply during startup and normal pipeline operation.

vi) Checking of Instruments, Controls & Interlocks

This is to check that instrument controls and interlocks are functional as per the normal operating conditions.

vii) Checking of Utilities

This is to check that utilities like power, nitrogen, UPS system instrument air, etc. are available prior to startup.

viii) Any other checks as may be considered necessary.

4.2 **DEWATERING**

4.2.1 **General**

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.

4.2.2 Operational Requirements

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.

4.2.3 Acceptance Criteria

Before proceeding to the next stage of the inertisation operation Contractor shall ensure that bulk of the water has been removed from the pipeline. Contractor shall specify when the dewatering phase if finished and shall obtain approval of the company before proceeding to the next inertisation phase.

4.3 Swabbing

4.3.1 General

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 10%. 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.

4.3.2 Acceptance Criteria

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.

4.4 Inertisation

During the inertisation operation, the air left in the pipeline shall be replaced by nitrogen before admitting the product natural gas that the pipeline will ultimately carry.

The inertisation operation shall start as soon as possible after the swabbing operation has been completed and approved by the company. Contractor shall submit the detailed purging procedure for approval for the company prior to its implementation.

Nitrogen needed for inertisation of the pipeline, shall be provided by the Contractor. The maximum allowable oxygen content inside the pipeline shall be less than 1% by volume.

Multiple separation pigs with nitrogen slugs in between shall be used for pipeline commissioning. At least three batches of nitrogen separated by four separation pigs shall be used for inertisation of the pipeline during charging of gas in it. The combined nitrogen column length to be used for inertisation should be at least 5% of the total pipeline length.

4.4.1 Safety Review before start of commissioning

A pre-startup safety review shall be carried out of the pipeline system before permitting entry of natural gas into the new facility. Owner/ Owner's representative shall also participate in the pre- startup safety review.

4.5 COMMISSIONING

4.5.1 General

Commissioning of pipeline shall be considered completed when the line is charged with product natural gas at operating pressure and the total system operated at normal operating parameters for a minimum period of 72 hours with all the instruments, controls and interlocks working satisfactorily at normal operating conditions. Contractor shall submit a detailed commissioning procedure for company's approval.

5.0 DOCUMENTATION

Contractor shall submit for approval of the company the complete description, detailed procedure and time schedule of all the dewatering, swabbing, purging and commissioning operations, as applicable.

Documents shall also contain all procedures and safety plans to be followed while carrying out the activities. Upon successful completion of the work, Contractor shall prepare a final report of the work which shall include necessary charts, diagrams, graphs, calculations, recordings, daily logs, measurements, details of the operation, etc. Report shall also include all certificates of calibration of instruments required together with records of calibration performed at site prior to the start of any operation.

5.1 Spares and Consumables

Supply of spares, tools and consumables for start-up & commissioning.

5.2 **Safety**

Follow the safety practice during execution of pre-commissioning/ commissioning works as detailed in the scope of work. Maintain and follow all safety practices equivalent or better than those being practiced for the pipeline during pre-commissioning and commissioning.

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SPECIFICATION

FOR

HEALTH, SAFETY AND ENVIRONMENT (HSE) MANAGEMENT

SPECIFICATION NO. : SIPI/Steel/TS/22

C O N T E N T S

1.0 SCOPE

This specification establishes the Healthy, Safety and Environment (HSE) management requirement to be compiled with by the Contractors during construction.

Requirement stipulated in this specification shall supplement the requirement of HSE management given in relevant Act (S)/ legislations. General Condition of Contract (GCC) Special Condition of Contract (SCC) and Job Specifications. Where different documents stipulate different requirements, the most stringent shall be adopted.

2.0 REFERENCES

This document should be read in conjunction with following:

- General Conditions of Contract (GCC)
- Special Conditions of Contract (SCC)
- Job Specifications
- Relevant IS Codes (refer Annexure-A)
- Reporting Formats (refer Annexure-B)

3.0 REQUIREMENT OF HEALTH, SAFETY & ENVIRONMENT (HSE) MANAGEMENT SYSTEM TO BE COMPLETED BY BIDDERS.

3.1 Management Responsibility

3.1.1 The Contract should have a document HSE policy to cover commitment of the organization to ensure health, safety and environment aspects in their line of operations

3.1.2 The HSE management system of the Contractor shall cover HSE requirement including but not limited to what specified under clause 1.0 & 2.0 mentioned above

3.1.3 Contractor shall be fully responsible for planning and implementing HSE requirement to the satisfaction of the company. Contractor as a minimum requirement shall designate/deploy the following to co-ordinate the above:

No. Of workers deployed Up to 250	-	Designate one safety supervisor who will guide the workers from time to time, as well as impart training basic guidelines at least weakly once.
Above 250 & upto 500	-	Deploy one qualified and experienced safety Engineer/ Officer who will guide the workers from time to time as well as impart basic guideline & training at least weakly once.
Above 500 (for every 500 or less)	-	One additional safety engineer/Officer whose function will be as mentioned above

Contractor shall indemnify and hold harmless OWNER/ SIPI & their representatives from any and all liabilities arising out of non-fulfillment of HSE requirements.

3.1.4 The Contractor shall ensure that the Health, Safety and Environment (HSE) requirements are clearly understood & faithfully implemented at all levels, at each and every site/ work place.

3.1.5 The Contractor shall promote and develop consciousness for Healthy, Safety and Environment among all personnel working for the Contractor. Regular awareness programs and fabrication shop/work site meeting shall be arranged on HSE activities to cover hazards involved in various operations during construction.

3.1.6 Arrange suitable first aid measures such as First Aid Box, trained personnel to give First Aid, Stand by Ambulance or Vehicle and install fire protection measures such as: adequate number of steel buckets with sand and water and adequate fire extinguishers to the satisfaction of OWNER/ SIPI.

3.1.7 The Contractor shall evolve a comprehensive planned and documented system for implementation and monitoring of the HSE requirements. This shall submitted to OWNER & SIPI for approval well in advance, prior to start of work. The monitoring for implementation shall be done by regular inspection and compliance to the observations thereof. The Contractor shall get similar HSE requirements implemented at his subcontractor (s) work site/ Office. However, compliance of HSE requirement shall be the sole responsibility of the Contractor. Any review/ approval by OWNER/ SIPI shall not absolve the Contractor of his responsibility/ liability in relation to all HSE requirements.

3.1.8 Non-Conformance on HSE by the Contractor (including his Subcontractors) as brought out during review/ audit by SIPI/ OWNER representative shall be resolved forthwith by Contractor. Compliance report shall be possibility submitted to SIPI/ OWNER at the earliest.

3.1.9 The Contractor shall ensure participation of his Resident Engineer/Site-in- Charge in the Safety Committee/HSE Committee meetings arranged by OWNER/ SIPI. The compliance of any observation shall be arranged urgently. Contractor shall assist OWNER/SIPI to achieve the targets set by them on HSE during the project implementation.

3.1.10 The Contractor shall adhere consistently to all provisions of HSE requirements. In case of non-compliance or continuous failure in implementation of any of HSE provisions; OWNER/ SIPI may impose stoppage of work without any Cost & Time implication to Owner and/or impose a suitable penalty for non-compliance with a notice of suitable period, upto a cumulative limit of 1.0% (one percent) of Contract value with a ceiling of Rs. 10 lakhs. This penalty shall be in addition to all other penalties specified else where in the contract. The decision of imposing stoppage of work, its extent & monitory penalty shall rest with SIPI/OWNER & binding on the Contractor.

3.1.11 All fatal accidents and other personnel accidents shall be investigated by a team of Contractor's senior personnel for root cause and recommend corrective and preventive actions. Findings shall documented and suitable actions taken to avoid recurrences shall be communicated to OWNER/SIPI. OWNER/SIPI shall have the liberty to independently investigate such occurrences and Contractor shall extend all necessary help and co-operation in this regard.

3.2 **House Keeping**

3.2.1 Contractor shall ensure that a high degree of house keeping is maintained and shall ensure the followings:

a. All surplus earth and debris are removed/disposed off from the working site to identified location (s).

b. Unused/Surplus Cables Steel items and steel scrap lying scattered at different places within the working areas are removed to identified location (s).

c. All wooden scrap, empty wooden cable drums and other combustible packing materials shall be removed from work place to identified location(s).

d. Roads shall be kept clear and materials like pipes, steel, sand, boulders, concrete chips and bricks, etc. shall not be allowed in the roads to obstructs free movement of men & machineries.

e. Fabricated steel structurals, pipes & piping materials shall be stacked properly for erection.

f. Water logging on rods shall not be allowed.

g. No parking of trucks/ trolleys, cranes and trailors etc. shall be allowed on of roads, which may obstruct the traffic movements.

h. Utmost care shall be taken to ensure over all cleanliness and proper up keep of the working areas.

i. Trucks carrying sand, earth and pulverized materials etc. shall be covered while moving within the plant areas.

3.3 Healthy, Safety and Environment

a) The Contractor shall provide safe means of access to any working place including provision of suitable and sufficient scaffolding at various stages during all operations of the work for the safety of his workmen, and OWNER/ SIPI. Contractor shall ensure deployment of appropriate equipment and appliances for adequate safety and healthy of the workmen and protection of surrounding areas.

b) The Contractor shall ensure that all their staff workers including their sub-Contractor (s) shall wear Safety Helmet and Safety shoes. Contractor shall also ensure use of safety belt, protective goggles, gloves etc. by the personnel as per jobs requirements. All these gadgets shall conform to relevant IS specification equivalent.

c) Contractor shall ensure that a proper Safety Net System shall be used at appropriate locations. The safety net shall be located not more than 30 feet (9.0 metres) below the working surface at site to arrest or to reduce the consequences of possible fall of persons working at different heights.

d) Contractor shall ensure that flash back arrester shall used while using gas Cylinders at site. Cylinders shall be mounted on trollys.

e) The Contractor shall assign to his workmen, tasks commensurate with their qualification, experience and state of health for driving of vehicles, handling and erections of materials and equipment’s. All lifting equipments shall be tested certified for its capacity before use. Adequate and suitable lighting at every work place and approach there to shall be provided by the contractor before starting the actual work/ operation at night..

f) Hazardous and/or toxic material such as solvent coating or thinners shall be stored in appropriate containers.

g) All hazardous materials shall be labeled with the name of the materials, the hazards associated with its use and necessary precautions to be taken.

h) Contractor shall ensure that during the performance of the work all hazards to the health of personnel have been identified assessed and eliminated.

i) Chemical spills shall be contained & cleaned up immediately to prevent further contamination.

j) All personnel exposed to physical agents such as ionizing or nonionizing radiation ultraviolet rays or similar other physical agents shall be provided with adequate shielding or protection commensurate with type of exposure involved.

k) Where contract or exposure of hazardous materials could exceed limits or could otherwise have harmful affects, appropriate personal protective equipment’s such as gloves, goggles, aprons, chemical resistant clothing and respirator shall be used

l) Contractor shall ensure the following facilities at work sites:

I) A Crèche where 10 or more female workers are having children below the age of 6 years.

II) Reasonable Canteen facilities are made available at appropriate location depending upon site conditions.

m) Suitable facilities for toilet, drinking water, proper lighting shall be provided at site and labor camps, commensurate with applicable Laws/Legislation.

n) Contractor shall ensure storage and utilization methodology of material that are not detrimental to the environment. Wherever required Contractor shall ensure that only the environment friendly material are selected.

o) All person deployed at site shall be knowledgeable of and comply with the environmental laws, rules & regulation relating to the hazardous materials substance and wastes. Contractor shall not dump, release or otherwise discharge or dispose off any such materials without the authorization of OWNER/ SIPI.

p) Before starting of any job at site, HSE shall be strictly followed, tool box talks shall be conducted by CONTRACTOR in front of EIC/PMC.

4.0 DETAILS OF HSE MANAGEMENT SYSTEM BY CONTRACTOR

4.1 On Awards of Contract

The Contractor shall prior to start of work submit his Health. Safety and Environment Manual of procedure and HSE Plans for approval by OWNER/SIPI. The Contractor shall participate in the pre-start meeting with OWNER/SIPI to finalize HSE plans including the following.

- Job procedure to be followed by Contractor for activities covering Handling of equipment's, Scaffolding, Electric Installation, describing the risks involved, actions to be taken and methodology for monitoring each.

- Organizations structure along with responsibility and authority records/ reports etc. on HSE activities.

4.2 During job execution

4.2.1 Implement approved Health, Safety and Environment management procedure including but not limited to as brought our under para 3.0. Contractor shall also ensure to:

- Arrange workmen compensation insurance, registration under ESI Act, third party liability insurance etc. as applicable.

- Arrange all HSE permits before start of activities (as applicable) like her work, confined space, work at heights, storage of Chemicals/explosives materials and its use and implement all precautions mentioned therein

- Submit timely the completed check list on HSE activities, Monthly HSE report, accident report, investigation report, etc. as per OWNER/SIPI requirements. Compliance of instructions on HSE shall be done by Contractor and informed urgently to OWNER/SIPI.
- Ensure that resident Engineers/Site-In-Charge of the Contractor shall amend all the Safety Committee/HSE meeting arranged by OWNER/ SIPI only in case of his absence from site, a seconds senior most person shall be nominated by him in advance and communicated to OWNER/SIPI.

- Display at site office and work locations caution boards, list of hospitals for emergency services available.

- Provided posters, banners, for safe working to promote safety consciousness

- Carryout audits/inspection at sub-Contractor work as per approved HSE documents & submit the reports for OWNER/SIPI review.

- Assist in HSE audits by OWNER/ SIPI and submit compliance report.

- Generate & submit HSE records/ reports as per HSE Plan.

- Appraise OWNER/SIPI on HSE activities at site.

ANNEXURE-A

RELEVANT IS-CODES FOR PERSONNEL PROTECTION

IS:2925-1984 : Industrial Safety Helmets.

IS:4770-1968 : Rubber gloves for electrical purposes

IS:6994-1973 (Part-I) : Industrial Safety Gloves (Leather & Cotton)

IS:1989-1986 (Part-I & III) : Leather safety boots and shoes.

IS:3738-1975 : Rubber knee boots

IS:5557-1969 : Industrial and Safety rubber knee boots.

IS:6519-1971 : Code of practice for selection, care and repair of Safety footwear

IS:11226-1985 : Leather Safety footwear having direct moulding sole.

IS:5983-1978 : Eye protectors.

IS:9167-1979 : Ear protectors.

IS:3521-1983 : Industrial Safety belts and harness.

ANNEXURE-B
Format – 1.0

1.0 HEALTHY, SAFETY & ENVIRONMENT (HSE) PLAN

Project:_____Contractor:_____

Date:_____Owner:_____

(To be prepared & submitted by each Construction Agency)

Activity Description	Procedure/ W.I./ Guidelines	Code of Conformance	Performing Function			Audit Function
			Performance	Checker	Approver	Customer Review/ Audit Requirements

PREPARED BY REVIEWED APPROVED BY

2.0 MONTHLY CHECKLIST CUM COMPLIANCE REPORT REGARDING HSE (1/6)

Project: _____ Contractor :_____

Date: _____ Owner :_____

Inspection By:_____

Note: write 'NC' (Not Concern) wherever any of the items are not applicable

Item	Yes	No	Remark	Action
HOUSEKEEPING				
Waste containers provided and used				
Sanitary facilities adequate and Clean				
Passageways and Walkways Clear				
General neatness of working areas				
Proper Material Storage				
Wooden Boards properly stacked & nails removed				
Cords, leads out of walk and traffic ways				
Scraps removed from the work site				
Other				
PERSONNEL PROTECTIVE EQUIPMENT				
Goggies: shields				
Face protection				
Hearing protection				
Safety Shoes provided				
Hand protection				

Respiratory Masks etc.				
Safety Belts				
Safety Helmets				
Other				
EXCAVATIONS/ OPENINGS				
Excavation permit				
Excavated earth kept away from edge				
Dewatering pump kept away from edge				
Safe access into excavated area				
Openings properly covered or barricaded				
Excavations shored				
Excavations barricaded				
Overnight lighting provided				
Other				

MONTHLY CHECKLIST CUM COMPLIANCE REPORT REGARDING HSE (2/6)

Item	Yes	No	Remark	Action
WELDING CUTTING				
Valid not work permit				
Flashback arrester provided for cylinders				
Power cable not crossing the welding cable				
Adequate earthing provided				
No combustible materials kept near welding & cutting works				
Gas cylinder chained upright & kept in trolleys				
Cables and hoses not obstructing				
Screens or shields used				
Flammable materials protected				
Fire extinguisher (s) accessible				
Other				
SCAFFOLDING				
Fully decked platform				
Guard and intermediate rails in place				
Toe boards in place & tied properly				
Adequate shoring				
Adequate access				
Other				
LADDERS				
Extension side rails I m above				
Top of landing				
Properly secured at top & bottom				
Angle ± 70° from horizontal				
Other				

MONTHLY CHECKLIST CUM COMPLIANCE REPORT REGARDING HSE (3/6)

Item	Yes	No	Remark	Action
HOISTS, CRANES AND DERRICKS				
Condition of cables and sheaves OK				
Condition of slings, chains, hooks and eyes OK				
Inspection and maintenance logs maintained				
Outinggers used				
Singh/barricades provided				
Signals observed and understood				
Qulified opretors				
Other				
MACHINERY, TOOLS AND EQUIPMENT				
Proper instruction				
Saftey devices				
Proper cords				
Inspections and maintenance				
Other				
VEHICLE AND TRAFFIC				
Rules and regulations observed				
Inspection and mantinance				
Licensed drivers				
Others				

MONTHLY CHECKLIST CUM COMPLIANCE REPORT REGARDING HSE (4/6)

Item	Yes	No	Remark	Action
TEMPORARY FACILITIES				
Emergency instruction posted				
Fire extinguishers provided				
Fire-aid equipment				
Secured against storm damage				
General nemeses				
In accordance with electrical requirements				
Other				
FIRE PREVENTION				
Personnel instructed				
Fire extinguishers checked				
No smoking in prohibited areas.				
Hydrants clear				
Other				

ELECTRICAL				
Proper wiring & earthing				
ELCB's provided				
Ground fault circuit interruptors				
Protection against damage				
Prevention of tripping hazards				
Proper electrical cable joints				
Light poles secured				
Clear way to power distribution board				
Proper rating of fuses				

MONTHLY CHECKLIST CUM COMPLIANCE REPORT REGARDING HSE (5/6)

Item	Yes	No	Remark	Action
HANDLING AND STORAGE OF MATERIALS				
Properly stored or stacked				
Passageways clear				
Other				
FLAMMABLE GASES AND LIQUIDS				
Containers clearly identified				
Proper storage				
Fire extingui HSErs nearby				
Other				
WORKING AT HEIGHT				
Erection plan				
Safety nets				
Safety belts tied properly				
Illumination				
No loose material at height				
NO body under working area				
All openings covered				
Other				
ENVIRONMENT				
Chemical and other Effluents properly disposed				
Cleaning liquid of pipes disposed off properly				
Seawater used for hydrotesting disposed off as per agreed proceeding				
Lubricant Waste/Engine oils properly disposed				
Waste from Canteen office, sanitation etc. disposed properly				
Disposal of surplus earth, stripping materials, Oily rags and combustible materials done properly				
Green belt protection				

MONTHLY CHECKLIST CUM COMPLIANCE REPORT REGARDING HSE (Contd…. 6/6)

Item	Yes	No	Remark	Action
HEALTH CHECKS				
Hygienic conditions at labour camps OL				
Availability of First Aid facilities				
Proper sanitation at site, officer and labour camps				
Arrangements of medical facility				
Measures for dealing with illness				
Availability of potable drinking waters for workmen & staff.				
Provision of cretches for children.				
ERECTION				
Slings/ D’shakle checked				
Signal Man				
Tag line for guiding the load				
Protecting the slings from sharp edges				
No loose materials at height				
Ladder & platform welding inspected				
No one under the suspended load				
Stay rope				
SWL				

_____

Signature of Resident
Engineer with Seal

ANNEXURE-B

Format-3
3.0 ACCIDENT REPORT
(To be submitted by Contractor after every accident within 2 hours of accident)

Report No:_____
Date: _____

Name of Site:-_____
CONTRACTOR_____
NAME OF THE INJURED……
…..
FATHER'S NAME……..
SUB-CONTRACTOR M/S……..……
…..
DATE & TIME OF ACCIDENT…….
LOCATION
……

BRIEF DESCRIPTION OF ACCIDENT

CAUSE OF ACCIDENT

NATURE OF INJURY/DAMAGE

MEDICAL AID PROVIDED/ACTIONS TAKEN

INTIMATION TO LOCAL AUTHORITIES

DATE: SIGNATURE OF CONTRACTOR WITH SEAL

To : OWNER…….. 1 COPY
: RCM/SITE-IN-CHARGE, SIPI 1 COPY

ANNEXURE-B

Format-4

4.0 SUPPLEMENTARY ACCIDENT & INVESTIGATION REPORT

Project:_____ Supplementary to Report No: _____

(Copy enclosed)

Site:_____ Date:_____

Contractor:_____

NAME OF THE INJURED ……

FATHER'S NAME……...

SUB-CONTRACTOR M/S……...

DATE & TIME OF ACCIDENT……

LOCATION……

BRIEF DESCRIPTION OF ACCIDENT

NATURE OF INJURY/DAMAGE

COMMENTS FROM MEDICAL PRACTITIONER WHO ATTENDED THE VICTIM/INJURED

SUGGESTED IMPROVEMENT IN THE WORKING CONDITION IF ANY

LOSS OF MANHOURS AND IMPACT ON SITE WORKS

DATE: SIGNATURE OF CONTRACTOR WITH SEAL

To : OWNER…….. 1 COPY

: RCM/SITE-IN-CHARGE, SIPI 1 COPY

5.0 MONTHLY Health, Safety & Environment (HSE) REPORT
(To be submitted by each Contractor)

Actual work start Date:_____ For the Month of:_____

Project:_____ Report No:_____

Name of the Contractor:_____ Status as on:_____

Name of Work:_____ Name of Safety officer:_____

Item	This Month	Cumulative
Total strength (Staff –Workmen)		
Number of HSE meeting organized at site		
Number of HSE awareness programmes conducted at site		
Whether workmen compensation policy taken		
Whether workmen compensation policy valid		
Whether workmen registered under ESI Act		
Number of Fatal Accident		
Number of Loss Time Accident (Other than Fatal)		
Other accident (Non Loss Time)		
Total No. of Accident		
Total man-hours worked		
Man-hour loss due to fire and accident		
Compensation cases raised with Insurance		
Compensation cases resolved and paid to workmen		
Remark		

Date: __/__/__

Safety Officer/RCM
(Signature and name)

To: OWNER…….. 1 COPY
RCM/SITE-IN-CHARGE SIPI 1 COPY

****

SPECIFICATION

FOR

QUALITY ASSURANCE SYSTEMS REQUIREMENTS

SPECIFICATION NO. SIPI/Steel/TS/23

CONTENTS

ATTACHMENTS

1.0 INTRODUCTION

This specification establishes the Quality Assurance Requirements to be met by the sub-contractors (including turnkey Contractors) and their sub-vendors.

In case of any conflict between this specification and other provisions of the contract/ purchase order, the same shall be brought to the notice of SIPI, at the stage of bidding and shall be resolved with SIPI, prior to the placement of order.

2.0 DEFINITION

Bidder

For the purpose of this specification, the word “Bidder” means the person(s), firm, company or organisation who is under the process of being contracted by SIPI/ Owner for delivery of some products (including service). The word is considered synonymous to supplier, contractor or vendor.

Correction

Action taken to eliminate the detected non-conformity.

Refers to repair, rework or adjustment and relates to the disposition of an existing non-conformity.

Corrective Action

Action taken to eliminate the causes of an existing non-conformity, defect or other undesirable situation in order to prevent recurrence.

Preventive Action

Action taken to eliminate the causes of a potential non-conformity, defect or other undesirable situation in order to prevent its recurrence.

Process

Set of inter-related resources and activities which transform inputs into outputs.

Special Process

Processes requiring pre-qualification of their process capability.

3.0 CONTRACTORS SCOPE OF WORK

3.1 Prior to award of contract

The bidder shall understand scope of work, drawings, specifications and standards etc., attached to the tender/ enquiry document, before he makes an offer.

The bidder shall submit milestone chart showing the time required for each milestone activity and linkages between different milestone activities alongwith overall time period required to complete the entire scope of work. The bidder shall develop and submit manpower and resource deployment chart.

The bidder shall submit, alongwith the bid, a manual or equivalent document describing/ indicating/ addressing various control/ check points for the purpose of quality assurance and the responsibilities of various functions responsible for quality assurance.

3.2 After the award of contract

The bidder shall submit the schedule for submission of following documents in the kick-off meeting or within two weeks of the placement of order, whichever is earlier.

- Detailed Bar Chart
- Quality plan for all activities, required to be done by the bidder, to accomplish offered scope of work.
- Inspection and test plans, covering various control aspects.
- ob procedures as required by SIPI/ Owner.
- Procurement schedule for items to be supplied by contractor covering inspection of the same.

Various documents submitted by the bidder shall be finalised in consultation with SIPI. Here it shall be presumed that ones a bidder has made an offer, he has understood the requirements given in this specification and agrees to comply with them in totality unless otherwise categorically so indicated during pre-award stage through agreed deviation/ exception request. All Quality Assurance Plan (QAP) documents shall be reviewed by concerned functional groups of SIPI and the bidder shall be required to incorporate all comments within the framework of this specification at this stage of the contract. It is also obligatory on the part of the bidder that obtains approval on every Quality Assurance Plan (QAP) documents, before he starts using a particular document for delivery of contracted scope of work. Participation of SIPI/ Owner in review/ approval of quality plan/ QAP documents does not absolve the contractor of his contractual obligations towards specified and intended use of the product (or service) provided/ to be provided by him under the contract.

3.3 During job execution

During job execution, the bidder shall fully comply with all quality document submitted and finalised/ agreed against the requirements of this specification. Approval of SIPI on all these documents shall be sought before start of work.
Bidder shall produce sufficient quality records on controlled/ agreed forms such that requirements given in this specification are objectively/ demonstrable.

Bidder shall facilitate SIPI/ Owner during quality/ technical audits at his works/ sites.

Bidder shall discharge all responsibilities towards enforcement of this specification on all his sub-contractors for any part of the scope which is subcontracted.

4.0 QUALITY ASSURANCE SYSTEM REQUIREMENTS

4.1 The bidder shall nominate an overall incharge of the contract titled as "Project Manager" for the scope of work of agreed contract. The name of this person shall be duly intimated to SIPI including all subsequent changes, if any. SIPI shall correspond only with the project manager of the bidder on all matters of the project. The project manager of the bidder shall be responsible for co-ordination and management of activities with bidder's organisation and all sub-vendors appointed by the bidder.

After award of work, the bidder may review augmentation of manpower and resources deployment chart (submitted earlier), detail it out, if so consented by SIPI/ Owner and resubmit the same as "issued for effective implementation of the project".

4.2 The bidder shall plan the contract scope of work on quality plan format such that no major variation is expected during delivery of contract scope of work. These quality plan shall be made on enclosed format complete in all respect. The quality plan shall be assumed to be detailing bidder's understanding and planning for the contract/ offered scope of work. The bidder shall plan the type of resources including various work methodology which he agrees to utilize for delivery of contract scope of work.

4.3 The bidder is required to review the contract at all appropriate stages to evaluate his capabilities with respect to timely and quality completion of all activities pertaining to contracted scope of work and shall report for constraints, if any to SIPI/ Owner.

4.4 The design activities, if any, performed during delivery of contract scope of work shall be so controlled that the outputs is reliable enough. It is expected that during development of design, the bidder shall take recourse to detailed checking, inter departmental reviews and documented verification methods.

4.5 For all documents which the bidder is likely to utilise for delivery of contract scope of work, a system must exist which assures that latest/ required version(s) of the document(s) is available at all location/ point of use.

4.6 In case the bidder decides to sub-contract any part/ full of the contract scope of work (without prejudice to main Contractual condition), the bidder shall :

- Evaluate the technical and financial capabilities and past performance of the sub-contractor(s) and their products and/ or services before awarding them with the sub-contracted scope of work. Selection of a sub-contractor should meet SIPI approval in documented form.

- Requirement of this specification shall be enforced on sub-contracted agency also. The bidder shall choose sub-contractor based on their capability to meet requirements of this specification also.

Note: It may so happen that, in a given situation, a sub-contractor may not have a system meeting the requirements of this specification. In all such eventualities, bidder may lend his system to sub-contractor for the contract such that sub-contractor effectively meets the requirements of this specification. In all such cases SIPI shall be duly informed.

4.7 Bidder shall establish adequate methodology such that the materials supplied by the Owner/ SIPI shall be adequately preserved, handled and made use of for the purpose for which they are provided.

4.8 All output delivered against contract scope of work shall be suitably identified in such a manner that either through identification or some other means, sufficient traceability is maintained which permits effective resolution of any problem reported in the outputs.

4.9 Critical activities shall be identified and the bidder is required to have documented methodologies which he is going to utilize for carrying out such activities under the contract scope of work. Wherever it is difficult to fully inspect or verify the output (special process), bidder shall pre-qualify, the performers and methodologies.

4.10 All inspections carried out by the bidder’s surveillance/ inspection staff shall be conformity to quality plans and/ or inspection and test plans. All inspection results shall be duly documented on controlled/ agreed forms such that results can be co-related to specific product, that was inspected/ tested.

4.11 All inspection, measuring & test equipments (IMTEs) shall be duly calibrated as per National/ International standards/ codes and only calibrated and certified IMTEs shall be utilized for delivery of contract scope of work.

4.12 All outputs/ products delivered against contract scope of work shall be duly marked such that their inspection status is clearly evident during all stages/ period of the contract.

4.13 All non-conformities (NCs) found by the contractor’s inspection/ surveillance staff shall be duly recorded, including their disposal action. The deficiencies observed during stage of the product, shall be recorded and resolved suitably. Effective corrective and preventive action shall be implemented by the bidder for all repetitive NCs, including deficiencies.

4.14 All deficiencies noticed by SIPI/ Owner representative(s) shall be recorded on a controlled form (Format No. 00002). Such deficiencies shall be analysed by the bidder and effective and appropriate correction, corrective and preventive actions shall be implemented. Bidder shall intimate SIPI/ Owner of all such corrective and preventive action implemented by him.

4.15 Bidder shall establish appropriate methodologies for safe and effective handling, storage, preservation of various materials/ inputs encountered during delivery of contract scope of work.

4.16 Bidder shall prepare sufficient records for various processes carried out by him for delivery of contract scope of work such that requirements of this specification are objectively demonstrable. In case SIPI/ Owner finds that enough objective evidence/ recording is not available for any particular process, bidder shall be obliged to make additional records so as to

provide sufficient objective evidence. The decision of SIPI/ Owner shall be final and binding on such issues.

4.17 The bidder shall arrange internal quality audits at quarterly intervals, to independently assess the conformance by various performers to the requirements of this specification. The findings of such assessment shall be duly recorded and a copy shall be sent to SIPI/ Owner for review.

4.18 For all special processes, bidder shall deploy only qualified performers. Wherever SIPI/ Owner observes any deficiency, the bidder shall arrange the adequate training to the performer(s) before any further delivery of work.

OBSERVATION OF QUALITY ASPECTS
FORMAT - 00002

<table>
<tr><td colspan="4">Job No. and Description
Issued to :
No. :
M/s Date :</td></tr>
<tr><td colspan="4">Location of Work :
Item of Work :</td></tr>
<tr><td colspan="2">Details of Observation(Deficiency)</td><td colspan="2">Recommended Course of Action

Time Allowed for Correction :</td></tr>
<tr><td colspan="4">Issued by : _____
Name of Signature of SIPI</td></tr>
<tr><td colspan="4">Corrective Action taken report by Contractor/ Vendor :

Date : Name and Signature</td></tr>
<tr><td colspan="4">Distribution (before resolution) :</td></tr>
<tr><td>Project Manager Owner</td><td>Chief Business Executive SIPI</td><td>SIPI Inspection Benin</td><td>Residential Construction Manager, SIPI Site</td></tr>
<tr><td colspan="4">Verification of Resolution by SIPI:

Date : Name and Signature</td></tr>
<tr><td colspan="4">Distribution (before resolution) :</td></tr>
</table>

FORMAT – 00001

Bidder's Quality Plan		Project Name :				PO/ Contract Ref:				
General		Performing Functions				Inspection Functions			Audit Function	
Activity Description	Procedure Number	Code of Conformance	Performer	Checker	Reviewer/ Approver	Sampling Plan	Testing and Inspection Code	Type of (Approval) Surveillance	Audit Scope	Owner's/ SIPI Review/ Audit Requirement

Note: 1) The bidder ensures that the filled up format conforms to minimum requirements on Quality Plan/ Quality Assurance, specified by SIPI on drawings/ standards/ specifications/ write-up.

2) The bidder confirms that document is issued for information/ approval of Owner/ SIPI for the project implementation

SPECIFICATION

FOR

DOCUMENTATION FOR PIPELINE CONSTRUCTION

SPECIFICATION NO. SIPI/Steel/TS/24

C O N T E N T S

1.0 SCOPE

1.1 This specification covers the minimum requirements of various records, reports and drawings for all aspects of pipeline construction to be prepared by Contractor and submitted to the Company at intervals as described in this specification and as directed by Company.

1.2 All document required to prepared and submitted by Contractor as per this specification shall be in addition to the various reports, records, methodology statement, calculation, drawings etc. to be submitted by the Contractor for Company's record, review or approval as per the requirements of all other specification included in the Contract between the Company and Contractor.

1.3 This specification shall be read in conjunction with the conditions of all specifications and document included in the Contract between Company and Contractor.

2.0 RECORDS

Contractor shall submit daily, weekly, monthly and after completion to the Company, various records and reports for Company's documentation purpose during and immediately after the construction. This shall as minimum include, but not limited to the following :

2. Daily

- Separate progress reports of all crews
- Daily welding results and repairs
- Actual weather conditions
- Application for deviations, if any
- Accidents
- Damages
- Activities required from Company
- Materials Receipts
- Urgently required materials

2.2 Weekly

- Up-to-date list of confirmed site instruction issued by Company
- Materials `taken over'
- Material defects and repairs
- Outstanding activities of Company

- List of installed markers, chainage
- Required approval from Company
- Progress planned
- Reports of manning of all crews, equipment and plant
- Report of equipment and plant
- Report of accidents
- Report of damages
- Report of acquired release, permits
- Priced variations
- Required materials for next month

2.3 **Monthly**

- Progress report for payment, safety report, report of accidents, security report, health and environment report, material balance, approved deviations.

2.4 Further, Contractor shall supply (for approval if required to the Company with document such as but not limited :

- Organogram for construction work.
- Bio-data of key personnel (including foremen).
- (Revised) list of address of personnel in particular of medical staff, safety and security offers.
- (Revised) list of approved coaters.
- (Revised) list of approved sub-contractors.
- Time schedule.
- Acquired permits and/ or approvals from Authorities, if any.
- Minutes of meeting with Company with comments, if any.
- Material certificates, material receipt.
- Guarantee from vendors and sub-contractor.
- Calculations, temporary works, bouyance, blasting.

- Drawings issued by Contractor.
- Vendors drawings.
- As-built of route maps, alignment sheets, details drawings and isometric drawings.
- Procedures such as surveying, stacking, fencing.
- Welding procedure qualification records, radiographic procedure qualification, welder qualification.
- Coating procedure.
- Installation of crossings.
- Hydrostatic testing.
- Blasting.
- Radiographic report alongwith original radiographs
- Pipe and welding book.
- Reports

- Material tests (coating, welding, painting)
- Computerised Potential Logging Test
- Water Samples
- Cleaning, Pigging Report before Hydrostatic Test
- Hydrostatic Test
- Calibration Test
- Blasting Trials
- Equipment certificate (dead weight tester, instruments, vessels, equipment)
- Manuals
- Major water crossings
- Waste disposal
- Disposal of water after hydrostatic test.

2.5 Contractor shall submit to company colour photographs of various construction activities/ operations at regular intervals. Size, number and frequency of the photographs shall be mutually agreed upon at a later stage. Also Contractor shall make video recordings of all operations right from the start of construction till the completion of the work, covering to the extent as instructed by Company and submit to Company. Upon completion of the work, Contractor and submit edited master tape plus six copies of video recording in VHS formats or any format ordered by the Company. The duration of video recording shall be of ½ hour and shall cover all aspects of the job.

3.0 AS-BUILT DRAWINGS AND PIPE BOOK

3.1 General

Contractor shall prepare "as-built" drawings of all by or on behalf of Company issued drawings and of all Contractor work drawings including vendor drawing, such as but not limited to :

For Pipeline Section :

- Route Maps
- Alignment Sheets
- Detail Drawings (road, railway, minor water crossings, major water
- crossings, valley crossings)
- Isometric drawings of installations
- Special installation

Further Contractor shall prepare a pipe Weld Book.

If required by the Company, Contractor shall update the diskettes for drawings issued for construction of the job.

3.2 "As-Built" Drawings

Contractor shall prepare a complete set of "as-built" drawings. From the start of construction, Contractor shall on daily basis process any changes in two sets of drawings. Deleted parts shall be indicated in red, new parts in blue, remarks in green and unchanged parts in yellow. Said drawings shall be kept at site and be available to Company at all times. Contractor shall prepare "as-built" drawings based on these data. On completion of the work, one revised film transparency of all drawing made "as-built" by Contractor containing the "as-built" information shall be handed over to Company as well as one complete set of CD ROM/ floppy diskettes as specified by Company.

Contractor shall prepare and submit a specimen of the layout of the drawings for Company's approval.

The required measurement for "as-built" drawing shall be executed by Contractor by experienced, qualified surveyors.

The surveyors shall daily take care of all measurement required such as but not limited to:

- Horizontal location of pipeline with regard to deviations and Permanent Grid Pillars.

- Vertical Level with regard to Mean Sea Level of pipeline and grade.

    - Location and type of bends, fittings etc. and grades, points of intersection.

    - Change of wall thickness, materials.

    - Location and details of valves, insulating flanges, fencing.

    - Location and details of crossing pipes, vents.
    - Location and type of coating.

- Location and type of weighting, anchoring.
- Location and type of markers.
- Location of further appurtenance (Pig-Signallers)
- Location of ROU and of pipeline with respect to ROU.
- Type of soil.
- Type of rock
- Type of blasting and ripping.
- Sand padding.
- Type of road pavement.
- Details of bank protection, number of insulators, seals.

Contractor shall also prepare isometric drawings of all installation (facilitates) etc. for which the data as mentioned in or required for the Pipe and Welding Book can be identified and these drawings can also be used for material accounting.

3.3 Nameplates of Equipment

All permanent equipment supplied and installed by Contractor shall be provided with plates by Contractor. All texts shall be submitted to Company for approval before plates may be manufactured.

3.4 Pipe Book

Every page of the pipe and Welding Book shall mention:

- Data relevant to the project and section there of.
- Sequential number.
- Length brought forward (for pipes and other materials).
- Length to bring forward (for pipes and other materials).

Alignment sheet number and atleast the location thereon of two welds on every page of the pipe Book.

Further,

- Diameter of pipeline
- Length of each pipe
- Wall thickness
- Pipe number
- Heat number, certificate number

- Cut and re-numbered pipe ends
- Coating type
- Date of stringing
- Date of welding
- Direction of working
- Heat treatment
- Equipment used for radiography
- Limits of water crossings
- Test pressure and date of test.

In order to achieve this, Contractor shall identify all pipe elements. Sample format of Pipe Book shall be submitted for Company approval.

3.5 **As-Built Documents**

Contractor shall prepare all documents in the prescribed format as indicated below. In addition to the three hard copies, three copies of final documents shall also be submitted in electronic media i.e. PEN DRIVE.

Software used for the preparation of these documents shall be as follows: Type document Software

a. Reports/ Documents MS Office

b. Drawings Auto CAD

For the purpose of preparation of as-built drawings, Contractor shall update the “Issued for construction” drawings issued by the Company. It shall be the Contractor’s responsibility to covert the drawings furnished by the Company in hard copy into CAD drawings including scanning, digitising and converting the drawings into a suitable format compatible with the AutoCAD and above. As-built drawings shall be prepared only on AutoCAD drawings.

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SPECIFICATIONS

FOR

FIELD JOINT COATINGS OF PIPELINE FOR HDD CROSSING

SPECIFICATION NO. SIPI/Steel/TS/25

CONTENTS

1.0 SCOPE

1.1 **General**

This specification covers the minimum requirement for application of anticorrosion field joints coating on welded pipe section and field tie-in joints referred to herein after as Joint(s). The contractor shall perform all work in accordance with this specification, latest pipeline coating practices and to the full satisfaction of the Owner. The anti-corrosion pipe joint coating shall be compatible with yard applied, Ultraviolet (UV) radiation protected, 3-layer side extruded polyethylene coating conforming to DIN-30670. The sleeve width shall be suitable for cutting back of 120 ± 20 mm to be left at both the ends of coated pipes. The job includes supply of all materials equipment, consumables, labour, supervision, quality control, inspection repairs.

1.2 **Manpower, Material & Equipment**

1.2.1 The Contractor shall supply wrap around heat shrinkable sleeves which is composed of two parts such as adhesive coated wrap around and a curable modified epoxy primer along with applicator pad.

1.2.2 The supply of wrap around heat shrinkable sleeve shall be under Contractor's scope.

1.2.3 The Contractor shall provide all skilled/ unskilled personnel required for execution of this work.

1.2.4 The joint coating operation starting from cleaning and surface preparation till application of joint coating and wrapping of the pipe joints shall be performed under the supervision of skilled personnel who are well versed in the work.

1.2.5 Contractor shall at his own cost provide a fully equipped laboratory and test facilities with adequate inventory to carry out tests required for procedure qualification and during regular production, for testing of joint coating system.

2.0 **REFERENCE DOCUMENTS**

2.1 Provision of the following documents/ codes shall generally be followed for standard of specification and workmanship.

a) DIN – 30672 : Corrosion protection tapes and Heat Shrinkable Sleeves.
b) SIS – 055900: Pictorial surface preparation standard for painting steel surfaces.
c) SSPC – SP1 : Steel structure painting council – Solvent Cleaning.

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

3.0 **SPECIFICATION FOR FIELD JOINT COATING MATERIAL**

3.1 **General**

This scope covers the minimum requirement of materials, equipment required for installation of field joint coating by wraparound fiber reinforcement heat-shrinkable sleeve used for corrosion protection and sealing of field joints in pipelines that are forced through the soil by Horizontal Directional Drilling technique. The sleeves shall be suitable for 3LPE/FBE coated pipes operating up to 60°C continuously.

3.1.1 Each Joint Coating System shall consist of :

a) A wraparound heat shrinkable sleeve reinforced with fibre-glass. The sleeve shall be coated with a higher- shear- strength thermoplastic hot-melt adhesive.

b) A solvent-free, two component liquid epoxy primer

c) A specifically designed wear cone

d) A clamping belt

3.1.2 **Sleeve Backing**

The heat shrinkable sleeves shall be manufactured from minimum 1.0 mm thick radiation cross linked, thermally stabilized, UV -resistant heat shrinkable fabric, composed of a fiber glass reinforcement and polyolefin fibers, embedded in a polyolefin matrix.

3.1.3 **Sleeve Adhesive**

The inner surface of the sleeves shall be coated with a controlled thickness of minimum 1mm of adhesive which in combination with the modified epoxy primer, will bond to and seal to the steel pipe and common yard applied medium temperature yard coatings.

3.1.4 **Epoxy Primer**

The Epoxy primer shall be a solvent free, modified two components liquid epoxy type primer, which is applied to cleaned and dry steel surface. When the sleeve coatings comes in contact with the liquid primer during installation, a strong bond is formed upon full curing of the system.

3.2 **Properties of Field Joint Coating Material**

The pipe sleeves furnished under this specification shall be tested and shall meet the requirements specified in the table below:-

3.2.1 **Heat-Shrinkable Sleeve Material**

Property	**Test Method**	**Condition**	**Requirement**
Cold Crack	ISO 4675		Below 40°C
Chemical Resistance	ISO 175	168 hrs. immersion on either 0.1 N NaCl @ 23°C, 0.1N H_2SO_4 @ 23°C, 0.1 N NaOH @ 23°C, Fuel oil @ 23°C. Petroleum jelly @ 70°C	
Followed by test for bursting strength	ISO 3303	23°C	1100 N Min.
Thermal ageing Followed by test for bursting strength	ISO 188 ISO 3303	150°C 168 hrs. 23°C	1700 N Min.

3.2.2 **Adhesive material**

Property	**Test Method**	**Condition**	**Requirement**
Softening point	ASTM E28		85°C minimum
Peel Strength	DIN 30672	23°C. CHS* 100 mm/ min. 60°C	200 N/cm minimum 60 N/ cm
Peel Strength After immersion for 4 weeks at 23°C~NaOH pH12 H_2SO_4 pH2 ground water solution:- 1.2% H_3PO_4 1.6% KOH 1.2NaCl 1.0% Fe_2O_3	DIN 30672	23°C. CHS* 100 mm/ min.	200 N/cm minimum
Peel Strength after conditioning for 30 cycles from -30°C to 60°C	DIN 30672	23°C. CHS* 100 mm/ min.	60 N/cm minimum
Shear strength	ISO 4587	23°C. CHS* 50 mm/ min.	200 N/cm_2 minimum
Corrosive effect	ASTM D 2671	120°C. 16 hrs.	No corrosion

3.2.3 **Primer Material**

Property	**Test Method**	**Condition**	**Requirement**
Density	ASTM D1084	23 +/- 0.5_0 C Part A: 2 rpm, spindle #6 Part B: 20rpm, spindle #3	 Part A: 60+/- 30 Pas Part B: 1.55+/-0.55 Pas
Mixing ratio	By weight By volume	23°C	100:40 100:60
Shear strength	ISO 4587	23°C. CHS* 50 mm/ min.	1000 N/cm_2 minimum

*** CHS = Cross Head Speed**

3.2.4 **Functional Properties**

Property	**Test Method**	**Condition**	**Requirement**
Impact Resistance	DIN 30672	23°C. Class C	No holidays when tested at 20 KV
Penetration resistance	DIN 30672	60°C. Class C	Minimum 70% of original resistance thickness left; no holidays when tested at 20 KV
Specific coating Resistance	DIN 30672	23°C.	$10^{\wedge 8}$ Ohm sq. m minimum; no oxidation on pipe surface
Cathodic disbondment resistance	ASTM G42	60°C. 30 days	15 mm increase in radius of disbondment max.
Resistance to split	TEST METHOD- 1*		No cut propagation

propagation			
Resistance to circumferential edge loading	TEST METHOD- 2*		50 KN minimum
Resistance to local edge loading (chisel test)	TEST METHOD- 3*		6 KN minimum

***Test Methods**

3.3 Test Methods

3.3.1 Resistance to split propagation (Test Method -1)

A rectangular piece of 50mm width by 150 mm length shall be cut from the material as delivered. A 5mm long, clean cut shall be made mid-way in the piece along once of the long edges perpendicular to this edge. The sample shall be mounted on a clamp that holds it securely and avoids any shrinking during testing.

The assembly shall be placed in an air-circulating oven present at 170^{0}C. After 15 minutes, the sample shall be removed from the oven, allowed to cool down to room temperature and examined for cut propagation. This test simulates the unlikely event when the sleeve gets cut during the installation phase. Sleeves based upon extruded polyelfin show a distinct tendency to propagate the cut along the total width of the sleeve. Sleeves suitable for HDD works shall not exhibit this behaviour.

3.3.2 Resistance to circumferential edge loading (Test method -2)

The sleeve shall be installed on a DN 200 three -layer PE coated steel pipe piece. A thick wall steel ring that fits a DN 200 three-layer PE coated steel pipe with a tolerance of 0.2+-0.2 mm shall be positioned against the front edge of the wear cone sleeve and then pushed towards the sleeve system at a constant speed of 5 mm/ min over a distance of 50 mm. The forces necessary shall continuously be registered. The minimum required force shall be less than 50 KN.

During the pushing or pulling operation, any obstacle protruding from the smooth pipe surface is loaded by the surrounding soil that passes by. This test simulates the shear forces that are exerted on to the sleeve by rigid soil type.

3.3.3 Resistance to local edge loading (Chisel test: Test Method -3)

The sleeve shall be installed on a DN 200 three-layer-PE coated steel pipe piece.

A chisel as depicted in Figure -1 shall be positioned against the front edge of the wear cone sleeve and, pushed parallel to the pipe surface towards the sleeve system at a constant speed of 5mm/ min over a distance of 50 mm. The forces necessary shall continuously be registered. The minimum required force should not be less than 6 KN.

During the pushing or pulling operation, the pipe may traverse soil area containing solid particles, such as stones, pebbles or crushed rock. These particles tend to rip away the pipe

coating locally. Any obstacle protruding from the smooth pipe surface is lifted, leading to soil undercutting. This test determines the resistance of sleeve against this type of abuse.

3.4 Qualification for Contractor's supplied Materials and their Manufacturer

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

a. 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.

b. 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.

3.4.2 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

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

a. 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 the this specification.

b. Specific application instructions with pictorial illustrations.

c. Specific storage and handling instructions.

3.4.4 All documents shall be in English language only.

3.5 Storage of Materials

Material shall be stored in sheltered storage by the Contractor in the manufacturer's original packing and away from direct sunlight and in accordance with manufacturer's instructions.

4.0 APPLICATION PROCEDURE

4.1 General

a) The application procedure shall be in accordance with manufacturer's instruction and the minimum requirements required below whichever are the most stringent and shall be demonstrated to and approved by the Owner.

b) Contractor shall provide and maintain mobile facilities which contains all necessary tools, propane torches, epoxy primer pumps, silicon rollers, testing instruments, equipment, and spares for cleaning, coating, repairs, inspection and testing.

c) Contractor shall furnish sufficient number of the following equipment and the required spares as a minimum for inspection and testing purpose for each crew:

- Fully automatic full circle adjustable holiday detector with audio and visual output signal for inspection of coating.

- Portable Tensile Strength Tester

- Digital Thermometer

- Solid state digital thickness gauge for measuring thickness of joint coating.

4.2 Pipe Surface Preparation

a) The Contractor shall thoroughly clean and dry the joint surface by power tool cleaning in accordance with SSPC-SP1. The complete procedure and details of equipment used shall be prepared by the Contractor for Owner’s approval prior to commencement of joint coating work.

b) Prior to cleaning operation, Contractor shall visually examine the joint surface area and shall ensure that all defects, flats and other damages have been repaired or removed.

c) Where oil, grease or other materials detrimental to the finished coating is present, it shall be removed with a continuous removal solvents cleaning system to remove completely all such materials in accordance with SSPC-SP1.

d) The standard of finish for cleaned pipe surface shall conform to SA 2½ of Swedish Standard SIS-055900 latest edition. The degree of preparation required to obtain an end product that fulfil the requirements of this specification may not be sufficiently covered and is not limited by SIS-055900. Surface of pipe after shot blasting shall be have an anchor pattern of 50 to 70 microns. This shall be measured by a suitable instrument such as Elecometer.

e) Piper temperature immediately prior to blasting shall be minimum 20°C. At no time shall be blast cleaning be performed when the relative humidity exceeds 70%. Surface temperature must be at least 3°C above the dew point temperature.

f) The abrasive blast material shall be free of impurities and inclusions, water and oil. All abrasives shall be removed after blast by brush or vacuum type cleaner prior to applying joint coating. The abrasive shall be stored in a dry condition and maintained dry during use.

g) The compressed air for blasting shall be free of water and oil. Contractor to verify air cleanliness at the start of the work and every four hours thereafter. Separators and the traps shall be provided at the compressor and blasting station. Separators and traps shall be checked daily for effective moisture and oil removal during coating operations.

h) The ends of existing line pipe protective coating shall be inspected and chamfered. Unbonded portions of the coating shall be removed and then suitably trimmed. Portions where parent coating is removed shall be thoroughly cleaned as specified.

i) Pipe shall be visually inspected by Contractor immediately after blast cleaning for surface defects such as slivers, laminations, leafing, scores, indentation slugs or any other defects considered injurious to the coating integrity. Such defects shall be reported to Owner and on permission from Owner, such defects shall be removed by filling or grinding in such a way as not to "blue" the steel.

4.3 Procedure

a) The application procedure shall be in accordance with manufacturers instruction and the minimum requirements specified below, whichever are the most stringent and shall be demonstrated to and approved by the owner.

b) Applicators 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.

c) Prior to surface cleaning, the surface shall be completely dry. Effective heating equipment which shall not give rise to deposits shall be used. Care shall be taken to avoid damage to existing coating.

d) All pipe joint surfaces shall be thoroughly examined before the application of the coating in order to ensure that the surfaces are free of oil, grease, rust, mud, earth or any other foreign matter.

e) Liquid epoxy primer shall be applied on the joints immediately after the completion of heating operation.

f) The heat shrink sleeve is then wrapped around the joint while the primer is still wet and shall overlap the existing pipe coating by minimum 100 mm on each side.

g) The wraparound sleeve is 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, th pipe surface temperature shall be at least 60°C at every point. To check this, approved temperature indicators shall be used . temperature indicating crayons shall not be used.

h) The wraparound sleeve shall be entirely wrapped around the pipe positioning the closure patch off to one side of the pipe in 10m or 2 O'clock position, with edge of the undergoing layer facing upward and an overlap of min. 100 mm.

i) Heat shrinking shall be 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 as an closure patch to indicate that sufficient heat/ temperature has been

obtained. The joint coating shall have wear cone applied over the leading edge of the sleeve and the clamping belt tightened over it.

j) Application of Wear Cone - The leading edge will be given an extra wear cone. Start by heating the leading-edge area of the main sleeve to 70^{0}C. Wrap the leading-edge sleeve over the transition Mill coating. Ensure that the closure is placed away from the main sleeve closure Shrink the leading-edge sleeve.

k) Application of Metal Belt - The metal belt shall be applied over the wear cone sleeve. The metal belt will be tightened using the strapper tool supplied by the manufacturer.

l) Sufficient manpower working on opposite sides of each pipe joint are required for installation of the sleeve.

m) The installed sleeve shall not be disturbed until the adhesive has solidified.

5.0 INSPECTION

5.1 For wraparound coating, a visual inspection shall be carried out for the following:

- Mastic extrusion on either ends of the sleeves shall be examined.
- There shall be no sign of punctures or pinholes or bond failure. The external appearance of the sleeves shall be smooth, free of dimples, air entrapment or void formation.
- Welded bead profile shall be visible over the sleeves.
- The entire closure patch shall have changed color uniformly.

5.2 Holiday Inspection

5.2.1 The Holiday Detector used shall be checked and calibrated daily with an accurate D.C. voltmeter. The detector electrode shall be in direct contact with the surface of coating to be inspected.

5.2.2 The entire surface of the joint section shall be inspected by means of a full circle Holiday Detector approved by OWNER set to DC Voltage of at least 25 kV for wraparound sleeves. Inspection of the heat shrink sleeve coating shall be conducted only after the joint has cooled below + 50°C.

5.2.3 All the coated joints shall be subjected to Holiday Detection test.

5.2.4 An installed sleeve with more than two holiday shall be stripped and a new one be installed.

6.0 TESTING

a) OWNER reserves the right to test one out of every 30 joint coating subject to a minimum of 2 joints. CONTRACTOR shall provide all assistance in removing and testing of field joint coatings. From each test sleeve, one or more strips of size 25 mm x 200 mm shall be cut one perpendicular to the pipe axis and slowly peeled off. This test shall be conducted between either sleeve and metal or sleeve and mill coating as per direction of Owner/ Engineer-in charge.

b) The required peel strength shall be 60 N/cm (min.) at 23°C. The system shall fail only in the adhesive layer. No failure either in adhesion to steel or adhesion to backing shall be permitted. The adhesive layer that remains on the pipe surface shall be free of voids resulting from air or gas inclusion.

c) If the sleeve taken away for test does not meet the requirement of clause 6.0 (b), the adjacent two sleeves do not meet the requirements of clause 6.0 (b) the field joint coating shall be stopped until OWNER is satisfied with application methods.

d) For the test tensile strength, two parallel incisions spaced 1 CM. Apart are made right down to the surface of the steel. A further incision shall then be at right angles to the first angles to the first two incisions. With the aid of a 1 cm. Wide knife the coating is lifted over a length of about 2 cm. And clamped into the tensile tester, where upon a uniform pull is exerted at an angle of 90 degree. The tensile strength shall be more than 2500 psi.

e) Coating thickness shall be checked by nondestructive method for each field joint.

7.0 REPAIR OF FIELD JOINT COATING

7.1 If a field joint is detected to be unacceptable after inspection and testing as per clause no. 6.0 of this specification. The CONTRACTOR shall , at his own cost :

- determine the cause of the faulty results of the coatings.
- mobilise the services of expert of manufactures, if required.
- test to the complete satisfaction of the OWNER, already completed field joint coatings.
- stop joint coating until remedial measures are taken against the causes of such failures, to the complete satisfaction of the OWNER.

7.2 CONTRACTOR shall replace all the joints coating found or expected to be unacceptable as per clause no. 6.0 of this specification.

7.3 CONTRACTOR shall, at his own cost repair all areas where the coating has been removed for testing by the OWNER or by the CONTRACTOR to the complete satisfaction of the OWNER.

7.4 The upright edges of the damaged areas shall be chamfered, in addition to the steel shall be free from rust, dirt, oil and grease. The coating around the damaged area shall be roughened. After thorough mixing (in accordance with the recommendations of the manufacturer) the filler shall be applied, to sufficient Thickness with the aid of stooping knife, whilst observing ample overlap hardening. The material will require the approval of OWNER.

7.5 After the coating work on welded joints and repairs to the coating have been completed, The coating area as a whole shall be tested with sparktester before pull back/ lowering/jacking the pipeline.

7.6 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 the coating defects are established, the Contractor shall be responsible for excavation at such points, repairing the coating, spark testing and backfilling the excavations without extra charge.

8.0 REPAIR OF PIPE COATING DEFECTS

8.1 Any defect or damage in pipe coating observed till incorporation on permanent works shall be rectified by the Contractor at his risk and cost. However, for repair of damaged coating observed during taking over of Owner supplied pipe, if any, shall be paid extra in accordance with the relevant items of Schedule of Rates.

8.2 Field repair of coated pipes shall be carried out by using same type of wraparound sleeves used for joint coating.

8.3 The repair procedure shall be same as specified herein above for application of anti-corrosion field joint coating on welded pipe.

9.0 DOCUMENTATION

9.1 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 pipe line coating defects
- Procedure qualification record
- Inspection test plan
- Inspection format

9.2 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-in-charge.

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SPECIFICATION

FOR

PIPELINE CROSSINGS USING HORIZONTAL DIRECTIONAL DRILLING METHOD

SPECIFICATION NO. : SIPI/Steel/TS/26

C O N T E N T S

1.0 SCOPE

1.1 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.

1.2 This specification shall be read in conjunction with the requirements of specification and other documents included in the CONTRACT between owner and Contractor.

1.3 Contractor shall execute the work in compliance with laws, by laws, ordinance and regulations. Contractor shall provide all services, labour, inclusive of supervision thereof, supply of all materials (excluding "Owner supplied Material), equipment , appliances etc..

1.4 Contractor shall take full responsibility for the stability and safety of all operation and methods involved in the work.

1.5 Contractor shall be deemed to have inspected and examined the work area and its surroundings and to have satisfied himself as far as practicable with the surface conditions, hydrological and climatic conditions, the extent and nature of the work and materials necessary for the completion of the work, and the means of access to the work area.

1.6 Contractor shall be deemed to have obtained all necessary information with regard to risks, contingencies and all other circumstances, which may influence the work.

1.7 Contractor shall, in connection with the work, provide and maintain at his own costs all lights, guards, fencing, as necessary or directed by Owner or their representative.

1.8 For the purpose of this specification, the following definitions shall be held.

- The words `Shall' and `Must' are mandatory.
- The words `Should, May and Will' are non-mandatory, advisory, or recommendatory.

1.9 Contractor shall provide free of charge reasonable facilities to Owner's personnel to witness all stages of construction.

2.0 DESIGN AND ENGINEERING

2.1 The limits of each crossing shall be determined by the Contractor on the basis of crossing profile based on survey drawings, design, equipment, installation technique and site condition. Contractor shall furnish all engineering design calculation and crossing drawings etc. to owner for their approval prior to execution of the work.

2.2 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.

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, drainpipes, 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.

2.3 The entry and exit points of the pipeline at ground level shall not come within the limits of crossing as defined in the crossing drawings.

2.4 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.

2.5 **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.

2.6 **Back-reamed hole and Pipeline Interface**

2.6.1 Contractor shall derive combination of:

- Back-reamed hole diameter
- Bentonite density
- Pipeline submerged weight in bentonite (and means to achieve that weight) to optimize the crossing design in terms of pipeline stresses and power requirement

2.6.2 Contractor shall indicate what maximum shear stress in the pipeline coating will result from his choice of above parameters and other characteristics described in this section.

2.6.3 Contractor shall furnish all calculations for Owner's approval. If shear stress in pipe coating is, in the opinion of Owner, beyond the permissible limits, Contractor shall revise his choice of parameters to reduce shear stress on pipe coating to permissible value.

2.7 Contractor shall determine in the minimum allowable elastic bend radius for pipe from the following consideration:

2.7.1 <u>Maximum Longitudinal Stress During Installation</u>

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.

2.7.2. <u>Maximum Equivalent Stress During Final Hydrostatic Test</u>

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.

2.7.3 Maximum Equivalent Stress During Service

Permissible values of maximum equivalent stress during services shall be governed by the 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.

2.7.4 The minimum allowable radius of curvature for the pipeline shall be the highest value of the minimum pipeline elastic radius as computed from the considerations outlined in clause 2.7.1 to 2.7.3 above after correction for drilling inaccuracies or multiplication by the factor 1.85. whichever results in the highest permissible value of minimum elastic bend radius.

2.7.5 Contractor shall submit all calculations for Company’s approval alongwith procedure.

2.8 **Pipeline Configuration along the Support String Before Entry Point**

2.8.3 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 95% of the specified minimum yield strength for line pipe material.

2.8.4 Contractor shall furnish all calculation and specify the number of required supports, description of the supports, their co-ordinates and capacity in metric tons.

2.8.5 Contractor shall also furnish a drawing of the launching ramp indicating the pipeline configuration.

2.8.6 The distance between each roller shall also be specified and justified.

2.9 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.

2.10 All construction works shall be carried out in accordance with the construction drawings approved by Owner.

2.11 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.

3.0 **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.

3.1.0 **Installation Procedure**

3.1.1 Contractor shall, before commencing any work at site, submit for Owner’s approval a detailed installation procedure.

3.1.2 The installation procedure as a minimum shall include the following:

a) **Project Organisation Chart:**

This shall indicate Contractor’s organisational set-up at site and manpower deployment.

b) Details of fabrication yard and launching areas.

c) **Details of Equipment :**

Contractor shall furnish the complete list of all equipment to be deployed for preparation of pipe string and installation of crossing. Technical characteristics and capacity of each equipment including instrumentation, monitoring and control equipment shall be furnished in details.

d) Pipeline string preparation details (hauling, stringing, welding etc.)

e) Hydrostatic test procedure (pre and post installation)

f) Disposal methodology of bentonite slurry.

g) Method of installation covering all steps of construction, viz. Rig up, Pilot hole, Back-Reaming, Pulling Down, Backfilling etc.

h) Calculation for maximum pulling force on the rig and recommended maximum pulling velocity.

i) Time schedule for construction.

3.1.3 The time schedule shall be in accordance with overall time schedule for the project.

3.1.4 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.

3.2 **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.

3.3 **Pre-testing**

3.3.1 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.

3.3.2 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

3.3.3 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.

3.4 **Gauging**

3.4.1 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.

3.5 **Installation**

3.5.1 Installation shall be done in accordance with approval installation procedure.

3.5.2 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.

3.5.3 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.

3.5.4 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.

3.5.5 Contractor shall be responsible for maintaining the drilled hole till such time the pipeline is pulled in.

3.5.6 During pulling operation, the buoyancy of the pipeline shall be controlled by suitable approved methods so as to maintain the buoyancy as close as possible to zero during pull-back in order to reduce friction forces of the pipeline in the hole.

3.5.7 Bentonite slurry of specified viscosity shall be pumped into the hole, preventing the wall from collapsing and protecting the pipeline coating.

3.6 **Contractor shall be responsible for the integrity of the corrosion coating.**

3.6.1 Before pull-back operation, megger test shall be done for the entire pipeline (externally corrosion coated) string made for crossing by HDD method.

3.6.2 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.

3.6.3 However, if, in Owner's opinion, the integrity of external corrosion coating of bored pipeline string is not established by above (Clause No. 3.6.1 & 3.6.2), 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.

3.6.4 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.

3.7 Final Hydrostatic Test

3.5.1 The complete crossing section shall be tested after installation. The test pressure shall be as stipulated in the Special Conditions of Contract. After temperature stabilization, pressure shall be retained in the pipeline for a period of 6 hours and recorded by mano thermograph. The hydrostatic testing shall be carried out in accordance with approved procedures and specification detailed elsewhere in the document.

3.8 Final Clean up

3.8.1 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 landowner's and authorities having jurisdiction. All such work shall be done at no extra cost to Owner. The Owner shall be indemnified against any/ all claims arising as a result thereof.

4.0 DOCUMENTATION

4.1 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.
- Clearance certificate from the land owners and authorities having jurisdiction regarding satisfactory clean-up and restoration of the pipeline ROW and work sites.

4.2 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.

4.3 All documents shall be in English language.

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SPECIFICATION

FOR

CIVIL WORKS

SPECIFICATION NO. SIPI/Steel/TS/27
(CIVIL SECTION)

CIVIL & STRUCTURAL WORKS

Material Specifications

00.01 Aggregates

Coarse & fine aggregates for Civil & Structural work shall confirm in all respects to IS: 383 latest.

00.02 Water

Water used for Civil & Structural work shall be cleaned and free from injurious amount of oil, acids, alkalis, organic, matters or other harmful substances which may be deleterious to concrete, masonry or steel. The PH value of water shall not be less than 6. Potable water shall be considered satisfactory.

Tests on water samples shall be carried out in accordance with IS:3025 and they shall fulfil all the guidelines and requirements given in IS:456:2000.

00.03 Cement

Cement to be used for Civil & Structural work shall be of 43 grade/53 grade Ordinary Portland Cement confirming to IS:8112/IS:12269 respectively.

00.04 Steel

All Steel bars, sections, plates and other miscellaneous steel materials shall be free from rust, oil, mud, paint or other coatings. Reinforcement bars to be used for Civil & Structural work shall be of High Strength Deformed Steel Bars of grade Fe 415 confirming to
IS: 1786.

00.05 Brick

Bricks for masonry work shall be compliant to IS:1077 specification for common burn clay building bricks and shall be of 1st class. Specific requirements like dimensions, tolerances and other common requirements shall be confirmed to IS:1077. Bricks shall have smooth, rectangular faces with sharp corners and shall be well burned, sound, hard, tough and uniform in color. These shall be free from cracks, chips, flaws, and Florence. All tests shall be confirmed as per the requirements of IS 5454 and IS 3495. Water absorption shall not be more than 20% by its dry weight when soaked in cold water for 24 hours.

SCOPE OF WORK:

This specification shall apply to the civil works executed under the pipeline project such as foundations, pipe supporting structures & buildings works i.e. Excavation PCC, RCC, Brick work, Flooring, plastering, white washing, painting etc. The other mis. Civil works related to paths / roads / drains are also included in the scope of work and shall be executed as per drawings issued to contractor with the permission of Engineer-in-charge.

01.0 Dismantling of structures

Dismantling of all existing structures in RCC/PCC, Brick work, Roadwork etc. so that the site becomes suitable for construction activity. Disposal of disposable material to be cleared from the site to any authorized disposal site

Note: Demolition of RCC/PCC/road will be paid in Cubic metre.

02.0 Earthwork & Backfilling

02.01 Excavation & back filling for foundation, pits, trenches etc.

Excavation shall be carried out to true line and levels in all types of soil and shall be carried out for all lifts as required by the work. The Contractor shall provide suitable drainage arrangement to keep the pits dry. He shall also carry out all de-watering required within the quoted rate.

If excavation is made in excess of the depth required, the contractor shall at his own expenses fill up to the required level with lean concrete of mix 1:5:10 (1 cement:5coarse sand:10 aggregate) or as decided by site-in-charge.

The Contractor shall make necessary arrangements for lighting, fencing and other suitable measures for protection against risk of accidents due to open excavation at his own expense.

All shoring and strutting required holding the sides of excavation from collapse are included in the quoted rates.

No excavated material shall be deposited within 1.5 M of edge of excavation.

The Contractor shall not undertake any concreting in foundation until the excavation pit is approved by the site-in-charge.

The Contractor shall not backfill around any work until it has been approved by the site-in-charge.

Sweet Earth: Sweet earth is the clayey earth to be obtained from borrow areas indicated in the drawings or, prospecting and soil testing to be carried out by the Contractor as per detailed specifications and direction of the Owner. Earth obtained from the excavation of the plot may be used for plot filing, if found suitable (as per relevant IS code) by laboratory tests.
All materials required for the backfill etc shall be obtained from the designated borrow areas to be prospected & soil tested by the Contractor as per specification and as shown in construction drawings or as designated by the Owner.

The depth of cut in all borrow areas will be designated by the Owner and the cuts shall be made to such designated depths only. Shallow cuts will be permitted in the borrow areas if un-stratified materials with uniform moisture contents are encountered. Each designated borrow area shall be fully exploited before switching over to the next designated borrow area. Haphazard exploitation of borrow pits shall not be permitted.

Note: All permission to procure borrow earth, royalties, cess and transportation, etc. shall be contractors' responsibility.

Back filling shall be carried out of selected earth coming out of excavation. Back filling shall be carried out in layers of 15 cms and compacted to achieve 90% maximum dry density of the soil being used.

Any surplus earth generated shall be transported to areas designated by the Engineer-in-charge.

2.02 Sand filling in plinth/foundations/trenches

The grading shall conform to IS 383 and shall be within the limits of Grading Zone-III. The maximum size of particle shall be 4.75 mm and shall be graded down. Sand containing more than 10% of fine grains passing through 76 mesh sieve or having the fineness modulus less than 2 shall not be used.

Filling shall be carried out in layers not exceeding 15 cms and shall be compacted Mechanically or by saturation to specified grade and level and to obtain 90% laboratory maximum dry density or as specified in schedule or rates.

Compaction by flooding may be accepted at the discretion of the Engineer-in-charge, provided the required compaction is achieved.

The Contractor shall not commence filling in and around any work until it has been permitted by the Engineer-in-charge.

3.0 Restoration of The Excavated Trenches:

Depending upon type of pavement/ road through which the proposed pipeline will pass the restoration of the excavated pavement/road shall be carried out as per following specification:

3.01 <u>Existing Road having black top the restoration shall be carried out as per following specification and attached drawing No. SIPI/Plng./Steel/31:</u>

After laying of the pipeline as per the specifications of the tender and backfilling the same with proper compaction upto satisfaction of EIC and then preparing the surface for the application of the layers as per following in a ascending order upto the top of road surface:

- Compacted murum layer of 200 mm thickness.
- 300 mm thick layer of 60 mm metal with hard murum blindage
- 100 mm thick layer of 40 mm metal with stone screening blindage.
- 75 mm thick bituminous bound macadam

The above layers shall be constructed with specifications of relevant IS codes, and direction of Engineer In Charge

3.02 <u>Existing road having footpath covered with paver block the reconstruction shall be carried out as per following specification and attached drawing No. SIPI/Plng./Steel/32:</u>

After laying of the pipeline as per the specification of the tender and backfilling the same with proper compaction upto satisfaction of EIC and then preparing the surface for the application of the layers as per following in an ascending order upto the top of the pavement:

- Compacted hard murum layer of 200 mm thickness..
- 300 mm thick layer of 60 mm metal with hard murum blindage.
- 100 mm thick layer of 40 mm metal with stone screening blindage.
- Hard murum filling. and mentioned in the drawing SIPI/Plng./Steel/32:
- Providing 1:4:8 CC layer. and mentioned in the drawing SIPI/Plng./Steel/32:
- Providing of precast stone kerbing and 1:4:8 cc layer shall be as per above mentioned drawing No. SIPI/Plng./Steel/32:
- 100 mm thick layer of paver block shall be provided at top..

The above layers shall be constructed as per specifications of IS codes and direction of Engineer In Charge.

3.03 Existing road having paver block at the top, reconstruction shall be carried out as per following specification and attached drawing no. SIPI/Plng./Steel/33:

After laying of the pipeline as per the specification of the tender and backfilling the same with proper compaction upto satisfaction of EIC and then preparing the surface for the application of the layers as per following in an ascending order upto the top of the pavement:

- Compacted hard murum layer of 200 mm thickness.
- 300 mm thick layer of 60 mm metal with hard murum blindage.
- 100 mm thick layer of 40 mm metal with stone screening blindage.
- 100 mm thick paving block layer.

The above layers shall be constructed relevant IS codes and direction of Engineer In Charge.

3.04 Existing Road having concrete paving at the top, reconstruction shall be carried out as per following specification and attached drawing no. SIPI/Plng./Steel/34

After laying of the pipeline as per the specification of the tender and backfilling the same with proper compaction upto satisfaction of EIC and then preparing the surface for the application of the layers as per following in an ascending order upto the top of the pavement:

- Compacted hard murum layer of 200 mm thickness.
- 300 mm thick layer of 60 mm metal with hard murum blindage.
- 100 mm thick layer of 40 mm metal with stone screening blindage.
- 150 mm thick concrete paving (50 mm thick cc of 1:4:8 and 100 mm thick cc of 1:2:4)

The above layers shall be constructed as per specifications of IS codes and direction of Engineer In Charge.

3.05 Existing Road having black top full crust(type 1) at the top, reconstruction shall be carried out as per following specification and attached drawing no. SIPI/Plng./Steel/35

After laying of the pipeline as per the specification of the tender and backfilling the same with proper compaction upto satisfaction of EIC and then preparing the surface for the application of the layers as per following in an ascending order upto the top of the pavement:

- Compacted hard murum layer of 200 mm thickness.
- GSB Grade I and II each of 125 mm thick layer.
- 150 mm thick wet mix macadam layer with stone screening blindage.
- 75 mm thick BBM layer.

- 75 mm thick BM (3.3%).
- 75 mm thick DBM layer.
- 40 mm thick BC layer.

The above layers shall be constructed as per specifications of IS codes and direction of Engineer In Charge.

3.06 <u>Existing road having black top full crust(type 2) at the top, reconstruction shall be carried out as per following specification and attached drawing no. SIPI/Plng./Steel/36</u>

After laying of the pipeline as per the specification of the tender and backfilling the same with proper compaction upto satisfaction of EIC and then preparing the surface for the application of the layers as per following in an ascending order upto the top of the pavement:

- 200 mm thick layer of compacted hard murum.s
- 300 mm thick layer of 60 mm metal with hard murum blindage.s
- 100 mm thick layer of 40 mm metal with stone screening blindage.
- 75 mm thick BBM layer.
- 50 mm thick BM layer.
- 25 mm thick BC layer.

The above layers shall be constructed as per specifications of IS codes and direction of Engineer In Charge

04.0 Plain and Reinforced Cement Concrete

The cement is in the contractor's scope of supply Engineer-in- Charge may require tests to be carried out by the contractor as a part of his quoted rates to ensure conformity with the relevant Standards.
Engineer-in-charge may reject such of the cement supplied in the event of either unsatisfactory tests or in the event of deterioration due to age, bad storage etc. Decision of Engineer-in-charge shall be final in this regard.

Water used for concrete work shall be suitable for drinking and shall conform to IS 456:2000. It shall be free from injurious substances.

Source of Coarse and find aggregates shall be approved by Engineer-in-Charge.

Contractors shall store each type and grade of aggregate separately. He shall maintain at site of work adequate quantities to ensure conformity of work. Wet aggregate delivered to site shall be stored for 24 hrs to facilitate drawing before being used.

04.01 Grades & Proportioning

The grades indicated in drg. and schedules shall conform to IS :456:2000, the strengths being indicated below:S

PECIFIED CHARACTERISTIC COMPRESSIVE STRENGTH

04.02 Grade strength of 15 cm cube in N/MM_2

	28 days	7 days,
1:1.5:3 (Nominal Mix)	20	13.5

Min Consumption	No. of Samples to be tested.
1-6 m^3	1
6-15 m^3	2
15-30m^3	3

The water cement ratio, coarse aggregates and grading for each mix shall be predetermined from the results of cube tests of trial mixes. The mixed proportions determined thus shall be followed at site and shall in no way relieve the contractor of his responsibility as regards the prescribed strength mix. The mixed proportions, however, shall be revised if the results of the cube tests during the construction show consistently lower than the prescribed one. No claim to alter the rates of concrete work will be entertained due to such changes in mix designs, as the contractor will be responsible to produce the concrete of required grade. The aggregates shall be measured by volume.

All concrete shall be controlled concrete confirming to IS:456:2000. For mud-mat and filling purpose, ordinary concrete of 1:4:8 for proportion or as specified may be used as indicated in drawings.

04.03 Mixing

Mixing should be carried out in Mechanical mixers. Hand mixing can however be permitted by Engineer-in-charge in special cases subject to additional 10% extra cement without extra cost. Water cement ratio shall be rigidly controlled during mixing. Mixers shall be fitted with automatic devices to discharge measured quantity of water directly to the mixing pan. The water shall not be admitted to the drum until all the cement and aggregate constituting the batch are thoroughly mixed. Mixing shall continue until the concrete is uniform in colour and not less than 2 minutes after all the materials and water are in the drum.

04.04 Placing

The place where concrete is to be poured should be clean and free from all lose dirt, wooden pieces, dust, standing water etc. The form-work must be right and rigid, with all holes and crevices stopped effectively, to prevent cement slurry from running out.

Walking on reinforcement layers is not permissible , Walkways of wooden planks or similar can be placed with removable supports and should be independent of the reinforcement. The reinforcement position should not be disturbed nor should it sag during carriage and placement of concrete.

Placing and vibration should not take totally more than 20 minutes from time of mixing. Method of placing should be got approved by Engineer-in-charge. Segregation during carriage and placement should be avoided if during carriage concrete segregates, it should be re-mixed before placement.

Concrete should not be dropped from a height of over 1.5M.
To ensure bond and water tightness between old concrete surface and fresh concrete to be placed, the surface should be cleaned and roughened by “initial green out” by wire brushing or chipping. The initial green cutting may be done by wire brush after 6 hours of placing concrete in order to facilitate the work. Chipping can be done only after 48 hours. A layer of cement slurry with 1.1 mix (1 cement : 1 sand) should be poured to obtain a uniform coating on old concrete. Immediately thereafter, the fresh concrete should be poured.

Concrete shall be placed in a single operation to the full thickness of slabs, beams and similar members and shall be placed in horizontal layers not exceeding 1.5m deep in walls, columns and similar members. Concrete shall be placed continuously until completion
of the part of the work between construction joints or as directed by Engineer-in-Charge.

04.05 Placing in the inclement Weather

All precautions shall be taken for concreting in extreme weather in accordance with relevant clause of IS:456:2000. Due protection shall be provided to prevent cement being blown away while proportioning and mixing during windy weather. No concreting shall be carried out in continuous heavy rains and necessary arrangements to cover the freshly poured concrete shall be
provided, to protect it from the direct rays of the sun and from drying winds.

All concreting placements should be coordinated with placement of conduits, inserts, and embedded parts etc. executed either by same agency or separately.

Concrete in standing water shall be executed strictly as per IS : 456:2000.This shall be paid as a separate item where applicable.

04.06 Vibration

Concrete shall be compacted by means of vibrators of approved type under proper supervision as directed by the Engineer-in- Charge. The whole mass of concrete shall be well vibrated until a dense mass with a jelly like appearance and consisting and water just appearing on the surface is obtained. Over vibration and vibration of very wet mixes shall be avoided. Care should be taken
to avoid segregation and formation of air bubbles.

04.07 Construction Joint

Construction joints shall be made in the position as indicated in drawings and as approved by Engineer-in-charge. Such joints shall be truly vertical or horizontal as the case may be except that in an inclined or curved member the joint shall be strictly at right angles to the axis of the member.

04.08 Curing & Protection

The concrete shall be kept constantly wet for at least seven days from the date of placing of concrete. In very hot weather precaution shall be taken to see that temperature of wet concrete does not exceed 38°C while placing.
Concrete shall not be disturbed after initial setting has started. For freshly laid concrete from work shall not be jarred. Concrete placed below ground surface shall be protected from falling earth during and after placing.

04.09 Finishes

On striking the formwork, all blow holes and honey combing observed shall be brought to the notice of Engineer-in-Charge. The Engineer-in-charge may at his discretion allow such honey combing or blow holes to be rectified by necessary chipping and packing or grouting with concrete or cement mortar.

If mortar is used, it shall be 1:3 mix or as specified by Engineer-in- Charge. However, if honey-combing or blow holes are of such extent as being undesirable the Engineer-in-Charge may reject the work totally and his decision shall be binding on the contractor. No extra payment shall be made for rectifying these defects. All burrs and uneven faces shall be rubbed smooth by carborundum stone. The surface of non-shuttered faces shall be smoothened with a wooden float to give a finish equal to that of the rubbed down shattered faces. Concealed concrete faces shall be left as from the shuttering except that honey combed surface shall be made good as detailed above. The top faces of slabs not intended to be surfaced shall be leveled and floated smooth at the levels or slops shown on drawings. The floating shall not be executed to the extent of bringing excess find materials to the surface. The top faces of slab intended to be covered with screed, granolithic or similar surface shall be left with a rough finish. Sides and soffits to be later
covered with plaster shall be suitably roughened.

03.11 Procedure

A random sampling procedure shall be adopted to ensure that each concrete batch shall have a reasonable chance of being tested, that is the sampling should be spread over the entire period of
concreting and cover all mixing units.

3.12 Frequency of Sampling

The minimum frequency of sampling of concrete for each grade shall be in accordance with the following:

Quantity of concrete in the work in m^3	Number of samples
1-5 6-15 16-30 31-50 51 & above	1 2 3 4 4 plus one additional sample for each additional 50 m^3 or part thereof

Note: At least one sample shall be taken from each shift.
Wherever concrete is produced at continuous production unit, such as ready –mixed plant, frequency of sampling may agreed upon mutually by suppliers and Engineer-in-charge.

03.13 Test Specimen

Three test specimens shall be made from each sample for testing at 28 days. Additional cubes may be required for various purposes such as to determine the strength of concrete at 7 days or at the time of striking the form work, or to determine the duration of curing, or to check the testing error. Additional cubes may also be required for testing cubes cured by accelerated methods as described in IS:9013. The specimen shall be tested as described in IS:516. The contractor shall carry out tests at his own cost. If the results of the loading test be unsatisfactory, the Engineer-in-Charge may instruct the contractor to demolish and reconstruct the structure or part thereof at the contractor's cost.

04.00 Formwork & Centering

Formwork in general shall conform to IS: 456:2000.

For complicated work, the contractor shall submit his proposal of formwork before starting the work for the approval of the Engineer- in Charge. The number of props, their sizes and dispositions shall be such as to be able to safely carry the full deed load and constructional loads. However, approval of the Engineer-in-Charge to this effect shall not relieve the contractor of his responsibility for proper work and safety.

All forms of beams, slabs and similar members shall be so designed and erected that the sides can be removed without disturbing the soffit shutter and supports there to.

Before removal of the shuttering the concrete shall be examined and it's removal order taken from the Engineer-in-Charge. In no circumstances shall forms be struck until the concrete reaches a strength of at least twice the stress to which the concrete may be subjected at the time of striking.

Shuttering shall not be removed until the number of clear days specified in IS:456:2000, have elapsed since the last day of placing concrete in the member concerned. All formwork shall be removed without such shock or vibration as would damage the reinforced concrete.

05.00 Reinforcement in cement concrete

The steel for reinforcing bars shall be as indicated in drawings and conforming to specifications.

All reinforcement at the time of concreting, shall be free from loose rust or scales, oil, grease or other harmful matter, and other castings that will destroy or reduce the bond.

The number, size, form and position of all the reinforcement shall, unless otherwise directed or authorised by the Engineer-in-Charge be strictly in accordance with the drawings. Wherever inserts interfere with the placing of reinforcement as called for, proper adjustment shall be made as directed by Engineer-in-Charge, before concrete is placed.

All reinforcement work shall conform to IS:456:2000.

The steel reinforcement shall be connected to form a rigid cage. To prevent displacement before or during concreting the bars shall be secured to one another with 16 SWG black annealed binding wire.

Bars intended to be in contact at passing points shall be securely wired together similarly at all such points. Wooden planks provided for labour to move shall be supported independent from the reinforcement cage, and the cage shall never be remitted to sag or get displaced during concreting.

The vertical distances required between successive layers of bars in beams or similar members shall be maintained by the provisions of steel spacer bars inserted at such intervals that the main bars do not perceptibly sag between adjacent spacer bars without any extra cost.

Concrete spacer blocks shall be used to ensure cover of concrete over the bars. The concrete over the reinforcement bars shall be as shown in drawings and shall be the clean cover.

The contractor must obtain the approval of the Engineer-in-Charge to the reinforcement placed before any concrete in deposited. Spacers,Chair,Binding wires and wastages are not to be included in measurements.

06.00 **Brick Masonry works**

06.01 Cement Mortar

Cement mortar shall meet the requirements of IS:2250 and shall be prepared by mixing cement and sand by volume in a Mechanical mixer. Proportion of cement and sand shall be 1:6 (1 part of cement and 6 parts of sand), or as directed by the Engineer-in- Charge/shown on the drawing, for brick masonry of one brick thickness or more, while 1:4 cement mortar (1 part of cement and 4 parts of sand) shall be used for brick masonry of half brick thickness. The sand being used for mortar shall be sieved. The mortar shall be used as soon as possible after mixing and before it has begun to set and in any case within initial setting time of cement after water is added to the dry mixture. Mortar unused for more than initial setting time of cement, shall be rejected and removed from the site of work.

06.02 Proportioning

The unit of measurement for cement shall be a bag of cement weighing 50 kgs and this shall be taken as 0.035 cubic meter. Sand shall be measured in boxes of suitable size on the basis of its dry volume. In case of damp sand, its quantity shall be increased suitably to allow for bulkage.

06.03 Mixing

The mixing of mortar shall be done in a Mechanical mixer operated manually or by power. The Engineer-in-Charge may, however, permit hand-mixing as a special case, taking into account the magnitude, nature and location of work. The Contractor shall take the prior permission of Engineer-in-Charge, in writing, for using hand-mixing before the commencement of work.

06.04 Mixing in Mechanical Mixer

Cement and sand in specified proportions, by volume, shall be thoroughly mixed dry in a mixer. Water shall then be added gradually and wet mixing continued for at least one minute. Care shall be taken not to add more water than that which shall bring the mortar to the consistency of stiff paste. Wet mix from the mixer shall be unloaded on water-tight masonry platform, made adjacent to the mixer. Platform shall be at least 150 mm above the leveled ground to avoid contact of surrounding earth with the mix. Size of the platform shall be such that it shall extend at least 300mm around the loaded wet mix area. Wet mix, so Portland cement conforming to IS: 269J after addition of water. Mixer shall be cleaned with water each time before suspending the work.

06.05 Hand Mixing

The measured quantity of sand shall be leveled on a clean water tight masonry platform and cement bags emptied on top. The cement and sand shall be thoroughly mixed dry by being turned over and over, backward and forward, several times till the mixture is of uniform colour. The quantity of dry mix which can be consumed within initial setting time of cement shall then be mixed with just sufficient quantity of water to bring the mortar to the consistency of stiff paste.

06.06 *Construction Procedure*

Soaking of Bricks

Bricks shall be soaked in water before use for a period that is sufficient for the water to just penetrate the whole depth of bricks as well as to remove dirt, dust and sand. Proper soaking of bricks shall prevent the suction of water from the wet mortar as otherwise mortar will dry out soon and crumble before attaining any strength.

The bricks shall not be too wet at the time of use as they are likely to slip on mortar bed and there will be difficulty in achieving the plumpness of wall as well as proper adhesion of bricks to mortar. The period of soaking shall be determined at site by a field test by immersing the bricks in water for different periods and then breaking the bricks to find the extent of water penetration. The least period that corresponds to complete soaking, will be the one, to be allowed for in the construction work.

The soaked bricks shall be removed from the tank, sufficient early, so that at the time of laying, they are skin dry. The soaked bricks shall be stacked over a clean place, wooden planks or masonry platforms to avoid earth, dirt being smeared on them.

06.07 *Laying*

Brick Work

Brick work (one or more brick thickness) shall be laid in English Bond unless otherwise specified. Half or cut bricks shall not be used except when needed to complete the bond. The defective and overburnt bricks should not be used in brick work.

A layer of average thickness of 10mm of cement mortar shall be spread on full width over a suitable length of lower course or the concrete surface. In order to check and achieve uniformity in masonry, the thickness of bed joints shall be such that four courses and three joints taken consecutively shall measure equal to four times the actual thickness of the brick plus 30mm. Each brick with frog upward, shall be properly bedded and set in position by gently tapping with handle of trowel or wooden mallet. Its inside faces shall be buttered with mortar before the next brick is laid and pressed against it. After completion of the course, all vertical joints shall be filled from top with mortar.

All brick courses shall be taken up truly plumb; if battered, the batter is to be truly maintained. All courses shall be laid truly horizontal and vertical joints shall be truly vertical. The level and verticality of work in walls shall be checked up at every one meter interval. The masonry walls of structures shall be carried up progressively, leaving no part one metre lower than the other. If this cannot be adhered to, the brick work shall be raked back according to bond (and not left toothed) at an angle not more than 45 degrees but raking back shall not start within 60 centimeters of a corner. In all cases returns, buttresses, counter forts, pillars etc. shall be built up
carefully course by course, and properly bonded with the main walls. The brickwork shall not be raised more than fourteen (14) courses per day.

At the junction of any two walls, the bricks shall at each alternate course, be carried into each of the respective walls so as to thoroughly unite the work.

The courses at the top of plinth and sills, at the top of the wall just below the soffit of the roof slab or roof beam and at the top of the parapet, shall be laid with bricks on edge. Brick on edge course shall be so arranged as to tightly fir under the soffit of the roof beam or roof slab, restricting the mortar layer thickness upto 12mm, however, any gap between the finished brick work and soffit of roof slab/beam shall by suitably sealed with the mortar.

07.00 Brick Work (Half brick thickness)

For brick walls of half brick thickness, all courses shall be laid with stretchers. Wall shall be reinforced with 2 nos. 6mm diameter mild steel reinforcement bars, placed at every fourth course. The reinforcement bars, shall be straightened and thoroughly cleaned. Half the mortar thickness for the bedding joint shall be laid first and mild steel reinforcement, one on each face of the wall, shall be embedded, keeping a side cover of 12mm mortar. Subsequently the other half of the mortar thickness shall be laid over the reinforcement covering it fully.

The reinforcement bars shall be carried at least 150mm into the adjoining walls or RCC columns. In case the adjoining wall being of half brick thickness, the length of bars shall be achieved by bending the bars in plan. At the junction of two walls, the brick shall, at each alternate course, be carried into each of the respective walls so as to thoroughly unite the work. The brick masonry work shall not be raised more than 14 courses per day. Brick course under the soffit of beam or slab, shall be laid by restricting the mortar thickness of 12mm. However, any gap between the finished brickwork and soffit to slab/beam, shall be suitably sealed with the mortar.

08.00 Plastering

08.01 Materials

The specifications for cement, sand and water as given in specification including relevant clauses for quality and testing of materials shall also apply for cement plaster materials and works.

Cement mortar shall be of grade and thickness specified in drawing or as directed by the Engineer-in-Charge, if not specified. The surface on which plastering is to be done shall be thoroughly cleaned from dust, dirt, oil, etc. It should be washed properly and watered for 4 hours before plastering. The joints of brick work shall be raked out to a depth of atleast 12mm when plastering has to be done. On cement concrete surface shall be scarified by lines with trowel then it is still green or hacked if concrete is hard as directed by Engineer-in-Charge.

Plaster shall not in any case, be thinner than specified. It shall have uniform specified thickness. Any extra thickness of plaster done by contractor will not be paid for. When smooth finishing is required the cement plaster shall be floated over with neat cement within 15 minutes of the application of the final coat.

The plaster shall be protected from sun and rain by such means as the Engineer-in-Charge may approve. The plaster shall be cured for 14 days.

Construction joint shall be kept in plastering work at places approved by Engineer-in-Charge .

12.0 Pavior Blocks :-

Paver blocks is to be fixed over PCC floor including the filling joints with river sand over the sand bed as per scope given in detailed drawings and direction of Engineer-in-charge.

13.0 Permanent Shoring

Close timbering to be done by strutting, Shoring and packing cavities in pipe trenches in soft soil / liquid mud including pumping out sand/water as required. The minimum thickness of timber 25
mm to be used and for 2 mm if using steel plates. The timbering and shoring (face area) to be left permanently.

14.0 Safety of existing work

Before taking up any construction adjoining other property or existing work, the Contractor shall take all steps necessary for the safety and protection of such property or work at no extra cost to
the owner.

SPECIFICATION FOR STRUCTURAL WORKS

15.0 Scope of work

This Specification shall apply to supply, fabrication and erection of steel structures in building and other general structural works.

General description of structures

The steel structures shall consist of Fencing columns, column bracing, sag angles, sag rods, platforms, walkways, stairs, ladders, hand rails ,steel gates etc. The description and sizes mentioned above are indicative only. The works shall be executed as per actual sizes specified in the design drawings and approved fabrication drawings issued to the Contractor.

16.0 Materials

Structural Steel

Structural steel and other related materials for construction shall conform to IS 800.

Due to non-availability of specified materials, suitable substitutions may be provided with the consent of the Purchaser. Such substitution shall be incorporated in the As-Built’ drawings.

All the items are to be cut as per requirements of the drawing. If joints are to be provided in any item in order to meet requirements of size and shape, cutting plan showing locations of joints shall be prepared for consideration of the Purchaser. Joints so provided shall be incorporated in ‘As-Built’ drawings.

Rolling and cutting tolerances shall be as per IS 1852: 1985.

Only tested materials shall be used unless the Purchaser permits use of untested materials for certain secondary structural members. If test certificate for the material is not available from the main producer, the following tests shall be carried out at the discretion of the Purchaser:

a. Chemical Composition
b. Mechanical Properties
c. Weldability test

Bolts and Nuts

Black hexagonal bolts, nuts and lock nuts shall conform to IS 1363: 1992.

Precision and semi-precision hexagonal bolts, screws, nuts and lock nuts shall conform to IS 1364: 1992.

Electrodes

Mild steel electrodes shall conform to IS 814: 1991. Electrodes to be used for submerged arc welding shall conform to IS 7280: 1974.

Storage of materials

Materials shall be stored and stacked properly ensuring that place is properly drained and is free from dirt. It shall be ensured that no damage is caused due to improper stacking.

Material Preparation & Drilling

Cut edges shall be finished smooth by grinding or machining wherever necessary. Sufficient allowance (3mm to 5mm) should be kept in the items in case machining is necessary.

Drilling and punching of holes for bolts shall be done as per Clause no.11.2.4 of IS 800: 1984, unless otherwise specified by the Purchaser.

Drifting of holes for bolts during assembly shall not cause enlargement of holes beyond permissible limit or damage the metal. Holes for bolted connection should match well to permit easy entry of bolts. Gross mismatch of holes shall be avoided.

17.0 Assembly for fabrication

Fabrication of all structural steelwork shall be in accordance with IS 800: 1984 and in conformity with various clauses of this Specification unless otherwise specified in the drawings.

Fabricated structures shall conform to tolerance as specified in this Specification and in IS 7215: 1974. In case of contradiction, tolerance specified in this Specification shall prevail.

All the components of structures shall be free from twist, bend, damage, etc.

Suitable jigs and fixtures shall be used to avoid any distortion during welding shall carry out assembly of structures.

If pre-bending of the plate is required to avoid welding distortion, it shall be done in cold condition.

If extra joints are required to be provided in any column, prior approval should be obtained from the Purchaser. However, as a general guidance, the splice joints of column shall be of full strength butt weld and, wherever possible, shall be located at zones of minimum or substantially lesser stresses.

Splice joints of flange and web should preferably be staggered. Sufficient trial assembly of fabricated components (dispatch elements) shall be carried out in the fabrication works to control the accuracy of workmanship.

Where necessary, washers shall be tapered or otherwise suitably shaped to give the heads of nuts and bolts satisfactory bearing. The threaded portion of each bolt shall project through the nut at least by one thread.

Permissible deviation from designed (true) geometrical form of the despatch elements shall be in accordance with IS 7215: 1974.

18.0 Welding

Contractor shall work out welding procedure for Purchaser's approval considering the following:

a. Specification and thickness of steel,
b. Specification of electrode or/and base wire,
c. Welding process (manual arc welding, submerged arc welding, etc.),
d. Type of structures to be welded (thickness of components meeting at a joint),
e. Pre and post heating requirements,
f. Preparation of fusion faces,
g. Sequence of welding,
h. Weather conditions,
i. Use of jigs and fixtures, etc.,
j. Type of non-destructive testing to be carried out,
k. Inspection procedure to be followed and
l. Design requirements of the joints.

Welding of any load bearing structure shall be carried out only by the person who has passed welder's qualification as per IS 7318 (Part 1): 1974.

All metal arc welding shall be carried out as per IS 9595: 1980. Submerged arc welding shall be carried out as per IS 4353: 1967. Electrodes shall conform to relevant clauses of this Specification.

For suitability of wire flux combination, procedure test shall be carried out as per IS 3613: 1974, if required.

Welding shall, unless otherwise specified, be done using electric arc process. Generally submerged arc welding, automatic or semi-automatic shall be employed. Only where it is not practicable, manual arc welding may be resorted to. In case of manual arc welding, recommendations of electrode manufacturers are to be strictly followed.

Surfaces to be welded shall be smooth, uniform and free from fins, tears, notches or any other defect that may adversely affect welding. For welds with multiple run weld deposits, the subsequent run shall be done only after thorough removal of slag and proper cleaning of surface.

welds, if specified, shall be done by such method that does not cause grooving or any other surface defects on the weld or on the parent metal.

All butt welds shall start and end with run-on and run-off plates. All such plates shall be carefully trimmed off by gas cutting after welding is over.

Fillet welds shall not be stopped at corners but shall be returned round them

If butt weld is to be ground flush with the surface of the member as per drawing, adequate reinforcement shall be built up and then the same shall be chipped off and ground flush. The grinding is to done in the direction of stress flow till the transverse marks are eliminated.

Welding shall not be done under such weather conditions that might adversely affect the efficiency of the welding.

Manipulators shall be used wherever necessary and shall be designed to facilitate welding and ensure that all welds are easily accessible to the operators.

Ends of structural members and portions of gussets to be welded at site shall be left unpainted.

19.0 Inspection and Testing

The Purchaser/Inspector shall have free access at all times to those parts of the premises of the Contractor or his Subcontractor that are concerned with the fabrication work. The Purchaser/Inspector shall be afforded all reasonable facilities at all stages of preparation, fabrication and trial assemblies for satisfying himself that the fabrication is being undertaken strictly as per the approved fabrication drawings and in accordance with the provisions of relevant Specifications.

The Contractor shall supply free of charge all gauges and templates, tools, apparatus, labour and assistance for checking the fabricated structures. The Purchaser/Inspector may, at his discretion, check the test results obtained at the Contractor's works, by independent test at the Government Test House or elsewhere, and should the material
so tested be found to be unsatisfactory, the cost of such test shall be borne by the Contractor.

The Contractor shall make all necessary arrangements for stage inspection by Purchaser/Inspector during the fabrication at shop and incorporate all on the spot instructions/changes conveyed in writing to the Contractor.

Material improperly detailed or wrongly fabricated shall be reported to the Purchaser/Inspector and shall be made good as directed. Minor misfits which can be remedied by moderate use of drift pins, moderate amount of reaming and/or slight chipping may be corrected in that manner if, in the opinion of the Purchaser/Inspector, the strength or appearance of the structure will not be adversely affected. In the event the Purchaser/Inspector directs otherwise, the items will be rejected and a completely new piece shall be fabricated. The cost of correcting errors shall be to the account of the Contractor.

a. The Purchaser/Inspector shall have the power to certify before any structure Is submitted for inspection that the same is not in accordance with the Contract owing to the adoption of any unsatisfactory method of fabrication, to reject any structure as not being in accordance with Specification and approved fabrication drawings and to insist that no structure or part of the structure once rejected is resubmitted for inspection/test, except in cases where the Purchaser/Inspector or any representative authorised by the Purchaser/Inspector considers the defects as rectifiable.

b. If, on rejection of a structure by the Purchaser/Inspector, the Contractor fails to make satisfactory progress within the stipulated period, the Purchaser shall be at liberty to cancel the Contract and get the structure fabricated or authorise the fabrication of the structures at any other place he chooses at the risk and cost of the Contractor, without prejudice to any action being taken in addition to terms of General Conditions of Contract.

c. The decision of the Purchaser/Inspector regarding rejection shall be final and binding on the Contractor.

d. The Specification prescribes various tests at specified intervals for ascertaining the quality of the work done. If the tests prove unsatisfactory, Purchaser/Inspector shall have liberty to order the Contractor to redo the work done in that period and/or to order such alterations and strengthening as may be necessary at the cost of the Contractor. The Contractor shall be bound to carry out such orders failing which the rectification/redoing will be done by the Purchaser through other agencies and the cost recovered from the Contractor.

e. Notwithstanding any inspection at the fabrication yard, the Purchaser/Inspector shall have the liberty to reject, without being liable for compensation any fabricated members or materials brought to site that do not conform to Specification/approved fabrication drawings/design drawings.

f. All rejected materials shall be removed from the fabrication yard by the Contractor at his own cost and within the time stipulated by the Purchaser/Inspector.

The extent of quality control in respect of welds for structural elements structures shall be as follows and shall be conducted by the Contractor at his own cost:

a. Visual Examination: All welds shall be 100% visually inspected to check the presence of undercuts, visually identifiable surface cracks in both welds and base metals, unfilled craters, improper weld profile and size, excessive reinforcement in weld, surface porosity etc. Before inspection, the surface of weld metal shall be cleaned of all slag, spatter matter, scales etc. by using wire brush or chisel.

b. Dye Penetration Test (DPT): This shall be carried out for all important fillet and groove welds to check surface cracks, surface porosity etc. Dye Penetration Test shall be carried out in accordance with American National Standard ASTM E165.

c. Ultrasonic testing: This test shall be conducted for heat affected zones in important load bearing butt welds as desired by the Purchaser/Inspector to detect cracks, lack of fusion, slag inclusions, gas porosity etc.

Ultrasonic testing shall be carried out in accordance with American National Standard ANSI/AWS D1.1-96 Chapter -6: Part F.

Before ultrasonic test is carried out, any surface irregularities like undercuts, sharp ridges etc. shall be rectified. Material surface to be used for scanning by probes must allow free movement of probes.

For this purpose, surface shall be prepared to make it suitable for carrying out ultrasonic examination.

d. Radiographic Testing (x-ray and γ-ray Examination): This test shall be limited to 2% of length of welds for welds made by manual or semi- automatic welding and 1% of length of weld if made by automatic welding machines. The location and extent of welds to be tested

by this method shall be decided by the Purchaser/Inspector to detect gas porosity, slag inclusions, lack of penetration, lack of fusion, cracks etc.

Radiographic testing shall be conducted in accordance withAmerican National Standard ANSI/AWS D1.1-96 Part E.

Any surface irregularity like undercuts, craters, pits etc. shall be removed before conducting radiographic test. The length of weld to be tested shall not be more than 0.75xfocal distance. The width of the radiographic film shall be width of the welded joint plus 20mm oneither side of the weld.

20.0 Acceptable limits in Weld Defects

Limits of Acceptability of weld defects shall be as follows:

a. Visual inspection and Dye Penetration Test: The limits of acceptability for defects detected during visual inspection and Dye Penetration Test shall be in accordance with Clause 8.15.1.

b. Ultrasonic Testing: The limits of acceptability for defects detected during ultrasonic testing shall be in accordance with Clause 8.15.4 of American National Standard ANSI/AWS D1.1-96 Chapter 6: Part C.

c. Radiographic testing: The limits of acceptability for defects detected during radiographic testing shall be in accordance with Clause 8.15.3 of American National Standard ANSI/AWS D1.1-96Chapter 6:Part C.

21.0 Acceptance criteria for machined surface

Standard of acceptance for machined surfaces, wherever specified (e.g. in column cap plates, base plates and column shafts etc.) shall be as given as per Clause 14.02 and 14.03.

Maximum surface unevenness on bearing surface of cap/base plate shall not exceed 0.5mm.

When assembled, there must be physical contact for at least 75% of the contact surface. The checking shall be carried out with 0.2mm gauge. Care shall be taken that these connecting members are fixed with such accuracy that they are not reduced in thickness during machining by more than 1mm.

22.0 Completion Documents

On completion of work, the Contractor shall submit to the Purchaser the following documents:

a. The technical documents according to which the work was carried out.
b. Copies of ‘As-Built’ drawings showing thereon all additions and alterations done during the fabrication.
c. Manufacturer's Test Certificates.
d. Certificates/documents on control checking.
e. Test of welds.

The Purchaser/Inspector shall issue Inspection Certificates to the Contractor for the structures found acceptable in all respects.

23.0 ERECTION OF STEEL STRUCTURES

In addition to providing erection and transport equipment, the Contractor shall supply all tools and tackles, consumables, materials, labour and supervision and the scope of work shall cover, but not be limited to, the following:

a. Storing and stacking of all fabricated structural components/units/assemblies at site storage yards till the time of erection.

b. Transportation of structures from storage yard to site of erection including multiple handling, if required.

c. All minor rectification/modification such as removal of bends, kinks, twists etc. for parts damaged during transportation and handling, reaming of holes which do not register or which are damaged for use of next higher size bolt, plug-welding and re-drilling of holes which do not register and which cannot be reamed for use of next higher size bolt, drilling of holes which are either not drilled at all or are drilled in incorrect position during fabrication etc.

d. Fabrication of minor missing items as directed by the Purchaser/Inspector.

e. Verification of the position of embedded anchor bolts and inserts w.r.t. line-find based on Geodetic Scheme/Bench mark/Reference coordinates to be furnished by the Purchaser. Installation of levels shall not lie in Structural Contractor’s scope of work.

f. Assembly of steel structural components at site, wherever required, including temporary supports and staging.

g. Marking arrangement for provision of all facilities for conducting ultrasonic, X-ray or γ-ray tests by reputed testing laboratories, making available test films/graphs with reports/interpretation etc.

h. Rectification at site damaged portions of shop primer by cleaning and application touch-up paint.

i. Erection of structures including making connections by bolts/welding as per approved fabrication drawings.

j. Alignment of all structures true to line, level plumb and dimensions within the specified limits of tolerance.

k. Application at site, after erection, required number of coats of primer and finishing paint as per Specification and drawing.

l. Rectification of structures as per Preliminary Acceptance

Report and Final Acceptance Report.

24.0 Storage and Handling

Storage of structures shall be done with due consideration of erection sequence.

While storing, care shall be taken so that structures do not come in direct contact with the earth surface and/or accumulated water. Girders, beams, columns, etc., shall be placed and stored in such a manner that during rain, no rainwater accumulates on the structures. Stacking of the structures shall be done in such a way that erection marks are visible easily and handling does not become difficult. Wherever required, wooden sleepers/grillage may be used.
Handling and storage of materials shall be as per IS 7969: 1975 to ensure safety.

25.0 Erection

General

Erection shall be carried out in accordance with IS 800: 1984 and other relevant standards referred to therein.

For safe and accurate erection of structural steelwork, the Contractor shall erect staging, temporary support, false work etc. as required. The fabricated materials received at erection site shall be verified with respect of marking on the key plan/marking plan or shipping list. Any material found damaged or defective shall be stacked separately and the damaged or defective portions shall be painted in distinct colour for identification and the same shall be brought to the notice of the Purchaser.

Temporary bracing, wherever required, shall be provided to sustain forces due to erection loads, equipment etc. Erected parts of the structures shall remain stable during all stages of erection when subjected to the action of wind, dead weight and erection forces. Specified sequence of erection of vertical and horizontal structural
members shall be followed.

Erected members shall be held securely in place by bolts to take care of dead load, wind load and erection load. All connections shall achieve free expansion and contraction of structures wherever provided.

No final bolting or welding of joints shall be done until the structure has been properly aligned.

All structural members shall be erected with erection marks in the same relative position as shown in the appropriate erection and shop drawings.

The Contractor shall design, manufacture, erect and provide falsework, staging, temporary support etc. required for safe and accurate erection of structural steelwork and shall be fully responsible for the adequacy of the same.

The Contractor shall also provide facilities such as adequate temporary access ladders, gangways, tools and tackles, instruments etc. to the Purchaser/Inspector for his inspection at any stage during erection.

26.0 Field Connections

Wooden rams or mallet shall be used in forcing members into position in order to protect the metal from injury or shock.

Where bolting is specified on the drawing, the bolts shall be tightened to the maximum limit. The threaded portion of the each bolt shall be project through the nut by at least one thread. Tapered washers shall be provided for all heads and nuts to achieve uniform bearing on sloping surface.
To prevent loosening of nuts, spring washers or lock nuts shall be provided as specified in the design/shop drawings.

All machine-fitted bolts shall be perfectly tight and the ends shall be checked to prevent nuts from becoming loose. No unfilled holes shall be left in any part of the structures.

27.0 Assembly by welding

All field assembly by welding shall be executed in accordance with the requirements for shop fabrication. Where the steel has been delivered painted, the paint shall be removed before field welding for a distance of at least 50mm on either side of the joints to be welded.

All other requirements in welding shall be in accordance with clauses
specified under Section-1 of this Specification

28.0 PAINTING OF STEEL STRUCTURES

Surface preparation for Painting

General

The steel surface which is to be prepared shall be cleaned of dirt and grease and the heavier layers of rust shall be removed by grinding prior to actual surface preparation to a specified grade.

Surface preparation to be followed prior to painting shall be based on the requirement of a particular painting system as per relevant clause of this Specification. One of the following surface preparations is to be followed as per requirement.

Mechanical Cleaning

Manual/power tool cleaning.

Manual/power tool cleaning shall be done as per grade St-2 or St-3 of Swedish Standard Institution SIS 055900.

a. Grade St-2: Thorough scraping and wire brushing, machine brushing, grinding, etc. This grade of preparation shall remove loose mill scale, rust and foreign matter. Finally, the surface is to be cleaned with a vacuum cleaner or with clean compressed air or with clean brush. After preparation, the surface shall have a faint metallic sheen. The appearance shall correspond to the prints designated as St-2.

b. Grade St-3: Very thorough scraping and wire brushing, machine brushing, grinding, etc. The surface preparation is same as for grade St-2 but is to be done much more thoroughly.

After preparing the surface, it should have a pronounced metallic sheen. The appearance shall correspond to the prints designated as St-3.

29.0 Paint and Painting

For use of a specific painting system, the paint Manufacturer's Specification shall prevail.

General compatibility between primer and finishing paints shall be established through the paint Manufacturer.

Before buying the paint in bulk, it is recommended to obtain sample of paint and establish control area of painting. On control area, surface preparation and painting shall be carried out in the presence of the paint Manufacturer.

Whole quantity of paint for a particular system of paint shall be obtained from the same paint Manufacturer.

Thinners, wherever used, shall be as per recommendation of the paint Manufacturer.

Areas that become inaccessible after assembly of structures shall be painted before assembly after cleaning the surfaces as specified. All field-welded areas on shop painted item shall be Mechanically cleaned (including the weld area proper, adjacent areas contaminated by weld spatter or fumes and areas where existing primer is burnt). Subsequently, new primer shall be applied.

Application of paint shall be by spraying or brushing as per IS 487: 1985 in uniform layers of 50% overlapping strokes. Painting shall not be done when the temperature is less than 5°C or relative humidity more than 85%, unless permitted by the paint Manufacturer's recommendations. Also, painting shall not be done in frosty or foggy weather. During application, paint agitation must be provided wherever the paint Manufacturer recommends such agitation.

Paint shall be applied at the paint Manufacturer's recommended rates. The number of coats shall be such that the minimum dry film thickness (DFT) specified in the Specification/drawings is achieved. DFT of painted surfaces shall be checked with elcometer or measuring gauges to ensure application of specified DFT.

All structures shall receive appropriate number of primer and finishing coats in order to achieve overall DFT as per design drawings/Specification. First coat of primer paint shall be applied not later than 2-3 hours after preparation of surface, unless specified otherwise.

The finishing paint shall be of approved colour and quality. The under coat shall have different tint to distinguish the same from the finishing coat.

Edges, corners, crevices, depressions, joints and welds shall receive special attention to ensure that they receive painting coats of the required thickness.

Machine finished surface shall be coated with white lead and tallow before shipment or before being put into the open air. Surfaces that cannot be painted but require protection shall be given a coat of rust inhibitive grease according to IS 958: 1975 or equivalent international standard.

30.0 Painting system

The recommended paint systems for general service requirement of steel structures covering surface preparation, application of primer coats, intermediate coats (if necessary) and final coats to develop the required minimum dry film thickness on steel surface.

For general building and other structures, paint system shall be followed as specified for Mechanical works.

31.0 Material

The Contractor shall arrange and procure all steel sections, plates, fixtures and fittings required for gates and fencing and pipe supporting Structures clips, all the consumables like screws, bolts, turned and fitted bolts, nuts including spares and service bolts, washers of different types, electrodes, gas, shims, packs, paints, etc., for completing the work satisfactorily and the cost of the same shall be deemed to have been covered in his quoted price. If assistance is required by the Contractor in obtaining permits/proprieties in allotment of controlled/scarce material, if any, the Purchaser by way of issue of recommendation letter, essentiality certificate, etc., to Government Authorities may extend the same.

Delay, if any, in obtaining the materials will not constitute a ground for claiming any compensation or extension of time. Where any raw material required for the execution of the contract is procured with the assistance of the Purchaser or permit/licence/quota certificate or release order issued by or on behalf of or under authority of the Purchaser or by any officer empowered on their behalf by law, or where advance payments are made to the Contractor to enable him to purchase such raw material for execution of work, the Contractor shall:

a. hold such materials as trustee for the Purchaser,

b. use such materials economically and solely for the purpose of the contract,

c. not dispose of the same without prior permission in writing from the Purchaser and

d. maintain and produce due documents indicating stock position/consumption of such materials from time to time, as required by the Purchaser.

The Owner may plan to procure and supply from the producers/stockyards major items of structural steel such as RS Joists, channels, angles, plates, etc., required for the work. In that case these will be supplied to the Contractor in the indented lengths
or standard lengths available, as received from the Suppliers.

When steel is to be supplied by Purchaser, the Contractor shall be made the consignee for receiving all such steel materials. On receipt of materials at the nearest rail head, he shall be responsible for clearing, unloading and transporting the materials to his stockyards/place of work at his own cost. All demurrage due to any delay in clearing and/or unloading the steel

materials shall be borne by the Contractor. The Contractor shall keep the Purchaser informed of the receipt of materials regularly.

When material is issued from the Purchaser's stores, the Contractor shall be responsible for taking delivery at the stores and make his own arrangement for transporting the materials to the place of work.

The Purchaser reserves the right to take back such sections or quantity of steel issued in excess of the quantity as per fabrication drawings plus permissible wastage. The Contractor shall return to the Purchaser all such steel supplied in good and acceptable condition. In case of failure of the Contractor to return such surplus steel on demand by the Purchaser, the Purchaser reserves the right to recover the cost of such steel at 20% above the prevailing SAIL stockyard rates inclusive of all taxes.

In case the Contractor procures the steel, test certificates for the ame shall be made available to the Purchaser.

32.0 Wastage

For the purpose of accounting of material supplied by the Purchaser, free or on cost recoverable basis, the following wastage including rolling margin, invisible wastage and cut pieces of less than one metre length and plates of size less than 300mmx300mm in steel section, shall be allowed.

a: Structural Steel:

Rolled Sections: 5% on the quantity by weight computed, based on fabrication drawings.

Plates: 7.5% on the quantity by weight computed, based on fabrication drawings.

b: Other materials: 5% on the quantity by weight computed, based on manufacturing drawings.

Contractor’s responsibility

The Contractor shall, at his own cost, properly store all materials brought by him to the work site/fabrication shop to prevent damage due to rain, wind, direct exposure to sun, etc., and also from theft, pilferage, etc.

Equipment

All construction material and equipment once brought by the Contractor within the Project Area are not to be removed from there without the written authority from the Purchaser.

Despatch of fabricated materials

The Contractor is solely responsible for any loss or damage during transit to any of the fabricated members and as such, proper precautions shall be taken by him to guard against such mishaps.

Setting out

The Contractor shall be responsible for checking the alignment and levels of foundations, correctness of foundation, centres of anchor bolts, etc., well in advance of starting erection work and shall be responsible for any consequence for non-compliance thereof. Discrepancies, if any, shall immediately be brought to the notice of the Purchaser. Any mistake subsequently found in alignment and levels of the structural steelwork due to non-verification of foundation before erection shall be corrected by the Contractor at his own expense.

One set of reference axes and one benchmark level will be furnished to the Contractor. These shall be used for setting out of structures. Maintenance of such benchmark shall be the responsibility of the Contractor.

The Contractor shall provide measuring instruments for setting out,m leveling and aligning steelwork at his own expense.

Rules and regulations of safety, Electricity Boards, Factory, etc.

The Contractor shall at all times comply with all relevant factory acts, electricity rules, safety regulations, etc., as per statutory regulations of Central/State Government.

33.0 Extra items

Works which are not included in the Schedule of Items but which are required to be carried out for completion of the project shall be carried out as per Specification/drawings/sketches to be issued by the Purchaser. The payment for such items shall be based on rates to be derived wherever possible from available agreed rates. If such derivation of rates is not possible, the rates for such items shall be
derived on the basis of actual cost of materials labour and transportation, which shall be substantiated with relevant documents and records by the Contractor and verified by the Purchaser or his authorised representatives. An overall margin of 15% towards cost of
overhead and profit will be allowed.

34.0 Measurements

Structural Steel

Structural steelwork will be measured by the metric tonne and as per IS 1200 (Part-8): 1993 and IS 1200 (Part-9): 1973 subject to provisions outlined below:

a. The calculation of quantities shall be based on unit weights of structural sections as given in IS Handbooks. In the case of mild steel plates, the calculated weights shall be based on 78.5kg/m2/cm thickness of plate. The payments will be made on the basis of weights of members given in the approved fabrication drawings. However, if there are any changes on the above weights during fabrication or erection, payment shall be based on sketches approved by the Purchaser.

b. In the event the BIS does not specify any mode of measurement for a particular item of work, the same shall be measured as per any other relevant international standard or as directed by the Purchaser.

c. The weight of all plates and sections shall be calculated from the approved drawing using the minimum overall square or rectangular dimensions and theoretical weight, no deduction being made for skew cuts, holes, etc. In the case of plates, other than gussets, the actual dimensions shown on approved drawings shall apply unless approved otherwise by the Purchaser based on cutting diagram of mother plates.

d. The weight of all welding runs, bolts, stanchion base packings, cutting to waste and rolling margins and coatings of paint will be excluded from the measured weight and shall be deemed to have been allowed for in the rates for structural steelworks quoted by the Contractor.

e. Temporary works and all other materials not included in the permanent works shall be excluded from any measurement for payment.

35.0 Preliminary Acceptance

After completing the erection of a unit or portion thereof, the Contractor shall give a notice in writing stating that the job iscomplete in all respects and ready for preliminary acceptance. The job shall be jointly inspected visually by representatives of the Contractor and the Purchaser. All observed defects and omissions asper drawing and specification shall be noted down. If the defects are not major in the opinion of the Purchaser/Purchaser's representative, the Contractor will be issued a Preliminary Acceptance Certificate(PAC) mentioning the defects, deficiencies and omissions which shall be made good by the Contractor within a period of 4 (four) weeks.

Before commencement of inspection for final acceptance of the building or unit, the Contractor shall make available two complete sets of all drawings representing ‘As-Built’ drawings (all additions and alterations done during fabrication and erection shall be incorporated in the drawings).

The Contractor shall make good all defects, deficiencies andomissions noted down during Preliminary Acceptance (refer Clause 46.01) and shall inform in advance the Purchaser/his representative for conducting inspection for Final Acceptance. The Purchaser/his representative will issue final Acceptance Certificate (FAC) only after all defects/deficiencies/omissions noted under Preliminary Acceptance have been rectified.

36.0 Maintenance and Guarantee

Commencing from the date of issue of FAC or conclusion of Final Acceptance inspection, the Contractor shall stand guarantee for a period of 12 (twelve) calendar months for the satisfactory performance of steel structures of the unit. In the event of issue of more than one certificate by the Purchaser, maintenance period shall commence from the date of issue of last certificate for the particular unit. The Contractor shall replace/rectify all parts/components that become defective due to poor quality of material, bad fabrication or erection or due to any act of oversight or omission. Any leakage noticed in roof or side sheeting during this period shall be

rectified or affected sheets shall be replaced. All such rectification or replacements of defective materials or workmanship shall be done free of cost by the Contractor.

LIST OF APPROVED MAKES FOR CIVIL WORK

Cement	Portland cement	Gujrat Ambuja L&T Raymonds ACC DLF VIKRAM
Steel	Tor Steel	SAIL
		TISCO
		RATHI
	Structural Steel	SAIL
		TISCO
Bolts		Unbrako
		TVS
		GKW
Electrodes		ESAB
		Advani
		D&H
Paint		Asian Paints
		ICI
		Shalimar
		Berger
Translucent sheets		ISI Marked.
Pavior Block		Nitco
		Nimco
		KK
		KonKrete

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SPECIFICATION

FOR

ANTI BUOYANCY MEASURES

(CONCRETE WEIGHT COATING & SADDLE WEIGHT)

SPECIFICATION NO. SIPI/Steel/TS/28
(CIVIL ENGINEERING SECTION)

C O N T E N T S

1.0 SCOPE

This specification covers requirements for the materials, workmanship, quality assurance and handling for anti-buoyancy measures covering the external concrete weight coating of pipelines and concrete saddle weight installation.

1.1 PART-A : EXTERNAL CONCRETE WEIGHT COATING

1.2 This specification shall be read in conjunction with the conditions of all specifications and documents included in the CONTRACT between COMPANY and CONTRACTOR.

1.3 CONTRACTOR shall, execute the work in conformity with all standard practices, specifications, drawing and direction by the COMPANY and provide all services, labour, supervision, all materials, excluding the materials indicated as COMPANY supplied materials in the CONTRACT, equipment, appliances etc. required in or about the execution of the work, whether of a temporary or permanent nature.

1.4 All relevant specifications shall be referred to as per requirement, whether specifically mentioned or otherwise.

2.0 REFERENCE DOCUMENTS

2.1 Reference has been made in this specification to the following codes and standards :

a) IS:8112 : Indian Standard Specification for Ordinary Portland Cement.

b) IS:8112 : Indian Standard Specification for high strength Ordinary Portland Cement.

c) IS:383 : Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete.

d) IS:2386 (Parts-I : Indian Standard Methods of Test for to VIII) Aggregates for Concrete.

e) IS: 12330 : Indian standard specification for sulphate resisting Portland cement.

f) IS:456 : Indian standard code of practice for plain and reinforced concrete .

g) IS:3370 : Indian standard Code of practice for concrete structures for storage of liquids.

h) IS:1566 : Indian standard for Hard-drawn steel wire fabric for concrete reinforcement.

i) IS:432 (Part II) : Indian Standard for Mild steel and medium tensile steel bars and hard drawn steel wire for concrete Reinforcement.

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

2.2 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.
- 3.0’ and `Will’ are non-mandatory advisory or recommended.

3.0 MATERIALS

The CONTRACTOR shall supply all the materials necessary for the performance of the work.

Materials for concrete coating shall comply with following requirements. All materials supplied by the CONTRACTOR which in the opinion of COMPANY, do not comply with the appropriate specifications shall be rejected and immediately removed from site by CONTRACTOR at his expense.

3.1 Cement

Portland cement (conforming to IS:269), or High Strength Ordinary Portland Cement (conforming to IS:8112) shall be used. Cement which has hardened or partially set or has become lumpy shall not be used. Test certificates from the cement Manufacturer shall be supplied to the COMPANY for all cement delivered to site.

3.2 Aggregates

3.2.1 Aggregate shall comply with the requirements of IS:383 and shall be tested in accordance with IS:2386.

3.2.2 Fine Aggregates

Fine Aggregates’ shall mean any of the following, as defined in IS:383:

i) Natural sand.
ii) Crushed stone sand;
iii) Crushed gravel sand.

Sand shall be well-graded from fine to coarse in accordance with Table-4 of IS:383.

3.2.3 Coarse Aggregates

Use of coarse aggregates shall be subject to COMPANY approval.

3.2.4 Aggregates shall be clean and free from injurious amount of salt, alkali, deterious substances or organic impurities.

3.3 **Water**

The water shall preferably be clean, fresh and shall be free from non-permissible amounts of oils, acids, 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 doubtful sources shall be tested by the CONTRACTOR at his expense and approved by COMPANY before use.

3.4 **Reinforcement**

Concrete coating shall be reinforced by a layer or layers of steel reinforcement according to the provisions described here.

3.4.1 Reinforcement shall consist of welded steel wire fabric manufactured in flat sheets or in rolls (ribbon mesh) and shall conform to IS:1566-1995. Wires shall conform to IS:432, Part-II.

3.4.2 Steel wires shall be galvanized at finished size. The diameter of the wire and spacing of wires (mesh dimensions) shall be selected according to the following criteria.

3.4.2.1Wire fabric manufactured in flat sheets shall be 50 x 100mm max. steel wire mesh, 13 gauge 2.5mm thickness.

3.4.2.2Wire fabric manufactured in rolls (ribbon mesh) shall be 25 x 50mm of 14 gauge (2mm thickness). 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 guniting method.

4.0 **COATING REQUIREMENTS**

Pipes shall be concrete coated to a thickness as specified in the drawings and documents supplied/ approved by the COMPANY. The concrete unit weight shall be minimum 2245 kg/m^3 and the compressive strength shall not be less than 350 kg/cm^2 in 28 days and 235 kg/cm^2 in 7 days.

CONTRACTOR shall be permitted to select any proportioning of materials to achieve the specified requirements of concrete density and weight by doing mix design and trial tests.

5.0 **APPLICATION METHOD**

Concrete coating shall be applied either using casting or guniting method. Any alteration or modifications to the methods described in this specification shall be submitted to the COMPANY for approval. The application method shall however ensure the basic characteristics of concrete coating in compliance with the minimum requirements of this specification.

CONTRACTOR shall submit to the COMPANY, prior to commencement of work, the procedure/ method of application for approval.

Wherever practical, the total thickness of coating shall be applied in a single pass.

6.0 **EQUIPMENT**

The equipment used for the concrete coating shall be capable of giving 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. Concrete shall be mixed in a Mechanical mixer, which shall ensure thorough mixing of all materials. Any equipment that tends to separate the in gradients shall not be used.

7.0 **MEASUREMENTS & RECORDS**

7.1 All measurements as mentioned below shall be taken during the work stages and clearly recorded 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.

7.2 The following shall be subject to measurement and recording for each pipe length.

a) Line Pipe

1) Field identification number
2) Mill serial number
3) Length
4) Weight
5) Average outside diameter

b) Concrete Coating

6) Batch identification number
7) Date of placing of concrete coating
8) Average concrete coating thickness
9) "Dry weight" of concrete coated pipe
10) "Unit dry weight" of concrete coated pipe
11) "Negative buoyancy" (unit) of concrete coated pipe

7.3 No concrete placing shall be allowed before items 1 through 5 listed at clause 7.2, have been recorded and approved by COMPANY.

8.0 **PROCEDURE 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 which meets the requirements of section 4.0 of this specification.

8.1 The type of mix, i.e. the correct combination of the cement, aggregates and water which results in the desired properties of concrete shall be at first determined. 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.

8.2 Samples shall be prepared and tested in accordance with IS:456 to determine the dry specific gravity of the concrete.

Test for concrete specific gravity at intermediate time (7 days after coating) shall be performed.

8.3 When the results of the above tests do not meet the requirements, the mix shall be modified, and concrete samples tested until a proper mix has been determined.

8.4 The mix so determined, shall then be used for sampling of concrete to be submitted to compressive strength tests as per IS:456.

8.5 Frequency of sampling for tests for density and compressive strength of concrete shall be as follows :

`Quantity' of Concrete in the Work(m^3)	**Number of Samples**
Upto 25	3
26 to 50	4
51 and above	4 plus one additional sample for each additional 50m^3 or part thereof.

`Quantity' means the volume of concrete to be used.

9.0 APPLICATIONS OF REINFORCEMENT AND CONCRETE COATING

9.1 Two test cubes each per day shall be obtained from batches and tested at the end of 7 days after coating, for compressive strength and specific gravity.

9.2 The moisture content of the aggregates used shall be such as to maintain a satisfactory control on the water/ cement ratio of the concrete mix.
To maintain the water/ cement ratio constant at its correct, value, determination of moisture contents in both fine and coarse (if used) aggregates shall be made as frequently as possible.

9.3 **Pipe Length Preparation**

Prior to placing of reinforcement, the protective coating of each pipe length shall be carefully inspected visually and by holiday detectors and, if damages are found, they shall be repaired before start of the work. Foreign materials, if any, shall be removed from the surface of the protective coating.

9.4. **Reinforcement Application**

9.4.1 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 protrude a minimum 5 cm from the finished concrete coating.

9.4.2 Reinforcement shall rest on PVC 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" centers shall be 500 C/C and a minimum of 4 Nos. shall be provided at each `Crown' center.

9.4.3 Splices and attachments shall be done by binding with steel wire having 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.

9.4.4 One layer of reinforcement steel shall be provided for concrete thickness less than 50mm and the same shall be embedded approximately midway in the concrete coating thickness. For concrete thickness 50mm and above two layers of reinforcing steel shall be provided. If application method requires more than one pass concrete, one reinforcement layer for each pass is to be applied independently from concrete coating thickness.

9.5 **Concrete Placing**

9.5.1 Concrete shall be placed within a maximum of 30 minutes from the time of mixing (adding water to mix) and shall be handled in such a way so as to prevent aggregate segregation and excessive moisture loss. Concrete containers shall continuously be kept clean and free from hardened or partially hardened concrete.

9.5.2 If casting method is used, once reinforcement and mould have been applied around the pipe, concrete mixture shall be poured through an opening on the upper section of the same mould. Concrete shall not be deposited from a height greater than 1 metro. 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.

9.5.3 If guniting method is used, placement of concrete shall be upto the specified thickness in one continuous course, with allowance for splices of reinforcement and providing reinforcement in the right location.

9.5.4 No casting shall be interrupted or passes shall be stopped for more than 30 minutes. Before placing fresh concrete against the joint, the contact surfaces shall be carefully cleaned and wetted to obtain a good bond between the fresh material and the previously placed material.

9.5.5 Suitable means shall be provided to ensure that the temperature of the concrete, when placed, does not exceed 32°C.

9.5.6 All pipes shall be kept clean and free from cement concrete and grout either inside or outside of the uncoated sections.

9.5.7 Bevel protectors shall be kept in place throughout the coating application and after.

9.5.8 The coating at each end of the pipe shall be beveled 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.

9.6 **Curing**

9.6.1 Immediately after concreting, the exposed surfaces of the concrete shall be protected during `setting’ 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.

9.6.2 Curing shall be done by sprinkling water at regular intervals on gunny cloth wound around the concrete coated pipes.

Alternatively, curing may be done by application of an approved curing membrane using sealing compounds and shall meet the basic requirements of IS:456 and shall generally be of very high quality of manufacture and approved make. 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 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.

9.6.3 Before handling and hauling the concrete coated pipes, a check shall be made to make sure that the concrete coating is properly cured. Stacking and shipment of the coated pipes shall be initiated only after seven days provided that the concrete coating suffers no damage.

10.0 **TOLERANCES**

10.1 CONTRACTOR shall maintain a surface tolerance of 8mm 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.

10.2 The acceptance weight tolerance for any single pipe shall be limited to plus five (5) or minus two (2) percent of the calculated theoretical weight. The theoretical weight shall be calculated using total weight of the pipe with concrete and corrosion coating.

11.0 **WEIGHING**

11.1 The test specimen shall be selected at equal intervals during the course of production.

11.2 CONTRACTOR shall weigh each pipe when dry prior to shipment and 28 days after placing of concrete and mark the weight with paint on the inside of the pipe. The weight mark shall be followed with letters "DW" meaning Dry Weight.

12.0 **INSPECTION AND TESTS**

12.1 After curing, every length of concrete coated pipe shall be non-destructively tested by means such as "ringing" to determine if any suspected defects are present. In case this indicates faulty

coating, cores shall be removed from coating and inspected. When defective coating appears from cores, the concrete coating shall be removed from the pipe lengths.

12.2 Every length of concrete coated pipe shall be checked to verify insulation between steel reinforcement and pipe by means of a megger or equivalent device. 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.

12.3 During the tests as per clause 12.2 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 clause 13.0. Repairable concrete coatings shall be clearly marked while the non-repairable ones shall be removed from the pipe lengths.

13.0 THE COATING OF FIELD WELDS

13.1 The CONTRACTOR shall coat the uncoated pipe surface at field welds inaccordance with methods approved by COMPANY. CONTRACTOR shall submit a detailed procedure for joint coating for COMPANY's approval.

13.2 The reinforcement for the field welds shall be same as that for line pipe coating with the same number of layers and the same space between layers as for the existing coating. The edges of this meeting must be carefully secured with galvanized wire to the reinforcement extending from the existing coating. The reinforcement shall not make direct or electrical contact with the pipe. Synthetic resin spacer blocks may be used to keep the reinforcement free from the pipe coating as mentioned in cl. 9.4.2.

The moulds used for applying the concrete coating shall be supplied by the CONTRACTOR.

13.3 The composition of the concrete shall be the same as that of the concrete coating of the pipe.

When using moulds, the CONTRACTOR shall prevent air being trapped by applying Mechanical vibrators or by striking the outside of the moulds with sticks.

13.4 If the moulds remains around the pipe, e.g. in the case of submerged pipes floated into position, the CONTRACTOR shall take appropriate measures to prevent too much water entering the mould. This can be achieved by clamping strips of burlap between the ends of the mould and the existing concrete coating. After the mould has been filled with concrete the filling opening must also be closed off by clamping a strip on burlap under the sealing cover.

14.0 REPAIRS

The following are repairs that will be permitted to coating due to unavoidable damage in handling and in storage (This applies only to concrete that has set).

14.1 Spalling due to compression or shearing caused by impact against other objects. Spalling is defined as damage which causes a loss in concrete of more than 25 percent of the total thickness of the coating at the point of damage.

14.2 Damage due to spalling of a local area shall be repaired by removing loose concrete and exposing 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 repaired area at the top and shall be moist cured for a minimum of thirty six (36) hours before further handling.

14.3 Should the damaged area be more than 0.3m_2, coating shall be removed around the entire damaged area. A repair shall be made by satisfactorily restoring the reinforcement, forming the area with a metal form and pouring a complete replacement of materials similar to that from which the coating was made. The mixture shall be one (1) part of cement to three (3) parts of aggregate and the necessary water to produce a slump not to exceed 100mm. 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 moist cured for a minimum of 36 hours before further handling.

15.0 MARKING

15.1 Every concrete coated pipe length shall be clearly marked by a suitable type of paint (i.e. red and/ or white lead paint). Markings out of concrete coating shall be made inside of pipe close to bevel end, in such a way that the area involved by welding operations is not affected by paint.

15.2 For each concrete coated pipe length, at one of the two ends, the field identification number and the date of concrete placing shall be marked, while the dry as well as the net weight along with number of days after coating shall be marked at the other end.

16.0 UNLOADING, TRANSPORT, STORING AND HAULING

16.1 Once the pipe sections have been taken on charge, the CONTRACTOR, complying with provisions of the CONTRACT, shall execute their transport together with other material, either supplied by him or by the COMPANY, from the site of receipt to the 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.

16.2 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.

16.3 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.

16.4 During the operations of loading, unloading and stock-piling, the pipe sections shall be handled in such a way so as to avoid dents, cuts, cracks and other damages especially at beveled ends or damages to protective and/ or concrete coating.

16.5 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 COMPANY 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.

17.0 PART-B : CONCRETE SADDLE WEIGHT

17.1 This specification deals with the work of supply, precasting, and placement of concrete saddle weights of specified design and construction. Refer Standard Drawing No. SIPI/05/S/11/SK-03, Rev-0 Sheet 15 of 15)

17.2 This specification shall be read in conjunction with the conditions of all specifications and documents included in the CONTRACT between COMPANY and CONTRACTOR.

17.3 CONTRACTOR shall, execute the work in conformity with all standard practices, specifications, drawing and direction by the COMPANY and provide all services, labour, supervision, all materials, excluding the materials indicated as COMPANY supplied materials in the CONTRACT, equipment, appliances etc. required in or about the execution of the work, whether of a temporary or permanent nature.

17.4 All relevant specifications shall be referred to as per requirement, whether specifically mentioned or otherwise. Reference may generally be made to the cl. 2.0 REFERENCE DOCUMENTS (PART-A) of this document.

17.5 For materials and workmanship the reference shall be made to respective items.

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SPECIFICATION

FOR

FABRICATION, ERECTION AND PAINTING OF STEEL STRUCTURES, CHAIN LINK FENCING AND GATES

SPECIFICATION NO.: SIPI/Steel/TS/29

C O N T E N T S

LIST OF ANNEXURES

1.0 GENERAL

1.1 This specification shall apply to general steelwork, chain link fencing and gates in natural gas pipeline terminals. The structures shall include platforms, crossovers, ladders, staircases, pipe supports, skid supports, canopies, sheds, stockades/trestles, etc.

SECTION-1: FABRICATION OF STEEL STRUCTURES

2.0 SCOPE OF WORK

2.1 The scope of work under fabrication includes, but not limited to, the following:

a) Preparation and supply of material indents, bolt lists, bought out items list, etc.

b) Procurement and collection of all material from stockyards/stores, including loading, transportation, unloading and stacking and storing on skids or supports.

c) Procurement and collection of all consumables like bolts, nuts, washers, electrodes, paints, shims, packs, etc., including allowance for spares and wastage.

d) Preparation and submission of modification/rectification sketches, As-Built drawings, erection drawings, bill of materials, and shipping documents for approval of CLIENT.

e) Cold straightening of section and plates, whenever they are bent and kinked.

f) Fabrication of all steel structural components covered under tender drawings, design drawings and generally described under the scope of the project.

g) Making arrangements for and conducting tests such as chemical analysis, physicaland Mechanical tests on raw materials where specified/as directed by CLIENT.

h) Control Assembly of steel structural components at shop, wherever required.

i) Preparation of steel structural surfaces for painting as provided in the specifications/drawings.

j) Application for one primer coat of painting at shop, as specified in the design drawing/specifications.

k) Loading, transportation from fabrication workshop to site of erection and unloading of all steel structural components/units/assemblies.

l) Preparation of ‘As-built’ drawings.

3.0 MATERIALS

3.1 Structural Steel

3.1.1 Structural steel and other related materials for construction shall conform to **Annexure-F**.

3.1.2 Due to non-availability of specified materials, suitable substitutions may be provided with the consent of CLIENT. Such substitution shall be incorporated in the "As-built" drawings.

3.1.3 All the items are to be cut as per requirements of the drawing. If joints are to be provided in any item in order to meet requirements of size and shape, cutting plan showing locations of joints shall be prepared for consideration of purchaser. Joints provided shall be incorporated in "As-built" drawings.

3.1.4 Rolling and cutting tolerances shall be as per IS:1852-1985.

3.1.5 Only tested materials shall be used unless use of untested materials for certain secondary structural members is permitted by CLIENT. If test certificate for the material is not available from the main producer, the following tests shall be carried out at the discretion of CLIENT:

a) Chemical Composition
b) Mechanical Properties
c) Weldability test

3.2 Bolts and Nuts

3.2.1 Black hexagonal bolts, nuts and lock nuts shall conform to IS:1363-1992.

3.3 Electrodes

3.3.1 Electrodes shall conform to IS:814-1991.

4.0 STORING OF MATERIALS

4.1 Materials shall be stored and stacked properly ensuring that place is properly drained and is free from dirt. It shall be ensured that no damage is caused due to improper stacking.

5.0 MATERIAL PREPARATION

5.1 Cut edges shall be finished smooth by grinding or machining wherever necessary. Sufficient allowance (3mm to 5mm) should be kept in the items incase machining is necessary.

5.2 Cutting may be effected by gas cutting, shearing, cropping or sawing.

5.3 Straightening and bending shall be done in cold condition as far as practicable.

5.4 If required, straightening and bending may be done by application of heat between 900ºC and 1100ºC. Cooling down of the heated item shall be done slowly.

6.0 DRILLING AND PUNCHING OF HOLES

6.1 Drilling and punching of holes for bolts shall be done as per clause no.11.2.4 of IS:800-1984, unless otherwise specified by CLIENT.

6.2 Drifting of holes for bolts during assembly shall not cause enlargement of holes beyond permissible limit or damage the metal.

6.3 Holes for bolted connection should match well to permit easy entry of bolts. Gross mismatchof holes shall be avoided.

6.4 Permissible deviation in holes for mild steel bolts of normal accuracy and high strength bolts are given in the **Annexure-A**.

7.0 ASSEMBLY FOR FABRICATION

7.1 Fabrication of all structural steelwork shall be in accordance with IS:800-1984 and inconformity with various clauses of this Specification, unless otherwise specified in the drawings.

7.2 Fabrication of structures shall preferably be taken up as per the sequence of erection.

7.3 All erection units shall bear reference drawing no. at a prominent location on the structures for easy identification at site.

7.4 Fabricated structures shall conform to tolerance as specified in this Specification and in IS:7215-1974. In case of contradiction, tolerance specified in this Specification shall prevail.

7.5 All the components of structures shall be free from twist, bend, damage, etc.

7.6 Splice joints shall generally be of full strength butt weld and wherever possible, shall be located at zones of minimum or substantially lesser stress.

7.7 Splice joints of flange and web should preferably be staggered.

7.8 Where necessary, washers shall be tapered or otherwise suitably shaped to give the heads of nuts and bolts satisfactory bearing.

7.9 The threaded portion of each bolt shall project through the nut at least by one thread.

7.10 Tolerance of assembled components of structures are given in **Annexure-B**.

7.11 Permissible deviations from designed (true) geometrical form of the despatch elements shall be in accordance with IS:7215-1974.

8.0 WELDING

8.1 The Contractor shall work out welding procedure for CLIENT’s approval, considering the following factors:

i) Specification and thickness of steel.
ii) Specification of electrode or/and base wire.

iii) Welding process (manual arc welding, submerged arc welding).
iv) Type of structures to be welded (thickness of components meeting at a joint).
v) Sequence of welding.
vi) Weather condition.
vii) Inspection procedure to be followed
viii) Design requirements of the joints.

8.2 All metal arc welding shall be carried out as per IS:9595-1980.

8.3 Electrode shall conform to Clause no. 3.3 of this Specification.

8.4 Electrodes shall be stored in a dry place. Electrodes whose coatings are damaged due to absorption of moisture or due any other reason shall not be used.

8.5 Recommendations of electrode manufacturer are to be strictly followed.

8.6 Welding surface shall be smooth, uniform, free from fins, tears notches or any other defect which may adversely affect welding.

8.7 For multi-run weld deposit, the next run should be done only after thorough removal of slag and proper cleaning of surface.

8.8 Fillet weld shall have the correct profile with smooth transition into parent metal. Dressing of welds, if specified, shall be done by such method which does not cause grooving and other surface defects on the weld or on the parent metal.

8.9 Fillet welds shall not be stopped at corners but shall be returned round them.

8.10 Welding shall not be done under such weather conditions which might adversely affect the efficiency of the welding.

8.11 Ends of structural members and portions of gussets receiving welding at site shall be left unpainted.

8.12 Permissible deviation in assembly of weld joints shall be in accordance with **Annexure-C**.

9.0 INSPECTION & TESTING

9.1 CLIENT/Inspector shall have free access at all times to those parts of Contractor's or his Sub-contractor's works which are concerned with the fabrication of steel works and shall be afforded all reasonable facilities at all stages of preparation, fabrication and trial assemblies for satisfying himself that the fabrication is being undertaken in accordance with the provisions of relevant specification.

9.2 All gauges and templates, tools, apparatus, labour and assistance for checking shall be supplied by the contractor free of charge. CLIENT/Inspector may, at his discretion, check the test results obtained at the Contractor's works, by independent test at the Government Test House or elsewhere, and should the material so tested be found to be unsatisfactory, the cost of such test shall be borne by the Contractor.

9.3 Contractor shall make all necessary arrangements for stage inspection by CLIENT/Inspector during the fabrication at shop and incorporate all on-the-spot instructions/ changes conveyed in writing to the Contractor.

9.4 Material improperly detailed or wrongly fabricated shall be reported to CLIENT/Inspector andshall be made good as directed. Minor misfits which can be remedied by moderate use of drift pins, and moderate amount of reaming and slight chipping may be corrected in that manner, if in the opinion CLIENT/Inspector, the strength or appearance of the structure will not beadversely affected. In the event CLIENT/Inspector directs otherwise, the items will be rejectedand a completely new piece shall be fabricated. The cost of correcting errors shall be to the account of the Contractor.

9.5 i) CLIENT/Inspector shall have the power:

a) To certify, before any structure is submitted for inspection, that the same is not in accordance with the contract, owing to the adoption of any unsatisfactory method of fabrication.

b) To reject any structure as not being in accordance with Specification and drawings.

c) To insist that no structure or parts of the structure once rejected is resubmitted for inspection/test, except in cases where CLIENT/ Inspector considers the defects as rectifiable.

ii) If, on rejection of structure by CLIENT/Inspector, the Contractor fails to make satisfactory progress within the stipulated period, CLIENT/Inspector shall be at liberty to cancel the contract and fabricate or authorize the fabrication of the structures at any other place he chooses, at the risk and cost of the Contractor, without prejudice to any action being taken in addition to terms of General Conditions of Contract.

iii) CLIENT/Inspector’s decision regarding rejection shall be final and binding on the Contractor.

iv) The Specifications prescribe various tests at specified intervals for ascertaining the quality of the work done. If the tests prove unsatisfactory, CLIENT/Inspector shallhave liberty to order the Contractor to re-do the work, done in that period and/or to order such alterations and strengthening that may be necessary at the cost of the Contractor and the contractor shall be bound to carryout such orders failing which the rectification/redoing will be done by CLIENT through other agencies and the cost recovered from the Contractor.

v) Notwithstanding any inspection at the workshop, CLIENT/Inspector shall have the liberty to reject, without being liable for compensation any fabricated members or materials brought to site that do not conform to specifications/drawings.

vi) All rejected materials shall be removed from the site of fabrication by the Contractor at his own cost and within the time stipulated by CLIENT/Inspector.

10.0 CONTROL IN WELDING

10.1 The extent of quality control in respect of welds for structural elements shall be as follows and shall be conducted by the contractor at his own cost:

a) Visual Examination - All welds shall be 100% visually inspected to check the following:

i) Presence of undercuts
ii) Visually identifiable surface cracks in both welds and base metals
iii) Unfilled craters
iv) Improper weld profile and size
v) Excessive reinforcement in weld
vi) Surface porosity

Before inspection, the surface of weld metal shall be cleaned of all slag, spatter matter, scales etc. by using wire brush or chisel.

b) Dye Penetration Test (DPT) - This shall be carried out for all important fillet welds and groove welds to check the following :

i) Surface cracks
ii) Surface porosity

Dye Penetration Test shall be carried out in accordance with American National Standard ASTM E165.

11.0 ACCEPTABLE LIMITS OF DEFECTS IN WELD

11.1 The limits of acceptability of defects detected during visual inspection and Dye Penetration Test shall be in accordance with clause 8.15.1 American National Standard ANSI/AWS D1.1-96.

12.0 RECTIFICATION OF DEFECTS IN WELDS

12.1 In case of detection of defects in welds , the rectification of the same shall be done as follows :

a) All craters in the weld and breaks in the weld run shall be thoroughly filled with weld.

b) Undercuts, beyond acceptable limits, shall be repaired with dressing so as to provide smooth transition of weld to parent metal

c) Welds with cracks and also welds with incomplete penetration, porosity, slag inclusion etc. exceeding permissible limits shall be rectified by removing the length of weld atthe location of such defects plus 10 mm from both ends of defective weld, and shall be re-welded. Defective weld shall be removed by chipping hammer, gouging torch or grinding wheel. Care shall be taken not to damage the adjacent material

13.0 DESPATCH INSTRUCTIONS

Each despatchable structure shall bear mark no. along with reference drawing number at two prominent locations.

13.1 “As-built” drawings shall be prepared after fabrication is completed to indicate additions/alterations made during the process of fabrication. (Refer clause 3.1.2 & 3.1.3.)

13.2 Center lines of column flanges and both sides of web shall be punched, preferably at top and bottom to facilitate alignment after erection.

14.0 COMPLETION DOCUMENTS

14.1 On completion of work, the Contractor shall submit to CLIENT the following documents:

a)The technical documents according to which the work was carried out.

b)Copies of the "As built" drawings showing thereon all additions and alterations made during fabrication.

c)Manufacturer's test certificates

d)Certificates/documents on control checking

e)Test of welds

14.2 Inspection Certificates shall be issued to the contractor for the structures found acceptable in all respects by CLIENT/Inspector.

SECTION-2: ERECTION OF STEEL STRUCTURES

15.0 SCOPE OF WORK

In addition to provision of erection and transport equipment, the scope of work includes supply of tools and tackles, consumables, materials, labour and supervision and shall cover the following:

a) Storing and stacking of all fabricated structural components/units/ assemblies at site storage yards till the time of erection.

b) Transportation of structures from storage yard to site of erection, including multiple handling, if required.

c) All minor rectification/modifications such as:
   i) Removal of bends, kinks, twists etc. for parts damaged during transportation and handling.
   ii) Reaming of holes which do not register or which are damaged, for use of next higher size bolt.
   iii) Plug welding and re-drilling of holes which do not register and which cannot be reamed for use of next higher size bolt.
   iv) Drilling of holes which are either not drilled at all or are drilled in incorrect position during fabrication.

d) Fabrication of minor missing items as directed by CLIENT.

e) Verification of the position of embedded anchor bolts and inserts w.r.t. line find levels, installed by others based on Geodetic Scheme/Bench mark/ Reference co –ordinates taken by the Contractor.

f) Rectifying at site damaged portions of shop primer by cleaning and application touch-up paint.

g) Erection of structures including making connections by bolts/welding as per drawing.

h) Alignment of all structures true to line, level plumb and dimensions within specified limits of tolerance.

i) Application at site after erection, required number of coats of primer and finishing paint as per specification and drawing.

j) Rectification of structures as per instructions of the Engineer-Incharge.

16.0 STORING AND HANDLING

16.1 Storage of structures shall be preferably be done in such a manner that erection sequence is not affected.

16.2 While storing, care shall be taken so that structures do not come in direct contact with the earth surface and accumulated water.

16.3 Stacking of the structures shall be done in such a way that, erection marks are visible easily and handling does not become difficult. Wherever required, wooden sleepers/grillage may be used.

16.4 Handling and storage of materials shall be as per IS:7969-1975, to ensure safety.

17.0 ERECTION

17.1 General

17.1.1 Erection shall be carried out in accordance with IS:800-1984 and other relevant standards referred to therein.

17.1.2 For safe and accurate erection of structural steelwork, staging, temporary support, false work, etc. shall be erected as required.

17.1.3 The fabricated materials received at erection site shall be verified with respect of marking on the key plan/marking plan or shipping list.

17.1.4 Any material found damaged or defective shall be stacked separately and the damaged ordefective portions shall be painted in distinct colour for identification and the same shall be brought to the notice of CLIENT.

17.2 Erection Drawings

17.2.1 The approved erection drawings and any approved arrangement drg, specification or instruction accompanying them shall be followed in erecting structures.

17.3 Erection of Structures

17.3.1 Erection work shall be taken up after receipt of clearance from CLIENT.

17.3.2 For safety requirements during erection, provisions in IS:7205-974, IS:7969-1975 and other relevant standards shall be followed.

17.3.3 Erection shall be carried out with maximum safety possible.

17.3.4 Prior to commencement of erection, all the erection equipment, tools, tackles, ropes, etc. shall,be tested for their load carrying capacity. Such tests may be repeated at intermediate stages also if considered necessary and frequent visual inspection shall be done of all vulnerable areas and components to detect damages or distress in the erection equipment, if any.

17.3.5 Following shall be taken care of during erection, whenever necessary:

17.3.5.1 Erected members shall be held securely in place by bolts to take care of dead load, wind load and erection load.

17.3.5.2 All connections shall achieve free expansion and contraction of structures wherever provided.

17.3.5.3 No final bolting or welding of joints shall be done until the structure has been properly aligned.

17.3.5.4 Instrumental checking of correctness of initial setting out of structures and adjustment of alignment shall be carried out in sequence and at different stages as required. The final levelling and alignment shall be carried out immediately after completion of each section.

17.3.5.3 The Contractor shall design, manufacture, erect and provide falsework, staging temporary support etc. required for safe and accurate erection of structural steelwork and shall be fully responsible for the adequacy of the same.

17.3.5.4 The Contractor shall also provide facilities such as adequate temporary access ladders, gangways, tools & tackles, instruments, etc. to CLIENT/Inspector for his inspection at any stage during erection.

17.4 **Field Connections**

17.4.1 Assembly by permanent bolts.

17.4.1.1 The numbers of washers on permanent bolts shall not be more than two (and not less than one) for the nuts and one for the bolt head.

17.4.1.2 Wooden rams or mallet shall be used in forcing members into position in order to protect the metal from injury or shock.

17.4.1.3 Where bolting is specified on the drawing, the bolts shall be tightened to the maximum limit. The threaded portion of the each bolt shall be project through the nut by at least one thread. Tapered washers shall be provided for all heads and nuts to achieve uniform bearing on sloping surface.

17.4.1.4 To prevent loosening of nuts, spring washers or lock nuts shall be provided as specified in the design/shop drawings.

17.4.1.5 All machine-fitted bolts shall be perfectly tight and the ends shall be checked to prevent nuts from becoming loose. No unfilled holes shall be left in any part of the structures.

17.4.2 Assembly by welding.

17.4.2.1 All field assembly by welding shall be executed in accordance with the requirements for shop fabrication. Where the steel has been delivered painted, the paint shall be removed before field welding for a distance of at least 50mm on either side of the joints to be welded.

17.4.2.2 All other requirements in welding shall be in accordance with clauses specified under Section-1 of this Specification

18.0 ACCEPTANCE STANDARD OF WELDING

18.1 Acceptance standard of welding shall be as specified in Section-1 of this Specification.

19.0 BEDDING AND GROUTING

19.1 Base plates shall be set to elevations shown on the drawings, supported aligned and leveled using steel wedges and shims or by other approved methods. Plates shall be leveled properly, positioned and the anchor bolts tightened.

20.0 PAINTING AFTER ERECTION

20.1 The painting shall be as per painting specification (Section-4) of this Specification) and instruction given on drawings.

20.2 Site painting shall not be done in frosty or foggy weather or when humidity is such as to cause condensation on the surface to be painted.

21.0 ERECTION TOLERANCE

Maximum permissible tolerance in erected steel structures shall be as given in **Annexure-D**.

22.0 ACCEPTANCE OF WORK

22.1 Acceptance of erected steel structures shall be either after completion of erection of all the structures or in blocks.

22.2 Preliminary Acceptance will be done in the following cases:

i) Any steelwork or part thereof embedded in concrete.

ii) Steel structures which are to be covered in the process of carrying out further work.

23.0 DOCUMENTATION

23.1 The following documents shall be prepared at the time of acceptance of erected structures:

i) Documents showing actual deviations made during execution of erection work and approval of competent authority.

ii) Documents showing acceptance of embedded structures.

iii) Certificate/documents on control checking and test of materials (if any) and weld.

iv) Data and result of geodetic measurements obtained while checking the erection of the structures.

23.2 Copies of "As-Built" drawing showing thereon all additions and alternations which took place between approval of drawing and erection of structures.

SECTION-3: FABRICATION AND ERECTION OF MISCELLANEOUS STRUCTURES

24.0 SIDE & ROOF CLADDING OF GALVANISED CORRUGATED STEEL (GCS) SHEETS

The scope of work shall cover:

a) Procurement and supply of GCS sheets of all sizes, flashing and any other accessories, cutting of sheets wherever required, drilling of holes, all as per specifications and drawings.

b) Procurement and supply of hook bolts and nuts, stitch bolts and nuts, clips, bitumen washers, GI diamond or limpet washers.

c) Loading, transportation, unloading and delivery of sheeting material from place of procurement to erection site.

d) Provision of all tools, tackles, equipment, labour, supervision and services required for the satisfactory completion of the work specified herein and on the drawings.

e) Erection in position of all GCS sheets at all locations; all work as per specification and drawings.

24.1 **Fixing**

24.1.1 All fixing of the roof and side sheeting to purlins and rails shall be by 8mmØ galvanized hook bolts. All bolts are to pass through the crown of the corrugation and are to be provided with GI flat washers and bitumen washers of approved quality.

24.1.2 GI seam bolts with GI Flat washers and bitumen washers are to be used for fixing corners, barge boards and other accessories wherever necessary.

24.1.3 The spacing of GI hook bolts is to be not more than four corrugations apart and GI seam bolts not more than 600 mm.

24.2 **Holing**

All holes for sheeting and accessories to be drilled. Punching of holes will not be permissible under any circumstances.

24.3 **Laps**

24.3.1 All roof sheets shall be provided with a minimum end lap of 150 mm along the slope and minimum side lap of 44 mm measured horizontally. Where four sheets meet at a lap the corners of two sheets shall be suitably mitered.

24.3.2 Over hang of the sheets on the roof and side cladding shall not exceed 300mm.

24.4 **Erection**

24.4.1 Erection is to be carried out with the lay of the side laps such that under the prevailing wind, rain is not driven into the lap.

25.0 CHAIN LINK FENCING AND GATE

The scope of work shall cover:

a) Procurement and supply mesh, line wire, stretcher bar, barbed wire (if shown in the drawings) and other accessories for chain link fencing and gate all as per specifications and drawings.

b) Loading, transportation, unloading and delivery of material for fencing and gate from place of procurement to erection site.

c) Provision of all tools, tackles, equipment, labor, supervision and services required for the satisfactory completion of the work specified herein and on the drawings.

d) Erection in position of the fencing and gate at all locations, all work as per specification and drawings.

25.1 **Erection**

25.1.1 The height of barbed wire shall be 2m top of vertical post. Where barbed wire is to be provided, the height shall be an extra 500mm to the top line of barbed wire attached to the cranked top.

25.1.2 Straining posts shall be provided at all ends and corners of fences, at changes in direction or acute variations in levels and at intervals not exceeding 66m on straight lengths of the fence. Intermediate posts shall be spaced at regular intervals not exceeding 1.5m.

25.1.3 Struts shall be fitted to all straining posts behind the chain link fabric in the direction of the fence.

25.1.4 There shall be four evenly spaced rows of line wire. The top wire shall be doubled, making five line wires in all. The bottom wire shall be close to the ground. Each line wire shall be strained

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

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

25.1.6 Four lines of barbed wire shall be provided where specified in the drawing. The wire shall be attached by eyebolts to the cranked tops of the straining posts. On all the intermediate posts, they shall be secured to cranked tops with stirrup wires. The barbed wire shall be fitted with one dropper at the center of each bay and secured to the wires to prevent them from bunching together.

25.2 **Gate**

25.2.1 A gate of suitable width shall be provided in the direction of the chain link fabric. The mesh and barbed wire used for the fabrication of gate shall be identical in all respects to that of chain link fencing. The door may be single leaf or double leaf depending on the width of the gate.

25.2.2 The gate frame shall be an angle frame with stiffeners at mid-height and mid-width. The mesh shall be welded to the gate frame/stiffeners.

25.2.3 Each leaf of the gate shall be supported on a pivot in the foundation for the straining post and shall be laterally held at two points, one near the top of the straining post and second near the middle of the straining post. The free end of each leaf shall be provided with a tower bolt at the base of the frame. An aldrop shall be provided at the mid-height of the frame.

SECTION-4: PAINTING OF STEEL STRUCTURES

25.0 SURFACE PREPARATION FOR PAINTING

25.1 **General**

The steel surface which is to be prepared shall be cleaned of dirt and grease and the heavier layers of rust shall be removed by grinding prior to actual surface preparation to a specified grade.

Surface preparation to be followed prior to painting shall be based on the requirement of a particular painting system as per Clause 27.0.

25.2 **Mechanical Cleaning**

Manual/ power tool cleaning shall be done as per grade St-2 or St-3, of Swedish Standard Institution SIS 055900.

i) Grade St-2: Thorough scraping and wire- brushing, machine brushing, grinding etc. This grade of preparation shall remove loose mill scale, rust and foreign matter. Finally the surface is to be cleaned with a vacuum cleaner or with clean compressed air or with clean brush. After preparation, the surface should have a faint metallic sheen. The appearance shall correspond to the prints designated St-2.

ii) Grade St-3: very thorough scraping and wire brushing, machine brushing, grinding etc. The surface preparation is same as for grade St-2 but to be done much more thoroughly. After preparing the surface, it should have a pronounced metallic sheen nd correspond to the prints designated St-3.

25.3 If no grade of surface preparation is specified, Grade St-2 shall be followed.

26.0 PAINTS AND PAINTING

26.1 For use of specific painting system as mentioned in the SOR, the paint manufacturer's specification shall prevail.

26.2 General compatibility between primer and finishing paints shall be established through the paint manufacturer supplying the paints.

26.3 Before buying the paint in bulk, it is recommended to obtain sample of paint and establish "Control Area of Painting". On control area surface preparation and painting shall be carried out in the presence of manufacturer of paint.

26.4 In order to ensure that the supplied paint meets the stipulation in design drawing/specification, if required, samples of paint shall be tested in laboratories to establish quality of paint with respect to viscosity, adhesion/bond of paint in steel surfaces, adhesion/simulated salt spray test, chemical analysis (percentage of solids by weight), normal wear resistance as encountered during handling & erection, resistance against exposure to acid fumes, etc.

26.5 Whole quantity of paint for a particular system of paint shall be obtained from the same manufacturer.

26.6 Thinners, wherever used, shall be as per recommendation of the paint manufacturer.

26.7 Areas which become inaccessible after assembly of structures shall be painted before assembly, after cleaning the surfaces as specified.

26.8 Wherever shop primer painting is scratched, abraded or damaged, the surfaces shall be thoroughly cleaned using emery paper and power driven wire brush wherever warranted, and touched up with corresponding primer. Touching up paint shall be matched and blended to eliminate conspicuous marks.

26.9 If more than 50% of the painted surface of an item requires repair, the entire item shall be Mechanically cleaned and new primer coats shall be applied followed by finishing coats as per painting specification.

All field-welded areas on shop painted item shall be Mechanically cleaned (including the weld area proper, adjacent areas contaminated by weld spatter or fumes and areas where existing primer. intermediate / finishing paint is burnt). Subsequently, new primer and finishing coats of paint shall be applied as per painting specification.

26.10 Application of paint shall be by spraying or brushing as per IS:487-1985 and in uniform layers of 50% overlapping strokes. Painting shall not be done when the temperature is less than 5°C or relative humidity more than 85%, unless manufacturer’s recommendations permit. Also painting shall not be done in frosty or foggy weather. During application, paint agitation must be provided wherever such agitation is recommended by the manufacturer.

26.11 Paint shall be applied at manufacturer’s recommended rates. The number of coats shall be such that the minimum dry film thickness (DFT) specified is achieved. The dry film thickness of painted surfaces shall be checked with elcometer or measuring gauges to ensure application of specified DFT.

26.12 All structures shall receive appropriate number of primer and finishing coats in order to achieve overall DFT as per design drawings/specifications. First coat of primer paint shall be applied not later than 2-3 hours after preparation of surface, unless specified otherwise.

26.13 The finishing paint as specified shall be of approved colour and quality. The under coat shall have different tint to distinguish the same from the finishing coat.

26.14 Edges, corners, crevices, depressions, joints and welds shall receive special attention to ensure that they receive painting coats of the required thickness.

26.15 Parts of surfaces embedded in concrete shall be thoroughly cleaned of grease, rust, mill scale etc. and shall be given a protective coat of Portland cement slurry immediately after fabrication. No paint shall be applied on this part.

26.16 Zinc-rich primer paints, which have been exposed several months before finishing coat is applied, shall be washed down thoroughly to remove soluble zinc salt deposits. In similar circumstances, the surfaces of paint based on epoxy resin should be abraded or lightly blast cleaned to ensure adhesion of next coat.

26.17 Surfaces which cannot be painted but require protection shall be given a coat of rust inhibitive grease according to IS:958-1975 or equivalent international standard.

27.0 PAINTING SYSTEM

The recommended painting system for general service requirement of steel structures covering surface preparation, application of primer coats, intermediate coats (if necessary) and final coats to develop the required minimum dry film thickness on steel surface is indicated as below

a. Surface preparation: St 2 according to Swedish Standard SIS055900.

b. Primer paint: Two coats of redoxide zinc chromate in phenolic alkyd medium (DFT 25ì/coat) of single pack type with 30-35% solids and covering capacity 12-13 m²/lit/coat.

c. Finishing paint: Two coats of synthetic enamel in alkyd medium with superior quality water and weather resistant pigments (DFT 20ì/coat) of single pack type with 30-40% solids and covering capacity 16-18 m²/lit/coat.

28.0 MEASUREMENTS

28.1 Structural Steel

Structural steelwork will be measured by the metric tonne and as per IS:1200(Part-8)-1993 and IS:1200(Part-9)-1973 subject to provisions outlined below:

a) The calculation of quantities shall be based on unit weights for structural sections as given in IS Handbooks. In the case of mild steel plates, the calculated weights shall be based on 78.5 kg/m2/centimeter thick plate. The payments will be made on the basis of weights of members as per drawings. However, any changes on the above weights during fabrication erection, payment shall be based on sketches approved by CLIENT.

b) In the event the IS does not specify any mode of measurement for a particular item of work, the same shall be measured as per any other relevant international standard or as directed by CLIENT.

c) The weight of all plates and sections shall be calculated from the approved drawing using the minimum overall square or rectangular dimensions and theoretical weight, no deduction being made for skew cuts, holes etc. In the case of plates, other than gussets, the actual dimensions shown on approved drawings will apply unless approved otherwise by the purchaser based on cutting diagram of mother plates.

d) The weight of all welding runs, bolt, stanchion base packing, cuttings to waste and rolling margins, and coatings of paint, will be excluded from the measured weight and shall be deemed to have been allowed for in the rates for structural steelworks quoted by the Contractor.

e) Temporary works and all other materials not included in the permanent works shall be excluded from any measurement for payment.

f) Chain link fencing shall be measured in running meter basis, as specified and shown on the drawings.

28.2 GCS & AC Sheets

28.2.1 Asbestos Cement Corrugated sheets for roofing and side cladding shall be measured by the square meter of net laid area, as specified and shown on the drawings.

28.2.2 No allowance shall be made for wastage, cutouts, overlaps, etc., in the measurement.

28.2.3 The unit rate shall include all fasteners, flashing and fitting such as ridges corners, aprons and other accessories.

28.2.4 No deduction will be made for openings for area less than a single sheet. Also no extra payment will be made for making openings.

29.0 ACCEPTANCE OF WORKS

29.1 After completing the erection of a unit or portion thereof, the Contractor shall give a notice in writing stating that the job is complete in all respects and ready for preliminary acceptance. The job shall be jointly inspected visually by representatives of Contractor and CLIENT. All observed defects and omissions as per drawing and specification shall be noted down.

29.2 The Contractor shall make good all these defects, deficiencies and omissions and shall inform in advance CLIENT/Inspector for inspection. The Engineer-Incharge shall satisfy himself that all the defects, deficiencies and omissions noted down during preliminary acceptance have been rectified.

Annexure-A
Permissible deviations in pitch and gauge of holes for bolts of normal accuracy

Sl. No.	Description	Hole Diameter (mm.)	Permissible deviations in spacing (mm.)	Permissible deviations in each group of holes	
				Carbon steel	Low alloy steel
a.	Deviation in hole diameter.	Upto 17	**+1.0**	No limits	
		Above 17	+1.5		
b.	Ovality (Difference between the biggest and the smallest diameters).	Upto 17	+1.0	No limits	
		Above 17	+1.5		
c.	Curves exceeding 1mm. and cracks on the hole edges.	-	-	Not permissible	
d.	Non-coincidence of holes in separate details of the assembled unit:				
	Upto 1mm.	-	-	Upto 50%	Upto 50%
	Above 1mm. upto 1.5mm.	-	-	Upto 10%	Upto 10%
e.	Slope of axis	-	Upto 30% the thickness of unit.	No limits	No limits

Annexure-B
Tolerance of Assembled Components of Structures

Sl. No.	Description of components in structures	**Deviation (±) mm. for elements of structures**						
1.		**Upto 1m.**	**1m. to 5m.**	**5m. to 10m.**	**10m. to 15m.**	**15m. to 20m.**	**20m. to 25m.**	**Over 25m.**
I.	Deviations from the dimensions assembled. Length and width of the details cut:							
a.	Manual gas cutting as per marking	3.0	3.5	4.0	4.5	5.0	-	-
b.	With shears or with saw as per marking.	2.0	2.5	3.0	3.5	4.0	-	-
c.	With shears or with a saw with a stop.	1.5	2.0	2.5	3.0	3.5	-	-
d.	Machine gas cutting	2.0	2.5	3.0	3.5	4.0	-	-
ii.	Length and width of planed processed on edge planing machine.	1.0	1.5	2.0	2.5	3.0	-	-
2.								
i.	Distance between centers of the end holes:							
a.	Drilled according to marking	2.0	2.5	3.0	3.5	4.0	-	-
b.	Drilled according to a gauge with bushing.	1.0	1.5	2.0	2.5	3.0	-	-
ii.	Distance between centers of adjacent holes:							
a.	Drilled according to marking or a gauge..	1.5	-	-	-	-	-	-
b.	Drilled according to a gauge with bushing.	0.5	-	-	-	-	-	-

Annexure-C

Tolerances in Erected Steel Structures

Sl.No.	Description	Tolerance
1.	Deviation of structure at foundation top level w.r.t. true axis	
a	in longitudinal direction.	± 5mm.
b	In lateral direction.	± 5mm.
2	Deviation in the level of bearing surface of structures at foundation top w.r.t. true level.	± 5mm.
3	Out of plumb of structure from true vertical axis and measured from structure top.	± H/1000 or ±25mm. Whichever is less.

Note: ‘H’ above is the structure height in mm.

Notes:

1. The tolerances do not apply to steel structures where deviations from true positions are intimately linked or directly influenced by technological processes. In such cases, tolerances on erected steel structures shall be as per recommendations of process technologists/equipment suppliers.

2. The observed or calculated values of deviations of steel structures from their true positions shall be rounded off in accordance with IS:2-1960 for comparison with permissible tolerances specified in this table. The number of significant places retained in the rounded off value shall be the same as that specified in this table.

Annexure-D

Material of construction (as applicable)

1.0 Unless otherwise specified in the drawing, all rolled sections and plates shall conform to Grade-A as per IS: 2062-1992.

2.0 Steel sheets shall conform to IS:1079-1988.

3.0 Steel tubes for structural purposes shall conform to IS: 1161-1979 (Grade YST-240).

4.0 ACC sheets shall be 6mm. thick with corrugation conforming to IS: 459-1992.

5.0 Gutters and down comers shall be of copper bearing steel conforming to IS: 2062-1992.

6.0 Crane rails shall conform to IS: 3443-1980.

7.0 All black hexagonal bolts, nuts and lock nuts shall conform to IS: 1363-1984 and IS: 1364-1983 (for precision and semi-precision hexagonal bolts). Washers shall conform to IS: 1148-1982.

8.0 Covered electrodes for arc welding shall conform to IS: 814-1991. Coding of electrodes shall be as follows:

a. ER 421 'C' x for mild steel of Grade A and Grade B as per IS: 2062-1992.

b. EB 542 'C' x H3X for: mild steel of Grade B as per IS: 2062-1992 for dynamically loaded structures (arising out of crane, vibratory screen, equipment, etc.), SAIL-MA micro alloyed steel 350 HYA/HYB and when combined thickness (CT) for steel conforming to IS:2062-1992 exceeds 40mm.

where ‘C’ is the value of current as recommended by the electrode manufacturer.

9.0 Material for chain link fencing shall conform to IS:2721-1979. Mesh for chain link fencing shall be of 3.15mm hot dip galvanized steel mesh wire, the diameter being measured over zinc coating. The diameter of mesh wire shall not vary from the specified diameter by more than 0.05mm. The material for mesh wire and line wire of chain link fencing shall conform to IS:280-1978. Stretcher bar for erection of mesh shall consist of mild steel flats 25mmx4.75mm. The stirrup wire for securing the line wires to the intermediate post shall be of 2.5mm mild steel wire. Hairpin staples for fastening the bottom-line wire to the foundation concrete shall be of 6mmÖ mild steel wire with ends of staples bent outwards for adequate anchorage. The cleats for eyebolts shall be of mild steel plate 10mm thick.

10.0 Material for barbed wire shall conform to IS:278-1978. Line wire for the barbed wire shall be made from two strands of galvanized steel wire of nominal dia 2.5mm twisted together. Barbs shall be made of point wire of galvanized steel of nominal dia 2.5mm in such a way that four points of the barbs are set and located or locked as far as possible at right angles to each other. Droppers for barbed wire shall be of mild steel flat 25mmx4.75mm with 38mmx4.85mm half round staples for fastening the barbed wire.

****

SPECIFICATION

FOR

WARNING MATS

SPECIFICATION NO. : SIPI/Steel/TS/30

SPECIFICATION FOR THE WARNING MATS

Purpose	:	For using as a warning sign for Under Ground Natural Gas Pipeline
Width	:	(D + 300) mm
Thickness	:	1.0mm thick and 0.25mm thick (two different sizes)
Material of the mat	:	The material shall be of high density Polyethylene
Colour of the mat	:	Golden Yellow
Art Work	:	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. Copy of Art work is enclosed at Page 2
Mechanical Properties of HDPE Tensile Strength	:	Minimum 1.8 kg/cm2
Elongation at Break	:	Minimum 125%
Bundle Length		1.0mm thick warning mat shall be supplied as 50 mtrs. bundle. 0.25mm thick warning mat shall be supplied as 100 mtrs. each bundle
Test Certificates		Vendor has to submit the all test certificates to Purchase
Inspection		The manufacturer has to submit the QAP before commencement of production

33. PIPING MATERIAL SPECIFICATION SIPI/Steel/TS/33

<table>
<tr><th colspan="6">PIPING SPECIFICATION</th></tr>
<tr><td colspan="2" rowspan="2">BASIC P&ING SPECIFICATION DATAS</td><td colspan="4">MAXIMUM DESIGN CONDITIONS</td></tr>
<tr><td colspan="2">TEMPERATURE °C</td><td colspan="2">PRESSURE bar(g)</td></tr>
<tr><td>PRIMARY FLANGE RATING</td><td>300#-RF</td><td>Carbon Steel</td><td>- 20 to 65</td><td>Carbon Steel</td><td>49</td></tr>
<tr><td></td><td></td><td>LTCS</td><td>- 20 to 65</td><td>LTCS</td><td>49</td></tr>
<tr><td>BASIC MATERIAL</td><td>CARBON STEEL</td><td colspan="4" rowspan="11"><table><tr><td colspan="2">Temperature & Pressure Rating</td></tr><tr><td>Temp. (Deg.C)</td><td>Pressure bar (g)</td></tr><tr><td>-29</td><td>51.10</td></tr><tr><td>0</td><td>51.10</td></tr><tr><td>38</td><td>51.10</td></tr><tr><td>93</td><td>46.60</td></tr></table></td></tr>
<tr><td></td><td></td></tr>
<tr><td>CORROSION ALLOWACE</td><td>1.6 MM (MIN)</td></tr>
<tr><td></td><td></td></tr>
<tr><td>X-RAYS</td><td>100%</td></tr>
<tr><td></td><td></td></tr>
<tr><td>SIZE RANGE</td><td>1/2"-18"</td></tr>
<tr><td></td><td></td></tr>
<tr><td>CODE</td><td>ANSI B 31.8</td></tr>
<tr><td colspan="6">FLUIDS</td></tr>
<tr><td colspan="6">NG: NATURAL GAS</td></tr>
<tr><td colspan="6">AG: ACTUATING GAS</td></tr>
</table>

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 BI6.25	6.4 mm	API 5L	APT 5L X 52	HFW / SMLS
		6”	BE-ANSI B16.25	6.4 mm	API 5L	API 5L X 52	HFW / SMLS
		8”	BE-ANSI B16.25	6.4 mm	API 5L	API 5L X 52	HFW / LSAW
		10”	BE-ANSI B16.25	6.4 mm	API5L	API 5L X 56	HFW / LSAW
		12”	BE-ANSI B16.25	6.4 mm	API5L	API 5L X 56	HFW / LSAW
ELBOW 90 LR	E	1/2" - 2"	BW - ANSI BI6.25	SEE PIPE	ANSI B16.9	ASTM A 234 WPB	SEAMLESS
		4" - 8" 10” - 18”	BW - ANSI BI6.25	SEE PIPE	ANSI B16.9	API 5L X 52 or ASTM A860 WPHY 52 / API 5L X 56 or ASTM A860 WPHY 56	
ELBOWS 45 LR	E45	1/2" - 2"	BW - ANSI BI6.25	SEE PIPE	ANSI B16.9	ASTM A 234 WPB	SEAMLESS
		4" - 8" 10” - 18”	BW - ANSI BI6.25	SEE PIPE	ANSI B16.9	API 5L X 52 or ASTM A860 WPHY 52 / API 5L X 56 or ASTM A860 WPHY 56	
ELBOWS 30 LR	E30	1/2" - 2"	BW - ANSI BI6.25	SEE PIPE	ANSI B16.9	ASTM A 234 WPB	SEAMLESS
		4" - 8" 10" - 18"	BW - ANSI BI6.25	SEE PIPE	ANSI B16.9	API 5L X 52 or ASTM A860 WPHY 52 / API 5L X 56 or ASTM A860 WPHY 56	
ELBOWS 22.5 LR	E22.5	1/2" - 2"	BW - ANSI BI6.25	SEE PIPE	ANSI B16.9	ASTM A 234 WPB	SEAMLESS
		4" - 8" 10" - 18"	BW - ANSI BI6.25	SEE PIPE	ANSI B16.9	API 5L X 52 or ASTM A860 WPHY 52 / API 5L X 56 or ASTM A860 WPHY 56	
ELBOWS 15 LR	E15	1/2" - 2"	BW - ANSI BI6.25	SEE PIPE	ANSI B16.9	ASTM A 234 WPB	SEAMLESS
		4" - 8" 10" - 18"	BW - ANSI BI6.25	SEE PIPE	ANSI B16.9	API 5L X 52 or ASTM A860 WPHY 52 / API 5L X 56 or ASTM A860 WPHY 56	
REDUCER CONCENTRIC	RC	1/2" - 2"	BW - ANSI BI6.25	SEE PIPE	ANSI B16.9	ASTM A 234 WPB	SEAMLESS
		4" - 8" 10" - 18"	BW - ANSI BI6.25	SEE PIPE	ANSI B16.9	API 5L X 52 or ASTM A860 WPHY 52 / API 5L X 56 or ASTM A860 WPHY 56	
REDUCER ECCENTRIC	RE	1/2" - 2"	BW - ANSI BI6.25	SEE PIPE	ANSI B16.9	ASTM A 234 WPB	SEAMLESS
		4" - 8" 10" - 18"	BW - ANSI BI6.25	SEE PIPE	ANSI B16.9	API 5L X 52 or ASTM A860 WPHY 52 / API 5L X 56 or ASTM A860 WPHY 56	

ITEM	SHORT CODE	SIZE FROM-THRU	END CONNECTION	RATING AND/OR SCHED.	DIMENSION STANDARD	MATERIAL	REMARKS
TEE EQUAL	T	1/2" - 2"	BW - ANSI BI6.25	SEE PIPE	ANSI B16.9	ASTM A 234 WPB	SEAMLESS
		4" - 8" 10" - 18"	BW - ANSI BI6.25	SEE PIPE	ANSI B16.9	API 5L X 52 or ASTM A860 WPHY 52 API 5L X 56 or ASTM A860 WPHY 56	
TEE REDUCER	TR	1/2" - 2"	BW - ANSI BI6.25	SEE PIPE	ANSI B16.9	ASTM A 234 WPB	SEAMLESS
		4" - 8" 10" - 18"	BW - ANSI BI6.25	SEE PIPE	ANSI B16.9	API 5L X 52 or ASTM A860 WPHY 52 API 5L X 56 or ASTM A860 WPHY 56	
SOCKOLET	SW	1/2" - 3/4"	BW - ANSI B16.11	6000#	MSS-SP-97	ASTM A 105	The size inicated in this table refers to Mainline size. For Branch Size of Sockolet, Please refer to the Chart given in this Document
		1" - 1 1/2"	BW - ANSI B16.11	3000#	MSS-SP-97	API 5L X 52 or ASTM A860 WPHY 52	
WELDOLET	WEL	1 1/2" - 18	BW - ANSI B16.11	SEE PIPE	MANUFACTURER	ASTM A 105	The size inicated in this table refers to Mainline size. For Branch Size of Sockolet, Please refer to the Chart given in this Document
CAPS	C	1/2" - 2"	BW - ANSI BI6.25	SEE PIPE	ANSI B16.9	ASTM A 234 WPB	
		4" - 8" 10" - 18"	BW - ANSI BI6.25	SEE PIPE	ANSI B16.9	API 5L X 52 or ASTM A860 WPHY 52 API 5L X 56 or ASTM A860 WPHY 56	
NIPPLES	NBEP NOET NBET	1/2" - 1.1/2" 1/2" - 1.1/2" 1/2" - 1.1/2"	BOTH ENDS PLAIN ONE END THRD-MNPT BOTH ENDS THRD-MNPT	80 80 80	ANSIB36.10	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	
CAPS THRD	C2	1/2" - 1.1/2"	FNPT ANSI B1-20-1	3000#	ANSI B16. I I	ASTM A 105	
PLUGS THRD	PL	1/2" - 1.1/2"	MNPT ANSI BI-20-1	3000#	ANSI B16. I I	ASTM A 103	

NOTE: :
SOCKOLET SW THE SIZE INICATED IN THIS TABLE REFERS TO MAINLINE SIZE. FOR BRANCH SIZE OF SOCKOLET, WALL THICKNESS FOR TEES, ELBOWS, REDUCERS AND CAPS SHALL BE DETERMINED BY VENDOR AS PER THE REQUIREMENTS OF ASME B 16.9 § 2.3. MINIMUM THICKNESS OF TEE SHALL ALSO MEET THE REQUIREMENTS OF ASME B 31.8, APPENDIX -F FOR BRANCH OPENING. FURTHER, MINIMUM THICKNESS OF TEES, ELBOWS, REDUCERS AND CAPS SHALL NOT BE LESS THAN THAT OF MATING PIPE. ALL WALL THICKNESS CALCULATIONS SHALL BE APPROVED BY OWNER. THE MATING PIPE DETAILS SHALL BE TAKEN AS MENTIONED IN THE PIPE SECTION OF THISPMS.

ITEM	SHORT CODE	SIZE FROM-THRU	END CONNECTION	RATING AND/OR SCHED.	DIMENSION STANDARD	MATERIAL	REMARKS
WN FLANGES	F	1/2" - 2"		600# RF	ANSI B16-5	ASTM A 105	The pressure rating of the flange shall be same with the connecting Valve and equipment flang
		4" - 8" 10" - 18"		300# RF	ANSI B16.9	ASTM A 694 F 52 ASTM A 694 F 56	
ORIFICE FLANGES	FO	1" -2"		600# RF	ANSI B16 - 36	ASTM A 105	COMPLETE WITH GASKET, BOLTS, NUTS, JACK-SCREWS AND PLUGS
		4" - 8" 10" - 18"		300# RF	ANSI B16 - 36	ASTM A 694 F 52 ASTM A 694 F 56	
BLIND FLANGE	FB	1" -2"		600# RF	ANSI B16-5	ASTM A 105	
		4" - 8" 10" - 18"		300# RF	ANSI B16-5	ASTM A 694 F 52 ASTM A 694 F 56	
DRIP RING	DR	1" -2"		600# RF	ANSI B16 - 36	ASTM A 105	3/4" FNPT OUTLET CONNECTION
		4" - 8" 10" - 18"		300# RF	ANSI B16 - 36	ASTM A 694 F 52 ASTM A 694 F 56	
SPECTACLE BLINDS	SB	1" -2"		600# RF	ANSI B16-5	ASTM A 515 GR 70	
		4" - 8" 10" - 18"		300# RF	ANSI B16-5	ASTM A 694 F 52 ASTM A 694 F 56	
RESTRICTION ORIFICE	RO	1" -2"		600# RF	ANSI B16-5	ASTM A240 GR 304	
		4" - 8" 10" - 18"		300# RF	ANSI B16-5	ASTM A 694 F 52 ASTM A 694 F 56	
MOLOTHIC INSULATING JOINT	IJ	2"	BW - ANSI BI6.25	300#	ANSI B16-5	PIPE PUPS SAME AS PIPING MATERIAL FORGED RING - ASTM A 105	
		4" - 8" 10" - 18"	BW - ANSI BI6.25	300#	API 5L	PIPE PUPS SAME API 5L X 56 FORGED RING - ASTM A 694 F56	
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" - 2"		600# RF	ASME B 16.20	WINDING SS 316, FILLING PURE GRAPHITE, OUTER RING CS, INNER RING SS 316	
		4" - 18"		300# RF			
BALL VALVES	VBA	1/2" - 2"	FLGD RF: ANSI B16-5 OR BW: ANSI B16 25	600#	ANSI B16 - 10	BODY: ASTM A 105 BALL: SS316	FULL BORE WRENCH OPERATED. FIRE SAFE
		4" - 18"		300#		BODY: ASTM A 216 WCB/A234 WPB BALL: (ASTM A 216 WCB/A234 WPB) WITH END (75 MICRONES)	FULL BORE / REDUCED BORE DOUBLE BLOCK & BLEED BALL: GEAR OPERATED./ACTUATED FIRE SAFE

ITEM	SHORT CODE	SIZE FROM-THRU	END CONNECTION	RATING AND/OR SCHED.	DIMENSION STANDARD	MATERIAL	REMARKS
GLOBE VALVE	VGL	1/2" - 2"	FLGD RF: ANSI B16-5 OR BW: ANSI B16 25	600#	ANSI B16 - 10	BODY: ASTM A 105 TRIM: ASTM A 182 F6	HANDWHEEL FIRE SAFE
		4" - 18"	FLGD RF:ANSI B16-5	300#		BODY: ASTM A 216 WCB/A234 WPB TRIM: ASTM A 182 F6	HANDWHEEL FIRE SAFE
SWING CHECK VALVE	VCH	1/2" - 2"	FLGD RF: ANSI B16-5 OR BW: ANSI B16 25	600#	ANSI B16 - 10	BODY: ASTM A 105 TRIM: ASTM A 182 F6	HORIZONTAL INSTALLATION VERTICAL INSTALLATION FLOW UPWARDS
		4" - 18"	FLGD RF:ANSI B16-5	300#		BODY: ASTM A 216 WCB TRIM: ASTM A 216 WCB	HORIZONTAL INSTALLATION VERTICAL INSTALLATION FLOW UPWARDS

REDUCERS CHART

SMALL SIZE

LARGE SIZE \ 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	X										
4"				X	X	X									
6"					X	X	X								
8"						X	X	X							
10"							X	X	X						
12"								X	X	X					
14"									X	X	X				
16"										X	X	X			
18"											X	X	X		
20"												X	X	X	
24"													X	X	X

LEGEND

X: CONCENTRIC AND ECCENTRIC REDUCERS-BW

BRANCH CHART

BRANCH SIZE

HEADER SIZE	1/2"	3/4"	1"	1. 1/2"	2"	3"	4"	6"	8"	10"	12"	14"	16"	18"	20"	24"
1/2"	T															
3/4"	TR	T														
1"	TR	TR	T													
1. 1/2"	SW	TR	TR	T												
2"	SW	SW	TR	TR	T											
3"	SW	SW	SW	TR	TR	T										
4"	SW	SW	SW	SW	TR	TR	T									
6"	SW	SW	SW	SW	W	TR	TR	T								
8"	SW	SW	SW	SW	W	TR	TR	TR	T							
10"	SW	SW	SW	SW	W	W	TR	TR	TR	T						
12"	SW	SW	SW	SW	W	W	BW*	TR	TR	TR	T					
14"	SW	SW	SW	SW	W	W	BW*	BW*	TR	TR	TR	T				
16"	SW	SW	SW	SW	W	W	BW*	BW*	BW*	TR	TR	TR	T			
18"	SW	SW	SW	SW	W	W	BW*	BW*	BW*	BW*	TR	TR	TR	T		
20"	SW	SW	SW	SW	W	W	BW*	BW*	BW*	BW*	BW*	TR	TR	TR	T	
24"	SW	SW	SW	SW	W	W	BW*	BW*	BW*	BW*	BW*	BW*	TR	TR	TR	T

LEGEND

T : TEE EQUAL-BW
TR : REDUCING TEE-BW
W : WELDOLET- BW
BW : BRANCH WELD-CHECK IF REINFORCING PLATE IS NECESSARY ACCORDING ANSI B 31.8
SW : SOCKOLET

***NOTE** : IN PLACE OF BRANCH -WELD, EXTRUDED TEE, CONFORMING TO ASME B 16.9 SPECIFICATION, MAY BE USED, SUBJECT TO AVAILABILITY

LIST OF RECOMMENDED VENDORS / SUBCONTRACTORS

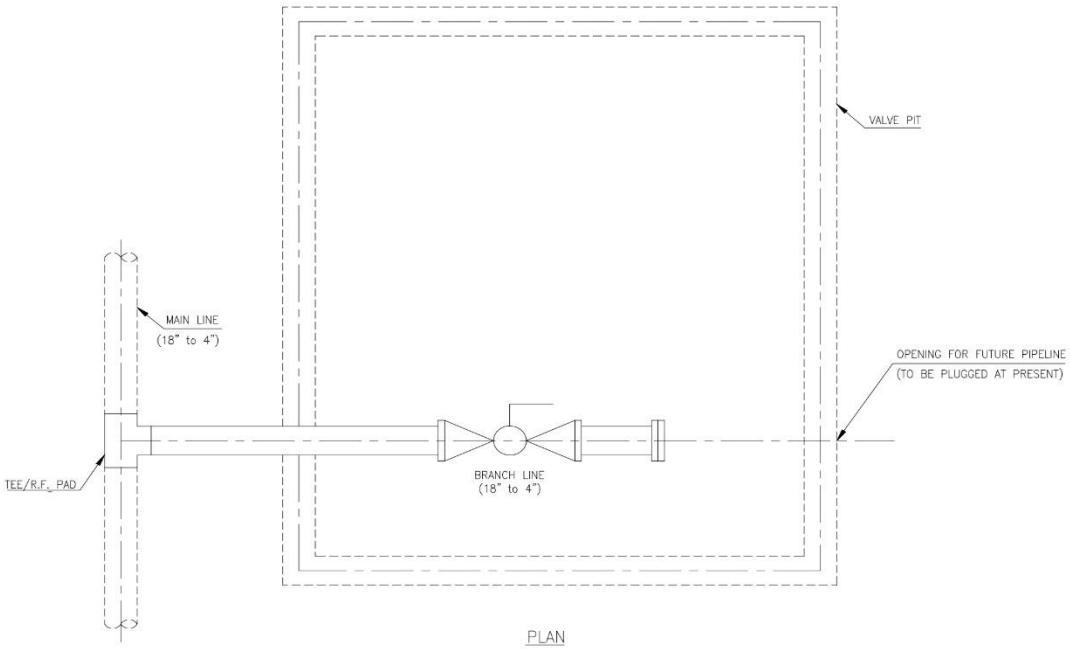
For piping material less or equal to 2” NB size, bidder can select Local/International vendor provided QAP/ITP to be submitted for owner/owner’s representative approval before procurement.

34. STANDARD DRAWINGS

SIPI/Steel/TS/34

S.No	STANDARD DRAWING DESRCRIPTION	Drawing No.
1	GENERAL ARRANGEMENT DRAWING FOR FUTURE TAP OFF	REPL/CGD/STD/CSP-001
2	PIIPING GENERAL ARRANGEMENT DRAWING FOR CONNECTIVITY TO RO / CNG STATION	REPL/CGD/STD/CSP-002
3	TYPICAL TRENCH DETAILS	REPL/CGD/STD/CSP-003
4	TYPICAL ROAD CROSSING (OPEN CUT/JACKING METHOD)	REPL/CGD/STD/CSP-004
5	TYPICAL ROAD CASED CROSSING (B+C) **TYPE -I** SEPRATE CASING FOR CARRIER AND OFC	REPL/CGD/STD/CSP-005
6	TYPICAL ROAD CASED CROSSING (B+C) **TYPE -II** COMMON CASING OFC BUNDLED WITH CARRIER (WITHOUT CS CONDUIT)	REPL/CGD/STD/CSP-006
7	TYPICAL RAILWAY CASED CROSSING (B+C) - **TYPE I** SEPRATE CASING FOR CARRIER AND OFC	REPL/CGD/STD/CSP-007
8	TYPICAL RAILWAY CASED CROSSING (B+C) - **TYPE II** COMMON CASING OFC BUNDLED WITH CARRIER (WITHOUT CS CONDUIT)	REPL/CGD/STD/CSP-008
9	TYPICAL HDD RIVER CROSSING SHOWING MAX. SCOUR LEVEL & MIN. COVER FOR PIPE	REPL/CGD/STD/CSP-009
10	TYPICAL DRAWING FOR MAJOR CANAL CROSSING OPEN CUT	REPL/CGD/STD/CSP-010
11	TYPICAL DRAWING FOR MAJOR CANAL CASSED CROSSING	REPL/CGD/STD/CSP-011
12	TYPICAL DRAWING FOR MINOR CANAL/KHADI/NALA CROSSING	REPL/CGD/STD/CSP-012
13	TYPICAL DRAWING FOR UNDER GROUND PIPE CROSSING **TYPE-I**	REPL/CGD/STD/CSP-013
16	TYPICAL DRAWING FOR EXISTING UNDER GROUND PIPE CROSSING **TYPE-II**	REPL/CGD/STD/CSP-014
14	TYPICAL DRAWING FOR UNDER GROUND CABLE CROSSING	REPL/CGD/STD/CSP-015
15	TYPICAL OVERHEAD POWER LINE CROSSING DETAILS	REPL/CGD/STD/CSP-016
17	TYPICAL CONCRETE COATING FOR MECHANICAL PROTECTION	REPL/CGD/STD/CSP-017
18	TYPICAL MECHANICAL PROTECTION CONCRETE SLAB DETAILS	REPL/CGD/STD/CSP-018
19	POLE MARKER WITH FOUNDATION	REPL/CGD/STD/CSP-019
20	BRICK VALVE CHAMBER (2.0M X 1.5M) **TYPE A**	REPL/CGD/STD/CSP-020
21	BRICK VALVE CHAMBER (1.5M X 1.5M) **TYPE B**	REPL/CGD/STD/CSP-021
22	TYPICAL DETAILS OF RCC VALVE CHEMBER (TYPE-1,2,3 & 4)	REPL/CGD/STD/CSP-022
23	DRAWING FOR PLAN AND REINFORCMENT DETAILS OF VALVE CHAMBER	REPL/CGD/STD/CSP-023
24	TYPICAL DETAILS OF FENCING	REPL/CGD/STD/CSP-024
25	TYPICAL PIPE SUPPORT DETAILS	REPL/CGD/STD/CSP-025
26	TYPICAL DETAILS OF RCC ROUTE MARKER	REPL/CGD/STD/CSP-026
27	TYPICAL DETAILS OF BARRICADING	REPL/CGD/STD/CSP-027
28	TYPICAL DETAILS OF CAUTION BOARD	REPL/CGD/STD/CSP-028
29	IMPRESSED CURRENT CATHODIC PROTECTION SCHEMATIC	REPL/CGD/STD/CSP-029
30	FABRICATION AND INSTALLATION DETAILS OF CuCuSO4 REFRENCE ELECTRODE	REPL/CGD/STD/CSP-030

31	FABRICATION AND INSTALLATION DETAILS OF CABLE LAYING (TYPICAL) FOR CATHODIC PROTECTION	REPL/CGD/STD/CSP-031
32	FARBRICATION AND INSTALLATION DETAILS OF DEEP ANODE GROUND BED	REPL/CGD/STD/CSP-032
33	TEST LEAD POINT & JUNCTION BOX WITH FOUNDATION DETAILS	REPL/CGD/STD/CSP-033
34	TEMPORARY CATHODIC PROTECTION SCHEMATIC	REPL/CGD/STD/CSP-034
35	TYPICAL CATHODIC PROTECTION SCHEME FOR CASED CROSSINGS	REPL/CGD/STD/CSP-035
36	INSTALLATION DETAILS OF VERTICAL SHALLOW ANODE BED	REPL/CGD/STD/CSP-036
37	CABLE TO PIPE CONNECTION BY PIN BRAZING	REPL/CGD/STD/CSP-037
38	SPARK GAP ARRESTOR INSTALLATION	REPL/CGD/STD/CSP-038
39	TYPICAL INSTALLATION DETAILS OF SHALLOW HORIZONTAL ANODE BED	REPL/CGD/STD/CSP-039
40	THERMIT WELDING DETAILS	REPL/CGD/STD/CSP-040
41	CONSTRUCTION DETAILS OF ZINC GROUNDING CELL (20KG)	REPL/CGD/STD/CSP-041
42	TYPICAL INSTALLATION AND CONNECTION DETAILS OF EXTERNAL ER PROBE WITH TEST STATION	REPL/CGD/STD/CSP-042
43	TYPICAL DRAWING FOR SLAB PROTECTION TO PIPELINE	REPL/CGD/STD/CSP-043
44	TYPICAL RAIN CAP FOR VENT PIPES	REPL/CGD/STD/CSP-044
45	TYPICAL GENERAL ARRANGEMENT DRAWING FOR SV STATION (12” PIPE LINE NB) IN VALVE CHAMBER	REPL/CGD/STD/CSP-045



PLAN

FUTURE TAP-OFF	BRANCH CONNECTION
18"x18"	TEE
18"x16"	REDUCING TEE
18"x12"	REDUCING TEE
18"x8"	R.F. PAD
18"x6"	R.F. PAD
16"x16"	TEE
16"x12"	REDUCING TEE
16"x8"	REDUCING TEE
16"x6"	R.F. PAD
12"x12"	TEE
12"x8"	REDUCING TEE
12"x6"	REDUCING TEE
12"x4"	R.F. PAD
8"x8"	TEE
8"x6"	REDUCING TEE
8"x4"	REDUCING TEE
6"x6"	TEE
6"x4"	REDUCING TEE
4"x4"	TEE

NOTES:
1. TAP OF THE PIPE SHALL BE AT MINIMUM 1.2M DEPTH.
2. APPROXIMATE SIZE OF THE PIT WILL BE 2Mx2M & 2Mx1.5m. IT DEPENDS ON THE SITE CONDITION.
3. BRANCHING CONNECTIOS (TEE/ R.F. PAD) SHALL DEPEND UPON THE MAIN LINE & BRANCH LINE.

LEGEND

BW BALL VALVE

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

PROJECT: Glo Djigbe Industrial Zone, Benin

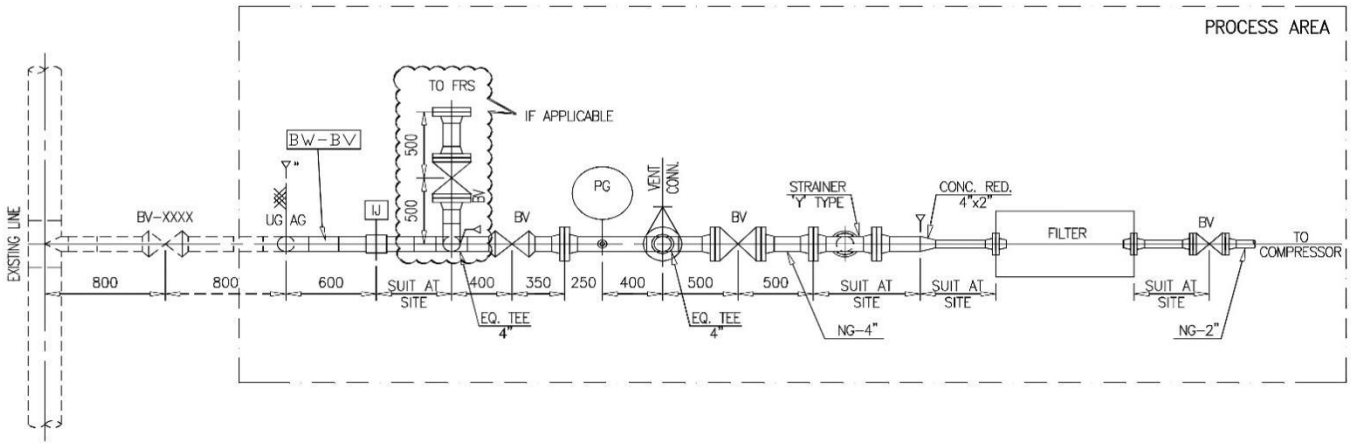
SUBJECT:
GENERAL ARRANGEMENT DRAWING
FOR FUTURE TAP OFF

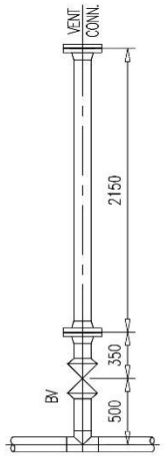
Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

RESONANCE ENERGY PVT. LTD.

Drawing No. REPL/CGD/STD/CSP-001

NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE STATED.
2. DRAWING IS NOT TO SCALE.





VENT DETAIL

Rev.	Date (D M Y)	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

PROJECT: Glo-Djigbe Industrial Zone, Benin

SUBJECT:

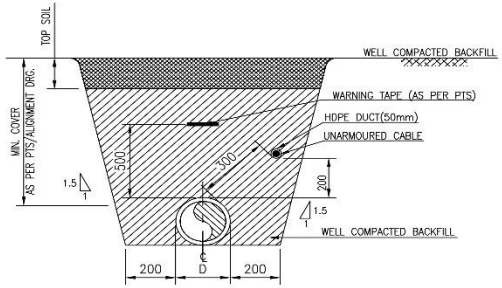
PIPING GENERAL ARRANGEMENT DRAWING FOR CONNECTIVITY TO RO / CNG STATION

Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

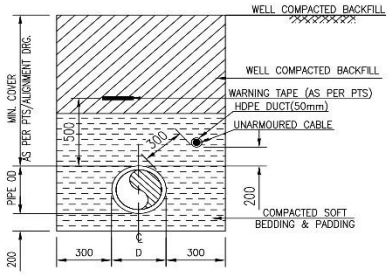
RESONANCE ENERGY PVT. LTD.

Drawing No. REPL/CGD/STD/CSP-002

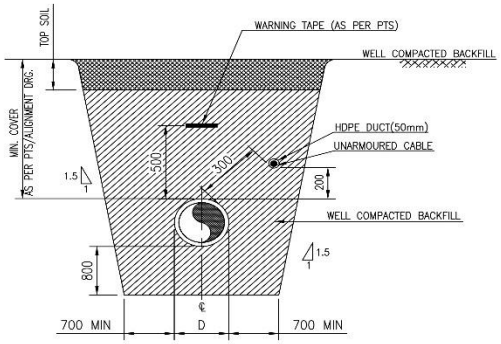
SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**



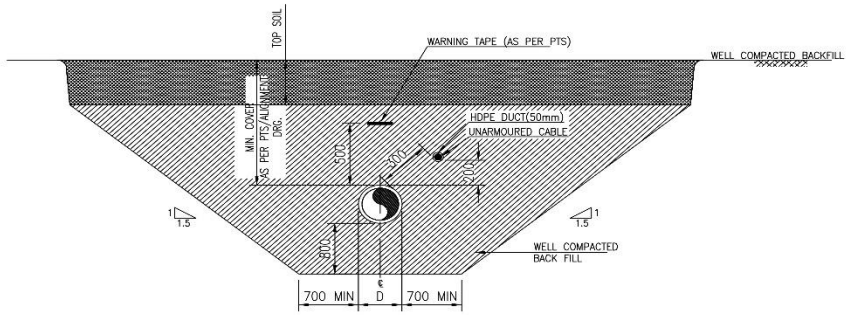
TYPICAL TRENCH DETAILS IN NORMAL SOIL
TYPE–1



TYPICAL TRENCH DETAILS IN ROCK AREA
TYPE–2



TYPICAL TRENCH DETAILS FOR REVERSE SLIP FAULT (IN NORMAL SOIL) AREAS
TYPE–3



TYPICAL TRENCH DETAILS FOR SLIP FAULT (IN NORMAL SOIL) AREAS
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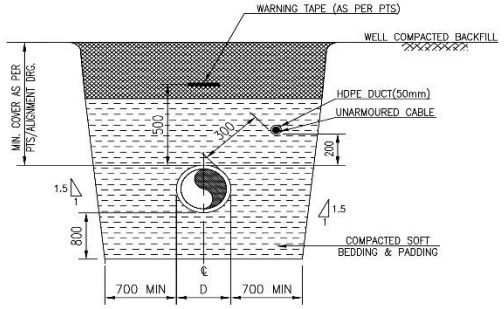
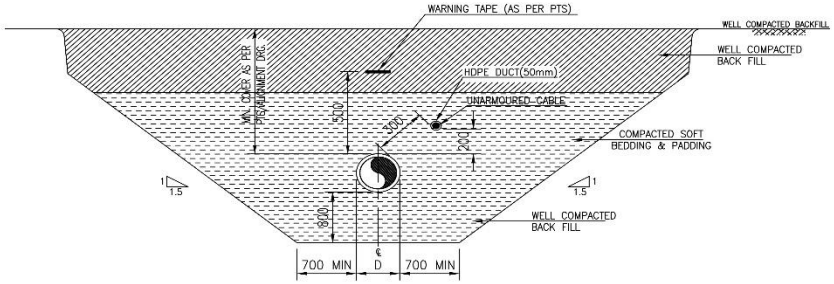


TYPICAL TRENCH DETAILS FOR REVERSE SLIP FAULT (IN ROCK) AREAS
TYPE–5



TYPICAL TRENCH DETAILS FOR SLIP FAULT (IN ROCK) AREAS
TYPE–6

NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. MINIMUM COVER OVER LINEPIPE SHALL BE AS PER PTS, ALIGNMENT SHEET AND REQUIREMENT OF CONCERNED AUTHORITY.
3. THIS SKETCH IS INDICATIVE ONLY.
4. IF, AS PER SPECIFICATION, OFC IS TO BE PROVIDED, IT WILL BE LAID ALONGWITH LINEPIPE AS PER THE APPROVED PROCEDURE REFER DRAWING NO. _____ FOR OFC INSTALATION.
5. TYPE OF TRENCHING TO BE USED SHALL BE AS PER PTS AND APPROVED PROCEDURE.
6. ALL TYPICAL CROSS SECTIONS MUST BE VIEWED LOOKING IN THE DIRECTION OF FLOW.

Rev.	Date	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB
	D M Y				

PROJECT: Glo-Djigbe Industrial Zone, Benin

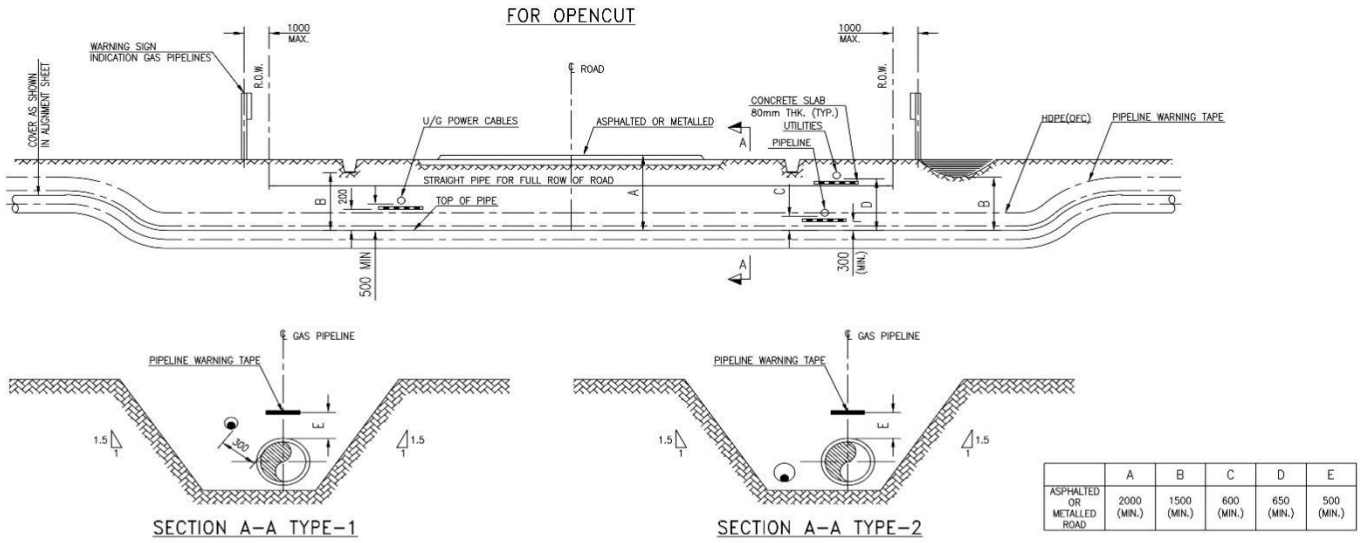
SUBJECT: TYPICAL TRENCH DETAILS

RESONANCE ENERGY PVT. LTD.

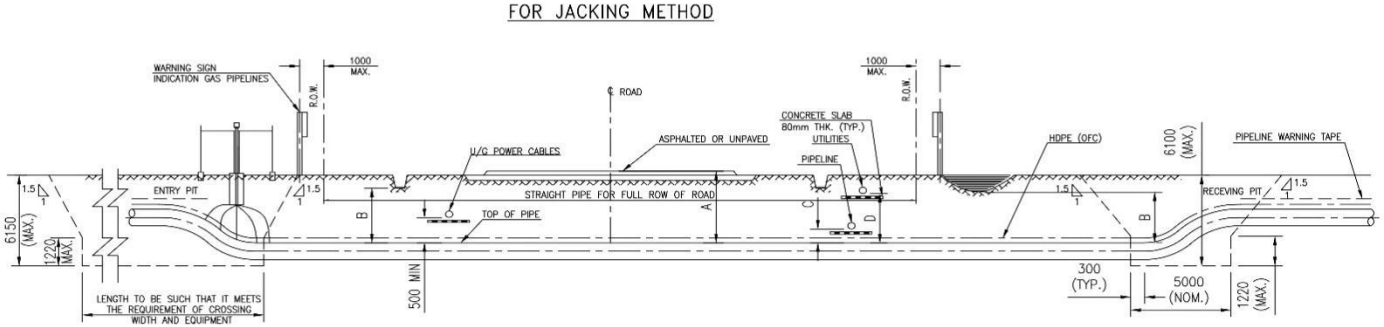
Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

Drawing No. REPL/CGD/STD/CSP-003

SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**



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



	A	B	C	D
REQUIRED DIMENSION	2000 (MIN.)	1500 (MIN.)	600 (MIN.)	600 (MIN.)

NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. ROAD/HIGHWAY CROSSING SHALL BE RESTORED TO ORIGINAL CONDITION TO THE ENTIRE SATISFACTION OF OWNER AND CONCERNED AUTHORITIES HAVING JURISDICTION.
3. REFER API RP 1102 FOR OTHER DESIGN AND INSTALLATION REQUIREMENTS.
4. ANGLE OF INTERSECTION BETWEEN PIPELINE AND THE ROAD/HIGHWAY SHALL BE AS CLOSE TO 90° AS POSSIBLE BUT IN NO CASE < 30°.
5. IN CASE PIPELINE COATING IS LIABLE TO DAMAGE WHILE BORING/JACKING, A PROTECTIVE COATING OF CONCRETE OR ANY OTHER SUITABLE MATERIAL SHALL BE PROVIDED ON CARRIER PIPE IN ACCORDANCE WITH PTS & AS DIRECTED BY OWNER/OWNER'S REPRESENTATIVE.
6. CONTRACTOR SHALL VERIFY THE ACTUAL DIMENSIONS WITH RESPECT TO SURVEY DETAILS FOR EACH ROAD/HIGHWAY CROSSING AND PREPARE DETAILED DRAWING FOR INDIVIDUAL CROSSING FOR OWNER'S APPROVAL BEFORE COMMENCEMENT OF CONSTRUCTION.
   FOR DETAIL OF CONCRETE SLAB REFER DWG NO. REPL/CGD/STD/CSP-043
7. THE TABLES INDICATES THE MINIMUM DIMENSIONS. THE APPLICABLE MOST STRINGENT DIMENSIONS SHALL BE FOLLOWED.

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

PROJECT: Glo-Djigbe Industrial Zone, Benin

SUBJECT:

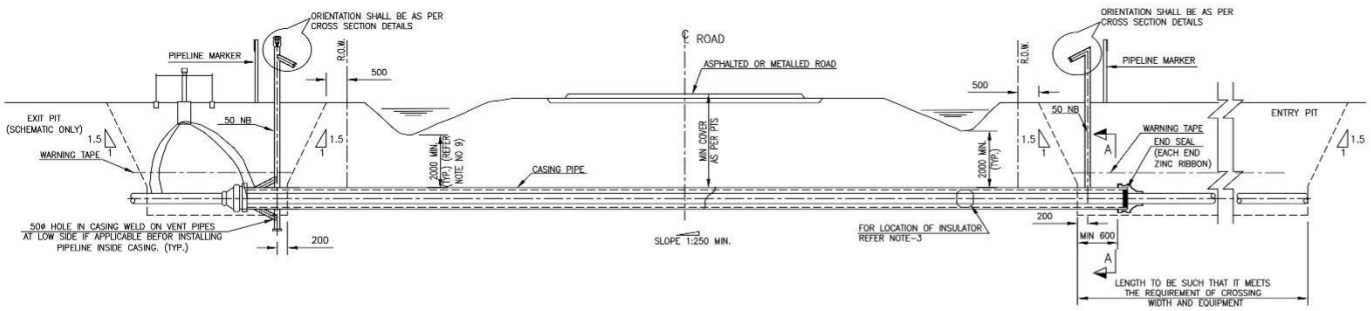
TYPICAL ROAD CROSSING
(OPEN CUT/JACKING METHOD)

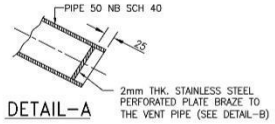
Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

RESONANCE ENERGY PVT. LTD.

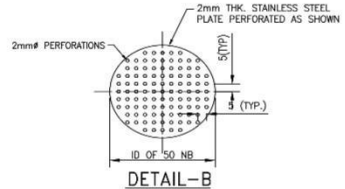
Drawing No. REPL/CGD/STD/CSP-004

SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**

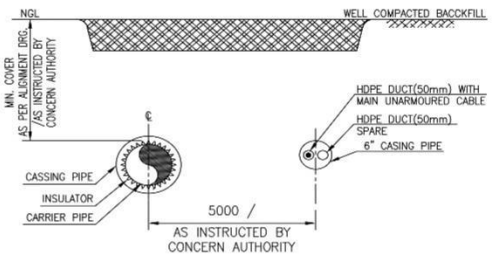




DETAIL-A

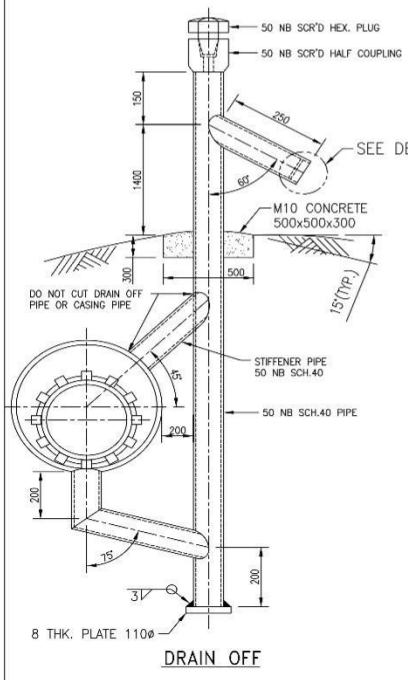


DETAIL-B



SECTION A-A

TYPICAL BORE PIT EXCAVATION



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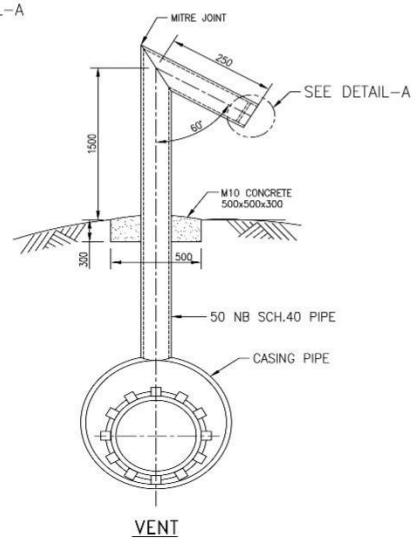


VENT

S. NO.	SIZE OF CARRIER PIPE (INCH NB)	MINIMUM SIZE OF CASING PIPE (FOR TYPE-II)	MINIMUM THICKNESS OF CASING (MM)
1.	4"	10"	5
2.	6"	12"	5
3.	8"	14"	5
4.	10"	16"	6
5.	12"	18"	7
6.	16"	22"	8
7.	18"	24"	8
8.	20"	26"	9
9.	24"	30"	11
10.	30"	36"	12
11.	36"	42"	15
12.	42"	48"	16
13.	48"	54"	19
CASING PIPE MATERIAL: API 5L GR. B, PSL1 or EQUIVALENT APPROVED BY EIC.			

NOTES:

1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. THE CROSSING WORKS SHALL BE EXECUTED IN ACCORDANCE WITH API RECOMMENDED PRACTICE 1102 LATEST EDITION.
3. 500mm AWAY FROM BOTH ENDS, TWO NOS. INSULATORS SHALL BE PLACED. IN BALANCE LENGTH MAX. SPACING OF INSULATORS SHALL BE 2000 mm.
4. ELECTRICAL INSULATION BETWEEN THE CASING AND CARRIER PIPE SHALL BE CHECKED WITH A SUITABLE MEGGER.
5. MATERIAL OF THE CASING INSULATORS SHALL BE HDPE. END SEALS SHALL BE HEAR SHRINKABLE TYPE (MAKE RAYCHEM OR EQUIVALENT), CONTRACTOR SHOULD TAKE PRIOR APPROVAL FOR MATERIAL OF CONSTRUCTION FOR END SEAL & SHALL SUBMIT MATERIAL CERTIFICATES TO OWNER/ CONSULTANT FOR APPROVAL.
6. 1:250 SLOPE TO BE PROVIDED FOR DRAINING DURING INSTALLATION OF CASING PIPE.
7. CASING PIPE SHOULD EXTEND MIN. 600mm BEYOND THE TOE OF THE SLOPE OR BASE GRADE, OR MIN 900mm BEYOND THE BOTTOM OF THE DRAINAGE DITCH, WHICHEVER IS MORE.
8. CONTRACTOR SHOULD SUBMIT DETAILED WORK PROCEDURE ALONG WITH SKETCHES AND MATERIAL TEST CERTIFICATES FOR APPROVAL.
9. THE CROSSING SHALL BE CARRIED OUT WITH PIPE SIZE AND MINIMUM THICKNESS GIVEN IN THE PTS & DESIGN BASIS. THE SIZES GIVEN IN THIS SHEET ARE MINIMUM INDICATIVE ONLY.
10. FILLING OF ANNULAR SPACE BETWEEN CASING AND CARRIER PIPE SHALL BE AS PER PROJECT SPECIFICATION.
11. CROSSING MAY BE CARRIED OUT PRIOR TO MAINLNE ACTIVITIES ADDITIONAL ROU. IF REQUIRED, FOR APPROACH TO CROSSING, PIPELINE STRINGING, HYDROTESTING, WORKING PIT FOR CROSSING. TO AVOID CAVING OF SOIL, SHALL BE PROCURED BY CONTRACTOR WITHOUT ANY COST IMPLICATION.
12. CATHODIC PROTECTION: - ALL CASING PIPES FOR ROAD CROSSING SHALL BE C.P. PROTECTED, USING SACRIFICIAL ANODE.
13. TEST STATION ON BOTH OF CROSSING.
14. THE LOCATION OF ENTRY AND EXIT PIT SHALL BE DECIDED AT SITE TO SUIT THE SITE REQUIREMENT.
15. AT EACH CROSSING, PIPELINE CROSSING WARNING SIGN SHALL BE INSTALLED ON EITHER SIDE OF CROSSING. THE WARNING PLATE MAY BE MOUNTED ON THE VENT/DRAIN OFF PIPE.
16. ALL CARRIER PIPELINE JOINTS SHALL BE 100% RADIOGRAPGHED.
17. PIPELINE SECTION SHALL BE PRETESTED HYDROSTATICALLY SEPARATELY FROM THE MAIN LINE TESTING WHEN REQUIRED BY CONCERNED AUTHORITIES OR AS DIRECTED BY CLIENT.
18. THE CASING PIPE SHALL BE PROVIDED WITH MINIMUM 50mm DIAMETER VENT PIPE FOR FILLING THE FILLER MATERIAL. IF REQUIRED, AS PER PROJECT SPECIFICATION. AFTER FILLING, VENT PIPE AT BOTH ENDS SHALL BE TRIMMED AND PLUGGED/SEALED WITH END CAPS.
19. IN ANY CASE, THE MINIMUM LENGTH OF CASING PIPE SHALL BE 72M FOR NATIONAL HIGHWAY CROSSING AND 60M FOR ALL STATE HIGHWAY/ MDR CROSSING.
20. THICKNESS OF CASING PIPE SHALL BE CALCULATED AS PER API RP 1102 AND SYBMITTED FOR APPROVAL.

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

PROJECT: Glo-Djigbe Industrial Zone, Benin

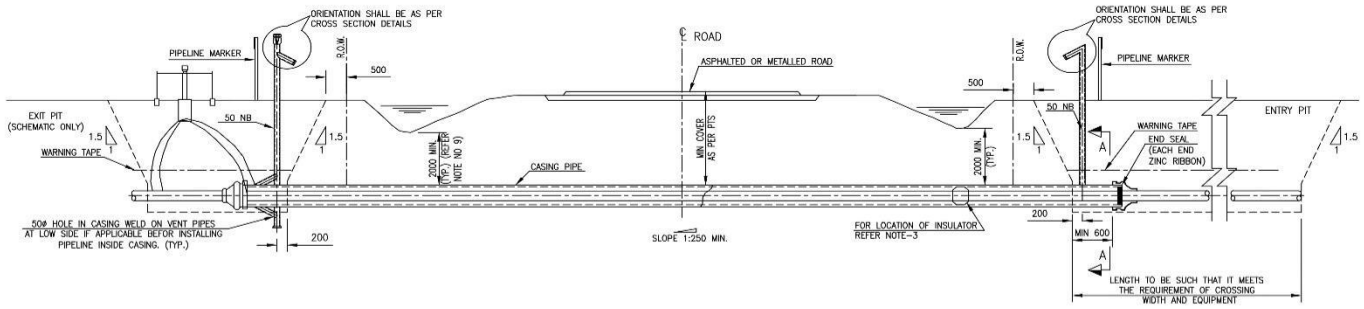
SUBJECT:
TYPICAL ROAD CASED CROSSING (B+C)
TYPE - I
SEPARATE CASING FOR CARRIER AND OFC

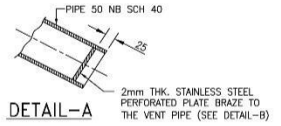
Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

RESONANCE ENERGY PVT. LTD.

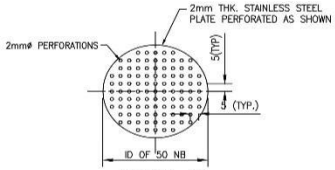
Drawing No. REPL/CGD/STD/CSP-005

SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**

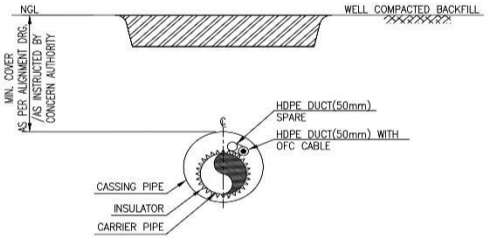




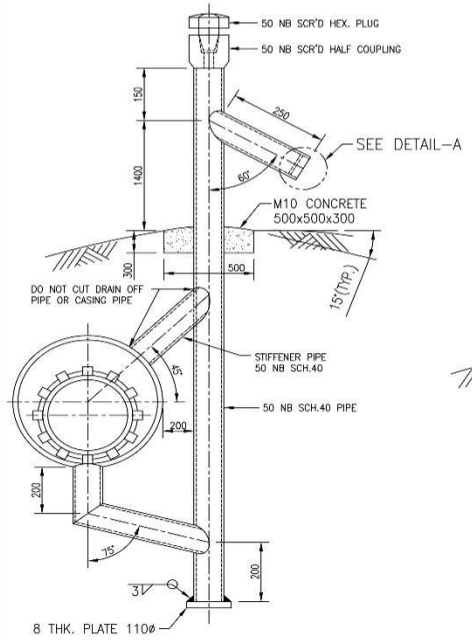
DETAIL-A



DETAIL-B



SECTION A-A
(APPLICABLE FOR TYPE-II)
TYPICAL BORE PIT EXCAVATION



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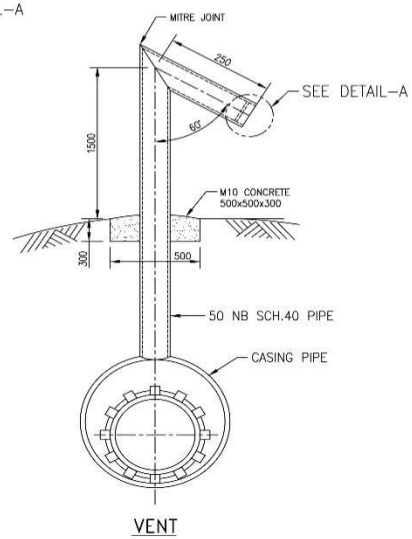


VENT

S. NO.	SIZE OF CARRIER PIPE (INCH NB)	MINIMUM SIZE OF CASING PIPE (FOR TYPE-II)	MINIMUM THICKNESS OF CASING (MM)
1.	4”	10”	5
2.	6”	12”	5
3.	8”	14”	5
4.	10”	16”	6
5.	12”	18”	7
6.	16”	22”	8
7.	18”	24”	8
8.	20”	26”	9
9.	24”	30”	11
10.	30”	36”	12
11.	36”	42”	15
12.	42”	48”	16
13.	48”	54”	19
CASING PIPE MATERIAL: API 5L GR. B, PSL1 or EQUIVALENT APPROVED BY EIC.			

NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. THE CROSSING WORKS SHALL BE EXECUTED IN ACCORDANCE WITH API RECOMMENDED PRACTICE 1102 LATEST EDITION.
3. 500mm AWAY FROM BOTH ENDS, TWO NOS. INSULATORS SHALL BE PLACED. IN BALANCE LENGTH MAX. SPACING OF INSULATORS SHALL BE 2000 mm.
4. ELECTRICAL INSULATION BETWEEN THE CASING AND CARRIER PIPE SHALL BE CHECKED WITH A SUITABLE MEGGER.
5. MATERIAL OF THE CASING INSULATORS SHALL BE HDPE. END SEALS SHALL BE HEAR SHRINKABLE TYPE (MAKE RAYCHEM OR EQUIVALENT), CONTRACTOR SHOULD TAKE PRIOR APPROVAL FOR MATERIAL OF CONSTRUCTION FOR END SEAL & SHALL SUBMIT MATERIAL CERTIFICATES TO OWNER/ CONSULTANT FOR APPROVAL.
6. 1:250 SLOPE TO BE PROVIDED FOR DRAINING DURING INSTALLATION OF CASING PIPE.
7. CASING PIPE SHOULD EXTEND MIN. 600mm BEYOND THE TOE OF THE SLOPE OR BASE GRADE, OR MIN 900mm BEYOND THE BOTTOM OF THE DRAINAGE DITCH, WHICHEVER IS MORE.
8. CONTRACTOR SHOULD SUBMIT DETAILED WORK PROCEDURE ALONG WITH SKETCHES AND MATERIAL TEST CERTIFICATES FOR APPROVAL.
9. THE CROSSING SHALL BE CARRIED OUT WITH PIPE SIZE AND MINIMUM THICKNESS GIVEN IN THE PTS & DESIGN BASIS. THE SIZES GIVEN IN THIS SHEET ARE MINIMUM INDICATIVE ONLY.
10. FILLING OF ANNULAR SPACE BETWEEN CASING AND CARRIER PIPE SHALL BE AS PER PROJECT SPECIFICATION.
11. CROSSING MAY BE CARRIED OUT PRIOR TO MAINLNE ACTIVITIES ADDITIONAL ROU. IF REQUIRED, FOR APPROACH TO CROSSING, PIPELINE STRINGING, HYDROTESTING, WORKING PIT FOR CROSSING. TO AVOID CAVING OF SOIL, SHALL BE PROCURED BY CONTRACTOR WITHOUT ANY COST IMPLICATION.
12. CATHODIC PROTECTION: - ALL CASING PIPES FOR ROAD CROSSING SHALL BE C.P. PROTECTED, USING SACRIFICIAL ANODE.
13. TEST STATION ON BOTH OF CROSSING.
14. THE LOCATION OF ENTRY AND EXIT PIT SHALL BE DECIDED AT SITE TO SUIT THE SITE REQUIREMENT.
15. AT EACH CROSSING, PIPELINE CROSSING WARNING SIGN SHALL BE INSTALLED ON EITHER SIDE OF CROSSING. THE WARNING PLATE MAY BE MOUNTED ON THE VENT/DRAIN OFF PIPE.
16. ALL CARRIER PIPELINE JOINTS SHALL BE 100% RADIOGRAPGHED.
17. PIPELINE SECTION SHALL BE PRETESTED HYDROSTATICALLY SEPARATELY FROM THE MAIN LINE TESTING WHEN REQUIRED BY CONCERNED AUTHORITIES OR AS DIRECTED BY CLIENT.
18. THE CASING PIPE SHALL BE PROVIDED WITH MINIMUM 50mm DIAMETER VENT PIPE FOR FILLING THE FILLER MATERIAL. IF REQUIRED, AS PER PROJECT SPECIFICATION. AFTER FILLING, VENT PIPE AT BOTH ENDS SHALL BE TRIMMED AND PLUGGED/SEALED WITH END CAPS.
19. IN ANY CASE, MINIMUM LENGTH OF THE CASING SHALL BE INDICATED IN ALIGNMENT SHEET OR 60 M WHICHEVER IS MORE.
20. THICKNESS OF CASING PIPE SHALL BE CALCULATED AS PER API RP 1102 AND SUBMITTED FOR APPROVAL.

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

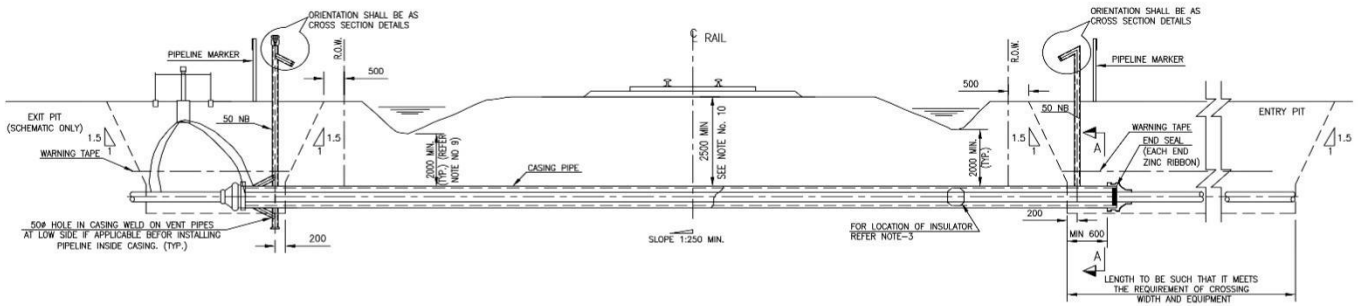
PROJECT: Glo-Djigbe Industrial Zone, Benin

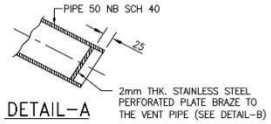
SUBJECT:
TYPICAL ROAD CASED CROSSING (B+C)
TYPE - II
COMMON CASING - OFC BUNDLED WITH CARRIER (WITHOUT CS CONDUIT)

Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

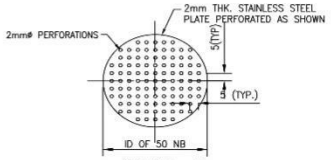
RESONANCE ENERGY PVT. LTD.
Drawing No. REPL/CGD/STD/CSP-006

SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**

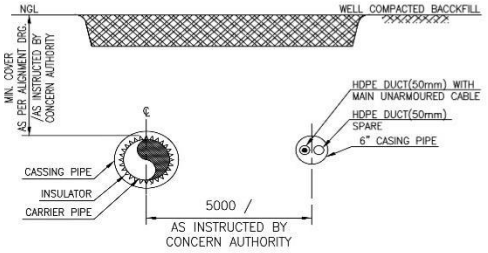




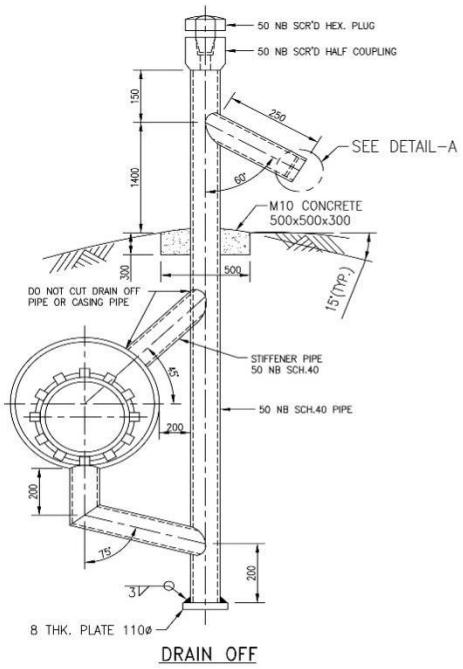
DETAIL-A



DETAIL-B



SECTION A-A
(APPLICABLE FOR TYPE-I)
TYPICAL BORE PIT EXCAVATION



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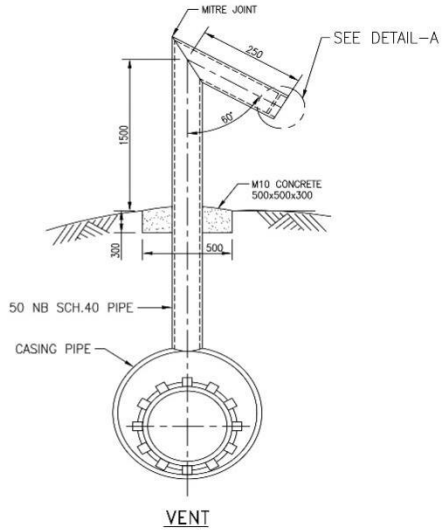


VENT

S. NO.	SIZE OF CARRIER PIPE (INCH NB)	MINIMUM SIZE OF CASING PIPE (FOR TYPE-II)	MINIMUM THICKNESS OF CASING (MM)
1.	4”	10”	5
2.	6”	12”	5
3.	8”	14”	5
4.	10”	16”	6
5.	12”	18”	7
6.	16”	22”	8
7.	18”	24”	8
8.	20”	26”	9
9.	24”	30”	11
10.	30”	36”	12
11.	36”	42”	15
12.	42”	48”	16
13.	48”	54”	19
CASING PIPE MATERIAL: API 5L GR. B, PSL1 or EQUIVALENT APPROVED BY EIC.			

NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. THE CROSSING WORKS SHALL BE EXECUTED IN ACCORDANCE WITH API RECOMMENDED PRACTICE 1102 LATEST EDITION.
3. 500mm AWAY FROM BOTH ENDS, TWO NOS. INSULATORS SHALL BE PLACED. IN BALANCE LENGTH MAX. SPACING OF INSULATORS SHALL BE 2000 mm.
4. ELECTRICAL INSULATION BETWEEN THE CASING AND CARRIER PIPE SHALL BE CHECKED WITH A SUITABLE MEGGER.
5. MATERIAL OF THE CASING INSULATORS SHALL BE HDPE. END SEALS SHALL BE HEAR SHRINKABLE TYPE (MAKE RAYCHEM OR EQUIVALENT), CONTRACTOR SHOULD TAKE PRIOR APPROVAL FOR MATERIAL OF CONSTRUCTION FOR END SEAL & SHALL SUBMIT MATERIAL CERTIFICATES TO OWNER/ CONSULTANT FOR APPROVAL.
6. 1:250 SLOPE TO BE PROVIDED FOR DRAINING DURING INSTALLATION OF CASING PIPE.
7. CONTRACTOR SHOULD SUBMIT DETAILED WORK PROCEDURE ALONG WITH SKETCHES AND MATERIAL TEST CERTIFICATES FOR APPROVAL.
8. THE MINIMUM 2.5M COVERAGE SHALL BE MAINTAINED BETWEEN TOP SURFACE OF CASING PIPE AND BOTTOM RAIL UNLESS OTHERWISE STATED IN PTS OR REQUIRED BY RAILWAY AUTHORITIES.
9. AT EACH CROSSING, PIPELINE CROSSING WARNING SIGN SHALL BE INSTALLED ON EITHER SIDE OF CROSSING. THE WARNING PLATE MAY BE MOUNTED ON THE VENT/DRAIN OFF PIPE.
10. ALL CARRIER PIPELINE JOINTS SHALL BE RADIOGRAPHED.
11. PIPELINE SECTION SHALL BE PRETESTED HYDROSTATICALLY SEPARATELY FROM THE MAIN LINE TESTING WHEN REQUIRED BY CONCERNED AUTHORITIES OR AS DIRECTED BY CLIENT.
12. CASING PIPE SHOULD EXTEND A MIN OF 600MM BEYOND THE TOE OF THE SLOPE OR BASE GRADE, OR 900MM BEYOND THE BOTTOM OF THE DRAINAGE DITCH WHICHEVER IS GREATER.
13. CROSSING SHALL BE CARRIED OUT WITH CASING PIPE SIZE & THICKNESS GIVEN IN PTS & DESIGN BASIS. THE SIZES & THICKNESS GIVEN IN THIS SHEET ARE MINIMUM REQUIREMENT AND INDICATIVE ONLY.
14. CROSSING MAY BE CARRIED OUT PRIOR TO MAINLINE ACTIVITIES ADDITIONAL ROU, IF REQUIRED, FOR APPROACH TO CROSSING, PIPELINE STRING, HYDROTESTING, WORKING PIT FOR CROSSING, TO AVOID CAVING OF SOIL, SHALL BE PROCURED BY CONTRACTOR WITHOUT ANY COST IMPLICATION.
15. CATHODIC PROTECTION: - ALL CASING PIPES FOR RAILWAY CROSSING SHALL BE C.P. PROTECTED, USING SACRIFICIAL ANODE.
16. TEST STATION ON BOTH OF CROSSING.
17. FILLING OF ANNULAR SPACE BETWEEN CASING AND CARRIER PIPE SHALL BE AS PER PROJECT SPECIFICATION.
18. THE LOCATION OF ENTRY AND EXIT PIT SHALL BE DECIDED AT SITE TO SUIT THE SITE REQUIREMENT.
19. THE CASING PIPE SHALL BE PROVIDED WITH MINIMUM 50mm DIAMETER VENT PIPE FOR FILLING THE FILLER MATERIAL. IF REQUIRED, AS PER PROJECT SPECIFICATION. AFTER FILLING, VENT PIPE AT BOTH ENDS SHALL BE TRIMMED AND PLUGGED/SEALED WITH END CAPS.
20. MINIMUM LENGTH OF THE CASING SHALL BE INDICATED IN ALIGNMENT SHEET OR 60 M WHICHEVER IS MORE.
21. THICKNESS OF CASING PIPE SHALL BE CALCULATED AS PER API RP 1102 AND SUBMITTED FOR APPROVAL.

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.08.2023	Issued for Bid	VS	KM	VB

PROJECT: Glo-Djigbe Industrial Zone, Benin

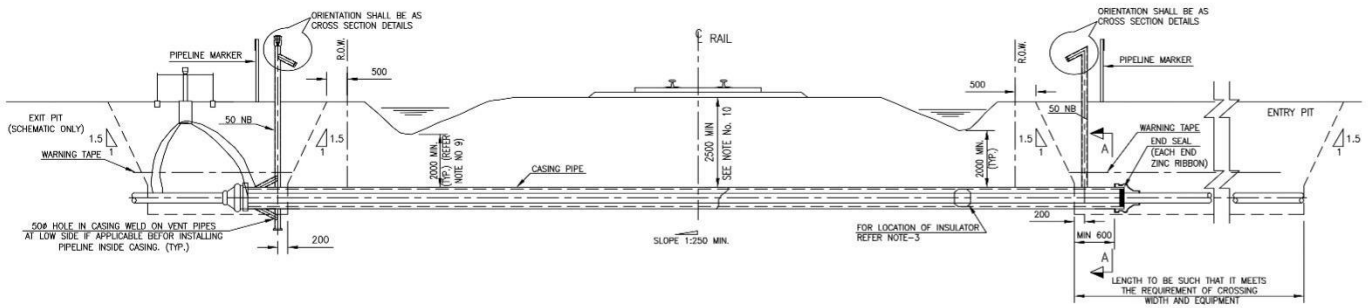
SUBJECT:
TYPICAL RAILWAY CASED CROSSING (B+C)
TYPE-I
SEPARATE CASING FOR CARRIER AND OFC

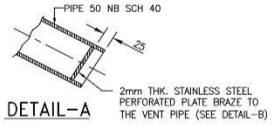
Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

RESONANCE ENERGY PVT. LTD.

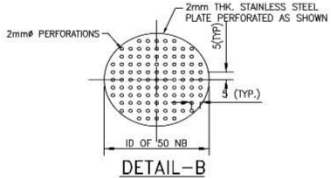
Drawing No. REPL/CGD/STD/CSP-007

SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**

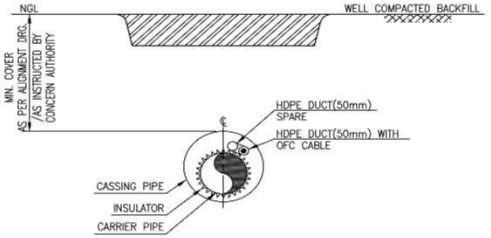




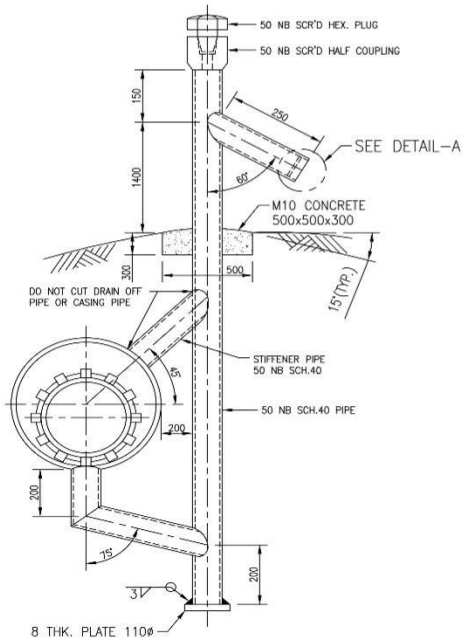
DETAIL–A



DETAIL–B



SECTION A–A
(APPLICABLE FOR TYPE–II)
TYPICAL BORE PIT EXCAVATION



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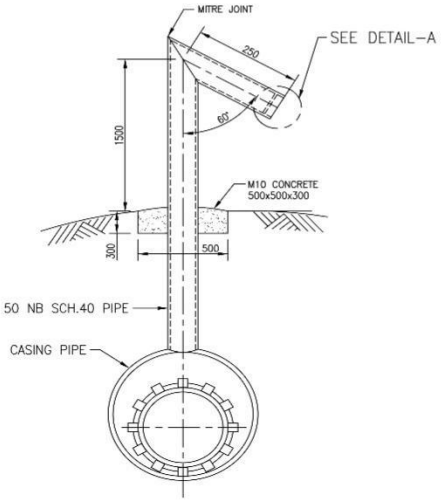


VENT

S. NO.	SIZE OF CARRIER PIPE (INCH NB)	MINIMUM SIZE OF CASING PIPE (FOR TYPE–II)	MINIMUM THICKNESS OF CASING (MM)
1.	4”	10”	5
2.	6”	12”	5
3.	8”	14”	5
4.	10”	16”	6
5.	12”	18”	7
6.	16”	22”	8
7.	18”	24”	8
8.	20”	26”	9
9.	24”	30”	11
10.	30”	36”	12
11.	36”	42”	15
12.	42”	48”	16
13.	48”	54”	19
CASING PIPE MATERIAL: API 5L GR. B, PSL1 or EQUIVALENT APPROVED BY EIC.			

NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. THE CROSSING WORKS SHALL BE EXECUTED IN ACCORDANCE WITH API RECOMMENDED PRACTICE 1102 LATEST EDITION.
3. 500mm AWAY FROM BOTH ENDS, TWO NOS. INSULATORS SHALL BE PLACED. IN BALANCE LENGTH MAX. SPACING OF INSULATORS SHALL BE 2000 mm.
4. ELECTRICAL INSULATION BETWEEN THE CASING AND CARRIER PIPE SHALL BE CHECKED WITH A SUITABLE MEGGER.
5. MATERIAL OF THE CASING INSULATORS SHALL BE HDPE. END SEALS SHALL BE HEAR SHRINKABLE TYPE (MAKE RAYCHEM OR EQUIVALENT), CONTRACTOR SHOULD TAKE PRIOR APPROVAL FOR MATERIAL OF CONSTRUCTION FOR END SEAL & SHALL SUBMIT MATERIAL CERTIFICATES TO OWNER/ CONSULTANT FOR APPROVAL.
6. 1:250 SLOPE TO BE PROVIDED FOR DRAINING DURING INSTALLATION OF CASING PIPE.
7. CONTRACTOR SHOULD SUBMIT DETAILED WORK PROCEDURE ALONG WITH SKETCHES AND MATERIAL TEST CERTIFICATES FOR APPROVAL.
8. THE MINIMUM 2.5M COVERAGE SHALL BE MAINTAINED BETWEEN TOP SURFACE OF CASING PIPE AND BOTTOM OF RAIL UNLESS OTHERWISE STATED IN PTS OR REQUIRED BY RAILWAY AUTHORITIES.
9. AT EACH CROSSING, PIPELINE CROSSING WARNING SIGN SHALL BE INSTALLED ON EITHER SIDE OF CROSSING. THE WARNING PLATE MAY BE MOUNTED ON THE VENT/DRAIN OFF PIPE.
10. ALL CARRIER PIPELINES JOINTS SHALL BE 100% RADIOGRAPHED.
11. PIPELINE SECTION SHALL BE PRETESTED HYDROSTATICALLY SEPARATELY FROM THE MAIN LINE TESTING WHEN REQUIRED BY CONCERNED AUTHORITIES/OR AS DIRECTED BY CLEINT.
12. CASING PIPE SHOULD EXTEND A MIN OF 600MM BEYOND THE TOE OF THE SLOPE OR BASE GRADE, OR 900MM BEYOND THE BOTTOM OF THE DRAINAGE DITCH WHICHEVER IS GREATER.
13. CROSSING SHALL BE CARRIED OUT WITH CASING PIPE SIZE & THICKNESS GIVEN IN PTS & DESIGN BASIS. THE SIZES & THICKNESS GIVEN IN THIS SHEET ARE MINIMUM REQUIREMENT AND INDICATIVE ONLY.
14. CROSSING MAY BE CARRIED OUT PRIOR TO MAINLINE ACTIVITIES ADDITIONAL ROU, IF REQUIRED, FOR APPROACH TO CROSSING, PIPELINE STRING, HYDROTESTING, WORKING PIT FOR CROSSING, TO AVOID CAVING OF SOIL, SHALL BE PROCURED BY CONTRACTOR WITHOUT ANY COST IMPLICATION.
15. CATHODIC PROTECTION: - ALL CASING PIPES FOR RAILWAY CROSSING SHALL BE C.P. PROTECTED, USING SACRIFICIAL ANODE.
16. TEST STATION ON BOTH OF CROSSING.
17. FILLING OF ANNULAR SPACE BETWEEN CASING AND CARRIER PIPE SHALL BE AS PER PROJECT SPECIFICATION.
18. THE LOCATION OF ENTRY AND EXIT PIT SHALL BE DECIDED AT SITE TO SUIT THE SITE REQUIREMENT.
19. THE CASING PIPE SHALL BE PROVIDED WITH MINIMUM 50mm DIAMETER VENT PIPE FOR FILLING THE FILLER MATERIAL. IF REQUIRED, AS PER PROJECT SPECIFICATION. AFTER FILLING, VENT PIPE AT BOTH ENDS SHALL BE TRIMMED AND PLUGGED/SEALED WITH END CAPS.
20. MINIMUM LENGTH OF THE CASING SHALL BE INDICATED IN ALIGNMENT SHEET OR 60 M WHICHEVER IS MORE.
21. THICKNESS OF CASING PIPE SHALL BE CALCULATED AS PER API RP 1102 AND SUBMITTED FOR APPROVAL.

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

PROJECT: Glo-Djigbe Industrial Zone, Benin

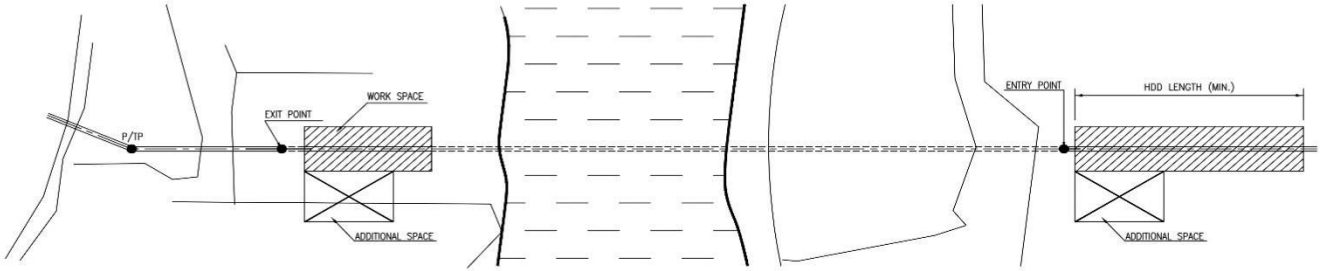
SUBJECT:
TYPICAL RAILWAY CASED CROSSING (B+C)
TYPE - II
COMMON CASING - OFC BUNDLED WITH CARRIER (WITHOUT CS CONDUIT)

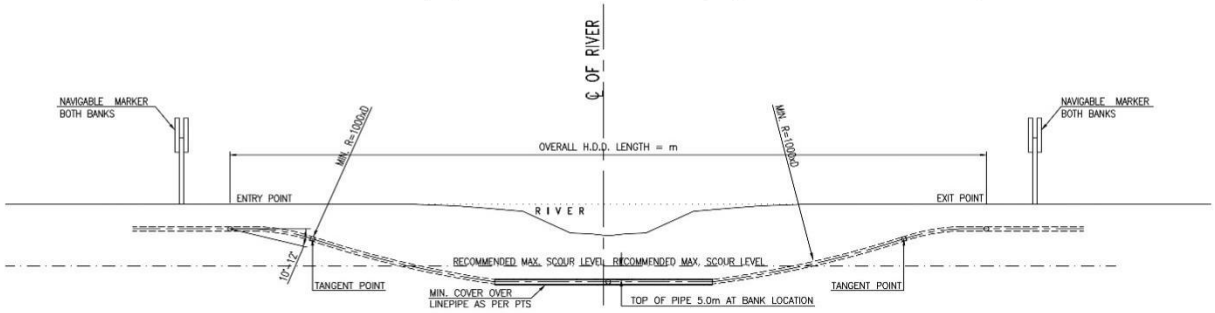
Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

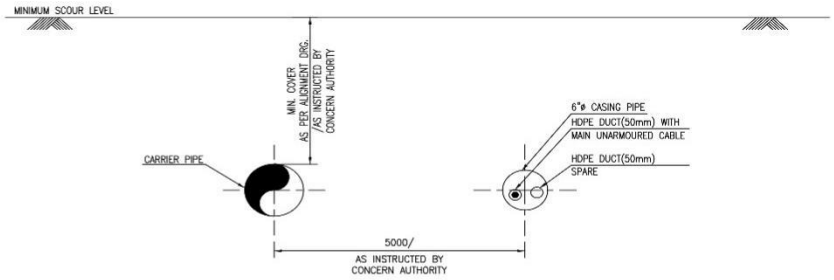
RESONANCE ENERGY PVT. LTD.

Drawing No. REPL/CGD/STD/CSP-008

SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**







CROSS-SECTION

NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. THE MINIMUM TEMPORARY WORKING SPACE ALLOCATED TO CONTRACTOR AS PER SITE CONDITION, ANY OTHER TEMPORARY WORKING SPACE OR TEMPORARY ACCESS IF REQUIRED, AT ALL HDD CROSSING SHALL BE ARRANGED BY THE CONTRACTOR AT HIS RISK & COST.
3. IF THE DRILLING POINTS (ENTRY/EXIT) ARE LOCATED BELOW THE HIGHEST WATER LEVEL THE CONTRACTOR SHALL PROTECT THE DRILLING POINTS BY CREATING A DYKE 50M MINIMUM ABOVE THE HIGHEST RECORDED WATER LEVEL. FOR PIPE LINE WITH NB > 500mm THE CONTRACTOR SHALL SPECIFY THE BALLASTING METHOD HE INTENDS TO USE TO LIMIT THE FRICTION DURING PULL BACK.
4. PRIOR TO HDD THE PROFILE/DESIGN SHALL BE SENT TO OWNER/OWNER'S REPRESENTATIVE FOR THEIR APPROVAL.
5. ADDITIONAL ROU, IF REQUIRED, FOR WORKING AND EXCAVATION OF CROSSING TO AVOID CAVING OF SOIL SHALL BE PROCURED BY CONTRACTOR WITHOUT ANY COST IMPLICATION.

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

PROJECT: Glo-Djigbe Industrial Zone, Benin

SUBJECT: TYPICAL HDD RIVER CROSSING SHOWING MAX. SCOUR LEVEL & MIN. COVER FOR PIPE

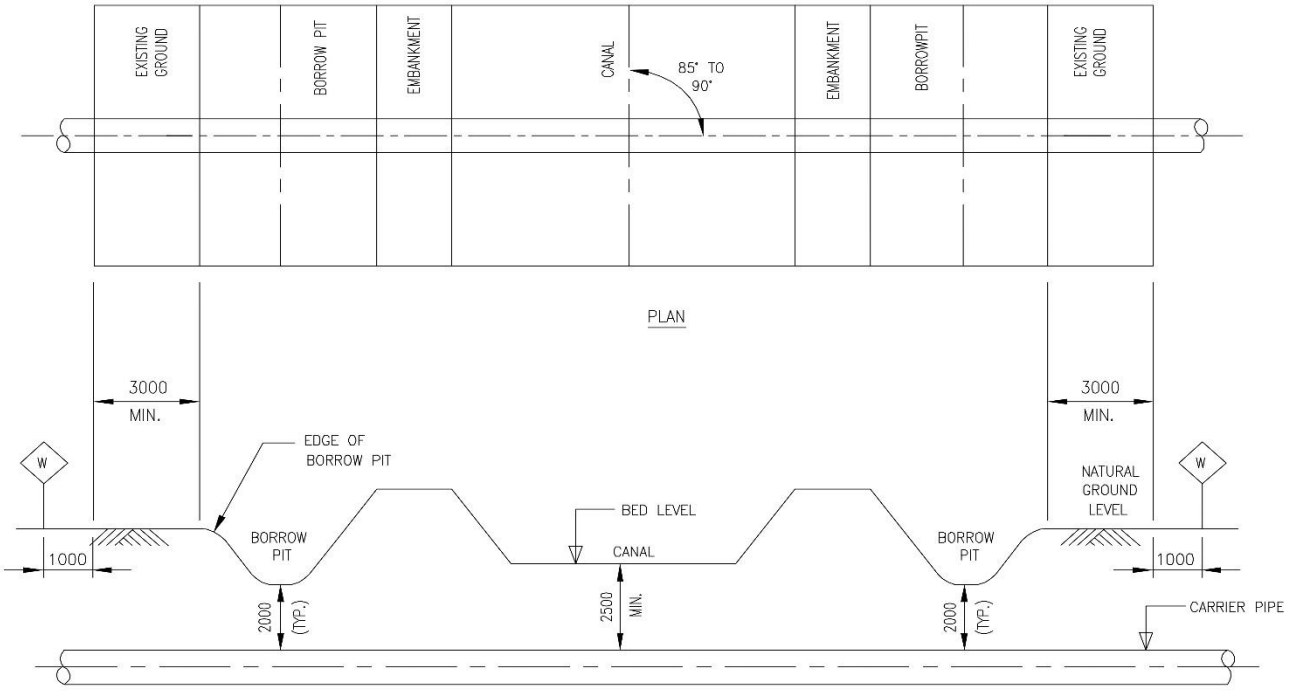
Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

RESONANCE ENERGY PVT. LTD.

Drawing No. REPL/CGD/STD/CSP-009

SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**

MAJOR CANAL CROSSING BY OPEN CUT



NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE STATED.
2. REFER API RP 1102 FOR OTHER DESIGN AND INSTALLATION REQUIREMENT.
3. AT EACH CROSSING, PIPELINE CROSSING WARNING SIGN SHALL BE INSTALLED ON BOTH SIDE OF CANAL.
4. CONTRACTOR SHALL VERIFY THE ACTUAL DIMENSIONS WITH RESPECT TO SURVEY DETAILS OF EACH CROSSING AND PREPARE DETAILED DRAWING FOR INDIVIDUAL CROSSINGS FOR COMPANY CONCERNED AUTHORITIES APPROVAL BEFORE COMMENCEMENT OF CONSTRUCTION.
5. PIPELINE SECTION LENGTH OF CROSSING SHALL BE PRETESTED HYDROSTICALLY SEPARATELY FROM THE MAIN TESTING. ALL PIPELINE JOINTS SHALL BE 100% RADIOGRAPHED.
6. AFTER INSTALLATION OF CARRIER PIPES, THE CANAL RESTORATION SHALL BE TO THE SATISFACTION OF CANAL AUTHORITIES/OWNER.
7. ANGLE OF INTERSECTION BETWEEN PIPELINE AND THE ROAD HIGHWAY SHALL BE AS CLOSES TO 90° AS POSSIBLE IN NO CASE LESS THAN 85°.

ABBRIVIATION :	
——— - - ———	CENTERLINE OF CROSSING
W	WARNING SIGN

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

PROJECT: Glo-Djigbe Industrial Zone, Benin

SUBJECT:

TYPICAL DRAWING FOR MAJOR CANAL CROSSING OPEN CUT

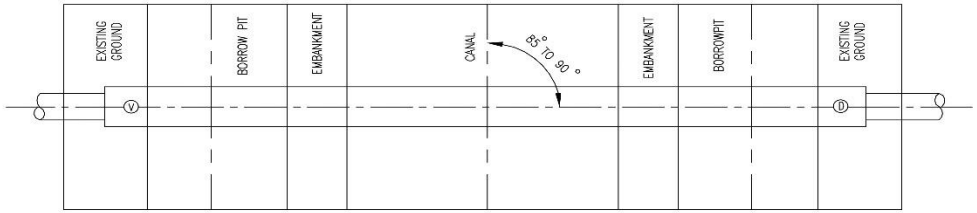
Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

RESONANCE ENERGY PVT. LTD.

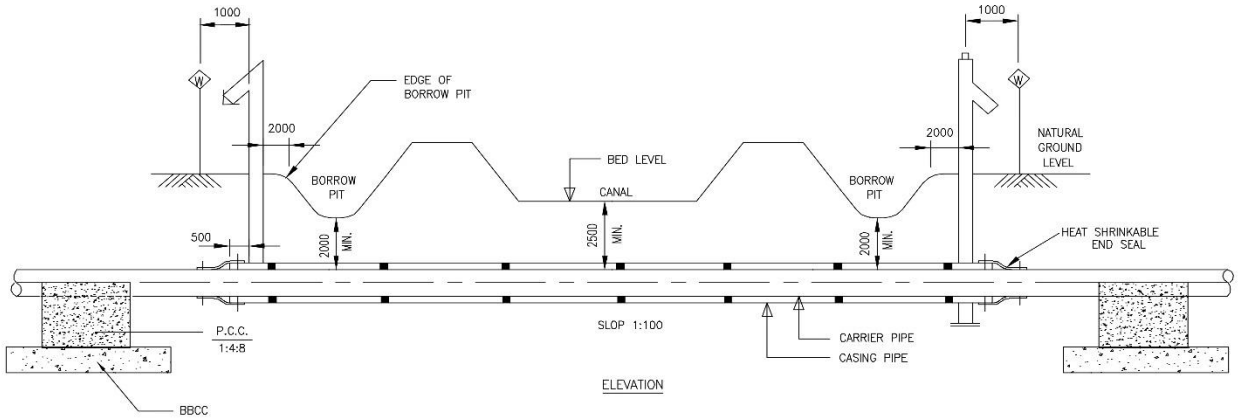
Drawing No. REPL/CGD/STD/CSP-010

SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**

MAJOR CANAL CASED CROSSING



PLAN



ELEVATION

NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE STATED.
2. REFER API RP 1102 FOR OTHER DESIGN AND INSTALLATION REQUIREMENT.
3. CASING DIAMETER SHALL BE MINIMUM 150 MM LARGER THAN CARRIER PIPE DIAMETER.
4. AT EACH CROSSING, PIPELINE CROSSING WARNING SIGN SHALL BE INSTALLED ON BOTH SIDE OF CANAL.
5. CATHODIC PROTECTION TEST STATION BOX MAY BE MOUNTED NEAR VENT PIPE.
6. CONTRACTOR SHALL VERIFY THE ACTUAL DIMENSIONS WITH RESPECT TO SURVEY DETAILS OF EACH CROSSING AND PREPARE DETAILED DRAWING FOR INDIVIDUAL CROSSINGS FOR COMPANY CONCERNED AUTHORITIES APPROVAL BEFORE COMMENCEMENT OF CONSTRUCTION.
7. PIPELINE SECTION LENGTH OF CROSSING SHALL BE PRESTESTED HYDROSTATICALLY SEPARATELY FROM THE MAIN TESTING. ALL PIPELIN JOINTS SHALL BE 100% RADIOGRAPHED.
8. ELECTRICAL INSULATION BETWEEN CASING AND CARRIER PIPES SHALL BE CHECKED WITH SUITABLE MEGGER.
9. AFTER INSTALLATION OF CASING AND CARRIER PIPES, THE CANAL RESTORATION SHALL BE TO THE SATISFACTION OF CANAL AUTHORITIES/OWNER.
10. FOR CASING PIPE INSULATOR SPACING END SEALS ETC REFER RELEVANT STD.
11. ANGLE OF INTERSECTION BETWEEN PIPELINE AND THE ROAD HIGHWAY SHALL BE AS CLOSES TO 90° AS POSSIBLE IN NO CASE LESS THAN 85°.
12. THE SIZE OF PLASTIC GRATING/ HDPE SHEET/ CONC. SLAB WILL BE AS PER THE SPECIFICATION PROVIDED BY AUTHORITY HAVING JURISDICTION.

ABBRIVIATION :	
——— _ ———	CENTERLINE OF CROSSING
W	WARNING SIGN

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

PROJECT: Glo-Djigbe Industrial Zone, Benin

SUBJECT:

TYPICAL DRAWING FOR MAJOR CANAL CASSED CROSSING

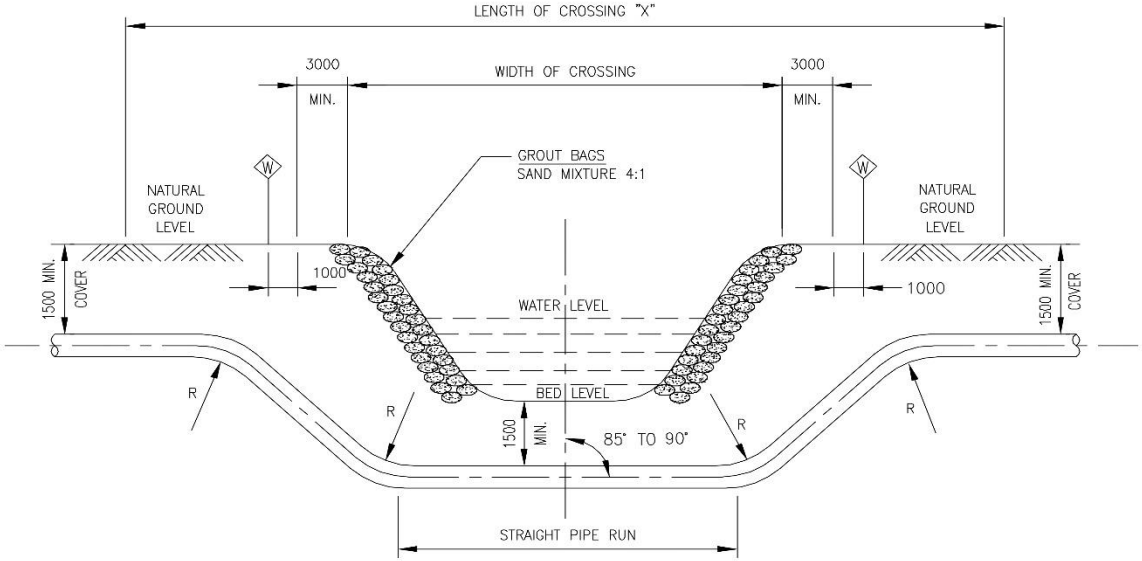
Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

RESONANCE ENERGY PVT. LTD.

Drawing No. REPL/CGD/STD/CSP-011

SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**

MINOR CANAL/KHADI/NALA CROSSING WITH OVER & SAG BEND



MINIMUM BAND RADIUS R = 6D

ADDITIONAL NOTE :
"X" SHALL BE REINFORCED CONCRETE COATING INCASE OF KHADI AND NALA.

NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE STATED.
2. REFER API RP 1102 FOR OTHER DESIGN AND INSTALLATION REQUIREMENT.
3. AT EACH CROSSING, PIPELINE CROSSING WARNING SIGN SHALL BE INSTALLED ON BOTH SIDE OF ROAD.
4. CONTRACTOR SHALL VERIFY THE ACTUAL DIMENSIONS WITH RESPECT TO SURVEY DETAILS OF EACH CROSSING AND PREPARE DETAILED DRAWING FOR INDIVIDUAL CROSSINGS FOR COMPANY CONCERNED AUTHORITIES APPROVAL BEFORE COMMENCEMENT OF CONSTRUCTION.
5. AFTER INSTALLATION OF CARRIER PIPES, THE CANAL RESTORATION SHALL BE TO THE SATISFACTION OF CANAL AUTHORITIES/OWNER.
6. ANGLE OF INTERSECTION BETWEEN PIPELINE AND THE ROAD HIGHWAY SHALL BE AS CLOSES TO 90° AS POSSIBLE IN NO CASE LESS THAN 85°.
7. GROUT BAGS IS PROVIDED WIDTH = TRENCH WIDTH + 1.5 MTR ON BOTH SIDE OS THE PIPE LAID.
8. CP TEST STATION SHALL BE PROVIDED AT CANAL CROSSING.

LEGEND :	
——— - ———	CENTERLINE OF CROSSING
W	WARNING SIGN

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

PROJECT: Glo-Djigbe Industrial Zone, Benin

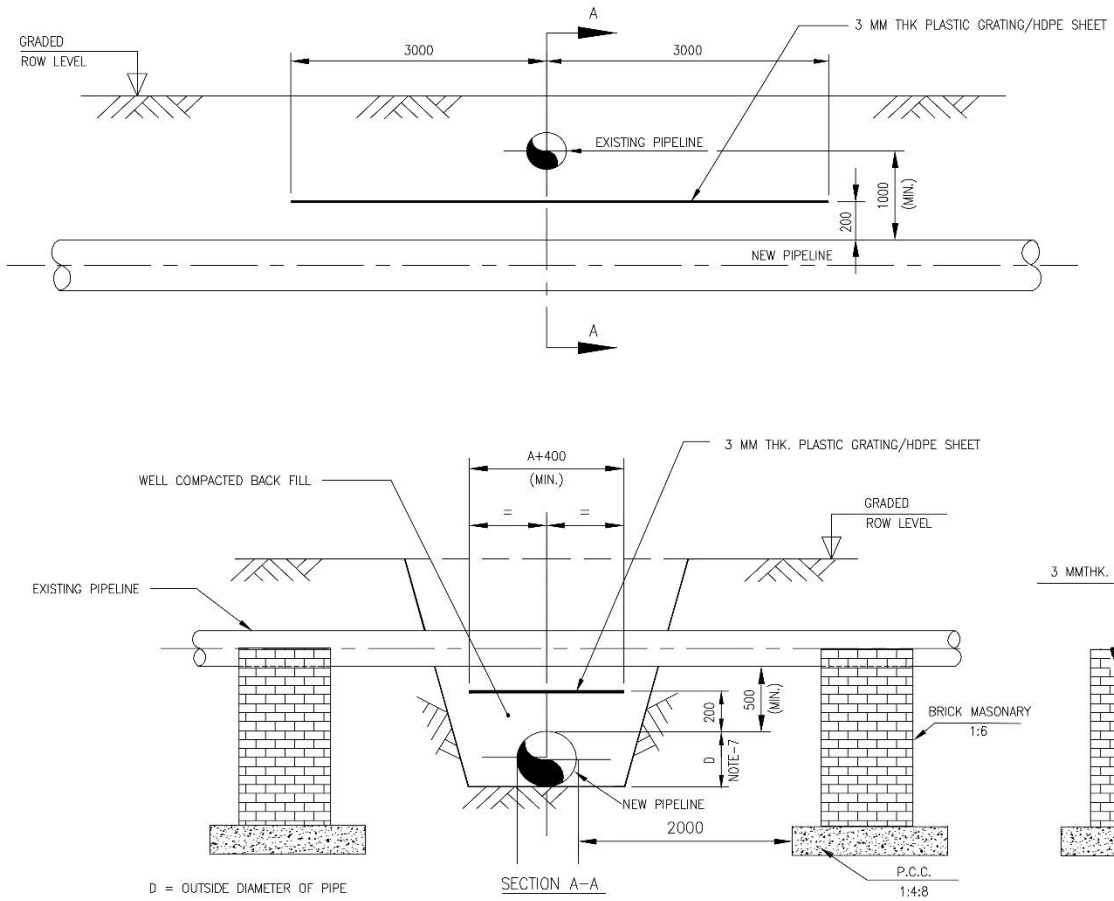
SUBJECT:
TYPICAL DRAWING FOR
MINOR CANAL /KHADI /NALA CROSSING

RESONANCE ENERGY PVT. LTD.

Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

Drawing No. REPL/CGD/STD/CSP-012

EXISTING UNDER GROUND PIPE CROSSING TYPE–I



NOTES:

1. A PIPELINE WARNING SIGN SHALL BE INSTALLED WHERE THE PIPELINE CROSSES AN EXISTING PIPELINE CARRYING HAZARDOUS FLUID.
2. PLASTIC CRATING AS PER RELEVANT STANDARD/SPECIFICATION.
3. PLASTIC GRATING NEED NOT BE PROVIDED BETWEEN AN EXISTING CASED PIPELINE AND NEW PIPELINE.
4. SUITABLE CATHODIC PROTECTION BONDING TEST STATION SHALL BE PROVIDED BETWEEN CROSSING PIPELINES. IN SOME CASES THE NEW PIPELINE MAY REQUIRE ELECTRICAL SECTIONALIZATION.
5. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE STATED.
6. DIMENSION 'A' SHALL BE CALCULATED USING FORMULA A=(D1 D2...Dn)+(N-1)x500 WHERE D1,D2,Dn IS THE DIAMETER OF PIPELINES IN THE SAME TRENCH AND N IS NUMBER OF PIPELINE IS SAME TRENCH.
7. DIMENSION 'D' SHALL BE THE LATEST DIAMETER OF THE PIPELINES LAID IN THE SAME TRENCH.
8. TRENCH DIMENSIONS SHALL BE IN ACCORDANCE WITH RELEVANT STANDARDS/ SPECIFICATIONS.
9. APPROVAL OF THE CROSSING SHALL BE OBTAINED FROM CONCERNED AUTHORITIES/OWNER.
10. RATIO OF PCC & BRICK MASONARY ARE INDICATIVE ONLY. HOWEVER PCC AND BRICK MASONARY SHALL BE CARRIED OUT AS PER THE REQUIREMENT OF CONCERNED AUTHORITY.
11. THE SIZE OF PLASTIC GRATING/ HDPE SHEET/CONC. SLAB WILL BE AS PER THE SPECIFICATION PROVIDED BY AUTHORITY HAVING JURISDICTION.

Rev.	Date	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB
Rev.	D M Y	Status	Drawn	Checked	Approved

PROJECT: Glo-Djigbe Industrial Zone, Benin

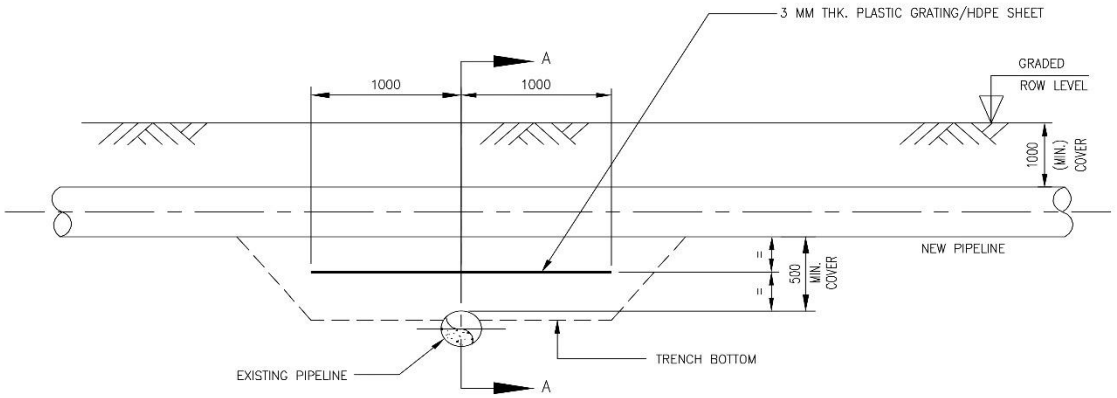
SUBJECT:
TYPICAL DRAWING FOR
EXISTING UNDER GROUND PIPE CROSSING TYPE -1

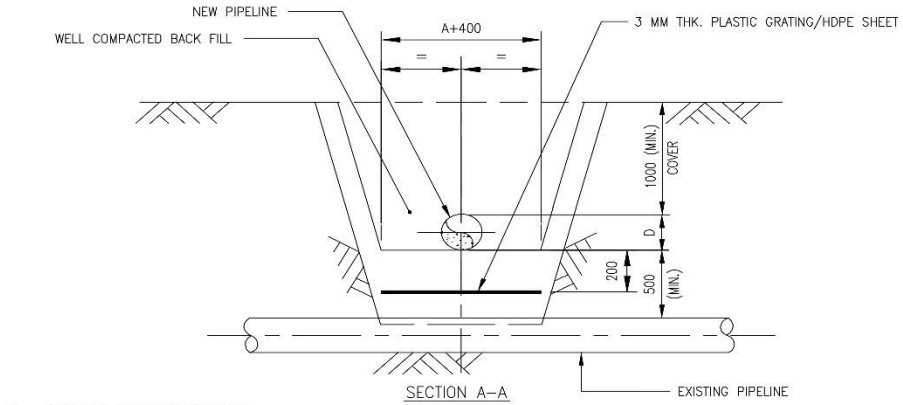
Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

RESONANCE ENERGY PVT. LTD.

Drawing No. REPL/CGD/STD/CSP-013

EXISTING UNDER GROUND PIPE CROSSING TYPE–II





SECTION A–A

D = OUTSIDE DIAMETER OF PIPE

NOTES:

1. A PIPELINE WARNING SIGN SHALL BE INSTALLED WHERE THE PIPELINE CROSSES AN EXISTING PIPELINE CARRYING HAZARDOUS FLUID.
2. PLASTIC CRATING AS PER RELEVANT STANDARD/SPECIFICATION.
3. PLASTIC GRATING NEED NOT BE PROVIDED BETWEEN AN EXISTING CASED PIPELINE AND NEW PIPELINE.
4. SUITABLE CATHODIC PROTECTION BONDING TEST STATION SHALL BE PROVIDED BETWEEN CROSSING PIPELINES. IN SOME CASES THE NEW PIPELINE MAY REQUIRE ELECTRICAL SECTIONALIZATION.
5. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE STATED.
6. DIMENSION 'A' SHALL BE CALCULATED USING FORMULA A=(D1 D2...Dn)+(N-1)x500 WHERE D1,D2,Dn IS THE DIAMETER OF PIPELINES IN THE SAME TRENCH AND N IS NUMBER OF PIPELINE IS SAME TRENCH.
7. DIMENSION 'D' SHALL BE THE LATEST DIAMETER OF THE PIPELINES LAID IN THE SAME TRENCH.
8. TRENCH DIMENSIONS SHALL BE IN ACCORDANCE WITH RELEVANT STANDARDS/ SPECIFICATIONS.
9. THE SIZE OF PLASTIC GRATING/ HDPE SHEET/CONC. SLAB WILL BE AS PER THE SPECIFICATION PROVIDED BY AUTHORITY HAVING JURISDICTION.

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

PROJECT: Glo-Djigbe Industrial Zone, Benin

SUBJECT:

TYPICAL DRAWING FOR
EXISTING UNDER GROUND PIPE CROSSING TYPE-II

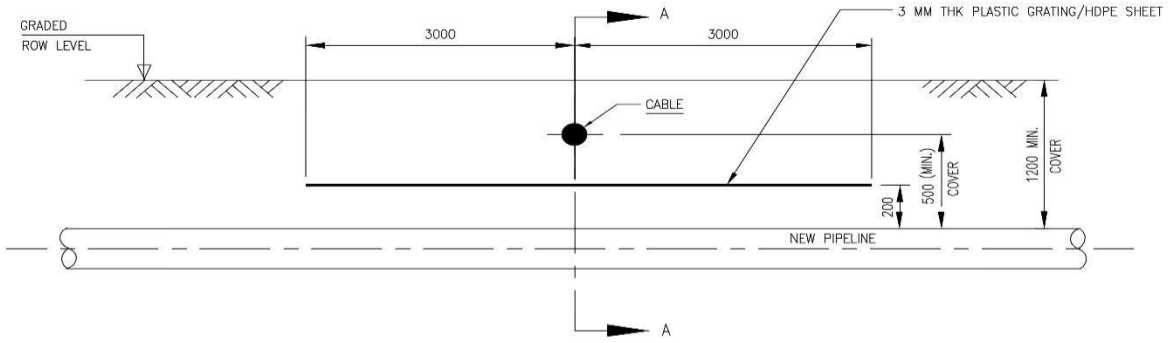
Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

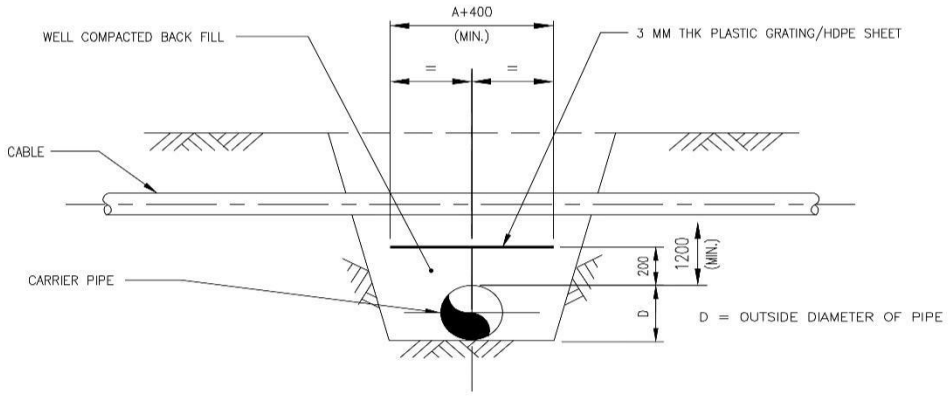
RESONANCE ENERGY PVT. LTD.

Drawing No. REPL/CGD/STD/CSP-014

SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP /REPL/003/STPL**		**Date: 03/08/2023**

UNDERGROUND CABLE CROSSING





SECTION A–A

NOTES:

1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE STATED.
2. A PIPELINE WARNING SIGN SHALL BE INSTALLED CLOSED TO CROSSING.
3. PLASTIC CRATING AS PER RELEVANT STANDARD/SPECIFICATION.
4. PLASTIC GRATING NEED NOT BE PROVIDED BETWEEN CABLE AND CASED PIPELINE.
5. IN CASE OF ARMOURED AC CABLE, C.P. BONDING TEST STATIOS IS TO BE PROVIDED BETWEEN PIPELINE AND CABLERMOUR. INCASE OF UNARMOURED AC CABLES, ARRANGEMENT FOR ELECTRO-MAGNETIC SHEILDING (BY PROVIDING CASING ON EITHER THE PIPE LINE OR CABLE) SHALL BE CONSIDERED.
6. DIMENSION 'A' SHALL BE CALCULATED USING FORMULA A=(D1 D2...Dn)+(N-1)x500 FOR MORE THAN ONE PIPELINE LAID IN COMMON TRENCH WHERE D1,D2,Dn ARE THE DIAMETER OF PIPELINES AND 'N' IS NUMBER OF PIPELINE IS SAME TRENCH.
7. DIMENSION 'D' SHALL BE THE LATEST DIAMETER OF THE PIPELINES LAID IN THE SAME TRENCH.
8. TRENCH DIMENSIONS SHALL BE IN ACCORDANCE WITH RELEVANT STANDARDS/ SPECIFICATIONS.
9. APPROVAL OF THE CROSSING SHALL BE OBTAINED FROM CONCERNED AUTHORITIES/OWNER.

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

PROJECT: Glo-Djigbe Industrial Zone, Benin

SUBJECT:

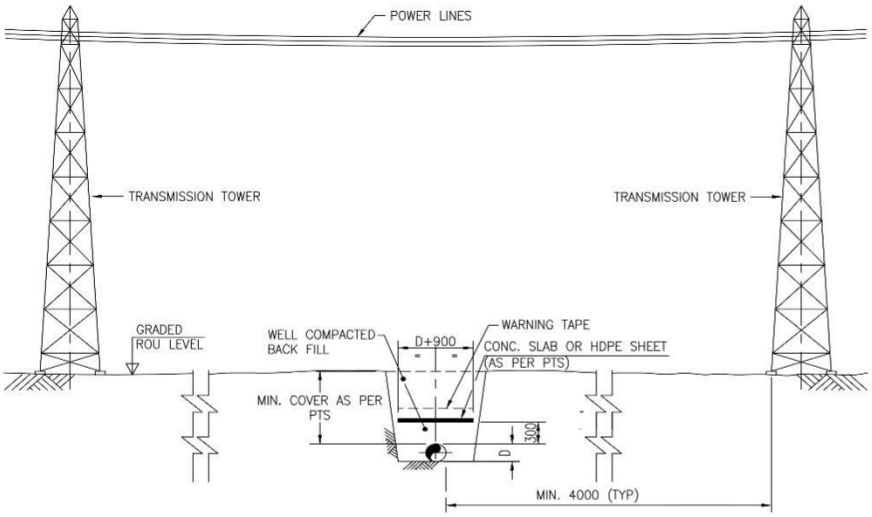
TYPICAL DRAWING FOR UNDER GROUNG CABLE CROSSING

Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

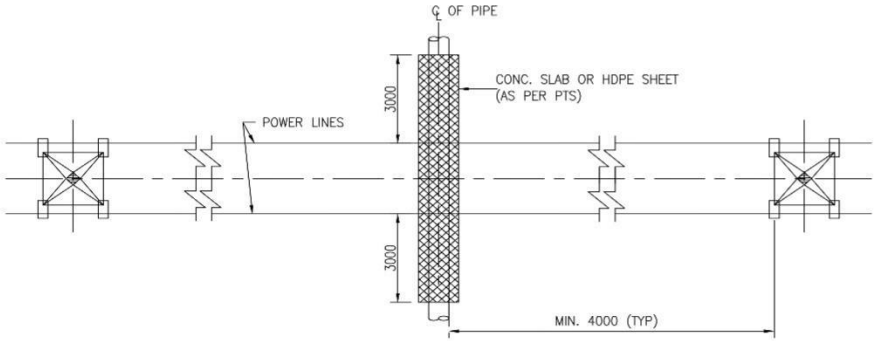
RESONANCE ENERGY PVT. LTD.

Drawing No. REPL/CGD/STD/CSP-015

SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**



SECTION



PLAN

NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. SUITABLE MEASURES SHALL BE TAKEN FOR THE PROTECTION OF THE LINE AND SECURITY OF PERSONNEL WHEREVER FOUND NECESSARY.
3. APPROVAL OF THE CROSSING SHALL BE OBTAINED FROM CONCERNED AUTHORITIES.
4. FOR CONCRETE SLAB REFER STANDARD DRAWING
5. HDPE SHEET SHALL BE PROVIDED FOR HIGH VOLTAGE LINES FROM 11KV TO 66KV. FOR 66KV AND ABOVE CONCRETE SLAB SHALL BE PROVIDED.

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

PROJECT: Glo-Djigbe Industrial Zone, Benin

SUBJECT:

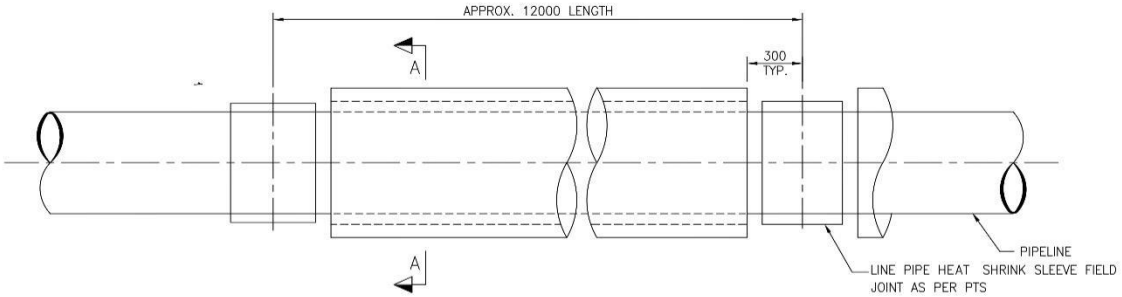
TYPICAL OVERHEAD POWER LINE CROSSING DETAILS

Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

RESONANCE ENERGY PVT. LTD.

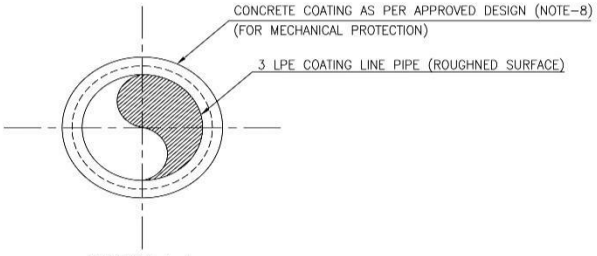
Drawing No. REPL/CGD/STD/CSP-016

SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP /REPL/003/STPL**		**Date: 03/08/2023**



DETAIL OF PIPELINE WITH MECHANICAL PROTECTION CONCRETE COATING

REFER TO ALIGNMENT SHEET FOR LACATION AND LENGTH OF CONC. COATED PIPE



SECTION A-A

NOTES:

1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. REINFORCEMENT SHALL CONSIST OF WELDED STEEL WIRE FABRIC MANUFACTURED IN SLOT SHEETS OR IN ROLLS (RIBBON MESH) AND SHALL CONFORM TO ASTM A-135. WIRES SHALL CONFORM TO ASTM A-82.
3. GALVANIZING OF STEEL WIRE SHALL BE AS PER ASTM.
4. THICKNESS OF STEEL WIRE SIZE SHALL BE 2.4mm AND SPACING OF WIRE SHALL BE 50mm x 100mm.
5. ANTIBUOYANCY CALCULATION SHALL BE SUBMITTED FOR APPROVAL.
6. MINIMUM THICKNESS OF CONCRETE COATING SHALL BE 75mm.
7. CONCRETE COATING SHALL BE M20 USED.
8. MINIMUM THICKNESS OF CONCRETE COATING SHALL BE AS MAINTAINED IN PTS & ALIGNMENT SHEETS.

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.08.2023	Issued for Bid	VS	KM	VB

PROJECT: Glo-Djigbe Industrial Zone, Benin

SUBJECT:

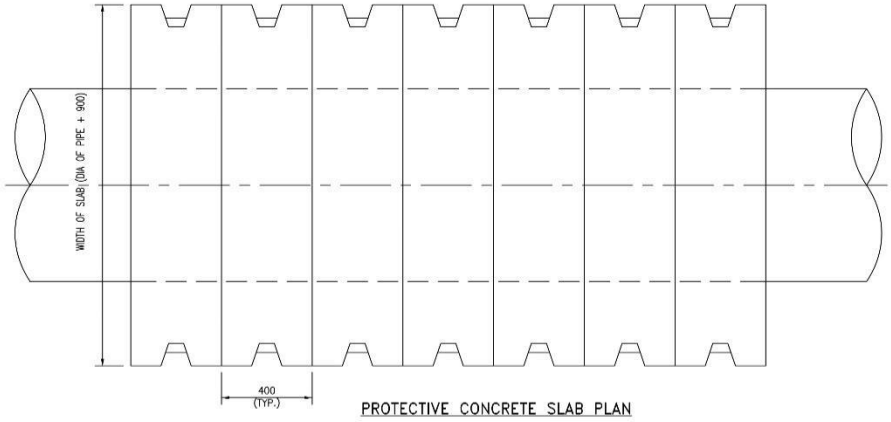
TYPICAL CONCRETE COATING FOR MECHANICAL PROTECTION

Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

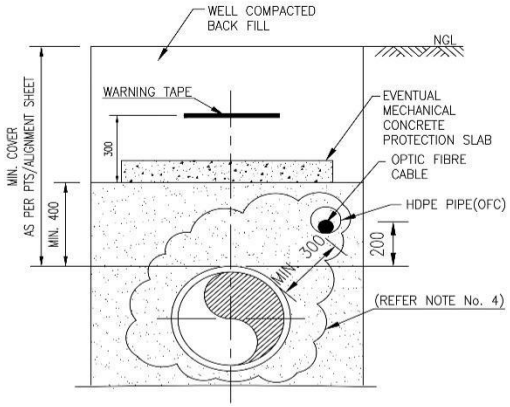
RESONANCE ENERGY PVT. LTD.

Drawing No. REPL/CGD/STD/CSP-017

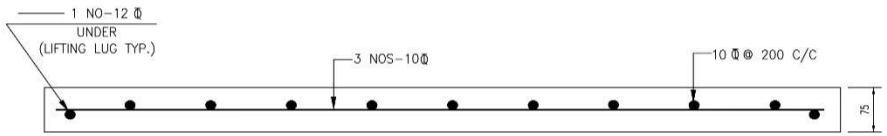
SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**



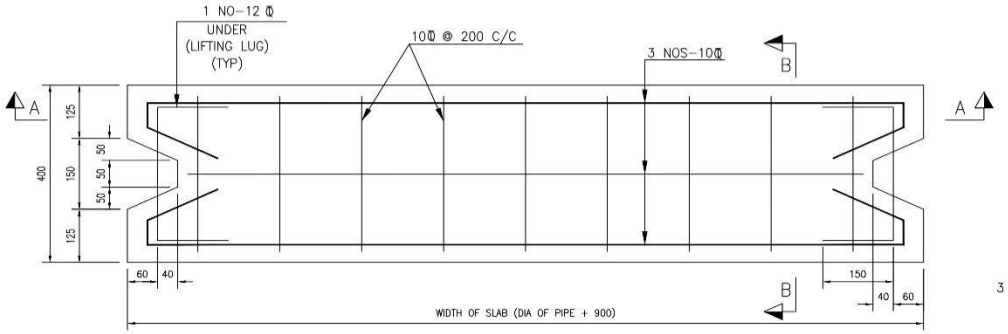
PROTECTIVE CONCRETE SLAB PLAN



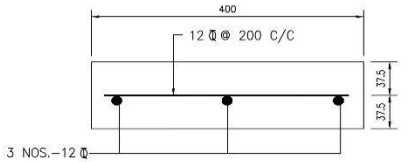
NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. MINIMUM COVER OVER LINE PIPE SHALL BE AS PER SPECIFICATIONS AND REQUIREMENT OF CONCERNED AUTHORITIES.
3. THIS SKETCH IS INDICATIVE ONLY.
4. TYPE OF TRENCHING SHALL BE AS PER PTS AND APPROVED PROCEDURE.
5. CONCRETE MIX M20 SHALL BE USED.
6. LENGTH OF THE MECHANICAL PROTECTION SLAB REQUIREMENT SHALL BE AS PER SITE REQUIREMENT.



SECTION A–A
SCALE–1 : 10



REINF. DETAIL PROTECTIVE CONCRETE SLAB



SECTION B–B
1 : 10

Rev.	Date	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB
	D M Y				

PROJECT: Glo-Djigbe Industrial Zone, Benin

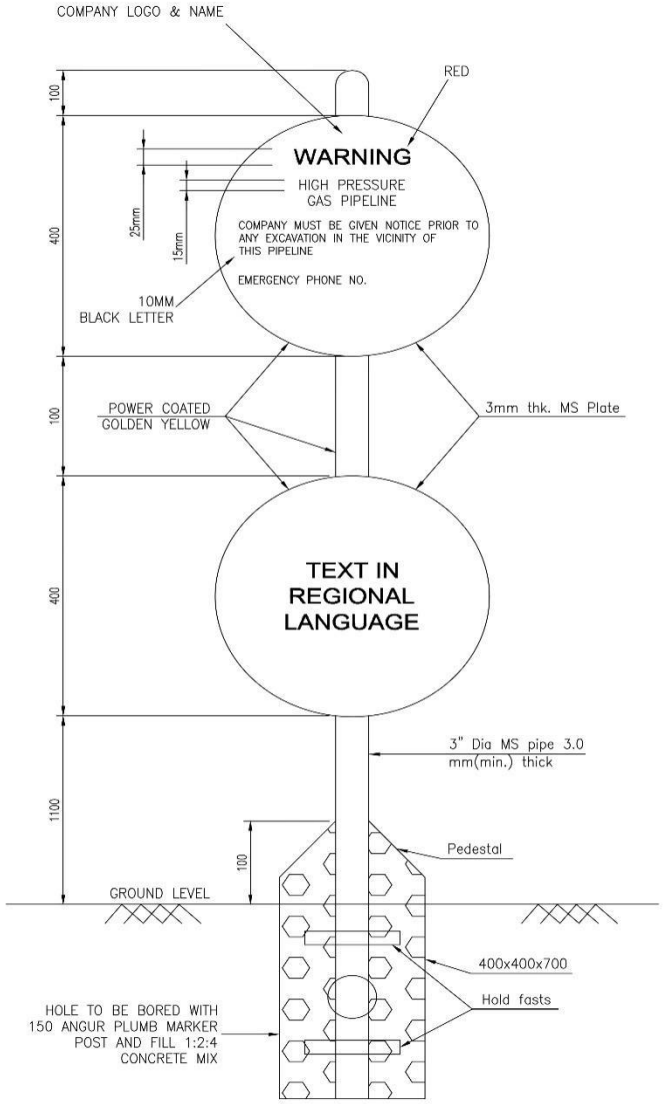
SUBJECT:
TYPICAL MECHANICAL PROTECTION
CONCRETE SLAB DETAILS

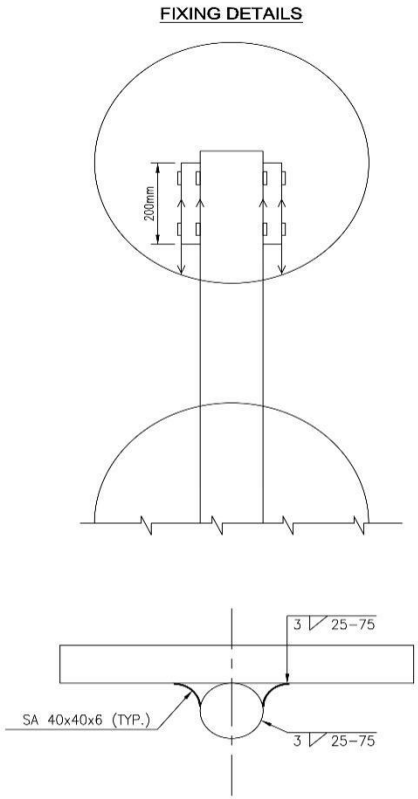
Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

RESONANCE ENERGY PVT. LTD.

Drawing No. REPL/CGD/STD/CSP-018

SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**





NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. THE FULL WORKING AND SIZES ARE ONLY 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 LETERS "WARNING" TO BE PAINTED BLACK.
4. APPROVAL OF WARNING MARKER DESIGN SHALL BE OBTAINED BEFORE THE COMMENCEMENT OF WORK.

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.08.2023	Issued for Bid	VS	KM	VB

PROJECT: Glo-Djigbe Industrial Zone, Benin

SUBJECT:

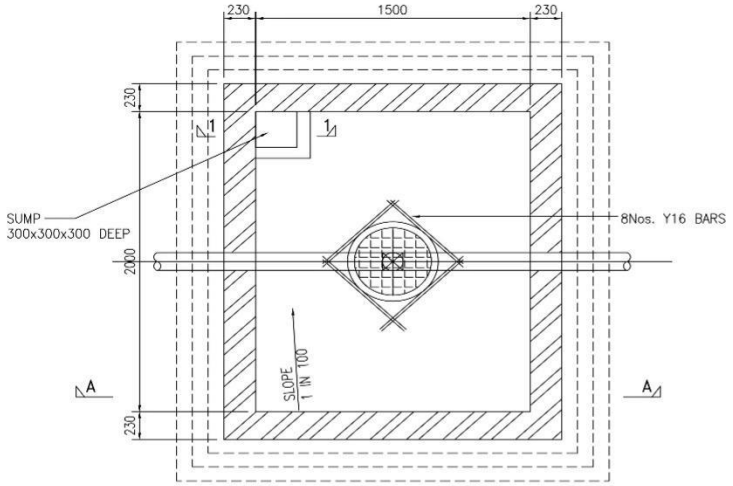
POLE MARKER WITH FOUNDATION

RESONANCE ENERGY PVT. LTD.

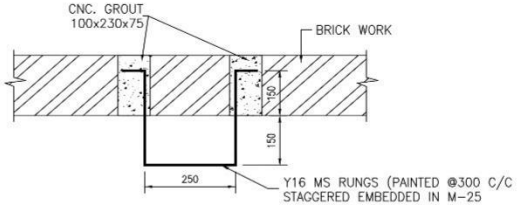
Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

Drawing No. REPL/CGD/STD/CSP-019

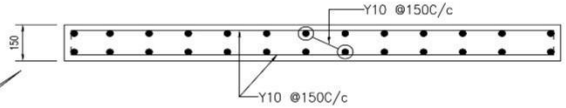
SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**



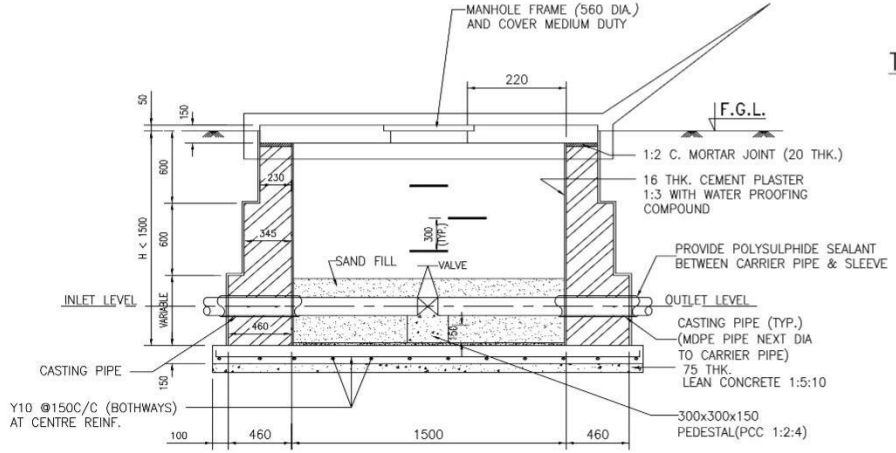
VALVE PIT PLAN



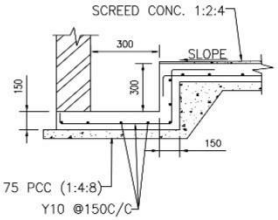
TYPICAL DETAILS OF MS RUNGS



TYPICAL SLAB R/F DETAIL



SECTION A–A



SECTION 1–1

NOTES:

1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. FOLLOW WRITTEN DIMENSIONS ONLY. DO NOT SCALE.
3. CLEAR COVER TO MAIN REINFORCEMENT SHALL BE: SLAB = 20mm.
4. GRADE OF CONCRETE SHALL BE M-25.
5. REINFORCEMENT SHALL BE OF HYSD (GRADE Fe 415) OR EQUIVALENT APPROVED BY EIC.

Rev.	Date	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB
	D M Y				

PROJECT: Glo-Djigbe Industrial Zone, Benin

SUBJECT:

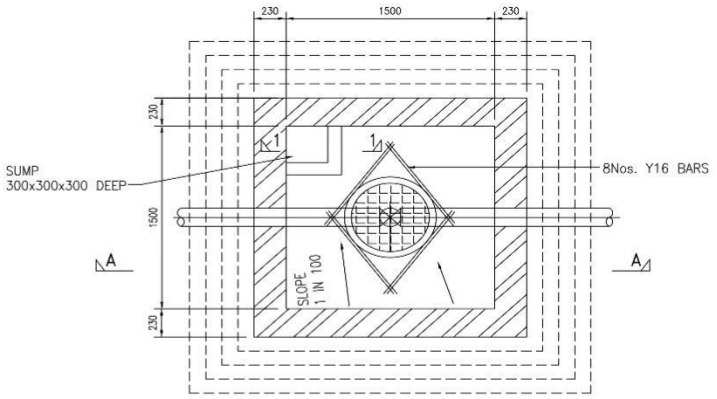
BRICK VALVE CHAMBER (2.0M X 1.5M)
TYPE - A

Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

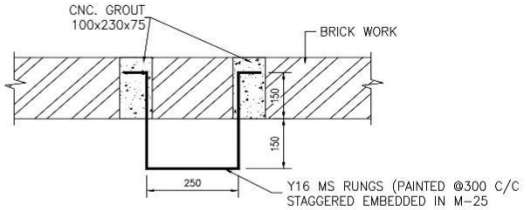
RESONANCE ENERGY PVT. LTD.

Drawing No. REPL/CGD/STD/CSP-020

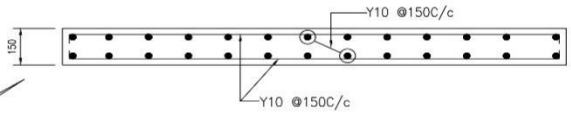
SIPI	**Laying & construction of 12" NB X 30 km and 06" NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**



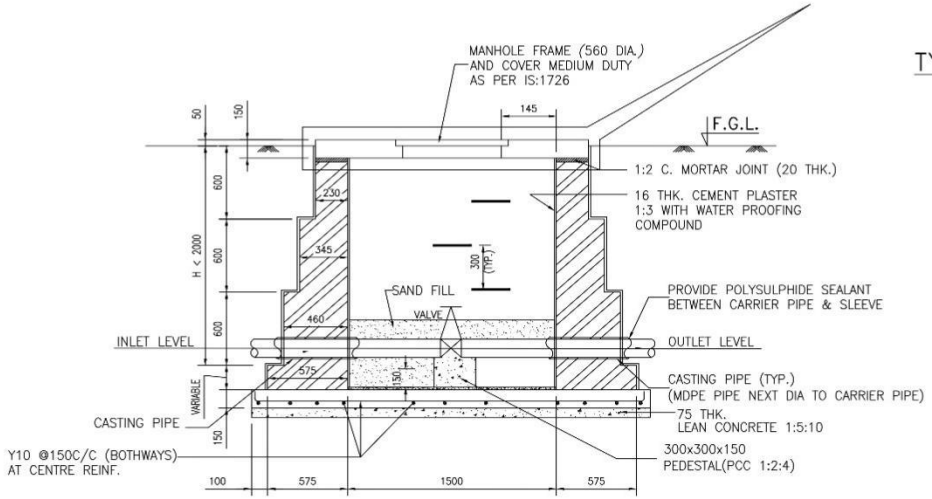
VALVE PIT PLAN



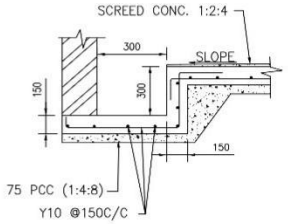
TYPICAL DETAILS OF MS RUNGS



TYPICAL SLAB R/F DETAIL



SECTION A-A



SECTION 1-1

NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. FOLLOW WRITTEN DIMENSIONS ONLY. DO NOT SCALE.
3. CLEAR COVER TO MAIN REINFORCEMENT SHALL BE: SLAB = 20mm.
4. GRADE OF CONCRETE SHALL BE M-25.
5. REINFORCEMENT SHALL BE OF HYSD (GRADE Fe 415).

Rev.	Date	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB
	D M Y				

PROJECT: Glo-Djigbe Industrial Zone, Benin

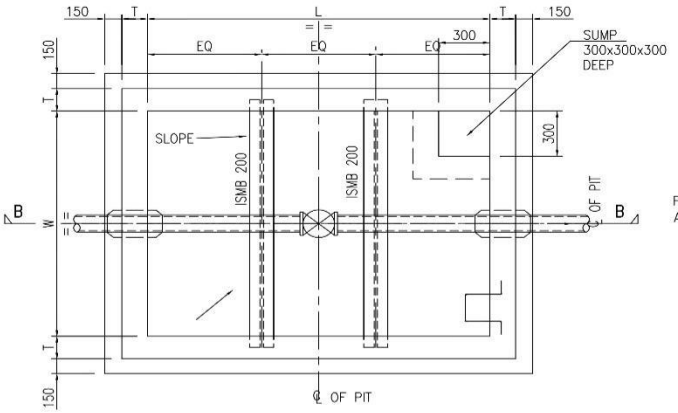
SUBJECT:
BRICK VALVE CHAMBER (1.5M X 1.5M)
TYPE - B

Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

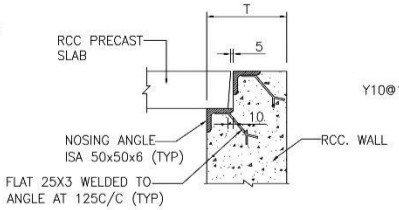
RESONANCE ENERGY PVT. LTD.

Drawing No. REPL/CGD/STD/CSP-021

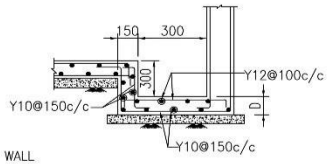
SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**



VALVE PIT BOTTOM PLAN

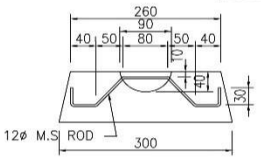


DETAIL–A

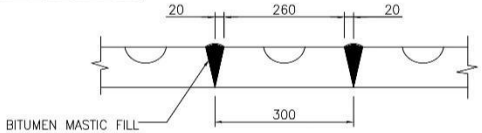


TYP. REINF. DETAIL FOR SUMP

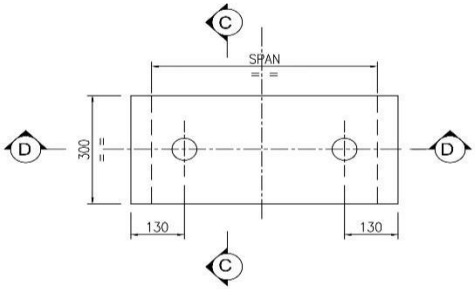
NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. FOLLOW WRITTEN DIMENSIONS ONLY. DO NOT SCALE.
3. RCC SHALL BE OF M-25 GRADE.
4. ALL REINFORCEMENT MARKED 'Y / Q' SHALL BE FE415 GR OR EQUIVALENT APPROVED BY EIC.
5. CLEAR COVER TO MAIN REINFORCEMENT SHALL BE SLAB = 20mm.
6. WHEEL LOAD CONSIDERED 11.40 TON.
7. PRECAST SLAB TO BE PLACED ACROSS THE VEHICLES MOVEMENT.



DETAIL OF HOOK



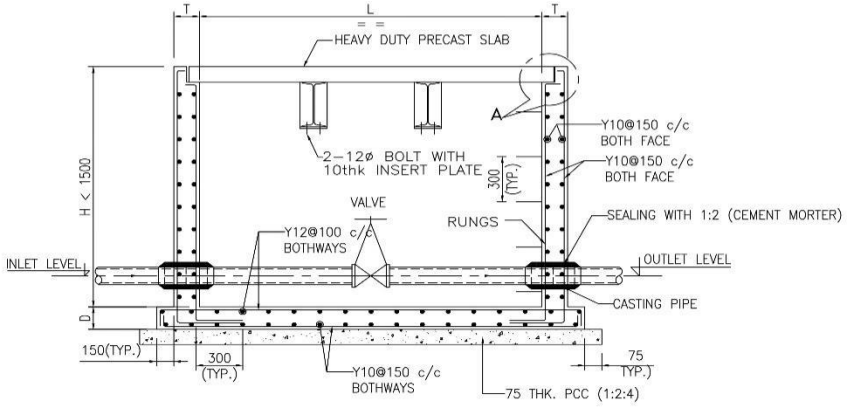
JOINTING DETAIL OF PRECAST COVER SLAB



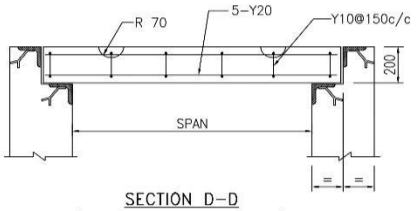
PLAN OF PRECAST COVER SLAB
(FOR VEHICLE MOVING AREA)

SCHEDULE OF VALVE CHAMBER

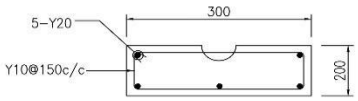
S.NO.	TYPE	SIZE			
		L	W	D	T
1	TYPE–1	2.00m	1.50m	0.15	0.15
2	TYPE–2	2.00m	2.00m	0.15	0.15
3	TYPE–3	2.50m	2.00m	0.20	0.20
4	TYPE–4	2.75m	2.00m	0.20	0.20



SECTION B–B



SECTION D–D
(FOR VEHICLE MOVING AREA)



SECTION C–C
(FOR VEHICLE MOVING AREA)

Rev.					
0	12.06.2023	Issued for Bid	VS	KM	VB
Rev.	D M Y	Status	Drawn	Checked	Approved

PROJECT: Glo-Djigbe Industrial Zone, Benin

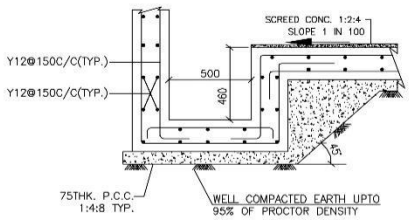
SUBJECT:
TYPICAL DETAILS OF RCC VALVE CHAMBER
(TYPE - 1, 2, 3 & 4)

RESONANCE ENERGY PVT. LTD.

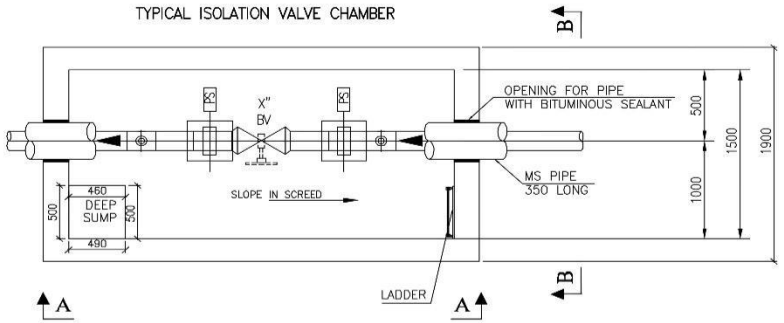
Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

Drawing No. REPL/CGD/STD/CSP-022

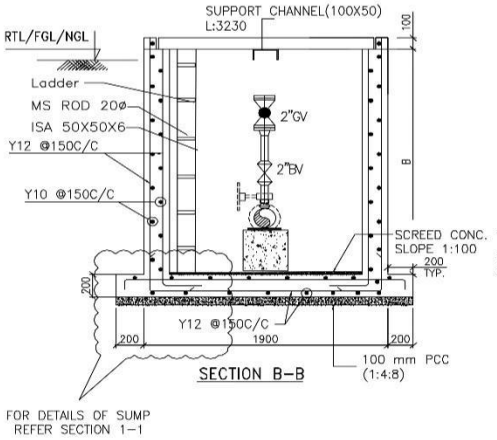
SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**



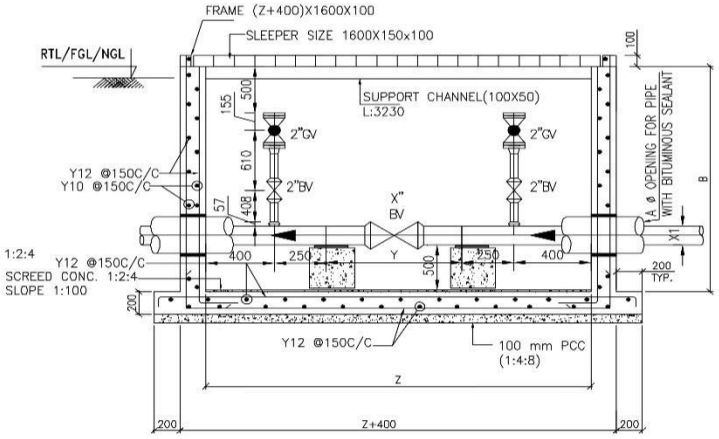
SECTION 1-1



PLAN VIEW



SECTION B-B



SECTION A-A

DIMENSION DETAILS OF VALVE CHAMBER					
SR. NO.	X/X1	Y	Z	A	B
1	4"	305	1605	6"	2230+O.D. OF PIPE
2	6"	403	1703	8"	2230+O.D. OF PIPE
3	8"	419	1719	10"	2230+O.D. OF PIPE
4	10"	568	1868	12"	2230+O.D. OF PIPE
5	12"	648	1948	14"	2230+O.D. OF PIPE

NOTES:

1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. FOLLOW WRITTEN DIMENSION ONLY ,DO NOT SCALE
3. THE DRAWING SHALL BE READ IN CONJUNCTION WITH CONTRACT TERMS AND CONDITION ,SPECIFICATION AND SCHEDULED OF ITEMS
4. ALL LOOSE SOIL OR POCKET OF EARTH FOUND IN EXCAVATION AT FOUNDATION LEVEL SHALL BE EXCAVATED OUT AND BACK FILLED WITH LEAN CONCRETE 1:4:8
5. CONCRETE MIX M-25 SHALL BE USED IN ALL R.C.C WORK U.N.O
6. HIGH STRENGTH DEFORMED BARS OF YIELD STRENGTH 415 N/MM^2 SHALL BE USED AS REINFORCEMENT IN R.C.C WORK
7. LAP LENGTH OF BARS SHALL BE 42 TIMES OF BAR DIA FOR M 25 CONC
8. CLEAR COVER TO THE MAIN REINFORCEMENT SHALL BE AS FOLLOW
   A. WALL =50 MM
   B. PEDESTAL =40 MM
9. GROUTING (AS PER SPEC)SHALL BE DONE AFTER ERECTION OF STRUCTURE
10. EARTH FILLING SHALL BE COMPACTED WITH APPROVED NON -EXPANSIVE SOIL IN LAYER NOT EXCEEDING 300 MM (FOR ROAD AREA NOT EXCEEDING 200 MM)N TO ACHIEVE MINIMUM 95% O-MAXIMUM DRY DENSITY.
11. ALL STRUCTURE STEEL AND PLATES SHALL HAVE MIN. YIELD STRENGTH 415 N/mm2.
12. WELDING ELECTRODES SHALL BE CONFIRMED TO AWS.
13. ALL WELDING SHALL BE DONE AS PER AWS, AS APPROPRIATE USING ELECTRODE APPROVED MANUFACTURE AND CONFORMING TO AWS APPLICATION.
14. FABRICATION AND ERECTION OF STEEL STRUCTURE WORK SHALL CONFORM TO AWS SPECIFICATION.
15. ALL EDGES SHALL BE FREE FROM BURRS ,SHARP CORNERS ,FINS GOUGES AND OTHER DEFECT
16. ALL STEEL WORK SHALL BE FREE OF WELD SPLATTERED BEFORE SURFACE TREATMENT
17. STRUCTURAL STEEL TO HAVE TWO COATS OF SYNTHETIC ENAMEL PAINTING OF APPROVED COLOR OVER TWO COAT OF RED OXIDE / ZINC CHROMATE PRIMER
18. GRATING AND RUNGS SHALL HAVE MINIMUM 300 MICRON HOT DIP GALVANIZED COATING
19. POLYETHYLENE HOPE SHEET THICKNESS (100 GAUGE ; 0.2 MM THICK) TO BE PROVIDED BELOW P.C.C (1:4:8)
20. JOINT SEALING COMPOUND IN R.C.C SLAB SHALL BE AS PER EIC.
21. BRICK WORK SHALL BE DONE AS PER TENDER SPECIFICATION/ EIC.

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

PROJECT: Glo-Djigbe Industrial Zone, Benin

SUBJECT:

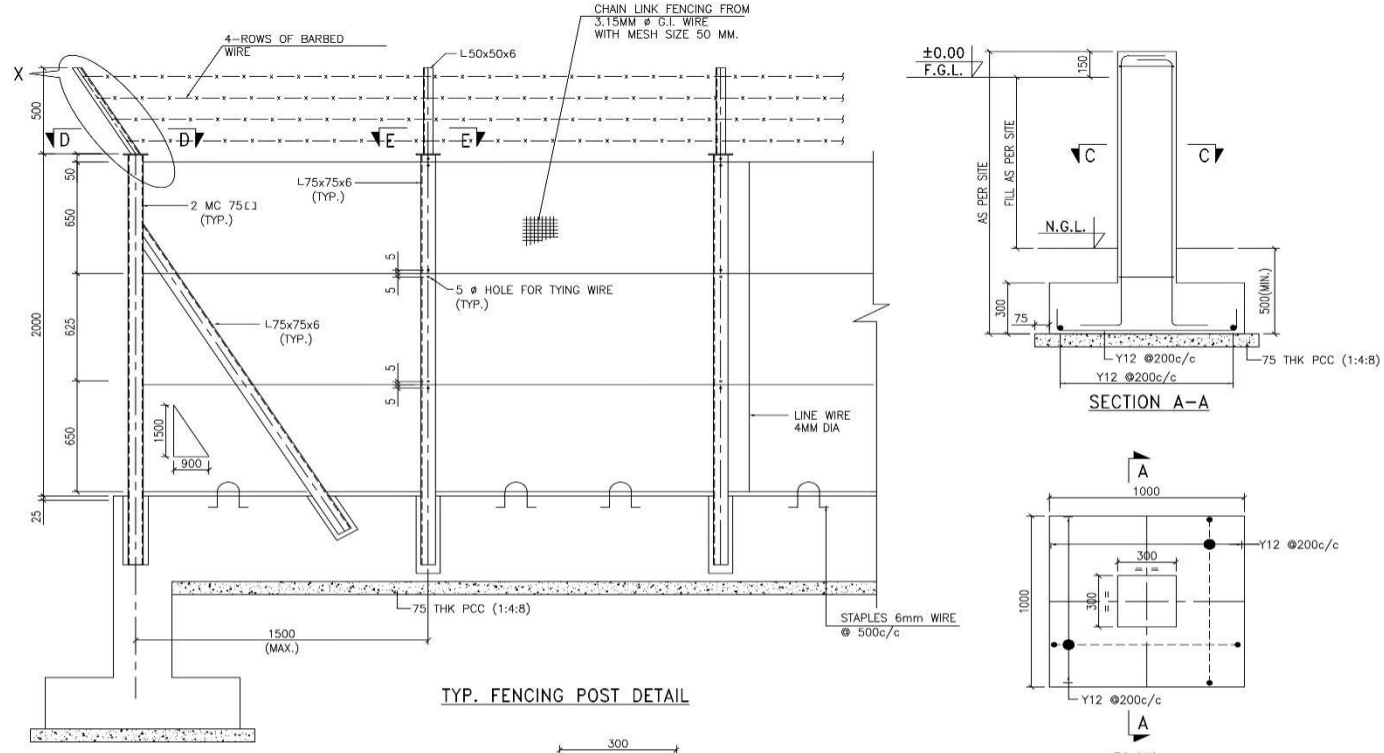
DRAWING FOR PLAN AND REINFORCEMENT DETAIL OF VALVE CHAMBER

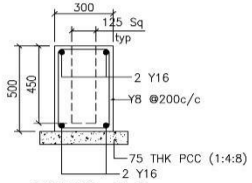
Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

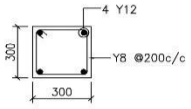
RESONANCE ENERGY PVT. LTD.

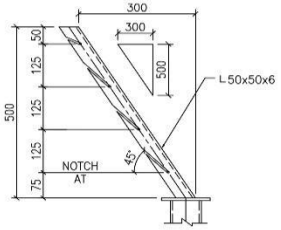
Drawing No. REPL/CGD/STD/CSP-023

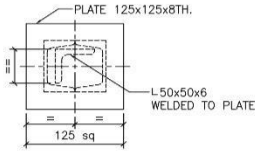
SIPI	**Laying & construction of 12" NB X 30 km and 06" NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**

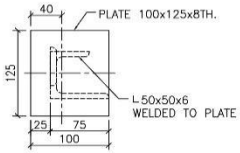


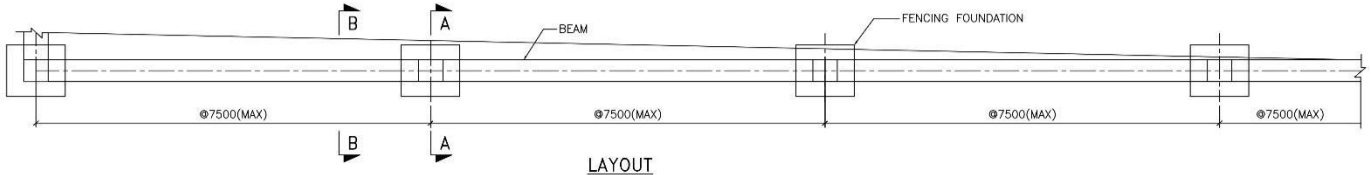












NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. FOLLOW WRITTEN DIMENSIONS ONLY. DO NOT SCALE.

Rev.	Date	Status	Drawn	Checked	Approved
0	12.08.2023	Issued for Bid	VS	KM	VB
	D M Y				

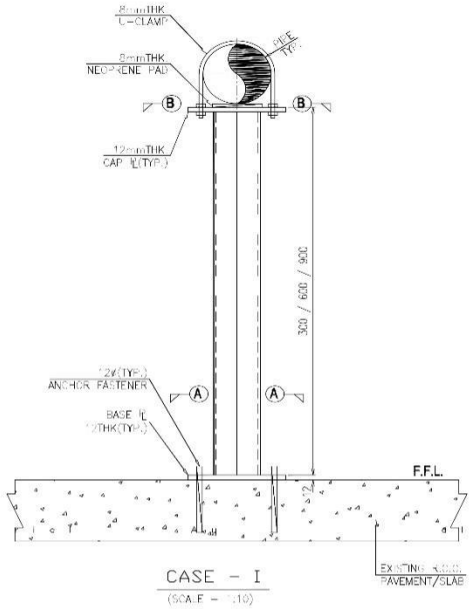
PROJECT: Glo-Djigbe Industrial Zone, Benin

SUBJECT: TYPICAL DETAILS OF FENCING

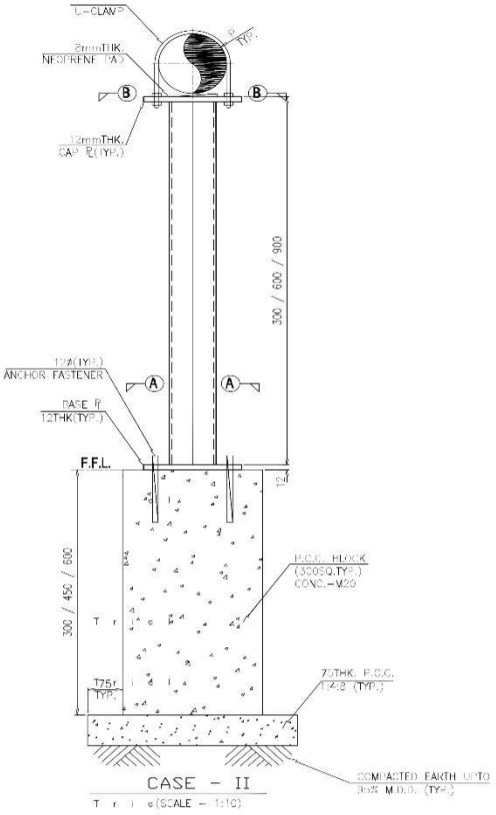
Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

RESONANCE ENERGY PVT. LTD. Drawing No. REPL/CGD/STD/CSP-024

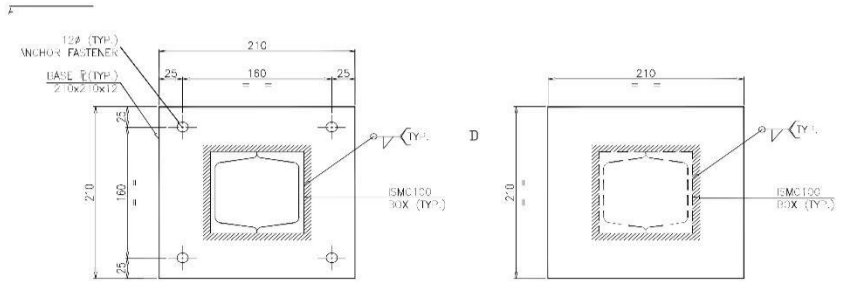
SIPI	**Laying & construction of 12" NB X 30 km and 06" NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**



CASE – I
(SCALE – 1:10)



CASE – II
(SCALE – 1:10)



SECTION DETAILS
(SCALE – 1:5)

SECTION–B
(SCALE – 1:5)

SECTION–A
(SCALE – 1:5)

NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. FOLLOW WRITTEN DIMENSIONS ONLY. DO NOT SCALE.
3. THE PIPE SUPPORTS (CASE -1 & CASE -2) IS APPLICABLE UP TO 8"∅ PIPE ONLY.

Rev.	Date	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB
	D M Y				

PROJECT: Glo-Djigbe Industrial Zone, Benin

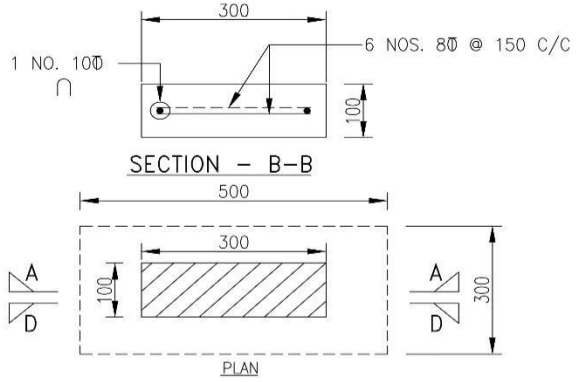
SUBJECT: TYPICAL PIPE SUPPORT DETAIL

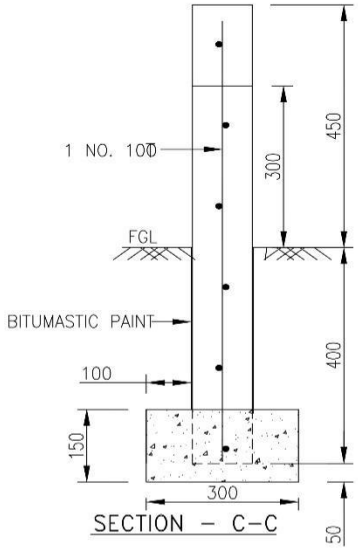
Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

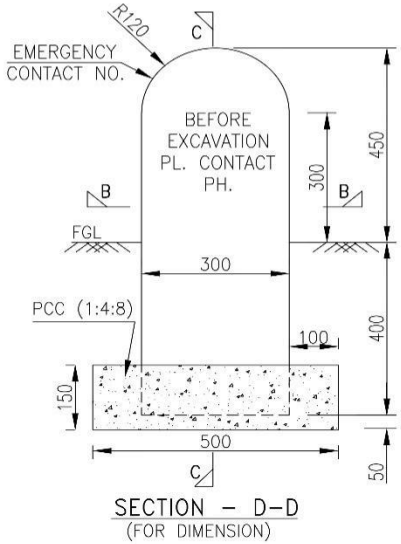
RESONANCE ENERGY PVT. LTD.

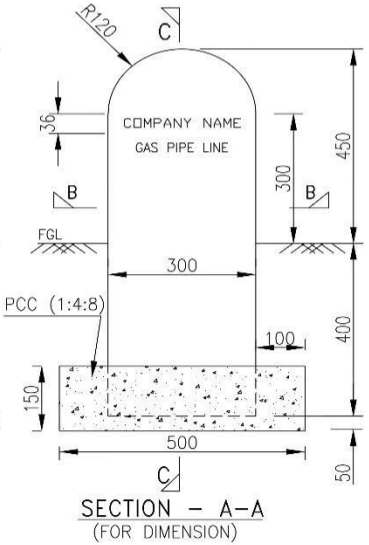
Drawing No. REPL/CGD/STD/CSP-025

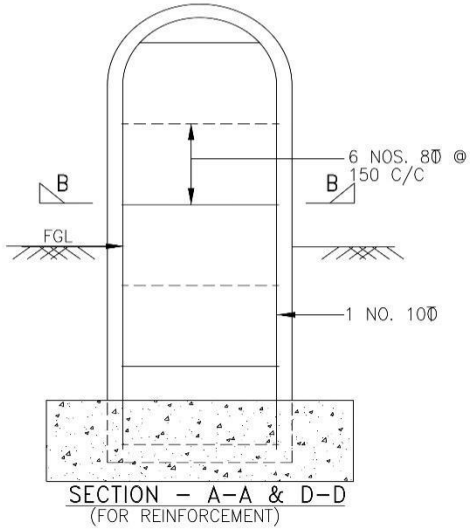
SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**











NOTES:
1. DRAWING IS NOT TO SCALE.
2. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
3. MARKERS SHALL BE INSTALLED IN EVERY 50 METER INTERVAL AS PER INSTRUCTIONS OF ENGINEER-IN-CHARGE.
4. ALL BOUNDARY MARKERS SHALL BE PRECAST & INSCRIPTIONS SHALL BE ENGRAVED 5mm DEEP IN THE MOULD ON BOTH FACE.
5. CONCRETE FOR BOUNDARY MARKER SHALL BE M-20

Rev.	Date	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB
	D M Y				

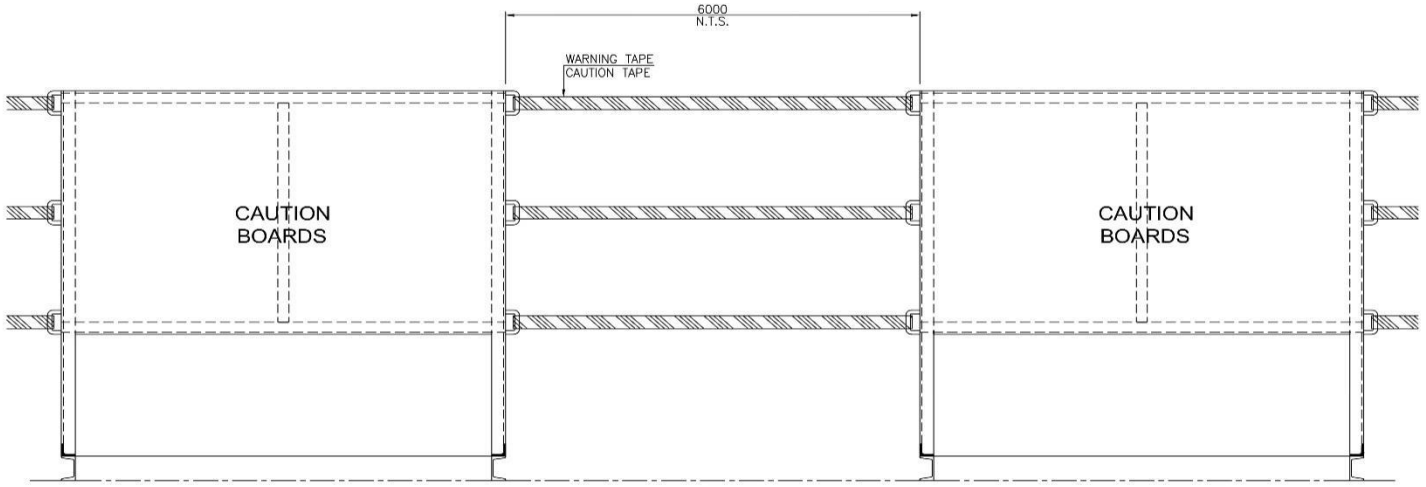
PROJECT: Glo-Djigbe Industrial Zone, Benin

SUBJECT: TYPICAL DETAILS OF RCC ROUTE MARKER

Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

RESONANCE ENERGY PVT. LTD. Drawing No. REPL/CGD/STD/CSP-026

SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **A I I P /REPL/003/STPL**		**Date: 03/08/2023**



SCHEMATIC LAYOUT OF CAUTION BOARDS AND BARRICADDING

NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. FOLLOW WRITTEN DIMENSIONS ONLY. DO NOT SCALE.

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

PROJECT: Glo-Djigbe Industrial Zone, Benin

SUBJECT:

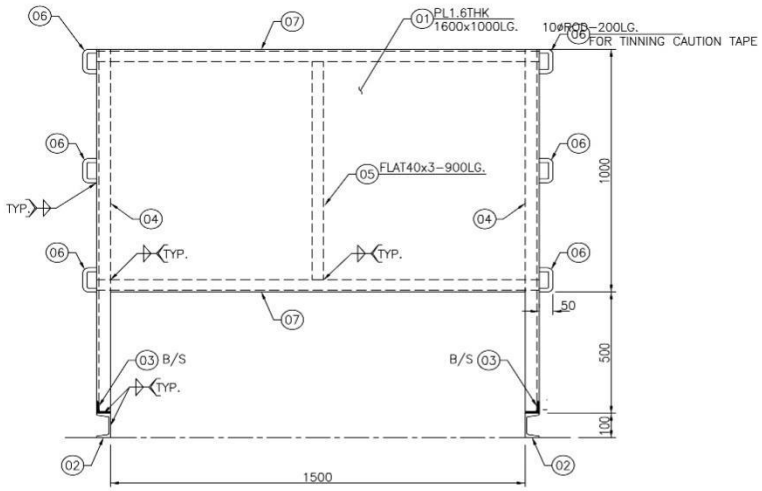
TYPICAL DETAIL OF BARRICADING

Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

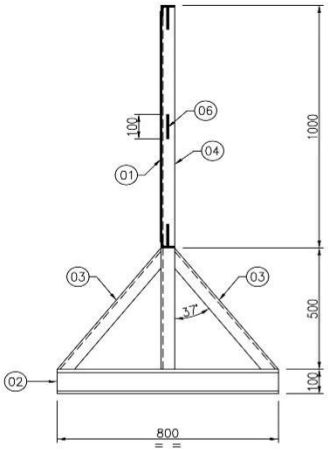
RESONANCE ENERGY PVT. LTD.

Drawing No. REPL/CGD/STD/CSP-027

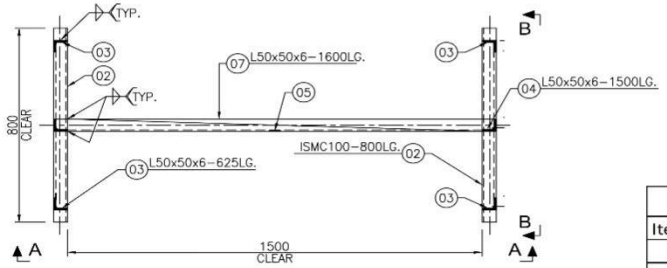
SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**



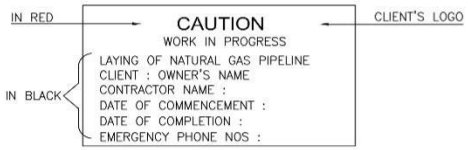
ELEVATION A-A
(SCALE 1:100)



ELEVATION B-B
(SCALE 1:100)



PLAN VIEW
(SCALE 1:100)



(TO BE PRINTED ON BOTH SIDE OF ITEM NO. 01)

BILL OF MATERIAL

Item Mkd.	Section	Width	length	Item Qty. (All Marks)	Weight Kgs/M,M2	In Kgs Total Weight
1	PL 1.6 Thk.	1600	1000	1	12.56	20.1
2	ISMC 100	-----	8000	2	9.2	14.72
3	L50 x 50 x 6	-----	625	4	4.5	11.25
4	L50 x 50 x 6	-----	1500	2	4.5	13.5
5	Flat 3 thk.	40	900	1	0.94	0.03
6	10 dia rod	-----	200	6	0.62	0.74
7	L50 x 50 x 6	-----	1600	2	4.5	14.4
				Grand Total (Kg)		74.74

NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. FOLLOW WRITTEN DIMENSIONS ONLY. DO NOT SCALE.

Rev.	Date	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB
	D M Y				

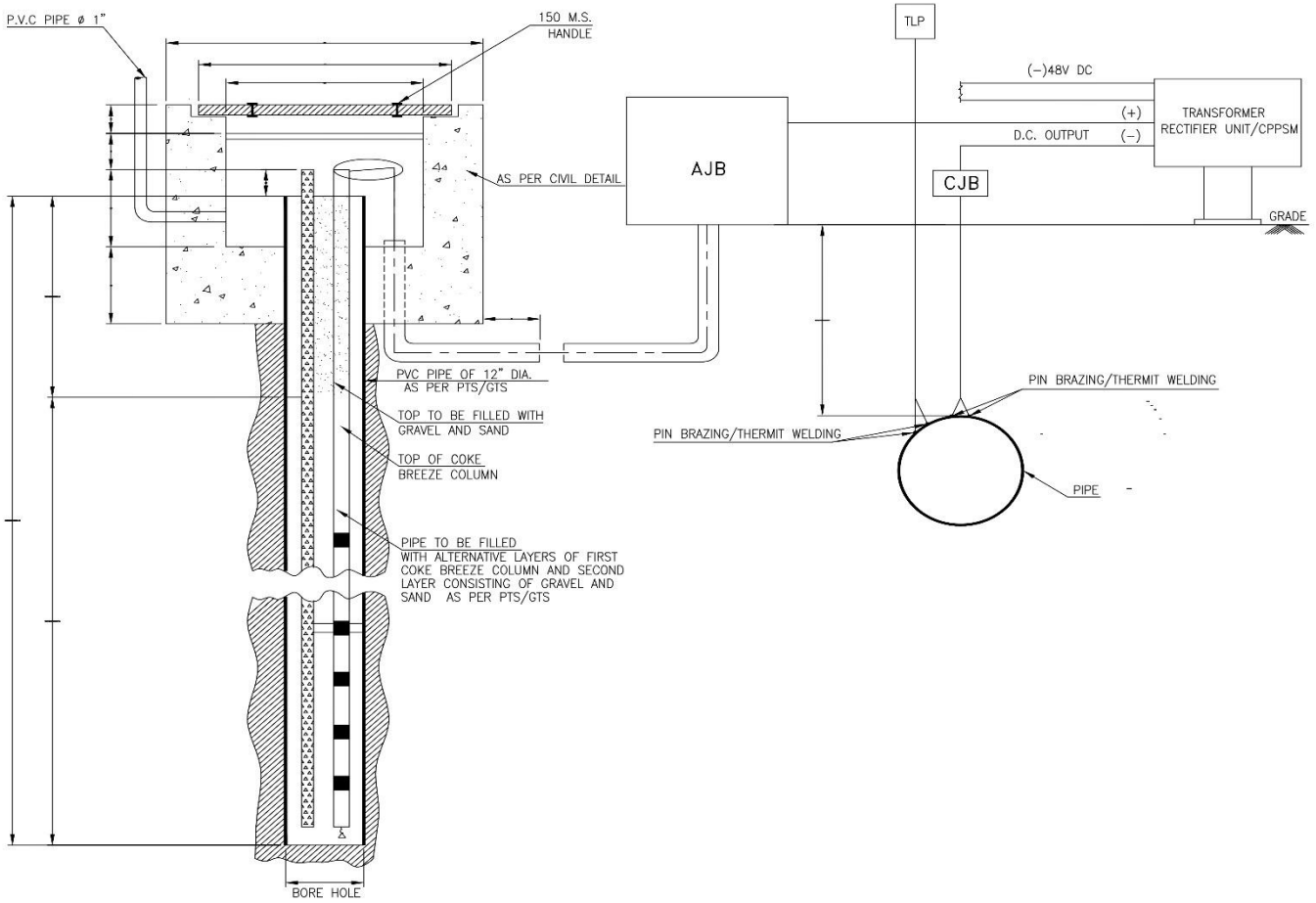
PROJECT: Glo-Djigbe Industrial Zone, Benin

SUBJECT:
TYPICAL DETAIL OF CAUTION BOARD

Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

RESONANCE ENERGY PVT. LTD.

Drawing No. REPL/CGD/STD/CSP-028



30 M DEEP ANODE BED
CONSISTING OF 1 STRING ANODES

NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. FOLLOW WRITTEN DIMENSIONS ONLY. DO NOT SCALE.
3. THESE DIMENSIONS ARE INDICATIVE ONLY. THESE DIMENSIONS MAY BE ALTERED TO SUIT THE SITE REQUIREMENT APPROVED BY EIC.
4. THIS DRAWING FOR INFORMATION AND GUIDANCE ONLY. ACTUAL DRAWING AND DOCUMENT TO BE PREPARED BY CONTRACTOR AND APPROVED FROM OWNER/ CONSULTANT BEFORE EXECUTION OF SAME.
5. ANODE BED TYPE (DEEP WELL OR HORIZONTAL TYPE) SHALL BE FINALISED DURING DETAIL ENGINEERING SUBJECT TO APPROVAL.

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

PROJECT: Glo-Djigbe Industrial Zone, Benin

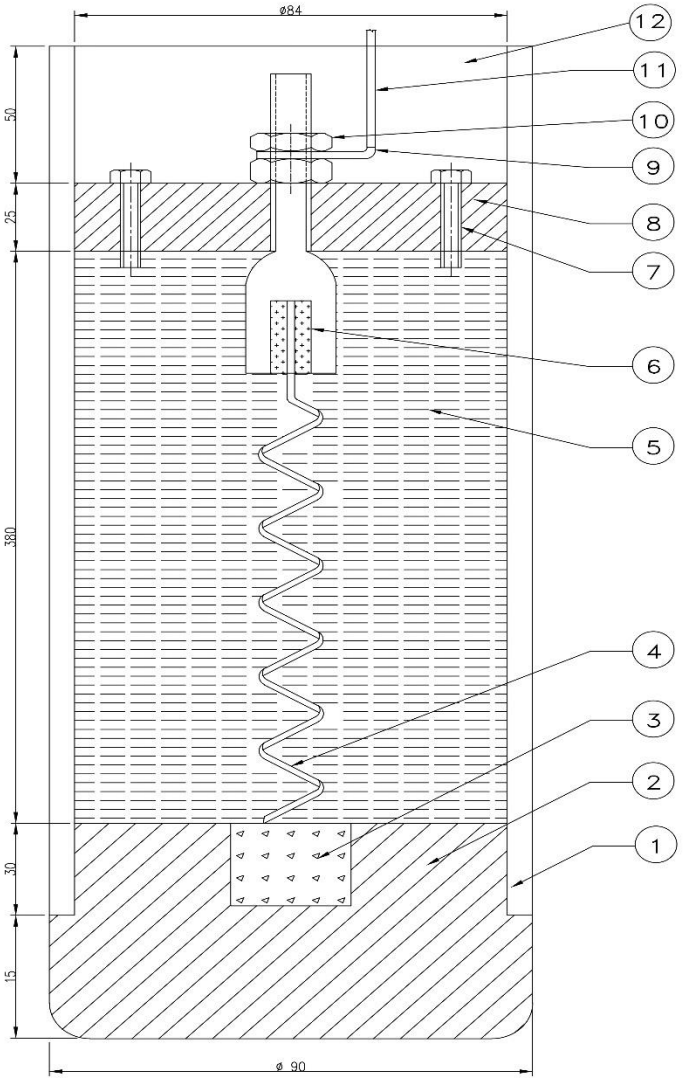
SUBJECT:
IMPRESSED CURRENT CATHODIC PROTECTION SCHEMATIC

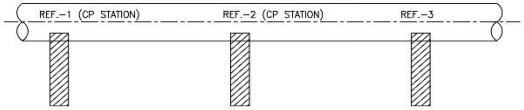
Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

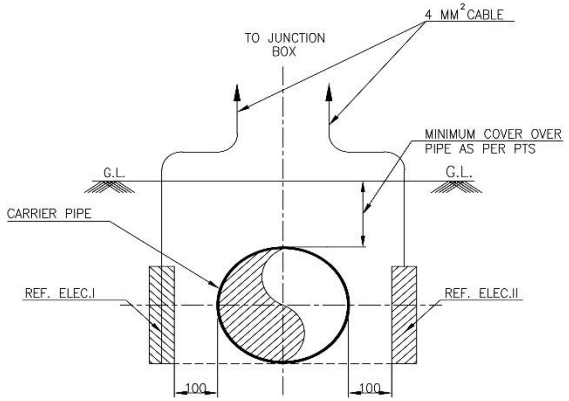
RESONANCE ENERGY PVT. LTD.

Drawing No. REPL/CGD/STD/CSP-029

SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**







ARRANGEMENT OF TWO REFERENCE ELECTRODES ON PIPE LINE TYPICAL INSTALLATION DETAILS

NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. FOLLOW WRITTEN DIMENSIONS ONLY. DO NOT SCALE.
3. THE PIPE ASSEMBLY SHALL BE HOT DIP GALVANISED AFTER FABRICATION.
4. BRICK WORK SHALL BE DONE AFTER COMPACTING THE SOIL.
5. INSTALLED DETAILS FOR PERMANENT CU-CUS04 REFERENCE CELLS AS MENTIONED IN THE DRAWING ARE FOR GUIDANCE ONLY.
6. HOWEVER, INSTALLATION PROCEDURE, DESIGN DRAWING ETC SHALL BE DONE AS PER APPROVAL OF OWNER/CONSULTANT.

BILL OF MATERIAL

SL NO.	DESCRIPTION	QTY.
1.	P.V.C PIPE 3 MM THICK	1 No.
2.	SAG WOOD PLUG	1 No.
3.	$CuSO_4$ CRYSTALS	AS REQD.
4.	ELECTROLYTIC COPPER SPIRAL ø 8 MM	1 No.
5.	$CuSO_4$ SATURATED SOLUTION	AS REQD.
6.	BRAZED COPPER JOINT	1 No.
7.	WATER FILLING BOLTED HOLES ø 8 MM	2 Nos.
8.	HYLAM BUSH	1 No.
9.	COPPER LUG	1 No.
10.	BOLTED CABLE CONNECTION	1 No.
11.	CONNECTION CABLE 10 MM^2	AS REQD.
12.	EPOXY FOR SEALING	AS REQD.

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

PROJECT: Glo-Djigbe Industrial Zone, Benin

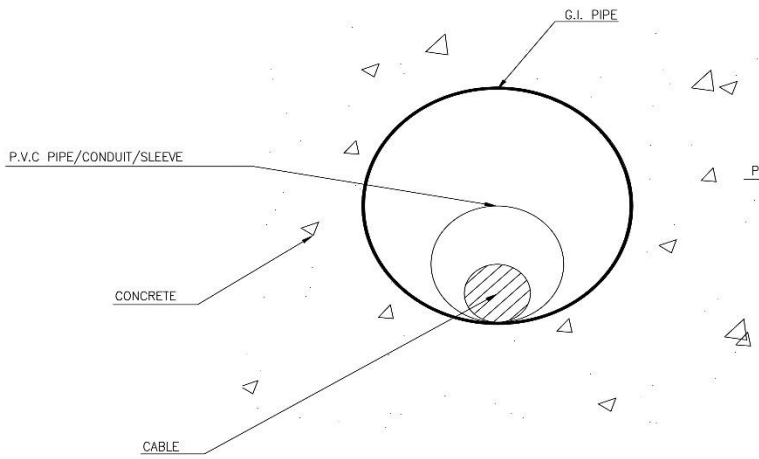
SUBJECT: FABRICATION AND INSTALLATION DETAILS OF CuCuSO4 REFERENCE ELECTRODE

RESONANCE ENERGY PVT. LTD.

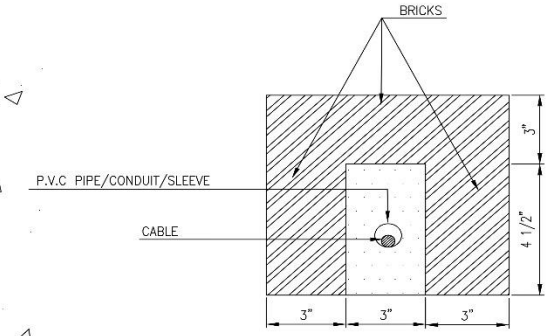
Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

Drawing No. REPL/CGD/STD/CSP-030

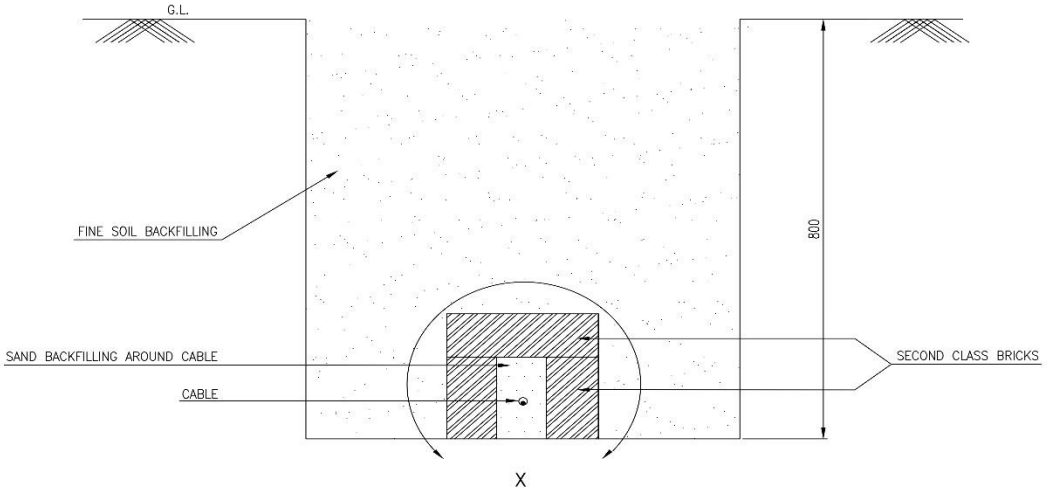
SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**



SECTION VIEW OF CABLE LAYOUT IN CONCRETE



ENLARGED DETAIL–X
FOR NORMAL LAYING IN EARTH



TYPICAL CROSS–SECTION OF CABLE LAYING IN EARTH

NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. FOLLOW WRITTEN DIMENSIONS ONLY. DO NOT SCALE.
3. ALL UNDERGROUND CABLE SHALL BE LAID IN BRICK COVERING WITH SAND BACKFILL.
4. FOR MORE THAN ONE CABLE IN THE SABE CABLE TRENCH, CABLE SHALL BE LAID SIDE BY SIDE IN SEPARATE BRICK COVERING.
5. AT BOTH ENDS OF CABLE TERMINATION, A LOOP OF ONE METER (MINIMUM) SHALL BE KEPT AS SPARE.
6. WHEREVER TERMINATION IN BETWEEN IS REQUIRED, T-JOINTS OR ELBOWS SHALL BE PROVIDED.
7. AT ROAD/NALA CROSSINGS, G.I. PIPE CONDUIT SHALL BE USED.

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

PROJECT: Glo-Djigbe Industrial Zone, Benin

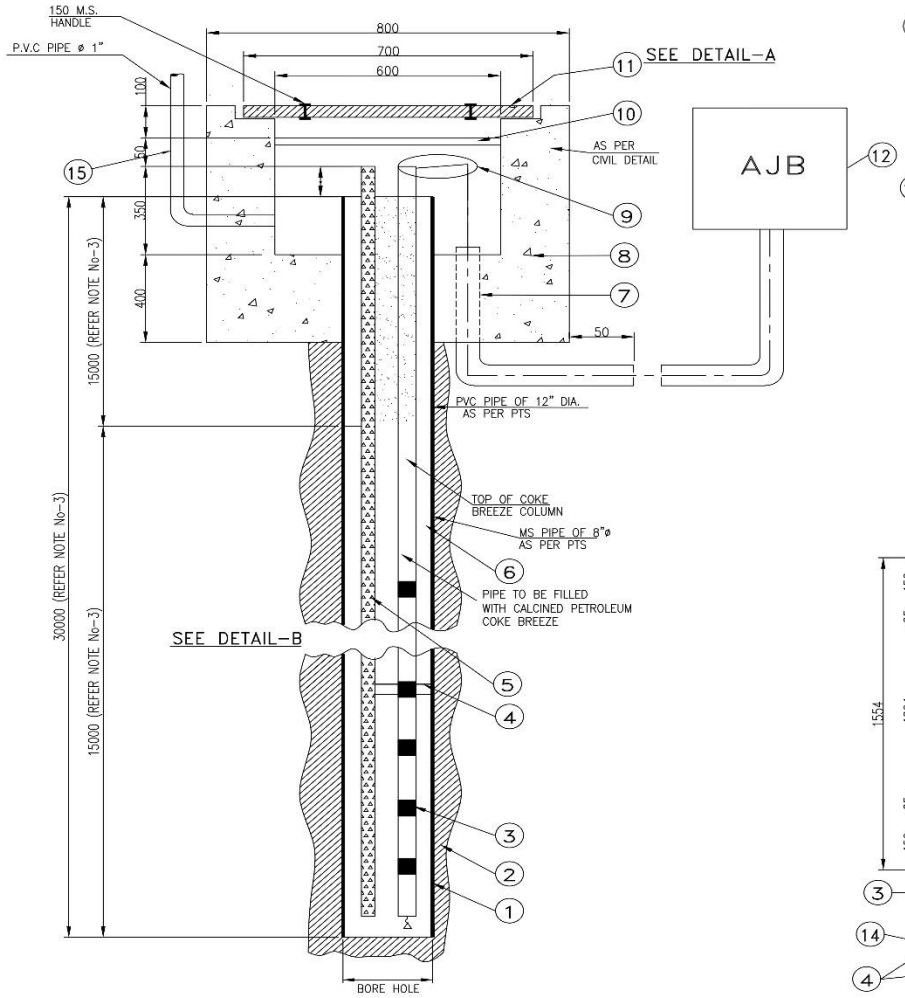
SUBJECT:
FABRICATION AND INSTALLATION
DETAILS OF CABLE LAYING (TYPICAL) FOR CATHODIC PROTECTION

RESONANCE ENERGY PVT. LTD.

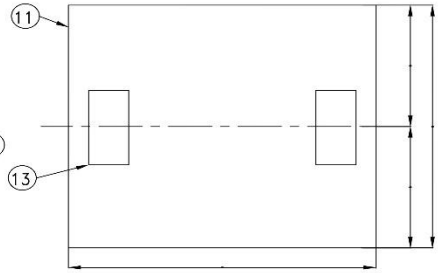
Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

Drawing No. REPL/CGD/STD/CSP-031

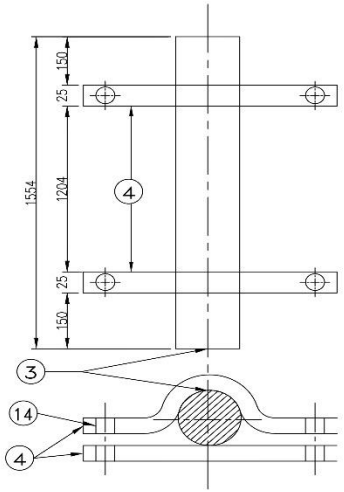
SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**



30 M DEEP ANODE BED (TENTATIVE)
CONSISTING OF 1 STRING ANODES



DETAIL–A
PLAN OF PIT COVER



DETAIL–B
M.S. CENTRALISER CLAMP ARRANGEMENT

NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. FOLLOW WRITTEN DIMENSIONS ONLY. DO NOT SCALE.
3. THESE DIMENSIONS ARE INDICATIVE ONLY. THESE DIMESNIONS MAY BE ALTERED TO SUIT THE REQUIREMENT APPROVED BY EIC.
4. THE MMO ANODE STRING SHALL BE DUAL FEED TYPE.
5. ALL WORK SHALL BE CARRIED OUT BY EXPERIENCED AND QUALIFIED PERSONNEL WITH APPROVED DESIGN AND DRAWING FROM OWNER/CONSULTANT.

BILL OF MATERIAL

SL NO.	DESCRIPTION	QTY.
1.	PVC CASING PIPE OF 12” DIA.	15 Mtrs.
2.	COKE BREEZE	AS REQD.
3.	ANODE SIZE IS 2.5 MM X 1000 MM, OUTPUT OF 8 Amp.	1 STRING MMO
4.	M.S. CENTRALISER	10 Nos.
5.	P.V.C PERFORATED VENT PIPE 1” ø	AS REQD.
6.	CABLE LEADS	1 No.
7.	P.V.C PIPE 100 MM ø	AS REQD.
8.	CONCRETE WORK FOR TOP OF ANODE BED	AS REQD.
9.	CABLE TIE WITH 1/4” NYLON ROPE	AS REQD.
10.	G.I. PIPE 2” ø FOR SUPPORTING CABLE	1 No.
11.	M.S. PLATE TOP COVER	1 No.
12.	ANODE LEAD JUNCTION BOX	1 No.
13.	M.S. LIFTING HANDLES	2 Nos.
14.	M.S. NUT & BOLT	56 Nos.
15.	P.V.C PIPE 4” ø	AS REQD.

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

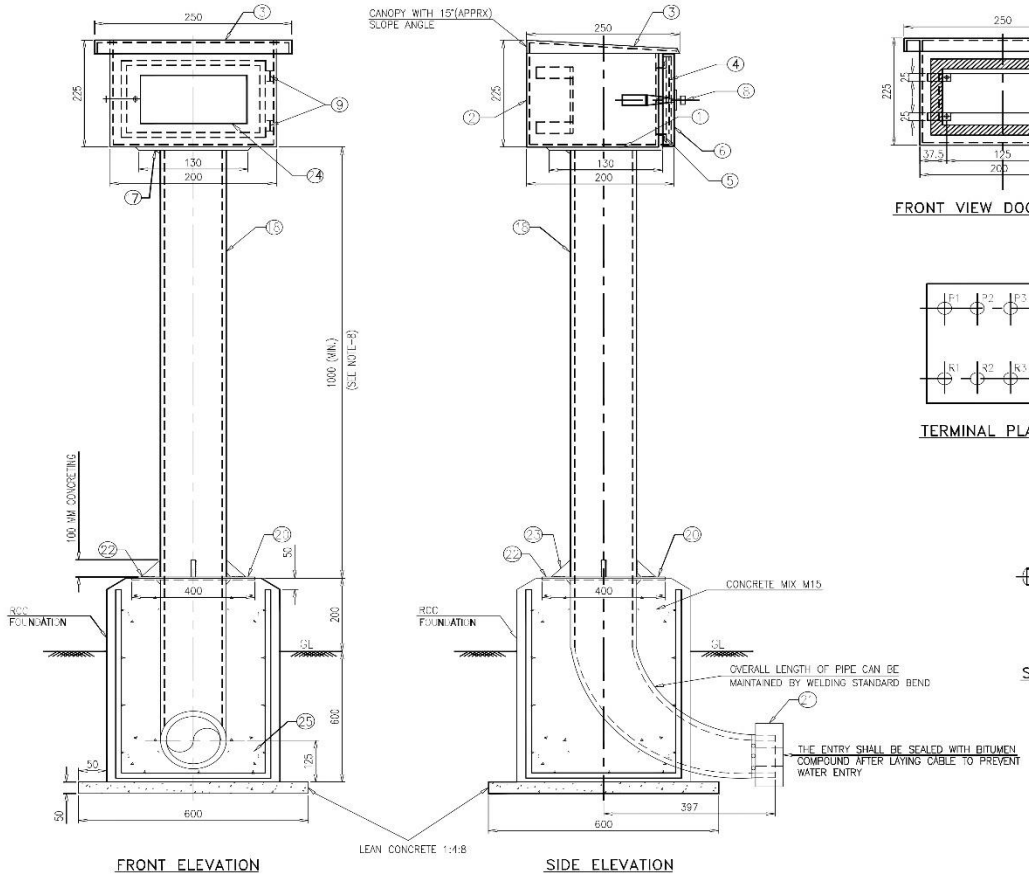
PROJECT: Glo-Djigbe Industrial Zone, Benin

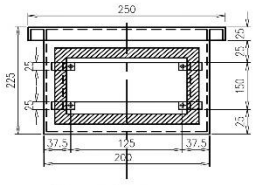
SUBJECT:
FABRICATION AND INSTALLATION
DETAILS OF DEEP ANODE GROUND BED

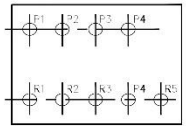
Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

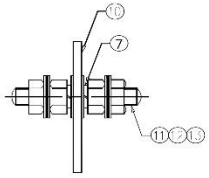
RESONANCE ENERGY PVT. LTD.
Drawing No. REPL/CGD/STD/CSP-032

SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**









NOTES:

1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. FOLLOW WRITTEN DIMENSIONS ONLY. DO NOT SCALE.
3. THE SHUTTER SHALL BE HINGED TYPE WITH CONCEALED LOCK & SHALL HAVE DOOR GASKET TO MAKE THE TEST STATION WEATHER PROOF.
4. THE INNER & OUTER SURFACE OF THE TEST STATION SHALL BE EPOXY PAINTED.
5. THE NAME PLATE SHALL BE ANODISED ALUMINIUM WITH BLACK BACKGROUND & WHITE LETTERS & SHALL BE FIXED TO THE INNER SIDE OF SHUTTER.
6. TEST STATION SHALL BE ERECTED WITH THEIR SHUTTERS PARALLEL TO THE LINE OF AXIS AND FACING THE PIPELINE. THE DIMENSIONS OF THE TEST STATION WILL VARY DEPENDING ON THE TYPE OF THE TEST STATION.
7. THE CHAINAGE OF TEST STATION SHALL BE WRITTEN WITH BLACK PAINT ON THE OUTER SIDE OF FRONT SHUTTER.
8. HEIGHT OF THE TEST STATION SHOWN ABOVE GROUND LEVEL IS MINIMUM ONLY. THE ACTUAL HEIGHT SHALL BE DECIDED BASED ON THE LOCAL FLOOD LEVELS TO BE ASCERTAINED.
9. AFTER INSTALLATION OF FOUNDATION BOLT, 4"(100MM) CONCRETING TO BE DONE ABOVE THE PLATES AS AN EXTENSION OF PCC(M-15) FOUNDATION. TOTAL DEPTH OF THE FOUNDATION SHALL BE 900 MM AND 300 MM ABOVE THE GRADED LEVEL.

BILL OF MATERIAL

SL NO.	DESCRIPTION	QTY.
1.	BOTTOM PLATE, 5THKx194 MS PLATE	1No
2.	REAR & SIDE, 2.67x217x704 MS	1No
3.	TOP, 2.67x250x300 MS	1No
4.	FRONT TOP 2.67 x190x81 MS	1No
5.	FRONT BOTTOM, 2.67x190x81 MS	1No
6.	SHUTTER 2.67x234x234 MS	1No
7.	SPRING WASHER SC. 8.6	66Nos
8.	CASTLE LOCK WITH MASTER KEY (3NOS. KEY)	1No
9.	HINGE FOR SHUTTER	9Nos
10.	TERMINAL PLATE, 8x150x150 PHENOLIC LAM SHT.	1No
11.	BRASS STUD M6x50LONG (FOR TERMINALS)	1No
12.	BRASS NUT M6	44Nos
13.	BRASS WASHER	44Nos
14.	MS. ANGLE 5THKx50x50x30	4Nos
15.	STEEL SCREW, M6x16	4Nos
16.	LATCH FOR SHUTTER	1No
17.	MS COUPLING PLATE, 5THKx130x130 MS PLATE	1No
18.	MS PIPE, 100 NB x 5.4 THKx 1275MM	1No
19.	NEOPRENE RUBBER GASKET 6 THK.	1SET
20.	FOUNDATION PLATE 6THKx400x400	2Nos
21.	RUBBER BUSH	1No
22.	FOUNDATION BOLT M14x125 LONG WITH SPRING WASHER AND NUT	1No
23.	STIFFENER PLATE 6THKx100x100	1No
24.	NAME PLATE ANNODISED AL 0.9x120x160	1No

Rev.					
0	12.06.2023	Issued for Bid	VS	KM	VB
Rev.	D M Y	Status	Drawn	Checked	Approved

PROJECT: Glo-Djigbe Industrial Zone, Benin

SUBJECT:

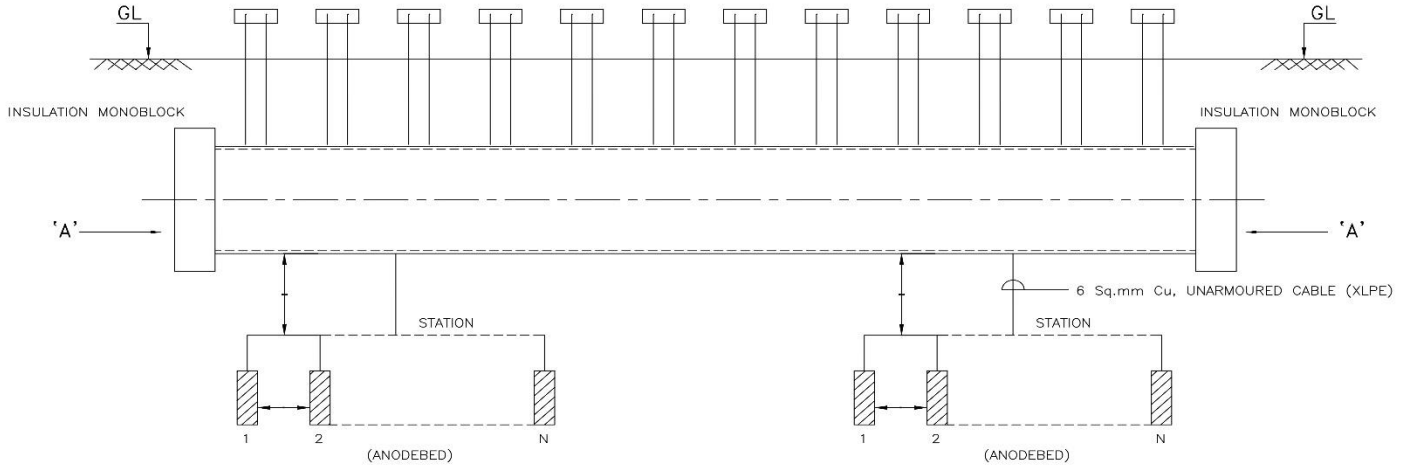
TEST LEAD POINT & JUNCTION BOX WITH FOUNDATION DETAILS

Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

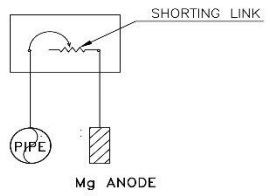
RESONANCE ENERGY PVT. LTD. Drawing No. REPL/CGD/STD/CSP-033

SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**

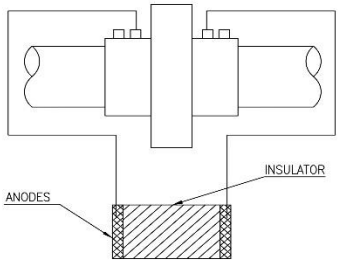
TEST LEAD POINTS (TLP) AT EVERY 1.0 Km.



TLP CONNECTION DETAILS



INSULATION MONOBLOCK



VIEW – 'A'

NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. FOLLOW WRITTEN DIMENSIONS ONLY. DO NOT SCALE.
3. Mg ANODES TO BE INSTALLED AS PER THE APPROVED DESIGN DOCUMENT.
4. ALL NATIVE BACKFILL SOIL SHALL BE FREE OF ROCKS, GARBAGE, PAPERS, PLASTICS ETC.
5. CABLES SHALL BE LAID WITH ENOUGH SLACKNESS TO AVOID DAMAGE TO CABLES DURING BACK FILLING ETC.
6. ANODE TAIL CABLE SHALL NOT BE USED FOR LIGHTING THE ANODE. ROPE SLINGS SHALL BE USED FOR LIFTING THE ANODE DURING INSTALLATION IN TO GROUND BED.
7. THE SCHEME/ SPECIFICATION ARE FOR GUIDANCE ONLY.
8. ANODE CONFIGURATION SHALL BE CONTINUOUS FORWARD/ BACKWARD SEQUENCES (FOR REMOVABLE BONDING) AND TWO ANODE OUTPUT CURRENT SHALL NOT BE LESS THAN 90mA.
9. CABLE LOOP OF 0.5m IS TO BE PROVIDED WITH EACH ANODE.

(a) M.g. ANODE WEIGHT-AS PER SCOPE OF WORK.
(b) TAIL CABLE-MINIMUM 10 MTR. LENGTH SEALING COMPOUND.
(c) COTTON BAG 200x200MM VENDOR TO CONFIRM.
(d) SPECIAL BACK FILL COMPOSITION.
(i) GYPSUM - 75 %
(ii) BENTONITE - 20%
(iii) SODIUM SULPHATE - 5%
(e) ANODE UTILIZATION FACTOR - 85%

10. DRAWING REFER TEST STATION CONNECTION SCHEME TYPE A & A+1.

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

PROJECT: Glo-Djigbe Industrial Zone, Benin

SUBJECT:

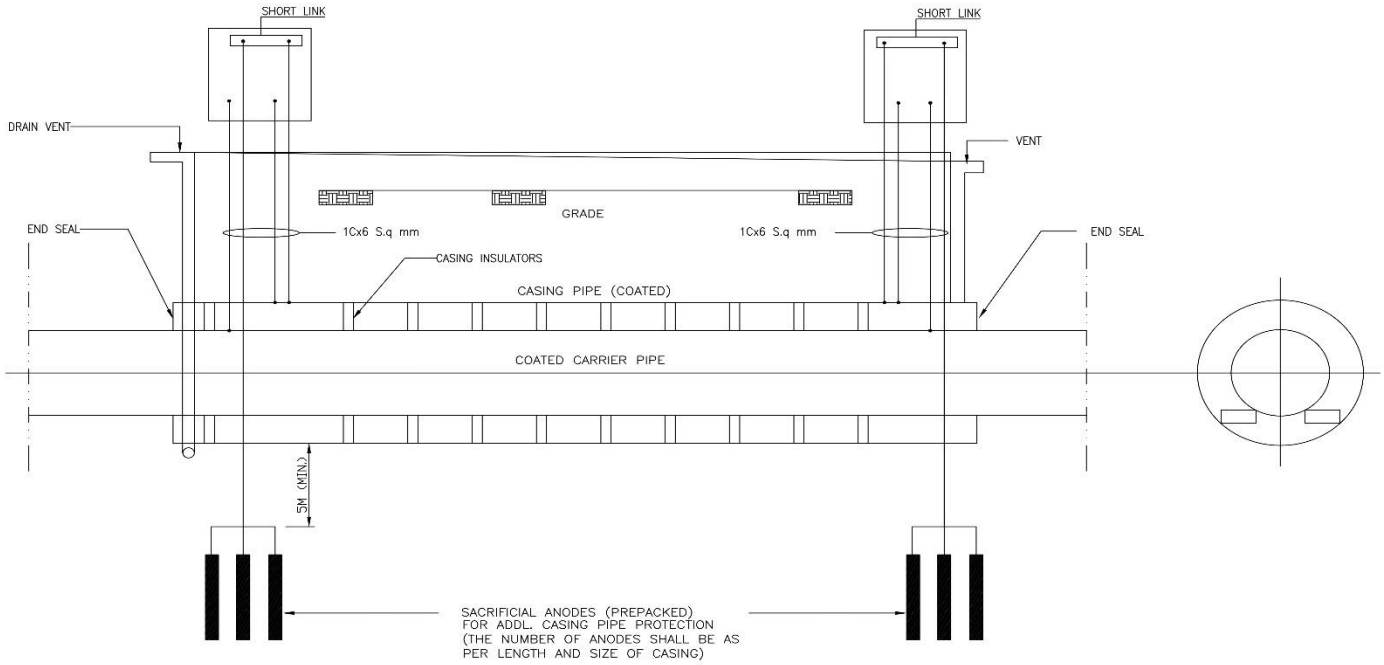
TEMPORARY CATHODIC PROTECTION SCHEMATIC

Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

RESONANCE ENERGY PVT. LTD.

Drawing No. REPL/CGD/STD/CSP-034

SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**



NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. FOLLOW WRITTEN DIMENSIONS ONLY. DO NOT SCALE.
3. CASING PIPE: SACRIFICIAL ANODE SHALL BE PROVIDED AT BOTH ENDS OF CASING PIPE FOR PROTECTION.
4. THE ANNULAR SPACE BETWEEN CASING AND CARRIER PIPE SHOULD BE FILLED WITH DIELECTRIC MATERIAL LIKE PETROLEUM WAX OR PETROLEUM BASED COMPOUNDS AS SPECIFIED IN NACE SPO200-2014.
5. THIS DRAWING FOR GUIDANCE ONLY. HOWEVER, CONTRACTOR TO PREPARE SEPARATE DRAWING, SPECIFICATION AND PROCEDURE FOR APPROVAL FROM OWNER/ CONSULTANT.

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

PROJECT: Glo-Djigbe Industrial Zone, Benin

SUBJECT:

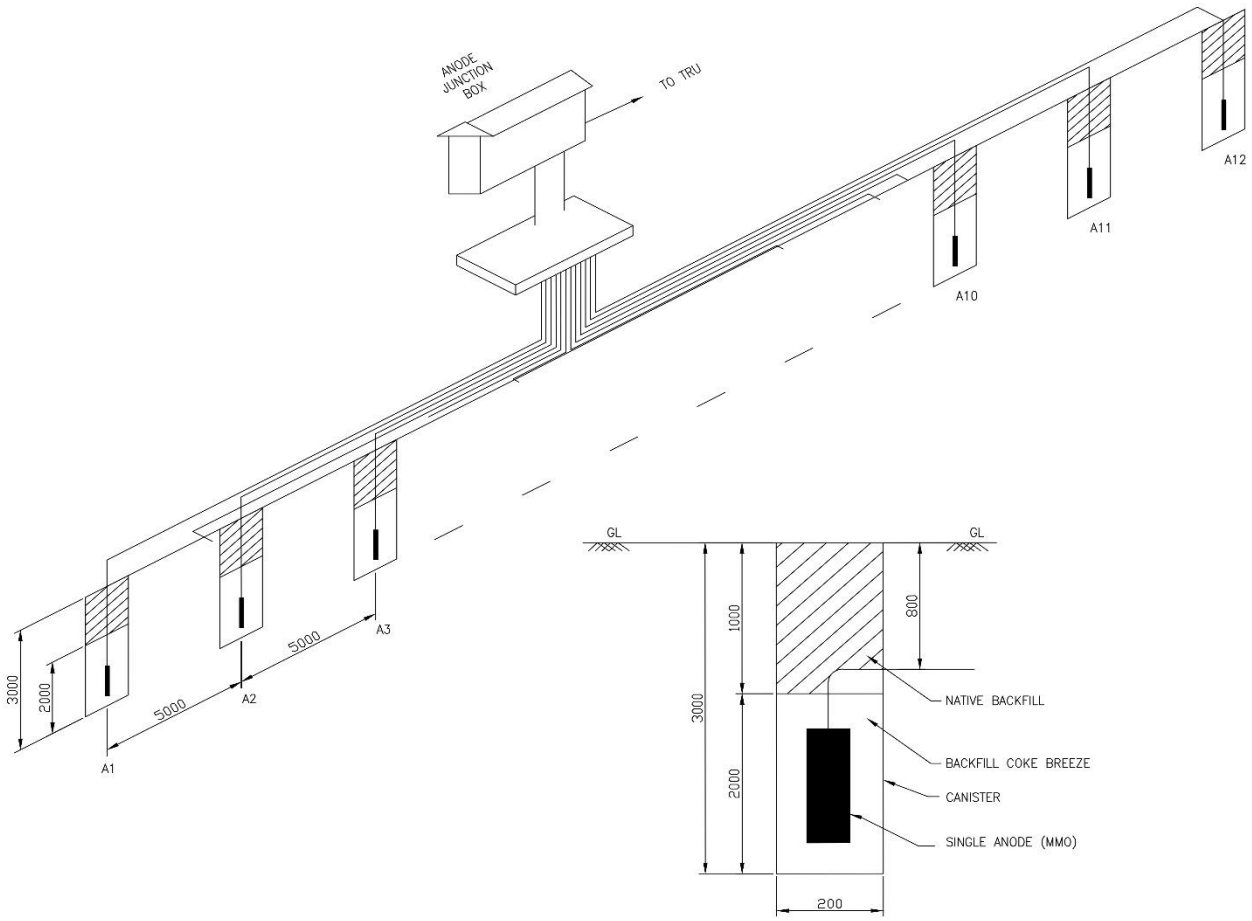
TYPICAL CATHODIC PROTECTION
SCHEME FOR CASED CROSSINGS

RESONANCE ENERGY PVT. LTD.

Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

Drawing No. REPL/CGD/STD/CSP-035

SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP /REPL/003/STPL**		**Date: 03/08/2023**



NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. FOLLOW WRITTEN DIMENSIONS ONLY. DO NOT SCALE.
3. THESE DIMENSIONS ARE INDICATIVE ONLY. THESE DIMENSIONS MAY BE ALTERED TO SUIT THE SITE REQUIREMENT.
4. QUANTITY OF ANODE SHALL BE FINALISED DURING DETAIL ENGINEERING BY APPROVAL OF OWNER AND CONSULTANT.
5. MMO ANODE SHALL BE INSTALLED IN CANISTER.
6. SPECIFICATION MENTIONED FOR GUIDANCE.

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

PROJECT: Glo-Djigbe Industrial Zone, Benin

SUBJECT:

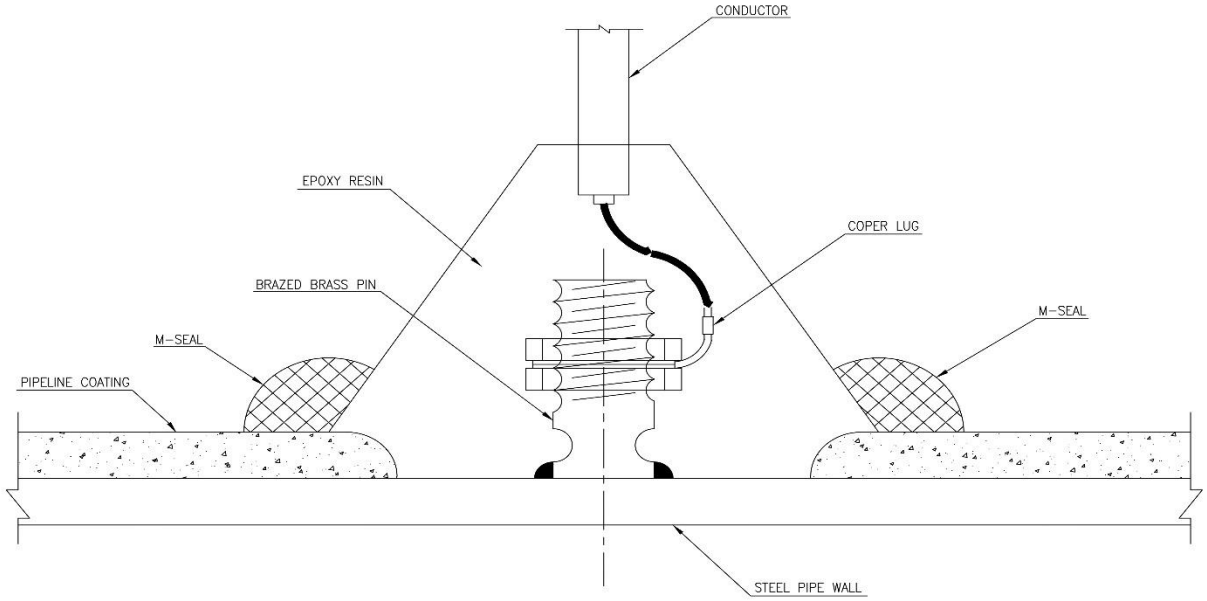
INSTALLATION DETAILS OF VERTICAL SHALLOW ANODE BED

Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

RESONANCE ENERGY PVT. LTD.

Drawing No. REPL/CGD/STD/CSP-036

SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**



NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. FOLLOW WRITTEN DIMENSIONS ONLY. DO NOT SCALE.
3. THE CABLE WILL BE FIXED TO THE PIPELINE AT AN ANGLE TO FACILITATE LAYING OF THE CABLE ALONG THE PIPELINE.
4. TEST CERTIFICATE & BATCH NOS. OF PINS TO BE RECORDED.
5. THE PIN BRAZING TO HAVE THE FOLLOWING CHARACTERISTICS:
   (a) EXTREMELY LOW CONTACT RESISTANCE : ≤ 0.1 Ω
   (b) LOW TRANSITION RESISTANCE : 7.5 TO 14 MΩ PER BRAZED UNIT
   (c) HIGH MECHANICAL STRENGTH : BINDING STRENGTH 490 N/mm^2 SHEAR STRENGTH 245 N/mm^2
   (d) BRAZING TEMPERATIRE : 500 C
   (e) TIME PER BRAZE : 2 SECONDS
   (f) WEATHER EFFECT : SUITABLE FOR ALL WEATHER OPERATION
   (g) LIFE : 40 YEAR
   (h) FIELD TEST : CABLE CONNECTION THROUGH PIN BRAZING TO BE FIELD TESTED FOR CONTACT RESISTANCE & TEMPERATURE ETC.
6. ACTIVITY TO BE DONE BEFORE HYDROSTATIC TESTING OF PIPELINE.

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

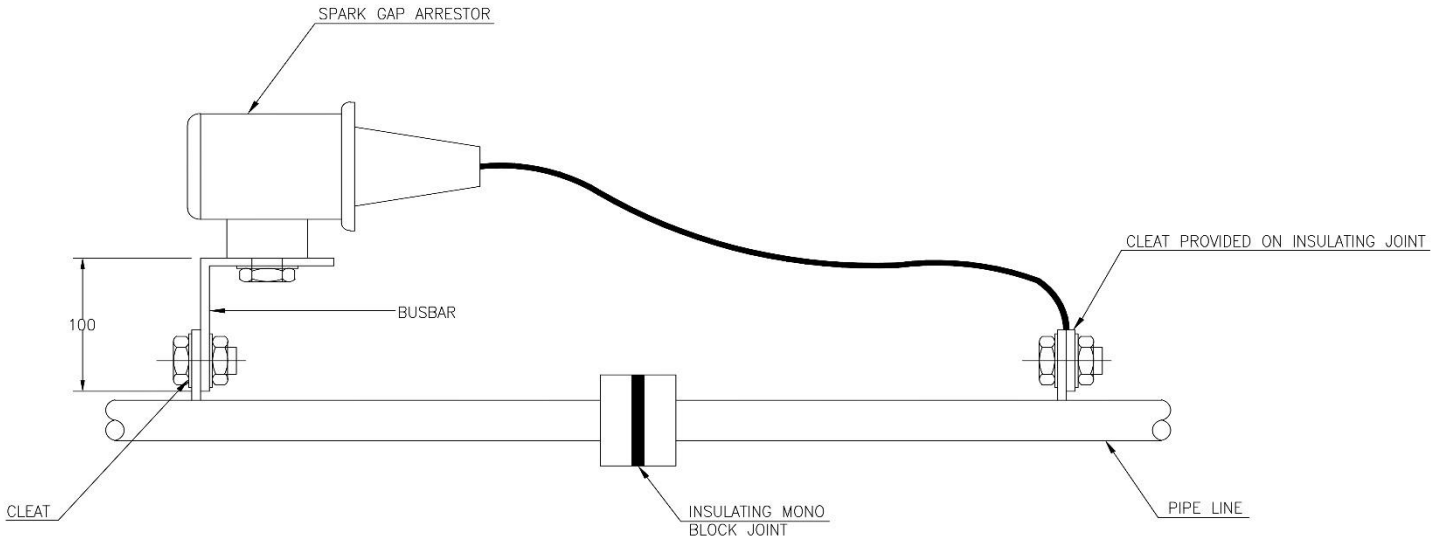
PROJECT: Glo-Djigbe Industrial Zone, Benin

SUBJECT:
CABLE TO PIPE CONNECTION
BY PIN BRAZING

Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

RESONANCE ENERGY PVT. LTD.

Drawing No. REPL/CGD/STD/CSP-037



NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. FOLLOW WRITTEN DIMENSIONS ONLY. DO NOT SCALE.
3. THIS DRAWING FOR INDICATIVE ONLY.

S.No.	DESCRIPTION	QTY.
1	TINNED COPPER BUS BAR 25mm X 3mm THK 550mm LONG 90°SMOOTH BEND AT 100mm AT ONE END BOTH END WILL HAVE M12 HOLES	1
2	TINNED COPPER BUS BAR 25mm X 3mm THK 'L' SHAPE BEND AT CENTER FOR TOTAL LENGTH 200mm TO BE DIVIDED IN TWO PART BOTH END WILL HAVE M12 HOLES	1
3	2 NOS M 10 SIZE BRASS NUT BOLTS, WASHERS 2 NOS NUT BOLTS ARE PROVIDED WITH EACH SPARK GAP ARRESTOR.	2

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

PROJECT: Glo-Djigbe Industrial Zone, Benin

SUBJECT:

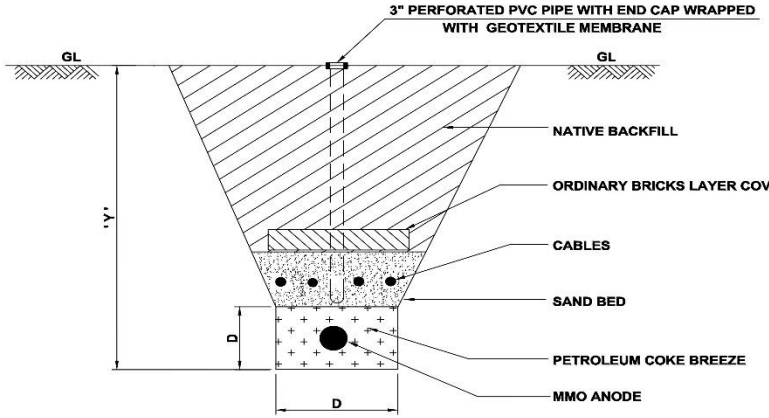
SPARK GAP ARRESTOR INSTALLATION

RESONANCE ENERGY PVT. LTD.

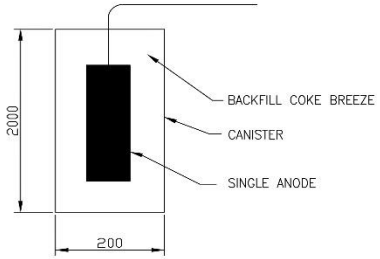
Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

Drawing No. REPL/CGD/STD/CSP-038

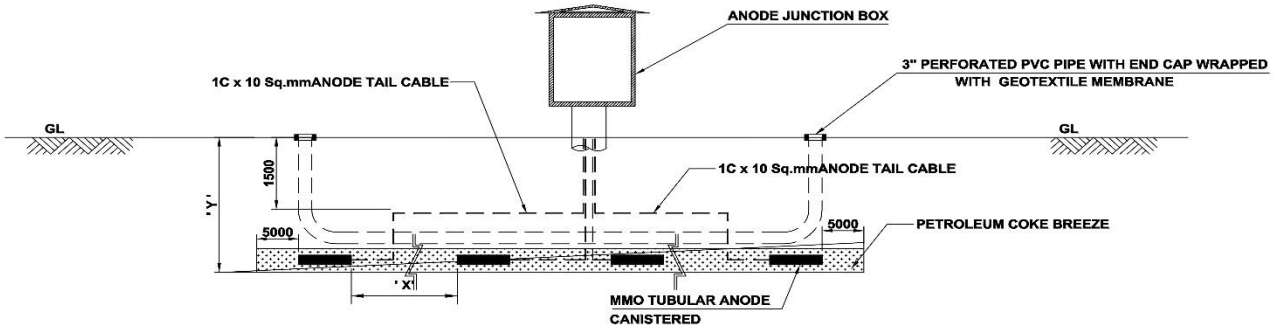
SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**



SIDE VIEW FOR DETAIL FOR HORIZONTAL ANODE GROUND BED INSTALLATION



PRE PACKAGED CANISTER ANODE



HORIZONTAL ANODE GROUND BED

Y	DEPTH OF ANODE BED(Mtr)
X	DISTANCE BETWEEN ANODE

NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. NO. OF ANODE SHALL BE AS PER CP DESIGN REQUIREMENT.
3. DEPTH AREA & LENGTH OF ANODE BED INSTALLATION & ANODE DIMENSIONS SHALL BE IN LINE WITH DESIGN.
4. ALL ANODE SHALL BE INSTALLED WITH CANISTER.
5. AJB SHALL BE KEPT AS PER SITE SUITABILITY & ACCESS & NOT NECESSARILY AT CENTER OF ANODE BED.
6. DISTANCE BETWEEN ANODE TO ANODE SHALL BE AS PER DESIGN APPROVAL.
7. SHEET STEEL CANISTER SHALL BE 22 SWG, 200 MM DIA AND 2000 MM LONG.
8. DEPTH OF ANODE BED SHALL BE AS PER DESIGN APPROVAL ON CASE TO CASE.
9. ANODE TAIL CABLE SHALL BE LAID THROUGH SUITABLE FLEXIBLE PVC PIPE.
10. 3" DIA PERFORATED PVC PIPE WITH CAP WRAPPED WITH GEOTEXTILE MEMBRANE SHALL BE INSTALLED FOR WATERING THE GROUND BED.
11. SPECIFICATION MENTIONED FOR GUIDANCE ONLY.
12. IDENTIFICATION OF ANODE:
    FIRST FIGURE - NO. OF Cp. STN.
    SECOND FIGURE - No OF ANODE ROW
    THIRD FIGURE - ITS OWN SERIAL STARTING SEQUENTIALLY.

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

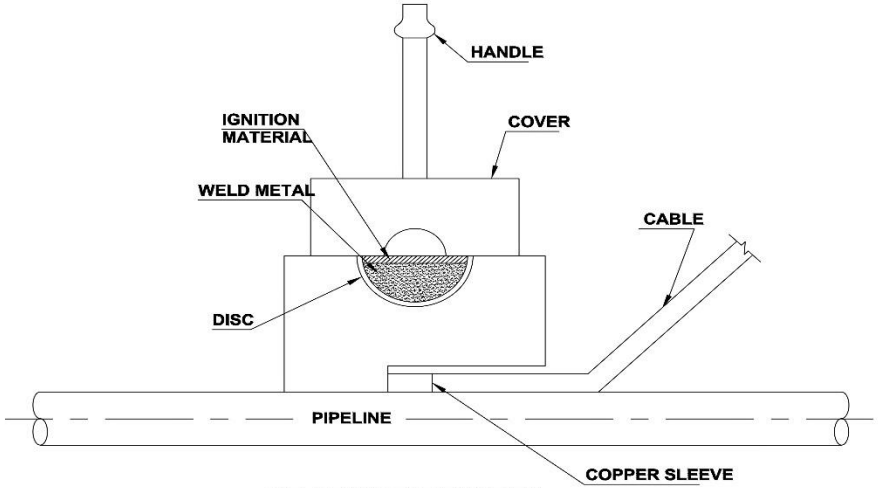
PROJECT: Glo-Djigbe Industrial Zone, Benin

SUBJECT:
TYPICAL INSTALLATION DETAILS OF SHALLOW HORIZONTAL ANODE BED

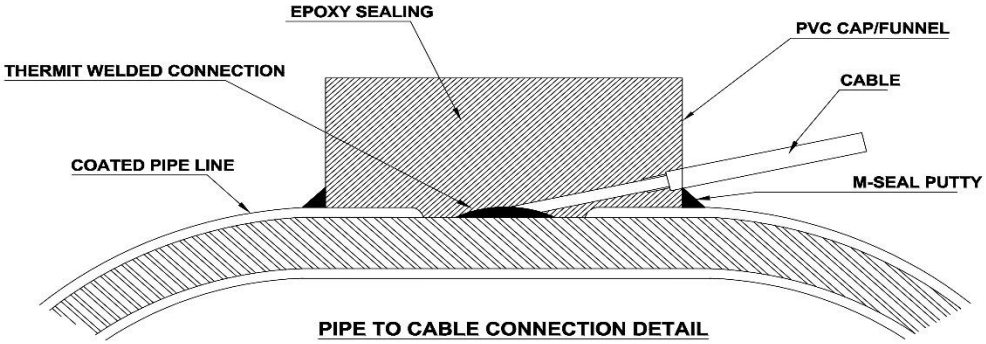
Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

RESONANCE ENERGY PVT. LTD.

Drawing No. REPL/CGD/STD/CSP-039



WELDED CABLE POSITION



PIPE TO CABLE CONNECTION DETAIL

NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. FOLLOW WRITTEN DIMENSIONS ONLY. DO NOT SCALE.
3. THE CABLE WILL BE FIXED TO THE PIPELINE AT AN ANGLE TO FACILITATE LAYING OF THE CABLE ALONG THE PIPELINE.
4. TEST CERTIFICATE & BATCH NOS OF PINS TO BE RECORDED.
5. AT LOCATION OF THERMIT WELD CONNECTION REMOVE 50mm x 50mm SQUARE OF THE PIPELINE COATING, EXPOSED AREA OF PIPELINE SHALL BE FILLED TO BRIGHT METAL AND BE FREE OF RUST, PAINT, DIRT, GREASE AND MOISTURE.
6. WELD METAL SIZE SHALL DEPEND ON THE SIZE OF CABLE.
   (a) 4 Sq. mm - 16 Sq. mm - CA-15
   (b) 16 Sq. mm - 35 Sq. mm - CA 32
7. ACTIVITY TO BE DONE BEFORE HYDROSTATIC TESTING OF PIPELINE.

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

PROJECT: Glo-Djigbe Industrial Zone, Benin

SUBJECT: THERMIT WEDING DETAILS

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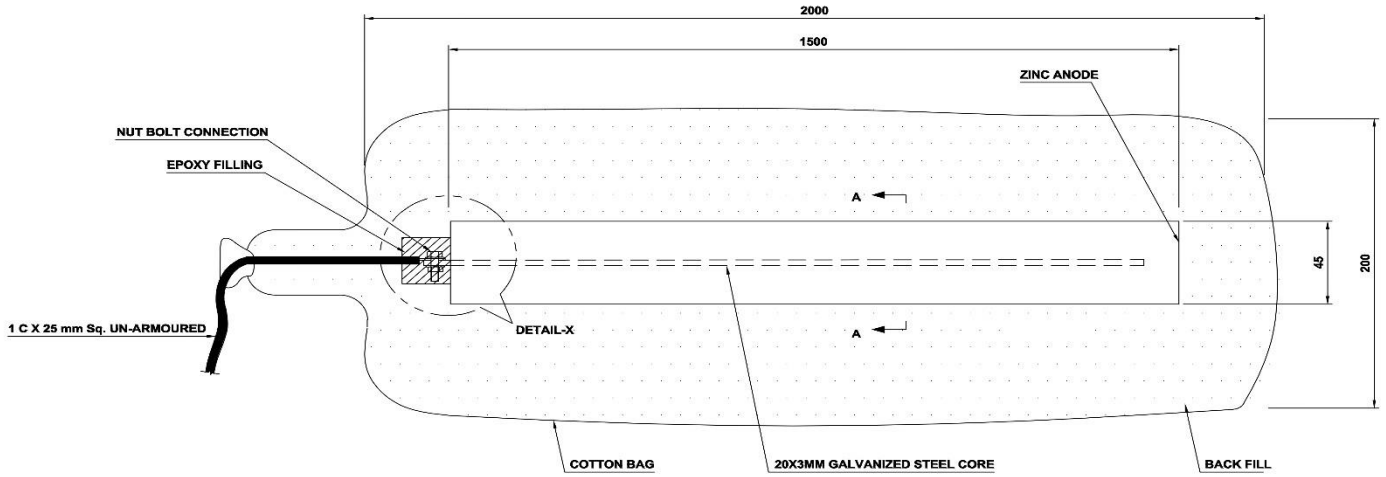
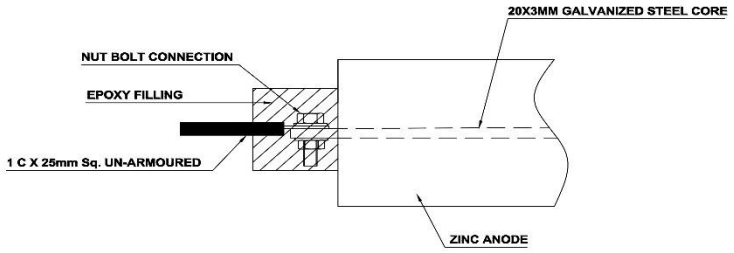
Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

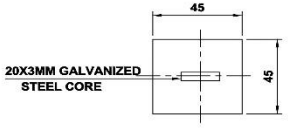
Drawing No. REPL/CGD/STD/CSP-040

SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**





DETAIL-X



SECTION-A-A

NOTES:
1. THE DIMENSIONS ARE INDICATIVE.
2. PROVIDE BILL OF MATERIAL FOR ZINC GROUNDING CELL AND ACCEPTABLE CHEMICAL COMPOSITION.
3. ZINC ANODE SHALL BE PROVIDED ACROSS INSULATING JOINT AND HIGH TENSION LINE CROSSING.
4. (a)Pre packed weight 110kg.
   (b)Open circuit potential -1.05 to -1.11 (w.r.t. Cu-Cuso4)
   (c)Current capacity 750 Amp Hrs/Kg.
   (d)Actual consumption 11.2 Kg/Amp Year.

BACKFILL COMPOSITION	
GYPSUM	75%
BENTONITE	20%
SODIUM SULPHATE	5%

TOLERANCE	
LENGTH :	+/- 2.5%
WIDTH :	+/- 5%
THICKNESS :	+/- 5%

DETAILS OF BARE ANODE			DETAILS OF PREPACKED ANODE		
NET BARE WEIGHT	LENGTH	SIZE	PREPACKED WEIGHT	LENGTH	DIA
20 Kg	1500mm	45 x 45 mm	110 Kg APPROX.	2000mm	200 mm

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

PROJECT: Glo-Djigbe Industrial Zone, Benin

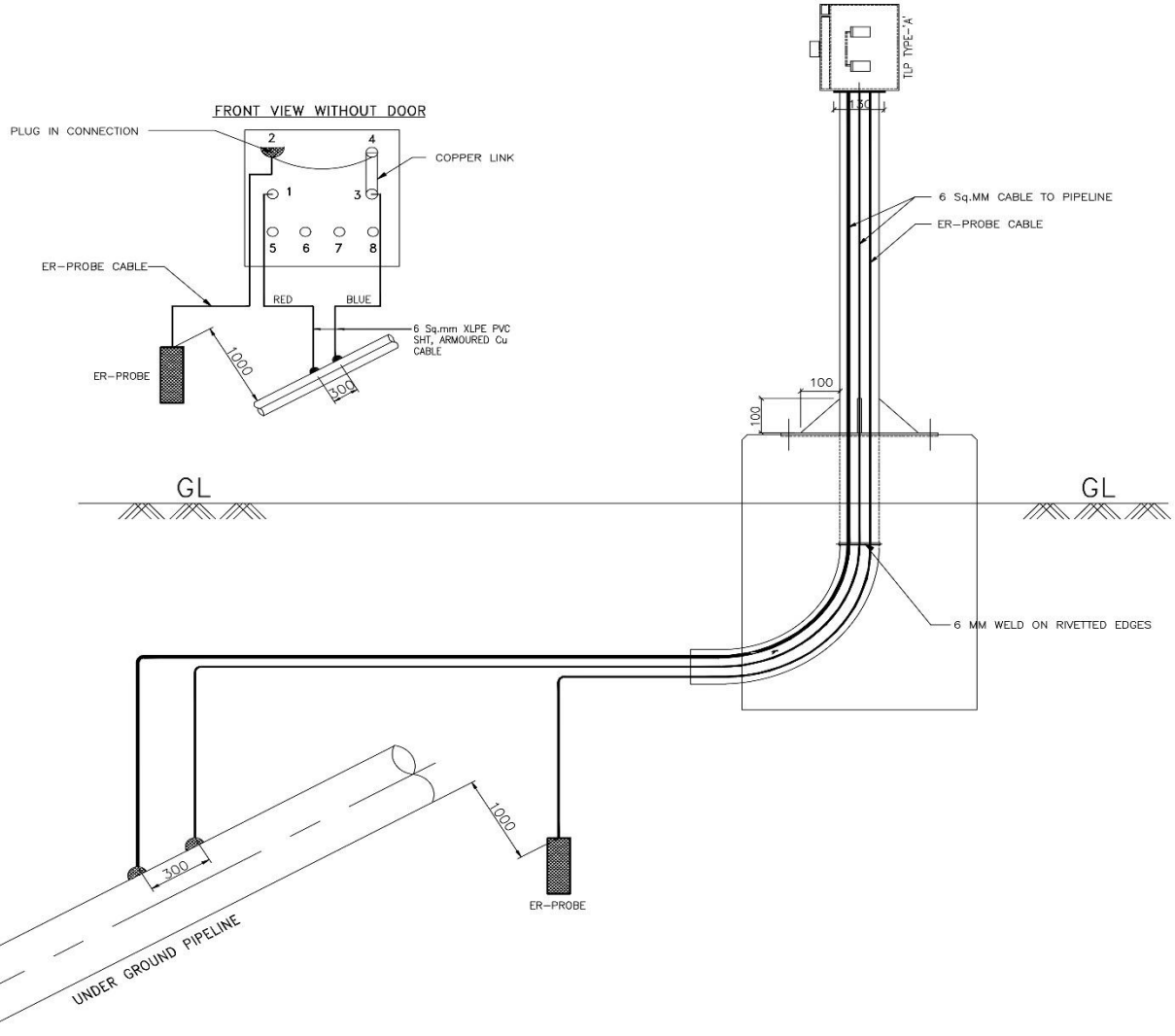
SUBJECT: CONSTRUCTION DETAILS OF ZINC GROUNDING CLL (20 kg)

Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

RESONANCE ENERGY PVT. LTD.

Drawing No. REPL/CGD/STD/CSP-041

SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**



NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. INSTALLATION DETAILS INDICATED IN THE DRAWING IS INDICATIVE. VENDOR SHALL DEVELOP THEIR OWN INSTALLATION DRAWING BASED ON THE RECOMMENDATION OF MANUFACTURER.
3. SIZE OF THE TLP SHALL BE SUITABLE TO ACCOMMODATE DIGITAL PORTABLE READER FOR ER PROBE.

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

PROJECT: Glo-Djigbe Industrial Zone, Benin

SUBJECT:
TYPICAL INSTALLATION AND CONNETION
DETAILS OF EXTERNAL ER PROBE WITH TEST STATION

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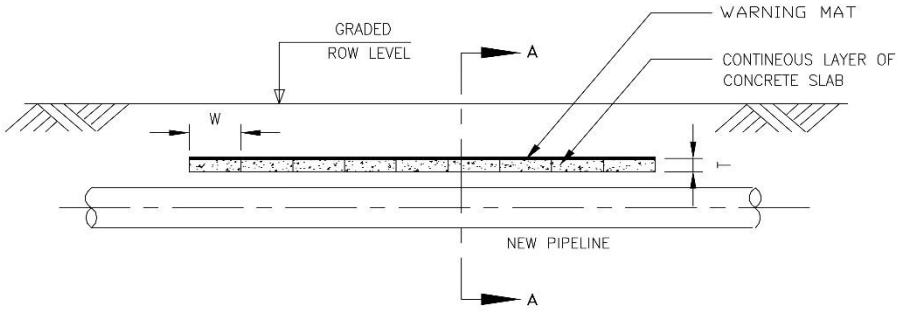
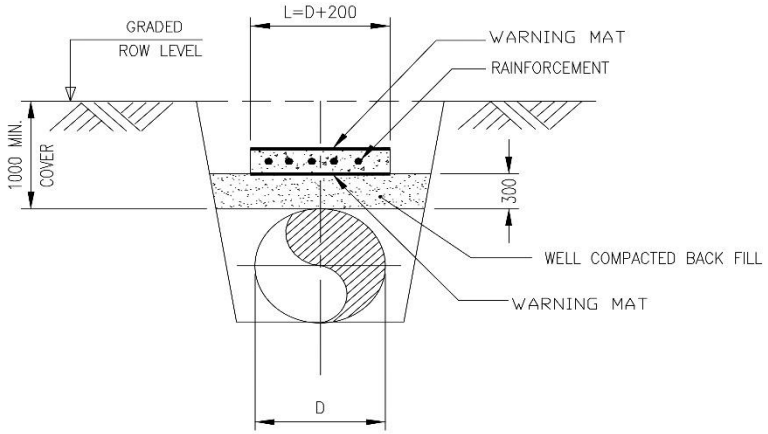
Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

Drawing No. REPL/CGD/STD/CSP-042

SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP/REPL/003/STPL**		**Date: 03/08/2023**

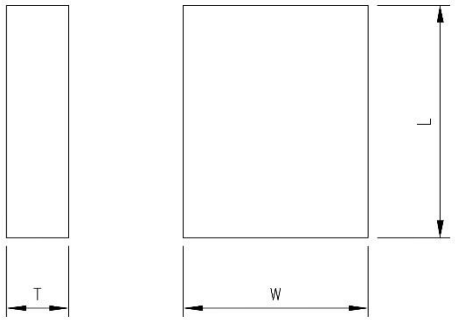
SLAB PROTECTION TO PIPELINE





SECTION A – A

DETAILS OF REINFORCED CONCRETE SLAB



T = 100 MIN.
L = D + 200
W = 500

COMPRESSIVE STRENGTH = M20 MINIMUM
WITH NORMAL STELL REINFORCEMENT.

NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. A MODIFIED PIPELLINE WARNING SIGN SHALL BE INSTALLED WHERE THE CONTINUOUS LAYER OF RCC CONCRETE SLAB ARE PLACED ON PIPELINE
3. CONCRETE SLAB SHALL BE INSTALLED ON WELL COMPACTED AND LEVEL SOIL
4. DISTANCE BETWEEN TWO CONCRETE SLAB SHALL BE MORE THAN 25 MM AT THE TIME PLACEMENT
5. DESIGN OF REINFORCEMENT &MANUFACTURING OF CONCRETE SLAB SHALL BE IN ACCORDANCE WITH RELEVANT STANDARD
6. TRENCH DIMENSION SHALL BE AS PER RELEVANT STANDARD
7. TO BE USED EITHER FOR LOCATION CLASS PROBLEM AND /OR MECHANICAL PROTECTION.

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

PROJECT: Glo-Djigbe Industrial Zone, Benin

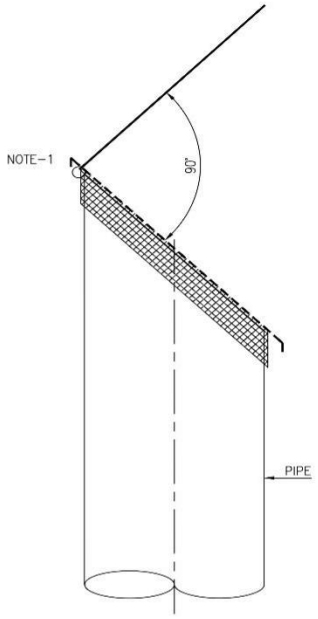
SUBJECT:
TYPICAL DRAWING FOR
SLAB PROTECTION TO PIPELINE

Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

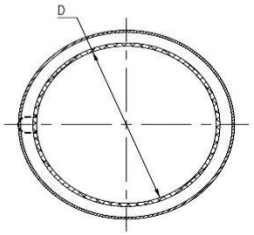
RESONANCE ENERGY PVT. LTD.

Drawing No. REPL/CGD/STD/CSP-043

SIPI	**Laying & construction of 12” NB X 30 km and 06” NB X 6 km (approx.) Sub Transmission Steel Pipeline Network & associated works from Maria Gleta to Glo-Djibe Industrial Zone, Benin.**	Resonance Energy
Tender Document No: **AIIP /REPL/003/STPL**		**Date: 03/08/2023**



ELEVATION



PLAN

NOTES:
1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. HINGE DETAILS TO BE DECIDED BY VENDOR.
3. MATERIAL OF CONSTRUCTION OF FLAP SHALL BE NON-SPARKING.
4. 1/2" CIRCULAR RING SHALL BE PROVIDED AROUND THE FLAP.
5. STOPPER TO BE PROVIDED SO THAT THE FLAPPER GOES BACK TO ITS ORIGINAL POSITION AFTER COMPLETION OF VENTING.

Rev.	D M Y	Status	Drawn	Checked	Approved
0	12.06.2023	Issued for Bid	VS	KM	VB

PROJECT: Glo-Djigbe Industrial Zone, Benin

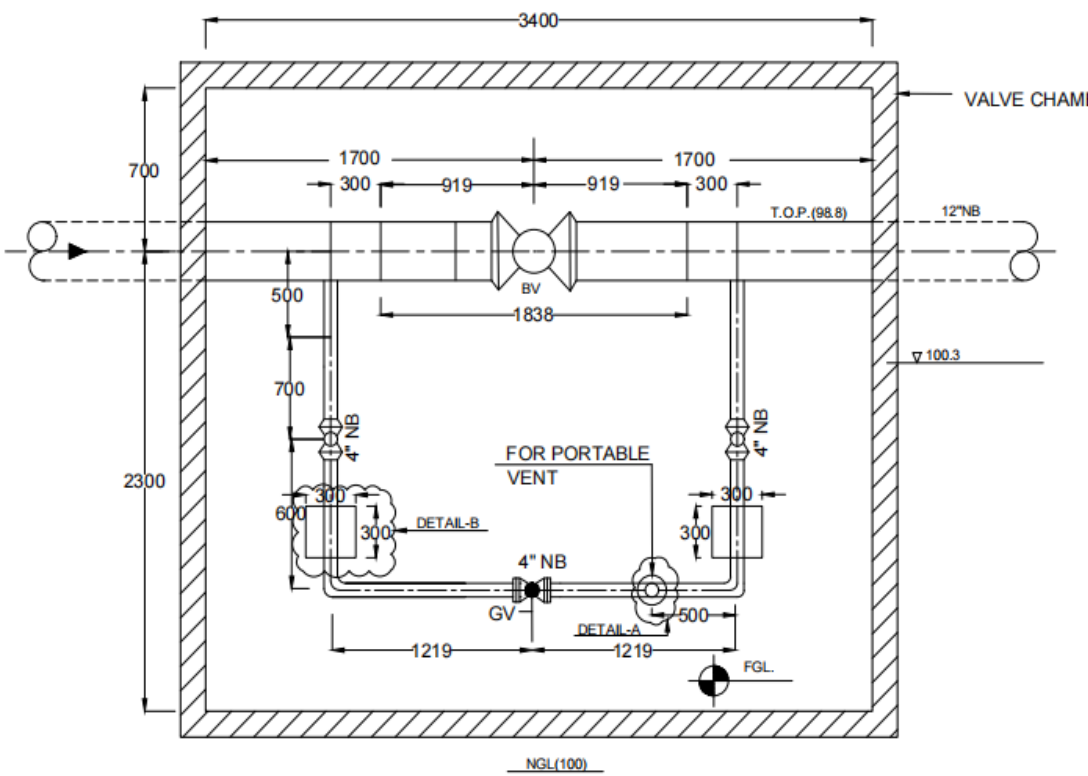
SUBJECT:

TYPICAL RAIN CAP FOR VENT PIPES

Size	Scale	Sheet	Rev.
A3	NTS	01 of 01	0

RESONANCE ENERGY PVT. LTD.

Drawing No. REPL/CGD/STD/CSP-044



NOTE

1.ALL DIMENSION ARE IN MM

LEGEND:-

- ABOVE GROUND
- UNDER GROUND
- BUTT WELD BALL VALVE
- BUTT WELD GLOBE VALVE (G.V)
- FLAGED GLOBE VALVE
- FLAGED BALL VALVE
- FINISHED GROUND LEVEL (FGL.)
- VALVE CHAMBER
- CENTER OF PIPE
- T.O.P. TOP OF PIPE
- RCC PIPE SUPPORT

Rev.	D.M.Y	STATUS	Drawn by	Checked by	Approved by
0	27/07/2023	Issued for Bid	AS	KM	VBS

PROJECT-GLO DJIGBE INDUSTRIAL ZONE
BENIN

GDIZ GLO DJIGBE INDUSTRIAL ZONE — BENIN —

SIPI

SUBJECT-PIPING GENERAL ARRANGEMENT DRAWING FOR SV STATION (TYPICAL FOR 12" NB PIPELINELINE) IN VALVE CHAMBER

Resonance Energy

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Size	Scale	Sheet	Rev.
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Drawing No: –REPL/CGD/STD/CSP–045